FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT

MILITARY MUNITIONS RESPONSE PROGRAM
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
PASSAGE KEY AIR-TO-GROUND GUNNERY RANGE
MANATEE COUNTY, FLORIDA

FUDS PROJECT NUMBER: I04FL040101

July 2018

Contract No.: W912DY-10-D-0025
Task Order No.: 0021

Prepared For:

U.S. ARMY CORPS OF ENGINEERS

Prepared By:

PIKA-PIRNIE JV, LLC
12723 Capricorn Drive, Suite 500
Stafford, Texas 77477

FINAL

REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT

MILITARY MUNITIONS RESPONSE PROGRAM
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
PASSAGE KEY AIR-TO-GROUND GUNNERY RANGE
MANATEE COUNTY, FLORIDA

FUDS PROJECT NUMBER: I04FL040101

Contract No.:	W912DY-10-D-0025
Task Order No.:	0021

I have reviewed this document and certify that it contains accurate content and is sufficient to guide project execution.

JV Program Manager
Shahrukh Kanga, P.E., PMP, CSP, CHMM

18 July 2018
Date

JV Deputy Program Manager

18 July 2018
Date

JV Corporate Quality Manager
Al Larkins

18 July 2018
Date

JV Project Manager
Susan Burtnett, PE, BCEE

18 July 2018
Date

SUSAN R. BURTNETT, P.E.
LICENSE
No. 70380
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS .... **III**
LIST OF APPENDICES .... **IX**
LIST OF TABLES .... **X**
LIST OF FIGURES .... **XI**
LIST OF ACRONYMS AND ABBREVIATIONS .... **XII**
EXECUTIVE SUMMARY **1**
1.0 INTRODUCTION **1-1**
1.1 PURPOSE 1-2
1.2 PROPERTY DESCRIPTION AND PROBLEM IDENTIFICATION 1-2
1.2.1 Project Location 1-2
1.2.2 Passage Key ATGGR Overview 1-2
1.2.3 Climate 1-3
1.2.4 Topography, Soils, and Vegetation 1-3
1.2.5 Geology 1-4
1.2.6 Hydrogeology 1-4
1.2.7 Natural Resources 1-5
1.2.7.1 Habitat Type 1-5
1.2.7.2 Ecological Receptors 1-5
1.2.7.3 Wetlands 1-6
1.2.8 Cultural and Archaeological Resources 1-6
1.2.9 Demographics 1-6
1.2.10 Current and Future Land Use 1-7
1.3 HISTORICAL INFORMATION 1-7
1.4 PREVIOUS INVESTIGATIONS 1-8
1.4.1 1993 Inventory Project Report (Initial) 1-8
1.4.2 2000 Inventory Project Report (Supplemental) 1-8
1.4.3 2002 Archives Search Report 1-9
1.4.4 2008 Site Inspection Report 1-9
1.4.5 Potential for Chemical Warfare Materiel Presence 1-9
1.5 REPORT ORGANIZATION 1-9
2.0 PROJECT REMEDIAL RESPONSE OBJECTIVES **2-1**
2.1 CONCEPTUAL SITE MODEL AND PROJECT APPROACH 2-1
2.1.1 Preliminary Conceptual Site Model 2-1
2.1.2 Project Approach 2-3
2.2 PRELIMINARY REMEDIAL ACTION OBJECTIVES 2-4
2.3 IDENTIFICATION OF POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS 2-6
2.3.1 Definition of Applicable or Relevant and Appropriate Requirements 2-6

2.3.2 Types of ARARs ... 2-7
2.3.3 Identification of ARARs ... 2-8
2.4 SUMMARY OF INSTITUTIONAL ANALYSIS ... 2-8
2.5 DATA NEEDS AND DATA QUALITY OBJECTIVES ... 2-8
2.5.1 Data Needs ... 2-8
2.5.2 Data Quality Objectives ... 2-11
3.0 CHARACTERIZATION OF MEC ... 3-1
3.1 GENERAL ... 3-1
3.1.1 Identification and Evaluation of Areas of Concern ... 3-1
3.1.2 Overview of MEC Investigation Field Activities ... 3-1
3.2 CHARACTERIZATION OF MEC ... 3-2
3.2.1 Task 1: Pre-Mobilization Activities ... 3-2
3.2.2 Task 2: Mobilization/Site Preparation Activities ... 3-2
3.2.2.1 Mobilization ... 3-2
3.2.2.2 On-Site Document Review and Communication/Logistics ... 3-2
3.2.2.3 Site-Specific Training ... 3-3
3.2.2.4 Vegetation Clearance and Surface Removal ... 3-3
3.2.2.5 Location Surveys and Mapping ... 3-3
3.2.3 Task 3: Geophysical System Verification ... 3-4
3.2.3.1 Introduction ... 3-4
3.2.3.2 Marine IVS Design and Results ... 3-4
3.2.3.3 Blind Seeding ... 3-4
3.2.4 Task 4: DGM Surveys ... 3-5
3.2.4.1 Geophysical Equipment ... 3-5
3.2.4.2 Survey Types ... 3-6
3.2.4.3 Data Processing ... 3-7
3.2.4.4 Quality Control ... 3-8
3.2.4.5 Data Management ... 3-8
3.2.4.6 Anomaly Selection ... 3-8
3.2.4.7 Dig Sheet Development ... 3-10
3.2.5 Task 6: Geostatistical Analysis ... 3-11
3.2.6 Task 7: Anomaly Reacquisition ... 3-11
3.2.7 Task 8: MEC Removal and Management ... 3-12
3.2.7.1 Excavation Procedures ... 3-12
3.2.7.2 Munitions with the Greatest Fragmentation Distance ... 3-13
3.2.7.3 Minimum Separation Distance ... 3-13
3.2.7.4 Exclusion Zone ... 3-13
3.2.7.5 Identification and Removal ... 3-13
3.2.7.6 Inspection of Material Potentially Presenting an Explosive Hazard ... 3-14
3.2.7.7 Material Documented As Safe ... 3-14
3.2.7.8 Munitions and Explosives of Concern Treatment ... 3-14
3.2.8 Task 9: Anomaly Resolution ... 3-14
3.2.9 Task 10: Demobilization ... 3-15

3.2.10 Task 11: Final Report 3-15
3.3 CHARACTERIZATION OF MC 3-15
3.4 DEVIATIONS FROM THE FINAL QAPP 3-15
4.0 REVISED CONCEPTUAL SITE MODEL AND REMEDIAL INVESTIGATION RESULTS 4-1
4.1 MUNITIONS AND EXPLOSIVES OF CONCERN FINDINGS 4-1
4.1.1 Marine Environment Geophysical Results 4-1
4.1.1.1 Marine DGM Transect Survey 4-1
4.1.1.2 Marine DGM Grid Survey 4-2
4.1.1.3 Analog Transects 4-3
4.1.2 Quality Control for Geophysical Surveys 4-3
4.1.2.1 Daily Field Activity Records 4-7
4.1.2.2 Daily QC Reports 4-7
4.1.3 Intrusive Investigation Results 4-7
4.1.3.1 Marine Investigation 4-7
4.1.4 Source, Nature, and Extent of Munitions at Passage Key ATGGR 4-9
4.1.5 Data Usability Assessment 4-10
4.1.6 Remedial Investigation Field Activities Documentation 4-10
4.2 REVISED CONCEPTUAL SITE MODEL 4-11
4.2.1 Munitions and Explosives of Concern Exposure Pathway Analysis 4-11
4.2.1.1 Source 4-11
4.2.1.2 Access 4-11
4.2.1.3 Activity 4-12
4.2.1.4 Receptors 4-12
4.2.2 Munitions and Explosives of Concern Exposure Conclusions 4-12
4.2.3 Munitions Constituents Exposure Pathway Analysis 4-14
4.2.3.1 Source 4-14
4.2.3.2 Access 4-14
4.2.3.3 Activity 4-14
4.2.3.4 Receptors 4-14
4.2.4 Munitions Constituents Exposure Pathway Conclusions 4-14
5.0 CONTAMINANT FATE AND TRANSPORT FOR MEC /MC 5-1
5.1 FATE AND TRANSPORT DYNAMICS 5-1
5.1.1 MEC Fate and Transport Mechanisms 5-1
5.1.2 MC Fate and Transport Mechanisms 5-1
5.2 PASSAGE KEY AIR-TO-GROUND GUNNERY RANGE 5-2
5.2.1 Munitions and Explosives of Concern 5-2
5.2.2 Munitions Constituents 5-3
6.0 HAZARD ASSESSMENT FOR UXO/DMM/MC 6-1
6.1 MEC HAZARD ASSESSMENT GENERAL 6-1
6.1.1 MEC Hazard Assessment Components 6-2
6.1.1.1 Severity 6-2
6.1.1.2 Accessibility 6-3

6.1.1.3 Sensitivity 6-4
6.1.2 Site-Specific MEC Risk Assessment 6-5
6.1.3 Baseline Scoring Results 6-6
6.1.4 Munitions and Explosives of Concern Qualitative Hazard and Risk Assessments 6-7
6.1.4.1 Passage Key ATGGR Qualitative MEC Hazard Assessment 6-7
6.1.4.2 Passage Key ATGGR Qualitative MEC Risk Assessment 6-7
6.2 MUNITIONS RESPONSE SITE PRIORITIZATION PROTOCOL 6-8
6.3 RISK ASSESSMENT FOR MUNITIONS CONSTITUENTS 6-8
7.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES FOR MEC AND MC 7-1
7.1 REMEDIAL ACTION OBJECTIVES 7-1
7.1.1 Identification of Applicable or Relevant and Appropriate Requirements 7-2
7.2 GENERAL RESPONSE ACTIONS 7-2
7.2.1 Land Use Controls 7-3
7.2.2 Surface Removal 7-3
7.2.3 Subsurface Removal 7-4
7.3 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES 7-4
7.3.1 Identification and Screening of MEC Technologies 7-4
7.3.2 Evaluation of Technologies 7-5
7.3.2.1 Detection Technologies 7-5
7.3.2.2 Recovery Technologies 7-6
7.3.2.3 Treatment Technologies 7-6
7.3.3 Screening of Technologies 7-6
8.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES 8-1
8.1 DEVELOPMENT OF ALTERNATIVES 8-1
8.1.1 Alternative 1: No Action 8-2
8.1.2 Alternative 2: Land Use Controls 8-2
8.1.3 Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas 8-4
8.1.4 Alternative 4: Complete Surface and Subsurface Clearance – Entire Site 8-5
8.2 SCREENING OF INDIVIDUAL ALTERNATIVES 8-5
9.0 DETAILED ANALYSIS OF ALTERNATIVES 9-1
9.1 INTRODUCTION 9-1
9.2 NCP CRITERIA CATEGORIES 9-1
9.2.1 Definitions of NCP Criteria 9-2
9.2.1.1 Overall Protection of Human Health and the Environment 9-2
9.2.1.2 Compliance with ARARs 9-2
9.2.1.3 Long-Term Effectiveness and Permanence 9-2

9.2.1.4 Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment 9-2
9.2.1.5 Short-Term Effectiveness 9-2
9.2.1.6 Implementability 9-3
9.2.1.7 Cost 9-3
9.2.1.8 State Acceptance 9-3
9.2.1.9 Community Acceptance 9-3
9.3 INDIVIDUAL ANALYSIS OF ALTERNATIVES 9-3
9.3.1 Alternative 1: No Action 9-3
9.3.1.1 Threshold Criteria 9-3
9.3.1.2 Balancing Criteria 9-4
9.3.1.3 Modifying Criteria 9-4
9.3.2 Alternative 2: Land Use Controls 9-4
9.3.2.1 Threshold Criteria 9-4
9.3.2.2 Balancing Criteria 9-4
9.3.2.3 Modifying Criteria 9-5
9.3.3 Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas 9-5
9.3.3.1 Threshold Criteria 9-5
9.3.3.2 Balancing Criteria 9-6
9.3.3.3 Modifying Criteria 9-6
9.3.4 Alternative 4: Complete Surface and Subsurface Clearance – Entire Site 9-6
9.3.4.1 Threshold Criteria 9-7
9.3.4.2 Balancing Criteria 9-7
9.3.4.3 Modifying Criteria 9-7
9.4 COMPARATIVE ANALYSIS OF ALTERNATIVES 9-10
9.4.1 Protectiveness 9-10
9.4.2 Compliance with ARARs 9-11
9.4.3 Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment 9-11
9.4.4 Short-Term Effectiveness 9-12
9.4.5 Long-Term Effectiveness 9-12
9.4.6 Implementability 9-12
9.4.7 Cost 9-13
9.4.8 State and Community Effectiveness 9-13
9.4.9 Comparative Benefit Determination 9-13
10.0 SUMMARY OF RESULTS 10-1
10.1 RI FIELD WORK SUMMARY 10-1
10.1.1 Nature and Extent of MEC 10-1
10.1.2 Nature and Extent of MC Contamination 10-2
10.1.3 Fate and Transport 10-2
10.1.4 MEC Hazard Characterization and Qualitative Risk Assessment 10-3
10.1.5 MC Risk Characterization 10-3
10.2 RI RECOMMENDATIONS 10-3
10.3 FS FINDINGS 10-4

10.3.1 Comparative Analysis of FS Alternatives... 10-5
11.0 REFERENCES.. 11-1

LIST OF APPENDICES

APPENDIX A	**PERFORMANCE WORK STATEMENT**
APPENDIX B	**SITE MAPS**
APPENDIX C	**TECHNICAL PROJECT PLANNING MEETING MEMORANDUM**
APPENDIX D	**INSTITUTIONAL ANALYSIS REPORT**
APPENDIX E	**DAILY REPORTS, FIELD FORMS, AND AFTER ACTION REPORT**
APPENDIX F	**DIGITAL GEOPHYSICAL MAPPING REPORTS AND MEMORANDUMS**
APPENDIX G	**DIGITAL GEOPHYSICAL MAPPING AND ANALOG DATA**
APPENDIX H	**PHOTOGRAPH LOG**
APPENDIX I	**MUNITIONS DEBRIS FORM 1348-1A AND EXPLOSIVES ACCOUNTABILITY RECORDS**
APPENDIX J	**MEC HAZARD ASSESSMENT**
APPENDIX K	**COST ESTIMATE**
APPENDIX L	**POST-RI/FS GEOGRAPHIC INFORMATION SYSTEM DATA DELIVERABLE**

LIST OF TABLES

Title **Page**

Table ES-1: Remedial Alternatives Evaluated ES-5

Table ES-2: Summary of Comparative Analysis ES-9

Table 1-1: Federal and State Listed Threatened and Endangered Species in Manatee County 1-5

Table 2-1: Passage Key ATGGR Preliminary CSM 2-1

Table 2-2: Decision Rules 2-11

Table 2-3: Data Quality Objectives 2-12

Table 3-1: Passage Key ATGGR Temporary Control Monuments 3-3

Table 3-2: Summary of Survey Investigations 3-6

Table 3-3: Initial Anomaly Prioritization for DGM Transects in Elevated Anomaly Density Areas 3-9

Table 4-1: NCMUA VSP MEC Density Analysis 4-3

Table 4-2: Analog QC Results 4-4

Table 4-3: Marine DGM QC Results 4-5

Table 4-4: Intrusive Investigation Results Summary 4-7

Table 4-5: Munitions Related Findings 4-10

Table 6-1: Summary of the MEC HA Levels 6-2

Table 6-2: Passage Key ATGGR MEC HA Input Factor and Scores 6-5

Table 6-3: MEC HA Baseline Hazard Level Score 6-6

Table 7-1: Preliminary Remediation Goals Evaluated for Passage Key ATGGR 7-1

Table 7-2: ARARs at Passage Key ATGGR 7-2

Table 7-3: Technology Screening Matrix 7-7

Table 8-1: Remedial Alternatives Evaluated for Passage Key ATGGR 8-1

Table 9-1: NCP Criteria for Passage Key ATGGR 9-8

Table 9-2: Remedial Action Cost Estimates 9-10

Table 9-3: MEC HA Evaluation (Baseline versus Remedial Alternatives) 9-11

Table 10-1: Summary of Survey Investigations 10-1

Table 10-2: Summary of Anomalies Selected for Intrusive Investigation 10-2

Table 10-3: Summary of Comparative Analysis 10-6

LIST OF FIGURES

Title		**Page**
Figure 4-1:	MEC Conceptual Site Exposure Model	4-15
Figure 8-1:	Passage Key Signs at Anna Maria Island	8-3
Figure 8-2:	Passage Key Signs at Anna Maria Island	8-3

LIST OF ACRONYMS AND ABBREVIATIONS

3Dg	3D Geophysics, Inc.
AAR	After Action Report
APP	Accident Prevention Plan
ARAR	Applicable or Relevant and Appropriate Requirements
ASR	Archives Search Report
ATGGR	Air-to-Ground Gunnery Range
BCEE	Board Certified Environmental Engineer
BIP	Blow-in-Place
BSI	Blind Seed Item
CD	Compact Disc
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CESAJ	United States Army Corps of Engineers, Jacksonville District
CFR	Code of Federal Regulations
CHE	Chemical Warfare Materiel Hazard Evaluation
ChE	Early Gate
ChL	Late Gate
cm	centimeter
CMUA	Concentrated Munitions Use Area
CSM	Conceptual Site Model
CWM	Chemical Warfare Materiel
DA	Department of the Army
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DGPS	Differential Global Positioning System
DID	Data Item Description
DoD	Department of Defense
DOI	Department of Interior
DQCR	Data Quality Control Report
DQO	Data Quality Objective

DU	Decision Unit
DVD	Digital Versatile Disc
EHE	Explosive Hazard Evaluation
EM	Engineer Manual or Electromagnetic
EM CX	Environmental and Munitions Center of Expertise (at U.S. Army Engineer and Support Center, Huntsville)
EMI	Electromagnetic Induction
EOD	Explosive Ordnance Disposal
EP	Engineer Pamphlet
ER	Engineer Regulation
ESP	Explosives Site Plan
ESQD	Explosive Safety-Quantity Distance
ESRI	Environmental Systems Research Institute
ESTCP	Environmental Security Technology Certification Program
EZ	Exclusion Zone
^{o}F	Degrees Fahrenheit
FCR	Field Change Request
FDEP	Florida Department of Environmental Protection
FL	Florida
FFWCC	Florida Fish and Wildlife Conservation Commission
FNAI	Florida Natural Areas Inventory
FS	Feasibility Study
FUDS	Formerly Used Defense Site
GIS	Geographic Information System
GPS	Global Positioning System
GSV	Geophysical System Verification
HAWID	Half Amplitude Width
HE	High Explosive
HFD	Hazardous Fragment Distance
HHE	Human Health Evaluation
HHRA	Human Health Risk Assessment
HP	High Powered

IAW	In Accordance With
ID	Identification
IGD	Interim Guidance Document
INPR	Inventory Project Report
ISOs	Industry Standard Objects
ITS	Instrument Test Strip
IVS	Instrument Verification Strip
JV	Joint Venture (PIKA-Pirnie JV, LLC)
lb	pound
LTM	Long-Term Management
LUC	Land Use Control
MC	Munitions Constituents
MD	Munitions Debris
MDEH	Material Documented as an Explosive Hazard
MEC	Munitions and Explosives of Concern
MEC HA	MEC Hazard Assessment
MGFD	Munitions with the Greatest Fragmentation Distance
mm	millimeters
MMRP	Military Munitions Response Program
mph	miles per hour
MPC	Measurement Performance Criteria
MPPEH	Material Potentially Presenting an Explosive Hazard
MR	Munitions Response
MRA	Munitions Response Area
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
MSD	Minimum Separation Distance
mV	millivolt
NA	Not Applicable
NAD83	North American Datum of 1983
NAEVA	NAEVA Geophysics, Incorporated
NCMUA	Non-Concentrated Munitions Use Area

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OESS	Ordnance and Explosives Safety Specialist
OSHA	Occupational Safety and Health Administration
PE	Professional Engineer
PLS	Professional Land Surveyor
PMP	Project Management Professional
PRG	Preliminary Remediation Goal
PVC	polyvinyl chloride
PWS	Performance Work Statement
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAO	Remedial Action Objective
RCA	Root Cause Analysis
RI	Remedial Investigation
RTK	Real Time Kinematic
SDSFIE	Spatial Data Standards for Facilities, Infrastructure, and Environment
SI	Site Inspection
SLERA	Screening Level Ecological Risk Assessment
SSI	SubSurface Instruments, Incorporated
SSS	Side-Scan Sonar
SUXOS	Senior Unexploded Ordnance Supervisor
TM	Technical Manual
TO	Task Order
TOI	Target of Interest
TP	Target Practice or Technical Paper
TPP	Technical Project Planning
TSD	Team Separation Distance
UFP	Uniform Federal Policy
U.S.	United States
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering and Support Center – Huntsville

USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UUTA	Underwater UXO Towed Array
UXO	Unexploded Ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
UXOTI	Unexploded Ordnance Technician I
UXOTII	Unexploded Ordnance Technician II
UXOTIII	Unexploded Ordnance Technician III
VSP	Visual Sample Plan
WERS	Worldwide Environmental Remediation Services
WWII	World War II
%	Percent

EXECUTIVE SUMMARY

This Remedial Investigation (RI)/Feasibility Study (FS) Report has been prepared on behalf of the United States Army Corps of Engineers (USACE) to further remedial activities under the Military Munitions Response Program (MMRP) at the former Passage Key Air-to-Ground Gunnery Range (hereafter referred to as Passage Key ATGGR) located in Manatee County, Florida (FL). By completing the RI/FS, the USACE is in compliance with the Defense Environmental Restoration Program (DERP) statute (10 USC 2701 et seq.), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended (42 USC § 9601 et seq.,), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This RI/FS Report is consistent with the United States Environmental Protection Agency (USEPA) *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988) and the United States Army Engineering and Support Center, Huntsville (USAESCH) Data Item Description (DID) Worldwide Environmental Remediation Services (WERS)-010.01 (2010). All work has been prepared in accordance with (IAW) procedures developed in the Final RI/FS Uniform Federal Policy (UFP) – Quality Assurance Project Plan (QAPP) (JV, 2015) except for one field change that was required based on site conditions. All work was also conducted IAW the USACE, Department of the Army, and Department of Defense (DoD) requirements (listed below) regarding personnel, equipment, and procedures.

ES 1.1 OBJECTIVE

The objective of the RI was to characterize the nature and extent of munitions and explosives of concern (MEC) at Passage Key ATGGR meeting the requirements of the following guidance documents:

- WERS Contract No. W912DY-10-D-0025, TO 0021, *Remedial Investigation/Feasibility Study for the Passage Key Air-to-Ground Gunnery Range, Manatee County, Florida.* Performance Work Statement (USACE, 2014).
- Environmental and Munitions Center of Expertise (EM CX) Engineer Manual (EM) 200-1-15 - *Technical Guidance for Military Munitions Response Actions* (USACE, 2015);
- Engineer Regulation (ER) 200-3-1 – *Environmental Quality Formerly Used Defense Sites (FUDS) Program Policy* (USACE, 2004); and
- *Munitions Response Remedial Investigation/Feasibility Study Guidance* [United States (U.S.) Army, 2009].

The primary goal of the RI was to collect the appropriate amount of information to determine if there is an unacceptable risk to human health, safety, and the environment arising from MEC.

ES 1.2 REMEDIAL INVESTIGATION FIELD WORK SUMMARY

The PIKA-Pirnie JV, LLC (hereafter referred to as the JV), with subcontractors, conducted RI activities from 2 November 2015 through 15 December 2015 IAW the Final RI/ FS QAPP (JV, 2015b) and one field change required due to site conditions. The JV has prepared this RI/FS Report to describe the methods and results of the RI activities conducted at the former Passage Key ATGGR, which is comprised of 13,147.72 acres. The area that is the focus of the RI/FS includes approximately 649 acres and consists of the former bombing range safety fan. The RI/FS Investigation Area includes the area used in conjunction with the range as the bombing and strafing target where munitions use has been confirmed based on the RI findings. The remaining area (i.e., 12,498.72 acres) consists of the safety fan for the gunnery range. This area served as a buffer area for the Passage Key ATGGR; no targets are known to have existed in this area and no munitions have been found in this area.

To accomplish the site characterization goals, the following tasks were conducted:

- Geophysical Systems Verification (GSV), including an Instrument Verification Strip (IVS), Instrument Test Strip (ITS) and blind seeding program;
- Geophysical investigation;
- Intrusive investigation;
- Conceptual site model updates; and
- Reporting.

For the RI, digital geophysical mapping (DGM) and analog surveys were conducted within the RI/FS Investigation Area at the Passage Key ATGGR. The geophysical investigation was delineated into land and marine components, which required different methods of technology implementation due to the varying site conditions. The geophysical investigation involved the following:

- DGM transect and grid surveys in the marine environment; and
- Analog (i.e., mag and dig) transect surveys on the land (i.e., sand bar) and in the nearshore environment

The geophysical team conducted the marine geophysical investigation using a high-power EM61-Flex3 metal detector mounted on an underwater towed array deployment platform. Data were collected with the sensor along transects and within discrete grids. Analog surveys in areas inaccessible to the marine geophysical equipment (i.e., on land and in the nearshore environment adjacent to the key) were also conducted. The geophysical surveys, in total, covered approximately 16.4 acres of the marine environment and the sand bar at Passage Key ATGGR. The DGM and analog transect surveys covered approximately 11.4 acres (or 14.6 miles) and DGM grids covered approximately 5.02 acres.

The geophysical team used a Global Positioning System (GPS) receiver to reacquire each anomaly selected for intrusive investigation. A total of 192 DGM and 20 analog anomalies were selected for intrusive investigation. Four unexploded ordnance (UXO) items were found at the site. All investigated anomalies were identified as UXO, munitions debris (MD), small arms ammunition, seed items, scrap metal, other, no find, or false positives (i.e., no contact or anomalies deeper than four feet). The RI transect and grid data confirmed used of the target, with the only concentrated munitions use area (CMUA) identified at the historical 1940s location of Passage Key ATGGR (where the target banks were constructed and maintained). This CMUA, identified as Target Area 1, has a total area of 198.5 acres.

The four UXO items found included a fuzed 37-millimeter (mm) projectile, a 4.5-inch aerial rocket, and two bomb burster/fuzes from 100-lb photoflash bombs at depths ranging from six and 36 inches below the sediment surface in water approximately five to fifteen feet deep. The 4.5-inch aerial rocket could not be confirmed as practice and, therefore, it was treated as a high explosive (HE) rocket. Numerous MD associated with aerial rockets, photoflash bombs, and practice bombs were identified, inspected, and documented as safe during the RI field activities. These findings confirm previous site documentation that indicated that these were the primary munitions types used at the Passage Key ATGGR. A large amount of non-munitions-related scrap metal (i.e., nails, wire, metal pipe) was also found during the intrusive investigation at Passage Key ATGGR. MD and scrap metal were inspected and certified as free from explosives as outlined in the Final RI/FS QAPP.

Due to dynamic coastal environment at the site and lack of a source of MC, no MC sampling was conducted during the RI.

ES 1.3 CONCEPTUAL SITE MODEL, MUNITIONS RESPONSE SITE PRIORITIZATION PROTOCOL, MUNITIONS AND EXPLOSIVES OF CONCERN HAZARD ASSESSMENT, AND HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT RESULTS

The MEC pathway analysis for the Passage Key ATGGR indicates that there are potentially complete exposure pathways for human and ecological receptors based on the results of the RI field work and historical information/previous investigations. While no indication of MEC presence was found on the ground surface at the current location of Passage Key, the dynamic marine environment creates the potential for MEC to either be uncovered or to move during storms, with strong currents, and with shifting sands. As such, MEC could be potentially be exposed in more accessible areas in the future. There are potentially complete exposure pathways via handle/tread underfoot contact (surface), as well as via work that may be conducted on the ground surface. Potentially complete exposure pathways are identified in the subsurface and in sediment (underwater) for human receptors, such as outdoor site workers who may perform intrusive work and recreational users who may visit the site and disturb subsurface soil or sediment. A complete exposure pathway was not identified because the locations where the MEC items were found are not used by receptors since these locations are east of the current location of Passage Key and the area surrounding the key where boats temporarily anchor. Additionally, all MEC items identified to date have been detonated and/or removed from the site. The subsurface pathway is also potentially complete for biota that may nest or burrow, however, the potential for biota to disturb MEC items is low and, therefore, the risk negligible.

Due to the lack of a MC source area, exposure pathways are all considered incomplete for human and ecological receptors. As a result, a human health risk assessment and screening level ecological risk assessment were not conducted per the MC data quality objectives and further evaluation of MC remedial alternatives is not warranted.

A MEC Hazard Assessment (MEC HA) and a Munitions Response Site Prioritization Protocol (MRSPP) were developed for the Passage Key ATGGR. The MEC HA is discussed in Sections 6 and 9 of the RI/FS Report where details regarding the hazard assessment are provided, as well as comparison of the reduction in relative scores for the remedial alternatives evaluated in the FS). Because the MRSPP is subject to an independent review and may be changed after the RI/FS Report is final, it was prepared as a separate document from the RI/FS Report.

A qualitative evaluation of unacceptable risk was also performed based on the RI findings. Based on the types of MEC found at the site, their relative low sensitivity for detonation, the limited quantity found that is consistent with the short historical use of the site (for only a few years during WWII), the inaccessibility of MEC found underwater and in the sediment, as well as the infrequent use of the area (i.e., Target Area 1) by receptors indicate that the likelihood of encounter is low and the risk to receptors from MEC minimal. However, given the potential for MEC items to become exposed due to storms or other mechanisms, the risk to receptors remains unacceptable without implementation of remedial alternatives, as presented and discussed in the FS.

ES 1.4 Feasibility Study

ES 1.4.1 The following remedial alternatives, summarized in **Table ES-1,** were developed and analyzed as part of the FS to offer a range of remedial approaches as required by CERCLA guidance.

