Digital Geophysical Mapping/ Electromagnetic Surveys

Culebra Water Ranges – Flamenco Bay Water Area (MRS 03) and Luis Peña Channel (MRS 12)

Culebra, Puerto Rico

Final
Phase 2 Remedial Investigation Work Plan

May 14, 2015

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Culebra, Puerto Rico

May 14, 2015

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ABBREVIATIONS AND ACRONYMS

AP	armor piercing
ApA	anomalies per acre
APP	Accident Prevention Plan
ARAR	applicable or relevant and appropriate requirement
ASR	Archives Search Report
cal	caliber
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CRL	Corporate Reference Library
CSM	conceptual site model
dBA	A-weighted decibels
DERP	Defense Environmental Restoration Program
DFW	definable feature of work
DGM	digital geophysical mapping
DID	Data Item Description
DNER	Department of Natural and Environmental Resources
DoD	Department of Defense
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
DR	Daily Report
EBS	Environmental Baseline Survey
EE/CA	Engineering Evaluation and Cost Analysis
EEG	Ellis Environmental Group, Inc.
EM	electromagnetic
EPP	Environmental Protection Plan
EQB	Environmental Quality Board
ESA	Endangered Species Act
FAR	Federal Acquisitions Regulations
FCR	Field Change Request
FOL	field operations lead
FS	Feasibility Study
FUDS	Formerly Used Defense Site
GIS	geographic information system
GPS	global positioning system
GQCM	geophysics quality control manager
HAZWOPER	Hazardous Waste Operations and Emergency Response

ABBREVIATIONS AND ACRONYMS
(Continued)

HD	high definition
HE	high explosives
HIPS	Hydrograph Information Processing System
INPR	Inventory Project Report
ISO	industry standard object
IVS	instrument verification strip
KO	Commanding Officer
MBE	multibeam echosounder
MC	munitions constituent
MD	munitions debris
MEC	munitions and explosives of concern
MLW	mean low water
mm	millimeter
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
NAD83	North American Datum 1983
Navy	Department of the Navy
NCR	nonconformance report
NHA	National Heritage Area
NHL	National Historic Landmarks Program
NMFS	National Oceanic and Atmospheric Administration National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRIS	National Register Information System
PjM	Project Manager (TtEC)
PM	Project Manager (USACE)
PNNL	Pacific Northwest National Laboratory
PPE	personal protective equipment
PWS	Performance Work Statement
QA	quality assurance
QC	quality control
QCM	Quality Control Manager
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RTK	real-time kinematic

ABBREVIATIONS AND ACRONYMS
(Continued)

SHM	Safety and Health Manager
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SSS	sidescan sonar
T&E	threatened and endangered
T&M	time and materials
TEMA	Towed Electromagnetic Array
TMP	Technical Management Plan
TPP	Technical Project Planning
TtEC	Tetra Tech EC, Inc.
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineering and Support Center, Huntsville
USBL	ultra-short baseline
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
VHF	very high frequency
VSP	Visual Sample Plan

1.0 INTRODUCTION

1.1 PROJECT AUTHORIZATION

1.1.01 Tetra Tech EC, Inc. (TtEC) is the prime contractor to the U.S. Army Engineering and Support Center, Huntsville (USAESCH) under Contract W912DY-10-D-0015, Task Order 0003. This Task Order was established to perform a munitions and explosives of concern (MEC) Remedial Investigation/Feasibility Study (RI/FS) of the Culebra Water Ranges, located in Culebra, Puerto Rico. Relevant portions of the Performance Work Statement (PWS) are included as Appendix A.

1.1.02 This project falls under the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS). The work conducted for this project will be performed in a manner consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Sections 104 and 121; Executive Order 12580; and the National Oil and Hazardous Substances Pollution Contingency Plan. All activities involving work in areas potentially containing material potentially presenting an explosive hazard will be conducted in full compliance with USAESCH, Department of Defense (DoD), Department of Army, U.S. Army Corps of Engineers (USACE), and local requirements regarding personnel, equipment, and procedures. Activities under this PWS fall under the applicable provisions of 29 Code of Federal Regulations (CFR) 1910.120.

1.2 PROJECT PURPOSE AND SCOPE

1.2.01 The purpose of this phase (Phase 2) of the RI is to conduct a geophysical survey to detect metallic anomalies at two underwater Munitions Response Sites (MRSs)—MRS 03 and MRS 12. MRS 03 and MRS 12 are located offshore east and west-southwest, respectively, of the Northwest Peninsula of Culebra, Puerto Rico. MRS 03, also known as the Flamenco Bay Water Area (FUDS Project No. I02PR006812M01), and MRS 12, also known as the Luis Peña Channel Water Area (FUDS Project No. I02PR006803M01), will be referred to herein as Flamenco Bay and the Luis Peña Channel, for consistency.

1.2.02 The primary field activity performed during Phase 2 of the RI will be to conduct digital geophysical mapping (DGM) with a Towed Electromagnetic Array (TEMA) survey. The TEMA towfish incorporates three high-power electromagnetic (EM) coils (high-power variant of the EM61-MKII) covering a 3-meter-wide swath. This system will be used to detect metallic objects on or under the seafloor. The TEMA-MK3 towfish also includes a camera that will provide real-time video to the operators on the vessel to help prevent contact with sensitive habitats such as coral reefs or seagrass beds. In deeper water, it will be actively flown to maintain an approximate 1 to 2 meter altitude above the bottom. In shallow water, the TEMA-Lite will be deployed. The TEMA-Lite features the same instrumentation as the TEMA-MK3 and is floated at the surface by paddleboards and maneuvered by hovercraft to enable access to shallow areas with minimal vessel and instrument draft.

1.2.03 EM survey operations will be constrained in the sensitive habitat areas that were defined as a result of the Environmental Baseline Survey (EBS). The survey will be conducted in accordance with the Supplemental Environmental Standard Operating Procedures for Endangered Species Conservation and their Critical Habitat, February 2014 (and Addendum 1, February 2015) contained in Appendix B-1. In areas without seagrass beds and with sand bottom (such as portions of MRS 03), the hovercraft-towed TEMA-Lite can be floated right up onto the beach. For sensitive habitat areas with water depth greater than 4 feet deep, the TEMA will only be deployed where it can be flown approximately 1 to 2 meters above the highest point and not within a 10-meter horizontal radius buffer around the sensitive habitat. These sensitive habitat avoidance measures will limit areas that can be surveyed as well as the minimum size of MEC items that can be detected.

1.2.04 The TEMA operator will see the coral in the live video and then begin to raise the towfish. The estimated time required to observe and maneuver the TEMA is based on the following:

- The average reaction time of a human is approximately between 0.2 second to 0.25 second, and recognition of visual images is no less than 0.4 second, all of which combined can be rounded up to 1 second.
- The winch system can pay in cable at 1 meter per second.
- The survey boat will be moving at 1 to 2 knots, which is 0.5 to 1 meter per second.
- There will be visibility of over 10 meters (likely 20+ meters).

1.2.05 Based on these parameters, the operator will have 10 to 20 seconds of lead time, allowing for 1 second of reaction time, 1 second winch spin up, and 0.5 meter per second winch pay-in speed.

1.2.06 These values will yield 4 meters of altitude change; assuming a speed of 2 knots, only 10 meters of visibility, and a slow winch pay-in speed, there will be 8 seconds of time to alter the towfish altitude up to 4 meters.

1.2.07 Images from the high-definition (HD) video (as well as stills from a digital single-lens reflex Nikon camera on the TEMA-MK3) will be recorded and used to identify Endangered Species Act– (ESA) listed corals in relation to potential MEC items.

1.2.08 There is no fixed depth that defines deep vs. shallow; this is a condition-dependent value. For the most part, the areas that were surveyed during the EBS are considered “deep.” These are the areas, approximately 3 meters deep, that the vessel towing the TEMA-MK3 can safely operate in.

1.2.09 The TEMA-Lite will be collecting HD video images that will be used to determine the location of ESA-listed corals in relation to MEC items. The camera will be located in a wet box

mounted on a "boogie board" that will have a transparent bottom that is flush with the bottom of the TEMA-Lite. Surveys will be conducted in the shallowest areas at high tide and will not be conducted in coral areas with less than 6 inches of water. No portion of the TEMA-Lite will have greater than a 6-inch draft when operating in areas with less than 1 foot of water.

1.2.010 The launching and boarding sites to be used for the TEMA-Lite will be locations that are currently accessible by road and used to launch and recover kayaks and paddle boards. At MRS 03, the sand beach areas of Flamenco will be used, and in MRS 12, mainly those of Tamarindo Bay.

1.2.011 The hovercraft noise as measured in air is only 83 A-weighted decibels (dBA). For comparison, a very loud restaurant is 82 dBA and a lawn mower 90 dBA. The hovercraft will generate less underwater noise than many standard boats because the source of the sound is not in contact with the water but instead transmitted through the air into the water. Owing to the great difference of acoustic characteristic impedance between air and water, the sound transmission loss from an airborne source into water is very high. Therefore, the USACE does not consider noise from the hovercraft to be any more of an issue than it would be from any other marine vessel, and consider the use of a hovercraft to be sufficiently addressed in the existing standard operating procedures (SOP).

1.2.012 Sensitive habitat is any area where contact with the bottom is not allowed according to the SOPs developed by the USACE in coordination with the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) office and the U.S. Fish and Wildlife Service (USFWS). The TEMA-MK3 boat-towed system will operate in water deeper than 2 meters at altitudes of:

- 0 to 0.5 meter in sandy areas,
- 0.5 to 1 meter in areas with seagrass, and
- About 1 to 2 meters in areas with corals.

1.2.013 The 10-meter radius is the safe operating distance that the TEMA-MK3 can be flown around obstructions and areas with steep slopes. This does not apply to the TEMA-Lite. The TEMA-Lite will work in areas with 6 inches to 2 meters water depth, always floating on the surface. The SOPs developed by the USACE and the USFWS allow for data collection with the TEMA-Lite in as little as 6 inches of water.

1.2.014 Areas where the systems cannot be operated within the above mentioned parameters will be excluded, because they are not accessible.

1.2.015 Other data collection methods, including the use of MEC divers with hand-held EM units, could be employed to survey within the areas shallower than 2 feet, and in areas with slopes too great to survey with the TEMA; however, that is outside the scope of this project.

These areas are not large enough to impact attaining the Data Quality Objectives (DQO) for the project.

1.3 WORK PLAN ORGANIZATION

1.3.01 This work plan has been prepared in accordance with Data Item Description (DID) WERS-001.01 (Work Plans) and Engineer Manual 1110-1-4009 Chapter 4 – Work Plans. The sections that comprise the Work Plan are discussed below.

- Section 1, Introduction, of this Work Plan details the overall scope and objective of the project, presents the organization of the work plan, and presents an overview of the site and its history.
- Section 2, Technical Management Plan, details the organizational structure, lines of authority, and communication of the survey team.
- Section 3, Field Investigation Plan, describes the approaches to be taken for the procedures that will be implemented to complete the required field work.
- Section 4, Quality Control (QC) Plan, describes TtEC's procedures for controlling and measuring the quality of work performed, including the organization, responsibilities, and policies to be implemented.
- Section 5, Explosives Management Plan, describes details for management of explosives used to destroy MEC recovered during the project, including acquisition receipt, storage, transportation, and inventory. This plan is not included in this Work Plan for the RI but will serve as a placeholder section.
- Section 6 is the Environmental Protection Plan (EPP), which provides general information and lists applicable requirements to protect resources and threatened or endangered species.
- Section 7, Property Management Plan, describes how property management will be performed.
- Section 8, Interim Holding Facility Siting Plan for Recovered Chemical Warfare Materiel (RCWM) Projects, is not applicable to this project and will serve as a placeholder section only.
- Section 9, Physical Security Plan for RCWM Project Sites, is not applicable to the project and will serve as a placeholder section only.
- Section 10, References, includes a list of references used in the preparation of this Work Plan.

1.3.02 Additional information and plans are included in this Work Plan as appendices:

- Task Order Scope of Work: Relevant portions from the PWS are included as Appendix A.

- Supplemental Environmental SOPs: The SOPs were prepared by USACE and are included as Appendix B-1; they identify procedures to follow for endangered species and critical habitat conservation during underwater investigations.
- Site Maps: Appendix C contains all maps prepared in support of this Work Plan.
- Points of Contact: Various points of contact are listed in Appendix D to this Work Plan.
- Accident Prevention Plan (APP): The APP is attached as Appendix E of this Work Plan. The APP describes the health and safety procedures, personal protection standards, and environmental health hazards applicable to this project.
- Contractor Forms: Relevant forms and templates are provided in Appendix F including:
  - Survey Log Sheet
  - Example Daily Report
  - TEMA Daily Start-up QC Checklist
  - TEMA Video Acquisition Daily Start-up QC Checklist
  - Example Daily QC Report
  - Preparatory Phase Checklist
  - Initial Phase Checklist
  - Field Change Request
  - Field Change Request Log
  - Nonconformance Report
  - Design Change Notice
  - Visitor Log
- Contractor Personnel Qualifications Certifications Letter: Qualification certifications of key personnel are included in Appendix G.
- Technical Project Planning (TPP) Work Sheets and Documentation: Appendix H contains the TPP Work Sheets, conceptual site models (CSMs) for MEC and munitions constituents (MC), and minutes from the TPP meetings.
- Survey MEC Exposure Risk Assessment: Appendix I assesses the risk to the survey team from MEC.
- Transect Sampling for Unexploded Ordnance (UXO) Target Detection: Appendix J summarizes the probability of traversing and detecting a target area of specific size and shape for different transect spacings.

1.4 PROJECT PROPERTY DESCRIPTION

1.4.01 Culebra Island is located approximately 17 miles east of the island of Puerto Rico and is approximately 9 miles from the Island of Vieques (Figure 1-1).

Figure 1-1. Location Map of Culebra

1.5 PROJECT HISTORY

1.5.01 The Culebra Island Archipelago (including the Northwest Peninsula of Culebra and these two water range MRSs) was used as an impact range for aerial bombs and rockets, missiles, mortars, and naval projectiles from 1903 until 1975. The southern portion of the Northwest Peninsula of Culebra lies between the two water range MRSs. This peninsula was used as a target for aerial bombing, aerial rockets, strafing, and naval gunfire from roughly 1941 until 1975. Most of the gunfire was indicated to have been fired from ships in the water east of the peninsula and directed at targets on its eastern beach and ridges and plateaus. The upland targets included white painted drums, Sherman tanks, trucks, panels, and circular targets painted on the ground. A movable cable target system was constructed in this area and used for a short time.

1.5.02 The areas between the ridges on the peninsula were used as impact areas for conventional and napalm-laden bombs. Landing practice operations also took place on the beach areas of Flamenco Bay. Some of these exercises were accompanied by the firing of illuminating flares and white phosphorus projectiles. Floating target structures may also have been towed off-shore into Flamenco Bay or the waters of Luis Peña Channel and used for training. Most of the munitions discovered to date on the Northwest Peninsula appear to have resulted from naval gunfire, illumination flares, and practice bombs. Since relatively flat trajectory projectiles were typically fired from the ships, it appears unlikely that many projectiles fired from the northeast

would have impacted on the western slope of the peninsula ridge. However, there may have been overshoots resulting in the potential for MEC in the Luis Peña Channel.

1.5.03 No confirming evidence has been discovered that upland targets were ever placed on the steep western slopes of the peninsula or shoreline areas to the south. The steepness and inaccessibility of these slopes would have made the placement and maintenance of upland targets very difficult. It is also not known with certainty whether floating targets were ever used on the western side of the Northwest Peninsula in the Luis Peña Channel. Naval firing from the west is believed to have been less likely because of the relatively shallow water in many areas and restrictive reefs and small cays. In consideration of these factors, prior MEC investigations in the upland areas of the Northwest Peninsula have focused primarily on its eastern side and northern portion (including the beach and shoreline areas of Flamenco Bay) where evidence of upland targets has been found. The Archives Search Report stated that the TtEC biological dive team observed munitions at Flamenco Beach. This was the only report of MEC or munitions debris (MD) in the water of Flamenco Bay. The Archives Search Report also documented a local scuba dive instructor who said he spotted many underwater ordnance items around Culebra, with the highest concentration in the Luis Peña Channel and water west of Flamenco Peninsula. It was not indicated whether these items were MEC or MD.

1.5.04 The RI for Flamenco Bay and the Luis Peña Channel is being conducted in three phases: Phase 1, the EBS, to develop basemaps to guide the following phases; Phase 2, the DGM, to provide an assessment of the distribution and density of metallic items and debris fields that may be MEC; and Phase 3, an intrusive investigation to help determine which metallic items are indeed MEC and sampling to determine if any chemical contaminants from MEC are present in sediments. The Phase 1 EBS activities have been completed. The primary field activities performed during the EBS included acquisition of multibeam echosounder (MBE) bathymetry, sidescan sonar (SSS) imagery, and underwater video and still photography used to perform a benthic terrain and habitat assessment. The purpose of the EBS was to provide information to help characterize the nature and extent of sensitive marine habitats such as coral reefs and seagrass beds and endangered or threatened species within the boundaries of Flamenco Bay and the Luis Peña Channel. The objective of the EBS field activities was to identify areas and boundaries of sensitive habitat and to determine where towed operations and sampling can be safely conducted without damaging these resources during the follow-on phases of the field investigation that include the Phase 2 activities utilizing towed geophysical sensors and the Phase 3 intrusive activities. Underwater investigation activities that were conducted as part of the EBS consisted of visual observations, boat operations, and remote sensing surveys.

1.5.05 Data from the EBS are being used to guide the Phase 2 work described in this work plan by providing information and basemaps that show benthic terrain and delineations of sensitive habitats within these two MRSs. Following completion of the RI, an FS will be performed to identify and compare remedial alternatives, followed by development of a Proposed Plan that

recommends a preferred remedy and Record of Decision that documents the selected remedy for Flamenco Bay and the Luis Peña Channel.

1.6 CURRENT AND PROJECTED LAND USE

1.6.01 In 1901, Culebra's public land was placed under Department of the Navy (Navy) control. The Island and adjacent cays were used as impact areas and firing ranges for aerial bombs and rockets, missiles, mortars, small arms, artillery projectiles, and naval projectiles by the Navy and U.S. Marine Corps from 1903 until 1975. In 1978, part of the public land was transferred to the Commonwealth of Puerto Rico and the rest to the USFWS. Lands were transferred to the Commonwealth through a Quitclaim Deed and a Cooperative Management Agreement signed by the Government of Puerto Rico and the Department of the Interior in 1982.

1.6.02 The Finding and Determination of Eligibility, dated December 24, 1991, qualified 2,660 acres of Culebra Island and adjacent cays as eligible for consideration under the DERP-FUDS. However, upon subsequent review of historical material from the National Archives, it was determined that all of Culebra Island and the adjacent cays should be considered a FUDS except the Northwest Peninsula, which is not eligible under the 1982 Quitclaim Deed and Public Law 93-166, and the tract that was controlled by the Navy after 1986. The revised area covered by the DERP-FUDS projects for Culebra Island and adjacent cays consists of approximately 8,430 acres. Figure 1-2 shows the DERP-FUDS project for Culebra.

Figure 1-2. DERP-FUDS Projects for Culebra

1.6.03 The objectives of all the DERP-FUDS projects are to reduce risk to human health and the environment and reduce the hazards to public safety presented by military munitions through implementation of effective, legally compliant, and cost-effective response actions. In order to gather additional information that would help to determine the nature and extent of MC or MEC contamination on Culebra Island MRSs, it was agreed by the TPP Team, comprising federal and Commonwealth of Puerto Rico agencies, to conduct underwater investigations and to prepare an RI/FS. The main objectives of the underwater investigations are to: a) characterize and map benthic habitats within investigation areas; b) determine, identify, and map endangered or threatened species, in particular coral colonies; c) gather the necessary information to determine potential effects (e.g., location of species versus location of suspected MEC) on endangered or threatened species during remedial investigations and cleanup activities; d) determine presence or absence of MC and MEC; e) characterize the nature and extent of MC and MEC presence; and f) determine if the MC or MEC pose an unacceptable risk to human health and the environment, which would require further considerations or a response action.

1.7 PREVIOUS INVESTIGATIONS

1.7.01 This section summarizes previous investigations conducted at Culebra. The following sections are taken, in part, from the Final Site Inspection Report (Parsons 2007) and include more recent investigations that have been performed since this report was issued.

1.7.1 1991 Inventory Project Report

1.7.1.01 An Inventory Project Report (INPR) was signed on December 24, 1991, establishing the Culebra Island site as a FUDS, defining a site boundary, and assigning the FUDS Project No. I02PR006800 (USACE 1991). The Findings and Determination of Eligibility concluded that "the site, except for 87.5 acres still under control of the Navy, has been determined to be formerly used by the Department of Defense. It is therefore eligible for the Defense Environmental Restoration Program (DERP)."

1.7.2 1995 Archives Search Report

1.7.2.01 The Archives Search Report (ASR) was completed by the USACE Rock Island District in February 1995 (USACE 1995) after reviewing available records, photographs, and reports that documented the history of the site. As part of the ASR, a site visit was conducted in October 1994, during which the team identified MD on Cayo Botella, Cayos Geniqui, and Cayo del Agua. In addition, MD was identified on Flamenco Beach, Flamenco Peninsula, and the hillside near Cerro Balcon. The ASR listed several ordnance items verified on-site by either explosive ordnance disposal personnel or the ASR field team. Table 1-1 lists MEC items previously found.