Table ES-1: Remedial Alternatives Evaluated

Alternative	Description
Alternative 1: No Action	The NCP requires a No Action alternative to be evaluated. • No further effort or resources would be expended by USACE • No changes to the existing conditions or USFWS restrictions, if already in place, would occur

Alternative	Description
Alternative 2: LUCs	Administrative controls would be put in place to discourage access and provide education to the public about the former ATGGR training activities. • Signage regarding the WWII historical use and that munitions may remain at Passage Key and surrounding waters from those training activities would be placed at the public park on Anna Maria Island where there is existing information regarding the key. • Administrative controls would include public education materials, as well as incorporating a note on the National Oceanic and Atmospheric Administration (NOAA) chart and/or a Notice to Mariners through the United States Coast Guard (USCG) to reflect the potential hazard for UXO. A Long-Term Management plan would be required to identify LUC enforcement actions, inspect LUCs, and provide/update education materials on a periodic basis.
Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas	Limited surface and subsurface removal would be conducted in the high anomaly density area (i.e., Target Area 1 or 198.5 acres) of the RI/FS Investigation Area, which includes portions of the sand bar. • Clearance would be conducted to a maximum depth of 5 feet below ground surface (maximum depth of 4 feet detected during the RI plus 1 foot for buffer). • Public access to the key and surrounding water would be restricted during clearance activities. • Protected species (i.e., threatened and endangered species) and sensitive habitats, if present in the area where the clearance is planned, might be impacted depending on the time of year when activities take place and whether avoidance and/or mitigation measures are implemented. • LUCs would be implemented consistent with Alternative 2.
Alternative 4: Complete Surface and Subsurface Clearance – Entire Site	Complete surface and subsurface removal would be conducted over the entire RI/FS Investigation Area. • Clearance over 100 percent of the site to a maximum depth of five feet below ground surface (maximum depth of four feet investigated during the RI plus one foot for buffer). • Public access to the key and surrounding water would be restricted during clearance activities. • Protected species (i.e., threatened and endangered species) and sensitive habitats, if present, might be significantly impacted depending on the time of year when activities take place and whether avoidance and/or mitigation measures are implemented.

ES 1.4.2 IAW ER 200-3-1, innovative technologies were considered during development of the FS. These included advanced classification as part of the subsurface removal alternatives, as well as newly developed acoustical sensors for use in the marine environment. However, neither technology was found to be as cost effective as those used in conjunction with traditional subsurface clearance methods.

ES 1.5 COMPARATIVE ANALYSIS OF ALTERNATIVES

The No Action alternative (Alternative 1) is not protective of human health since it does not mitigate the potential hazard associated with MEC. The No Action alternative is readily implementable since it requires no actions and has no associated costs. The LUC alternative (Alternative 2) provides overall protectiveness, is effective and, while it requires more action to implement than Alternative 1, it is more readily implementable than both the surface and subsurface clearance alternatives (Alternative 3 and 4). The LUC alternative is more expensive than the No Action alternative, but substantially less costly than Alternatives 3 and 4. Alternative 3 is protective of human health and has greater long-term effectiveness than Alternative 1 and 2. There is moderate short-term explosive hazards associated with the removal of MEC during Alternative 3. There are potential marine environment disturbances and natural resource impacts related to Alternative 3 if avoidance and/or mitigation measures are not used, which makes it less implementable than either the No Action or LUC alternatives. Alternative 3 is substantially more costly than the No Action and LUC alternatives, but less costly than Alternative 4. Alternative 4 provides protectiveness of human health through the greatest potential reduction in MEC, but requires significantly more natural resource impacts than the other alternatives if mitigation measures are not used. Alternative 4 provides the most long-term effectiveness of all the alternatives and has potentially the most short-term explosive hazards associated with the removal of MEC. Alternative 4 is the least implementable of all four alternatives because of the potential marine environment disturbances and natural resource impacts that will require more mitigation measures. Alternative 4 is significantly more costly than any of the other three alternatives. A summary of the comparative analysis for the FS alternatives against the NCP criteria is presented in **Table ES-2**.

Table ES-2: Summary of Comparative Analysis

Alternatives	Threshold Criteria		Primary Balancing Criteria				
	Overall Protectiveness	**Complies with ARARs**	**Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment**	**Short-Term Effectiveness**	**Long-Term Effectiveness**	**Implementability**	**Cost**
Alternative 1: No Action	Not protective of human health and the environment	Complies	No Reduction	Low Short-Term Hazards	Not Effective	Readily Implementable	$0
Alternative 2: LUCs	Protective of human health and the environment	Complies	No Reduction	Low Short-Term Hazards (*from Installing Signs and Public Awareness*)	Effective	Readily Implementable	$$
Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas	Protective of human health and the environment (*localized natural resource impacts during clearance activities are possible if mitigation measures are not implemented*)	Complies	Some Reduction	Moderate Short-Term Hazards (*from Munitions Removal in High Anomaly Density Areas*)	More Effective	Moderately Implementable (*with natural resource impacts possible if mitigation measures are not implemented*)	$$$$
Alternative 4: Complete Surface and Subsurface Clearance - Entire Site	Protective of human health and the environment (*significant natural resource impacts during clearance activities are possible if mitigation measures are not implemented*)	Complies	Greatest Reduction	Greatest Short-Term Hazards (*from Munitions Removal*)	Most Effective	Least Implementable (*with significant natural resource impacts if mitigation measures are not implemented*)	$$$$$

Threshold criteria are pass or fail and, as such, is not graded with the color system.	Most Desirable	Significantly Desirable	Moderately Desirable	Least Desirable

Contract No. W912DY-10-D-0025, TO 0021
July 2018

1.0 INTRODUCTION

1.0.1 The PIKA-Pirnie JV, LLC[1] (hereafter referred to as the JV) prepared this Remedial Investigation (RI)/Feasibility Study (FS) Report on behalf of the United States Army Corps of Engineers (USACE) to further remedial activities under the Military Munitions Response Program (MMRP) at the Passage Key Air-to-Gunnery Range (hereafter referred to as Passage Key ATGGR), located in Manatee County, Florida (FL). Passage Key ATGGR is a Formerly Used Defense Site (FUDS) with designated FUDS project number I04FL040101. The FUDS Program is overseen by the USACE. This RI/FS Report is consistent with the United States Environmental Protection Agency (USEPA) *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988) and the United States Army Engineering and Support Center, Huntsville (USAESCH) Data Item Description (DID) Worldwide Environmental Remediation Services (WERS)-010.01 (2010), and it has been prepared in accordance with (IAW) the Environmental and Munitions Center of Expertise (EM CX) Engineer Manual (EM) 200-1-15 – Technical Guidance for Military Munitions Response Actions (USACE, 2015), Engineer Regulation (ER) 200-3-1 – Environmental Quality FUDS Program Policy (USACE, 2004), and *Munitions Response Remedial Investigation/Feasibility Study Guidance* [United States (U.S.) Army, 2009]. All work was conducted IAW the field investigation procedures further developed in the Final RI/FS Uniform Federal Policy (UFP) – Quality Assurance Project Plan (QAPP) for Passage Key ATGGR (USACE, 2015) except for one field change that was required based on site conditions (see Section 3.4 of this RI/FS Report).

1.0.2 The JV performed this RI/FS under USAESCH WERS Contract W912DY-10-D-0025, Task Order (TO) 0021. This TO was issued and is being administered by USAESCH. USACE, Jacksonville District (CESAJ) provides overall project management, stakeholder coordination, as well as regional support. The work required under the Performance Work Statement (PWS) (provided in **Appendix A**) falls under the Defense Environmental Restoration Program (DERP) – FUDS Program. All activities regarding personnel, equipment, and procedures in areas potentially containing munitions and explosives of concern (MEC) hazards were conducted consistent with requirements of the USAESCH, USACE, Department of the Army (DA), and

[1] The JV is comprised of protégé firm PIKA International, Incorporated (Inc.) and its mentor ARCADIS-US, Inc. (formerly Malcolm Pirnie, Inc.).

Department of Defense (DoD). In addition, 29 Code of Federal Regulations (CFR) 1910.120 also applies to all actions taken at this site. The Passage Key ATGGR environmental restoration activities, including munitions response, were performed under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and pursuant to ER 200-3-1, dated 10 May 2004.

1.1 PURPOSE

1.1.1 The overall goal of the RI is to gather sufficient information to characterize the nature and extent of MEC, including unexploded ordnance (UXO) and discarded military munitions (DMM), and to assess the potential hazards to human health, safety, and the environment from MEC. Since a concentrated source of munitions does not exist at the site based on previously documented information, munitions constituent (MC) sampling was not conducted as part of this RI/FS.

1.1.2 The overall goal of the FS is to develop remedial action alternatives to reduce the unacceptable risk to an acceptable level while meeting the respective remedial objectives. As such, the FS is designed to develop an appropriate range of potential alternatives to manage the hazards identified during the RI, evaluate those alternatives using the nine NCP criteria, and, then, perform a comparative analysis of the alternatives.

1.2 PROPERTY DESCRIPTION AND PROBLEM IDENTIFICATION

The following sections provide site description, environmental, and climatic information for the Passage Key ATGGR.

1.2.1 Project Location

The project site is located approximately 10 miles northwest of downtown Bradenton, FL, one mile north of Anna Maria Island, and 1.35 miles south of Egmont Key in Manatee County at the entrance to the Tampa Bay from the Gulf of Mexico (see **Map B-1** in **Appendix B**).

1.2.2 Passage Key ATGGR Overview

Passage Key, which is only accessible by boat, is a meandering barrier island surrounded by the waters of the Gulf of Mexico and Tampa Bay. Although once much larger, the key today consists of a small sand bar with limited vegetation. The water surrounding the sand bar is very shallow, with depths of just one to two feet (ft). Passage Key is closed to all public use due to its small size, importance to wildlife, and designation as a National Wildlife Refuge. However, there are limited signs noting that access is prohibited and no fences to restrict access and, as such, the key and surrounding waters are routinely used by the public for swimming, boating and fishing. Due to erosion/deposition and shifting sands, the key has changed in location and shape over time (see **Map B-2** in **Appendix B** for site details). During the RI field activities, the UXO-qualified dive team noted a shift in the location of the island between the months of November and December 2015 due to several storms with strong winds from the west/northwest that occurred in that timeframe (see **Map B-3** in **Appendix B**). The FUDS boundary, which is comprised of approximately 170.5 acres, includes the historical (early 1940s) location of Passage Key and the surrounding waters. The historical air-to-ground gunnery range and bombing target area (5.7 acres) is located within the FUDS boundary. The area that is the focus of the RI/FS includes approximately 649 acres and consists of the former bombing range safety fan. This area includes the FUDS boundary, as well as the other locations where Passage Key migrated over time. The Passage Key ATGGR munitions response site (MRS), which is comprised of 13,147.72 acres and extends from Tampa Bay west into the Gulf of Mexico, includes the RI/FS Investigation Area and the surrounding water area associated with the former air-to-ground gunnery range safety fan. The RI/FS Investigation Area focuses on the former target area for the bombing and gunnery range. The remaining area (i.e., 12,498.72 acres) consists of the safety fan for the gunnery range. This area served as a buffer area for the Passage Key ATGGR; no targets are known to have existed in this area and no munitions have been found in this area.

1.2.3 Climate

1.2.3.1 The climate in this area is subtropical, characterized by mild-to-moderate dry winters and warm, humid summers. Temperatures are moderated by the waters of the Gulf of Mexico and Tampa Bay. The average annual temperature is 73 degrees Fahrenheit (°F), with an average annual low temperature of 52°F and high temperature of 91°F for the area.

1.2.3.2 Afternoon humidity is usually 60% or higher in the summer months, but ranges from 50 to 60% the remainder of the year. Prevailing winds are easterly, but westerly afternoon and early evening sea breezes occur most months of the year. The outstanding feature of the area's climate is the summer thunderstorm season. Thunderstorms typically occur in the late afternoon hours from June through September. Annual rainfall is about 56 inches, of which approximately 60 percent (%) of the total precipitation falls from June through September. Tropical storms and hurricanes are known to occasionally affect the area between the months of June and November. The highest frequency of dangerous lightning occurs during the months of June, July, and August.

1.2.4 Topography, Soils, and Vegetation

The project area consists of an intermittently submerged sandbar and the surrounding water at the entrance to Tampa Bay from the Gulf of Mexico. **Map B-4** in **Appendix B** illustrates the bathymetry from 2007, the most recent year available, and the bathymetric data that was collected during the RI digital geophysical mapping (DGM) transect and grid surveys in the RI/FS Investigation Area. General water depths range from zero along the shoreline of Passage Key to approximately 20 feet at the RI/FS Investigation Area perimeter. Water depths tend to be shallower in the southern portion and deeper in the northern portion of the site. The soils of the former Passage Key ATGGR are comprised mainly of sand and shell fragments. There are two basic types of soil. The first type is beach sand, which is comprised of slightly alkaline sand and shell fragments along the Gulf of Mexico shoreline. The majority of the beach deposits are under water during high tides. The second soil type is very similar. It typically has a surface layer that is seven inches thick. It is composed of fine sand and about 10% sand-sized shell fragments. Vegetation on Passage Key is limited to small shrubs and grasses, or non-existent at times, due to the dynamic environment in which the key is located. The sand bar, and historically larger land area, changes in size and location over time due to storms, currents, and erosion/deposition of bottom sediments at the mouth of Tampa Bay where the key is located. The ephemeral nature of the sand bar/land area is affected by the erosion/deposition of sediments and is also subject to lateral movement over time, as well.

1.2.5 Geology

In the region where Passage Key is located there are two major geologic formations: the Hawthorn Formation of the lower Miocene and the Caloosahatchee Marl of the lower Pliocene. The Caloosahatchee Marl is of marine origin. It consists of sand, sandy clay and marl and is from 2% to 85% shells. The maximum thickness of the formation is about 50 ft. The Hawthorn Formation consists of interbedded sand, clay, marl, limestone, lenses of fuller's earth, and land-pebble phosphate. The surface soils in the area have been identified as Palm Beach and St. Lucie. The Palm Beach series consists of nearly level well-drained shelly sands. Typically, the surface layer, about 20 inches thick, is light gray sand that is about 18% small shells and shell fragments. Below this area are layers of light-gray sand in which the content of shell fragments increases with increasing depth. These layers extend to a depth of 80 inches. The water table in the Tampa Bay area tends to occur at a depth of more than 40 inches. The soil has very rapid permeability, very low water capacity, low organic-matter content, and low natural fertility. The St. Lucie series consists of shell sub-stratum sand in a nearly level soil. In most places the surface layer is very dark gray fine sand about three inches thick. Below this is very dark gray fine sand about 34 inches thick. The next layer is very pale brown, loose fine sand that extends to a depth of 40 inches or more. This is underlined by layers of mixed light-gray or white sand, seashells, and shell fragments.

1.2.6 Hydrogeology

The Floridan aquifer is the principal aquifer supplying most of the water used in the region. It is represented by limestone and dolomites of the Upper Floridan aquifer which includes the Avon Park Limestone and Ocala Group limestones (including the Suwannee Limestone). The top of the Floridan aquifer is defined as the first consistent limestone below which no clay confining beds occur. The configuration of the top of the aquifer is highly variable due to erosion and dissolution of the limestones that form its upper surface. The elevation of the top of the aquifer within the area ranges from 300-450 ft below sea level. The regional direction of ground-water movement in the Floridan Aquifer is from east to west. Recharge of the Floridan aquifer occurs from the overlying water-table aquifer in areas where it is in direct contact with the Floridan or through confining beds between the Floridan and the water-table aquifer.

1.2.7 Natural Resources

A variety of habitats (i.e., shallow marine areas, a sand bar and ponded water) exist within the Passage Key ATGGR RI/FS Investigation Area that support the potential presence of threatened and endangered species, as well as other important ecological resources, that may visit the key or transit the site depending on the time of year. The following subsections describe the ecological resources identified at the project site based on site-specific information, as well as that obtained from the FL Natural Areas Inventory (FNAI), the United States Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA)/National Marine Fisheries Service (NMFS), and the Florida Fish and Wildlife Conservation Commission (FFWCC).

1.2.7.1 Habitat Type

The project site is comprised of a small sand bar (or key), within the Tampa Bay estuary system and is within a coastal zone management area. The key and adjacent coastal waters also comprise the Passage Key National Wildlife Refuge. The site is neither part of nor adjacent to a national marine sanctuary, national estuarine reserve, or national marine fisheries protected or management area.

1.2.7.2 Ecological Receptors

1.2.7.2.1 Several species of flora and fauna considered to be federally, and/or state, threatened or endangered are known to be present within Manatee County, FL. According to FNAI's tracking list and the USFWS, there are eight federally-listed species, as well as other state-listed species, known to exist near Passage Key in Manatee County as noted in **Table 1-1**. These species may periodically visit or transit the site depending on the time of year.

Table 1-1: Federal and State Listed Threatened and Endangered Species in Manatee County

Common Name	Scientific Name	Federal and State Status
Mammals		
West Indian Manatee	*Trichechus manatus*	FE/SE
Birds		
American Oystercatcher	*Haematopus palliates*	ST
Black Skimmer	*Rynchops niger*	ST
Least Tern	*Sternula antillarum*	ST
Little Blue Heron	*Egretta caerulea*	ST
Piping Plover	*Charadrius melodus*	FT/ST
Reddish Egret	*Egretta rufescens*	ST
Roseate Spoonbill	*Platalea ajaja*	ST
Snowy Plover	*Charadrius nivosus*	ST
Tricolored Heron	*Egretta tricolor*	ST

Common Name	Scientific Name	Federal and State Status
Wood Stork	*Mycteria Americana*	FE/SE
Fish		
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	FT/ST
Reptiles		
Green Sea Turtle	*Chelonia mydas*	FE/SE
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	FE/SE
Leatherback Sea Turtle	*Dermochelys coriacea*	FE/SE
Loggerhead Sea Turtle	*Caretta caretta*	FT/ST

Notes: FE = Federal Endangered; SE = State Endangered
FT = Federal Threatened; ST = State Threatened
CCA = Federal Conservation Coordination Agreement; SSC = State Species of Concern

1.2.7.2.2 Passage Key, a USFWS National Wildlife Refuge that was returned to the Department of Interior (DOI) in 1946 following the DoD's use of the island and surrounding waters, was at one time a larger, mangrove-covered island with a fresh water lake. Currently, the key consists of a sand bar that is mostly submerged depending on the tides. Both the size and location of Passage Key have changed and shifted significantly over time. Storms, such as hurricanes and tropical storms, as well as the key's location at the mouth of Tampa Bay, create changing conditions where sediment erosion and deposition occur constantly. While successful nesting had not been observed on the island for several years, the key has increased in size due to sediment deposition over the last year or two and now provides a resting area for birds. With the key's location at the mouth of Tampa Bay and because the majority of the site consists of open water, marine mammals, sea turtles, and other protected marine species could be present in the project area depending on the time of year. While seagrass habitats have been identified in the project area (see **Map B-5** in **Appendix B**), the majority of the site consists of a sandy bottom with little to no seagrass and no reef or corals.

1.2.7.3 Wetlands

There are no documented fresh water wetlands that exist within the project area.

1.2.8 Cultural and Archaeological Resources

No known historical, archeological, or cultural sites are located within the project site.

1.2.9 Demographics

1.2.9.1 The nearest city to Passage Key ATGGR is Bradenton, which is approximately 10 miles southeast of the project site and located within Manatee County. Based on the 2010 U.S. Census Bureau QuickFacts website (http://quickfacts.census.gov/qfd/index.html), the population of Manatee County, FL was 322,833 in 2010, which corresponds to approximately 434.5 persons per square mile. The estimated population for the city of Bradenton in 2010 was 49,546 or about 15% of the total population of Manatee County, FL (U.S. Census Bureau, 2010).

1.2.9.2 The segment of the population in Manatee County under the age of 18 is 19.5%, while 25.5% are over the age of 65. Approximately 86.4% of the population is Caucasian, 9.3% African American, 2.0% Asians, 0.5% American Indian and Alaska Native. There are 179,035 households within the county with an average household size of 2.48 (United States Census Bureau, 2010).

1.2.9.3 The former Passage Key ATGGR lies within the northernmost portion of a large census tract (18). Three other census tracts are contiguous to census track 18 (9900, 12.04 and 17.01), with the 9900 census track comprised of water areas associated with the Gulf of Mexico and Tampa Bay. For 2010, there was an estimated population of 4,849 persons within census tract 18 (United States Census Bureau, 2010).

1.2.10 Current and Future Land Use

Because of its small size and importance to wildlife, Passage Key is closed to all public use. Although the island is small, it provides an important resting area for birds and remains under the USFWS jurisdictional control as the Passage Key National Wildlife Refuge. Public access is technically restricted at the site, but there are limited signs and no barriers to prevent access to the key or the surrounding waters. As such, the key and surrounding waters are routinely used by the public for swimming, boating and fishing. Future land use is expected to remain the same.

1.3 HISTORICAL INFORMATION

1.3.1 Prior to military use, Passage Key, located in Manatee County, Florida, was owned by the DOI and managed as one of the first national wildlife refuges, which DOI established in 1905 (USACE, 1993). In 1943, the War Department acquired a permit to use the key and surrounding waters as a ground strafing and dive bombing range. The site was used for training purposes during World War II until October 1945. The former Passage Key ATGGR was comprised of 13,146.72 acres extending from Tampa Bay west into the Gulf of Mexico. The majority of the acreage consisted of the water area associated with the safety fan for the range. Refer to **Map B-1** in **Appendix B** for the general location of the former Passage Key ATGGR.

1.3.2 The site included Passage Key, which was a 36.37-acre island in the early 1940s where air-to-ground gunnery range bombing and strafing targets were located. The land associated with Passage Key today is little more than a sand bar that is situated northwest of Passage Key's location in the 1940s. In the 1940s, the Sarasota Army Air Field was assigned the responsibility for constructing, maintaining, and operating the bombing and strafing targets on Passage Key. There were two banks of targets aligned north to south and constructed. The 13,146.72-acre area associated with the former Passage Key ATGGR contained two banks of targets located on Passage Key. The two banks of targets, which were aligned north to south, were constructed 500 ft apart, with each bank set up with six targets. While Passage Key ATGGR was configured as a practice range only, there have been historical findings at the range that included photoflash, practice and high explosive (HE) bombs, aerial rockets, and small arms ammunition. These items have been found near the bombing and strafing target location within the Passage Key ATGGR. The much larger 13,146.72-acre area associated with the Passage Key ATGGR includes the range safety fan that served as a buffer area when the range was in use.

1.3.3 The War Department relinquished the permit for the Passage Key ATGGR in March 1946, which returned Passage Key back to the DOI (Parsons, 2008). The site has been managed as the Passage Key National Wildlife Refuge by the USFWS since that time.

1.4 PREVIOUS INVESTIGATIONS

The previous studies conducted at Passage Key ATGGR are listed below.

- *Inventory Project Report* (Initial), USACE, Jacksonville District, September 1993
- *Inventory Project Report* (Supplemental), USACE, Jacksonville District, August 2000
- *Archives Search Report Findings for the Former Passage Key Air-to-Ground Gunnery Range, Manatee County, Florida, Project Number I04FL040101*, USACE, August 2002
- *Final Site Inspection Report: Passage Key Air-to-Ground Gunnery Range, Manatee County, Florida, FUDS Project No. I04FL040101*, Parsons for USACE, March 2008

Information and findings from each of the previous studies and historical documents are summarized in the sections that follow.

1.4.1 1993 Inventory Project Report (Initial)

The 1993 Inventory Project Report (INPR), prepared in (and dated) September 1993, identified Passage Key as a practice bombing and gunnery range and determined the site was formerly used by the DoD. As such, it was eligible for the FUDS inventory (Property No. I04FL040101) under the DERP. The Findings of Determination of Eligibility, prepared in (and dated) September 1993, recommended a no further action of Passage Key ATGGR. The associated INPR established the site history and preliminary site boundaries. The INPR was approved on December 1993 via separate correspondence (USACE, 2000).

1.4.2 2000 Inventory Project Report (Supplemental)

The 2000 INPR reviewed the initial report and concluded further ordnance and explosive investigation was warranted after the findings of four UXO items at the site in 1998. The UXO items identified in 1998 included three 100-pound (lb) general purpose bombs and one 100-lb photoflash bomb discovered on or near the island. The bombs were detonated by either the U.S. Air Force or U.S. Navy Explosive Ordnance Disposal (EOD) unit (USACE, 2002). The 2000 INPR recommended that an engineering evaluation/cost analysis be performed at the Passage Key ATGGR.

1.4.3 2002 Archives Search Report

The USACE, St. Louis District completed the ASR for Passage Key ATGGR in August 2002. The ASR was prepared after reviewing reports, newspaper articles, historical documents, and reference material available that documented the history of the site. This report is the source of most of the historical information pertaining to site activities. As part of the ASR, a site visit was conducted to assess the presence and potential for ordnance and explosives. No indications of MEC or MD were observed during the site visit.

1.4.4 2008 Site Inspection Report

The 2008 Site Inspection Report (Parsons, 2008) identified one MRS as requiring further investigation. No indications of MEC or MD were observed during the Site Inspection (SI) field work. Based on past discoveries of MEC and MD at the MRS, the potential for MEC still exists; as such, this MRS was recommended to proceed to the RI/FS phase for MEC. MC sampling was not conducted during the SI. Due to the dynamic coastal environment at the site and lack of a concentrated source of MEC, the SI noted that sampling for MC was not recommended.

1.4.5 Potential for Chemical Warfare Materiel Presence

There is no clear evidence of chemical warfare materiel (CWM) storage, usage, or disposal at Passage Key ATGGR and no documentation of use has been encountered during previous investigations. No CWM was encountered by the JV during the RI field activities.

1.5 REPORT ORGANIZATION

1.5.1 This RI/FS Report is prepared consistent with DIDs approved for the WERS contract, along with various USACE guidance documents. The sections of this RI/FS Report have been organized following DID WERS-010.01 and Army RI/FS guidance per the PWS. Specifically, this report includes the following:

- **Section 1: Introduction –** presents the purpose of the project and report with a description of work authorization, an overview of the MRS being addressed, and content of the report.
- **Section 2: Project Remedial Response Objectives –** presents a discussion of the preliminary conceptual site model (CSM), project approach, preliminary remediation goals, identification of potential applicable or relevant and appropriate requirements (ARARs), data needs, and data quality objectives (DQOs) used to develop the RI.
- **Section 3: Characterization of MEC and MC –** provides details on the approach, methods, and procedures used to characterize MEC and MC. Subsections have been grouped into common or specific operational categories and organized to present required elements of work in an approximate chronological order to facilitate communication of the work completed.

- **Section 4: Revised Conceptual Site Model and Remedial Investigation Results –** presents the results of the RI and updated CSM based on the additional information gathered during the RI.
- **Section 5: Contaminant Fate and Transport for MEC/MC –** presents a discussion of the fate and transport of MEC/MC in the environment.
- **Section 6: Baseline Risk Assessment for MC and Hazard Assessment for MEC –** presents the assessment of human health and ecological risks as a result of presence or potential presence of MEC and MC, as applicable.
- **Section 7: Identification and Screening of Technologies for MEC and MC –** presents the remedial action objectives (RAOs) resulting from the remediation action goals that were developed during the RI; identifies the general response actions for MEC; and presents a detailed evaluation of each technology based on effectiveness, implementability, and cost.
- **Section 8: Development and Screening of Alternatives –** provides details on how the technologies and general response actions were combined to form remedial alternatives, including a general description of each alternative. This section provides details on the screening process and evaluation criteria (i.e., effectiveness, implementability, and cost as discussed in ER 200-3-1 and the NCP).
- **Section 9: Detailed Analysis of Alternatives –** describes the detailed analysis of alternatives against seven of the nine criteria from the NCP, Section 300.430.
- **Section 10: Summary of Results –** presents the RI summary and conclusions.
- **Section 11: References –** provides a list of references used in preparing the RI Report.

1.5.2 In addition, the following appendices are provided to supplement the results reported in this document:

- **Appendix A:** PWS
- **Appendix B:** Site Maps
- **Appendix C:** Technical Project Planning (TPP) Meeting Memorandum
- **Appendix D:** Institutional Analysis Report
- **Appendix E:** Daily Reports, Field Forms, and After Action Report (AAR)
- **Appendix F:** DGM Reports and Memorandums
- **Appendix G:** DGM and Analog Data
- **Appendix H:** Photograph Log
- **Appendix I:** MD Form 1348-1A and Explosives Accountability Records

- **Appendix J:** MEC Hazard Assessment (MEC HA)
- **Appendix K:** Cost Estimate
- **Appendix L**: Post-RI/FS Geographic Information System (GIS) Data Deliverable

1.5.3 Refer to the table of contents for the specific sections and appendices comprising this RI/FS Report. In several cases, the appendices contain stand-alone documents and reference to these documents, where applicable, is made in this RI/FS Report.

2.0 PROJECT REMEDIAL RESPONSE OBJECTIVES

This section presents a discussion of the preliminary CSM, project approach, data needs, and DQOs considered while developing response objectives during the RI for Passage Key ATGGR.

2.1 Conceptual Site Model and Project Approach

2.1.1 Preliminary Conceptual Site Model

The preliminary CSM for Passage Key ATGGR was developed during the planning phases of the RI by integrating information from the INPRs, ASR, and the Site Inspection Report (Parsons, 2008). This section presents the preliminary CSM within **Table 2-1**, which provided the basis for identifying data collection needs during the RI. The data collected during the RI have been incorporated into the revised CSM, which is presented in Section 4.

Table 2-1: Passage Key ATGGR Preliminary CSM

Profile Type	Site Characterization
MRS Profile	**Area and Layout** ▪ The RI/FS Investigation Area comprises 649 acres located at the entrance to Tampa Bay from the Gulf of Mexico. ▪ The property includes a single key, which has changed in location and shape over time.
	Structures There are no structures present at the project site. The site is operated as a National Wildlife Refuge for migratory birds and is off-limits to the public. While the site is uninhabited, there are single and multi-family residential and commercial developments located on Anna Maria Island, which is approximately one mile to the south of the key.
	Boundaries Passage Key is bordered to the east by Tampa Bay and to the west by the Gulf of Mexico.
	Utilities No utility lines are present at the project site.
	Security There are no restrictions to access the site.
Land Use and Exposure Profile	**Current Land Use** ▪ Passage Key is currently managed as a National Wildlife Refuge and under the jurisdiction of the USFWS. ▪ Public access is technically restricted at the key, but there are no barriers to prevent access. ▪ The remainder of the MRS includes the water area surrounding Passage Key that is used recreationally for fishing, boating, and swimming. The MRS is publicly accessible by boat.
	Potential Future Land Use No future development plans are known to exist for this area. As such, future land use is expected to remain the same.