Table 1-1. Munitions and Explosives of Concern (MEC) Items Previously Identified in or Adjacent to MRS 03, MRS 12

Item	Quantity	Notes	MRS	Reference	Location	Date
Candle, illumination, from 5-inch 38 naval projectile	1	Filled with 50% of illumination composition	2	MTA TCRA	Northwest Peninsula Grid No. 1	1995
Bomb, practice, 25 pound, MK 76/BDU-33	1	Appeared spotting had functioned but too corroded to certify	2	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Projectile, 40mm, M81A1 TP-T	1	Tracer present	2	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Projectile, 40mm, M81A1 TP-T	1	Tracer partly burnt	2	MTA TCRA	Northwest Peninsula Grid No. 2	1995
BLP, 3 inch, with tracer	1	Condition not determined due to corrosion	2	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Projectile, 3 inch, 50 HE	1	Armed, PD, fuze	2	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Projectile, 40mm, M81A1 TP-T	1	Tracer Present	2	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Fuze, BD, from 5-inch 38 projectile	1	Tracer Residue Present	2	MTA TCRA	Northwest Peninsula Grid No. 3	1995
Fuze, BD, from 5-inch 38 projectile	1	Condition not determined due to corrosion	2	MTA TCRA	Northwest Peninsula Grid No. 4	1995
Projectile, 40mm, Bofors	1		2	MTA TCRA	Northwest Peninsula Grid No. 4	1995
Candle, illumination, from 5-inch 38 naval projectile	1	Filled with 75% of illumination composition	2	MTA TCRA	Northwest Peninsula Grid No. 4	1995
Naval gun fire, 3-inch	1	Surface, fired, unfuzed	2	EE/CA	Northwest Peninsula NP-1	1997
Rocket, 5-inch, HVAR	1	Sheared on surface	2	EE/CA	Northwest Peninsula NP-11	1997
Naval gun fire, 3-inch	2	4 and 5-inch depth	2	EE/CA	Northwest Peninsula NP-12	1997
Bomb, practice, MK 23	1	Unknown depth	2	EE/CA	Northwest Peninsula NP-12	1997
Projectile, 20mm HEI	1	3-inch depth	2	EE/CA	Northwest Peninsula NP-12	1997
Fuze, sheared base		Unknown depth, number, or type	2	EE/CA	Northwest Peninsula NP-12	1997
Candle, illumination, 5 inch	3	6-inch depth	2	EE/CA	Northwest Peninsula NP-15	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	2	Unknown depth, sheared fuzes	2	EE/CA	Northwest Peninsula NP-15	1997
Naval gun fire, 6 inch	2	5-inch depth, sheared fuzes	2	EE/CA	Northwest Peninsula NP-16	1997

Table 1-1. MEC Items Previously Identified (continued)

Item	Quantity	Notes	MRS	Reference	Location	Date
Mortar, 81mm	1	7-inch depth	2	EE/CA	Northwest Peninsula NP-16	1997
Naval gun fire, 5 inch	1	7-inch depth, sheared fuze	2	EE/CA	Northwest Peninsula NP-16	1997
Naval gun fire, 3 inch	1	6-inch depth, sheared fuze	2	EE/CA	Northwest Peninsula NP-16	1997
Naval gun fire, 3 inch	1	4-inch depth, sheared fuzes	2	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 5 inch	1	5-inch depth, sheared fuze	2	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 5 inch	2	6-inch depth, sheared fuzes	2	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 6 inch	1	6-inch depth, sheared fuze	2	EE/CA	Northwest Peninsula NP-17	1997
Grenade, w/o fuze	1	No fuze	2	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 5 inch	1	Partial	2	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 5 inch	2	5-inch depth, no fuzes	2	EE/CA	Northwest Peninsula NP-18	1997
Candle, illumination, 5 inch	1	Surface	2	EE/CA	Northwest Peninsula NP-19	1997
Naval gun fire, 5 inch	1	Surface	2	EE/CA	Northwest Peninsula NP-20	1997
Naval gun fire, 6 inch	2	Surface, sheared fuzes	2	EE/CA	Northwest Peninsula NP-21	1997
Mortar, 81mm	1	Surface, no fuze	2	EE/CA	Northwest Peninsula NP-21	1997
Fuze, projectile base	1	Surface	2	EE/CA	Northwest Peninsula NP-21	1997
Candle, illumination, 5 inch	2	Surface, no fuze	2	EE/CA	Northwest Peninsula NP-22	1997
Naval gun fire, 3 inch	2	6-inch depth, fired fuzes	2	EE/CA	Northwest Peninsula NP-3	1997
Candle, illumination, 5 inch	2	Surface	2	EE/CA	Northwest Peninsula NP-4	1997
Candle, illumination, 5 inch	1	Unknown depth	2	EE/CA	Northwest Peninsula NP-4	1997
Naval gun fire, 5 inch	1	Fired mod 2 fuze, 8-inch depth	2	EE/CA	Flamenco Beach FB-6	1997
Projectile, 37mm HE	1	No fuze, 5 inch depth	2	EE/CA	Flamenco Beach FB-6	1997
Warhead, rocket, 5-inch	1	Sand filled with fired fuze, 4- inch depth	2	EE/CA	Flamenco Beach FB-6	1997
Candle, illumination, 5-inch	2	Flares, no fuze, 4-inch depth	2	EE/CA	Flamenco Beach FB-6	1997
Various UXO	249	Various UXO identified on Northwest Peninsula	2	UXO Construction Support, Ellis	Northwest Peninsula	2001-2002

Table 1-1. MEC Items Previously Identified (continued)

Item	Quantity	Notes	MRS	Reference	Location	Date
Candle, illumination, 5-inch	1	10-inch depth, unfuzed, magnesium filled	2	Ellis Grid Log	2029724.479N 2529724.682E	2002
Bomb, 100 pound	1	Surface, fuzed, HE	2	Ellis Grid Log	2029921.471N 25279.397E	2002
Bomb, 1,000 pound	1	12-inch depth, fuzed, HE	2	Ellis Grid Log	2029922.685N 252796.915E	2002
Candle, illumination, 5-inch	1	10-inch depth, fuzed, magnesium filled	2	Ellis Grid Log	2029922.685N 252796.915E	2002
Mortar, 81mm	1	18-inch depth, fuzed, w/p filled	2	Ellis Grid Log	2029924.127N 252920.989E	2002
Bomb, 100 pound	1	Surface, fuzed, HE, BIP	3	USACE, USN EOD	Flamenco Beach, underwater MRS03	2014, Jan
Bomb, 100 pound	1	Surface, fuzed, HE, BIP	3	USACE, USN EOD	Flamenco Beach, underwater MRS03	2014, Apr

Source: Parsons (2007)

1.7.3 1995 Interim Remedial Action

1.7.3.01 In 1995 MTA, Inc. completed an interim remedial action on 3.66 acres of the Flamenco Bay Campground (MRS 02) near Flamenco Beach to dispose of UXO within 2 feet of the ground surface at the campground (MTA 1995). Work was conducted on the site between May 12 and May 26, 1995. MTA found 11 items of UXO and munitions-related scrap.

1.7.4 1997 Final Engineering Evaluation/Cost Analysis

1.7.4.01 In March 1997, Environmental Science and Engineering, Inc. submitted the *Final Engineering Evaluation and Cost Analysis (EE/CA) for the Former Culebra Island Naval Facility, Culebra Island, Puerto Rico* (ESE 1997). The EE/CA investigation included surface and subsurface sample grids on Flamenco Peninsula, Isla Culebrita, Cayo Botella, Cayo del Agua, Cayo Lobo, and Cerro Balcon, where only ordnance-related scrap was identified. Items found included 20 millimeter (mm) high-explosive incendiary devices, Mk76 practice bombs, Mk50s, 37-mm projectiles, 5-inch rockets, 76-mm projectiles, 3- to 6-inch naval projectiles, 81-mm mortars, and a grenade.

1.7.5 2004 UXO Construction Support

1.7.5.01 In June 2004, Ellis Environmental Group, LC (EEG) submitted the *Site-Specific Final Report, UXO Construction Support, Culebra Island Wildlife Refuge, Culebra Island, Puerto Rico* (EEG 2004). The report documented clearance efforts conducted by EEG on the Northwest Peninsula. Ellis performed four phases of clearance from January 2001 to February 2004. Phase I consisted of clearance support by clearing roadways, a wind generator foundation, and a desalination plant foundation, as well as re-grading the site. Phase II of the construction support was not exercised due to a stop in funding for the construction project. Phase III included surface clearance of 70 acres of bird nesting area and 4-foot-depth subsurface clearance of roadways, firebreaks, and an observation post. Phase IV consisted of demilitarization of scrap, construction of a fence and information kiosk, and development of public awareness information. The public awareness information included a video, UXO safety poster, and UXO safety brochure.

1.7.5.02 During UXO Construction Support project, Ellis excavated 6,121 holes and recovered 15,479 pounds of scrap metal and 249 UXO items. Fifteen (15) of the 249 UXO items were found within the boundary of the southern portion of the Northwest Peninsula principal area of interest.

1.7.6 2004 Archives Search Report Supplement

1.7.6.01 The ASR Supplement was completed by the USACE Rock Island District as an addition to the 1995 ASR (USACE 2004). This report provides details of aerial training conducted by the Navy between 1935 and 1975 and identifies range/sub-range areas. Of the

identified areas, boundaries of the following sub-ranges encompass areas within or adjacent to MRSs 03 and 12:

- Water West: Part of this area in included in MRS 12. A local diver reported underwater ordnance in this area. Suspect munitions include Mk II 6-inch high explosive (HE) projectiles.
- Water Center: This area is included in MRS 12. A local diver reported underwater ordnance in this area. Suspect munitions include Mk II 6-inch HE projectiles.
- Naval Gunfire Target Area: This range was a naval gunfire and air-to-ground range with its target located on Northwest Peninsula. Munitions included general small arms, .50-caliber small arms, Mk80s series general purpose bombs, M1 105mm HE, Mk21 8-inch armor piercing (AP), Mk5 16-inch AP, 2.75-inch rockets, and the 11.75-inch Tiny Tim rocket.
- Agua Cay: This area, also known as Water Key, is part of MRS 02 and was used as a target for bombing and rocket fire. Munitions include Mk80 series general purpose bombs and 2.75-inch rockets.
- Air-to Ground North: This target was located at the northern tip of Northwest Peninsula. Munitions used include general small arms, .50-caliber small arms, Mk82 500-pound general purpose bombs, 2.75-inch rockets, and 11.75-inch Tiny Tim rockets.
- Air-to Ground South: This target was located at the northern tip of Northwest Peninsula. Munitions used include general small arms, .50-caliber small arms, Mk82 500-pound general purpose bombs, 2.75-inch rockets, and 11.75-inch Tiny Tim rockets.

1.7.6.02 No site visit was conducted in support of the ASR Supplement.

1.7.7 2005 Revised Inventory Project Report

1.7.7.01 A Revised INPR was completed in June 2005 (USACE 2005a). The Revised INPR further clarified the military use of the Island of Culebra and divided the original site, Property No. I02PR0068, into 14 separate MRSs. One hazardous and toxic waste project was identified and assigned the number 00, and 13 Military Munitions Response Program (MMRP) project areas were identified and assigned Risk Assessment Code scores. MRSs 03 and 12 were each assigned as Risk Assessment Code 1.

1.7.8 2005 Supplemental Archives Search Report

1.7.8.01 The Supplemental ASR was completed by the USACE St. Louis District in 2005 as an addition to the 1995 ASR (USACE 2005b). The Supplemental ASR is the source of most of the historical information pertaining to site operations and identified the key areas of focus for the 2007 site inspection. This document provided a detailed summary of military activities conducted on Culebra Island and the surrounding cays. The document summarizes planned

and/or executed maneuvers and training conducted at the site, including specific time periods, locations, and munitions used.

1.7.9 Cultural and Archeological Resources

1.7.9.01 The following is taken from the Final Site Inspection Report (Parsons 2007):

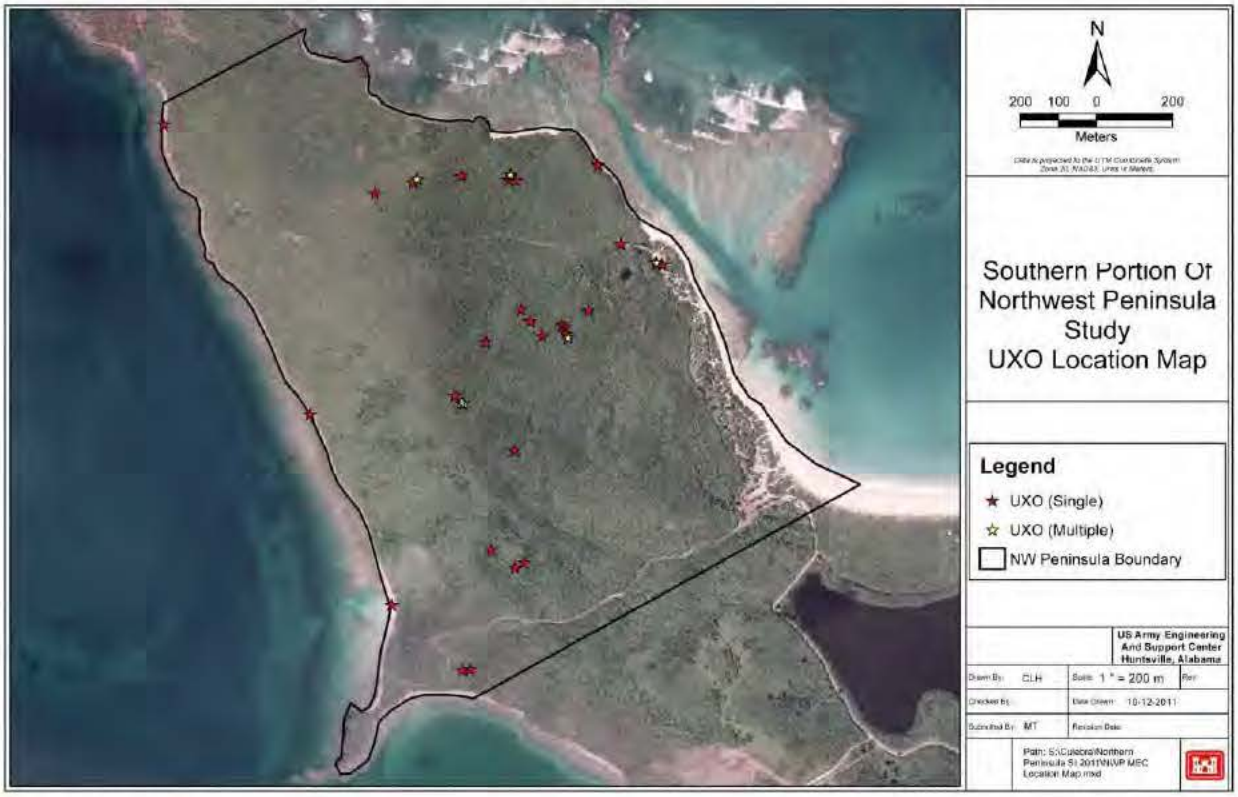
> "According to the National Register Information System (NRIS), National Historic landmarks (NHL) list, national Heritage Areas (NHA) list, and national park Service (NPS), there is only one registered cultural resource within the boundaries of the Culebra Island site. On the Isla Culebrita is an historic lighthouse called Faro Isla de Culebritas. The lighthouse is not open to the public due to building deterioration. According to the Puerto Rica State Historic Preservation Office (SHPO), there are no known architectural resources within the boundaries of the Culebra Island site; however, an architectural survey has not yet been conducted for Culebra. An archeological survey performed at Lower Camp in 1992 found evidence of prehistoric and historic inhabitants distributed over a half-acre area within the Lower Camp site."

1.7.10 USACE's Assessment of the Northwest Peninsula Area

1.7.10.01 On behalf of the DoD, a Congressionally mandated study was performed by the USACE under Public Law 111-383 in 2011 to assess the presence of UXO in the portion of the Northwest Peninsula transferred to the Commonwealth of Puerto Rico. A summary of their estimate of the types and amounts of UXO, as reported in DoD (2012), is presented below.

1.7.10.02 The Northwest Peninsula was used for live gunnery practice between 1936 and January 1, 1972. During this period, approximately 750,000 naval rounds were fired into the Northwest Peninsula. Of these, an estimated 80 percent (600,000) were 5 inch/38 caliber (cal) and 5-inch/54 cal projectiles and an estimated 10 percent (75,000) were 3-inch/50 cal, 6-inch/47 cal, and 8-inch/55 cal gun ammunition. The balance included other types of military munitions including 16-inch/50 cal, and munitions for both mortars and howitzers. Additionally, during 1942 to 1968, approximately 320,000 naval aviation munitions (e.g., bombs and rockets) were used (dropped or fired) within the Northwest Peninsula (U.S. Navy 1973).

1.7.10.03 Since 1995, 70 UXO have been encountered within approximately 19 acres of the Study Area. This total, which includes 36 UXO discovered during this study, equates to approximately 3.7 UXO per acre. The locations of the 36 UXO discovered during USACE's 2011 assessment are shown on Figure 1-3.



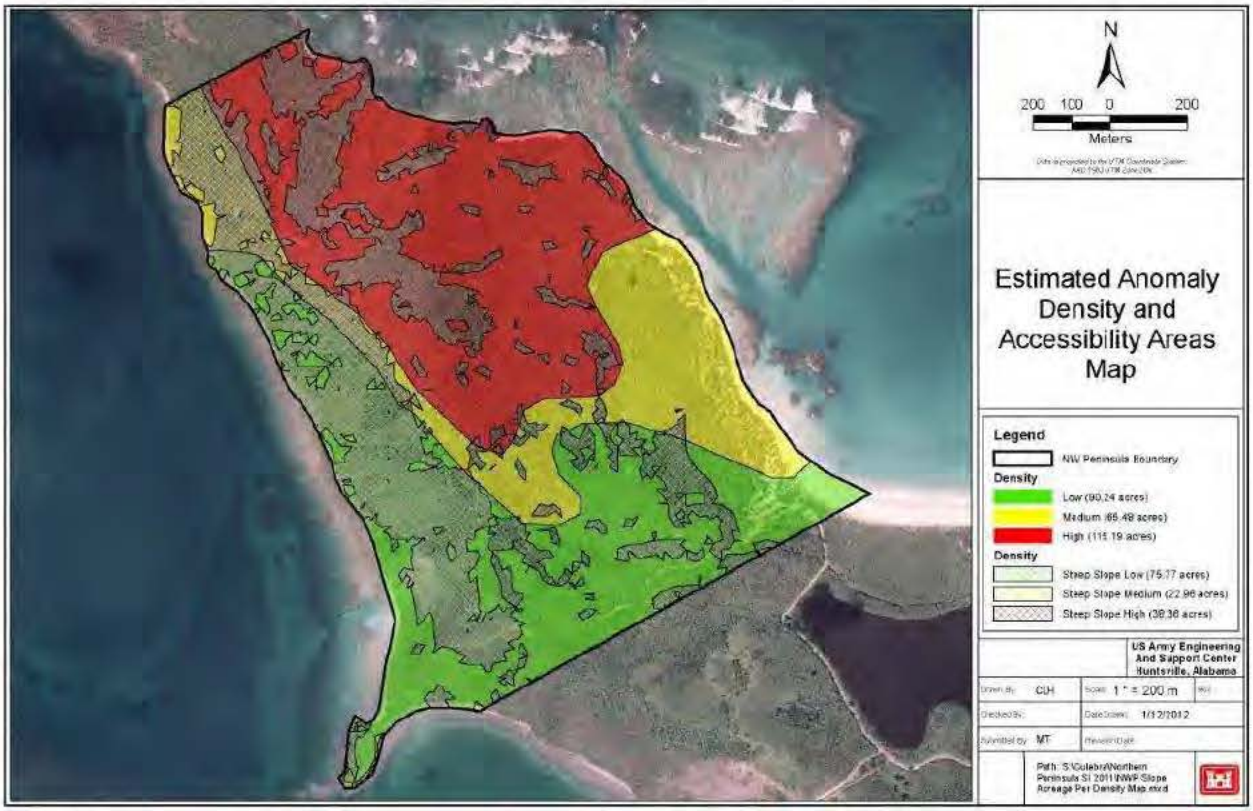
source: DoD (2012)

Figure 1-3. Locations of Individual or Multiple UXO

1.7.10.04 The predominant military munition encountered within the Study Area as UXO was the 5-inch high explosive naval projectile. Other UXO encountered included the following types of military munitions: 2.75-inch rockets, 3-inch naval projectiles, 40-mm projectiles, 75-mm projectiles, 81-mm mortars, 100-pound General Purpose bombs, a 500-pound General Purpose bomb, and Bomb Dummy Unit-33 practice bombs.

1.7.10.05 The USACE divided the Study Area into three areas based upon the number of metallic anomalies they detected during the geophysical survey, their estimate of the density of those metallic anomalies within each area, and the steepness of the terrain (see Figure 1-4). The three areas reflect an estimated anomaly density of:

- Low (Green): 0 to 785 anomalies per acre
- Medium (Yellow): 786 to 1,040 anomalies per acre
- High (Red): 1,041 to 1,400 anomalies or more per acre



source: DoD (2012)

Figure 1-4. Estimated Anomaly Density and Accessibility Areas Map

1.7.11 Environmental Baseline Survey

1.7.11.01 An EBS was conducted by TtEC in December 2012 and January 2013 as Phase 1 of the current RI. The survey included multibeam echosounder and sidescan surveys of 100 percent of the surveyable area of MRS 03 and MRS 12. A video survey was also conducted during this time. The purpose of the EBS was to determine appropriate equipment and methodologies for follow-on DGM/EM surveys (Phase 2 of the RI) and more intrusive investigations (Phase 3 of the RI) in order to prevent damage to threatened/endangered (T&E) species and/or critical habitat.

1.8 INITIAL SUMMARY OF MEC RISK

1.8.01 A risk assessment provided in Appendix I shows there is a very low risk of the survey team coming into contact with MEC during the proposed Phase 2 survey.

1.8.02 Although the risk of the survey team contacting MEC is very low during the Phase 2 survey, MEC is a safety hazard and, as such, may constitute an imminent and substantial endangerment to the general public, on-site personnel, and the environment. Numerous MEC and MD items have previously been recovered from Culebra (see Section 1.6), and there is

potential for additional items to be present. Members of the public have access to Flamenco Bay and Luis Peña Channel; consequently, there is potential for public access to MEC where present.

1.8.03 Potential MEC at the Flamenco Bay and Luis Peña Channel sites consists of both munitions known or suspected to have been used and the types of MEC and MD that have previously been recovered or observed. Types of munitions anticipated based on the ASR and EE/CA findings include:

- Small caliber ammunition;
- Rockets;
- Grenades;
- Projectiles;
- Artillery;
- Mortars;
- Mines; and
- Various fuzes associated with the above munitions.

1.8.04 All field personnel will be given recognition training on the types of munitions known or suspected to be present prior to commencing any field activities. This phase (Phase 2) of the RI includes no intrusive activities, but in the event MEC is encountered, all personnel will be instructed to avoid any physical contact with the item or surrounding terrain, to record its location and associated sensor or imagery data, and provide this information to the USACE. For public safety reasons, the location of the MEC finds will not be included in survey reports. There is a possibility MC may also be present at the site, although there are currently no data available to make this determination and sampling for MC will not be performed until Phase 3 of the RI is performed. In certain concentrations and site conditions, MC may pose risks to human health or the environment.

1.9 INITIAL CONCEPTUAL SITE MODEL

1.9.01 A CSM is a description of a site and its environment that can be used to summarize potential sources and areas of contamination and pathways that may lead to possible exposures to human and environmental receptors. A CSM is also used to focus the design and plans for implementing the investigation of the potential source areas or areas where potential exposures may occur. The CSM is a “living document” based on existing knowledge and updated throughout the course of the project as more data become available.

1.9.02 An initial CSM was developed in relation to the MEC and MC in these two MRSs in accordance with Engineer Manual 1110-1-1200. One form of CSM is a flow chart that shows the potential MEC and MC contamination as well as the receptors that may come into contact with any potential contamination via various media and migration pathways. This flow chart

form of CSM is presented in Figure 1-5. Given the site history presented above, the potential primary source of MEC and possibly the associated MC are the marine sediments on the floor of Flamenco Bay and in the Luis Pena Channel. MEC items may have been directly deposited in the Flamenco Bay sediments as the result of firing at floating targets, undershoots of the targets on the Northwest Peninsula, errant aerial dropping relative to the upland targets, or intentional cover fire or flares during beach landing training. To a lesser extent, some MEC may have been transported into Flamenco Bay by upland runoff and erosion. MEC in the Flamenco Bay sediments may have been subsequently transported and redistributed within the Bay by tidal forces, wave action, or localized currents. Sediment and any MEC items within it may also have been moved around by the mechanical activity of boats or beach maintenance equipment. The processes of sedimentation and scouring would be working to cover and uncover, respectively, items deposited on the surface of the sediment. These potential sources and transport processes are illustrated in the CSM presented in Figure 1-5. MEC items may also have been directly deposited in the Luis Pena Channel sediments as the result of overshoots of the targets on the Northwest Peninsula, errant aerial dropping relative to the upland targets, or firing at floating targets. Once again, some small amount of MEC may have been transported into the Luis Peña Channel by upland run-off and erosion. MEC deposited in the Luis Peña Channel sediments may have been transported locally by the same natural transport processes noted above. MEC items that were previously deposited in either MRS may have been subsequently covered over by more recent sediment deposits. Figure 1-5 also provides a preliminary indication of which exposure pathways to MEC and MC may be "complete" and warrant further assessment.

1.9.03 People may be exposed to any MEC or MC associated with items in the sediment as the result of recreational use of these waters through wading, swimming, snorkeling, fishing, diving, camping, and boating. Others may access or utilize these waters as part of the management or study of their coral and underwater ecological habitats or the plants and animal species of the shorelines. People's exposures may be via direct contact with MEC items or MC in the sediments located in the shallow water or through contact with items by anchors or diving gear in somewhat deeper waters. Secondary exposure to MC in the surface water or that has been absorbed by biota is a possibility, but is unlikely to be significant from a human health or ecological perspective.