Profile Type	Site Characterization
	Human Receptors Human receptors include agency personnel, contractors, visitors (e.g., conducting natural resource surveys or other studies), or trespassers, and recreational users (fishing, boating, swimming).
Ecological Profile	**Degree of Disturbance** Passage Key is a National Wildlife Refuge and provides habitat for many species of flora and fauna that may be present at the site depending on the time of year. While the threatened and endangered species listed in **Table 1-1** may transit the area, there are no known threatened and endangered species that permanently use the site.
Munitions/ Release Profile	**Munitions** Munitions potentially used at Passage Key ATGGR based on historical documents include: ▪ Small Arms (.50 caliber) ▪ Bomb, Miniature, Practice ▪ Bombs, Miniature Practice signals ▪ Bomb, Practice, 100-lb, ▪ Bomb, General Purpose, 100-lb ▪ Bomb, Photoflash, 100-lb ▪ Rocket, Practice, 2.25-inch ▪ Spotting charges UXO found and detonated at the site prior to the RI field effort included three 100-lb general purpose bombs and two 100-lb photoflash bombs. While practice munitions do not contain an explosive filler similar to HE munitions and are not nearly as hazardous as HE munitions, they do contain a spotting charge which does present an explosive hazard.
	Munitions Debris ▪ No indications of MEC or munitions debris (MD) were observed during the ASR and SI site visits.
	Associated Munitions Constituents ▪ MC sampling was not conducted during the SI. Due to the dynamic coastal environment at the site and lack of a concentrated source of MEC, sampling for MC has not been performed.
	Transport Mechanisms / Migration Routes / Pathway Analysis ▪ Potentially complete exposure pathways were identified for MEC in surface and subsurface sediment (i.e., underwater). ▪ Incomplete exposure pathways for human and ecological receptors were identified for MC due to the lack of a MC source area.

2.1.2 Project Approach

All RI tasks were performed IAW the USAESCH WERS PWS, dated 14 April 2014, and subsequent modifications (**Appendix A**), and the Final RI/FS UFP-QAPP (JV, 2015b). RI activities included document reviews, site visits, stakeholder and public information meetings, and field activities. The following summarizes the status and key elements of tasks associated with the RI:

- Technical Project Planning (TPP) Process – TPP meetings were held on 04 November 2014 and 15 October 2015 for the Passage Key ATGGR RI/FS project. The TPP memorandum and addendum are included in **Appendix C**.
- Explosives Site Plan (ESP) – An ESP was prepared IAW DID WERS-003.01 (Safety Submissions) (USAESCH, 2010) and the EM 200-1-15 (USACE, 2015). The ESP is a stand-alone document that provides specifics on the minimum separation distance (MSD) and engineering controls that were enforced during intrusive operations; it was incorporated into the RI/FS UFP-QAPP (JV, 2015b). The ESP was approved by DDESB in July 2015 (JV, 2015a).
- Dive Plan – A Dive Plan was prepared IAW U.S. Navy Diving Manual (Volume I) and EM 381-1-1 (USACE, 2008). The Dive Plan is a stand-alone document that establishes the guidelines for personnel engaged in munitions response diving operations and addressed the water work that involved: diving and boat operations, anomaly reacquisition, self-contained underwater breathing apparatus (SCUBA) diving operations, scientific snorkeling operations, anomaly excavation, and underwater demolition procedures. It was also incorporated into the RI/FS UFP-QAPP (JV, 2015b). The Dive Plan was approved by the USACE District Dive Coordinator in May 2015. Diver certifications/qualifications were approved in August 2015.
- RI/FS UFP-QAPP – The RI/FS UFP-QAPP documents the detailed approach for MEC and MC RI activities, IAW DID WERS-001.01 (USAESCH, 2010) and EM 200-1-15 (USACE, 2015). The RI/FS UFP-QAPP was reviewed and approved/accepted by USACE, Florida Department of Environmental Protection (FDEP), and Manatee County in October 2015.
- RI Fieldwork – Fieldwork included the following tasks to meet the objectives of the RI: location surveying and mapping, geophysical system verification (GSV), land and marine geophysical investigation, and intrusive investigation.
    - GSV – The GSV, which consisted of an Instrument Verification Strip (IVS) and a blind seeding program during production mapping, was completed IAW DID WERS-004.01 (USAESCH, 2010) and the Final Geophysical Systems Verification Report [Environmental Security Technology Certification Program (ESTCP), 2009]. The Draft IVS Letter Report was submitted after the completion of IVS fieldwork. The USACE QA Geophysicist accepted the document on 17

November 2015 and the Final IVS Letter Report is included with this RI/FS Report as **Appendix F**.

- o Geophysical Investigation – Marine transects and grids were mapped using the approved DGM methodology IAW the Final RI/FS UFP-QAPP. Under the oversight of the Senior Geophysicist, NAEVA Geophysics, Inc.'s (NAEVA's) geophysical data processor identified anomalies that met the pre-established target anomaly selection criteria and DQOs, and prioritized the targets. Land-based analog ("mag and dig") transects were performed with the approved analog instrumentation and were investigated real-time.
- o Intrusive Investigation – An intrusive investigation of selected anomalies identified during the DGM survey, as well as all analog anomalies encountered, was conducted at Passage Key ATGGR. This task included anomaly reacquisition; a 100% inspection of all material potentially presenting an explosive hazard (MPPEH); onsite demolition activities including two consolidated shots comprising 25 items; including four MEC items to render them safe and 21 munitions debris (MD) items to remove their ordnance-like appearance. Small arms ammunition (expended cartridge casings) were collected and removed from the site, as well as some cultural metal debris.

- RI/FS Report – This RI/FS Report is submitted IAW the USEPA document *Guidance for Conducting Remedial Investigations and Feasibility Studies Under Comprehensive Environmental Response, Compensation, and Liability Act* (1988); USACE documents EM 200-1-15 (USACE, 2015) and ER 200-3-1 (USACE, 2004); and the *U.S. Army Military Munitions Response Program Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009).
- Community Involvement – Prior to the RI field effort, a fact sheet was prepared to provide information regarding the RI/FS project, as well as public safety information. This information was made available for public review as part of the Administrative Record for the site maintained at the Holmes Beach Public Library on Anna Maria Island.

2.2 PRELIMINARY REMEDIAL ACTION OBJECTIVES

2.2.1 The purpose of the RI was to conduct an on-site investigation and gather sufficient data to characterize the nature and extent of explosive safety hazards (including MEC on the surface, in the subsurface, and in sediment), and to perform a MEC HA. The primary goal of the RI was to collect the appropriate amount of information to determine if there is an unacceptable risk to human health, safety, and the environment arising from MEC.

2.2.2 RAOs are site-specific, initial clean-up objectives that are established on the basis of the nature and extent of impacts, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. For Passage Key ATGGR, the RAOs are not determined by constituents in the soil and/or sediment (*i.e.*, MC do not pose a risk to receptors since no MC source has been identified), but by potential contact with MEC. RAOs related to MEC consist of specific goals for reducing the explosives safety hazard to ensure protection of human health, safety, and the environment. Based on the RI findings indicating the potential for MEC presence in surface and subsurface soil and sediment at the site, RAOs were developed for the protection of human health and the environment based on the following site-specific information:

- The contaminant of interest at the site is MEC, which has the potential to occur at the seafloor surface and within the upper four feet of the seafloor subsurface. Note that environmental factors (e.g., storm surges, currents, shifting sands) may unearth residual MEC in the seafloor subsurface.
- The exposure pathway of concern for MEC is direct exposure (i.e., physical contact). Receptors may have direct exposure to MEC on the ground surface, or in the subsurface when engaged in activities requiring ground disturbance / digging / excavation.
- The depths for potential exposure range from the surface to four feet bgs.
- The media of interest are surface and subsurface soil and sediment to a depth of four feet bgs (i.e., slightly greater than the maximum depth at which UXO or MD have been found at the site).

2.2.3 The following RAOs were developed for Passage Key ATGGR:

- Reduce human exposure and interaction with potential MEC such that negligible risk to human receptors can be demonstrated. This RAO applies to current and anticipated future use for recreation (e.g., boating, fishing) within the boundaries of Target Area 1 to a depth of four feet below ground surface/seafloor surface.
- Control the specific exposure pathways for MEC identified within the RI/FS Investigation Area, including contact by human receptors (i.e., boaters) or biota within the seafloor surface and subsurface (e.g., digging or burrowing). The majority of site activities are recreational in nature, with intrusive activities limited to depths no greater than one foot below ground surface/seafloor surface.
- Implement safety and institutional procedures that allow for current land use of the site to continue and are protective for the reasonably anticipated future land use (which is the same as current).

2.2.4 It is important to note that once a MEC source area is identified, there will always be a residual exposure hazard, regardless of the remedial action chosen. The limit of technology for the detection and removal of MEC in the marine environment, combined with the nature of the hazard (explosive), results in a residual hazard that must be considered when selecting a remedial action.

2.2.5 Preliminary remediation goals (PRGs) for MEC are methods that are protective of the specific exposure pathways identified at Passage Key ATGGR. Exposure pathways for MEC include direct contact by humans and ecological receptors. Typical PRGs for MEC to reduce or prevent direct contact include physically removing MEC, educating potential human receptors (recreational users, contractors, visitors, etc.) of potential MEC presence, and instituting land use controls (LUCs), such as fencing and signs, warning potential human receptors of the potential hazards.

2.3 IDENTIFICATION OF POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section defines ARARs and discusses the three general categories of ARARs. A discussion of ARARs that apply to the proposed alternatives is found in Section 7.

2.3.1 Definition of Applicable or Relevant and Appropriate Requirements

2.3.1.1 Pursuant to Section 300.400(g) of the NCP, a list of ARARs is developed to identify requirements applicable to the release or remedial action contemplated based upon an objective determination of whether the requirement specifically addresses a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a site. CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the NCP require that the development and evaluation of remedial alternatives must attain ARARs and ensure protection of public health and the environment as the minimum threshold criteria that must be met during selection of a future response action. ARARs are defined as follows:

- Applicable requirements mean 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 found 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 means 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 in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

2.3.1.2 It is first determined whether an ARAR is applicable for the CERCLA 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 CERCLA site. In some cases, only a portion of a requirement would be both relevant and appropriate. When 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.

2.3.1.3 As the RI/FS process continues, the list of ARARs is further defined, particularly with respect to data collected during the RI. The ARARs are used to establish the appropriate extent of cleanup; to aid in scoping, formulating, and selecting proposed treatment technologies and remedial alternatives; and to govern the implementation and operation of the selected remedial alternative. Throughout the RI/FS phase, ARARs are identified and used by taking into account the following:

- Contaminants suspected or identified to be at the site (e.g., MEC and/or MC);
- Chemical analysis performed;
- Types of media (air, soil, groundwater, surface water, and sediment);
- Geology and other site characteristics;
- Use of site resources and media;
- Potential contaminant transport mechanisms;
- Purpose and application of potential ARARs; and
- Remedial alternatives considered for site cleanup.

2.3.2 Types of ARARs

2.3.2.1 Generally, ARARs pertain to either contaminant levels or to performance or design standards to ensure protection at all points of potential exposure. ARARs are divided into three general categories: chemical-specific ARARs, location-specific ARARs, and action-specific ARARs. CERCLA actions may have to comply with them as follows:

2.3.2.2 **Chemical-Specific.** Chemical-specific requirements define acceptable exposure levels for specific hazardous substances and, therefore, may be used as a basis for establishing preliminary remediation goals and cleanup levels for chemicals of concern in the designated media. Chemical-specific ARARs are also used to determine treatment and disposal requirements for remedial actions. In the event a chemical has more than one requirement, the more stringent of the requirements will be used.

2.3.2.3 **Location-Specific.** Location-specific requirements set restrictions on the types of remedial actions that can be performed based on site-specific characteristics or location.

2.3.2.4 **Action-Specific.** Action-specific requirements set controls or restrictions on the design, implementation, and performance of remedial actions. They are triggered by the particular types of treatment or remedial actions that are selected to accomplish the cleanup.

2.3.3 Identification of ARARs

The results of the identification of ARARs for Passage Key ATGGR are discussed in Section 7.

2.4 SUMMARY OF INSTITUTIONAL ANALYSIS

2.4.1 Institutional analyses are prepared to support the development of institutional control strategies and plans of action as a munitions response alternative. These strategies rely on existing powers and authorities of government agencies to protect the public at large from MEC hazards and MC risks.

2.4.2 A review of government institutions and private entities that exercise jurisdiction and ownership indicates that the property encompassing the Passage Key ATGGR is under the jurisdiction and ownership of DOI and USFWS, government agencies. For properties owned or controlled by government agencies, remedial actions, to include LUCs, can typically be more easily implemented, maintained, and/or enforced. LUCs include any type of physical, legal, or administrative mechanism that restricts the use of, or limits access to, real property to prevent or reduce risks to human health and the environment. Physical mechanisms include barriers to limit access to property, such as fences or signs. Legal mechanisms used for LUCs include restrictive covenants, easements, and deed notices. Administrative mechanisms include notices, ordinances, construction permitting, and community educational programs, such as instructional pamphlets and meetings. Before any remedial alternative containing LUC components can be selected, there needs to be documented commitment from the current landowners that they will implement, maintain, and enforce the LUC(s). For additional details regarding the institutional analysis for Passage Key ATGGR, refer to the Institutional Analysis Report in **Appendix D**.

2.5 DATA NEEDS AND DATA QUALITY OBJECTIVES

2.5.1 Data Needs

2.5.1.1 Prior to the initiation of RI field activities, representatives and stakeholders from USACE, FDEP, USFWS, FFWCC, Manatee County, the USCG and the JV participated in two TPP meetings (i.e., TPP 1 and TPP 2). The intent of the TPP is to provide a comprehensive and systematic planning tool for the project.

2.5.1.2 The first TPP meeting (TPP 1) was held on 4 November 2014 at the Manatee County Public Safety Center in Bradenton, FL. At this meeting, an overview of the Passage Key ATGGR history and the RI/FS project approach, objectives, planning documentation, field investigation, and reporting requirements were presented and discussed. The second TPP meeting (TPP 2) was held on 15 October 2015 via teleconference call to discuss field effort activities, logistics and schedule, as well as to review the MEC technical approach with project stakeholders. Details regarding the planned MEC field activities were presented and discussed among the group. Throughout the TPP process, project stakeholders discussed and helped to refine project goals and DQOs, as well as reviewed the RI/FS QAPP. The TPP memorandum is provided in **Appendix C**.

2.5.1.3 The results of the TPP sessions supported the field activities planned as part of the RI. The overall RI technical approach for the Passage Key ATGGR was focused on characterizing the nature and extent of MEC within the RI/FS Investigation Area. The data needs included characterization of the nature and extent of contamination associated with former munitions activities at Passage Key ATGGR that may have resulted in the presence of MEC. For MEC, data needs included determining the types, locations, condition, and number of MEC items present within the RI/FS Investigation Area so the potential hazard to human health could be assessed and remedial decisions can be made. The JV’s MEC approach, in general, included:

- DGM and analog transects designed in Visual Sample Plan (VSP) to traverse and detect elevated anomaly density areas (e.g., practice or high explosive [HE] impact/target areas) with a 90% confidence level.
    - DGM and analog geophysical data were collected along transects to detect anomalies in land and marine areas. Transects (two meters-wide) were spaced 404 feet apart within the RI/FS Investigation Area. DGM data was the primary geophysical method used, but analog data was collected along transects in areas inaccessible to the EM61-Flex3 equipment (e.g., land and near-shore marine environment).
    - DGM anomalies were detected using the EM61-Flex3, with positioning via the real time kinematic (RTK) differential Global Positioning System (DGPS).
    - Analog (i.e., mag and dig) anomalies were detected with a hand-held White’s all-metals detector with positioning via a handheld GPS (e.g., Trimble GeoXT).
- Geostatistical analysis of DGM transects to determine anomaly densities and distribution (i.e., potential target and non-target areas).
    - Surface and subsurface anomaly density and distribution was mapped.
    - Anomaly density and distribution along transects was determined using the VSP geostatistical analysis tool.
    - VSP was also used to delineate the approximate boundary of the potential target/non-target areas (i.e., the boundary between the high and low anomaly density areas).
- Randomly placed DGM grids designed in the RI Module of VSP (using UXO Estimator equivalent settings) outside of identified high anomaly density areas to verify that the MEC density is less than 1.0 UXO/acre;

- 2.3 acres of DGM grids were surveyed in non-target areas (10, 50-foot x 200-foot grids).

- Biased DGM grids outside potential target areas to determine an upper limit of the UXO density outside these target areas.
  - In target areas, transect data were used for anomaly identification and for intrusive investigation. Additionally, two 50-foot by 200-foot marine DGM grids were surveyed within the central target area to aid in estimating the total number of anomalies within the target area and to characterize the nature of anomalies within the potential target area.
  - The grid locations were reviewed by USACE prior to completing fieldwork within the grids.

- Reacquisition and intrusive investigation of anomalies on DGM and analog transects and within DGM grids.
  - Anomalies were selected for intrusive investigation as outlined in the IVS Letter Report (**Appendix F**), the Anomaly Selection Memo (**Appendix F**), and Root Cause Analysis (RCA) 1 (**Appendix F**), which is summarized as follows:
    - Outside potential target areas
      - All detected DGM grid anomalies that met the anomaly selection criteria and were not suspected noise were intrusively investigated.
    - Inside potential target areas, or Decision Units (DUs)
      - DGM transect anomalies were broken down into five groups based on their peak anomaly response and Half Amplitude Width (HAWID) and prioritized for intrusive investigation as outlined in Section 3.2.4.6.
      - All DGM grid anomalies that met the anomaly selection criteria and were not suspected noise were intrusively investigated.
    - All detected analog transect anomalies were intrusively investigated.
  - Intrusive results were used in the MEC HA to determine the MEC hazard levels for the range.

- MD/material potentially presenting an explosive hazard (MPPEH) handling and explosives demolition.

2.5.1.4 The JV also met the following performance objectives in compliance with the PWS:

- Boundaries of all identified MEC contaminated areas and areas likely to contain MEC will be delineated by the transect design to an accuracy of less than +/- 250 ft.

- Within elevated anomaly density areas, DGM grid surveys and intrusive investigations will ensure that a 90% confidence in the nature (type, density and potential depth) of MEC and MEC-related debris, for each high anomaly density area, is achieved.
- The potential depth of MEC will be bound to at least 90% confidence.
- DGM surveys and intrusive investigations within MEC impacted areas will ensure that remedial cost drivers are correctly estimated to +50% / -30% accuracy.

2.5.1.5 The data usability assessment, which is summarized in Section 4.1.5, and the Data Usability Assessment Report, which is included as Appendix F, provide further details regarding the determination that the MEC data collected during the RI met the measurement performance criteria (MPCs) and DQOs and was sufficient to make the decisions that need to be made as part of this RI/FS.

2.5.2 Data Quality Objectives

2.5.2.1 The DQOs are qualitative and quantitative statements that define the type, quantity, and quality of data necessary to support the decision-making process during the RI. The DQOs were developed for Passage Key ATGGR using the *Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4* (USEPA, 2006). The DQOs were developed to ensure that the following conditions are met: (1) the field sampling, chemical analyses, and physical analyses are reliable; (2) the preliminary data collected are sufficient; (3) the quality of data generated is acceptable for the intended use of the data; and (4) valid assumptions can be inferred from the data. The DQO process is fully outlined in the Final RI/FS QAPP (JV, 2015b).

2.5.2.2 Based on the DQO analysis, the following decision rules were developed and followed for the RI field activities.

Table 2-2: Decision Rules

Scenario	Decision Rule
Presence of known MEC on site	If MEC or MPPEH was found on site during the field work activities, then the UXO team responded and removed the finds through appropriate measures.
Confirmation of site boundaries	If MEC was found near the RI/FS Investigation Area boundary, then a geophysical step out procedure was used to refine boundaries/MEC impacted areas.
MEC characterization	If subsurface anomalies were found during geophysical investigation, then MEC characterization took place through an intrusive investigation of a select number of anomalies.

2.5.2.3 Based on the DQO process outlined in the Final RI/FS QAPP (JV, 2015b), and the development of decision rules outlined above, the following project DQOs shown in **Table 2-3** were established for the RI/FS at Passage Key ATGGR. Detailed DQOs are provided in the Final RI/FS QAPP (JV, 2015b).

2.5.2.4 Quality assurance (QA) / QC procedures outlined in the Final RI/FS QAPP (JV, 2015b) were followed closely. These procedures and the overall design of the investigation were created initially to assure that the DQOs were met. All intrusive MEC work completed at the site was overseen by the UXOQCS to verify that the JV field team completed the project as outlined in the QAPP or, where a change to the QAPP was necessary, that the change adhered to the overall intent of the work to be completed and that the DQOs outlined in the QAPP were met.

Table 2-3: Data Quality Objectives

DQO 1:	
Intended data use:	To define current and future land use
Data need requirement:	Current and future land access, development, and use
Data category:	Basic
Quantity of data:	Sufficient data to characterize current and projected human activity at Passage Key ATGGR
Data collection method:	Coordination with stakeholders
DQO 2:	
Intended data use:	To delineate nature and extent of MEC within the concentrated munitions use areas (CMUA) and non-concentrated munitions use areas (NCMUA) in the RI/FS Investigation Area
Data need requirement:	MEC potential within Passage Key ATGGR
Data category:	Basic
Quantity of data:	Any presence of MEC on the surface or subsurface of the Passage Key ATGGR
Data collection method:	Site visits, interviews, historical analysis, geophysical investigation, and intrusive investigation
DQO 3:	
Intended data use:	To update the CSM
Data need requirement:	Potential risk to human health and safety from MEC
Data category:	Basic
Quantity of data:	MEC on the surface or subsurface of the site
Data collection method:	Site visits, interviews, historical analysis, geophysical investigation, and intrusive investigation

DQO 4:

Intended data use:	To perform a MEC risk analysis
Data need requirement:	Potential risk to human health and safety from MEC
Data category:	Basic
Quantity of data:	MEC on the surface or subsurface of the site
Data collection method:	Site visits, interviews, historical analysis, geophysical investigation, and intrusive investigation

DQO 5:

Intended data use:	To complete the Decision Document
Data need requirement:	MEC hazard at site, current and future land use
Data category:	Basic
Quantity of data:	MEC on the surface or subsurface of the site
Data collection method:	MEC risk analysis, land use data, and public comment

3.0 CHARACTERIZATION OF MEC

This section presents the comprehensive project approach, methods, and operational procedures used for the RI MEC characterization performed at Passage Key ATGGR.

3.1 GENERAL

3.1.1 Identification and Evaluation of Areas of Concern

3.1.1.1 Based on the 2008 SI, the PWS, and analysis of historical aerial imagery, the Passage Key ATGGR RI/FS Investigation Area includes the area within the current FUDS boundary, as well as the other locations where Passage Key has migrated over time. The area that is the focus of the RI/FS includes approximately 649 acres, most of which is water.

3.1.1.2 The RI/FS Investigation Area description, environmental setting, and land use are provided in Section 1.2. The RI/FS Investigation Area is shown on **Map B-2**, included in **Appendix B.**

3.1.2 Overview of MEC Investigation Field Activities

3.1.2.1 Field activities for the RI at the Passage Key ATGGR were conducted on-site between 2 November 2015 and 15 December 2015. The following major tasks (or Definable Features of Work [DFW] as referenced in the RI/FS QAPP) were performed to meet the project objectives:

- Task 1: Pre-Mobilization Activities;
- Task 2: Mobilization/Site Preparation;
- Task 3: Implementation of a marine GSV program;
- Task 4: DGM surveys, including marine DGM transect and grid surveys;
- Task 5: Analog (i.e., mag and dig) geophysical transect surveys;
- Task 6: Geostatistical Analysis;
- Task 7: Marine anomaly reacquisition and marking;
- Task 8: Intrusive investigation, including onsite MEC demolition activities and proper disposal of all recovered MD and non-MD material IAW federal, state, and local regulations;
- Task 9: Anomaly Resolution;
- Task 10: Demobilization; and
- Task 11: RI/FS Report.

3.2 CHARACTERIZATION OF MEC

3.2.1 Task 1: Pre-Mobilization Activities

Prior to mobilizing to the site, the JV prepared and gained USACE approval and regulatory concurrence on the QAPP, Accident Prevention Plan (APP), Explosives Site Plan (ESP), and Dive Plan. In addition, the JV set up a GIS database and project ftp site that was used to transfer files between the JV, subcontractors, and USACE.

3.2.2 Task 2: Mobilization/Site Preparation Activities

3.2.2.1 Mobilization

3.2.2.1.1 The subcontractor, NAEVA, assisted by 3D Geophysics, Inc. (3Dg), team mobilized to the site on 29 October 2015, and the UXO dive team mobilized to the site on 1 November 2015. Mobilization included the following:

- Identifying/procuring, packaging, shipping, and inventorying project equipment;
- Coordinating with local agencies, including police, hospital, and fire department, natural resource and law enforcement personnel, as well as the USCG;
- Coordinating communications and logistical support (e.g., establishing radio communication on the water and cellular communication with resources on land);
- Finalizing operating schedules;
- Testing and inspecting equipment;
- Assembling and transporting the work force;
- Coordinating the District Dive Coordinator (or designated dive inspector) review and acceptance of the dive team (these activities continued during the first week of the field effort);
- Conducting site-specific training on the QAPP and MEC procedures and hazards; and
- Verifying that all forms and project documentation are in order, and JV personnel understand their responsibilities regarding completion of project reporting requirements.

3.2.2.1.2 The MEC field team consisted of a Senior UXO Supervisor (SUXOS), a UXO Safety Officer (UXOSO) / UXO Quality Control Specialist (UXOQCS), and four UXO Technician IIs (UXOTIIs) of which three were qualified as UXO Technician IIIs (UXOTIIIs) and served as UXO Technician IIIs when needed. The SUXOS and UXOSO/UXOQCS coordinated activities with local officials on a daily basis.

3.2.2.2 On-Site Document Review and Communication/Logistics

The UXO and geophysical teams reviewed all documents prepared during Pre-Mobilization Activities (Task 1 or DFW1) before commencing field activities. The site management team also established communication and logistics for project coordination. Before engaging in any activities on site, all personnel reviewed the QAPP, APP, ESP and Dive Plan. A Daily Safety Tailgate Meeting was completed every morning before the commencement of the day's activities. Daily Activity Reports, Daily Site Safety Tailgate Meeting Reports, Daily QC Reports (DQCRs), and field forms/notes are included in **Appendix E**.

3.2.2.3 Site-Specific Training

Site-specific training was conducted on 30 October 2015 for geophysical subcontractor personnel and on 2 November 2015 for the UXO-qualified dive team and boat captain IAW the RI/FS QAPP. The training included protected species monitoring and avoidance measures for both subcontractor and UXO personnel. Additional UXO team training included hand-held GPS receiver use during data collection, equipment familiarization and use, dive-specific training, as well as other topics. Subcontractor and UXO personnel reviewed and signed the project planning documents, to include the QAPP, APP, ESP, and Dive Plan. A site orientation and review of the RI/FS project goals was also included.

3.2.2.4 Vegetation Clearance and Surface Removal

The majority of the RI/FS Investigation Area consists of water, so vegetation clearance and surface removal activities were not required. For the small amount of land-based investigation work, it was carried out by qualified UXO technicians using analog instrumentation, so vegetation clearance and surface removal activities were also not required.

3.2.2.5 Location Surveys and Mapping

3.2.2.5.1 Location surveys and mapping activities to establish survey control monuments used as RTK DGPS base station locations for the project were performed IAW the procedures outlined in the Final RI/FS QAPP (JV, 2015b). George F. Young, Inc., a FL professional licensed surveyor (PLS), established two control monuments on Anna Maria Island south of the Passage Key ATGGR RI/FS Investigation Area for use as base station control points for the RTK DGPS that was used to position DGM data. The location surveys and mapping task included the following:

- Establishing site controls relative to the FL State Plane West projection, North American Datum 1983 (NAD 83), in units of U.S. survey feet.

3.2.2.5.2 Survey control locations used during the DGM surveys are listed in **Table 3-1**. The geophysical grid locations are contained within the MS Access Database in the DGM data found in **Appendix H**.

Table 3-1: Passage Key ATGGR Temporary Control Monuments

Monument ID	Easting (feet)(1)	Northing (feet)(1)	Elevation (feet)(2)
GPS1	1165688.56	414858.56	4.85
GPS2	1165809.69	415184.42	4.67

(1) The coordinates are provided in FL State Plane Zone West NAD 83, with units of U.S. survey feet.
(2) Elevation data is provided in North American Vertical Datum 88 datum with units of feet.

3.2.3 Task 3: Geophysical System Verification

3.2.3.1 Introduction

3.2.3.1.1 The JV used the GSV process to monitor and verify geophysical equipment functionality during the DGM surveys. The GSV process consisted of an IVS and a blind seeding program during production mapping that was conducted IAW the Final RI/FS QAPP (JV, 2015b) and the Final GSV Report (ESTCP, 2009). A modified GSV process was used to monitor data quality during the marine DGM surveys. Although the GSV process is not directly applicable to analog procedures (because there is no recordable response to verify), UXO technicians also tested their analog sensors on land at a test strip each day to ensure they obtained a positive response. As such the sections that follow apply only to DGM procedures.