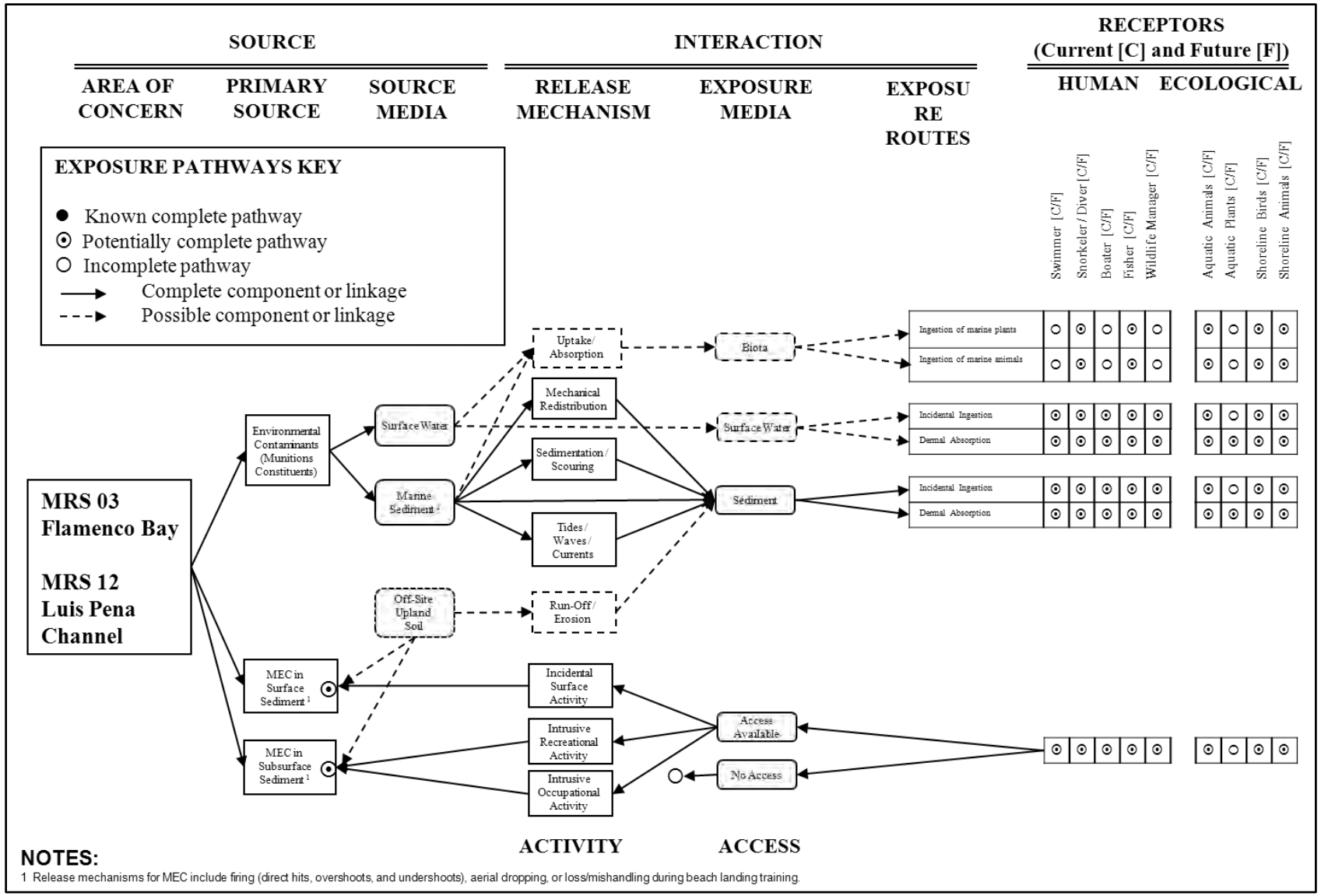


Figure 1-5. Preliminary Conceptual Site Model for Potential Exposure to MEC and MC at the Culebra Water Ranges MRS 03 and MRS 12

1.9.04 Based on this CSM, MEC may be present in the sediments of Flamenco Bay and the Luis Peña Channel. No specific locations are known at this time to be concentrated MEC source areas due to the lack of prior investigation. However, locations closest to the shorelines of the Northwest Peninsula where a large number of training targets were located are more likely to be where the MEC was originally deposited. In addition, the locations closest to the shorelines in both MRSs would typically be most accessible and provide the greatest opportunity for people to come into contact with any items that are present given the receptors listed on the CSM and the types of activities they would be expected to engage in. Accordingly, both MRSs were divided into subareas for the in-water surveys based on the depth of water. Three primary depth zones were defined for these MRSs using publicly available bathymetry (see Figures 1-6 and 1-7 for MRS 03 and MRS 12, respectively):

- Zone A Near Shore (mean low water [MLW] to MLW-10′) – This is the depth range in which wading, swimming, snorkeling, some fishing, some boating, and some wildlife management exposures are more likely to occur. In the sandy beach areas of Zone A, the 30 feet of marine environment nearest to the beach is specifically designated as Zone A′ given the even greater potential for human exposure and contact with possible MEC in this strip.
- Zone B Intermediate (MLW-10′ to -25′) – This is the depth range in which novice diving and less incidental fishing, boating, and wildlife management exposures are more likely to occur.
- Zone C Intermediate (> MLW-25′) – This is the depth range in which more experienced diving and more specialized fishing, boating, and wildlife management exposures are more likely to occur.

1.9.05 These preliminary CSMs are included with the TPP documentation in Appendix H of this Work Plan. The CSMs will be updated as new information is available and presented to the stakeholders during the TPP meetings in support of the RI/FS project. The TPP documentation is included in Appendix H. A separate Phase 2 data report will not be prepared. The Phase 2 survey data will be presented at the post-survey TPP meeting and within the Phase 3 Work Plan, and RI Report, as gridded EM data, anomaly density plots, and target lists. There is no separate Phase 2 data report in the project scope.

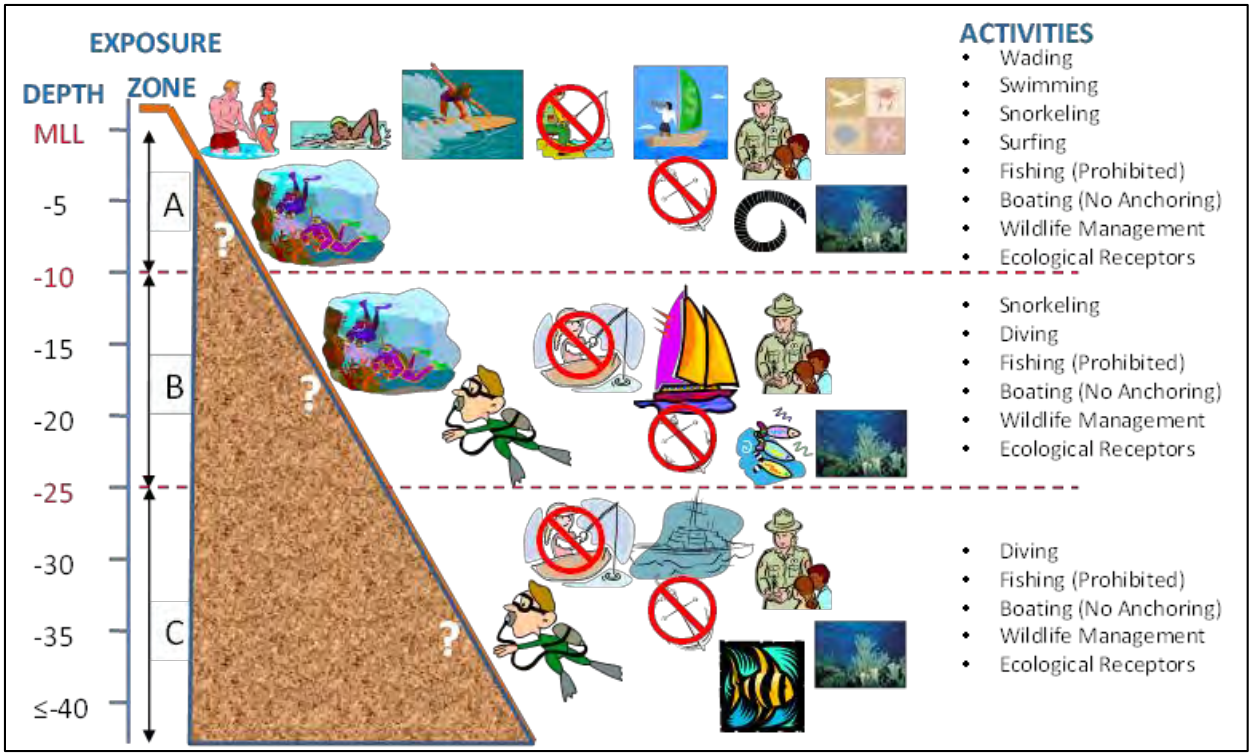


Figure 1-6. Potential Human and Ecological Receptors Culebra Water Ranges – MRS 03

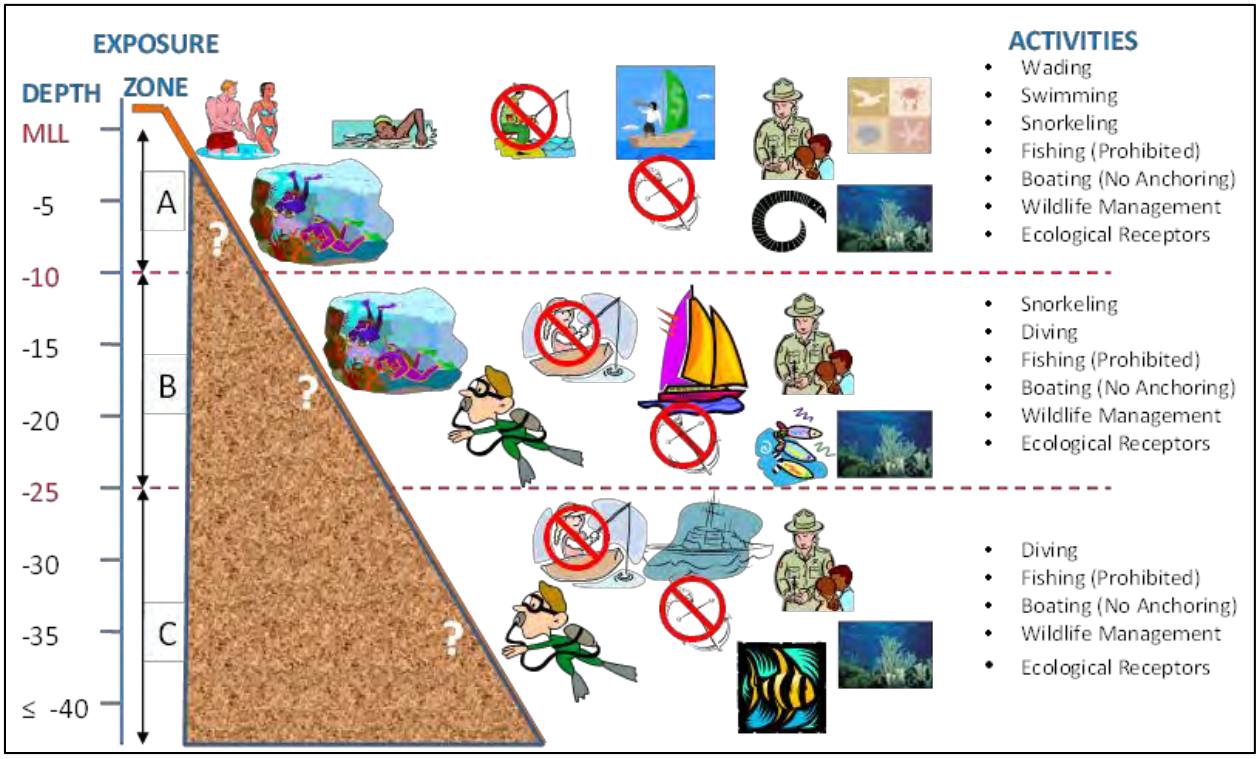


Figure 1-7. Potential Human and Ecological Receptors Culebra Water Ranges – MRS 12

2.0 TECHNICAL MANAGEMENT PLAN

2.1 INTRODUCTION

2.1.01 The purpose of the Technical Management Plan (TMP) is to provide the approach and procedures that will be used to execute the tasks required to meet the project objectives for Phase 2 of the RI. Field procedures for Phase 2 of the RI include non-intrusive marine geophysical surveys. The TMP focuses on project objectives, organization, personnel, communication and reporting, deliverables, schedule, billing, public relations, duties and responsibilities, as well as the functional relationship between the different organizations specific to Phase 2 of the RI. Additional and remaining elements of the TMP will be addressed in subsequent plans for Phase 3 of the RI.

2.2 OBJECTIVES

2.2.01 The objective of Phase 2 of the RI is to determine the location and distribution of metallic objects in the survey areas using a towed or floated DGM system within the boundaries of MRS 03 Flamenco Bay and MRS 12 Luis Peña Channel. To achieve this objective, a survey line plan that characterizes each MRS sufficiently to provide at least a 90 percent probability that areas of higher electromagnetic anomaly density that may contain MEC will be identified and located will be specified. In addition, survey line spacings that provide even greater coverage and a finer scale characterization of the potential presence of MEC will be used to account for the potential exposure footprints associated with the activities expected to be performed in Depth Zones B and A of the MRSs, as identified in Section 1.9.04 above. The resulting characterization from a survey plan that considers both of these objectives will be sufficient to ultimately meet the data needs for the RI (following Phase 3). The overall purpose of Phase 2 of the RI is to determine the likely distribution of MEC items within the study areas based on the observed distribution of the detected electromagnetic anomalies. The process of developing the DQOs for Phase 2, which were defined and then refined during the initial TPP meetings, has led to a number of general statements or specifications. These included:

- The presence of MEC, or indicators of MEC, is the key condition for future site management decision making and, as such, is the principal parameter of interest to be identified by the Phase 2 (and later Phase 3) survey investigation and data analysis;
- The quantity, density, and distribution of subsurface anomalies and surficial MEC should be estimated based on the results of a Phase 2 survey;
- This survey should be performed along a pattern of parallel transects with the survey line spacings selected to ensure at least a 90 percent probability of traversing and detecting a potential area of elevated total anomaly density of approximately 100 anomalies per acre (ApA);
- Closer survey line spacings should be employed in those portions of the MRSs where there is a greater potential for direct human exposure; and
- Anomaly locations will be mapped to 1-meter positional accuracy.

2.2.02 Phase 2 of the RI will be performed to determine the location and density of metallic objects in the MRSs using the towed or floated TEMA system. A survey line plan was developed that will provide the coverage needed to achieve the established DQOs and the specifications presented above to characterize the survey areas with regard to location and density of metallic objects. No intrusive investigation will be conducted during Phase 2 of the project. The TPP Team will develop and coordinate further investigations for Phase 3 of the RI based on the Phase 1 and 2 RI results.

2.2.03 Based on the CSMs presented above, both MRSs were divided into subareas for the in-water surveys based on the depth of water. As was noted, three depth zones were defined for purposes of this survey based on the potential for exposure and type of potential exposure to MEC:

- Zone A Near Shore (MLW to MLW-10′) (with the first 30 feet of water area in the sandy beach areas – Zone A′);
- Zone B Intermediate (MLW-10′ to MLW -25′); and
- Zone C Intermediate (> MLW-25′).

2.2.04 The Zone A (and Zone A′) portions of both MRSs require the highest level of survey coverage and detailed characterization information due to the higher probability that they contain MEC source areas and likely preferential exposure points. Zones B and C, respectively, would require relatively less coverage and detailed information in consideration of these two same factors. The bathymetric data from the Phase 1 EBS were then used to locate and calculate the fraction of the total MRS in each depth zone category.

2.2.05 Multiple types of surveys will be performed in these waters as part of Phase 2 of the RI. Because different survey devices/techniques have different effective swath widths, a certain survey transect spacing (assuming roughly parallel survey lines separated by a specified distance) will result in different coverage of the seabed for different surveys. As the EM survey has the narrowest survey line swath width, the transect design was based on ensuring sufficient EM coverage. In so doing, coverage for the other detectors will be more than sufficient for the RI. In addition, the Phase 1 EBS identified areas which will be inaccessible for the Phase 2 investigation survey. The lack of coverage in these areas was accounted for in the design of the Phase 2 survey relative to achieving the specified DQOs and/or overall specifications. The Phase 2 DQOs are listed in Table 2-1. The DQO Table adheres to the seven-step standard DQO nomenclature and content guidelines. The table initially presents DQOs pertaining to the overall Phase 2 Survey and, thereafter, presents activity-specific DQOs pertaining to:

- DGM Data Collection;
- Positioning Accuracy and Consistency;
- Potential Munitions Item Detectability; and
- Video and Photographic Data Collection.

Table 2-1. Project Data Quality Objectives (DQOs) for the Phase 2 Survey

Goals / Objectives	Step 1 State the Problem	Step 2 Identify the Decision	Step 3 Identify Inputs to the Decision	Step 4 Define the Study Boundaries	Step 5 Develop a Decision Rule	Step 6 Specify Tolerable Limits on Decision Errors	Step 7 Optimize the Design for Obtaining Data
Description	***Summarize the contamination problem that will require new environmental data, and identify the resources available to resolve the problem***	***To identify the decision that requires new environmental data to address the contamination problem***	***To identify the information that will be required to support the decision and specify which inputs require new environmental measurements***	***To define the spatial and temporal boundaries that the data must represent to support the decision***	***To develop a logical "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative actions***	***To specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data***	***To identify a resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs***
Overall Phase 2 Survey (DQO 1)							
1. The Phase 2 Digital Geophysical Mapping (DGM) Survey of the Offshore Areas of the Northwest Peninsula to Locate Potential Munitions and Explosives of Concern (MEC) within the Formerly Used Defense Site (FUDS) Boundaries	2. Past training activities involving the Northwest Peninsula of Culebra Island have resulted in expended munitions and unexploded ordnance being present in the offshore environment around the Peninsula in what has been designated MRS 03 (Flamenco Bay and the waters off the eastern side of the Northwest Peninsula) and MRS 12 (Luis Pena Channel and the waters off the western and southwestern side of the Northwest Peninsula). MEC have previously been recovered from these areas and there have been other reports that MEC is still present in these offshore areas. These MEC are likely to be present due to overshoots and undershoots relative to upland targets on the Northwest Peninsula. 3. The waters and seabed sediments of MRS 03 and MRS 12 contain sensitive ecological habitats in many locations within the MRS boundaries, including a number of protected coral species. In addition, recreational and occupational activities occur (e.g., wading, swimming, snorkeling, surfing, diving, boating [but no anchoring], and wildlife management) that could bring people into potential contact with MEC in the sediments at different water depths. The presence of MEC on the seabed or buried in the near-surface sediments would pose a direct contact risk to these people and ecological resources. 4. A collection of site managers, regulatory agencies, and natural resource trustees have come together to evaluate MRS 03 and MRS 12 to determine if MEC poses an unacceptable risk to the public or the environment. These include: the U.S. Army Corps of Engineers (Huntsville and Jacksonville); U.S. Environmental Protection Agency Region 2 (Puerto Rico and New York City); Puerto Rico Environmental Quality Board (PREQB); Puerto Rico Department of Natural and Environmental Resources (DNER); U.S. Fish and Wildlife Service (USFWS); the National Oceanic and Atmospheric Administration (NOAA) and the National Marine Fisheries Service (NMFS). 5. MRS 03 and MRS 12 are being investigated and evaluated through a Remedial Investigation/ Feasibility Study (RI/FS) in a manner consistent with the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) under the Defense Environmental Restoration Program (DERP) and these areas have been designated FUDS.	6. Does the MEC contamination in MRS 03 or MRS 12 pose an unacceptable risk to human health and the environment (and, therefore, require further evaluation and/or a response action) or is no further action necessary?	7. The Archive Search Report (ASR) findings on the historical munitions-related activities that took place on the Northwest Peninsula 8. The data collected and results of the Engineering Evaluation / Cost Analysis (EE/CA) performed to the upland area of the Northwest Peninsula 9. The results of the Phase 1 Environmental Baseline Survey (EBS) performed for MRS 03 and MRS 12 (e.g., bottom types, locations of protected coral, locations of other obstacles on the seabed) 10. The density distribution of EM anomalies throughout MRS 03 and MRS 12 that could be potentially be MEC contamination 11. The nature of the MEC contamination present in MRS 03 and MRS 12 (i.e., munitions types (makes and models), whether they are an explosive hazard (i.e., material potentially presenting an explosive hazard (MPPEH)), their sensitivity to detonation if contacted) 12. The extent of the MEC contamination present in MRS 03 and MRS 12 (i.e., the spatial distribution of MEC within each MRS and the depth of the MEC contamination relative to the seabed) 13. The potential for the MEC contamination to migrate within the MRSs or to become buried in the sediment or alternately to be exposed from the sediment by natural forces 14. The location of the MEC contamination with respect to the sensitive environmental habitats and the protected corals 15. Anecdotal reports about the presence of MEC contamination from local residents or users of the waters within MRS 03 and MRS 12	16. Spatial – The lateral or horizontal extents of the investigation are the established FUDS boundaries for both MRS 03 and MRS 12 17. Spatial – The vertical depth of interest into the seabed for both MRS 03 and MRS 12 are the depths of practical intrusion into the sediment by the recreational and occupational activities identified for the conceptual site model (CSM) for potential exposures to MEC 18. Spatial – The MRSs have been divided up into 3 primary Depth Zones: Depth Zone A (<10-foot water depth); Depth Zone B (10 to 25-foot water depth); and Depth Zone C (>25-foot water depth) 19. Temporal – Information must be collected or compiled in time to support the analyses associated with the Phase 2 Survey phase of the RI, which is scheduled to be completed by April 2015. 20. Temporal – Survey data must be collected when the weather, wind, waves and tides allow for safe and protective sampling activities	See the Survey Component-Specific Decision Rules Below	See the Survey Component-Specific Tolerable Limits on Decision Errors Below	See the Survey Component-Specific Designs Below

Table 2-1. Project Data Quality Objectives (DQOs) for the Phase 2 Survey (continued)

Goals / Objectives	Step 1 State the Problem	Step 2 Identify the Decision	Step 3 Identify Inputs to the Decision	Step 4 Define the Study Boundaries	Step 5 Develop a Decision Rule	Step 6 Specify Tolerable Limits on Decision Errors	Step 7 Optimize the Design for Obtaining Data
Description	***Summarize the contamination problem that will require new environmental data, and identify the resources available to resolve the problem***	***To identify the decision that requires new environmental data to address the contamination problem***	***To identify the information that will be required to support the decision and specify which inputs require new environmental measurements***	***To define the spatial and temporal boundaries that the data must represent to support the decision***	***To develop a logical "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative actions***	***To specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data***	***To identify a resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs***
Survey Component: DGM Data Collection (DQO 2)							
1. Approach and Coverage of the MRSs with Respect to DGM Data Collection	2. MEC that is MPPEH may be present anywhere within MRS 03 or MRS 12 on or within the near-surface sediment of the seabed. 3. A DGM survey can be performed to characterize some portion of the MRSs to locate items that may be MPPEH. 4. There are limitations in the ability of electromagnetic (EM) detector systems to detect metallic objects within the sediment below the seabed (i.e., smaller items, are less to be detected if they are located deeper in the sediment). 5. EM detectors can locate metallic items on the seabed or within the sediment below the seabed to some depth within the footprint of the survey path (i.e., detector swath width and survey line length). 6. The DGM survey can report the locations and the strength of the anomalous electromagnetic response produced by these metallic objects which can be charted. 7. DGM information collected within the footprint of the survey path can also be used to interpolate the density of anomalies that may be MPPEH in the areas between the completed survey paths where DGM data was not collected. All performance metrics for DGM will be met.	8. How much of MRS 03 and MRS 12 must be DGM surveyed to collect the information needed to support the RI and allow a determination to be made as to whether the presence of MEC poses an unacceptable risk to human health or the environment?	9. The primary purpose of the DGM survey in the MRSs or a portion of an MRS: - Searching for a cluster of metallic items that may be MPPEH or an area with a higher density of anomalous DGM responses that could indicate the presence of MPPEH - Characterizing the density of items that may be MPPEH in an area of higher human exposure potential. Note: Survey coverage in the portions of MRSs that are in Depth Zone B were judged to need greater coverage (i.e., smaller transect spacings) than in Depth Zone C and the survey coverage in the portions of MRSs that are in Depth Zone A were judged to need greater coverage than in Depth Zone B due to the potentially smaller exposure footprints in going from Depth Zone B to Depth Zone A. Note: During the Phase 2 Survey, only the locations of potential MEC items (which would be flagged as an anomalous elevated EM response caused by metallic objects that may be MEC) would be documented as no intrusive investigation will be performed to identify the sources of the anomalies or to allow them to be classified as MEC or MPPEH.	10. Spatial – The lateral or horizontal boundaries within with the Phase 2 Survey is to be performed are the established FUDS boundaries for both MRS 03 and MRS 12. 11. Spatial – The MRSs have been divided up into 3 Depth Zones (i.e., Depth Zones A, B and C, as defined above based on the different potential for exposure to MEC with water depth associated with the recreational and occupational activities identified for the CSM for potential exposures. In addition, Depth Zone A was subsequently further divided into Depth Zone A' (i.e., the first 30 lateral or horizontal feet out from the MLW line) and the remainder of Depth Zone A (i.e., out to a water depth of 10'). 12. Spatial – The portions of the MRSs that can be accessed to survey will be constrained to those areas where the detector systems can be positioned without endangering the sensitive habitats and protected corals as defined by the Phase 1 EBS and the subsequent SOPs developed for Phase 2. 13. Temporal – The survey should be conducted when conditions within the MRSs (e.g., tides, waves, storm surge) minimize the potential damage to the sensitive habitats and protected corals.	14. If the area within MRS 03 or MRS 12 is within Depth Zone A/A', B or C, then the survey should be designed to locate a cluster of metallic items that may be MPPEH or an area with a higher density of anomalous DGM readings that could indicate the presence of MPPEH with defined characteristics and a suitably high level of confidence. 15. If the area within MRS 03 or MRS 12 is within Depth Zone A/A′ or B, then the survey should be designed to have greater coverage (i.e., smaller survey line spacings). 16. If the TEMA-MK3 detector platform is being used, then DGM data will be collected only if the system can be kept 10m laterally away from and 3m above coral reefs and slope areas. Otherwise no DGM data will be collected at that location. 17. If the TEMA-Lite detector platform is being used, then DGM data will be collected only if the system can be kept 2 meters laterally away from exposed reef and 0.15 meter (6 inches) above submerged coral reefs and slope areas with less than 2m of overlying water). Otherwise, no DGM data will be collected at that location. 18. If the results for the survey lines on the outer boundaries of the MRS in Depth Zone C show anomaly densities 3x higher than the local background level (indicating the potential for MEC to be present outside of the current MRS/FUDS boundary), then the extension of the survey beyond the MRS boundary using the same Depth Zone C survey design will be discussed with the U.S. Army Corps of Engineers and the Project Delivery Team.	19. At minimum, the survey design for all portions of the MRSs should be able to traverse and detect a cluster of metallic items that may be MPPEH or an area with a higher density of anomalous EM readings that is circular with a radius of 400 feet and has a characteristic density of 90 anomalies per acre (ApA) over a background anomaly density of 10 ApA with at least 90% probability. 20. Due to the increased potential for exposure in the portions of the MRSs with shallower water, the survey lines in Depth Zone B should be spaced to have a minimum coverage of 10% of the total Depth Zone, the survey lines in Depth Zone A (that are not in A') should be spaced to have a minimum coverage of 25% of the total Depth Zone, and the survey lines in Depth Zone A' should be spaced to have a minimum coverage of 100%.	21. Use the Visual Sample Plan (VSP) with the inputs identified in Sections 2.2.06 through 2.2.014 of the Work Plan, which leads to the following separations between survey lines: (1) for Depth Zone B, the required separation between survey lines for a detector swath width of 3 meters and a required coverage of 10% is 100 feet (a geometrical calculation); (2) for Depth Zone A (that is, not A′), the required separation between survey lines for a detector swath width of 3 meters and a required coverage of 25% is 30 feet (a geometrical calculation); and (3) for Depth Zone A′, the required separation between survey lines for a detector swath width of 3 meters and a required coverage of effectively 100% is 10 feet (a geometrical calculation). 22. Check the validity of the identified survey design assumptions using the data collected during the Phase 2 Survey. If significant differences are identified between the pre-Phase 2 Survey–assumed parameters and those actually measured, assess the implications of the differences on the likelihood that the survey achieved the Phase 2 DQOs. If it is indicated that a DQO was not met, discuss the situation with the U.S. Army Corps of Engineers and the Project Delivery Team to identify possible corrective action during Phase 3.