3.2.3.2 Marine IVS Design and Results

3.2.3.2.1 The IVS provided a means to verify on an ongoing basis that the geophysical equipment was operating properly. The IVS was established in an area adjacent to the RI/FS Investigation Area that was relatively free of background anomalies prior to the start of the field activities. The IVS was seeded with two 25-lb weights. IVS construction details, procedures, and results of the IVS are detailed in the Final IVS Letter Report included in **Appendix D**.

3.2.3.2.2 The EM61-Flex3 was tested daily at the IVS before DGM surveys. IVS-specific data and results collected daily during the DGM survey effort are provided with the DGM data in **Appendix H**. Data collected on each day of DGM at the IVS show repeatable results for the seed items. All peak responses from the IVS seed items were observed to be greater than the minimum anomaly selection threshold of 15mV as derived from site background noise statistics and within the two-meter positioning measurement quality objective. These results demonstrate that the digital geophysical equipment was functioning within a tolerable range to achieve the necessary detection performance metrics.

3.2.3.3 Blind Seeding

3.2.3.3.1 A blind seeding program was instituted in the marine DGM grids to provide ongoing monitoring of the geophysical instrumentation detection performance. All seeds were blind to the geophysical data processing teams. Blind seed items (BSIs), consisting of a 25-lb weights, were placed within DGM grids at a frequency that ensured at least one seed would be encountered by the marine DGM team per day. Seeding was performed IAW the Final RI/FS QAPP (JV, 2015b). The locations of the BSIs were surveyed using RTK DGPS.

3.2.3.3.2 The depth, type, geophysical response, and offset of each BSI placed within the DGM grids are provided in the MS Access Database in **Appendix H**. The BSIs placed within the DGM grid survey areas were observed in the geophysical data with a signal greater than the minimum anomaly selection threshold and within the two-meter offset metric established in the Final RI/FS QAPP (JV, 2015b), except for the BSI placed in grid PKG-08. During the emplacement of BSI PKG-08, the NAEVA/3DG field team did not notice that the GPS had lost

RTK Fix and that the positional accuracy of the GPS was decreased. RCA 2 details the evaluation of the positional inaccuracies for this BSI (see **Appendix F**).

3.2.4 Task 4: DGM Surveys

3.2.4.1 Geophysical Equipment

3.2.4.1.1 The JV performed marine DGM transect and grid surveys using the Underwater UXO Towed Array (UUTA) developed by 3Dg at Passage Key ATGGR. The UUTA consists of a high-power EM61-Flex3 system, based on the Geonics EM61-MK2 metal detector sensor, mounted to a support platform (whale tail) supported by a rigid down-rigging system. The EM61-Flex3 sensor consists of two air-cored 1.0 x 0.5 meter receiver coils arranged side-by-side with the long axis oriented in the across-line direction inside a 2.0 x 0.5 meter transmitter coil. The UUTA downrigger is equipped with a control surface (hydrofoil or “elevator”) and an electric winch system that allows the system operator to control the height of the coil above the sea bottom during data acquisition. Several sensors are integrated with the UUTA to provide position control of the Flex3 coil platform. A pressure transducer on the platform measures the accurate depth of the receiver coils. An inclinometer measures the exact angle of the downrigger and is used to determine horizontal offset of the coil platform from the boat.

3.2.4.1.2 DGM sensor positioning was supplied by RTK DGPS during all marine DGM surveys. The UUTA uses two RTK receivers to accurately measure the exact position and heading of the boat. The rigid downrigger is designed to keep the sensor platform in-line with the keel of the boat and the two RTK GPS receivers so that accurate geolocation of the platform can be achieved. The RTK DGPS base station used during the surveys was set on a survey control point and checked daily at a second survey control point, established or identified by a FL PLS to Class I, third order accuracy. The EM61-Flex3 sensor records two time gates (Early Gate [ChE] and Late Gate [ChL] roughly equivalent to CH2 and CH3, respectively, on the standard EM61-MK2) at a 10 Hertz rate. Datasets were recorded in a single file in the MLFXMarine data collection software. All standard instrument checks, including static background, spike, cable shake, personnel checks, and latency checks were performed at a frequency IAW the RI/FS QAPP (JV, 2015b). The results of these QC checks are presented in Section 4.1.3 of this RI/FS Report.

3.2.4.1.3 The JV performed analog transect investigations using White’s All-Metals Detectors. Analog geophysical anomalies were located using a handheld GPS (e.g., Trimble GeoXH). Equipment QC checks were conducted by UXO Technicians every day prior to commencing field work. The results of these QC checks are presented in Section 4.1.3 of this RI/FS Report and are included in the Analog Investigation MS Access Database contained in **Appendix G**.

3.2.4.1.4 All position data was collected and reported in reference to the FL State Plane West projection, NAD83, in units of U.S. survey feet.

3.2.4.2 Survey Types

3.2.4.2.1 The RI field objective was to perform digital and analog geophysical surveys to determine the nature and extent of MEC across Passage Key ATGGR. Land-based and near-shore (e.g., less than three-foot water depth) analog (i.e., mag and flag) transect surveys were performed to determine if munitions-related material was present within the small section of exposed sand bar and surrounding shallow water environment at the center of the RI/FS Investigation Area. The underwater DGM surveys included two-meter wide DGM transects as well as 100% DGM coverage of 12 50-foot by 200-foot grids. **Table 3-2** presents a summary of the investigated areas by survey method. Refer to Section 4.1 for a complete summary of the investigation results.

Table 3-2: Summary of Survey Investigations

Survey Method	Area Investigated (Acres)	Transect Length (Miles)
DGM Transects	10.65	13.4
DGM Grids	5.02	N/A
Analog Transects	0.63	1
Overall Totals	**16.3**	**14.4**

3.2.4.2.2 The White's all-metal submersible detector and the Subsurface Instrument ML3 were the selected analog detection instruments used to accomplish the intrusive investigation objectives for this project. An ITS was established on Passage Key to verify functionality and simulate the techniques needed to detect MEC while working underwater. Two industry standard objects (schedule 80 pipe nipples) were buried below the ground surface. The ITS was swept at the beginning of fieldwork activities each day using a White's all-metal submersible detector and Subsurface Instrument ML3. The SUXOS and UXOQCS/UXOSO performed additional training to demonstrate the required level of proficiency at the ITS on a daily basis. The ITS was cleared of all anomalies prior to use.

3.2.4.2.3 A Trimble GeoXH hand-held GPS receiver was used to navigate to the anomaly locations, as well as to record location within the nearshore and land areas associated with Passage Key where analog data collection took place. Each morning, prior to the start of fieldwork activities, the SUXOS and UXOQCS/UXOSO drove to a known benchmark location (USCG Station Cortez, Cortez, Florida) and checked to make sure the hand-held GPS positioning was correct. They compared the latitude and longitude shown on the GPS receiver with that of the benchmark. Throughout the field effort, the GPS receiver was found to be in good working order, with coordinates noted to be at the benchmark where the checks were conducted. This information was noted in the field notebook and a log of the equipment checks was maintained and provided with the daily report and DQCR for each day of field work.

3.2.4.2.1 DGM Transect Surveys

NAEVA/3Dg collected approximately 13.4 miles (10.65 acres) of marine DGM transects using the EM61-Flex3. The nominal DGM transect spacing was 123 meters, or approximately 400 feet, but varied in some areas due to water depth. **Map B-6**, provided in **Appendix B**, illustrates the locations of transects within the RI/FS Investigation Area.

3.2.4.2.2 DGM Grid Surveys

3.2.4.2.2.1 A total of 5.02 acres of marine DGM grid data were collected across 100% of 10 50-foot by 200-foot grids (4.06 acres) in potential non-target areas, as well as two 50-foot by 200-foot grids (0.96 acres) in potential target areas. The locations of DGM grids were determined after the marine DGM transect surveys were completed and after an evaluation of the anomaly density and distribution of the transect data in VSP determined the approximate boundary of high anomaly density areas (i.e., potential target areas; see Section 3.2.6 for further details of the VSP analysis). Within the large identified potential target area, two 50-foot by 200-foot grids were placed to determine the nature of anomalies. The non-target area grids were placed randomly in accessible areas with water depths adequate for marine DGM surveys. **Map B-6**, provided in **Appendix B**, shows the locations of the DGM grids and transects in relation to the high anomaly density areas.

3.2.4.2.2.2 The 3.66 acres of non-target area DGM grids were randomly located throughout the low anomaly density areas (i.e., outside the high anomaly density areas) of the RI/FS Investigation Area to confirm that the UXO density outside of the target areas is less than 1.0 UXO/acre to a 95% confidence level.

3.2.4.3 Data Processing

3.2.4.3.1 NAEVA used Geosoft's Oasis montaj, including the UX-Process and UX-Detect Modules, to process, interpret, and present the marine DGM data. The JV performed daily QC and data processing of all data sets in the same manner as demonstrated and established at the IVS. The DGM data was processed, and the anomaly selection criteria were established to determine anomalies potentially representative of UXO (refer to Section 3.2.4.6). These selection criteria included peak anomaly response and HAWID. The JV implemented a sequential anomaly selection and excavation feedback process to refine the anomaly selection process. The DGM data was acquired, processed, and QC checked IAW the Final RI/FS QAPP (JV, 2015b), DID WERS-004.01, EM 200-1-15, and the *Ordnance and Explosives Digital Geophysical Mapping Guidance Operational Procedures and Quality Control Manual (DGM QC Guidance)* (USAESCH, 2003). DGM data processing consisted of the initial field processing; standard data analysis (e.g., leveling and performing latency corrections); and data storage and preliminary processing as outlined in the Final RI/FS QAPP (JV, 2015b).

3.2.4.3.2 After DGM data processing, the DGM transects were evaluated in VSP to determine the anomaly density and distribution across the site to identify potential CMUAs. Four potential

CMUAs, or DUs were identified during the VSP analysis. See Section 3.2.5 for further details of the VSP analysis.

3.2.4.4 Quality Control

Data processing QC metrics were tracked daily throughout the life of the project. The Senior Geophysicist, or his designee, performed QC measures not only on the QC instrument function tests, but also on the data collected by the EM61-Flex3 sensor. The following parameters were analyzed:

- Static repeatability
- Dynamic repeatability
- Along-line measurement spacing
- Speed
- Coverage
- Target selection
- Anomaly resolution
- Geodetic equipment functionality
- Geodetic internal consistency
- Geodetic accuracy
- Geodetic repeatability

3.2.4.5 Data Management

All data related to DGM surveys were managed using Geosoft® Oasis montaj software. All spatial data (e.g., anomaly locations) were managed using a GIS database and are stored in Environmental Systems Research Institute® (ESRI)-compatible GIS formats, primarily ArcView shape files. GIS data created for this project is provided IAW DID WERS-007.01 and can be found in **Appendix M**. Data were stored in site-specific folders based on individual field efforts, data type, and file extensions. All DGM data were provided electronically to the USACE QA Geophysicist for QA, and the USACE QA Geophysicist accepted all geophysical data. Data were provided via the NAEVA ftp site and were backed up on the ARCADIS internal network and project workstation.

3.2.4.6 Anomaly Selection

3.2.4.6.1 Preliminary Anomaly Selection

3.2.4.6.1.1 The preliminary anomaly selection criteria were developed based on the analysis of EM61-Flex3 background noise observed at the IVS area adjacent to the RI/FS Investigation Area, and through discussions with the USACE Geophysicist. As discussed in the IVS Letter

Report (see **Appendix D)**, the minimum target response threshold for the RI is 15 millivolts (mV) on the EM61-Flex3ChL. However, due to elevated levels of observed noise within the transect data resulting from unfavorable ocean currents and other external factors, the agreed-upon target response threshold used for transect target selection, and subsequent density analysis, was 25mV on the ChL. However, the 15mV anomaly selection threshold was maintained for grids surveyed within the RI/FS Investigation Area because they had considerably less noise then the DGM transects since they were oriented with the wind and current as opposed to the DGM transects, which were oriented orthogonal to the wind and current directions. See RCA1 in **Appendix F** for further discussion of the noise levels in the DGM transect data. Based on response curves derived from measurements acquired with the EM61-Flex3 during free air tests, the 25-mV threshold enabled detection of a Medium ISO40 sized object in a horizontal orientation to a total distance of 33 inches below the sensor.

3.2.4.6.1.2 DGM anomalies on grids were selected from the gridded data using the Blakely Test target selection algorithm in Oasis montaj. DGM anomalies on transect data were selected from the profile data using the "pick peaks along profile" target selection method in Oasis montaj. Target review consisted of manually evaluating all selected targets and removing or merging multiple targets associated with large anomalies. Where necessary, targets were moved to the location of the peak response or target center of a given anomaly footprint.

3.2.4.6.2 Anomaly Prioritization

3.2.4.6.2.1 All DGM grid anomalies (100%) that had a ChL (late gate) peak response greater than 15 mV were selected as candidates for intrusive investigation. All DGM transect anomalies within the three small high anomaly density areas that had a ChL (late gate) peak response greater than 25 mV were also selected as candidates. Additional anomaly selection criteria were evaluated to develop a prioritization method for selecting anomalies to intrusively investigate. The JV used the HAWID, which is a measure of the width of the anomaly at the amplitude that is half of the peak amplitude response to establish an anomaly prioritization protocol for the anomalies inside the four high anomaly density areas and within the full coverage grids. **Table 3-3** presents the anomaly prioritization and dig percentages transects in high density areas that was established in the Anomaly Selection Technical Memorandum (see **Appendix F**). The higher priority digs (e.g., 1 – 3) were varied to capture a large percentage of the larger anomalies, which are more likely to be representative of the anticipated MEC at the site (e.g., 2.25-inch rockets, 100-lb bomb and larger).

Table 3-3: Initial Anomaly Prioritization for DGM Transects in Elevated Anomaly Density Areas

Group	ChL (Late Gate) Response (mV)	HAWID (feet)	Dig Percentage
1	≥ 30 mV	> 4.3	41%
2	≥ 30 mV	≤ 4.3	24%

Group	ChL (Late Gate) Response (mV)	HAWID (feet)	Dig Percentage
3	≥ 25 and < 30 mV	> 4.3	10%
4	Remaining anomalies ≥ 25 mV	HAWID Not Factored	11%
5	Remaining anomalies < 25 mV	HAWID Not Factored	14%

3.2.4.6.2.2 Due to a significant number of "No Finds" during intrusive investigation, the anomalies selected for intrusive investigation were modified as follows in RCA 1:

1. To avoid digging DGM transect anomalies that were due to noise, the dig list for the DGM transects was modified for intrusive investigation conducted after 20 November 2015 as follows:
    a. Anomalies with responses below 30 mV were not intrusively investigated. This means Group/Target Types 3, 4, or 5 anomalies that were not already intrusively investigated were removed from the dig list. This also means that no anomalies were intrusively investigated within DU4 since all of the anomalies within that DU were either group 4 or 5 anomalies.
    b. Additional Group/Target Type 1 and 2 DGM targets within DUs 1-3 that had a ChL response greater than 100 mV were added to the dig list to minimize the number of "no-finds" encountered moving forward.
2. Within DGM grids, the JV continued to dig all targets with normal decay since the DGM grids did not appear to be affected by higher noise levels than the IVS.

3.2.4.6.2.3 Within each group, anomalies were selected at random and placed on the dig sheet. The Senior Geophysicist, or his designee, reviewed all transect and grid survey data to ensure that anomalies with responses equal to or greater than the anomaly selection threshold and those that exceeded other anomaly selection criteria were included on the dig list.

3.2.4.7 Dig Sheet Development

3.2.4.7.1 Following the selection of anomalies from the geophysical data evaluation, the anomaly locations and characteristics were compiled into a dig list. The Senior Geophysicist, or his designee, exported the target database from Geosoft Oasis montaj to Excel and verified the Excel file was in the proper format and populated with the correct dig list. The Senior Geophysicist, or his designee, assigned each anomaly a unique target identifier and entered the corresponding information for the target into the database. The following information was included in the database for each anomaly:

- Grid or transect ID;
- Unique target ID, including the grid or transect ID;

- Easting and northing position;
- Channel 2 response amplitude.

3.2.4.7.2 Dig lists developed following digital data analysis are presented along with the preliminary intrusive investigation results in **Appendix G**. The final, QC'ed dig results are presented in the MS Access Database contained in **Appendix G**.

3.2.5 Task 6: Geostatistical Analysis

After the initial DGM transect targets were selected, the JV used VSP to evaluate the anomaly density and distribution of targets to determine the approximate locations of high anomaly density areas that were indicative of potential target areas. The target locations and DGM transect swaths were imported into VSP and evaluated using the geostatistical analysis tool. For this investigation, high anomaly density areas were defined as areas at least two acres in size where anomalies with responses greater than 25 mV were present and anomaly densities were greater than 20 anomalies/acre. The results of the VSP analysis were presented to the USACE QA Geophysicist, who concurred with the findings. The Anomaly Selection Technical Memorandum provides further details on the VSP analysis (see **Appendix F**). **Map B-6**, included in **Appendix B**, shows the locations of transects, high anomaly density areas, and the anomalies identified along transects**.** The JV concluded from the VSP analysis that there were four high anomaly density areas, or DUs within the RI/FS Investigation Area. Two 50-foot x 200-foot grids were placed within the large central high anomaly density area (DU 1). Each of the grids was surveyed using the EM61-Flex3 and all anomalies above the 15mV anomaly selection threshold that had normal decay were investigated. The three smaller high anomaly density areas were assessed by investigating anomalies detected within transect data in these areas. For anomaly investigation along transects, the anomaly prioritization protocol discussed in Section 3.2.4 was utilized. The smaller high anomaly density areas were generally believed to be edge effect artifacts of the VSP analysis (i.e., they were due to a small cluster of anomalies in a small area at the edge of DGM data) or due to the increased noise levels seen in the DGM transect data.

3.2.6 Task 7: Anomaly Reacquisition

3.2.6.1 Anomalies detected during the marine DGM surveys were reacquired for intrusive investigation. To complete anomaly reacquisition, the boat maneuvered itself into position over the listed GPS coordinates of the anomaly and a marker buoy was placed in the water.

3.2.6.2 Sea state, tides, current, wind and diving method determined the type of moor to be used, but generally a three-point moor was preferred (two anchors forward and one anchor aft). A heavy clump (non-magnetic) was placed over the side with a descent line (the descent line is a line that is tensioned on the front of the dive platform and attached to the clump allowing the diver a means to accurately go from the seafloor surface to the search area and have a clear and distinct means of resurfacing next to the dive platform). The diver followed the descent line to the clump and conducted a circle search using either the SSI ML3 or the submersible White's

BeachHunter 300 All-Metals detector to locate the anomaly. Upon location of an anomaly source, the diver excavated the item using the procedures listed in Section 3.2.8.1. When anomalies could not be reacquired (i.e., they were "no contact"), the diver increased the circle line search radius to 10 ft to enhance the chance of locating the anomaly. All "no contact" anomalies initially investigated with the SSI ML3, which is a magnetometer, were returned to and investigated with the White's BeachHunter 300 All-Metals detector. In addition, marine reacquisition procedures were verified at the marine IVS to demonstrate that the reacquisition team's procedures were adequate to reacquire targets.

3.2.7 Task 8: MEC Removal and Management

Surface and intrusive anomaly investigations were conducted according to the methodology established in the Final RI/FS QAPP (JV, 2015b) and summarized below. The results of the intrusive investigation are discussed in Section 4.1.3.

3.2.7.1 Excavation Procedures

Results of the intrusive investigation are provided in the MS Access Databases in **Appendix G**. Photographs of the anomaly excavation process are provided in **Appendix H**.

3.2.7.1.1 Marine Anomalies

3.2.7.1.1.1 Excavation was conducted using two possible ways; an air lift or a water jet. Due to the nature of the bottom (sandy, clay, mud), excavation naturally had gently sloped sides so there was no danger of excavation collapse. The maximum depth of excavation was four feet, or the limit of the equipment used for excavation. Sediment moved by currents tends to fill excavations and they return to the steady state depth. Excavation time varied widely depending on current, visibility, depth of item (under sand), and the number of items in a dig.

3.2.7.1.1.2 *Air Lift* – The airlift is relatively non-invasive and was a faster means of excavating sand and gravel. Excavation was accomplished by placing the working end of the lift on the bottom and allowing air pressure to cause a vacuum and pull sand from the bottom. The sand was discharged immediately behind the diver.

3.2.7.1.1.3 *Water Jet* – The water jet is a self-contained apparatus that was used when the diver was unable to operate the airlift due to clutter on the bottom, or the bottom was of a compacted material such as clay. Sea grass presence was a factor in determining which excavation technique was used to minimize impacts during excavation.

3.2.7.1.2 Land / Near-Shore Anomalies

Analog anomalies detected on land or near-shore were accessed and excavated by the UXO team using standard hand tools. Once the anomaly was uncovered, it was visually inspected, identified, and assessed for hazards by two UXO personnel. If the subsurface contact proved to be non-MEC, it was removed, and the hole rechecked with a magnetometer. If there was no response left in the hole, it was refilled and tamped. Throughout the excavation, the UXO Technician used the metal detector to check and verify the location of the anomaly. Anomalies were pursued to a maximum depth of four feet, unless determined otherwise by the SUXOS. The anomalies were excavated, identified, and a description of the item and its disposition was recorded in the handheld GPS (e.g., Trimble GeoXT).

3.2.7.2 Munitions with the Greatest Fragmentation Distance

The munition with the greatest fragmentation distance (MGFD) is the munition with the greatest fragment distance that is reasonably expected (based on research or characterization) to be encountered within the MRS. As specified in the approved ESP (USACE, 2015a), the MGFD was the 100-lb AN M30A1 Bomb.

3.2.7.3 Minimum Separation Distance

Based on the characteristics of the MGFD, the minimum separation distance (MSD) is the protective distance at which personnel must be separated from an intentional or unintentional detonation. The hazardous fragment distance (HFD), also known as the 1-in-600 distance, is the calculated distance at which a fragment impacts at 58 foot-pounds, or more, of energy. This is also the distance at which non-essential personnel must be kept from MEC activities for unintentional detonations for fragmenting munitions. The team separation distance (TSD) is the distance that essential personnel must be separated by while conducting MEC activities on an MRS. Normally, this is the K40 distance of the NEW of the MGFD for the MRS. For the Passage Key ATGGR, the HFD established for nonessential personnel was set at a distance of 413 feet, and the TSD was determined to be 154 feet.

3.2.7.4 Exclusion Zone

Exclusion zones (EZs) were established during intrusive investigations at Passage Key ATGGR to protect essential and nonessential personnel from unintentional and intentional detonations. The primary protective distance is provided above in Section 3.2.7.3. The applicable EZ distance was enforced during all intrusive investigations at Passage Key ATGGR.

3.2.7.5 Identification and Removal

3.2.7.5.1 Surface and intrusive investigation activities were conducted by the UXO-qualified dive team, consisting of the SUXOS, UXOSO/UXOQCS, and four UXOTIIs (three of which were qualified as UXOTIIIs and served as UXOTIIIs when needed). Items that were considered MPPEH were inspected by the UXOTII (who was qualified as a UXOTIII) and then confirmed by the UXOQCS.

3.2.7.5.2 The UXO Dig Teams identified the source of DGM and analog detected anomalies and logged the anomaly characteristics real-time in the field. Target anomaly characteristics logged included, but were not limited to: item category (e.g., MEC, MD, seed, no contact, etc.); item description (e.g., scrap metal, 2.25-inch aerial rocket); estimated weight of item; estimated depth of item; and confirmation of hole cleared. Any suspected MEC items encountered were photographed for documentation purposes. At the end of each day, dig data were included in the anomaly log provided with the Daily Report and uploaded to the project FTP site for inclusion in the project MS Access databases.

3.2.7.6 Inspection of Material Potentially Presenting an Explosive Hazard

During the course of the RI intrusive activities, military munitions-related items were considered MPPEH until properly inspected. As it was encountered in the field, MPPEH was inspected by a UXOTII and a UXOTIII and classified as MD or material documented as an explosive hazard (MDEH).

3.2.7.7 Material Documented As Safe

3.2.7.7.1 Items classified in the field as MD posed no explosive hazard. MD (other than the expended small arms ammunition) were retained and included in the detonation shots to remove their munitions-like appearance. Expended small arms ammunition (i.e., expended cartridge casings) were collected and removed from the site for proper handling. These items were certified and verified as free from explosives, and stored in a locked container. The storage container was under the control and custody of the JV from the time the MD was inspected and certified until turned-over for final disposition.

3.2.7.7.2 Following recovery, the SUXOS inspected the MD and the UXOQCS performed a re-inspection to verify the process and ensure that only inert items were stored in the locked container. The SUXOS and UXOQCS inspection was also conducted immediately prior to the turn-in of MD (small arms ammunition) with the completed Form 1348-1A signed by the SUXOS and UXOQCS to certify and verify the material listed had been 100% inspected by a UXOTII, 100% re-inspection by an UXOTIII, and classified as MD. After the Form 1348-1A was signed by the SUXOS and UXOQCS, a copy was maintained and the original accompanied the MD to its final disposition. A copy of Form 1348-1A is provided in **Appendix J**. The total amount of MD turned-in was five lbs.

3.2.7.8 Munitions and Explosives of Concern Treatment

Four UXO were identified during the RI/FS field activities, a 37-millimeter (mm) projectile (fuzed), a 4.5-inch aerial rocket, and two bomb burster/fuzes from 100-lb photoflash bombs. The 4.5-inch aerial rocket could not be confirmed as practice and, therefore, it was treated as a HE rocket. These UXO items were consolidated at two of the locations where the items were found and detonated. **Map B-10** included in **Appendix B** details the locations of demolition activities performed in support of the RI/FS. The two locations where UXO were consolidated prior to detonation were selected because they were determined to provide a safe location (e.g., away from structures, boat traffic, and natural resources) and adequate buffer for securing and monitoring the exclusion zone.

3.2.8 Task 9: Anomaly Resolution

Anomaly resolution was not performed on anomalies identified in the marine DGM datasets. For the land and near-shore analog transects, the UXOQCS performed anomaly resolution on all detected anomalies to ensure that the source of the anomaly was removed using the procedures included in the Final RI/FS QAPP (JV, 2015b).

3.2.9 Task 10: Demobilization

The UXO team demobilized once all field activities were completed. All wastes were removed from the site immediately upon completion of each day's field activities. Therefore, no post-activity cleanup was required. A post-activity inspection was conducted by the UXOQCS to ensure the staging areas were left clean.

3.2.10 Task 11: Final Report

This RI/FS documents the field procedures and results of the RI investigation and is written IAW the PWS and applicable guidance documents as outlined in Section 1.

3.3 CHARACTERIZATION OF MC

MC sampling, IAW the Final RI/FS QAPP (USACE, 2015b), was not conducted as part of the RI/FS field activities. Due to the dynamic coastal environment at the site and lack of a source of MC, sampling for MC was not needed.

3.4 DEVIATIONS FROM THE FINAL QAPP

3.4.1 No significant deviations from the Final RI/FS QAPP occurred, however, one field change was required based on the site conditions. This change was documented in a field change request (FCR), which is included in **Appendix G** and is briefly outlined below.

- FCR 1 – Changed the reacquisition process from that described in Standard Operating Procedure SOP-03 to allow placement of the clump marking the anomaly location by hand using a GPS with sub-meter, or better, accuracy. This change was necessary due to the rougher sea conditions experienced at Passage Key in November and December 2015.

4.0 REVISED CONCEPTUAL SITE MODEL AND REMEDIAL INVESTIGATION RESULTS

4.0.1 This section presents the results of the RI, including the nature and extent of MEC and the revised CSM for the former Passage Key ATGGR. The CSM is based on the physical and ecological profile information (as presented in Section 1) and field data collected during the RI (as presented in this section and Section 3).

4.0.2 The field data are presented within the following sections and correspond to the field task components used to achieve the Passage Key ATGGR RI goals. For specific details/definitions of these tasks and equipment used, see Section 3. The main field task components are listed below:

- DGM data collection, processing, analysis and anomaly selection;
- Anomaly reacquisition;
- Intrusive investigation of reacquired anomalies; and
- Analog data collection and intrusive investigation ("mag and dig").

4.0.3 The following sections detail the results of these activities.

4.1 MUNITIONS AND EXPLOSIVES OF CONCERN FINDINGS

4.1.1 Marine Environment Geophysical Results

The following sections present the results of the marine DGM transect and grid surveys and analog transect surveys (i.e., mag and dig) conducted at Passage Key ATGGR. The marine DGM transect surveys covered approximately 10.65 acres (or 13.4 miles) across the entire site within the marine environment and the analog transects covered approximately 0.63acres (1 miles) across the land and shallow marine environment. The marine DGM grids covered 5.02 acres. A total of 192 anomalies selected from the marine DGM transect and grid surveys were reacquired and intrusively investigated, while 20 anomalies were detected and intrusively investigated on the analog transects. **Map B-7** shows the results of the DGM survey and targets selected for intrusive investigation. The intrusive investigation results are discussed in Section 4.1.3.

4.1.1.1 Marine DGM Transect Survey

4.1.1.1.1 Using an EM61-Flex3 sensor, a total of 13.4 miles of marine DGM transect surveys were performed within the RI/FS Investigation Area at Passage Key ATGGR. Based on the anomaly prioritization process, 135 targets along the DGM transects were selected for reacquisition and intrusive investigation within the high anomaly density areas. The remaining DGM transect targets were either outside of potential target areas or they were not selected for investigation based on the prioritization protocol outlined in Section 3.2.4.6. The intrusive investigation results are discussed in Section 4.1.3 and included in the MS Access Database that is IAW DID WERS-004.01 and found in **Appendix H**.

4.1.1.1.2 The Senior Geophysicist, or his designee, used the marine DGM transects and anomalies as input to VSP to identify high anomaly density areas (potential target areas) within the RI/FS Investigation Area at Passage Key ATGGR. **Map B-7** shows the identified anomalies, including those selected for intrusive investigation.

4.1.1.1.3 Based on the dig results, further discussed in Section 4.1.3, one CMUA was identified: Target Area 1 that is approximately 198.5 acres in size.

4.1.1.2 Marine DGM Grid Survey

4.1.1.2.1 A total of ten 50-foot x 200-foot grids were randomly placed outside of identified high density areas and surveyed with the EM61-Flex3 sensor. An additional two 50-foot by 200-foot grids were strategically placed within the central high anomaly density area surrounding Passage Key. A total of 57 anomalies with responses greater than the anomaly selection threshold, a ChL (late gate) response of 15 mV, were selected for intrusive investigation within the DGM grids. The intrusive investigation results are discussed in Section 4.1.3 and included in the MS Access Database found in **Appendix H**.

4.1.1.2.2 While the RI/FS Investigation Area focus on the 649 acres bombing and strafing target, the investigation was designed to characterize the MRS. When designated in the INPR, the boundary and acreage were included for the entire safety fan associated with the ATGGR (more than 13,000 acres). Munitions related activities were focused at the targets on Passage Key ATGGR in the 1940s and not throughout the range safety fan. The RI transect and grid data confirmed used of the target, with the only CMUA identified at the former (historical 1940s location of Passage Key ATGGR (where the target banks were constructed and maintained). After the intrusive investigation, the MEC density within NCMUAs was evaluated in VSP to determine the upper limit of the MEC density at the Passage Key ATGGR. As noted above, Target Area 1 was determined to be a CMUA based on the intrusive investigation results. This CMUA has a total area of 198.5 acres. The remaining three target areas, as well as areas outside the four target areas, were determined to be NCMUAs based on the VSP geostatistical analysis (see **Appendix F**) and lack of munitions finds during intrusive investigation. Therefore, all areas outside of Target Area 1 are considered to be NCMUAs. **Table 4-1** presents the inputs and outputs of the Post-Survey Analysis of target of interest (TOI) Estimation/Comparison within VSP. Based on the RI results, there is at least a 90% confidence level that there are no more than 0.456 MEC/acre, or 201 unacceptable items (i.e., MEC), in the NCMUA and a 99.4% confidence level there are no more than 1.0 UXO/acre, or 441 unacceptable items (i.e., UXO), in the NCMUA.

Table 4-1: NCMUA VSP MEC Density Analysis

Inputs	
Size of NCMUA	440 acres
Amount of random DGM grid surveys	5.02 acres
Number of unacceptable items found	0
Confidence level	90%
True rate of unacceptable items in the site ranges from 0 to no more than:	1.0 per acre
Use a Bayesian method?	No
Post-Survey Analysis	
Rate Estimate	Based on observing 0 TOI and surveying 5.02 acres, the rate is 0 per acre.
Analysis Statement (1) Hold Confidence: P	You can be at least 90% confident that the unacceptable item rate is no larger than 0.45668 per acre and there are no more than 201 unacceptable items in the NCMUA.
Analysis Statement (2) Hold Rate:	You can be 99.4% confident that the unacceptable item rate is no larger than 1.0 per acre and there are no more than 441 unacceptable items in the NCMUA.

4.1.1.3 Analog Transects

Analog transects were traversed using a White's All-Metals detector along 0.63 miles of marine environment including shallow water and sand bars/near-shore areas that were inaccessible to the EM61-Flex3 sensor. A total of 20 anomalies were detected and investigated by UXO Technicians to determine the anomaly source. Two of the anomalies were seed items emplaced by the UXOQCS. The intrusive investigation results are further discussed in Section 4.1.3 and included in the MS Access Database in **Appendix H**.

4.1.2 Quality Control for Geophysical Surveys

4.1.2.1 The Senior Geophysicist, his designee, and the UXOQCS performed various QC functions in addition to evaluating the GSV results. The following sections outline the additional QC performed during the RI.

4.1.2.2 Geophysical performance metrics were evaluated during the RI to ensure that DGM and analog data met the project measurement quality objectives. **Tables 4-2** and **4-3** present the results of the QC tests conducted as part of the analog and marine DGM surveys, respectively. Based on these results, the performance criteria have been met IAW the Final RI/FS QAPP (JV, 2015b), FCRs, and RCAs approved during the field investigation.

4.1.2.3 The results of the QC tests are documented in the MS Access Database in **Appendix G**.

Table 4-2: Analog QC Results

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Results
Repeatability (instrument functionality)	All	All items in ITS detected (trains ear daily to items of interest)	Min 1 daily	Pass
Dynamic repeatability	Transects with digging	Repeat a segment of transect and show extra flags/digs not greater than the greater of 20% or 8 flags/digs, or within range of adjacent segments.	Second party repeat of 2% per lot.	Pass
Anomaly resolution	Verification checking of excavated locations (analog EMI instrument)	70% confidence <10% unresolved anomalies	Rate varies depending on lot size (see Acceptance Sampling Table in WERS DID-004.01). Lot size will be one day's worth of anomalies per team.	Pass

Table 4-3: Marine DGM QC Results

Requirement	Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Results
Static repeatability (instrument functionality)	All	Response (mean static spike minus mean static background) within ±20%	Twice daily (beginning and end of the day)	Pass
Pressure Sensor Test (Positioning Functionality)	All	The pressure sensor's depth results are required to be within 3 inches of the known depth.	Beginning of the day	Pass
Downline Data Density	All	98% <= 25 cm along line	By transect/grid or dataset	Pass
Dynamic Detection Repeatability (IVS)	IVS	Response is greater than minimum anomaly selection threshold as determined by results of initial IVS	Beginning of the day	Pass
Dynamic Positioning Repeatability (IVS)	IVS	Position offset of seed item targets <= 2.0 m	Beginning of the day	Pass
Dynamic Detection Repeatability (DGM)	DGM Grids	Response is greater than minimum anomaly selection threshold as determined by results of initial IVS	By day of data collection	Pass
Dynamic Detection Repeatability (DGM)	DGM Grids	Position offset of seed item targets <= 2.0 m	By day of data collection	All Pass, except PKG-08, which is discussed in RCA 2 in **Appendix F**
Survey Coverage (horizontal)	All	**Grids:** >90% coverage at line spacing. **Transects:** Transect spacing will not vary greater than 20% from intended spacing unless obstructions cause the separation.	By transect/grid or dataset	Pass

Requirement	Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Results
Survey Coverage (vertical)	All	98% of data at an altitude of less than or equal to 5 feet, or 1.52 meters, above the sea floor.	By transect/grid or dataset	Pass
Target Selection	All	All dig list targets are selected according to project design	By transect/grid or dataset	Pass
Geodetic Equipment Functionality	All	Position offset of known/temporary control point ≤ 10 cm.	Daily	Pass
Geodetic Accuracy	Points used for RTK base station	Project network must be tied to HARN, CORS, OPUS or other recognized network. Project control points that are used more than once must be repeatable to within 5 cm.	For points used more than once, repeat occupation of each point used, either monthly (for frequently used points) or before re-use (if used infrequently).	Pass

4.1.2.1 Daily Field Activity Records

The JV UXOQCS ensured all operational checks of instruments and equipment by site personnel were conducted, and that the appropriate log entries were made. QC inspections were performed at random, with unscheduled checks of the site to ensure personnel accomplished all work as specified in the Final RI/FS QAPP. **Appendix E** contains the daily field activity reports, DQCRs, and daily equipment check logs.

4.1.2.2 Daily QC Reports

The JV UXOQCS prepared DQCRs that were included in the daily site reports submitted to the project manager for distribution to the appropriate personnel. The DQCRs are included in **Appendix E**. Additional QC information was entered on pre-printed forms containing site and contract specific data requirements. The JV UXOQCS maintained a QC Logbook to support or supplement other data entries.

4.1.3 Intrusive Investigation Results

The following sections present the results of the intrusive investigations conducted at the Passage Key ATGGR. **Map B-8** shows the intrusive investigation results by investigation method within the RI/FS Investigation Area at Passage Key ATGGR. **Appendix G** provides the complete dig lists by the surveying methods. The results of the intrusive investigation are included in the MS Access Database included in **Appendix G**.

4.1.3.1 Marine Investigation

The results of the DGM and analog transect and grid investigations are discussed in the following sections. **Table 4-4** provides a summary of all the items recovered within the RI/FS Investigation Area at Passage Key ATGGR. It should be noted that a single anomaly often resulted in the dive team finding multiple items during the intrusive investigation; therefore, the dig results reported in **Table 4-4** do not match the number of anomalies that were dug.

Table 4-4: Intrusive Investigation Results Summary

Survey Type	UXO	MD	Small Arms Ammunition	Scrap Metal	Seed	Other (shared targets)	No Find	No Contact (or Anomalies Deeper than Four Feet)	Total
Marine DGM Transects	3	21	6	50	N/A	17	39	11	147
Marine DGM Grids	1	0	19	29	4	9	8	1	71
Analog Transects	0	0	0	20	2	0	0	0	22
Total	**4**	**21**	**25**	**99**	**6**	**26**	**47**	**12**	**240**

4.1.3.1.1 Marine DGM Transect Investigation

4.1.3.1.1.1 A total of 135 underwater anomalies were intrusively investigated along DGM transects. A total of four UXO and 21 MD items, including one intact 100-lb practice bomb that was initially identified as MPPEH and later confirmed to be MD, were recovered during intrusive investigations on the DGM transects. The UXO items included a fuzed 37mm projectile at a depth of six inches below sediment surface, a 4.5-inch aerial rocket at a depth of 12 inches below sediment surface, and the bursters/fuzes from two 100-lb photoflash bombs that were recovered at depths of six and 36 inches below sediment surface. The 4.5-inch aerial rocket could not be confirmed as practice and, therefore, it was treated as a HE rocket. The MD included various pieces of 2.25-inch rockets, 4.5-inch rockets (practice), and 100-lb bombs, as well as expended small arms ammunition. MD were recovered from depths ranging from 0 to 36 inches below sediment surface. **Map B-9** shows the locations of UXO and MD recovered during the intrusive investigation. The remainder of the items recovered consisted of non-munitions-related pieces of scrap metal, other (shared targets), no finds, and no contacts. Items classified as "other" did not fall under one of the above noted categories (e.g., a shared item across multiple anomalies, such as a long wire rope or pipe, etc.). No finds for the underwater intrusive activities were defined as anomalies that had no audible contact from the submersible analog geophysical instrument used for reacquisition and intrusive investigation. No contacts were defined as anomalies that generated an audible signal from the analog geophysical instrument during reacquisition, but were deeper than the maximum intrusive investigation depth of four feet. When anomalies could not be found, the UXO-qualified dive team conducted a circle search out to at least 10 feet from the reacquired anomaly location to confirm that they still could not find the source of the anomaly. The relatively high number of no finds along the marine DGM transects was addressed in the *Passage Key Intrusive No-Find Root Cause Analysis* (RCA1) included in **Appendix F**.

4.1.3.1.1.2 Based on the results of the DGM transect intrusive investigation, potential Target Area 1 was confirmed to contain MEC and significant quantities of MD. This area is concluded to be a CMUA. No MEC was found in potential Target Area 2; however, MD was recovered at two of the eight anomalies dug within this target area. Four of the anomalies were no finds. Target Area 2 is considered a NCMUA because MEC was not found and only 25% of the targets resulted in finding MD. Potential Target Areas 3 and 4 were also confirmed to be NCMUAs based on the lack of MEC and MD found within them. Instead, these two target areas were the result of increased noise in the DGM transect data as discussed in the *Passage Key Intrusive No-Find Root Cause Analysis* (RCA1) included in **Appendix F**. The areas outside of the four potential target areas was also determined to be a NCMUA based on the VSP geostatistical analysis (see **Appendix F**) and lack of munitions finds during the intrusive investigation of transects and grids. Therefore, all areas outside of Target Area 1 are considered to be a NCMUA.

4.1.3.1.2 Marine DGM Grid Investigation

A total of 57 DGM grid targets meeting the anomaly selection criteria were reacquired and intrusively investigated. One UXO, a bomb burster/fuze from a 100-lb photoflash bomb, was recovered from grid PKG-12 within the central high-density area. No UXO were found within the 10 randomly placed DGM grids that were designed to show that there was less than 1.0 UXO/acre to a 95% confidence level. The remainder of the items recovered from the marine DGM grids consisted of small arms ammunition, 29 non-munitions-related debris items and nine no contacts or no finds. **Map B-8** in **Appendix B** shows the locations of the items recovered within the RI/FS Investigation Area at Passage Key ATGGR. The complete dig list is provided in **Appendix J**.

4.1.3.1.3 Analog Transect Investigation

A total of 20 anomalies were intrusively investigated along the analog transect survey lines. No UXO items were identified. All 20 items were classified as scrap metal and two seed items were recovered during the analog transect investigation. The items were recovered from ground surface to 22 inches below the sediment surface. Refer to **Table 4-4** for the items recovered by survey type. **Map B-8** shows the locations of the items recovered. The complete dig list is provided in **Appendix G**.

4.1.4 Source, Nature, and Extent of Munitions at Passage Key ATGGR

4.1.4.1 Approximately 4,100 lbs of MD and non-munitions-related (non-MD) items were identified during the intrusive investigation, the majority of items (3,941 lbs) being non-MD items. Many of the cultural items/scrap metal identified during intrusive investigation were left in place as they were too large to move, therefore, weights for these items are estimates. **Table 4-5** provides a breakdown of the total MD and non-MD identified by survey type at Passage Key ATGGR. **Map B-9** shows the locations of the UXO and MD items found at Passage Key ATGGR. All of the MD identified was associated with aerial rockets, photoflash bombs, practice bombs, and expended small arms ammunition. The remainder of the anomalies recovered during intrusive investigation were associated with non-munitions-related debris, such as nails, wire, or metal pipe. The presence of UXO and MD is indicative of munitions use. The majority of MD was related to aerial rockets, photoflash bombs, and practice bombs. While the explosive hazard associated with an aerial rocket, photoflash bomb, or practice bomb is less than that of a HE munitions item, all are considered to potentially present an explosive hazard.

4.1.4.2 While the marine DGM transect results indicated four high anomaly density areas within the RI/FS Investigation Area, the results of the RI field activities indicate that much of this is a result of either MD or non-munitions-related debris, neither of which demonstrates a high explosive hazard risk. Although MD does not represent an explosive hazard, the presence of MD within the high anomaly density areas does indicate that these areas are CMUAs. Only four digs resulted in UXO finds: a fuzed 37mm projectile, a 4.5-inch aerial rocket, and two bomb burster/fuzes for 100-lb photoflash bombs. The 4.5-inch aerial rocket could not be confirmed as practice and, therefore, it was treated as a HE rocket. The locations of the UXO items are shown on **Map B-9**. A complete hazard characterization for MEC at Passage Key ATGGR is included in Section 6.

Table 4-5: Munitions Related Findings

Range	UXO	MD[1] (lbs)	Non-MD[1] (lbs)	Total[1] (lbs)
DGM Transects	3	160	3,315	3,474
DGM Grids	1	8	620	628
Analog Transects	0	0	6	6
Total	**4**	**168**	**3,941**	**4,108**

(1) The weights reflected in **Table 4-5** were estimated in the field. Form 1348-1A (**Appendix I**) was used to track disposition of approximately five lbs of expended small arms ammunition that was recovered from Passage Key and the surrounding water. Remaining items were left in place if they were not munitions or were confirmed to be MD and no longer had a munitions-like appearance. Items that could not be confirmed by the UXO dive team as MD or that still had a munitions-like appearance were addressed by detonation to render them safe and to remove their munitions-like appearance.

4.1.5 Data Usability Assessment

The JV conducted a data usability assessment to evaluate whether the MEC data collected during the RI met the MPCs and DQOs established for the project. The assessment used the outputs from data verification and data validation and involved a qualitative and quantitative evaluation of data against the MPCs and DQOs established in the Final RI/FS QAPP to determine if the project data were of the right type, quality, and quantity to support the decisions that need to be made. The data usability assessment determined that the MEC data collected during the RI met the MPCs and DQOs and was sufficient to make the decisions that need to be made as part of this RI/FS. The Data Usability Assessment Report is included in **Appendix F** of this report.

4.1.6 Remedial Investigation Field Activities Documentation

During the RI field activities, site conditions and observations were noted in the field notebook, on the field forms, and summarized in the daily reports. Copies of the relevant pages from the field notebook, field forms, and the daily reports are included in **Appendix E**. The AAR, which summarizes the field activities and findings that are presented in detail in the RI/FS Report, is also included in **Appendix E**. Site conditions and observations were also photo-documented. The photograph log is provided in **Appendix H**. Note that references to site features made in the field notes, field forms, and photograph log relate to the RI site features as depicted on the maps included in **Appendix B**; they are described based on the observations made during the RI field effort.

4.2 Revised Conceptual Site Model

The following sections present the revised CSM for MEC and MC at the Passage Key ATGGR based on the results of the data collected for the RI; these results supplement or update the previous information provided in the SI report. The preliminary CSM was developed based on the SI report and is discussed in Section 2.1. The summary of the RI results for the Passage Key ATGGR is presented in Section 4.1. The revised CSM for MEC is depicted on **Figure 4-1** for the Passage Key ATGGR as a flow chart summarizing the pathway and exposure analysis discussed below.

4.2.1 Munitions and Explosives of Concern Exposure Pathway Analysis

This section summarizes the MEC exposure pathway analysis for the Passage Key ATGGR.

4.2.1.1 Source

4.2.1.1.1 The 1993 INPR identified Passage Key as a practice bombing and gunnery range used for military training during WWII. Later reports (i.e., Supplemental INPR, ASR, SI) completed prior to the RI identified UXO items, including three 100-lb general purpose bombs and one 100-lb photoflash bomb, that were found on or near the island and detonated at the site in 1998. Prior to the start of the RI field activities in 2015, one 100-lb photoflash bomb was found and detonated at the site.

4.2.1.1.2 Intrusive investigation activities during the RI resulted in the discovery of four UXO items: a fuzed 37mm projectile, a 4.5-inch aerial rocket, and two bomb bursters/fuzes from 100-lb photoflash bombs. The 4.5-inch aerial rocket could not be confirmed as practice and, therefore, it was treated as a HE rocket. During the intrusive investigation, approximately 168 lbs of MD were recovered, with the majority associated with 2.25- and 4.5-inch aerial rockets (practice), as well as bomb fragments. These items were completely empty with no explosive filler and were consistent with historical site operations. MD recovered during the RI was found at depths ranging from the sediment surface to a maximum depth of 36 inches.

4.2.1.2 Access

4.2.1.2.1 Public access is not permitted at Passage Key, which is managed by USFWS. While Passage Key is closed to all public use due to its small size and importance to wildlife, the key and surrounding waters are frequently visited by recreational boaters. A few signs indicating "National Wildlife Refuge, Bird Sanctuary, Area Closed" were observed at the key during the RI field effort. Signs with the same message that had fallen over in the water were also noted. There were also no other signs clearly stating that access is prohibited or fences to restrict access to the key or surrounding waters. As such, receptors have access to potential MEC that might be found at the surface at the key or on the sediment surface in shallow water by walking (i.e., treading underfoot) or by handling an item found. Receptors also have access to potential MEC on the sediment surface in the surrounding waters while snorkeling, swimming, fishing, or anchoring a boat. A receptor may contact MEC in the subsurface when performing intrusive activities. While items may be potentially buried deeper than can be reached, over time an item could be exposed due to storm surge, shifting sands, currents, etc. Recreational activities at Passage Key and in the surrounding waters could disturb MEC at the surface and subsurface.

4.2.1.2.2 The future land use for the MRS is anticipated to remain the same, allowing receptor access to the surface and subsurface.

4.2.1.3 Activity

4.2.1.3.1 Although access is technically restricted at the site, there are no barriers to prevent trespassers. Current activities at Passage Key and its surrounding waters are primarily recreational (e.g., boating, fishing, swimming, etc.). The maximum anticipated depth of recreational activity is anticipated to be no greater than one foot.

4.2.1.3.2 The anticipated future land use at the MRS is the same as the current land use.

4.2.1.4 Receptors

4.2.1.4.1 Human receptors identified for Passage Key ATGGR include both current and anticipated future users. Receptors include recreational users (e.g., boaters, fishermen, swimmers), and contractors (e.g., contractors conducting studies and surveys), and trespassers.

4.2.1.4.2 Ecological receptors (biota) are identified as mammals, birds, reptiles, as well as sensitive species (refer to **Table 1-1**) known to be present at the MRS or, based on the MRS physical setting (detailed in Section 1.2.7), reasonably anticipated to be present on a transient basis.

4.2.2 Munitions and Explosives of Concern Exposure Conclusions

4.2.2.1 The information collected during the RI was used to update the preliminary MEC CSM for Passage Key ATGGR and to identify complete, potentially complete, or incomplete source-receptor interactions for the RI/FS Investigation Area for current and anticipated future users. An exposure pathway is considered incomplete unless all of the following elements are present: (a) MEC contamination; (b) a receptor that might be affected by that contamination; and (c) a method for the receptor to be exposed to (i.e., come into contact with) the contamination. If all of these elements are present, an exposure pathway is considered complete. If all MEC found have been detonated or removed to address the safety hazard at the MRS, the pathway may still be considered potentially complete if 1) previous MEC finds or significant MD indicate the potential for MEC to remain and 2) both receptors and an exposure method are present. The revised exposure pathways analysis is presented on **Figure 4-1.**

4.2.2.2 Exposure pathways for MEC in the subsurface are considered potentially complete since MEC may remain at the site. While all MEC items that have been found at the site (prior to and during the RI field activities) have been addressed by detonation to remove the safety hazard, MEC may be located beneath the sediment surface in areas that were not along the transects or within the grids investigated. During the RI field activities, four UXO were found in the subsurface (i.e., 4.5-inch aerial rocket, fuzed 37mm projectile, and two bomb bursters/fuzes from 100-lb photoflash bombs) at depths between six and 36 inches below the sediment surface in water approximately five to fifteen feet deep. Note that the 4.5-inch aerial rocket could not be confirmed as practice and, therefore, it was treated as a HE rocket. Based on the RI results, there is a potential MEC source within the central high anomaly density area; however, access to potential MEC is limited due to the MEC being either at or below the sediment under water. Potentially complete exposure pathways exist for the workers, recreationists/visitors, and trespassers who may contact MEC in the subsurface when performing intrusive work or recreational activities that include subsurface disturbance.

4.2.2.3 In addition, MEC exposure pathways for the surface are considered to be potentially complete because the site is subject to sediment erosion and deposition due to its location at the mouth of Tampa Bay where it is affected by storm surge, currents, and changing sedimentation patterns. Sediment movement is driven more by periodic, significant storm events (*e.g.*, tropical storms, hurricanes and winter storms) than the diurnal east-west tidal patterns of Tampa Bay. In the marine environment, MEC items tend to undergo scour burial during typical flow conditions. During high intensity conditions, such as during storms, MEC items may be uncovered and, when this occurs, they tend to roll into deeper water where they are reburied when typical flow conditions return.

4.2.2.4 MEC that is currently on or below the sediment surface could be exposed as Passage Key changes in location and size over time and the depth of sediment beneath the surrounding waters changes over time. A complete exposure pathway was not identified because the locations where the MEC items were found are not used by receptors since these locations are east of the current location of Passage Key and the area surrounding the key where boats temporarily anchor. Additionally, all MEC items identified to date have been detonated and/or removed from the site.

4.2.2.5 Exposure pathways are potentially complete for biota that may contact MEC in the shallow subsurface sediment during burrowing and hunting activities. For instance, some fish species and marine mammals could disturb an item that slightly buried in the sediment while searching for food. However, the potential for biota to disturb MEC items is low and this disturbance is not likely to cause a MEC item to detonate, therefore, the risk to biota is negligible. Exposure pathways for both human and ecological receptors for MEC on the surface are considered potentially complete because, while no MEC was found on the surface during the RI, the possibility exists that MEC may be present in areas not investigated or may become exposed due to natural processes, such as by storm surge and deposition or erosion of the sand/sediment.

4.2.2.6 While the possibility exists that receptors could come in contact with MEC on the surface and in the subsurface, this represents a low potential for encountering MEC at the site because only a limited number of items have been found since the military training activities ceased in the mid-1940s, all MEC items identified during the RI were buried in the sediment (not found on the key or on the sediment surface), the area where the majority of the MEC items were found is away from the key and in water deeper than five feet, and all items found to date have been addressed to render them safe.

4.2.3 Munitions Constituents Exposure Pathway Analysis

This section summarizes the RI data results for the MC exposure pathway analysis for the Passage Key ATGGR.

4.2.3.1 Source

No MC source areas were identified during the RI. These results are consistent with the SI MC conclusions, which also did not identify any MC sources at the former Passage Key ATGGR.

4.2.3.2 Access

Refer to Section 4.2.1.2.

4.2.3.3 Activity

Refer to Section 4.2.1.3.

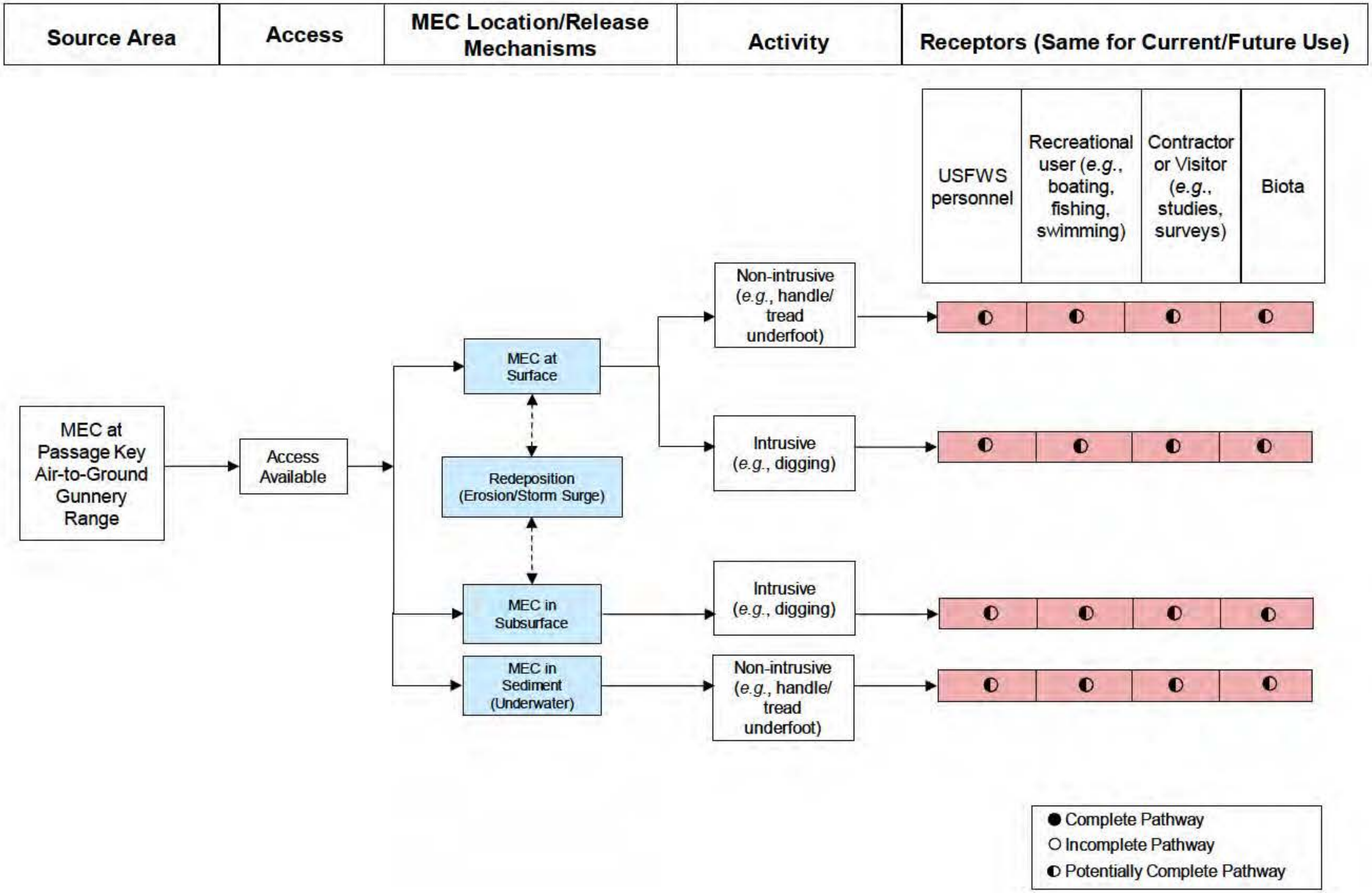
4.2.3.4 Receptors

Refer to Section 4.2.1.4.

4.2.4 Munitions Constituents Exposure Pathway Conclusions

Based on the RI findings, no MC source areas exist in sediment and exposure pathways are considered incomplete for all receptors in all environmental media.

Figure 4-1: MEC Conceptual Site Exposure Model



5.0 CONTAMINANT FATE AND TRANSPORT FOR MEC /MC

5.1 FATE AND TRANSPORT DYNAMICS

The intent of this section of the RI/FS Report is to describe the contaminant fate and potential transport mechanisms for MEC and MC identified at Passage Key ATGGR. Contaminant fate refers to the expected final state that an element, compound, or group of compounds will achieve following release to the environment. Contaminant transport refers to migration mechanisms away from the source area. Understanding the fate of the MEC and MC present in, or released to, the environment is important in evaluating the potential hazards to human health and the environment. For example, it is possible for natural processes to result in the movement, relocation, or unearthing of MEC in the subsurface to the surface, thereby, increasing the chance of exposure by human and ecological receptors.

5.1.1 MEC Fate and Transport Mechanisms

5.1.1.1 UXO have been found historically at Passage Key ATGGR and four UXO were identified and removed during the RI; therefore, MEC migration mechanisms and disposition factors are discussed in the following paragraphs as applicable to Passage Key ATGGR.

5.1.1.2 Potential routes of migration include physical processes that might result in movement or relocation of MEC from its original placement. If accessible, MEC has the potential to pose an explosive hazard to human and ecological receptors. The following physical processes can result in the transport of MEC from its original placement:

- Person(s) picking up or moving a potential MEC.
- Recreational activities that may disturb sediment (e.g., snorkeling, anchoring a boat) or cause recreational users to come into contact with surface MEC.
- Natural processes such as erosion/deposition or waves/currents/tides moving potential MEC.