Table 2-1. Project Data Quality Objectives (DQOs) for the Phase 2 Survey (continued)

Goals / Objectives	Step 1 State the Problem	Step 2 Identify the Decision	Step 3 Identify Inputs to the Decision	Step 4 Define the Study Boundaries	Step 5 Develop a Decision Rule	Step 6 Specify Tolerable Limits on Decision Errors	Step 7 Optimize the Design for Obtaining Data
Description	***Summarize the contamination problem that will require new environmental data, and identify the resources available to resolve the problem***	***To identify the decision that requires new environmental data to address the contamination problem***	***To identify the information that will be required to support the decision and specify which inputs require new environmental measurements***	***To define the spatial and temporal boundaries that the data must represent to support the decision***	***To develop a logical "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative actions***	***To specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data***	***To identify a resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs***
							23. Geo-reference the TEMA data using real-time kinematic (RTK) level GPS and, when the towfish is submerged, an ultra-short baseline (USBL) acoustic positioning system. During DGM, navigate the vessels to the line plan utilizing HYPACK (a navigation software package that shows the vessel position relative to the planned line in real-time and displays a left-right indicator that shows how close the vessel is following the planned line) and display the towed TEMA-MK3's position, as tracked by the USBL, in real time behind the survey vessel (see also Work Plan Section 2.11.3).
Survey Component: Positioning Accuracy and Consistency (DQO 3)							
1. Documentation of the Locations Surveyed and the Anomalies Detected within the Surveyed Areas	2. The boundaries and the locations surveyed internal to the MRSs during the Phase 2 Survey must be documented for the RI Report and the Administrative Record. 3. The locations of the transect lines that were surveyed during the Phase 2 Survey and the locations of the anomalies that were detected along those survey lines must be identified with sufficient accuracy to allow defensible geospatial analysis of the anomaly densities and distributions within each MRS and Depth Zone. 4. The locations of the anomalies detected along the Phase 2 Survey lines must be identified with sufficient accuracy to also allow those anomalies to be reliably reacquired during the Phase 3 Intrusive Investigation, if required.	5. How accurately must the survey lines and the detected anomalies be documented?	6. While the required accuracy of legal boundaries in offshore environments has not been standardized, 1-meter accuracy is the current best practice. 7. When a diver is re-acquiring an anomaly for intrusive investigation and classification, they are typically required to search an area within a 1-meter radius of the specified location and not find the source of an anomaly before they classify that target as a "no find." 8. Sub-meter accuracy on documenting the position of detected anomalies effectively minimizes delays and costs in re-acquiring the anomalies for intrusive investigation.	9. Spatial – Same as for the DGM Data Collection survey component above.	10. If the MRS and Depth Zone boundaries, survey lines, and detected anomalies can be identified to within 1m accuracy within the offshore environment, then the positioning will be acceptable for the purposes of the RI and the Administrative Record. 11. If lateral deviations from the planned survey lines become too large and/or persist for too long a period of time, then that length of the survey line will be re-surveyed until the limitations on the deviations are not exceeded.	12. 1m accuracy for point locations 13. Maximum allowable lateral deviations from the planned survey lines: - Depth Zones C and B: No more than 5m for more than 500 feet traversed (approximately 1 minute at maximum detector platform speed) - Depth Zone A (that is not A'): No more than 1m for more than 25 feet traversed - Depth Zone A': No more than 0.5m for more than 10 feet traversed	14. Use of a Real Time Kinematic (RTK) satellite-based Global Positioning System (GPS) in combination with a Global Acoustic Positioning System (GAPS) will provide sub-meter accuracy for these locations.

Table 2-1. Project Data Quality Objectives (DQOs) for the Phase 2 Survey (continued)

Goals / Objectives	Step 1 State the Problem	Step 2 Identify the Decision	Step 3 Identify Inputs to the Decision	Step 4 Define the Study Boundaries	Step 5 Develop a Decision Rule	Step 6 Specify Tolerable Limits on Decision Errors	Step 7 Optimize the Design for Obtaining Data
Description	***Summarize the contamination problem that will require new environmental data, and identify the resources available to resolve the problem***	***To identify the decision that requires new environmental data to address the contamination problem***	***To identify the information that will be required to support the decision and specify which inputs require new environmental measurements***	***To define the spatial and temporal boundaries that the data must represent to support the decision***	***To develop a logical "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative actions***	***To specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data***	***To identify a resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs***
Survey Component: Potential Munitions Item Detectability (DQO 4)							
1. Detectability Requirements for Different Potential Munitions Types in Different Survey Situations	2. EM detectors can locate metallic items on the seabed or within the near-surface sediment below the seabed to some depth within the footprint of the survey path (i.e., as defined by the detector swath width and survey line length). 3. Item detectability is strongly influenced by the distance between the object (on the seabed or in the sediment below the seabed) and the detector coils. Smaller items can be detected when this separation distance in smaller, but only larger items can be detected as this separation distance becomes greater. 4. A "detection" is typically associated with the case when the response produced by the detection system at the location of a possible item is noticeably greater than the response produced fairly uniformly by the "background" conditions when metallic items of potential interest are known to not be present. 5. EM systems are limited in their ability to detect metallic objects within the sediment below the seabed (i.e., smaller items are less likely to be detected if they are located deeper in the sediment). 6. The detector system must be kept at a suitable distance above the seabed at locations within sensitive ecological habitats or where there are protected coral. In areas without coral or sensitive habitat features, the detector system can be brought close to the seabed and smaller items may be detected at deeper depths within the sediment. In areas with coral or sensitive habitat features, the detector system must be raised up farther from the seabed and only larger items may be detected in the shallower sediment. 7. Use of a higher power EM coil detection system will allow smaller items to be detected at a given depth in the sediment.	8. What types of the set of potentially present munitions need to be detected and at what depths in the sediment?	9. The munitions types potentially associated with these MRSs include: 20mm high explosive (HE) incendiary devices, Mk76 practice bombs, Mk50s, 37mm projectiles, 5-inch rockets, 76mm projectiles, 3- to 6-inch Navy projectiles, and 81mm mortars. 10. The munition type with the least metallic mass are probably the 20mm projectiles and the munition type with the most metallic mass are probably the 6-inch naval projectiles. 11. High power EM coils can detect a given item 45% to 80% farther away than standard EM coils. 12. The largest munitions types associated with the site (i.e., the large artillery and rockets) are likely to be detected at depths up to 2 feet below the seabed if the detector coils are maintained at an altitude less than 2 meters above the seabed. 13. The smallest munitions types associated with the site (i.e., the 20 mm projectiles) are likely to be detected at depths from 1 to 1.5 feet below the seabed only if the detector coils are maintained at an altitude less than 0.5m above the seabed. 14. The munitions types with sizes/masses in between these two extremes are likely to be detected at depths from 1.5 to 2.5 feet below the seabed if the detector coils are maintained at an altitude less than 1.5 meters above the seabed and possibly detected if the detector coils are maintained at an altitude of 2 meters above the seabed. 15. Measurements of the detector system altitude collected concurrently with the EM response, position, and time so that the variability in the system's ability to detect the smaller munitions types associated with the site can be identified, mapped, and explicitly considered.	16. Spatial – The vertical depth of interest into the seabed for both MRS 03 and MRS 12 are the depths of probable intrusion into the sediment by individuals participating in the recreational and occupational activities identified for the CSM for potential exposures to MEC. 17. Spatial – The detector systems should be positioned as close to the seabed as possible provided the sensitive ecological habitats and protected coral are not disturbed.	18. If there are no sensitive ecological features or protected coral in the area, then the detector system should be kept as close to the seabed as practical. 19. If there are sensitive ecological features or protected coral in the area, then the detector system should be kept as close to the seabed as practical while maintaining the established setback distances. 20. If the detector coils are maintained at an altitude less than 2 meters above the seabed, then the larger projectile munitions types associated with the site will likely be detected. Otherwise, they may not be detected at these locations and these locations will contribute to a false negative rate for the system and survey relative to the larger items. 21. If the detector coils are maintained at an altitude less than 2 meters above the seabed, then the smaller projectile munitions types associated with the site will probably not be detected if those items are not on the seabed or buried just below the seabed. These locations will contribute to a false negative rate for the system and survey for these smaller items (which would be greater than for the larger items). 22. If the detector coils are not maintained at an altitude less than 2 meters above the seabed in an "accessible" area (consistent with the approved SOPs), then that area will be re-surveyed.	23. The largest munitions types associated with the site must be detected with a relatively high likelihood nearly all of the time during the Phase 2 Survey. 24. The smallest munitions types associated with the site must be detected as often as possible and practical during the Phase 2 Survey.	25. Utilize the detector systems with the high power EM coils. 26. Ensure that at least 90% of the time during the Phase 2 Survey the detector system will be maintained at an altitude at or below 2m (excluding areas that are not accessible for physical or ecological reasons). 27. Re-collect EM data such that at least 90% of the time during the Phase 2 Survey the detector system will be maintained at an altitude at or below 2 meters (excluding areas that are not accessible for physical or ecological reasons). See Table 4-2 for measurement quality metrics pertaining to EM data collection completeness.

Table 2-1. Project Data Quality Objectives (DQOs) for the Phase 2 Survey (continued)

Goals / Objectives	Step 1 State the Problem	Step 2 Identify the Decision	Step 3 Identify Inputs to the Decision	Step 4 Define the Study Boundaries	Step 5 Develop a Decision Rule	Step 6 Specify Tolerable Limits on Decision Errors	Step 7 Optimize the Design for Obtaining Data
Description	***Summarize the contamination problem that will require new environmental data, and identify the resources available to resolve the problem***	***To identify the decision that requires new environmental data to address the contamination problem***	***To identify the information that will be required to support the decision and specify which inputs require new environmental measurements***	***To define the spatial and temporal boundaries that the data must represent to support the decision***	***To develop a logical "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative actions***	***To specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data***	***To identify a resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs***
Survey Component: Video and Photographic Data Collection (DQO 5)							
1. Video and Still Photography Collected During the Phase 2 Survey	2. Video and still photography will be collected during the Phase 2 Survey to be used to provide additional context on the conditions present along the survey lines and to help identify items (munitions or otherwise) that are present on the seabed. 3. To be most useful for these purposes, the video and still photographs need to be of the highest quality possible, clear, and well lit. 4. The video and still photographs to be taken during the Phase 2 Survey will be collected using cameras mounted to the detector platform and will be potentially subject to motion blur. Note: Additional video and photographic data will be collected during the Phase 3 effort using a remotely operated vehicle (ROV) or divers which would effectively eliminate most motion blur problems. 5. Natural light may be limited at the seabed at water depths associated with Depth Zone C. 6. Currents and other natural forces or the motion of the detector platform may cause local disturbances that could increase the turbidity and reduce the visibility captured in the video or still photographs at that location. 7. The images collected during the survey must be able to be monitored remotely in real-time so that adjustments may be made, if warranted. (Surface floated TEMA-Lite excepted. Video will be reviewed each day for the TEMA-Lite)	8. How should video and still photographs be taken during the Phase 2 Survey to maximize their utility in collecting information for the RI and for planning the Phase 3 Intrusive Investigation?	9. Video or Still Photography – The resolution/ definition of each image collected in terms of pixel density 10. Video or Still Photography – The amount of light present relative to the amount needed for a well-lit image 11. Video or Still Photography – The detector platform speed at which motion blur will degrade the image 12. Video – The number of frames per second collected	13. Spatial – Typically within 0.5 to 2 meters of the seabed along the survey lines in all three Depth Zones.	14. If video or still photographic images are discovered to be degraded by real-time monitoring, then a real-time assessment must be made to determine whether adjustments in the survey parameters can be made that would improve the images and not jeopardize the quality of the DGM data being collected.	15. Since additional, possibly higher quality images, will be collected during the Phase 3 effort, obtaining very high quality video or still photograph images during the Phase 2 Survey is not required in all cases. 16. Good quality imagery should be collected in situations where there is potential MPPEH or a potentially significant historical or cultural artifact present on the seabed. 17. TEMA Video Acquisition Daily Start-up QC Checklist must be followed.	18. Underwater Camera on the TEMA MK3: - Maximum platform forward speed = 4 knots - Maximum platform turning/repositioning speed 22.5 degrees/second - Self-supplied light source up to 100,000 lumens (10,000 lumens minimum) - Video – High Definition video with 1080 horizontal lines of vertical resolution - Video – 24 frames per second - Still Photographs – At least 2 megapixels per image 19. Underwater Camera on the TEMA-Lite (i.e., GoPro): - Maximum platform forward speed = 4 knots - Maximum platform turning/repositioning speed 22.5 degrees/second - Self-supplied light source NA for surface tow - Video - High Definition video with 1080 horizontal lines of vertical resolution - Video - 24 frames per second - Still Photographs – At least 2 megapixels per image

2.2.06 Calculations were performed to identify survey line spacings that would be effective in traversing and detecting a possible undiscovered offshore area of high anomaly density that could contain MEC that was released by the historical training activities and altered in characteristics by the natural forces at work in the waters of these MRSs. This design evaluation was performed using the Visual Sample Plan (VSP) software (Version 7). VSP has been used for transect spacing design for many years for upland ranges and MRSs. However, the VSP software also has been applied by its developers (Pacific Northwest National Laboratory [PNNL]) to design survey spacings for underwater sites. One example that was very similar in its objective was the transect design for the wide area assessment investigation in the waters of Lake Erie for the Former Erie Army Depot and Toussaint River Site. PNNL (2014) states that the transect design tools in VSP provide a statistically defensible method for specifying the required number and location of transect surveys that cover a small proportion of a total study area (i.e., 1 to 3 percent) to identify target areas of an anticipated size, shape, and magnetic anomaly density. Once surveys are conducted, high density area flagging routines are applied, and anomaly density estimates are derived to separate potential target areas from areas that may require no further remediation. The former Erie Army Depot was used for almost a half century (i.e., from 1918 to 1966) by the Department of the Army for testing and proof-firing of artillery and as an ordnance storage and issue center. Munitions fired from the on-shore firing line would generally land in Lake Erie. PNNL was tasked to develop a transect survey design that would use an underwater towed-array system to detect magnetic anomalies along the floor of a water body. The transect survey design for this site was developed with the aid of the VSP software. For this application, PNNL used VSP's transect design, anomaly flagging, target-area delineation, and spatial anomaly density estimation and mapping modules (ESTCP 2007). PNNL also used VSP in an analysis of the Blossom Point Marine Transect Survey (ESTCP 2008).

2.2.07 To identify the spacing needed between survey transects to achieve a specified probability of traversing and detecting potential target areas of concern for the former Erie Army Depot, PNNL specified several operational parameters, including:

- width of the survey transect;
- transect pattern on the site;
- the size and shape of any target area that should be detected;
- density and distribution of anomalies in the target area;
- density of background anomalies at the site; and
- the instrument false negative rate.

2.2.08 After the parameters were entered by PNNL, a transect spacing was computed by VSP. VSP can be used to identify the spacing needed between transects to achieve a specified

probability of traversing and detecting an area with defined characteristics in an underwater environment. However, the key challenge is then specifying the characteristics of the area in the marine environment being sought and the associated VSP input parameters.

2.2.09 The Phase 2 DQOs specify the requirements of the Phase 2 Survey relative to determining a transect spacing for Depth Zone C. The following Figures 2-1, 2-2, and 2-3 show the VSP input screens used to enter the parameters needed to calculate a transect spacing to locate a "target" area or area of localized high anomaly density. First, it should be noted that "target" is the term used generally by VSP for the area of high anomaly density being looked for in a search. The high anomaly density areas that are one of the primary focuses of the Phase 2 surveys being performed in MRS 03 and MRS 12 were not "targets" in the sense of locations that were aimed at during repeated and prolonged firing or bombing. Rather, the MRS 03 and MRS 12 areas were originally safety fans or buffer areas associated with short-shot/long-shots relative to the actual "targets" that were on the land. Subsequent to the active firing period, items in the water have likely moved and may have re-concentrated in depressions or low spots in the seabed or along cliffs or reefs edges.

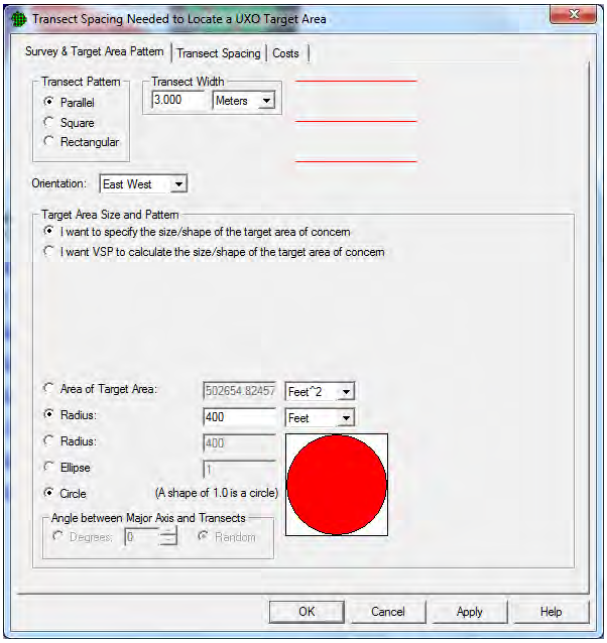


Figure 2-1. VSP Input Screen 1

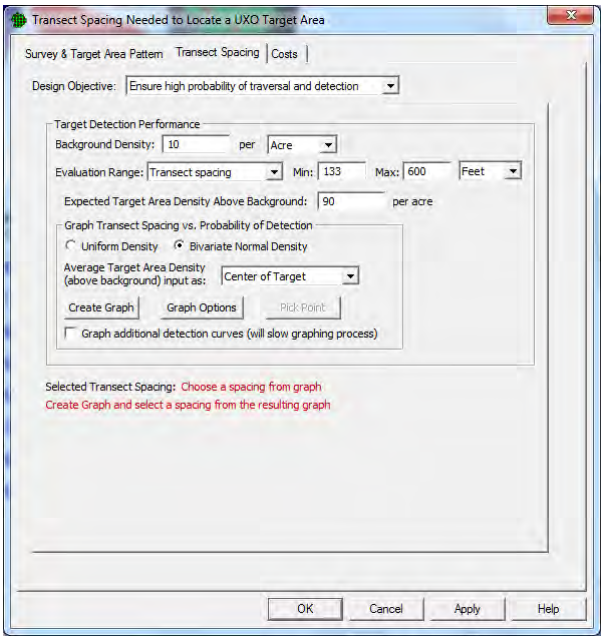


Figure 2-2. VSP Input Screen 2

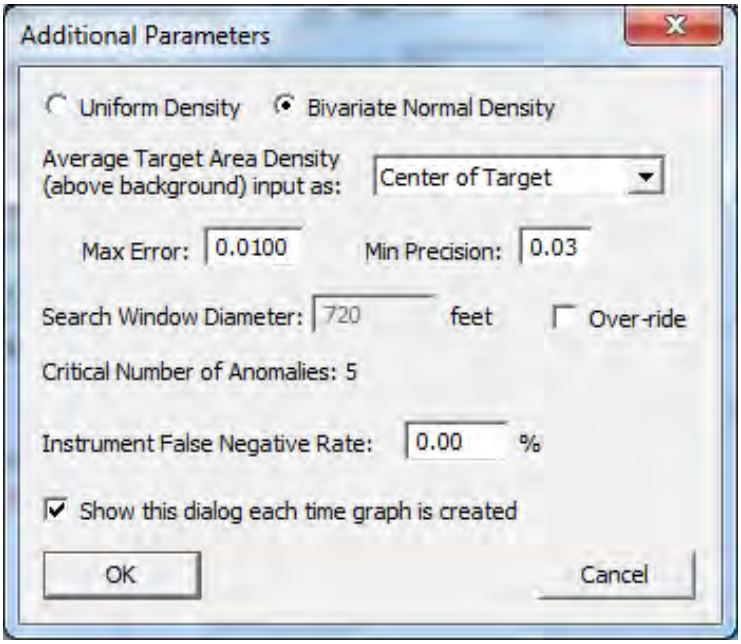


Figure 2-3. VSP Input Screen 3

2.2.010 Each required VSP input for this type of transect spacing design is discussed below in order of their appearance in the VSP input screens.

2.2.011 Screen 1 (refer to Figure 2-1):

- Transect Pattern – A pattern of parallel survey lines was chosen. This pattern is the most operationally simple and practical pattern to apply in an offshore environment where the survey lines must be performed with boats or floating platforms with somewhat less directional mobility than systems on land. It is noted that in actual application, the straight parallel survey lines sometimes will be laid out as parallel wavy lines to allow them to follow shorelines or other distinctive non-rectangular features.
- Transect Width – A 3-meter transect width corresponding to the width of the multi-coil detector array on either the TEMA-MK3 or the TEMA-Lite was assumed for the design. A 3-meter detector width was proposed and was specified for the VSP design because it generates more DGM data and allows a better evaluation of any particular anomaly than a narrower detector. For example, a 3-meter detector array produces three times more data per transect length than a 1-meter-wide detector array, has a somewhat greater detection capability due to the additive effect of multiple transmitters, is associated with more precise horizontal (x,y) positional information, and provides a fallback should one of the units in the array develop a technical problem. It also is the case that, all other VSP transect spacing design inputs being the same, a wider detector array leads to a wider transect spacing than a narrower detector array for the same required confidence level of traversal and detection. The baseline transect spacing calculated by VSP for a 3-meter

detector array to achieve a 90 percent probability of traversal and detection (i.e., approximately 350 feet – see Figure 2-4 in paragraph 2.2.014) is reduced to approximately 125 feet if the detector array is changed to 1 meter with all the same other inputs. As such, a wider detector array is advantageous from a number of perspectives.