5.1.1.3 Potential MEC in the water surrounding Passage Key ATGGR could be transported and redeposited by wave, current, and tidal processes, as well as by storm events. In the marine environment, MEC items tend to undergo scour burial during typical flow conditions. During high intensity conditions, such as during storms, MEC items may be uncovered and, when this occurs, they tend to roll into deeper water where they are reburied when typical flow conditions return. It should be noted that the potential transport and redeposition of munitions items also depend on an item’s size and shape. For example, a 100-lb bomb would require much more force to move than a 37mm projectile and would, therefore, be less likely to transported and redeposited via natural processes.

5.1.2 MC Fate and Transport Mechanisms

5.1.2.1 Although no MC source areas were identified during the RI, a discussion of MC fate and transport mechanisms is included to provide a comprehensive evaluation for MC. The primary environmental medium for MC at the Passage Key ATGGR is sediment. The primary MC associated with the munitions used historically at the Passage Key ATGGR are explosives and metals including iron and aluminum associated with munitions casings. Iron and aluminum occur naturally in soil and have fairly low toxicities; therefore, these metals were not considered MC of concern.

5.1.2.2 Explosives MC are subject to various fate and transport mechanisms if released from munitions items. These mechanisms include dissolution, transformation (especially via photodegradation), adsorption, advection, and volatilization. The position of potential munitions items at Passage Key ATGGR influences the dominant fate and transport mechanisms. For instance, if a munitions item is buried near the shoreline or in sediment, it is likely that if MC residues had been released, they would have been washed away due to wave action and/or beach erosion. Photodegradation of trinitrotoluene (TNT) and other nitroaromatic explosives compounds has been studied extensively. It is likely that, if present in the past at Passage Key ATGGR, most of the TNT (and potentially other explosives compounds) exposed to the atmosphere or water have been broken down due to photodegradation.

5.2 PASSAGE KEY AIR-TO-GROUND GUNNERY RANGE

5.2.1 Munitions and Explosives of Concern

5.2.1.1 In 1998, three 100-lb general purpose bombs and one 100-lb photoflash bomb were reportedly found on the key or between three to 10 feet of seawater. The location of the UXO items were found within the historical ATGGR TA boundary or the high anomaly density area (i.e., Target Area 1) as identified in the RI. Additionally, one 100-lb photoflash bomb was found approximately 200 feet west of the key in shallow water and detonated at the site on 6 September 2015 just prior to the start of the RI field activities. During RI characterization activities at Passage Key ATGGR, four UXO items were identified at depths ranging from six inches to 36 inches below the sediment surface. Items classified as MD were recovered at depths ranging from the sediment surface to 36 inches below the sediment surface. It is possible for natural processes to result in the movement, relocation, or unearthing of MEC, increasing the chance of exposure by human and ecological receptors. Passage Key MRS is vastly comprised of water bodies and an intermittently submerged sand bar due to its coastal location near large water bodies (i.e., Gulf of Mexico and Tampa Bay). The soils consist of nearly level to gently sloping moderately well to poorly drained sandy soils with intermixed shell fragments. Based on site topography and its sandy composition, it is plausible that natural causes, such as storm surges, currents/sand shifts, and erosion/deposition may impact source material. As the UXO items discovered were found at six to 36 inches below the sediment surface and numerous MD was found within three feet of the sediment surface, environmental factors (e.g., storm surges, currents, shifting sands, etc.) may unearth residual MEC in the sediment.

5.2.1.2 Individuals, including USFWS personnel, recreationists, and trespassers, could come in contact with potential MEC at the surface or shallow subsurface by boating, fishing, swimming or walking on the sand bar, if exposed. However, it is unlikely that individuals listed above could unearth potential MEC if performing intrusive activities. MEC hazards are likely buried between six inches to 36 inches below the sediment surface based on the RI findings. While environmental factors may expose potential MEC due to the ever-changing marine environment, the likelihood for MEC to be encountered or reached by a receptor underwater is low. Potential MEC may be disturbed or relocated during storm surges, currents, sand shifts, erosion/deposition. The likelihood of disturbing or relocating potential MEC is greater during storm surges, currents/sand shifts, erosion/deposition than intrusive activities.

5.2.2 Munitions Constituents

Due to the lack of a MC source area, exposure pathways are considered incomplete for all media.

6.0 HAZARD ASSESSMENT FOR UXO/DMM/MC

6.1 MEC HAZARD ASSESSMENT GENERAL

6.1.1 The MEC hazard assessment (MEC HA), a tool used to assess the risk from MEC at an MRS, was completed IAW the *Munitions and Explosives of Concern Hazard Assessment (MEC HA) Methodology* (USEPA, 2010). The purpose of the MEC HA is to evaluate the potential explosive hazard associated with conventional MEC present at an MRS. The MEC HA does not address hazards posed by chemical warfare materiel, MEC that is located underwater, or environmental and/or ecological hazards associated with MEC.

6.1.2 The Passage Key ATGGR evaluation is based on UXO identified historically and findings of the RI field effort. It should be noted that the MEC HA is not considered an appropriate tool to use for evaluating MEC hazards in water per EM 200-1-15 (USACE, 2015). As such, the MEC HA was developed for the land portion associated with Passage Key. Because the key has shifted in location over time, UXO identified at the site (whether on land or in water) were used in the evaluation. The MEC HA, which is used to score an MRS under a variety of MRS-specific conditions, including various cleanup scenarios and land-use assumptions, can be used to score a site several times to evaluate current site conditions, as well as reasonably anticipated future land uses. The MEC HA can also be used to assess MRS conditions after completion of different levels of proposed cleanup or the application of land use controls. The baseline MEC HA presented in Section 6 includes data/information available through the date of the RI and was developed for current land use scenarios only since the future use of the Passage Key ATGGR MRS is not expected to change from the current use. Results of the MEC HA evaluation for various remedial alternatives (i.e., No Action, LUCs, and surface/subsurface removals) are presented in Section 9.4.3. The MEC HA is provided in **Appendix J**.

6.1.3 The MEC HA evaluates risk through a review of three components of a potential explosive hazard.

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

6.1.4 Each component is assessed through the use of input factors that each have two or more categories associated with them and each category is associated with a numeric score that reflects the relative contributions of the different input factors to the hazard assessment. The sum of the input factor categories is then assigned to one of four defined ranges, called hazard levels. Each of the four hazard levels reflects site attributes that describe groups of sites and site conditions ranging from the highest to lowest hazards. The four hazard levels and corresponding minimum and maximum scores for each level of the MEC HA are shown in **Table 6-1**.

Table 6-1: Summary of the MEC HA Levels

Hazard Level	Maximum MEC HA Score	Minimum MEC HA Score	Description
1	1000	840	Highest potential explosive hazard condition under current conditions.
2	835	725	High potential explosive hazard condition under current conditions.
3	720	530	Moderate potential explosive hazard. Site is compatible with current uses but potentially not under more intrusive future uses.
4	525	125	Low potential explosive hazard. Site is compatible with current and future uses.

6.1.1 MEC Hazard Assessment Components

6.1.1.1 Severity

This component is defined in the MEC HA guidance (USEPA, 2010) as "[t]he potential consequences of the effect (i.e., injury or death) on a human receptor should a MEC item detonate." Two input factors are required to determine this component, energetic material type and location of additional human receptors. Each input factor is described in more detail below.

- Energetic Material Type – This factor describes the hazard associated with MEC known or suspected to be present at the MRS. MEC items identified, either on the surface or subsurface, are included in the MEC HA and the energetic material type associated with each item is selected (i.e., high explosive and low explosive filler in fragmenting rounds, white phosphorus, pyrotechnic, propellant, spotting change and incendiary). The energetic material with the highest value entered into the MEC HA (i.e., most hazardous) is included as the input factor category score.

- Location of Additional Human Receptors – This factor, which assumes that a receptor has unintentionally initiated the detonation of a MEC item, accounts for the possibility that secondary receptors could also be affected. Unintentional detonation of MEC would result not only in injury (or death) to the individual initiating the detonation, but also to other receptors that may be exposed to the overpressure or fragmentation hazards from the MEC detonation. For this input factor category, a determination is made whether there are places where people congregate that are either within the MRS or within the explosive safety-quantity distance (ESQD). The ESQD is based on the maximum fragment distance-horizontal of all the MEC items encountered within the MRS. The MRS is given a single value score if there is an affirmative response and no score if there is a negative response to the determination as to whether additional receptors may be exposed.

6.1.1.2 Accessibility

This component, defined in the MEC HA guidance (USEPA, 2010) as "[t]he likelihood that a human receptor will be able to come into contact with a MEC item", contains five input factors, which are described in the following sections.

6.1.1.2.1 Site Accessibility

Site accessibility describes the ease with which receptors can access the MRS. There are four potential site accessibility input factor categories, full, moderate, limited, and very limited. Each category is associated with a numerical value used in scoring. Below is a brief description of each category.

1. **Full Accessibility –** indicates there are no barriers to entry such as fencing, although signage may be present.
2. **Moderate Accessibility –** indicates there are some barriers to entry, such as barbed wire fencing or rough terrain.
3. **Limited Accessibility –** indicates there are significant barriers to entry, such as unguarded chain link fence or requirements for special transportation to reach the site.
4. **Very Limited Accessibility –** indicates there is either a guarded chain link fence or terrain that requires special equipment and skills (e.g., rock climbing) to access.

6.1.1.2.2 Potential Contact Hours

Potential contact hours, which is an estimate of the total number of receptor hours per year, assumes that both the number of receptors and the amount of time they spend at the MRS can affect the likelihood of the receptor encountering MEC. The potential contact hours takes into consideration the activities performed at the MRS as well as the receptor/exposure scenarios presented in the RI. The receptor hours per year for each activity are then summed and determined to be in one of the following four categories:

1. **Many hours –** greater than 1,000,000 receptor hours/year
2. **Some hours –** 100,000 to 999,999 receptor hours/year
3. **Few hours –** 10,000 to 99,999 receptor hours/year
4. **Very few hours –** less than 10,000 receptor hours/year

6.1.1.2.3 Amount of MEC

This input factor, which qualitatively describes the amount of MEC that may be present due to past munitions-related activities at the MRS, is assessed by determining the type of munitions activities that took place at the MRS (e.g., target area, open burn/open detonation area, maneuver area, safety buffer area, storage). Each category is associated with a value based on the relative hazard of each munitions activity.

6.1.1.2.4 MEC Depth Relative to Maximum Receptor Intrusive Depth

This input factor describes whether MEC items are located where receptor activities take place. The shallowest recorded MEC depth is compared to the deepest intrusive depth recorded and one of the following categories is selected. Each category is associated with a numerical value used to score the MRS.

1. Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.

2. Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth does not overlap with subsurface MEC.

3. Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.

4. Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth does not overlap with minimum MEC depth.

6.1.1.2.5 Migration Potential

This input factor describes the likelihood that MEC items can be moved and potentially exposed by natural processes such as erosion or frost heaving (repeated freeze/thaw cycles). Some elements that could affect the potential for migration include frost line depth, seasonal heavy rains, topographic slope, soil type, and vegetation. One of two categories is selected, possible or unlikely, and the selected category's associated numerical score is used to score the MRS.

6.1.1.3 Sensitivity

The sensitivity component is defined in the MEC HA guidance (USEPA, 2010) as "the likelihood that a MEC item will detonate if a human receptor interacts with it." Two input factors are required to determine this component, MEC classification, and MEC size.

- <u>MEC Classification</u> – The MEC HA guidance (USEPA, 2010) defines six categories of MEC; UXO Special Case, UXO, Fuzed DMM Special Case, Fuzed DMM, Unfuzed DMM, and Bulk Explosives. Each MEC classification has a numerical value and the value associated with the selected classification is used to score the MRS.

- <u>MEC Size</u> – The MEC Size input factor is used to account for the ease with which a MEC item can be moved by a receptor, which increases the likelihood that a receptor will pick it up or otherwise disturb the item. Two categories are used to describe the MEC size.

- **Small** – which are items that weigh less than 90 lbs
- **Large** – which are items that weight 90 lbs or more

6.1.2 Site-Specific MEC Risk Assessment

The baseline MEC assessment was completed for the Passage Key ATGGR using the MEC HA Guidance and accompanying automated scoring worksheets. MEC HA evaluations do not include the marine portion of the MRSs since the MEC HA worksheets are not applicable to water MRSs. The input factors and the MEC HA scores are shown on **Table 6-2**.

Table 6-2: Passage Key ATGGR MEC HA Input Factor and Scores

Input Factor		Input Factor Category	Score	Rationale for Selection of Input Factor
I.	Energetic Material Type	High Explosive and Low Explosive Filler in Fragmenting Rounds	100	The 100-lb bombs (AN-M30A1 and AN-M46) found historically as well as the four UXO items found during the RI (bomb boosters and fuzes [M111A2] from 100-lb photoflash bombs [AN-M46]; 4.5-inch aerial rocket [M8]; and 37mm projectile [M54]) used high explosives as filler type.
II.	Location of Additional Human Receptors	Outside of ESQD Arc	0	There are no features or facilities where people may congregate at the Passage Key National Wildlife Refuge within the RI/FS Investigation Area. Additionally, the refuge is closed to the public.
III.	Site Accessibility	Limited Accessibility	15	There are no signs or barriers to prevent access and the refuge is unstaffed and not routinely monitored; however, the area can only be accessed via boat thereby reducing site accessibility since special arrangements would need to be made to reach the site.
IV.	Potential Contact Hours	< 10,000 receptor hour/year	15	Because Passage Key is closed to the public and therefore visitor usage is not tracked, there is no way of knowing with certainty the number of people who illegitimately use the area for recreational purposes on an annual basis. USFWS personnel and contractors access the site to conduct natural resource surveys and other studies, and according to that USFWS website, volunteer opportunities exist for visitor center operations, manatee watch activities, and refuge maintenance projects. Based on its small size and lack of improvements, it is expected that site activities would fall within the "Very Few Hours" category with less than 10,000 hours of potential receptor contact time.
V.	Amount of MEC	Target Area	180	Target Area was selected because the ranges within the MRS included areas at which munitions fire was directed.

Input Factor		Input Factor Category	Score	Rationale for Selection of Input Factor
VI.	Minimum MEC Depth Relative to Maximum Intrusive Depth	Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.	150	This category was selected because a) munitions were known to have been found in the subsurface and b) the maximum intrusive depth for the MRS of one foot (based on current and anticipated future lands uses) is greater than the minimum depth at which munitions were encountered (0.5 feet). The maximum intrusive depth is one feet because a) access to Passage Key is prohibited b) the maximum anticipated depth of maintenance activities is one foot and c) while access id prohibited, the illegitimate recreational activity depth is anticipated to be no greater than one foot.
VII.	Migration Potential	Possible	30	Conditions exist at the MRS in which wind and water erosion could potentially expose subsurface MEC (i.e., Passage Key which has changed shape and position over time due to the ever changing marine environment).
VIII.	MEC Classification	UXO Special Case	180	The discovery of two fuzes (M111A2) from 100-lb photoflash bombs (AN-M46) that were found in the marine sediment during the RI; therefore, "UXO Special Case" was the MEC classification assigned.
IX.	MEC Size	Small	40	The smallest munitions item found on site was smaller than 90 lbs.
Total Score				**710**
Hazard Level Category				**3 (Moderate)**

6.1.3 Baseline Scoring Results

The baseline scoring results for the Passage Key ATGGR are included in **Table 6-3**. Scoring results are based on results from previous investigations, to include the RI, and current site conditions only. MEC HA scores for the potential remedial alternatives are addressed in Section 9.4.3. The MEC HA worksheets, with details on how the Passage Key ATGGR was scored, are included in **Appendix J**.

Table 6-3: MEC HA Baseline Hazard Level Score

MRS	MEC HA Score	Hazard Level
Passage Key ATGGR	710	3 – Moderate potential explosive hazard. Site is compatible with current uses but potentially not under more intrusive future uses.

Note: A MEC HA score of 1 indicates the highest potential risk and 4 indicates the lowest. Additionally, the MEC HA is not considered an appropriate tool to use for evaluating MEC hazards in water per EM 200-1-15 (USACE, 2015). As such, the MEC HA was developed for the land portion associated with Passage Key.

6.1.4 Munitions and Explosives of Concern Qualitative Hazard and Risk Assessments

To further evaluate hazards at the MRSs and to address limitations encountered during the MEC HA development (i.e., MEC finds required, limited parameters for selection, current restrictions in place, etc.), a qualitative hazard evaluation was completed for the Passage Key ATGGR. This evaluation is qualitative in nature and captures site attributes such as MEC and MD density and current and future land uses in a more flexible and subjective manner not possible in the MEC HA analysis.

6.1.4.1 Passage Key ATGGR Qualitative MEC Hazard Assessment

6.1.4.1.1 Passage Key ATGGR is located at the entrance to the Tampa Bay from the Gulf of Mexico and north of Anna Maria Island, the nearest inhabited area. There are no features or facilities at Passage Key, which has changed in shape and position over time due to the ever-changing marine environment. While Passage Key is closed to the public as a bird sanctuary, there are no barriers preventing trespassers to the key. The surrounding waters are used by recreational users (i.e., boating, fishing, swimming).

6.1.4.1.2 Four UXO items were found and detonated at the site in 1998, including three 100-lb general purpose bombs and one 100-lb photoflash bomb. Additionally, one 100-lb photoflash bomb was found and detonated at the site in 2015 just prior to the start of the RI field activities. While practice munitions do not contain an explosive filler similar to HE munitions and are not nearly as hazardous as HE munitions, they do contain a spotting charge which does present an explosive hazard. The UXO items were found between six to 10 feet of seawater within the high anomaly density area (i.e., Target Area 1) identified in the RI. The four UXO items were found during the investigation in the high anomaly density areas: a fuzed 37mm projectile, a 4.5-inch aerial rocket, and two bomb burster/fuzes from 100-lb photoflash bombs. While there are no known UXO items at the site where receptors would have access to them, there still exists a possibility that an item could become accessible due to storm surges, currents, shifting sands, etc. Intrusive activities associated with potential receptors are limited and unlikely due to the isolated conditions of the site. The maximum potential depth of recreational activity depth is anticipated to be no greater than one foot.

6.1.4.2 Passage Key ATGGR Qualitative MEC Risk Assessment

Based on the types of MEC found at the site (i.e., aerial bombs and rockets), they have a relative low sensitivity for detonation. Additionally, only a limited quantity of MEC has been found at the site, which is consistent with the short historical use of the site (for only a few years during WWII). Since MEC was found underwater in five to fifteen feet of water and was buried in the sediment, it is not readily accessible to receptors. In addition, the area where Target Area 1 is located is infrequently used by receptors since it is not located near the sand bar. As such, the likelihood of encounter is low and the risk to receptors from MEC minimal. However, given the potential for MEC items to become exposed due to storms or other mechanisms, the risk to receptors remains potentially unacceptable.

6.2 MUNITIONS RESPONSE SITE PRIORITIZATION PROTOCOL

The purpose of the Munitions Response Site Prioritization Protocol (MRSPP) is to prioritize potential actions at MRSs for national funding and responses. Because the MRSPP is subject to an independent review and may be changed after the RI/FS Report is final, it was prepared as a separate document from the RI/FS Report.

6.3 RISK ASSESSMENT FOR MUNITIONS CONSTITUENTS

Because no MC source areas have been identified at the site, no MC sampling has been conducted. As such, a Human Health Risk Assessment (HHRA) and a Screening Level Ecological Risk Assessment (SLERA) were not performed.

7.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES FOR MEC AND MC

This section presents a discussion of the process for developing and screening remedial technologies for the Passage Key ATGGR.

7.1 Remedial Action Objectives

The RI characterized the nature and extent of MEC at the Passage Key ATGGR for the purpose of developing and evaluating effective remedial alternatives. Details concerning the characterization of MEC are provided in Section 3.2 of this RI/FS Report and include information related to any data gaps that exist following the investigation. The lack of a MC source area demonstrates that MC does not pose a risk to human or ecological receptors at Passage Key ATGGR; therefore, MC remedial alternatives are not evaluated within the RI/FS. The MEC RAOs for Passage Key ATGGR focus on limiting interaction between potential MEC and receptors accessing the RI/FS Investigation Area. Specifically, the RAOs developed for Passage Key ATGGR, as presented in Section 2.2.3, include:

- Reduce human exposure and interaction with potential MEC such that negligible risk to human receptors can be demonstrated. This RAO applies to current and anticipated future use for recreation (e.g., boating, fishing) within the boundaries of Target Area 1 to a depth of four feet below ground surface/seafloor surface.
- Control the specific exposure pathways for MEC identified within the RI/FS Investigation Area, including contact by human receptors (i.e., boaters) or biota within the seafloor surface and subsurface (e.g., digging or burrowing). The majority of site activities are recreational in nature, with intrusive activities limited to depths no greater than one foot below ground surface/seafloor surface.
- Implement safety and institutional procedures that allow for current land use of the site to continue and are protective for the reasonably anticipated future land use (which is the same as current).

Methods by which interaction between potential receptors and MEC can be limited include, but are not limited to, LUCs (e.g., signage, restrictive use, and education) and surface and subsurface MEC removals. **Table 7-1** summarizes the media, exposure pathways, and PRGs for Passage Key ATGGR.

Table 7-1: Preliminary Remediation Goals Evaluated for Passage Key ATGGR

Media	MEC Exposure Pathways	PRGs
Sediment	Contact on the sediment surface and in the subsurface by human receptors and biota	Limit contact with MEC

7.1.1 Identification of Applicable or Relevant and Appropriate Requirements

Response actions under CERCLA must identify and attain or formally waive ARARs. The ARARs are used in determining the protectiveness of a remedy during design and analysis in this FS. The results of the identification of ARARs for Passage Key ATGGR are summarized in **Table 7-2**. ARARs will be further evaluated as part of the detailed analysis of alternatives (Section 9).

Table 7-2: ARARs at Passage Key ATGGR

Standard, Requirement, Criteria, or Limitation	Citation	Description
Chemical-specific		
Florida Cleanup Target Levels (Chapter 62-777, Florida Administrative Code) were identified as a potential ARAR for this RI/FS. However, because of the dynamic coastal environment at the site and lack of a MC source, chemical-specific ARARs are not carried forward into the FS or evaluated in the comparative analysis of alternatives.		
Location-specific		
Endangered Species Act	16 U.S.C. 1538(a)(1)(B) et seq, 50 CFR 402	Threatened and endangered species are present at the site, depending on the time of year, and could be affected by actions taken at the site. However, avoidance or mitigation measure can be used to reduce or eliminate impacts to these species.
Action-specific		
Resource Conservation and Recovery Act (RCRA) Subpart X (Miscellaneous Units)	40 CFR Part 264.601 "Environmental Performance Standards"	RCRA miscellaneous units are a unique category of hazardous waste management units. 40 CFR Part 264.601 "Environmental Performance Standards" is applicable if munitions are consolidated for treatment, storage, or disposal.

7.2 General Response Actions

A limited number of MEC response actions are available to address MEC contaminated sites. The following three actions have been identified and will be used in combination with one another to develop remedial alternatives, which will be evaluated for potential implementation at Passage Key ATGGR:

1. LUCs
2. Surface Removal
3. Subsurface Removal

7.2.1 Land Use Controls

LUCs are used to reduce and prevent explosive hazard exposure for potential human and ecological receptors. LUCs for MEC generally include physical and/or administrative/legal mechanisms that minimize the potential for exposure by limiting land use. LUC strategies can include engineering or non-engineering measures that are designed based on the remaining hazard. Institutional controls consist of legal or administrative mechanisms. Legal mechanisms, or institutional controls, as used in the NCP, consist of enforcing property restrictions through ownership (e.g., deed notices, restrictive covenants, negative easements). Administrative mechanisms are essentially regulatory in nature and include notices, local land use plans and ordinances, construction permits, and land use management systems to ensure compliance with use restrictions. Educational outreach (e.g., pamphlets, videos, meetings) is commonly used to reduce the risk to property owners or the public from unexpected exposure to hazards. Engineering controls include physical mechanisms, such as placing fencing or signage to protect property owners and the public from hazards by limiting access or preventing public access to areas. Physical mechanisms are a useful deterrent to prevent unintentional access to a hazardous site and commonly work in conjunction with non-engineering controls to provide the best protection for human health and the environment. The enforcement of LUCs on a property is often complicated. The Passage Key ATGGR is owned by the DOI and managed by USFWS. For properties owned by government agencies, land use restrictions can be more readily enforced and maintained and engineering controls (e.g., signs) replaced relatively easily. This process does not prevent exposure to MEC in all cases; however, it can effectively prevent exposure by restricting access to these items. LUCs can also be used in conjunction with other response actions.

7.2.2 Surface Removal

A surface removal is the removal of any MEC/Material Potentially Presenting an Explosive Hazard (MPPEH) visible in part or whole on the surface. No subsurface removal of MEC/MPPEH would be completed under this action. The surface removal would be conducted by qualified UXO technicians using handheld analog metal detectors. If MEC or MPPEH is discovered, it would be disposed using explosive demolition procedures. The general components for a surface removal include:

- Physical surface removal of MEC/MPPEH in designated areas or across the entire site
- Demolition and disposal operations

- o Demolition activities would be coordinated with all appropriate stakeholders, specifically USACE, USFWS, and Manatee County, to ensure standard operating procedures are followed.
- Erosion control measures (as necessary and if applicable to the site)

7.2.3 Subsurface Removal

7.2.3.1 Subsurface anomalies may be identified using handheld analog magnetometers or DGM instruments (e.g., EM61-MK2 for land environment or equivalent for marine environment). Subsurface removal consists of employing geophysical instruments (analog or DGM) to identify subsurface anomalies followed by an intrusive investigation (hand dig and inspect). Surface anomalies are also identified, investigated, and removed as necessary during a subsurface removal. The components of a subsurface removal include:

- Surface removal of MEC/MPPEH in designated areas or across the entire site
- Subsurface investigations
- Demolition and disposal operations
  - o Demolition activities would be coordinated with all appropriate stakeholders, specifically USACE, USFWS, and Manatee County, to ensure standard operating procedures are followed.
- Erosion control measures (as necessary and if applicable to the site)

7.2.3.2 Investigation and removal techniques in the land environment include hand digging, mechanical digging with conventional earth moving equipment in conjunction with hand digging; mechanical digging using armored equipment; and mechanical digging using remotely operated equipment. Investigation and removal techniques in the marine environment is typically conducted using one of two possible methods: an air lift or a water jet.

7.3 Identification and Screening of Remedial Technologies

As presented in Army RI/FS guidance, the natural characteristics of a particular site may limit the technologies that may be used. Due to the limited number of appropriate technology types and alternatives for MEC-only remedial actions, a limited number of remedial alternatives and technologies can be developed to meet the project objectives, as outlined above. A discussion of technologies specific to MEC identification and removal, as related to the Passage Key ATGGR, is provided in the following paragraphs.

7.3.1 Identification and Screening of MEC Technologies

7.3.1.1 MEC remedial technologies are divided into three categories: detection, recovery, and disposal. The following technologies were identified as being viable options for the general response actions. Although these technologies are industry-proven for detection and removal of

MEC, there are technology limitations and surface/subsurface residual hazards may remain even following a remedial action.

7.3.1.2 Potential UXO will be mapped using technologies that can discriminate MEC/UXO from non-hazardous items, have the highest detection performance, and provide an objective, documented audit trail of measurements and analyses used to support remedial actions. Work will adhere to the 2000 USEPA-DoD Memorandum of Understanding requiring the collection of digital geophysical data whenever possible. Where localized site conditions are present, less capable methods may be considered, provided they meet the RAOs. Probability of detection will be considered over ease of use. It is possible more than one method will be employed, with less reliable instrument used only where it is not possible to use more capable methods.

7.3.2 Evaluation of Technologies

7.3.2.1 Detection Technologies

The objective of MEC detection is to determine the presence and location of potential MEC items during investigation and removal. For the Passage Key ATGGR, marine-based magnetic and electromagnetic induction (EMI) sensors are available and could be used. Magnetic sensors often have a greater detection depth than EMI sensors and their effectiveness would not be affected by the geologic conditions at Passage Key. The depths for a subsurface removal action are typically based on site use and depth of munitions. The two types of geophysical sensors can be applied to either analog or digital systems. Both analog and digital geophysical equipment can be used to detect MEC at Passage Key ATGGR. Digital geophysical equipment (i.e., DGM) has a higher level of QC and provides the ability for advanced processing to limit the number of intrusive investigations. The digital data collected provides a record that can be used to document and evaluate the coverage and quality of the clearance. DGM sensors typically have a greater depth of detection than analog sensors due to greater sensitivity. Digital EMI sensors also typically have a larger transmit coil, which increases the depth of the detection. High powered EMI sensors can also be used to increase the detection depth capabilities. Analog instruments rely on an operator’s ability to detect geophysical anomalies potentially caused by MEC based on the real-time response of the instrument. QC plans must include a method of ensuring proper coverage and detection. Analog procedures are often more implementable within shallow water areas where access for DGM is difficult. There are innovative technologies that incorporate newer types of digital geophysical equipment; however, these technologies are under development with limited full-scale applications. The technologies also tend to be more expensive to implement and are less widely accepted at this time than more traditional digital geophysical methods. Additionally, there are currently no advanced geophysical classification underwater sensors available for evaluation. For this FS, it is assumed that digital electromagnetic equipment for the marine environment, including shallow water areas, would be used to locate subsurface anomalies. Anomalies in the shallow water areas, where a boat is inaccessible, would be collected with a float DGM system. If a remedial action is selected as the remedy, the remedial action contractor should select the appropriate detection technology to meet the objectives of the Decision Document.

7.3.2.2 Recovery Technologies

Removal or recovery technologies generally include hand excavation or mechanized equipment. Hand excavation consists of digging individual anomalies using commonly available hand tools. This is the industry standard method for performing MEC removals and investigations. UXO Technicians dig an anomaly that was either located using hand held instruments or a DGM instrument. The method involves using hand tools (shovels, picks, trowels, etc.) to excavate the selected item using only human power to do the work. In the marine environment, air and water jets can be used to help remove sediment. Other alternatives include dredging and sifting operations to suck the seafloor sediments and deposit it on a floating screen deck that has a mesh to catch any fragments. For this FS, it is assumed that air and water jets will be used to help remove sediment and excavate. Dredging and sifting operations would not be cost effective due to lower production rates on high anomaly density areas.

7.3.2.3 Treatment Technologies

The objective of a removal action is to eliminate or reduce receptor exposure to MEC hazards. Blow-in-place (BIP) is the destruction of a MEC item by detonating the item without moving it from the location where it was found. Normally, this is accomplished by placing an explosive charge alongside the item. MEC is dealt with individually in this approach, requiring direct exposure of personnel to each individual item. Consolidate and blow operations are defined as the collection, configuration, and subsequent destruction by explosive detonation of MEC. This process can be used either “in grid” (i.e., within a current working sector) or at a consolidation point, but can only be employed for munitions that have been inspected and deemed acceptable to move. This determination should be made by senior UXO-qualified personnel IAW appropriate regulations and guidance.

7.3.3 Screening of Technologies

7.3.3.1 The MEC detection, recovery, and disposal remedial technologies and process options have been screened with respect to effectiveness, implementability, and cost, as illustrated on **Table 7-2**.

7.3.3.2 IAW ER 200-3-1, innovative technologies were considered during development of the FS. This included newly developed acoustical sensors for use in the marine environment. Because this technology incorporates newer types of equipment and are currently under development with limited full-scale applications, the technology tends to be more expensive to implement and are less widely accepted at this time than more traditional digital geophysical methods for subsurface clearance projects. For this FS, traditional methods were found to be more effective for the subsurface clearance.

Table 7-3: Technology Screening Matrix

General Response Actions	Remedial Technology	Process Option	Effectiveness	Implementability	Cost
Surface Removal					
	Detection	Analog	**Medium/High -** Some technologies only detect ferrous anomalies.	**High -** Analog sensors can be easily used in any terrain and/or water to the recreational dive depth.	**Medium -** Manpower intensive. Additional seeding for QC required.
	Removal	Manual	**High -** Industry standard for MEC recovery.	**High -** Can be accomplished in almost any terrain and climate. Limited only by the number of people available.	**Low/Medium -** Standard by which all others are measured. Typically this is low cost option.
		Mechanized	**Low -** Not effective on remote locations (islands) or with limited access areas.	**Medium -** May be limited by remote locations and inaccessible areas for equipment (islands).	**Medium/High -** Costs for equipment may be balanced by increased production in accessible areas. Cost may be high to bring in equipment to remote areas.
	Treatment	Blow-in-Place	**High -** Each MEC item is individually destroyed with subsequent results individually verified. Post-detonation sampling may be required to evaluate any residual MC.	**High -** Techniques, transportable tools, and equipment, suited to most environments. Public exposure can limit viability. Engineering controls improve implementation.	**Medium -** Manpower intensive. Costs increase in areas of higher population densities or where public access must be monitored/controlled. Also may increase costs for explosives (multiple shots).
		Consolidate and Blow	**High -** Techniques recently developed and refined are providing documented successes. Donor munitions also proving effective. Limited in use to munitions that are "safe to move". Post-detonation sampling may be required to evaluate any residual MC.	**Medium/High -** Generally employs same techniques, tools and equipment as BIP. Requires larger area and greater controls. Most engineering controls not completely effective/applicable for these operations.	**Low/Medium -** Manpower intensive, may require material handling equipment for large scale operations.
Subsurface Removal					
	Detection	Analog	**Medium/High -** Some technologies only detect ferrous anomalies. Not as effective as DGM.	**High -** Analog sensors can be easily used in any terrain and/or shallow water.	**Medium -** Manpower intensive. Additional seeding for QC required.
		Digital Geophysical Mapping	**High -** Data is digital and provides a record of detections. Reduces number of digs. Advanced classification can be used to further reduce the number of digs.	**High -** Can be accomplished on land and in marine environment to complete mapping.	**High -** Lower production rates.
	Removal	Hand Excavation	**High -** Industry standard for MEC recovery.	**High -** Can be accomplished in almost any terrain and climate. Limited only by the number of people/ divers available.	**Low/Medium -** Standard by which all others are measured. Typically this is low cost option.
		Mechanized	**High -** Increases production rate but may not be as effective on steep terrain or with limited access areas.	**Medium -** May be limited by steep terrain and inaccessible areas for equipment (islands).	**Medium/High -** Costs for equipment may be balanced by increased production in accessible areas. Cost may be high to bring in equipment to remote areas.
		Dredging and Sifting	**High -** Decreases production rate and may not be as effective for the purposes of recovering MEC.	**High -** Can be accomplished in almost any terrain and climate. Significant disturbance of the bottom of habitat. Limited only by the number of people/divers and equipment available.	**Medium/High -** Costs for equipment is high and in limited availability.
	Treatment	Blow-in-Place	**High -** Each MEC item is individually destroyed with subsequent results individually verified. Post-detonation sampling may be required to evaluate any residual MC.	**High -** Techniques, transportable tools, and equipment, suited to most environments. Public exposure can limit viability. Engineering controls improve implementation.	**Medium -** Manpower intensive. Costs increase in areas of higher population densities or where public access must be monitored/controlled. Also may increase costs for explosives (multiple shots).
		Consolidate and Blow	**High -** Techniques recently developed and refined are providing documented successes. Donor munitions also proving effective. Limited in use to munitions that are "safe to move". Post-detonation sampling may be required to evaluate any residual MC.	**Medium/High -** Generally employs same techniques, tools and equipment as BIP. Requires larger area and greater controls. Most engineering controls not completely effective/applicable for these operations.	**Low/Medium -** Manpower intensive, may require material handling equipment for large scale operations.

8.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

8.1 Development of Alternatives

As discussed above in Section 6, this RI/FS Report presents a MEC HA conducted for the Passage Key ATGGR. Based on the results of the RI and MEC HA, there is a moderate potential to encounter an explosive hazard. To further evaluate this potential for explosive hazards at the site and to supplement the MEC HA, a qualitative evaluation was also conducted. The qualitative evaluation concluded that the likelihood of receptors encountering a MEC hazard level is low since only a limited number of items have been found since the military training activities ceased in the mid-1940s, all MEC items identified during the RI were buried in the sediment (not found on the key or on the sediment surface), the area where the majority of the MEC items were found is away from the key and in water deeper than five feet, and all items found to date have been addressed to render them safe. Although the possibility exists that an item could become more accessible due to storm surge, currents, and sediment erosion, it is unlikely to be found encountered due to the lack of accessibility to areas where concentrated munitions have been found in six to 10 feet of seawater. MEC remedial alternatives were developed for potential implementation at the Passage Key ATGGR based on the results of the RI, as listed below in **Table 8-1**. The alternatives represent a reasonable range of alternatives that meet the requirements of Army RI/FS guidance.

Table 8-1: Remedial Alternatives Evaluated for Passage Key ATGGR

Alternative	Description
Alternative 1: No Action	The NCP requires a No Action alternative to be evaluated. • No further effort or resources would be expended by USACE • No changes to the existing conditions or USFWS restrictions, if already in place, would occur
Alternative 2: LUCs	Administrative controls would be put in place to discourage access and provide education to the public about the former ATGGR training activities. • Signage regarding the WWII historical use and that munitions may remain at Passage Key and surrounding waters from those training activities would be placed at the public park on Anna Maria Island where there is existing information regarding the key • Administrative controls would include public education materials, as well as incorporating a note on the NOAA chart and/or a Notice to Mariners through the USCG to reflect the potential hazard for UXO A Long-Term Management (LTM) plan would be required to identify LUC enforcement actions, inspect LUCs, and provide/update education materials on a periodic basis.

Alternative	Description
Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas	Limited surface and subsurface removal would be conducted in the high anomaly density areas (i.e., Target Area 1 or 198.5 acres) of the RI/FS Investigation Area, which includes portions of the sand bar. • Clearance would be conducted to a maximum depth of 5 feet below ground surface (maximum depth of 4 feet detected during the RI plus 1 foot for buffer). • Public access to the key and surrounding waters would be restricted during clearance activities. • Protected species (i.e., threatened and endangered species) and sensitive habitats, if present in the area where the clearance is planned, might be impacted depending on the time of year when activities take place and whether avoidance and/or mitigations measures are implemented. • LUCs would be implemented consistent with Alternative 2.
Alternative 4: Complete Surface and Subsurface Clearance – Entire Site	Complete surface and subsurface removal would be conducted within the entire RI/FS Investigation Area. • Clearance over 100 percent of the RI/FS Investigation Area to a maximum depth of 5 feet below ground surface (maximum depth of 4 feet detected during the RI plus 1 foot for buffer). • Public access to the key and surrounding waters would be restricted during clearance activities. • Protected species (i.e., threatened and endangered species) and sensitive habitats, if present, might be significantly impacted depending on the time of year when activities take place and whether avoidance and/or mitigation measures are implemented.

A description of each alternative is provided in the following sections.

8.1.1 Alternative 1: No Action

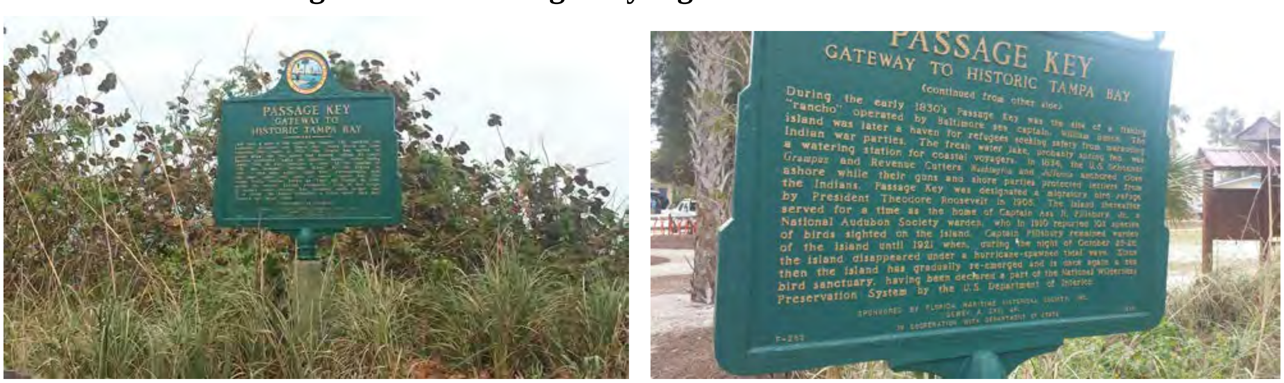
Alternative 1 involves taking no munitions response actions. While no munitions-related items would be removed from the site and no institutional or engineering controls would be implemented by the USACE, no changes to the existing conditions or USFWS restrictions, if already in place, would occur. Alternative 1 serves as the baseline against which the effectiveness of other alternatives is evaluated.

8.1.2 Alternative 2: Land Use Controls

8.1.2.1 Under Alternative 2, LUCs at the site would be included along with the existing signs at Anna Maria Island (see **Figures 8-1** and **8-2**) that provide the public information about Passage Key. Currently, this information does not include the WWII use. Additional signage describing the WWII historical use and the possibility that munitions may remain at the key and surrounding waters from those training activities would be installed next to the existing information regarding Passage Key at the public park on Anna Maria Island. This information would also be included to USFWS's website. While it is difficult to control access and/or implement engineering controls at the site, institutional controls, including informational signs, information available on publicly-accessible websites and notes on nautical charts that serve to educate the public about the potential MEC-related hazards that could be at the site and what to do if an UXO is found, has proven to be an effective way to inform the public and reduce/discourage access.

Figure 8-1: Passage Key Signs at Anna Maria Island

Figure 8-2: Passage Key Signs at Anna Maria Island



8.1.2.2 LUCs are defined broadly as legal measures that limit human exposure by restricting activity, use, and access to properties with residual contamination. Only one type of LUCs would be used: institutional controls. Institutional controls are administrative measures put in place to restrict human activity, in order to control future land use. Engineering controls, which include a variety of engineered constructed barriers to restrict human activity, to control future land use, are not feasible for Passage Key since the island shifts in location, as evidenced by observations made during the RI field activities where the key shifted within a month. Additionally, the CMUA identified during the RI is currently located to the east of Passage Key where water depths average 15 feet; this area is where the historical targets were located during WWII. Because the land portion associated with Passage Key shifts in location and size due to sediment accretion/erosion, engineering controls are not feasible. Instead, Alternative 2 would use institutional controls (e.g., educational signs) to minimize and control exposure to MEC / MPPEH on the surface or in the subsurface soil. The three general categories of institutional controls evaluated at Passage Key ATGGR, and which provide layers of protection, are as follows: governmental controls, proprietary controls, and informational devices, which assist with the management and implementation of LUCs (USEPA, 2000b; USEPA, 2010). Additionally, an education program would be initiated for recreational users and emergency responders that access Passage Key and the surrounding waters as well as incorporating a note to the NOAA chart to reflect a potential UXO hazard at the site.

8.1.2.3 A LTM process would be added as part of the LUCs to document continuing land use and that the remedy remains protective. Additionally, Alternative 2 would specify notification requirements to the USACE, USFWS, and Manatee County should land use change occur, or be planned.

8.1.2.4 Consistent with CERCLA guidance and for the purpose of comparison, the cost estimate for this alternative has been prepared to assume that LUCs with LTM would be maintained for 30 years.

8.1.3 Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas

8.1.3.1 Alternative 3 will include MEC / MPPEH clearance within the surface and the subsurface of the RI/FS Investigation Area in high anomaly density areas (i.e., Target Area 1 or 198.5 acres). The clearance will include location survey prior to the start of MEC activities. DGM will be conducted throughout the marine portion, and “mag and flag” will be used in the sand bar and shallow water portions of the site selected for clearance. All mapped items will be removed to approximately five feet below ground (maximum depth of 4 feet detected during the RI plus 1 foot for buffer).

8.1.3.2 Should any MEC / MPPEH items found on site be safe to move, these items will be consolidated and demolition operations will be conducted underwater to reduce the number of demolition shots and impacts to the marine environment. If they cannot be moved, the items will be BIP. MD will be handled under chain-of-custody protocols, flashed to 5X, and properly disposed of or recycled. Non-munitions-related scrap will be removed from site and properly disposed or recycled.

8.1.3.3 As part of Alternative 3, surface and subsurface clearances will not be completed over the entire RI/FS Investigation Area but only in the area identified as Target Area 1 (or 198.5acres) during the RI. Due to the residual MEC risk which would remain at the site following a limited surface and subsurface clearance, the LUCs and LTM identified in Alternative 2 will be included with Alternative 3.

8.1.3.4 Consistent with CERCLA guidance, and for the purpose of comparison, the cost estimate for this alternative has been prepared to assume that LUCs with LTM, including annual certification, would be maintained for 30 years.

8.1.4 Alternative 4: Complete Surface and Subsurface Clearance – Entire Site

8.1.4.1 Alternative 4 will include MEC / MPPEH clearance within the surface and the subsurface of the RI/FS Investigation Area. The clearance will include location surveys prior to the start of MEC activities. DGM will be conducted throughout the marine portion, and "mag and flag" will be used in the sand bar and shallow water portions of the site. All mapped items will be removed to approximately five feet below ground (maximum depth of 4 feet detected during the RI plus 1 foot for buffer) to ensure the property is acceptable for unlimited use and unrestricted access.

8.1.4.2 Should any MEC / MPPEH items found on site be safe to move, these items will be consolidated and demolition operations will be conducted underwater to reduce the number of demolition shots and impacts to the marine environment. If they cannot be moved, the items will be BIP. MD will be handled under chain-of-custody protocols, flashed to 5X, and properly disposed of or recycled. Non-munitions-related scrap will be removed from site and properly disposed or recycled.

8.1.4.3 It is important to note that limitations of technology for the identification and removal of MEC / MPPEH on site can result in a residual MEC hazard. If the residual hazard remaining is negligible after the removal action, LUCs and/or LTM are not warranted.

8.2 SCREENING OF INDIVIDUAL ALTERNATIVES

Per Army RI/FS guidance, the preliminary screening of individual alternatives is not required for many MEC sites because of the limited number of response actions and resulting remedial alternatives. Each of the remedial alternatives developed for the MRS and described in Section 8.1 will be individually and comparatively analyzed in the following sections to determine strengths and weaknesses. The remedial alternatives are individually and comparatively analyzed in Section 9.0 using the NCP criteria.

9.0 DETAILED ANALYSIS OF ALTERNATIVES

9.1 INTRODUCTION

9.1.1 The NCP (40 CFR 300) states that the primary objective of the FS is to "ensure that appropriate remedial alternatives are developed and evaluated," and that "the number and type of alternatives to be analyzed shall be determined at each site, taking into account the scope, characteristics, and complexity of the site problem that is being addressed." In this section, the remedial action alternatives that were developed are evaluated against the nine criteria identified in the NCP and how well they meet the RAOs.

9.1.2 In addition, the information from the MEC HA input factors and outputs can be used to support the analysis of alternatives. The FS examines three broad criteria: effectiveness, implementability, and cost. For the effectiveness criterion, the MEC HA input factors of Energetic Material Type, Location of Additional Human Receptors, Site Accessibility, Amount of MEC, and MEC Classification can provide information to support evaluation of short-term effectiveness, and compliance with ARARs.

9.1.3 An estimated cost for each alternative was developed and is presented in **Appendix K**.

9.2 NCP CRITERIA CATEGORIES

9.2.1 Section 300.430(e) of the NCP lists nine criteria against which each remedial alternative must be assessed. The first two criteria are threshold criteria that must be met by each alternative. The next five criteria are the primary balancing criteria upon which the analysis is based. The final two criteria are referred to as modifying criteria and are applied after the public comment period to evaluate State and community acceptance. The acceptability or performance of each alternative against the criteria is evaluated individually so that relative strengths and weaknesses may be identified.

9.2.2 The two threshold criteria are:

- Protection of human health and the environment; and
- Compliance with ARARs.

9.2.3 The five primary balancing criteria upon which the analysis is based on are:

- Long-term effectiveness and permanence;
- Reduction of mobility, volume, or toxicity of MEC based on treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

9.2.4 The two modifying criteria upon which the analysis is based on are:

- State of Florida (i.e., FDEP) acceptance; and
- Community acceptance (including USFWS and Manatee County acceptance).

9.2.5 A preliminary assessment of State and community acceptance of each alternative is presented in this FS; however, State and community acceptance will be further evaluated following review of the FS and receipt of state comments and public review of the Proposed Plan. The final evaluation for both criteria will be addressed in the Decision Document.

9.2.1 Definitions of NCP Criteria

9.2.1.1 Overall Protection of Human Health and the Environment

This criterion addresses whether a remedial alternative will achieve adequate protection of human health and the environment and describes how MEC at the site will be eliminated, reduced, or controlled through treatment, engineering, and/or LUCs. Because there is not an established threshold for MEC hazard, the goal is to effectively minimize or eliminate the exposure pathway between the MEC and receptor.

9.2.1.2 Compliance with ARARs

This criterion addresses whether a remedial alternative meets all applicable or relevant and appropriate selected cleanup criteria, standards of control or other requirements from federal and state environmental statutes and regulations. To be acceptable, an alternative shall comply with ARARs or be covered by a waiver.

9.2.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the ability of a remedial alternative to maintain reliable protection of human health and the environment over time. This criterion considers the magnitude of residual hazard, the adequacy of the response in limiting the hazard, and whether LUCs and long-term maintenance are required.

9.2.1.4 Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment

This criterion relates to the extent to which the remedial alternatives permanently reduce the volume of MEC and reduces the associated safety hazard. Factors for this criterion for MEC include the degree of permanence of the remedial action, the amount of MEC removed/demolished, and the type and quantity of MEC remaining.

9.2.1.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during implementation. MEC removal poses hazards to workers and the public that are not associated with environmental contaminants that must be considered and controlled.

9.2.1.6 Implementability

The technical and administrative feasibility of implementing each alternative and the availability of services and materials are addressed by this criterion. This criterion also considers the degree of coordination required by the regulatory agencies, successful implementation of the remedial action at similar sites, and research to realistically predict field implementability.

9.2.1.7 Cost

This criterion addresses the capital costs, in addition to annual costs anticipated for implementation of the response action.

9.2.1.8 State Acceptance

This criterion is used to evaluate the technical and administrative concerns of the State regulatory community regarding the alternatives, including an assessment of the regulatory community's position and key concerns regarding the alternative, and comments on ARARs or the proposed use of waivers.

9.2.1.9 Community Acceptance

This criterion includes an evaluation of the concerns of the public regarding the alternatives. It determines which component of the alternatives interested persons in the community support, have reservations about, or oppose.

9.3 INDIVIDUAL ANALYSIS OF ALTERNATIVES

9.3.1 Alternative 1: No Action

The No Action alternative involves taking no action at the Passage Key ATGGR. Under this alternative, no further effort or resources would be expended. An analysis of the No Action alternative based on the NCP criteria is provided below. A summary of this alternative compared to the NCP criteria is presented in **Table 9-1**.

9.3.1.1 Threshold Criteria

The No Action alternative does not meet the threshold factor since no action would be taken to reduce the risk of potential receptor exposure to MEC and it does not offer protection of human health. MEC density across the site is considered moderate, but there is a low potential to encounter MEC because only a limited number of items have been found since the military training activities ceased in the mid-1940s, all MEC items identified during the RI were buried in the sediment (not found on the key or on the sediment surface), the area where the majority of the MEC items were found is away from the key and in water deeper than five feet, and all items found to date have been addressed to render them safe. The site is owned by the DOI and managed by USFWS, and the reasonably anticipated future land use is the same as the current land use. No development is anticipated to occur at the site. The ARARs are not applicable to this alternative.

9.3.1.2 Balancing Criteria

The No Action alternative is not effective in the short or long-term because no actions would be taken to reduce potential contact with MEC nor does this alternative employ an action that will result in a permanent solution for the site. The "reduction of toxicity, mobility, and volume" generally refers to MC. However, the "volume" or potential hazards associated with MEC would not be reduced with the No Action alternative since no action would be taken. This alternative is readily implementable as no actions would be taken, and it is also the lowest cost alternative since there would be no associated cost.

9.3.1.3 Modifying Criteria

State and community acceptance of the alternatives will be further evaluated during the FS review period and following the public comment period for the Proposed Plan.

9.3.2 Alternative 2: Land Use Controls

The LUC alternative requires that signs be installed near an area with existing public information regarding the key at Anna Maria Island and that an educational program be implemented to warn of the potential explosive hazards associated with MEC at the site. An assessment based on the NCP criteria is provided below. A summary of the LUC alternative compared to the NCP criteria is presented in **Table 9-1**.

9.3.2.1 Threshold Criteria

Based on the results of the RI field activities and future anticipated land use of the site, the LUC alternative is protective of human health and the environment. MEC density across the site is considered moderate, but there is a low potential to encounter MEC. The site is owned by the DOI and managed by USFWS, and the reasonably anticipated future land use is the same as the current land use. No development is anticipated to occur at the site. Although this alternative would not remove any MEC from the site, it would increase awareness to the potential explosives hazards at the site and limit the potential for human receptors to contact MEC in the subsurface. This alternative does not address ecological receptors; however, the MEC hazard to ecological receptors is considered minimal. The environment would incur a low level of disturbance since minimal activities would be required. ARARs are not applicable to this alternative.

9.3.2.2 Balancing Criteria

9.3.2.2.1 The LUC alternative can be effective over the short- and long-term because it educates site users about the potential explosive hazards (signs/educational programs). The alternative does not involve treatment.

9.3.2.2.2 The LUC alternative can be implemented relatively easily and cost effectively by installing signs near the site in an area at Anna Maria Island with existing public information regarding the key, by posting educational material on USFWS's website, and by incorporating a note into the NOAA chart to reflect the potential UXO hazards at the site. The MRS is located on DOI property that is managed by USFWS making the implementation and enforcement of LUCs feasible assuming the USFWS is amenable, as they have been during previous munitions response activities at Passage Key ATGGR. The implementation of administrative controls is relatively easy compared to implementing engineering controls. The intent of the LUCs alternative is to provide institutional controls, such as educational signage and informative materials and notes, so the public is aware of the potential hazard and what to do if UXO is found in the future.

9.3.2.2.3 The LTM process will be added as part of the LUCs to document continuing land use is recreational and the remedy remains protective. Additionally, the remedial design will specify notification requirements to USFWS and Manatee County should land use change occur, or be planned.

9.3.2.2.4 Costs for the remedial action and LTM (30 years) are presented in **Table 9-2**. Data supporting the cost estimates are presented in **Appendix K**. Overall, the LUC alternative is a relatively low cost, easily implementable alternative.

9.3.2.3 Modifying Criteria

State and community acceptance of the alternatives will be further evaluated during the FS review period and following the public comment period for the Proposed Plan. However, based on discussions during TPP meetings, the State has indicated the LUC alternative would be acceptable as it would provide notification to potential human receptors (trespassers) through LUCs even if it does not remove MEC.

9.3.3 Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas

The Surface and Subsurface Clearance – Focused on High Anomaly Density Areas (i.e., Target Area 1 or 198.5 acres) alternative consists of conducting a surface and subsurface clearance in the high anomaly density areas of the RI/FS Investigation Area as identified in the RI (see **Map B-6** in **Appendix B**). The subsurface clearance would be completed to a depth of approximately five feet below ground (maximum depth of four feet detected during the RI plus one foot for buffer). Additionally, Alternative 3 will include the LUCs and LTM described in Alternative 2 to address any residual MEC hazard potentially remaining at the site in areas not cleared as part of the remedial action or due to limitations of technology for the identification and removal of MEC / MPPEH. An assessment based on the NCP criteria is provided below. The summary of this alternative compared to the NCP criteria is presented in **Table 9-1**.

9.3.3.1 Threshold Criteria

This limited surface and subsurface clearance alternative is protective of human health and the environment within the Passage Key ATGGR. Risks to human health are addressed through the limited removal of MEC on the surface and from the subsurface within Target Area 1 (or 198.5 acres) and through the implementation of LUCS and LTM. The environment would incur a localized level of disturbance as removal activities would be conducted at select locations with increased receptor access within the MRS, including the target locations and subsurface excavations. This alternative would comply with the ARARs specific to the Endangered Species Act if avoidance and mitigation measures are implemented to protect threatened and endangered species when the clearance work is done.

9.3.3.2 Balancing Criteria

9.3.3.2.1 This alternative would be effective over the short- and long-term because it would remove MEC from the surface and subsurface in the high anomaly density area of Target Area 1 (198.5 acres), which limits the exposure pathways to human and ecological receptors. Effectiveness would be further increased through the implementation of LUCs and LTM because it educates site users about the potential explosive hazards (signs/educational programs). There would be a slight increased short-term risk to workers associated with the clearance activities. This alternative would reduce the site explosive hazard, as MEC would presumably be removed from the site in the most concerning area (i.e., Target Area 1 or 198.5 acres). This limited surface and subsurface clearance alternative would reduce the "volume" of MEC through treatment from the surface and the subsurface in high anomaly density area in Target Area 1 (or 198.5 acres).

9.3.3.2.2 This alternative would be implemented with a high difficulty using conventional MEC surface and subsurface removal and disposal techniques and equipment due to weather and sea conditions. Implementation of this alternative would require a moderate amount of time and resources for the remedy when compared to Alternative 2. Implementation of the LUCs and LTM for Alternative 3 are the same as those discussed for the LUC alternative in Section 9.3.2 to address areas residual hazard in areas not included in the surface and subsurface clearances. Costs for the remedial action is presented in **Table 9-2**. Data supporting the cost estimates are presented in **Appendix K**.

9.3.3.3 Modifying Criteria

State and community acceptance of the alternatives will be further evaluated during the FS review period and following the public comment period for the Proposed Plan. Based on discussions during TPP meetings, this alternative would potentially satisfy the State, USFWS, and Manatee County as it would provide reasonable protection to potential human receptors (trespassers) through the surface and subsurface removal of MEC along high anomaly density area in Target Area 1 (or 198.5 acres). However, there may be concern because of the likelihood for impacts to the sensitive habitat (i.e., sea grasses).

9.3.4 Alternative 4: Complete Surface and Subsurface Clearance – Entire Site

The Surface and Subsurface Clearance – Entire Site alternative consists of conducting a surface and subsurface clearance over the entire site reducing exposure at the site. The subsurface clearance would be completed to a depth of approximately five feet below ground (maximum depth of four feet detected during the RI plus one foot for buffer) to ensure the property is acceptable for unlimited use and access. Alternative 4 as presented is an unlimited use/unrestricted exposure scenario. An assessment based on the NCP criteria is provided below. The summary of this alternative compared to the NCP criteria is presented in **Table 9-1**.

9.3.4.1 Threshold Criteria

This entire surface and subsurface clearance alternative is protective of human health and the environment within the Passage Key ATGGR. Hazards to human health are addressed through the site-wide removal of MEC on the surface and from the subsurface. The marine environment would incur a significant level of disturbance as removal activities would be conducted over a larger area than that for Alternative 3. This alternative would comply with the ARARs specific to the Endangered Species Act if avoidance and mitigation measures are implemented to protect threatened and endangered species when the clearance work is done.

9.3.4.2 Balancing Criteria

9.3.4.2.1 This alternative would be effective over the short- and long-term because it would remove MEC from the surface and subsurface at the site, which limits the exposure pathways to human and ecological receptors. There would be a slight increased short-term risk to workers associated with the clearance activities. This alternative would reduce the site explosive hazard, as MEC would presumably be removed from the site to the greatest extent possible. This entire surface and subsurface clearance alternative would remove the “volume” of MEC through treatment from the surface and the subsurface.

9.3.4.2.2 This alternative would be implemented with a high level of difficulty using conventional MEC surface and subsurface removal and disposal techniques and equipment due to weather and sea conditions. Implementation of this alternative would require a substantial amount of time and resources and would cause significant damage to the natural environment. Costs for the remedial action is presented in **Table 9-2**. Data supporting the cost estimates are presented in **Appendix K**.