- Orientation – This input does not matter in this case because VSP is not being used to plot the resulting transects on a site map within VSP that is oriented within a particular reference system. In addition, the assumed shape of the "target" area for the search is a circle. As such the orientation of the survey transects relative to the "targets" does not affect the probability of traversal or detection (see below).
- Target Area Size and Pattern:
  - Specification Option – Since the second option ("I want VSP to calculate the size/shape of the target area of concern") is only applicable to certain surface launched/fired or air launched/fired munitions types in relation to land-based targets, the first option was selected ("I want to specify the size/shape of the target area of concern").
  - Size/Shape of Target – Various factors could influence the specification of the size and shape of this area for MRS 03 and MRS 12. The selections considered what a high density area of concern associated with the historic munitions use might look like on land (e.g., on the Northwest Peninsula of Culebra), what the outer portions of the safety fan or buffer area associated with this upland area might look like, and then considered what changes to the size and density may have occurred because of the passage of time in the marine environment (e.g., as the result of damping, deflection, dispersion, and migration by natural forces, the rates of which will be dependent on benthic habitat type [e.g., sand versus coral]). These changes are likely to have resulted in a reduction of the possible size of a localized high anomaly density area. A circular shape is the most conservative choice for this VSP input parameter if the circle diameter is equated to the shorter axis of a potential oval target area (as was done for this design). The limited available information was used to estimate the radius of a circle or the shorter dimension of a potential oval target. Accordingly, the design does not assume that the orientation of a possible oval target area is known a priori such that the survey transects could or would be fortuitously oriented in every instance so as to intercept them on the broadside. As such, an assumption of a circular area in this manner leads to the narrowest (i.e., most conservative) survey line spacing. The results of the Phase 1 EBS video survey identified locations where MEC might be located and the areas where groups of multiple items that could be MEC were observed. These areas were on the order of 800 to 1,000 feet in characteristic dimension. As there has been no prior DGM survey in these MRSs and the locations highlighted by the Phase 1 EBS video survey were not further

intrusively investigated to date, little more can be inferred from the currently available information. The natural forces that could move munitions that are deposited in the water around are location-specific and affected by the physical features and hydraulic patterns of each location, and thus there are no established "typical" target sizes for marine environments. The 400-foot radius assumed for the VSP design is consistent with the information currently available. Accordingly, a radius of 400 feet was chosen to apply for the transect design.

2.2.012 Screen 2 (refer to Figure 2-2):

- Design Objective – Consistent with the form of the Phase 2 DQO established for the MRSs, the selection was to "Ensure a high probability of traversal and detection" of the high density area.
- Target Detection Performance:
  - Background (Anomaly) Density – No prior site-specific anomaly density information for the marine environment is available for these two MRSs. As such, other information was considered in the specification of this parameter for the VSP transect spacing design. An EE/CA was performed in 1997 for the southern portion of the Northwest Peninsula of Culebra and a number of grids were surveyed and anomaly densities were calculated. Grids FB-1 through FB-4, FB-6 and FB-10 were considered background locations on land. The average ApA for these grids was 10.6. It was anticipated that the marine environment would have a background anomaly density that was comparable or less than this value. Because the Phase 1 Pre-Survey was not performed in any area outside the MRS boundaries, the DGM survey equipment cannot be deployed in an area where there is not confidence that the survey would not damage any sensitive coral or where physical obstructions could damage or destroy the survey equipment. As such, an evaluation of the DGM data collected within all parts of the two MRSs is planned in the form of a spatial analysis of the Phase 2 survey data. This analysis is expected to show that much of the area "around the edges" of each MRS has lower anomaly densities than the other portions of the MRSs and that these anomaly densities could be interpreted as "background." The detection probability is lower when the background anomaly density is higher (i.e., more like the density in the "high density areas" being searched for), so a marine background value of 10 ApA was assumed. The same spatial analysis of the collected Phase 2 DGM survey data will be used to evaluate whether this assumption and a number of the other assumed VSP input parameters were accurate or representative of the actual observed site conditions.
  - Expected Target Area Density Above Background – The 1997 EE/CA also surveyed a number of upland grids in the target areas of the southern portion of the Northern Peninsula. The average anomaly density in these target locations on land was 763

ApA, and the range was 122 ApA to 1,725 ApA. MRSs 03 and 12 were originally the marine portions of the safety fans associated with these targets (most likely the leading edge of the undershoot area [MRS 03] or the overshoot area [MRS 12]). As the lowest upland grid had an anomaly density of 122 ApA, the undershoot area in the water that was a distance farther from the targets themselves would be expected to have a lower density. In addition, the energetic marine environment also would be expected to have dispersed the items that would cause the anomalies. As such, a total expected target anomaly density of 100 ApA was assumed, which made the expected target area density above background 90 ApA.

- Evaluation Range for the Transect Spacing – This range of transect spacings was explored in iterative fashion by performing a sensitivity analysis of the VSP results for different input parameter combinations reflecting the ranges of uncertainty or variability associated with each input parameter given the information currently available. The goal was to identify the range of spacings that would result in a probability of traversal and detection that met the DQO. This sensitivity analysis included exploring the effect of higher and lower anomaly densities in the "high density areas" than the baseline value assumed, higher and lower background anomaly densities compared to the baseline value assumed, assuming a bivariate normal anomaly distribution vs. a uniform anomaly distribution within the high density areas, and whether the elevated anomaly density estimated for the "high density areas" applied to the center or edge of the assumed bivariate distribution. The results of these runs were examined in terms of the transect spacing that would provide at least 90 percent confidence of traversing and detecting a high anomaly density area with the specified characteristics (as per the DQO). The noted Evaluation Range covered the vast majority of these cases and indicated parallel survey line spacings in the general range of 150 to 450 feet were associated with meeting the DQO.

- Grid Transect Spacing vs. Probability of Detection:
  - High Density Area of Concern Anomaly Distribution – The distribution of the "high density area" being searched for was assumed to be bivariate normal. This is the default selection for VSP. While little is known about the actual density distribution for possible anomaly clusters in the marine environment in these MRSs, this selection was made to be more conservative (i.e., leading to a narrower rather than a wider transect spacing) than selection the alternative of a uniform density distribution would typically be. This distribution may better reflect a situation where items may have migrated and re-clustered around a local depression or seabed obstruction. All other things being equal, assuming that the outer edges of a possible high density area have a higher anomaly density (as is typically the case with the uniform density

assumption) generally increases the probability of detection considerably at the outer edges, leading to wider transect spacings for the same DQO probability of traversal and detection with all other VSP inputs being the same. [NOTE: See the discussion of the next input parameter as well as there are connections between the two parameters.]

- Average Target Area Density (above background) – The input value of 90 ApA was specified to be applied as the maximum value of the bivariate normal distribution (i.e., at the peak) over and above the specified background anomaly density. VSP calls this part of the distribution the "Center of Target" anomaly density. Assuming a bivariate normal distribution with the co-specification that the anomaly density was the density at the center (or peak) of the distribution (and not the target average or the density at the outer edge of the distribution where anomaly densities would be the relatively lowest) is an example of two VSP inputs that must be linked and be self-consistent with the site's CSM. Each of the other two possible choices for where VSP applies the input anomaly density would have generally implied a higher anomaly density at the edge of the distribution and a greater probability of detecting the "high density area" than the application of this numerical density value to the center of the distribution. As such, the assumption of a bivariate normal distribution with the specified anomaly density applied at the center of the distribution is believed to be the conservative approach. Because there has been no prior DGM survey work in these MRSs and the natural forces that have caused the current distribution of anomaly-created objects are expected to be very location specific, the actual current distribution of anomalies within the MRSs cannot be known or estimated with much certainty. The spatial analysis of the collected Phase 2 DGM survey data will ultimately show what the distribution is. Even given this uncertainty, the selection of a bivariate normal distribution with the specified elevated anomaly density applied at the center of the distribution would not be expected to artificially inflate the probability of detection at the edges of the high density areas or artificially widen the transect spacing for the design.

2.2.013 Screen 3 (refer to Figure 2-3):

- Additional Parameters:
  - Maximum Error – The maximum error does not affect the magnitude of the transect spacing produced by VSP, only the time it takes VSP to calculate that spacing. Increasing and decreasing the maximum error has a small, but noticeable effect on the run-time of the VSP module (with smaller maximum errors requiring longer runs to achieve that threshold). This parameter was left at the default value of 0.01. The PNNL instructors at the VSP training courses recommend that this parameter be left

at the default because that value was established to optimize VSP's Monte Carlo simulation iteration performance over a wide range of scenarios.

- Minimum Precision – The minimum precision also is a parameter that primarily affects the simulation calculations. This parameter was left at the default value of 0.03. The PNNL developers also recommend that this parameter be left at the default because that value was established to optimize VSP's Monte Carlo simulation iteration performance over a wide range of scenarios. Changing this parameter does not change the average value of transect spacing produced by VSP over a number of runs with the same inputs, but a larger minimum precision threshold would lead to a somewhat greater variability in the transect spacing results for a set of repeated runs using the same VSP input parameters. The VSP developers have set these defaults in consideration of countless applications of the tool to provide a good balance of model calculation speed and transect spacing reproducibility with managed output variability. The VSP transect spacing cited and used in the design was associated with the central value or average of repeated runs with the same inputs.
- Search Window Diameter – This parameter refers to the diameter of the circular search window used during simulations to identify areas in which density is greater than the specified background density. The selection of an appropriate window diameter is dependent on the size of the target area of interest, transect width, and spacing between transects. The optimum window diameter is one that has sufficient traversed area within the window without including such a large area that potential high-density areas can be masked by the surrounding low-density areas also in the window. As a general rule, the window diameter should be less than the diameter, or two times the radius, of the target area of interest and no smaller than the spacing between the original transect design. A default value for this parameter is calculated by VSP to be 1.8 times the radius of the assumed high density area. As this radius was 400 feet, the default Search Window Diameter was calculated to be 720 feet. This default value was not overridden.
- Critical Number of Anomalies – This parameter is calculated by VSP and refers to the number of detected anomalies required inside a window to identify it as significantly greater than background.
- Instrument False Negative Rate – This parameter accounts for the fact that collected data may not be representative of the actual density because the electromagnetic detector may not identify all detectable anomalies. For example, a false negative rate of 5 percent would indicate the detector, on average, would fail to detect 5 percent of the detectable anomalies traversed (background and target area). It is generally assumed that the detector always detects individual anomalies of interest and above a specified pick threshold, thus a false negative rate of zero percent is used for a default value. As such, initial design runs of VSP were performed assuming an Instrument

False Negative Rate of zero percent. However, in a marine environment, this rate would probably only be zero or near zero for very large items or where the detector array can be maintained at a minimum separation from the seabed. Accordingly, areas with near flat topography should generally have low false negative rates. The Instrument False Negative Rate would be higher for smaller items located deeper in the sediment or where the detector array must be moved higher above the seabed to avoid a sensitive ecological species or physical obstruction. Sensitivity runs with the Instrument False Negative Rate as high as 40 percent were performed.

2.2.014 Using these inputs, the baseline VSP design for Depth Zone C yielded a 90 percent probability of traversal and detection at a transect spacing of approximately 349 feet between adjacent survey swaths (343 feet between survey line centers) (see Figure 2-4). The VSP-generated report for this Zone C baseline design is included in Appendix J.

Figure 2-4. Baseline Transect Spacing Meeting the DQO of 90 Percent Probability of Traversal and Detection

2.2.015 The sensitivity of the maximum transect spacing to the Instrument False Negative Rate was then evaluated. Increasing the Instrument False Negative Rate within VSP while holding all other input parameters constant does not change the calculated transect spacing for those inputs. The more likely impact of an increased Instrument False Negative Rate is the artificially lower resulting number of recorded or detected anomalies that will be associated with that location in the DGM survey. If this artificially lower number of detected anomalies is

associated with the outer edge of an area of high anomaly density, the post-Phase 2 DGM survey spatial analysis of the detected anomalies may not associate that location with the adjacent high anomaly density area or may not find that that location meets the high anomaly density area threshold at all. If an Instrument False Negative Rate of approximately 30 percent is considered, the VSP analysis indicates that a transect spacing of 271 feet between adjacent survey lines (281 feet between survey line centers) is required to meet the DQO (see Figure 2-5).

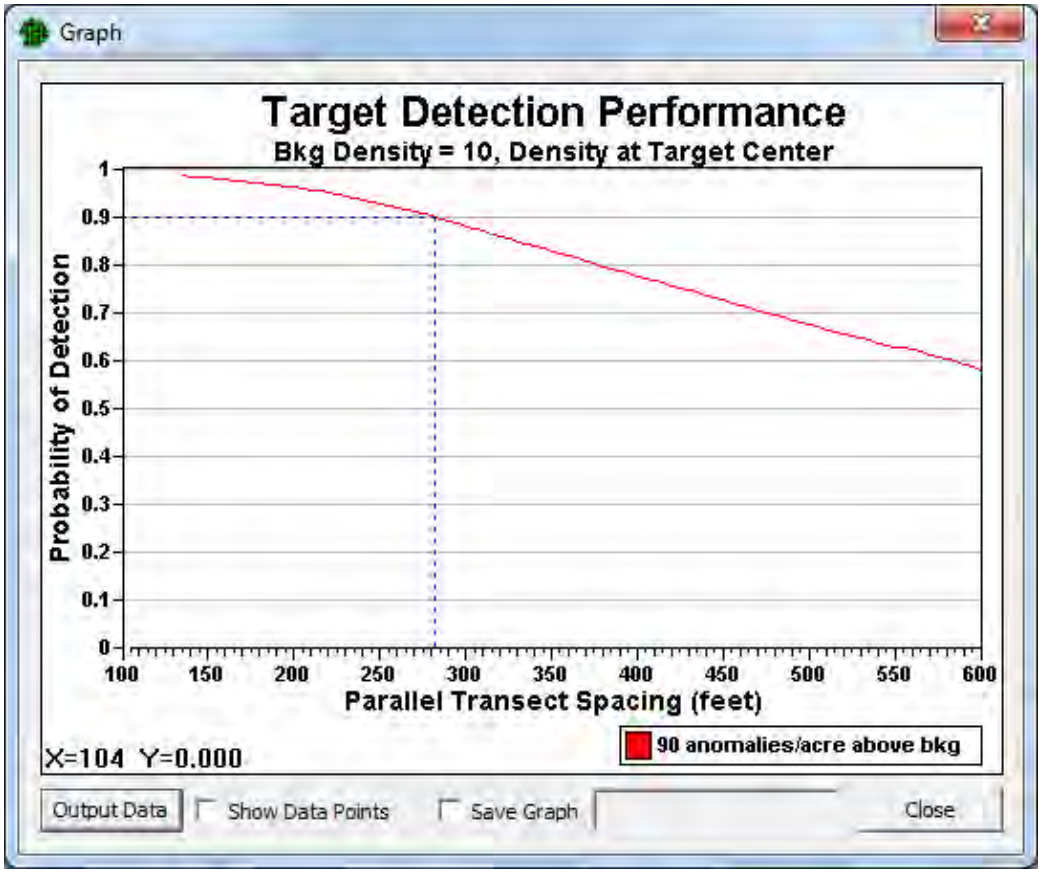


Figure 2-5. Transect Spacing Meeting the DQO of 90 Percent Probability of Traversal and Detection with an Instrument False Negative Rate of 30 Percent

2.2.016 In consideration of this important uncertainty and that there are uncertainties associated with some of the other inputs to the transect spacing design, tighter survey lines on 250-foot spacings were selected to be applied as the baseline line survey design for Zone C in both MRSs to meet the DQO of 90 percent probability of traversal and detection. This survey line spacing represents approximately a 3.8 percent survey coverage of the Zone C areas. The validity of the survey design assumptions used to arrive at this spacing and coverage will be checked using the data collected during the Phase 2 DGM survey. A spatial analysis of the collected data will be performed to evaluate whether a number of the assumed VSP input assumptions were accurate or representative of actual site conditions. All detected anomalies (potentially caused by MEC, MD, or inert debris) that pass quality control will be included in the

spatial analysis that will be performed to locate the areas of high anomaly density within each MRS. The implications of any significant differences between the parameters assumed for the transect spacing design and those actually measured during the survey will be assessed. If it is indicated that a DQO was not met, the situation will be discussed with the USACE and the Project Delivery Team for possible corrective action during Phase 3.

2.2.017 The portions of the MRSs in Depth Zone B were judged to require greater coverage and characterization on a somewhat smaller spatial scale (i.e., smaller transect spacings) than in Depth Zone C due to the potentially smaller exposure area footprints that may be associated with the activities expected to be routinely performed in Zone B (relative to Zone C) as reflected in the conceptual site models described above for each MRS. Similarly, the portions of the MRSs that are in Zone A (that are not in Zone A′) were judged to warrant even greater coverage than for Zone B due to the potentially still smaller exposure area footprints in these subareas. Finally, the portions of the MRSs right along the shorelines of the sandy beach areas (i.e., Zone A′) were judged to need 100 percent survey coverage in the accessible areas because of the greatest potential for localized exposure by site users. Accordingly, survey line spacings were established to provide an even finer spatial scale characterization of the anomaly densities in Depth Zones B, A, and A′ relative to the Depth Zone C line spacing developed using VSP to meet the project DQO. The following relationship pertaining to an idealized rectangular area to be surveyed relates the required percent coverage of the area by the DGM transect survey to the associated transect spacing assuming regularly-spaced parallel transects:

Required Survey Area Coverage (COV) % / 100 = Area Surveyed / Total MRS Area

where:

Area Surveyed = the effective detector array swath width (W) times the total length of transect surveyed (L)

Total MRS Area = the sum of the effective detector array swath width (W) and the spacing between adjacent parallel survey transects (SP) times the total length of transect surveyed (L)

2.2.018 This resulting approximate expression for the transect spacings in feet is then:

$$SP = [W / (COV/100)] - W$$

2.2.019 For the various Depth Zone exposure zones, this translates to:

- For Depth Zone B, the required survey coverage of 10 percent was judged to be sufficient to adequately characterize the potential exposure area footprints associated with the activities expected to be performed in this Zone. For a detector swath width of 3 meters and a required coverage of 10 percent, the resulting survey line separation is 100 feet (using the geometrical calculation).
- For Depth Zone A (that is not Zone A′), the required survey coverage of 25 percent was judged to be sufficient to adequately characterize the potential exposure area footprints

associated with the activities expected to be performed in this zone. For a detector swath width of 3 meters and a required coverage of 25 percent, the resulting survey line separation is 30 feet (using the geometrical calculation).

- For Depth Zone A′, the required survey coverage was judged to be 100 percent. For a detector swath width of 3 meters and a required coverage of 100 percent, the resulting survey line separation is effectively 6.5 feet (i.e., 2 meters) (a geometric characteristic of the detector array configuration).

2.2.020 These Depth Zone-specific survey line spacings all achieve the specified DQO that the survey be performed along a pattern of parallel transects with the survey lane spacings selected to ensure at least a 90 percent probability of traversing and detecting a potential source area of elevated anomaly density of approximately 100 ApA. The survey line spacings for Depth Zones B, A, and A′ meet this DQO and go further to characterize these zones with a smaller spatial scale. Table 2-2 shows the estimated length of survey transects and overall coverage for each Depth Zone in each MRS, accounting for the areas identified to be inaccessible during Phase 1. Figures C-2 and C-3 in Appendix C illustrate the survey lines for MRS 03 and MRS 12, respectively. Every effort has been made to represent the line plans shown in Appendix C as accurately as possible. A combination of contouring and lines oriented perpendicular to the anticipated surf/swell may be used. The final line plans will be adjusted based on site conditions.

2.2.021 The Phase 2 EM survey results will be reviewed using the geo-statistical analysis and mappings (e.g., special analysis) to see what they imply about the distribution and density of anomalies (and potential areas of high anomaly density) and to determine if any of the key assumptions used in the design of the EM survey were or were not borne out by the new data. If the assumptions were found to not be accurate in some way, the implication of this inaccuracy will be identified and a determination made of how to adjust the Phase 3 work to compensate such that the stated DQOs might still be met.

2.2.022 Step outs will be considered if a potential source area is identified in the EM data at an MRS boundary within an accessible area that is water covered (i.e., no on land data collection will be performed under this work assignment). The need for step outs will be assessed based on the evaluation of the Phase 2 results. Step outs, if necessary, will be performed as part of the Phase 3 operations after intrusive investigations have confirmed the presence of MEC at the margins of the site boundaries. The scope, DQOs, and approach to be used for Phase 3 will be developed after reviewing the results of the Phase 2 Survey.

Table 2-2. Summary of the Phase 2 Survey Design

Depth Zone	Area Fraction of MRS (%)	Size (acres)	Transect Spacing (ft)	Probability of Traversing/ Detecting High Density Area (%)	Approximate Length of Transects (ft)	Transect Width[1/] (ft)	Approximate Area of Transects (acres)	Inaccessible Area Due to Slope or Shallow Water (acres)	Percent Coverage of Accessible Area (%)	Percent Coverage of the Area within this Depth Zone (%)
MRS 03		**195.07**	**area of MRS Shapefile**							
A′ – Sandy Beaches[2,3/] [<MLW-10']	1.95	3.88	6.6	100	26,425.46	9.84	4.38	0	100.00	100.00
A - Near Shore[2/] [<MLW-10']	62.51	121.95	30	100	190,510.93	9.84	43.04	12.4	32.98	35.29
B - Intermediate [MLW-10' to -25']	17.54	34.21	100	~100	17,367.32	9.84	3.92	3.0	12.57	11.47
C - Open Water [>MLW-25']	19.95	38.91	250	>90	6,403.41	9.84	1.45	3.1	4.03	3.72
SUBTOTALS	**102**	**195.07**	–	–	**240,707.12**	–	**52.79**	**18.45**	**29.24**	**26.53**
MRS 12		**833.54**	**area of MRS Shapefile**							
A′ – Sandy Beaches[2,3/] [<MLW-10']	1.51	12.76	6.6	100	40,165.03	9.84	6.66	0	100.00	100.00
A - Near Shore[2/] [<MLW-10']	12.91	107.57	30	100	267,069.98	9.84	60.33	9.7	61.66	56.08
B - Intermediate [MLW-10' to -25']	14.36	119.66	100	~100	43,859.94	9.84	9.91	17.0	9.65	8.28
C - Open Water [>MLW-25']	72.74	606.31	250	>90	99,569.22	9.84	22.49	29.2	3.9	3.71
SUBTOTALS	**102**	**846.30**	–	–	**450,664.17**	–	**99.39**	**55.92**	**12.57**	**11.74**
	TOTAL	**1,045.25**	–	–	**691,371.29**	–	**152.17**	**74.37**	**15.67**	**14.56**

Notes:

1/ In-water survey transect width assumed to be 3 meters.

2/ Depth Zones A′ and A in MRS 03 and 12 contain land that is inaccessible, but also water-covered area that is accessible by hovercraft but was not included in the original MRS area boundaries. Including coverage estimates in these areas causes the Percent Coverage of Accessible Area value to exceed 100%. An example of this can be seen in Appendix C, Figures C-2 and C-3.

3/ Area of MRS boundary Shapefiles for MRS 03 contains land that is inaccessible, but also water-covered area that is accessible by hovercraft but was not included in the original MRS area boundaries. Including coverage estimates in these areas causes the Percent Coverage of Accessible Area value to exceed 100 percent.

2.3 RI ORGANIZATION

2.3.01 The RI project organization consists of representatives from TtEC as depicted in Figure 2-6. Appendix C lists the key points of contact for the Task Order for the RI. The roles of each of the Project Delivery Team members are described below.