9.3.4.3 Modifying Criteria

State and community acceptance of the alternatives will be further evaluated during the FS review period and following the public comment period for the Proposed Plan. Based on discussions during TPP meetings, this alternative would potentially satisfy the State, USFWS, and Manatee County as it would provide reasonable protection to potential human receptors from the site-wide surface and subsurface clearances. However, there may be concern because of the likelihood for impacts to sensitive habitat (i.e., sea grasses).

Table 9-1: NCP Criteria for Passage Key ATGGR

Criteria		Alternative 1: No Action
Threshold Criteria	Overall Protection of Human Health and the Environment	Not protective of human health and the environment because it does not mitigate the potential risk associated with the potential presence of MEC/MPPEH at Passage Key ATGGR.
	Compliance with ARARs	ARARs are not applicable.
Primary Balancing Criteria	Short-term Effectiveness	Does not meet the short-term effectiveness requirements since it does not remove MEC/MPPEH.
	Long-term Effectiveness	Does not meet the long-term effectiveness requirements since it does not remove MEC/MPPEH.
	Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment	Does not involve treatment.
	Implementability	Highly implementable because no remedial actions are conducted.
	Cost Estimate (Net Present Value [NPV])	No cost is associated with this alternative because no action would be taken.
Modifying Criteria	State and Community Acceptance	State and community acceptance of the alternatives will be further evaluated during the FS review period and following the public comment period for the Proposed Plan.
Criteria		**Alternative 2: LUCs**
Threshold Criteria	Overall Protection of Human Health and the Environment	Is protective of human health and the environment and reduces the potential impact to human health through education of explosive hazards through signage and other educational programs.
	Compliance with ARARs	ARARs are not applicable.
Primary Balancing Criteria	Short-term Effectiveness	Reduces the short-term potential for human receptor interaction with MEC at the site and poses no short-term risk during implementation.
	Long-term Effectiveness	Reduces the long-term potential for human receptor interaction with MEC at the site.
	Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment	Does not involve treatment.
	Implementability	Highly implementable because the cost to implement is low and specialized equipment or personnel are not required.
	Cost Estimate (NPV)	Total estimated cost is $248,000.
Modifying Criteria	State and Community Acceptance	State and community acceptance of the alternatives will be further evaluated during the FS review period and following the public comment period for the Proposed Plan. Based on discussions during TPP meetings, the LUC alternative would be acceptable as it would provide notification to potential human receptors (trespassers) through LUCs.
Criteria		**Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas**
Threshold Criteria	Overall Protection of Human Health and the Environment	Is protective of human health and but not the environment. Human health is protected through the removal of the direct contact pathway between potential receptors and MEC in high anomaly density areas and through education of explosive hazards through signage and other educational programs. The environment (marine) would be negatively impacted by the implementation of the Limited Surface and Subsurface Clearance alternative.
	Compliance with ARARs	Would comply with the applicable ARARs (i.e., 40 CFR 264.601 "Environmental Performance Standards") if consolidated shots are required during the remedial action.
Primary Balancing Criteria	Short-term Effectiveness	Increase in short-term risk to workers associated with completing the limited surface and subsurface clearance.
	Long-term Effectiveness	Reduces the long-term potential for human receptor interaction with MEC at the site.
	Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment	Effective at reducing the volume of MEC on the surface and subsurface in the areas identified for clearance only. LUCs and LTM further reduce the potential for human receptor exposure to MEC risks.

	Implementability	Implementable using conventional surface and subsurface land removal techniques. The required vegetation removal and the resulting negative impact to natural resources, protected species, and the public use of the property reduce implementability. LUCs and LTM are highly implementable because the cost to implement is low and specialized equipment or personnel are not required.
	Cost Estimate (NPV)	Total estimated cost is $3,518,000.
Modifying Criteria	State and Community Acceptance	State and community acceptance of the alternatives will be further evaluated during the FS review period and following the public comment period for the Proposed Plan. However, based on discussions during TPP meetings, this alternative would potentially satisfy the State, USFWS, and Manatee County as it would provide reasonable protection to potential human receptors (trespassers) through the surface and subsurface removal of MEC along high anomaly density area in Target Area 1 (or 198.5 acres). However, there may be concern because of the likelihood for impacts to the sensitive habitat (i.e., sea grasses).
Criteria		**Alternative 4: Complete Surface and Subsurface Clearance – Entire Site**
Threshold Criteria	Overall Protection of Human Health and the Environment	Is protective of human health but not the environment. Human health is protected through the removal of the direct contact pathway between potential receptors and MEC. The environment (marine) would be negatively impacted by the implementation of the Complete Subsurface and Subsurface Clearance alternative.
	Compliance with ARARs	Would comply with the applicable ARARs (i.e., 40 CFR 264.601 "Environmental Performance Standards") if consolidated shots are required during the remedial action.
Primary Balancing Criteria	Short-term Effectiveness	Increase in short-term risk to workers associated with completing the surface and subsurface clearance.
	Long-term Effectiveness	Reduces and may eliminate the long-term potential for human receptor interaction with MEC at the site.
	Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment	Effective at reducing the volume of MEC on the surface and subsurface.
	Implementability	Implementable using conventional surface and subsurface land and marine removal techniques. The weather and sea conditions as well as the impact to sensitive habitat and protected species reduce implementability. Marine operations would be more difficult to implement than typical land-based operations.
	Cost Estimate (NPV)	Total estimated cost is $7,795,000.
Modifying Criteria	State and Community Acceptance	State and community acceptance of the alternatives will be further evaluated during the FS review period and following the public comment period for the Proposed Plan. However, based on discussions during TPP meetings, this alternative would potentially satisfy the State, USFWS, and Manatee County as it would provide reasonable protection to potential human receptors from the site-wide surface and subsurface clearances. However, there may be concern because of the likelihood for impacts to the sensitive habitat (i.e., sea grasses).

Table 9-2: Remedial Action Cost Estimates

Alternative	Total Capital Cost	Total Annual Cost (Present Worth)	Total Capital Cost and Annual Costs
1 – No Action	$0	$0	$0
2 – LUCs	$120,000	$128,000	$248,000
3 – Limited Surface and Subsurface Clearance – Focused High Anomaly Density Areas	$3,387,000	$131,000	$3,518,000
4 – Complete Surface and Subsurface Clearance – Entire Site	$7,795,000	$0	$7,795,000

9.4 Comparative Analysis of Alternatives

The comparison of the alternatives is based on the threshold, balancing, and modifying criteria that consider effectiveness at protecting human health and the environment; compliance with ARARs; short- and long-term effectiveness; reduction of toxicity, mobility, and volume through treatment; implementability; cost; and regulatory and community acceptance.

9.4.1 Protectiveness

The No Action alternative does not meet this threshold criterion since it does not mitigate the potential risk associated with the potential presence of MEC. The LUC alternative protects human health by reducing the potential interaction with MEC through the establishment of LUCs, which have a nominal effect on the environment, similarly to the No Action alternative. For example, if the public is aware of the potential hazards associated with UXO potentially present at the site based on a note in the NOAA chart or reading a sign, then the LUCs provided a level of protectiveness by discouraging people from entering the area. The limited surface and subsurface clearance alternative is protective of human health through the localized removal of MEC in the surface and subsurface in high anomaly density area (i.e., Target Area 1 or 198.5 acres) and through the establishment of LUCs. The environmental disturbance required for the limited and complete surface and subsurface clearance alternatives are greater than the No Action and LUCs alternatives. The entire site surface and subsurface clearance alternative is protective of human health because all detectable MEC would be removed from the surface and from the subsurface, thereby eliminating the direct contact pathway between potential receptors and MEC on the sediment surface and in the subsurface. While the entire site surface and subsurface clearance alternative is protective of human health, it would entail a substantial amount of environmental disturbance to complete the removal actions and would require avoidance and/or mitigation measures to protect sensitive species.

9.4.2 Compliance with ARARs

ARARs are not identified for the No Action alternative or LUC alternative as exposure pathways are considered incomplete for all media due to the lack of a MC source area and because consolidated shots (relative to 40 CFR 264.601 "Environmental Performance Standards") are not required as part of either remedy. The limited and entire site surface and subsurface clearance alternatives would comply with 40 CFR 264.601 "Environmental Performance Standards", as consolidated shots may be required.

9.4.3 Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment

9.4.3.1 The No Action alternative does not reduce the volume of MEC as there is no action taken. The LUC alternative also does not reduce the volume of MEC; however, it increases awareness of the potential explosive hazards associated with MEC and thereby reduces the potential for human exposure to MEC risks. The limited surface and subsurface clearance alternative provides for localized removal of MEC in the surface and subsurface in high anomaly density area (i.e., Target Area 1 or 198.5 acres). However, there is a residual MEC hazard even following a removal action and, therefore, LUCs and LTM would still be required. The entire site surface and subsurface clearance alternative potentially provides the greatest reduction in MEC as a surface and subsurface removal would be conducted over the entire site to approximately five feet below ground (maximum depth of four feet detected during the RI plus one foot for buffer) to ensure the property is acceptable for unlimited use. The following table, **Table 9-3**, presents the baseline MEC HA score along with MEC HA scores developed for each of the remedial alternatives. The remedial action MEC HA, which MEC HAs for the baseline (current) conditions and each of the remedial alternatives, is included in **Appendix J**.

Table 9-3: MEC HA Evaluation (Baseline versus Remedial Alternatives)

Alternative	MEC HA Score	Hazard Level
Baseline (Current) Conditions	710	3 – Moderate Potential Explosive Hazard Condition
1 – No Action	710	3 – Moderate Potential Explosive Hazard Condition
2 – LUCs	710	3 – Moderate Potential Explosive Hazard Condition
3 – Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Area	475	4 – Low Potential Explosive Hazard Condition
4 – Complete Surface and Subsurface Clearance – Entire Site	405	4 – Low Potential Explosive Hazard Condition

Note: A MEC HA score of 1 indicates the highest potential risk and 4 indicates the lowest.

9.4.3.2 As discussed in the Section 6.0, the MEC HA baseline conditions at Passage Key ATGGR were determined to be a moderate potential explosive hazard. A site with a moderate potential explosive hazard is compatible with current uses, but potentially not compatible under more intrusive future uses.

9.4.4 Short-Term Effectiveness

The No Action alternative can be implemented quickly without any risk to the community, workers, or the environment because no actions would be taken in the short-term to offer protectiveness of human health or the environment. The LUC alternative can also be implemented quickly and allows response objectives to be reached in a timely manner without short-term risk for the community, workers, and the environment. The limited and entire site clearance alternatives take substantially more time to implement than either the No Action or LUC alternatives, as extensive planning and coordination are required. Additionally, there is a short-term risk to workers while the limited and complete clearance actions are being implemented.

9.4.5 Long-Term Effectiveness

The No Action alternative is not effective in the long-term because no actions would be taken to offer protectiveness. The LUCs, Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Area (i.e., Target Area 1 or 198.5 acres), and Complete Surface and Subsurface Clearance – Entire Site alternatives all offer increasing levels of long-term effectiveness and permanence through the reduction of potential human receptor interaction with MEC at the site through LUCs and/or removal actions. While the limited surface and subsurface clearance alternative would remove MEC from high anomaly density areas, the entire site surface and subsurface clearance alternative is most effective in the long-term relative to the No Action, LUC, and limited surface clearance alternatives since MEC will be removed from the entire surface and subsurface resulting in less residual risk. LTM would be required as part of the LUC and limited surface and subsurface clearance alternatives only. LTM would not be required following the surface and subsurface removals over the entire site (i.e., Alternative 4) since any residual risk remaining would be negligible.

9.4.6 Implementability

The No Action alternative presents no implementation risks. The LUC alternative is feasible, as all of the proposed LUCs are technically and administratively reasonable, and the services and goods required are readily available. Additionally, existing information on the history of Passage Key exists at Anna Maria Island with signs placed at the public park where Passage Key is visible from the island. This location would be a logical place to add signage regarding the historical munitions-related use of Passage Key and to educate the public regarding the potential presence of munitions associated with that use, as well as incorporating a note into the NOAA charts to reflect of the potential UXO hazards at the site. Public education is more easily implemented than other alternatives since there are established mechanisms (i.e., notes on nautical charts and signs on the beach or at boat ramps) to inform the public of a potential hazard. The limited and entire surface and subsurface clearance alternatives are feasible using conventional MEC removal techniques, goods, and services, but would be substantially more difficult to implement than the LUC alternative due to the technical nature and short-term risks associated with the services required. These clearance alternatives may also be more difficult to implement because MEC could be buried deeper than the planned clearance depth, making the alternatives less effective. The marine portion of the surface and subsurface clearance for the entire site alternative would pose higher implementation risks than the land portion. All alternatives are administratively feasible as the area is under the jurisdiction of the USFWS, who has historically been amenable to activities required as part of the munitions response. The surface and subsurface removals required as part of the limited and complete clearance alternatives are potentially problematic, as they would be more difficult to ensure all items are recovered since they could be buried more than five feet and would also require marine environment disturbances, which would be costly and damaging to the environment.

9.4.7 Cost

There are no costs associated with the No Action alternative. The LUC alternative is substantially less costly than the limited and entire surface and subsurface clearance alternatives, while still being protective of human health and the environment. The entire site surface and subsurface clearance alternative is the most costly.

9.4.8 State and Community Effectiveness

State and community acceptance of the alternatives will be further evaluated following review of the RI/FS Report and the public comment period for the Proposed Plan. However, based on discussions during TPP meetings, the State has indicated the LUC alternative would be acceptable and preferred as it would provide awareness to recreational users (e.g., boaters, fishers, swimmers) of the MEC hazards. The limited and entire site surface and subsurface clearance alternatives may potentially satisfy the State, USFWS, and Manatee County because they would provide a reasonable level of protectiveness to potential human receptors through varying combinations of LUCs and removal actions. The State, USFWS, and Manatee County have also expressed concern over the sensitive habitat impacts resulting from the surface and subsurface clearances which would be conducted as part of both the limited and entire site clearances.

9.4.9 Comparative Benefit Determination

The LUCs alternative provides benefits over the No Action, Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas, and Complete Surface and Subsurface Clearance – Entire Site alternatives as a level of awareness of the site conditions would be put in place. Although this alternative would not remove any MEC from the site, it would increase awareness to the potential explosives hazards at the site and limit the potential for human receptors to contact MEC in the subsurface. This alternative does not address ecological receptors; however, the MEC hazard to ecological receptors is considered minimal. These new controls would provide protectiveness of human health and the environment and are effective in the short and long-term under the current land use at the site which is not anticipated to change in the future. The LUCs alternative can be implemented quickly and at a minimal cost without the need for potential marine environment disturbances required for the limited and complete clearance alternatives.

10.0 SUMMARY OF RESULTS

This section summarizes the significant results obtained and the conclusions reached as a result of the RI activities conducted at the former Passage Key ATGGR. Only the most significant findings are presented in this section and are reproduced directly or abstracted from information contained in this report. The overall goal of the RI was to determine the nature and extent of MEC and subsequently to determine the potential hazards and risks posed to human health and the environment by MEC. The RI also provides additional data to assist in determining if a FS is necessary for the MRS. As a result of the characterization activities conducted at the former Passage Key ATGGR, the objectives of the RI have been met.

10.1 RI FIELD WORK SUMMARY

The RI fieldwork was conducted from 2 November 2015 to 15 December 2015 and included a GSV/IVS, DGM and evaluation, anomaly reacquisition and marking, intrusive investigations and identification of anomalies identified during the geophysical mapping, and proper disposal of all recovered MD and non-MD material. The preliminary CSM was updated and a MEC HA and a MRSPP were completed based on the RI results.

10.1.1 Nature and Extent of MEC

10.1.1.1 RI fieldwork was conducted IAW the Final RI/FS UFP-QAPP (JV, 2015b). The RI fieldwork included marine DGM and analog surveys followed by intrusive investigation of select subsurface anomalies within the land and marine environments. The geophysical surveys covered 16.3 acres (0.63 acres of analog and 15.67 acres of marine DGM) at Passage Key ATGGR; **Table 10-1** provides a breakdown by surveying method.

Table 10-1: Summary of Survey Investigations

Survey Method	Area Investigated (Acres)	Transect Length (Miles)
DGM Transects	10.65	13.4
DGM Grids	5.02	N/A
Analog Transects	0.63	1
Overall Totals	**16.3**	**14.4**

10.1.1.2 A total of 192 DGM and 20 analog anomalies were intrusively investigated within the RI/FS Investigation Area. **Table 10-2** provides the number of anomalies by surveying method. A total of four UXO and 21 items designated as MD, including one intact 100-lb photoflash bomb that was initially identified as MPPEH and later confirmed to be MD, were recovered during intrusive investigations. The four UXO were identified during the RI/FS field activities included: a 37-millimeter (mm) projectile (fuzed), a 4.5-inch aerial rocket, and two bomb burster/fuzes from 100-lb photoflash bombs. The 4.5-inch aerial rocket could not be confirmed as practice and, therefore, it was treated as a HE rocket. The MD included various pieces of 2.25-inch rockets, 4.5-inch rockets, and 100-lb practice bombs. These findings confirm previous site documentation that indicated that photoflash bombs, practice bombs, and aerial rockets were the primary munitions type used at the Passage Key ATGGR. As such, it confirms that Passage Key ATGGR was primarily used as a practice target, but also confirms that photoflash bombs and a limited amount of HE munitions (e.g., bombs and rockets) were used. The remaining anomalies primarily consisted of non-munitions-related scrap metal (98 items) and no-contacts/no-finds (60 locations). The scrap metal included such items as nails, tin cans, and fence wire. The relatively high number of no finds along the marine DGM transects was addressed in the *Passage Key Intrusive No-Find Root Cause Analysis* (RCA1) and is located in **Appendix F**.

Table 10-2: Summary of Anomalies Selected for Intrusive Investigation

Survey Method	Quantity
DGM Transects	135
DGM Grids	57
Analog Transects	20
Total	**212**

10.1.1.3 One CMUA with a total size of 198.5 acres was identified within the RI/FS Investigation Area. The target areas considered to be NCMUA portion of the site is 448.5 acres and there is a 90% confidence that the MEC density is less than approximately 0.457 MEC/acre and a 99.4% confidence that the MEC density is less than 1.0 UXO/acre. The areas outside of the four target areas were determined to be NCMUAs based on the VSP geostatistical analysis (see **Appendix F**) and lack of munitions find during the intrusive investigation.

10.1.2 Nature and Extent of MC Contamination

No MC source areas were identified based on previous studies and the RI findings. No MC samples were collected or analyzed per the protocols documented in the Final RI/FS QAPP (JV, 2015b).

10.1.3 Fate and Transport

10.1.3.1 Transport of MD, and possibly MEC, is likely given the density of items and their location primarily in the subsurface. The transport of MEC and/or MD at Passage Key ATGGR could potentially be caused by natural processes, including storms, currents, sand shifts and erosion/deposition. Intense rain events (including hurricanes) have the potential to expose and transport MD / MEC at the site. The other potential mechanism for exposure and transport is disturbance by humans or wildlife.

10.1.3.2 There are no MC source areas and no migration routes or transport pathways identified for MC at the former Passage Key ATGGR.

10.1.4 MEC Hazard Characterization and Qualitative Risk Assessment

10.1.4.1 The MEC hazard characterization is evaluated quantitatively and qualitatively as appropriate for the site. A qualitative MEC hazard evaluation for the site was completed based on a review of the historical site information and review of all investigations conducted to date on the site. Potential MEC exists on the surface and within the near subsurface (up to 36 inches based on RI findings although could exist deeper than 36 inches) at Passage Key ATGGR. The baseline MEC HA assigned a moderate hazard to Passage Key ATGGR which indicates the site is compatible with current uses but potentially not compatible under more intrusive future uses. The qualitative assessment of MEC hazards took into account additional factors at the Passage Key ATGGR such existing explosive hazard educational material and the anticipated future land uses (not expected to change from the current recreational use) and determined a low hazard level was more appropriate for the MRS.

10.1.4.2 A qualitative evaluation of unacceptable risk was also performed based on the RI findings. Based on the types of MEC found at the site, their relative low sensitivity for detonation, the limited quantity found that is consistent with the short historical use of the site (for only a few years during WWII), the inaccessibility of MEC found underwater and in the sediment, as well as the infrequent use of the area (i.e., Target Area 1) by receptors indicate that the likelihood of encounter is low and the risk to receptors from MEC minimal. However, given the potential for MEC items to become exposed due to storms or other mechanisms, the risk to receptors remains unacceptable without implementation of remedial alternatives, as presented and discussed in the FS.

10.1.5 MC Risk Characterization

No MC source areas exist and all exposure pathways are considered incomplete. There is no risk identified for human or ecological receptors and a HHRA and SLERA are not required.

10.2 RI RECOMMENDATIONS

10.2.1 Four UXO items were found during the RI field work within the high anomaly density area of Target Area 1 (or 198.5 acres). MD recovered at Passage Key ATGGR was consistent with historical information. These results correlate with historical information about the site. Based on historical information and the results of the RI, there is a low potential to encounter MEC at the Passage Key ATGGR because only a limited number of items have been found since the military training activities ceased in the mid-1940s, all MEC items identified during the RI were buried in the sediment (not found on the key or on the sediment surface), the area where the majority of the MEC items were found is away from the key and in water deeper than five feet, and all items found to date have been addressed to render them safe.

10.2.2 Since there are no identified source areas for MC at the former Passage Key ATGGR, the revised CSM reflects incomplete MC exposure pathways for all human and ecological receptors.

Since there are no complete exposure pathways, no response action is required. Therefore, the findings of the RI support no further action for MC at the former Passage Key ATGGR.

10.3 FS FINDINGS

An FS to support the selection of viable alternatives for mitigating the residual limited potential safety risks to human health and the environment due to MEC was completed for Passage Key ATGGR. Because it cannot be determined with complete certainty that MEC will not be discovered in the future, the FS alternatives included:

1. **No Action:** The NCP requires a No Action alternative to be evaluated.
2. **Land Use Controls with Long Term Management:** Administrative controls to discourage access and provide education to the public about the former bombing and gunnery range training activities. Some examples could include, but are not limited to:
    a. Signage regarding the WWII historical use and possibility that munitions may remain at Passage Key and surrounding waters from those training activities within Anna Maria Island, where there is existing information regarding the key
    b. Administrative controls would include public education materials
    c. While not a LUC, a long-term management plan would be required to identify LUC enforcement actions, inspect LUCs, and provide/update educational materials on a periodic basis.
3. **Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas:** Surface and subsurface clearance would be conducted in the high anomaly density area (i.e., Target Area 1 or 198.5 acres).
    a. Public access to the key and surrounding waters would be restricted during clearance activities.
    b. Protected species (i.e., threatened and endangered species) and sensitive habitats, if present in the area where the clearance is planned, might be impacted depending on the time of year when activities take place and whether avoidance and/or mitigation measures are implemented.
4. **Complete Surface and Subsurface Clearance – Entire Site:** Surface and subsurface clearance would be conducted over the entire RI/FS Investigation Area.
    a. Public access to the key and surrounding waters would be restricted during clearance activities.
    b. Protected species (i.e., threatened and endangered species) and sensitive habitats, if present, might be significantly impacted depending on the time of year when activities take place and whether avoidance and/or mitigation measures are implemented.

10.3.1 Comparative Analysis of FS Alternatives

The No Action alternative (Alternative 1) is not protective of human health since it does not mitigate the potential hazard associated with MEC. The No Action alternative is readily implementable since it requires no actions and has no associated costs. The LUC alternative (Alternative 2) provides overall protectiveness, is effective and, while it requires more action to implement than Alternative 1, it is more readily implementable than both the surface and subsurface clearance alternatives (Alternative 3 and 4). The LUC alternative is more expensive than the No Action alternative, but substantially less costly than Alternatives 3 and 4. Alternative 3 is protective of human health and has greater long-term effectiveness than Alternative 1 and 2. There is moderate short-term explosive hazards associated with the removal of MEC during Alternative 3. There are potential marine environment disturbances and natural resource impacts related to Alternative 3 if avoidance and/or mitigation measures are not used, which makes it less implementable than either the No Action or LUC alternatives. Alternative 3 is substantially more costly than the No Action and LUC alternatives, but less costly than Alternative 4. Alternative 4 provides protectiveness of human health through the greatest potential reduction in MEC, but requires significantly more natural resource impacts than the other alternatives if mitigation measures are not used. Alternative 4 provides the most long-term effectiveness of all the alternatives and has potentially the most short-term explosive hazards associated with the removal of MEC. Alternative 4 is the least implementable of all four alternatives because of the potential marine environment disturbances and natural resource impacts that will require more mitigation measures. Alternative 4 is significantly more costly than any of the other three alternatives. A summary of the comparative analysis for the FS alternatives against the NCP criteria is presented in **Table 10-3**.

Table 10-3: Summary of Comparative Analysis

Alternatives	Threshold Criteria		Primary Balancing Criteria				
	Overall Protectiveness	**Complies with ARARs**	**Reduction of Mobility, Volume, or Toxicity of MEC based on Treatment**	**Short-Term Effectiveness**	**Long-Term Effectiveness**	**Implementability**	**Cost**
Alternative 1: No Action	Not protective of human health and the environment	Complies	No Reduction	Low Short-Term Hazards	Not Effective	Readily Implementable	$0
Alternative 2: LUCs	Protective of human health and the environment	Complies	No Reduction	Low Short-Term Hazards *(from Installing Signs and Public Awareness)*	Effective	Readily Implementable	$$
Alternative 3: Limited Surface and Subsurface Clearance – Focused on High Anomaly Density Areas	Protective of human health and the environment *(localized natural resource impacts during clearance activities are possible if avoidance or mitigation measures are not implemented)*	Complies	Some Reduction	Moderate Short-Term Hazards *(from Munitions Removal in High Anomaly Density Areas)*	More Effective	Moderately Implementable *(with natural resource impacts possible if mitigation measures are not implemented)*	$$$$
Alternative 4: Complete Surface and Subsurface Clearance - Entire Site	Protective of human health and the environment *(significant natural resource impacts during clearance activities are possible if mitigation measures not implemented)*	Complies	Greatest Reduction	Greatest Short-Term Hazards *(from Munitions Removal)*	Most Effective	Least Implementable *(with significant natural resource impacts if mitigation measures are not implemented)*	$$$$$

Threshold criteria are pass or fail and, as such, is not graded with the color system.	Most Desirable	Significantly Desirable	Moderately Desirable	Least Desirable

11.0 REFERENCES

29 CFR 1910.120, Occupational Safety and Health Standards, Hazardous Materials, "Hazardous Waste Operations and Emergency Response."

40 CFR 300.415, "National Oil and Hazardous Substances Pollution Contingency Plan (NCP)."

Code of Federal Regulation. Comprehensive Environmental Response, Compensation, and Liability Act 42 U.S.C. §9601-11050.

ESTCP, 2009. Final Report Geophysical System Verification (GSV): A Physics-Based Alternative to Geophysical Prove-Outs for Munitions Response

JV, 2015a. *Final Explosives Site Plan, Remedial Investigation/Feasibility Study of Former Passage Key Air-to-Ground Gunnery Range, Manatee County, Florida*. FUDS Property Number I04FL040101. Prepared by the PIKA-PIRNIE JV for USACE. June 2015.

JV, 2015b. *Final Uniform Federal Policy – Quality Assurance Project Plan, Military Munitions Response Program, Remedial Investigation/Feasibility Study, Passage Key Air-to-Ground Gunnery Range, Manatee County, Florida*. FUDS Property Number I04FL040101. Prepared by the PIKA-PIRNIE JV for USACE. October 2015.

Parsons, 2008. *Final Site Inspection, Passage Key Air-to-Ground Gunnery Range, Manatee County, Florida*. Prepared by Parsons for USACE. March 2008.

U.S. Army, 2009. U.S. Army Military Munitions Response Program Remedial Investigation / Feasibility Study Guidance. November 2009.

USACE, 1993. *Defense Environmental Restoration Program, Formerly Used Defense Sites, Inventory Project Report (INPR), Passage Key Air-to-Ground Gunnery Range, Site No. I04FL040101*. December 1993.

USACE, 2000. *Defense Environmental Restoration Program, Formerly Used Defense Sites (DERP-FUDS), Inventory Project Report (INPR) Requiring an Ordnance and Explosives (OE) Engineering Evaluation and Cost Analysis (EE/CA) for Project No. I04FL040101, Passage Key Air-to-Ground Gunnery Range, Manatee County, FL*. August 2000.

USACE, 2002. *Archives Search Report, Passage Key Air-to-Ground Gunnery Range, Manatee County, Florida*, Project Number I04FL040101. 19 August 2002.

USACE, 2004. Formerly Used Defense Sites (FUDS) Program Policy, ER 200-3-1, 10 May 2004.

USACE, 2008. Safety and Health Requirements Manual, EM 385-1-1, 15 September 2008.

USACE, 2014. WERS Contract No. W912DY-10-D-0025, TO 0021, *Remedial Investigation/Feasibility Study for the Passage Key Air-to-Ground Gunnery Range, Manatee County, Florida*. 14 April 2014.

USACE, 2015. *Technical Guidance for Military Munitions Response Actions*, EM 200-1-15, 30 October 2015.

USAESCH, 2003. "Ordnance and Explosives Digital Geophysical Mapping Guidance

Operational Procedures and Quality Control Manual (DGM QC Guidance)," December 2003.

USAESCH, 2010. Data Item Description (DID) Worldwide Environmental Remediation Services (WERS), April 2010.

United States Census Bureau, 2010. "State and County Quickfacts". http://quickfacts.census.gov/qfd/index.htmlhttp://quickfacts.census.gov/qfd/index.html

United States Environmental Protection Agency (USEPA), 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA/540/G-89/004)*.

USEPA, 2010. Munitions and Explosives of Concern Hazard Assessment Guidance, Final, February 2010.

United States Fish and Wildlife Service, 2016. Endangered Species. https://www.fws.gov/endangered/