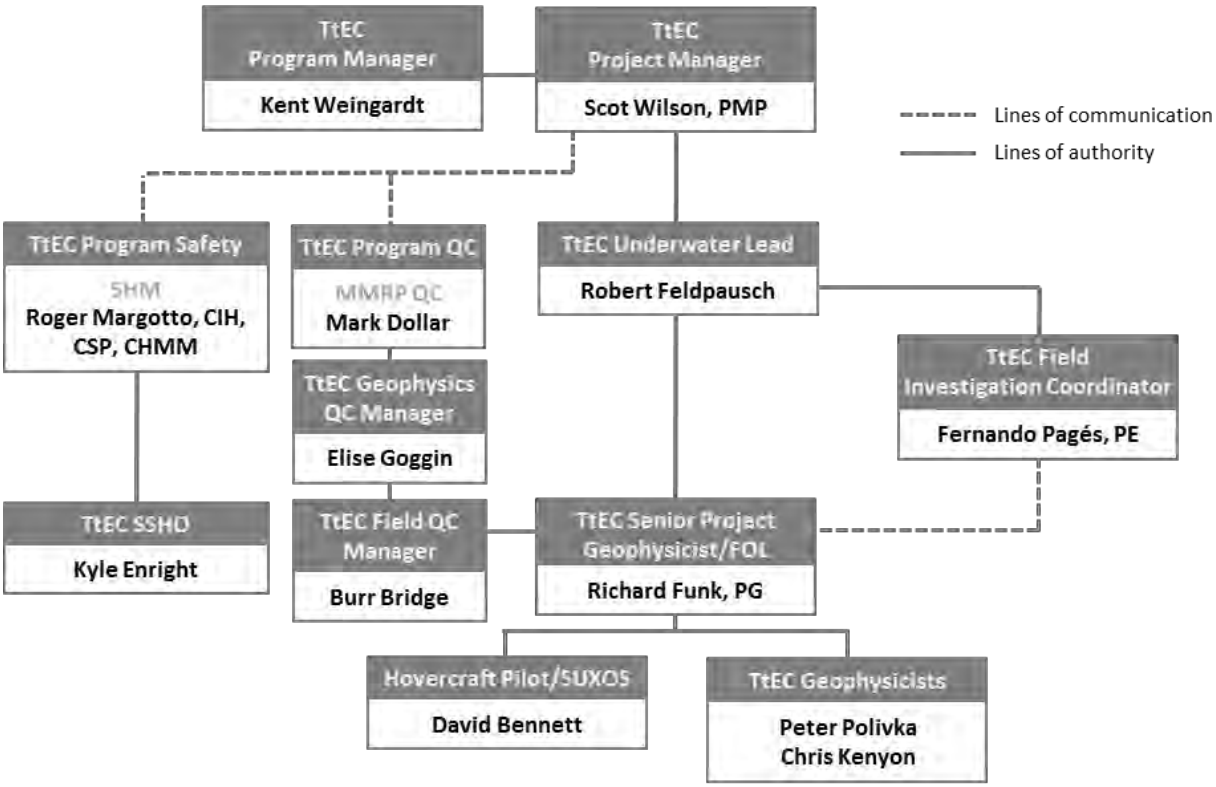


Figure 2-6. RI Organization

2.4 TETRA TECH EC PERSONNEL

2.4.01 The RI will be conducted by the personnel outlined below.

2.4.1 Program Management

2.4.1.01 TtEC program management is provided by following individuals:

- The program manager is Kent Weingardt. The program manager is responsible for ensuring contract requirements are met during the performance of the Task Order.
- The program safety manager is Roger Margotto. As program safety manager, Roger is the chief resource for all matters regarding safety and industrial hygiene. He directs and manages all company personnel functioning in safety positions, and provides technical support in safety, health, environmental compliance, industrial hygiene, hazardous materials, and other technical matters. He also reviews all project APPs, Site Safety and Health Plan (SSHPs), and AHAs and supports the projects when there are changes and questions.

- The MMRP program QC manager is Mark Dollar. Mark is responsible for implementation/oversight of the Munitions Response Quality Assurance (QA)/QC program for TtEC. He performs oversight of a full spectrum of quality tools and procedures for all MR projects. This includes implementing a comprehensive quality training program for TtEC UXO Quality Control Specialists, developing QC plans, Uniform Federal Policy for Quality Assurance Project Plans, and reviewing project plans and reports. He supervises all UXO Quality Control Specialists within the TtEC Munitions Response Program.
- The geophysics QC manager (GQCM) is Elise Goggin. Elise is responsible for the performance of QC oversight for marine DGM operations. She performs QC checks of DGM collection operations and DGM data processing to ensure the metrics measuring each definable feature of work (DFW) are achieved. As well, she interfaces with the survey team and data processors to ensure best practices and industry standards are followed to include all guidance provided in the DIDs.

2.4.2 Project Manager

2.4.2.01 The Project Manager (PjM), Scot Wilson, is responsible for the strategic and tactical leadership, management, and administration of the Task Order and is supported at the corporate level with health and safety, project controls, quality, finance, procurement, engineering, and environmental and regulatory compliance. The PjM is responsible for the day-to-day management of project activities, monitoring the project budget, updating the status the project schedule, and ensuring project compliance.

2.4.3 Field Investigation Coordinator

2.4.3.01 Fernando Pagés will serve as the Field Investigation Coordinator for the RI/FS. Fernando is based in Puerto Rico with knowledge of the personnel and resources for effective implementation of the project. The Field Investigation Coordinator is responsible for coordinating RI/FS resources on-site to support the project field investigation.

2.4.4 Underwater Lead

2.4.4.01 The marine survey lead, Robert Feldpausch, will oversee the technical management of the field program. The underwater lead ensures timely resolution of project-related technical, quality, and safety questions associated with in-water survey operations; coordinates and oversees in-water hydrographic and geophysical work performed by TtEC field and office technical staff, including data collection and interpretation; and coordinates preparation and review of hydrographic and geophysical deliverables.

2.4.5 Field Operations Lead/Quality Control Manager/Senior Project Geophysicist

2.4.5.01 The field operations lead (FOL) and senior project geophysicist, Richard Funk, is responsible for implementation of the field program. The FOL oversees day-to-day field

operations for in-water geophysical mapping and ensures that proper staffing and resources are available on-site, that personnel have reviewed and understand their responsibilities, and that data collection activities are conducted in accordance with the approved plan and cited standards. For the RI, the FOL will also serve as the field QC manager (QCM) and is responsible for all aspects of data quality. This individual must ensure that data collection procedures and data processing and interpretation procedures are observed and that the resulting data meet the performance specifications in the approved plan.

2.4.6 Geophysicists/Scientists

2.4.6.01 Geophysicists are responsible for reviewing and understanding their responsibilities as assigned and for general safety at the project site. They will carry out the daily field activities, which include deployment and operation of survey equipment and acquisition of high-quality survey data under the supervision of the FOL.

2.4.7 Observers

2.4.7.01 Each team performing underwater investigation work will be accompanied on the boat, or from shore or a second boat for hovercraft operations, by qualified, trained, and experienced personnel who have had a briefing by a qualified biologist to act as observers in order to identify the presence or absence of threatened or endangered species. Training and briefing of project personnel by the project biologist will be completed prior to performing any in-water work in accordance with the Final Supplemental SOPs for Endangered Species Conservation and their Critical Habitat during Underwater Investigations (February 2014) and Addendum 1 (February 2015), hereafter referred to as the Environmental SOPs (see Appendix B-1).

2.5 COMMUNICATION AND REPORTING

2.5.1 Recordkeeping

2.5.1.01 All aspects of administering the Task Order must be substantiated by permanent records, such as written correspondence, notes, and photographs. It is essential to summarize important non-written communications with notes covering conferences, telephone calls, and discussions, giving the date, location, parties involved, and important topics discussed. Written correspondence is the most deliberate, as well as the most important, of the three general types of contractual communication (i.e., person to person, telephone calls, and written correspondence).

2.5.1.02 The Administrative Record for this project is stored at the Culebra Foundation on Culebra and also at the USACE Antilles Office in San Juan.

2.5.2 Office Communications and Reporting

2.5.2.01 The TtEC PjM is responsible for issuing the following documents throughout the duration of the Task Order:

- Meeting minutes (due 5 business days after a meeting);

- Record of telephone conversations (due with the Project Status Report); and
- Project Status Reports (in accordance with DID WERS-016).

2.5.3 Field Communications and Reporting

2.5.3.01 The following communications will be documented in a chronological communications log maintained by the on-site FOL:

- When and why work is stopped for safety reasons;
- Health and safety violations;
- Personnel changes and reason for changes; and
- Any deviations from the approved Work Plan that occur in the field (for example, equipment changes, analysis, or problems encountered).

2.5.3.02 During field work, Daily Reports (DRs) will be completed to detail the personnel on-site, production, equipment, lessons learned, and summaries of safety and QC tasks. During the RI, the DR will include, at a minimum, weather information at the time of survey, field instrument measurements and calibrations (if applicable), any problems encountered, and any Government personnel directives.

2.6 DELIVERABLES

2.6.01 Project deliverables will meet the schedule requirements of the project and will be prepared in accordance with the applicable DID format referenced in the PWS. Deliverables will undergo internal TtEC technical and QC reviews prior to submittal to other organizations. The primary deliverables for associated with the RI are:

- Work Plan
- Chart and contact list showing potential MEC detections
- RI Report

2.6.02 The RI Report will include items presented in Table 2-3 and summarized in the sections below.

Table 2-3. Summary of Data Deliverables

Version	Product	Format
Draft	Report	Electronic (.pdf)
Draft Final	Report	Electronic (.pdf)
Final	Report	Electronic (.pdf) Paper
	EM returns/coverage	Geotiff
	Contact list Results	Excel spreadsheet ESRI shapefile

2.6.1 DGM/EM Survey Data

2.6.1.01 TtEC will provide the survey data results, including coverage, collected and analyzed data, and a description of the number and distribution of metallic contacts present in the area. The RI Report will document and evaluate the limits of detection for each sensor used. Areas that were surveyed outside the limits of detection will be flagged as incomplete and included in the data gap analysis. The areas noted as incomplete will be evaluated for additional DGM effort during the Phase 3 field work. The data text will be provided in Portable Document Format (.pdf) format, data products in the form of maps, and digital data in standard geographic information system formats. Geophysics data will be submitted in accordance with DID WERS-004.01 submittal requirements.

2.6.2 DGM/EM Deliverables

2.6.2.01 A combination of HYPACK, Oasis Montaj, ArcGIS and TtEC-developed software will be used to generate final data products. Charts displaying the EM response and detected features will be generated in the project datum at a scale appropriate for site evaluation.

2.6.2.02 In addition to delivering the final DGM/EM chart as described above, the anomaly detection data will also be provided in an Excel spreadsheet containing the feature location, detected signal level, sensor altitude, and other attribute data useful for target assessment. Geophysics data will be submitted in accordance with DID WERS-004.01 submittal requirements.

2.6.2.03 T&E species sightings and any measures taken when present within distances of the Phase 2 field operations established in the Environmental SOPs (see Appendix B-1) will be completed and submitted as described in Section 6 (Environmental Protection Plan).

2.7 SCHEDULE

2.7.01 A project schedule for this phase of the project and associated tasks has been prepared for work planning purposes (Figure 2-7, placed at end of Section 2 for convenience). This schedule will be updated, when necessary, and submitted to USAESCH with the associated progress report. The included schedule is based on the current Draft Work Plan and the anticipated time needed for stakeholder review, TtEC's response to comments and Draft Final and Final Work Plan preparation. Revisions to the project schedule will be included with the project status reports.

2.7.02 The normal working days will be 6 days per week up to 12 hours per day depending on the hours of available daylight and site conditions. The longer working hours are required for equipment set-up and transit time to and from the munition response sites.

2.8 PERIODIC REPORTING

2.8.01 Over the course of the project, periodic reports such as weekly/monthly project status reports and DRs will be required to document project activities. TtEC will prepare these reports

in accordance with the PWS, the applicable DIDs, and the project schedule. Specific reports associated with this RI phase are discussed in Section 2.6 of this Work Plan.

2.9 COSTING AND BILLING

2.9.01 This Task Order was awarded to TtEC as a combination of firm fixed price tasks and cost plus fixed fee tasks. The firm fixed price/firm fixed price tasks are billed based on work completed in accordance with the negotiated milestones or accepted unit rates. The cost plus fixed fee tasks are billed based on monthly progress. Milestones will be considered met or completed when the required QC documentation has been submitted, QA completed, and the submittal is accepted. A milestone payment schedule has been established for this Task Order.

2.10 PROJECT PUBLIC RELATIONS SUPPORT

2.10.01 Site personnel will not disclose any data generated or reviewed during this and each phase of the Task Order and will refer all requests for information concerning site conditions to the USACE Jacksonville District Project Manager (Wilberto Cubero) and the Public Affairs Specialist (Amanda Parker) with a copy furnished to the USAESCH (Roland Belew). Information gathered by this project is the property of the DoD and distribution to any other source is prohibited.

2.11 FIELD OPERATION MANAGEMENT PROCEDURES

2.11.01 This subsection lists the major field operation components of the DGM/EM survey. Detailed descriptions and field procedures to be followed during each of these steps are presented in the subsequent chapters and appendices of this Work Plan. Field operations for Phase 2 of the RI are separated into the following primary steps:

- Mobilization
- Equipment setup and instrument validation
- DGM/EM survey
- Demobilization

2.11.02 TtEC will manage and be responsible for all aspects of the field work during the DGM/EM survey phase (Phase 2 of the RI). All work will be performed in accordance with the approved Phase 2 Work Plan. The on-site FOL will be responsible for the on-site operations, ensuring project goals and data quality objectives are met and that work is conducted in a safe and effective manner. The FOL/QCM/Senior Geophysicist will be responsible for the management of on-site field data as they are generated.

2.11.1 General Approach

2.11.1.01 The DGM/EM survey will be conducted within the boundaries of MRS 03 and 12. Upon completion of the DGM/EM survey and subsequent data analysis, the survey team will evaluate the results for use in developing additional project work plans for the intrusive

investigation activities and/or remediation. Phase 3 of the RI will include intrusive investigation of metallic anomalies that will characterize the nature and define the extent of MEC contamination. The results of these investigations will be used to focus the collection of media samples for the MC analysis, which will also be performed during Phase 3 of the RI.

2.11.2 Mobilization

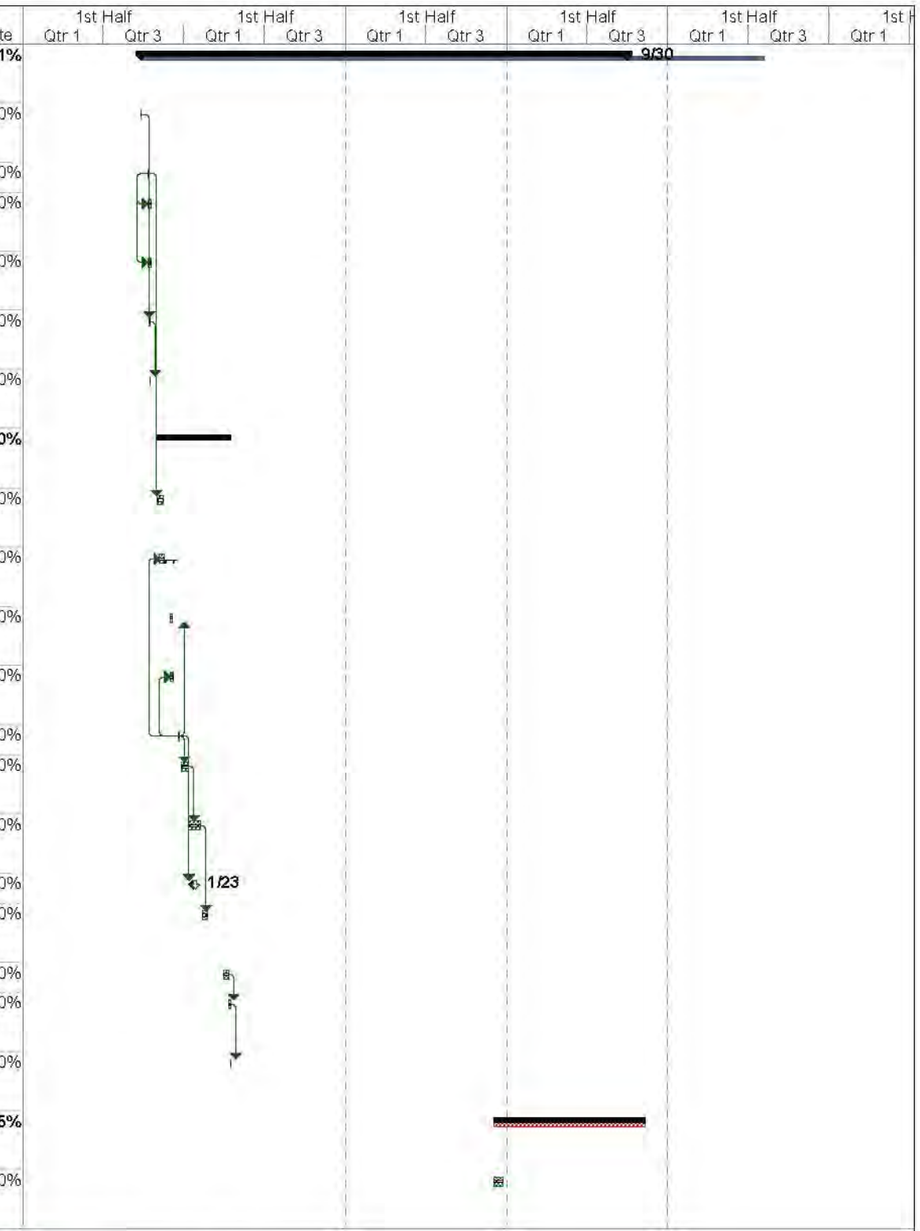
2.11.2.01 Preparation for mobilization will commence upon receipt of the notice-to-proceed. Upon receipt of the notice to proceed, the survey team will be notified, travel and lodging arrangements will be made, and the requisite copies of the applicable project and reference documents will be assembled.

2.11.2.02 Mobilization of the survey team and equipment will be conducted based on the sequence of the field tasks. All field personnel will attend site-specific training upon mobilization, including endangered species recognition and avoidance procedures to follow when doing the survey as required in the Environmental SOPs in Appendix B. The survey team and support personnel will mobilize to the site and establish the field office and support facilities, receive equipment deliveries, and prepare equipment for use. Site preparation activities include establishing support facilities and establishing docking and marine access arrangements, and establishing survey coordinates and parameters. The field crew will complete the installation of survey equipment on the vessels and perform required equipment installations and test prior to the survey.

2.11.3 DGM/EM Survey

2.11.3.01 Non-intrusive marine geophysical surveys will be conducted using the defined survey line plans in Flamenco Bay and Luis Peña Channel extending from approximately 4 feet mean lower low water to the offshore boundary of each site. The modification of the Environmental SOPs and the utilization of the TEMA-Lite will now allow for DGM in many areas with 0.5 to 4 feet of water. The DGM/EM survey will be conducted to evaluate the distribution of metallic items which are potential MEC items. The DGM/EM survey will be conducted using a float–mounted and/or towed TEMA to detect and map potential marine MEC items. The TEMA data will be geo-referenced using real-time kinematic (RTK) level GPS and, when the towfish is submerged, an ultra-short baseline (USBL) acoustic positioning system. During DGM, the vessels will navigate to the line plan utilizing HYPACK, a navigation software package that shows the vessel position relative to the planned line in real time. The software also displays a left-right indicator that shows how close the vessel is following the planned line. Additionally, it will display the towed TEMA-MK3's position, as tracked by the USBL, in real time behind the survey vessel.

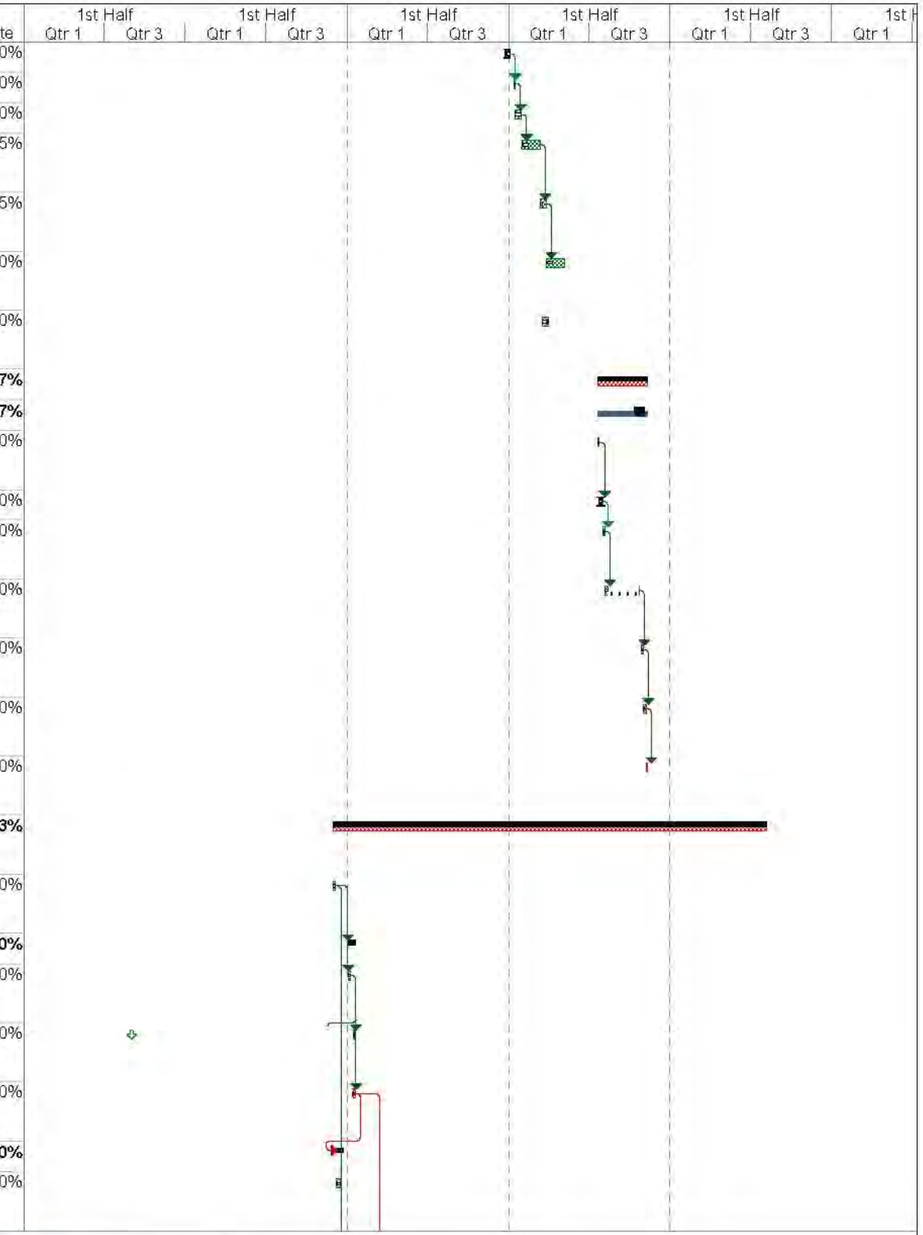
ID	Task Name	Duration	Start	Finish	% Complete
1	**RI/FS Culebra Underwater Ranges Phase I and II**	**787 d**	**Mon 9/26/11**	**Tue 9/30/14**	**91%**
2	Contract Award	1 d	Mon 9/26/11	Mon 9/26/11	100%
3	Kickoff Phone Conference	1 d	Tue 10/11/11	Tue 10/11/11	100%
4	Proposed Schedule	7 d	Tue 10/11/11	Mon 10/17/11	100%
5	Kickoff Meeting Minutes	7 d	Tue 10/11/11	Mon 10/17/11	100%
6	Army Contractor Manpower Reporting 1	1 d	Sat 10/15/11	Sat 10/15/11	100%
7	Army Contractor Manpower Reporting 2	1 d	Sun 10/16/11	Sun 10/16/11	100%
8	**Task 1a, Technical Project Planning (TPP) Phase 1 (EBS Survey)**	**168 d**	**Tue 11/1/11**	**Mon 4/16/12**	**100%**
9	Organize & Coordinate TPP Meeting	15 d	Tue 11/1/11	Tue 11/15/11	100%
10	Pre-TPP Meeting Materials	10 d	Mon 11/7/11	Wed 12/14/11	100%
11	AAPP	4 d	Fri 12/2/11	Mon 12/5/11	100%
12	Conceptual Site Model	7 d	Thu 12/1/11	Wed 12/7/11	100%
13	***Conduct 1st TPP Meeting***	2 d	Mon 12/19/11	Tue 12/20/11	100%
14	Prepare & Submit for Review Draft TPP Memorandum	14 d	Tue 12/27/11	Wed 1/11/12	100%
15	USACE and CX Review & Comment on Draft TPP Memorandum	27 d	Thu 1/12/12	Tue 2/7/12	100%
16	***Government Development of Fieldwork SOPs***	56 d	Mon 1/23/12	Mon 4/9/12	100%
17	Incorporate Comments, Prepare & Submit for Review Draft TPP Memorandum	10 d	Mon 2/13/12	Wed 2/22/12	100%
18	Response to USACE review comments	10 d	Sun 4/1/12	Tue 4/10/12	100%
19	Project Delivery Team back check	5 d	Wed 4/11/12	Sun 4/15/12	100%
20	Acceptance of Final TPP Phase 1 Memorandum	1 d	Mon 4/16/12	Mon 4/16/12	100%
21	**Task 1b Technical Project Planning Meeting Phase 2**	**244.4 d**	**Tue 12/3/13**	**Mon 11/10/14**	**65%**
22	Organize & Coordinate TPP Meeting	15 d	Tue 12/3/13	Mon 12/23/13	100%



Task | Critical | Milestone | Summary | Task | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Critical

Figure 2-7. Proposed Phase 2 DGM/EM Survey Schedule (page 1 of 4)

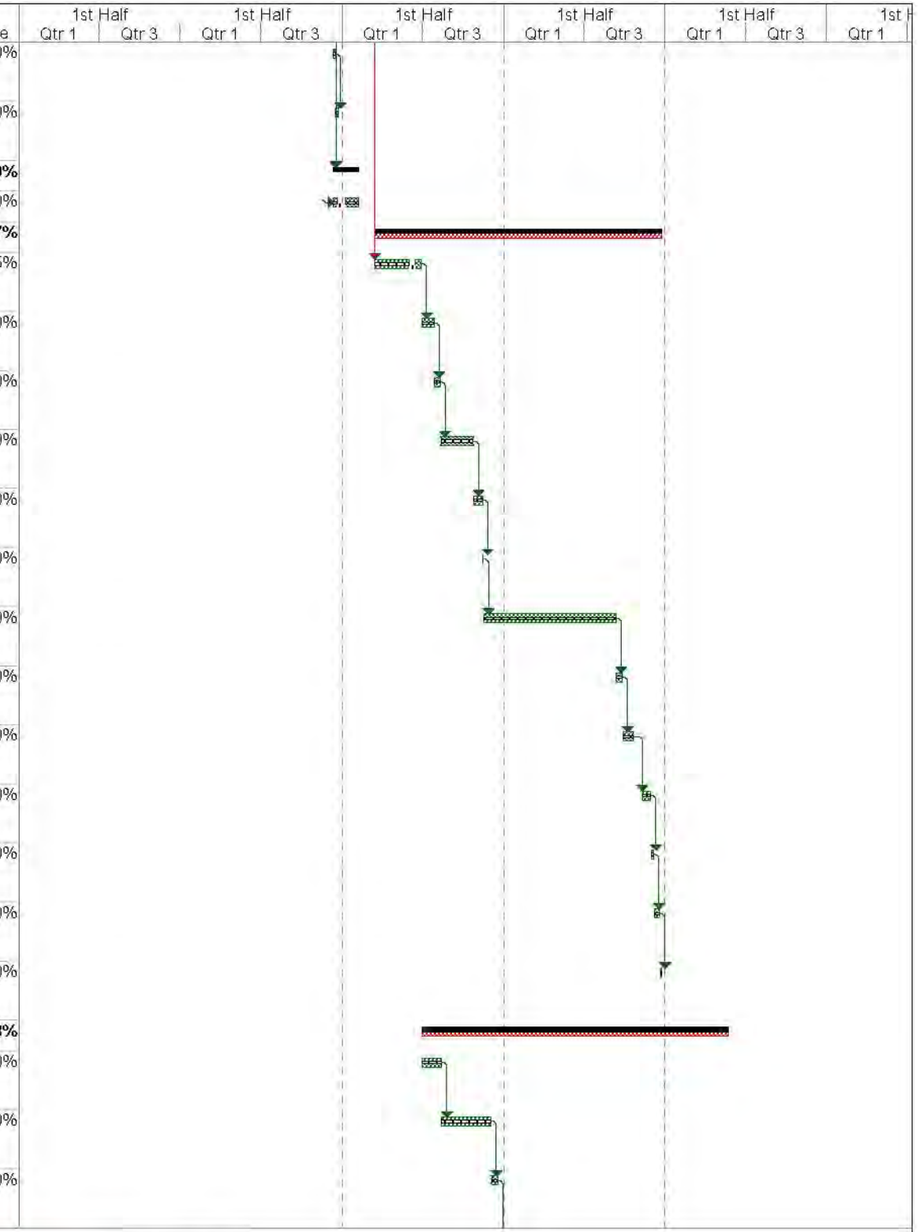
ID	Task Name	Duration	Start	Finish	% Complete
23	Pre-TPP Meeting Materials	10 d	Mon 12/23/13	Fri 1/3/14	100%
24	***Conduct 2nd TPP Meeting***	2 d	Tue 1/14/14	Wed 1/15/14	100%
25	Prepare & Submit for Review Draft TPP Memorandum	10 d	Thu 1/16/14	Wed 1/29/14	100%
26	USACE and CX Review & Comment on Draft TPP Memorandum	30 d	Thu 1/30/14	Wed 3/12/14	35%
27	Incorporate Comments, Prepare & Submit for Review Draft TPP Memorandum	10 d	Thu 3/13/14	Wed 3/26/14	35%
28	Regulator Review of Draft TPP Memorandum	30 d	Thu 3/27/14	Wed 5/7/14	30%
29	Pre TPP Meeting Materials	10 d	Tue 3/18/14	Mon 3/31/14	100%
30	*** Conduct 3rd TPP Meeting (not attened by Tt)**	**79.4 d**	**Tue 7/22/14**	**Mon 11/10/14**	**87%**
31	**Conduct 4th TPP Meeting (3rd Scoped TPP)**	**2 d**	**Wed 10/22/14**	**Thu 10/23/14**	**87%**
32	Prepare TPP Meeting Presentation	3 d	Tue 7/22/14	Thu 7/24/14	100%
33	USACE Review of Draft TPP Meeting Presentation	5 d	Fri 7/25/14	Thu 7/31/14	100%
34	Response to USACE review comments	3 d	Fri 8/1/14	Tue 8/5/14	100%
35	Project Delivery Team back check	5 d	Wed 8/6/14	Wed 10/22/14	100%
36	Conduct TPP meeting #4	4 d	Mon 10/27/14	Fri 10/31/14	100%
37	Prepare TPP meeting Adendum	5 d	Fri 10/31/14	Fri 11/7/14	50%
38	Acceptance of Final TPP Phase 2 Memorandum	1 d	Fri 11/7/14	Mon 11/10/14	0%
39	**Task 4, RI/FS Phase 1 Field Activities**	**981 d**	**Fri 11/30/12**	**Fri 8/7/15**	**93%**
40	Initial Mobilization (Logistics and Site Setup)	6 d	Fri 11/30/12	Wed 12/5/12	100%
41	***Task 4a MRS 3 Phase 1 Baseline Survey***	**12 d**	**Thu 1/3/13**	**Fri 1/18/13**	**100%**
42	Optional Task 4a1, Bathymetry	4 d	Thu 1/3/13	Tue 1/8/13	100%
43	Optional Task 4a2, Side Scan Sonar	2 d	Wed 1/16/13	Thu 1/17/13	100%
44	Task 4a3, ROV/AUV	5 d	Mon 1/14/13	Fri 1/18/13	100%
45	***Task 4b MRS 12 Phase 1 Baseline Survey***	**16 d**	**Sat 12/8/12**	**Sun 12/23/12**	**100%**
46	Optional Task 4b1, Bathymetry	8 d	Sat 12/8/12	Sat 12/15/12	100%



Task | Critical | Milestone | Summary | Task | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Critical

Figure 2-7. Proposed Phase 2 DGM/EM Survey Schedule (page 2 of 4)

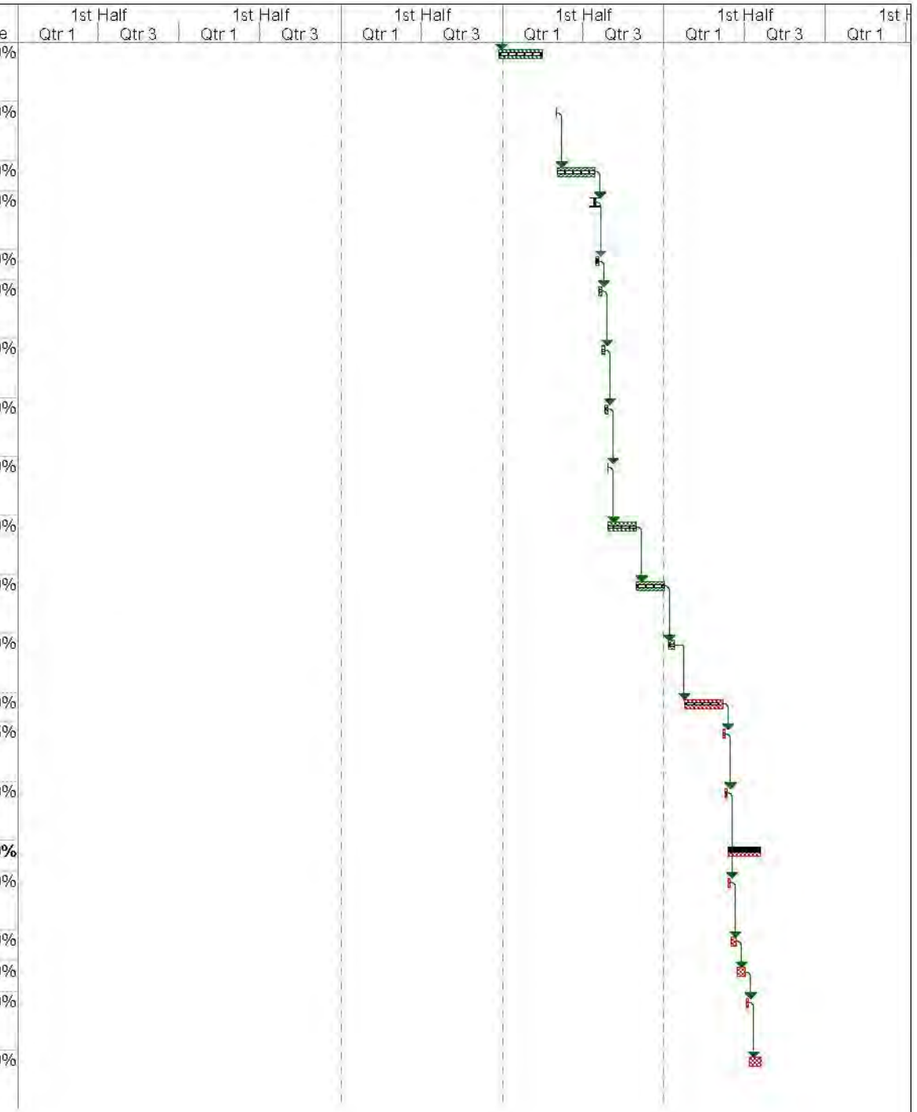
ID	Task Name	Duration	Start	Finish	% Complete
47	Optional Task 4b2, Side Scan Sonar	3 d	Thu 12/13/12	Sat 12/15/12	100%
48	Optional Task 4b3, ROV/AUV	8 d	Sun 12/16/12	Sun 12/23/12	100%
49	**Task 12, Environmental Sampling and Analysis**	**44.25 d**	**Wed 12/12/12**	**Thu 2/7/13**	**100%**
50	***Task 12c1 Phase I Beach Monitoring***	31 d	Wed 12/12/12	Thu 2/7/13	100%
51	**Task 14, Baseline Survey Report**	**461 d**	**Sat 3/16/13**	**Mon 12/22/14**	**97%**
52	Prepare Draft EBS Report	90 d	Sat 3/16/13	Fri 6/28/13	85%
53	USACE Review and Comment of Draft EBSSurvey Report	20 d	Mon 7/1/13	Fri 7/26/13	100%
54	Incorporate USACE Comments on Draft Baseline EBS Report	10 d	Mon 7/29/13	Fri 8/9/13	100%
55	Project Delivery Team Backcheck of Final EBS Report (Government Shutdown Impacted)	53 d	Mon 8/12/13	Wed 10/23/13	100%
56	Contractor prepares Draft Final EBS Report	15 d	Thu 10/24/13	Wed 11/13/13	100%
57	Contractor sends Draft Final EBS Report to Regulators for review	1 d	Fri 11/15/13	Fri 11/15/13	100%
58	Regulator Review and Comment on EBS Report (PREQB consultant delay)	214 d	Mon 11/18/13	Thu 9/11/14	100%
59	Address regulator comments from review	10 d	Fri 9/12/14	Thu 9/25/14	100%
60	PREQB Comment Response by Government	17 d	Mon 9/29/14	Tue 10/21/14	100%
61	Prepare Draft Final EBS Rev 1	15 d	Mon 11/10/14	Fri 11/28/14	100%
62	Prepare Final EBS Survey Report	5 d	Mon 12/1/14	Fri 12/5/14	100%
63	Project Delivery Team Backcheck of Final EBS Report	10 d	Mon 12/8/14	Fri 12/19/14	100%
64	Approval of Final EBS Report	1 d	Mon 12/22/14	Mon 12/22/14	100%
65	**TASK 2d Phase 2 Work Plans**	**495 d**	**Mon 7/1/13**	**Fri 5/22/15**	**98%**
66	Prepare and Submit Draft Phase II Survey Workplan	32 d	Mon 7/1/13	Tue 8/13/13	100%
67	USACE Review and Comment of Draft Phase II Survey Workplan (Government Shutdown Impacted)	80 d	Wed 8/14/13	Tue 12/3/13	100%
68	Incorporate USACEComments and prepare and submit Draft Phase II Survey Workplan	10 d	Wed 12/4/13	Tue 12/17/13	100%



Task | Critical | Milestone | Summary | Task | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Critical

Figure 2-7. Proposed Phase 2 DGM/EM Survey Schedule (page 3 of 4)

ID	Task Name	Duration	Start	Finish	% Complete
69	Project Delivery Team Backcheck	71 d	Mon 12/23/13	Mon 3/31/14	100%
70	USACE PM sends to CX for review	1 d	Fri 5/2/14	Fri 5/2/14	100%
71	CX Review (Government Delay)	61 d	Mon 5/5/14	Mon 7/28/14	100%
72	USACE PM Sends CX comments to Contractor	1 d	Tue 7/29/14	Tue 7/29/14	100%
73	Contractor addresses CX comments and sends back to US	5 d	Wed 7/30/14	Tue 8/5/14	100%
74	Project Delivery Team concurence with comments	5 d	Wed 8/6/14	Tue 8/12/14	100%
75	Contractor prepares Draft Final Phase II Work Plans	5 d	Wed 8/13/14	Tue 8/19/14	100%
76	Project Delivery Team Back Check of Draft Final Work Pla	5 d	Wed 8/20/14	Tue 8/26/14	100%
77	USACE PM sends Draft Final Work Plans to Regulators fo	1 d	Wed 8/27/14	Wed 8/27/14	100%
78	Regulator Review and Comment on Phase II Survey Work	45 d	Thu 8/28/14	Wed 10/29/14	100%
79	Address regulator comments from review and TPP meetin	45 d	Thu 10/30/14	Wed 12/31/14	100%
80	Government back check of regulator review comments	10 d	Mon 1/12/15	Fri 1/23/15	100%
81	Agency review of comment responses and Work Plan	63 d	Mon 2/16/15	Wed 5/13/15	90%
82	Prepare Final Phase II Work Plan	3 d	Thu 5/14/15	Mon 5/18/15	85%
83	Approval of Final Phase II Work Plan and NTP	4 d	Tue 5/19/15	Fri 5/22/15	60%
84	**Task 4, RI/FS Phase 2 Field Activities**	**54 d**	**Tue 5/26/15**	**Fri 8/7/15**	**0%**
85	Phase II Mobilization	4 d	Tue 5/26/15	Fri 5/29/15	0%
86	***Task 4a MRS 3 Phase II EM Survey***	10 d	Mon 6/1/15	Fri 6/12/15	0%
87	***Task 4b MRS 12 Phase II EM Survey***	15 d	Mon 6/15/15	Fri 7/3/15	0%
88	Phase II Demobilization	5 d	Mon 7/6/15	Fri 7/10/15	0%
89	Post Survey Data Processing	20 d	Mon 7/13/15	Fri 8/7/15	0%



Task | Critical | Milestone | Summary | Task | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Critical

Figure 2-7. Proposed Phase 2 DGM/EM Survey Schedule (page 4 of 4)

3.0 FIELD INVESTIGATION PLAN

3.0.01 Phase 2 of the RI will include a DGM/EM survey to detect and locate metallic items which are potential MEC items. Constraints that may limit the survey include areas that the EBS identified as having sensitive habitats such as shallow coral reefs that may be damaged by the TEMA as well as those related to maintaining the safety of the field crew, vessels, and equipment.

3.0.02 The collection of high-resolution bathymetry data that was done as part of the EBS in both MRS areas is critical to the success of the subsequent DGM effort. Magnetometer/ gradiometer and electromagnetic sensors inherently have very short detection ranges for anything but the largest MEC items. In a marine environment, with a sensor that must be flown on or very close to the bottom to provide useful data, it is absolutely imperative to have a very accurate three-dimensional model of the bottom to avoid damage to the equipment and sensitive marine life, such as corals, during survey operations. The multibeam bathymetry collected during the EBS is the basis for this model.

3.0.03 The field investigation is being conducted in three phases: Phase 1, the EBS, to develop basemaps to guide the following phases, completed in 2013; Phase 2, the DGM/EM survey, to provide an assessment of the distribution and density of metallic items and debris fields that may be MEC; and Phase 3, which will be an intrusive investigation. This document describes the activities for Phase 2 of the RI.

3.1 OVERALL APPROACH TO RI/FS ACTIVITIES

3.1.1 Site Characterization Processes

3.1.1.01 The DGM/EM survey will be conducted within MRSs 03 and 12 through a minimum cost survey plan designed to provide a 90 percent confidence that a given area has metallic targets above background level if present. A minimum cost survey plan means that the survey plan was designed to collect only required data to achieve the 90 percent confidence for the detection of the design impact area according to the sample design developed via VSP. Phase 2 of the RI will include the following components:

- Plan the survey using VSP, a software tool designed by PNNL to design statistically defensible sampling plans. VSP was used to ensure the DQO established through the TPP that the survey "should ensure at least a 90% probability" that the survey lines will traverse and detect a potential source area of elevated anomaly density would be achieved.
- Conduct a DGM/EM survey with the floating TEMA-Lite in very shallow water and the dynamically flown TEMA-MK3 in deeper water to maintain altitude levels that are low enough to provide a reasonable probability of detection for many MEC items.
- Avoid those areas where habitat protection guidelines preclude the use of a towfish.
- No sediment sampling or other intrusive methods will be conducted as part of Phase 2.

3.2 IDENTIFICATION OF AREAS OF CONCERN

3.2.01 The habitat areas within Flamenco Bay (MRS 03) and the Luis Peña Channel (MRS 12) are shown in Figure 3-1. Prior to the start of DGM/EM survey operations, the survey team, which includes local scientists, will review the EBS results and high-resolution aerial imagery, as well as local knowledge sources to delineate and avoid areas of sensitive habitat to minimize risk of damage to these resources during DGM/EM surveys.

3.2.02 The survey team will then perform non-intrusive marine geophysical surveys from approximately the minimum depth of 6 inches required by the TEMA-Lite and hovercraft for the shallow water operations, and an approximately 3-meter shallow water limit for the larger vessel TEMA operations.

3.2.03 In areas with depths less than approximately 2 meters, surveys will be conducted with the float-mounted TEMA-Lite (surface tow), and the system will be towed by a four-person hovercraft or other means as appropriate to the location (e.g., hand lines by personnel on shore).

3.2.04 In depths between approximately 2 and 4 meters, the TEMA may be suspended from floats to allow more controlled operation while maintaining low enough altitude above the bottom to achieve better probability of detection of smaller items.

3.2.05 Shallow areas containing coral may not be surveyed if either the depth falls below the minimum specified altitude, or wave conditions increase the risk of accidental contact with the coral. Other data collection methods, including the use of MEC divers with hand-held EM units, could be employed to survey within the excluded areas; however, that is outside the scope of this project.

3.2.06 Areas with slopes exceeding approximately 15 degrees cannot be surveyed with the towfish since it is not possible to maintain acceptable altitudes for good detection probability without having unacceptable levels of risk of impacting the bottom and damaging habitat or equipment. Other data collection methods, including the use of MEC divers with hand-held EM units, could be employed to survey within the areas with slopes too great to survey with the TEMA; however, that is outside the scope of this project.

3.2.07 The areas where different deployment methods for the TEMA will be used and the slope areas where the TEMA cannot be actively flown are shown in Figure 3-2.

3.2.08 Surface MEC will be identified from video and/or still photography collected during the DGM/EM survey. The TEMA-MK3 will employ a real-time HD video feed from the towbody that will be recorded and monitored, and a still camera (e.g., a GoPro) will collect stills for later review. The surface towed TEMA-Lite Hovercraft will employ a GoPro camera to collect video and still photography for later review. Additional high-resolution photos/video will be taken during the Phase 3 intrusive investigations to show potential MEC relative to sensitive habitats.

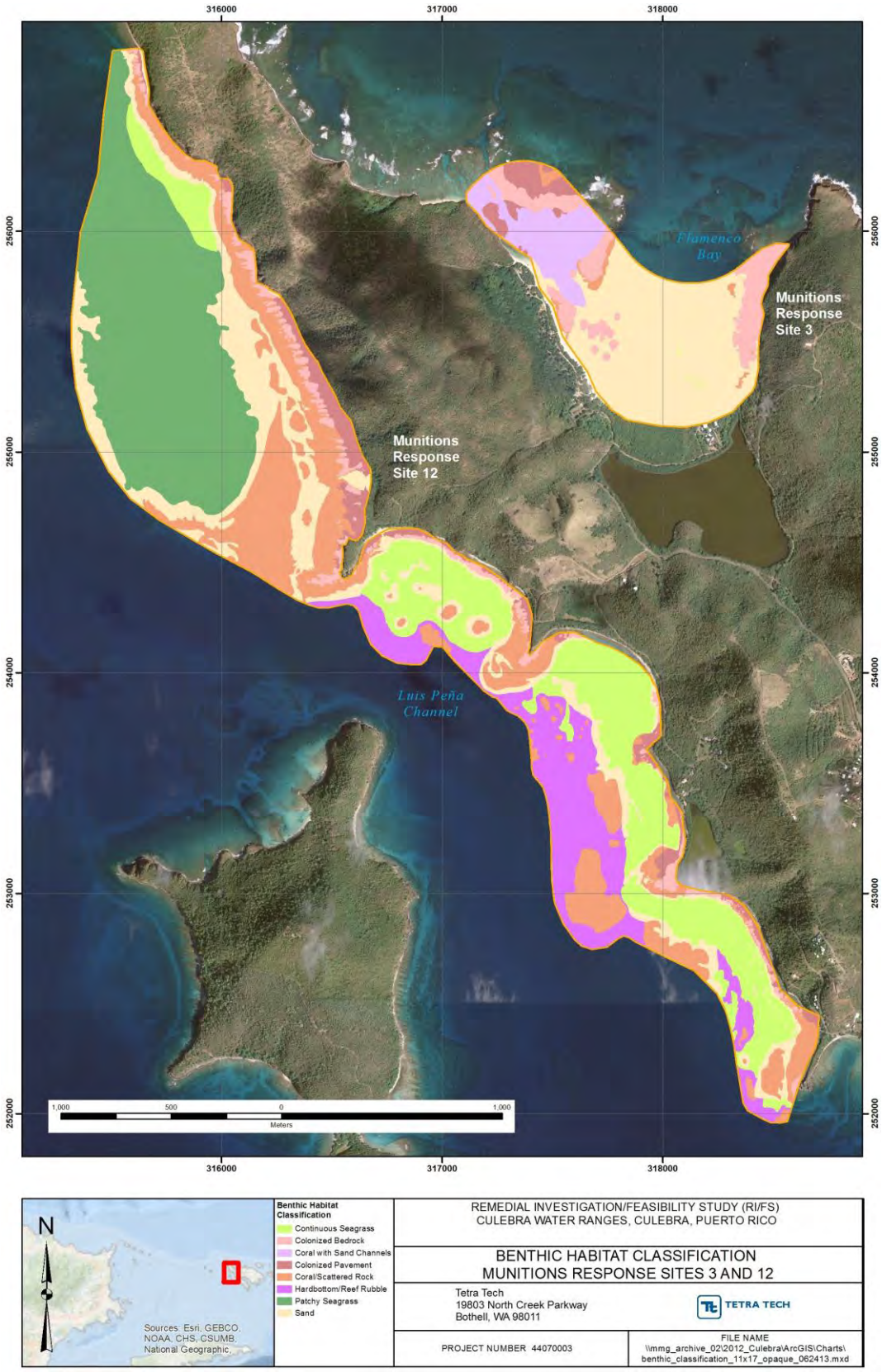


Figure 3-1. EBS Benthic Classification Areas

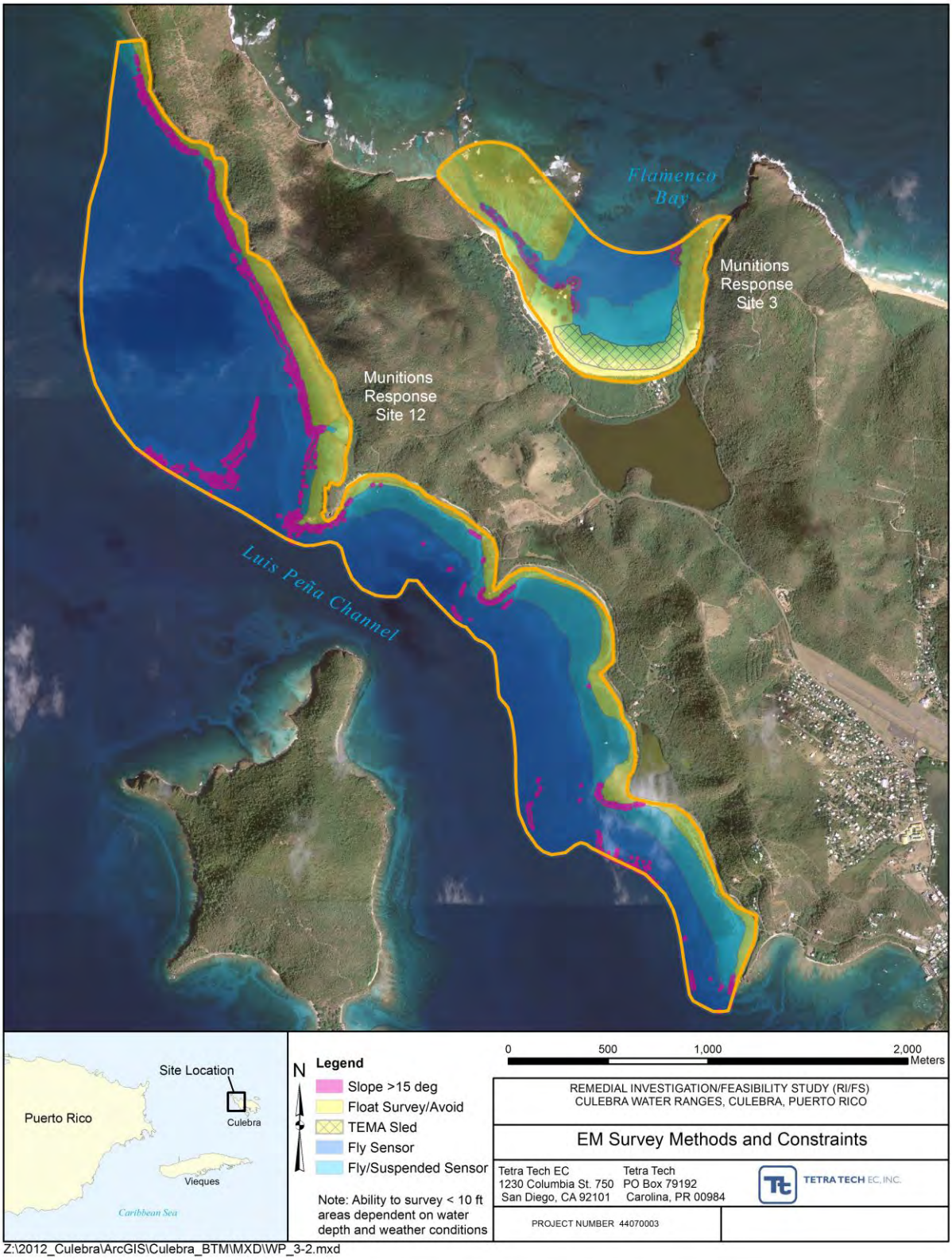


Figure 3-2. Suspended Sensor/Fly Sensor Deployment Methods/Slope Constraints

3.3 LOCATION SURVEYS AND MAPPING PLAN

3.3.1 DGM/EM Survey

3.3.1.01 The primary objective of the DGM/EM survey is to provide a wide area assessment survey to assess the distribution of potential MEC items for the RI and to guide planning for Phase 3 operations.

3.3.1.02 Due to site conditions and the challenges of performing DGM operations underwater and within areas with sensitive habitat, the sensor coil height will be constantly varying. This will affect sensor detection capability with the changing sensor height above the seabed, and can affect the ability to identify high-density anomaly areas. The sensor coil altitude will be continuously recorded via altimeters mounted on the TEMA systems. Data gaps related to altitudes above 2 meters will be identified and mapped during post-analysis. The instrument verification strip (IVS) plan includes testing of the sensors at different altitudes with industry standard object (ISOs) so that the variability in detection based on altitude can be approximated (see Appendix B for the IVS plan).

3.3.1.03 The TEMA system will be either surface towed on floats or, in deeper water, towed behind a 30- to 34-foot surface vessel, and dynamically flown above the bottom, using a winch for altitude control. The TEMA altitude will be recorded and will depend on the area being surveyed. Within sand bottom areas, the TEMA can be flown within 1 meter of the bottom (target of 0.5 meter). In areas where contact is not permitted, the TEMA will be flown higher (1 to 2 meters altitude). These estimates are not easily defined, as they will vary based on weather conditions and operational experiences gained while on-site. The Environmental SOPs (Appendix B-1) will be followed during Phase 2 data collection. TtEC has done testing of ISO detection with the TEMA system. Table 3-1 shows the response with respect to offset distance corrected for background of bench tests conducted with the TEMA. Table 3-2 shows the detection results for daily TEMA IVS data from a field project. The data shown in both Tables 3-1 and 3-2 were collected with the TEMA set to standard power (12 volts). The sensor was kept below 1 meter altitude during data collection. Because the TEMA utilizes the high-power variant of the EM61-MKII, it is expected that items on the order of a medium ISO (~81 mm mortar) will be detected at up to 1 meter altitude nearly all the time, with smaller items being detected some of the time, depending on the flight altitude of the platform when operated in standard power. Based on the results of the IVS, the system may be run in high-power (24 volts), which will increase the range of detection for all items by 45 to 80 percent depending on target characteristics.

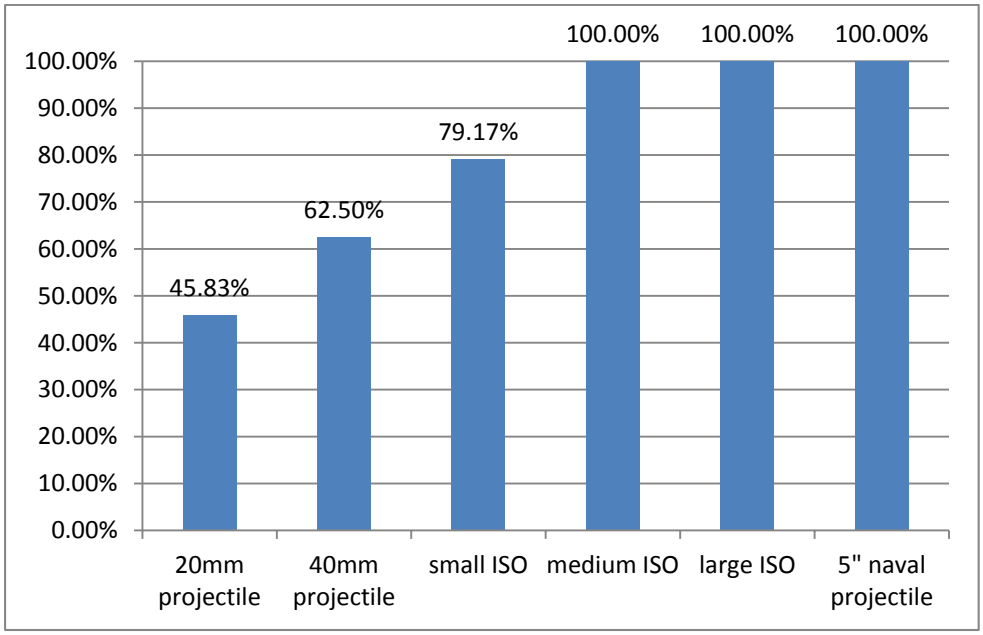
Table 3-1. Summary of TEMA Signal Response for ISOs (12-volt setting, not high power)

ISO Size	Distance (nominal - cm)	Orientation	Distance (measured - cm)	Average Response (mV)
small	20	Horizontal	20	320.89
small	30	Horizontal	30	138.58
small	50	Horizontal	50	28.34

Table 3-1. Summary of TEMA Signal Response for ISOs (12-volt setting, not high power) (continued)

ISO Size	Distance (nominal - cm)	Orientation	Distance (measured - cm)	Average Response (mV)
small	70	Horizontal	70	8.61
small	30	Vertical	30	1,381.04
small	50	Vertical	50	295.69
small	70	Vertical	70	78.00
medium	50	Horizontal	50	368.68
medium	75	Horizontal	75	76.88
medium	100	Horizontal	100	21.16
medium	50	Vertical	50	1,635.74
medium	75	Vertical	75	309.74
medium	100	Vertical	100	78.63
large	50	Horizontal	50	2,424.69
large	100	Horizontal	100	124.51
large	150	Horizontal	150	17.55
large	50	Vertical	50	5,580.05
large	100	Vertical	100	281.11
large	150	Vertical	150	33.65

Table 3-2. Summary of TEMA IVS Item Detections from a Recent Underwater Munitions Field Project Site (TEMA Altitude <1 meter)



3.3.1.04 Specific calibrations for the TEMA and data collection systems are detailed in Section 4 of this Work Plan and in the quality assurance project plan.

3.3.1.05 Positioning for the TEMA survey will vary depending on whether the system is being surface towed or submerged. When surface towed on floats, an antenna for an RTK GPS will be mounted on the system and positions measured directly from the GPS. For submerged operations, the tow vessel will have RTK GPS on board and the towfish will be tracked using a

USBL acoustic positioning system. The USBL system has an integrated initial positioning system and requires no calibration. The accuracy of this system is among the best at 0.2 percent of slant range and can achieve 0.03 degree accuracy for roll, pitch, and heading. Previous work that involved the TEMA being positioned with the Global Acoustic Positioning System provided sub-meter accuracy versus emplaced item positions in the IVS.

3.3.2 Data Spatial Density

3.3.2.01 The line plan for the TEMA survey was designed using the VSP design tool developed by PNNL as described above in Section 2.2.

3.3.2.02 The site will be surveyed using a line plan that is dependent on water depth ranges corresponding to levels of risk of exposure and other site constraints (see Table 2-2). The initial line spacings were based on achieving the minimum specified probability of traversing and detecting a potential source area of a presumed size and specified anomaly density characteristics using the 3-meter width/single pass TEMA system. These line spacings were then reduced further to provide higher coverage in areas with higher human exposure potential and correspondingly greater probabilities of traversing and detecting a potential source area in Depth Zones A and B.

3.3.2.03 As an additional quality check, allowable deviation from planned transect spacing will be limited as follows:

- Within Zones B and C up to 5 meters, with short areas of greater than 5 meters for up to 20 meters in length (i.e., a deviation of 6 meters for only 12 meters in length will not require gap fill).
- Within Zone A to 5 meters, with short areas of greater than 5 meters for up to 10 meters in length.
- Within Zone A′ to 1 meter, with short areas of greater than 1 meter for up to 2 meters in length.

The allowable deviation will help verify that the VSP confidences of detecting in high density areas have been met.

3.3.3 Equipment Specifications

3.3.3.01 The TEMA is a TtEC-developed EM array using high-power variants of the MKII marinized industry standard Geonics EM coil. The TEMA is normally configured as a towfish (shown in Figure 3-3) where the system is actively flown in the water column, but can also be configured on floats. (Figure 3-4 shows one floating option. The TEMA as shown in Figure 3-3 can also be floated.) The floats are secured to the tow vessel by floating line (e.g., polypropylene) to avoid snags on coral or other submerged obstacles, and the cables attached to the sensors are also suspended by buoys/floats along their length.

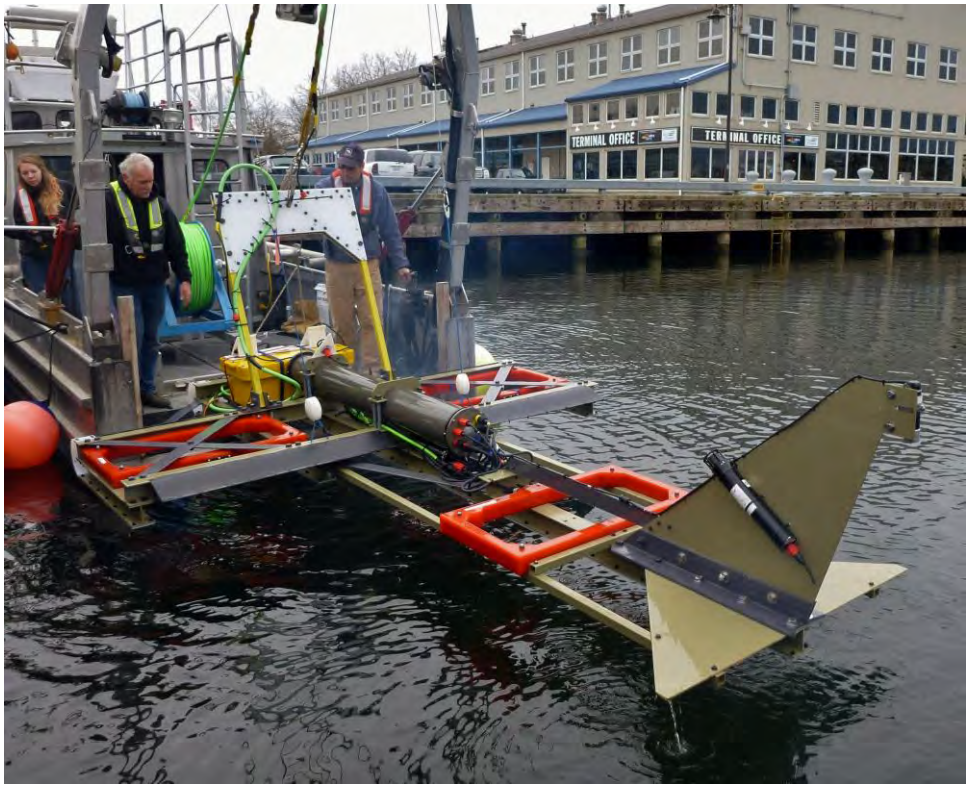


Figure 3-3. Launching the TEMA-MK3 Configured for Active Towing Operations

Figure 3-4. Launching TEMA-Lite on Floats

3.3.3.02 The TEMA-MK3 towfish (Figure 3-3) is approximately 5 meters long and 3 meters wide, with an overall height of just over 1 meter at the tail. While being towed and actively flown, the data collection will be along lines of equal water depth (i.e., contouring). This minimizes the need to perform sharp turns. When a turn is required, the TEMA-MK3 is brought up to the surface and, if the boat maintains speed over 1.5 knots, the TEMA-MK3 drafts less than the boat. The space required to make a turn is dependent on speed and wind and currents. The distance required to safely make a turn will be determined on-site. The TEMA-Lite (Figure 3-4) is 3 meters wide by about 4 meters long. The TEMA-Lite will be pushed in front of a custom, purpose-built hovercraft, which will result in a vessel and instrument draft of approximately 3 to 4 inches.

3.3.3.03 Table 3-3 contains a summary of the various systems that will be used and the purpose or value of their use. The systems are described in detail in the following sections.

Table 3-3. Summary of Technologies

Technology	Purpose/Value
TEMA-MK3	Towed EM array used for mapping metallic objects
TEMA-Lite	Floated EM array used for mapping metallic objects in shallow water
Positioning Equipment	Used to track the instrument locations and the vessel motion, and geo-reference features identified in the EM data.

3.3.4 Survey Vessel

3.3.4.01 A TtEC-owned vessel, or a similar vessel, will be mobilized to perform the Phase 2 RI activities. These vessels are equipped for coastal shallow water surveys with all required U.S. Coast Guard equipment, positioning instrumentation, equipment racks with operator stations, equipment mounts, and a hydraulic A-Frame and winch for deploying towed equipment. Both the TtEC 29.5-foot and the 34-foot aluminum survey vessels have a vessel draft of 2.5 feet (Figures 3-5 and 3-6). To obtain data in areas where depth to sensitive habitat is approaching the 4-foot specified minimum water depth below the vessel and/or survey equipment, the equipment will be mounted on a hovercraft (Figure 3-7), TtEC's Mark V Zodiac, or an equivalent inflatable. TtEC will not bring the survey vessel or equipment into areas where the minimum water depth below the vessel and equipment cannot be maintained to avoid potential damage to sensitive habitat.

Figure 3-5. TtEC's 29.5-foot Aluminum Survey Vessel

Figure 3-6. TtEC's 34-foot Aluminum Survey Vessel

Figure 3-7. TtEC's Hovercraft Survey Vessel

3.4 GEOSPATIAL INFORMATION AND ELECTRONIC SUBMITTALS

3.4.01 This section presents the methods, equipment, and accuracy required for conducting location surveys and mapping, and managing geospatial information in support of the RI.

3.4.1 Geodesy Settings

3.4.1.01 The project data will be horizontally (X, Y) referenced to North American Datum 1983 (NAD83) State Plane, Puerto Rico/Virgin Islands with units of meters. Elevation data will be collected in NAD83 ellipsoid and converted to PRVD02 orthometric heights using the NGS 2012A geoid. Table 3-4 presents the geodesy settings to be used for the project. Horizontal and vertical positioning will be achieved using RTK GPS, either stand-alone or in conjunction with a USBL system.

Table 3-4. Survey Geodesy Settings

Parameter	Setting
Projection	Universal Transverse Mercator
Zone	Zone 20 North
Horizontal Datum	NAD83
Vertical Datum	NAVD88
Distance Unit	Meters
Depth Unit	Meters
Geoid Model	National Geodetic Survey GEOID09 (or the latest GEOID available for the project area)

3.4.2 Accuracy

3.4.2.01 All data positional accuracies will be documented. The accuracy assessment will include the type and accuracy of the position sensor(s) used for the data and any other factors

that could affect the data location accuracy. For example, the accuracy of the towed EM data from the TEMA system is a function of the accuracies of the GPS used for vessel position, the USBL, the EM sensors, and the offset measurements of each of the sensors.

3.4.3 Map Requirements

3.4.3.01 The project maps shall be prepared in accordance with Engineer Manual 1110-1-4009 and DID WERS-007.01 to accurately depict the layers from the baseline environmental survey and the EM survey.

3.4.4 Monument Description

3.4.4.01 The control points and monuments used for this survey will be the same as those used in the EBS survey. Additional control points may need to be established based on site conditions.

3.4.5 Digital Format for Geographic Information System Data

3.4.5.01 A geographic information system (GIS) has been developed for the project to aid in the development of the CSM and to maintain and manage all project and geospatial data. The GIS was developed in accordance with DID WERS-007.01, Engineer Manual 200-1-2, Engineer Manual 1110-1-4009, and applicable interim guidance documents.

3.4.5.02 The geospatial data for the RI/FS will include the following:

- A comprehensive CSM.
- Available existing data applicable to the project will be consolidated into the geodatabase and analyzed to relay pertinent information to the Project Delivery Team. If an existing GIS database is available, it will be provided by the government.
- The analysis of data from the GIS will support all conclusions of the CSM.
- The pre-RI analysis will encompass social, environmental, and/or economic entities that will be or may be impacted by response-action activities.
- The post-RI and FS analysis will detail entities impacted by RI/FS activities and impacts of future response action activities (if applicable). The pre- and post-RI and FS analysis may detail the fieldwork strategies, areas of concern, survey requirements, environmental concerns, milestones, and/or other factors that affect product delivery and future action planning.
- Entities that may be affected by response actions include, but are not limited to, landowners, homeowners, rental tenants, schools, utilities, roads, businesses, recreational areas, tourists, air traffic, water bodies, and/or industries.
- The geodatabase will be a living repository that is refined throughout the life of the RI/FS and the entire project.
- Layers that overlay on maps of the site that identify physical features and areas of

possible debris found during the RI will be incorporated. Examples include streets, anomalies, MEC positively identified, identifiable MD, sampling location, cultural resources, and environmental, biological, and socio-economic variables.

- Archaeological site location(s) will not be released to the public without written permission from USACE.
- Civil surveys will be performed in accordance with Engineer Manual 1110-1-4009 and DID WERS-007.01.
- Property owner privacy will be preserved. Property owner names will not be disseminated in any documents.

3.4.5.1 Sources and Standard

3.4.5.1.01 The project geospatial data will include all information from the Project Site Microsoft Access project database (Engineer Manual 1110-1-4009). All digital GIS data will be created in an ArcView compatible format. All data will conform to the Spatial Data Transfer Standard and be ESRI-compliant (geodatabases). The standards are designed for computer assisted mapping methods that must interface with other surveying firms, government contractors and customers. DGM/EM survey coverage will be provided as a geo-referenced Tagged Image File Format (GeoTIFF). Supporting tabular data will be provided in ANSI SQL language compatible format, such as Microsoft Access. The GIS point, polyline and area vector data will be provided in ArcGIS format including geodatabases and .shp files and will include all appropriate metadata. The final electronic submittal will also include layout files for all plates, figures, and drawings conveyed in the report.

3.4.5.2 File Backup

3.4.5.2.01 The GIS data will be backed up daily and data processing progress will be documented on a data tracking spreadsheet.

3.4.6 Quality Control

3.4.6.01 QC checks will be completed periodically to confirm accurate data storage and backup. This process will be accomplished by reviewing survey logs and data processing logs. The FOL/Field QC manager will verify the performance of these QC activities. All data will then be checked by the GQCM (see Section 4.3.2).

3.5 DATA COLLECTION AND PROCESSING PROCEDURES

3.5.1 General Requirements and Procedures

3.5.1.01 The requirements in this section are applicable to all field activities including boating activities, marine geophysical mapping, and data verification. Historical review, administrative activities, or training conducted off-site are not subject to the requirements in this section. Environmental SOPs for the activities have been provided by the USACE and are presented in Appendix B-1 of this document.

3.5.1.1 Daily Briefings/Verification

3.5.1.1.01 At the beginning of each working day, the project FOL or designee will hold a daily briefing. At a minimum, the daily briefings will include:

1. Review of safety practices and emergency procedures
2. Review and testing of communication systems
3. Review of any site-specific or applicable task-specific hazards

3.5.1.1.02 Other topics that will be discussed, as necessary, include QC, changes to the work schedule, equipment maintenance, and any other issues that may affect the activities being performed that day or in the near future.

3.5.1.1.03 A qualified biologist will brief the survey team on the identification and recognition of endangered/threatened species and sensitive habitats as well as the procedures to avoid harm. The briefing will be documented prior to the start of field activities for any personnel who have not yet had this training. The biologist will be briefing the survey team on the Environmental SOPs and the points of contact to notify if any injured or stranded wildlife are spotted. The biologist will also be in the field with the survey team to ensure SOP compliance.

3.5.1.1.04 During the daily briefing, the FOL will also discuss selected work sites and/or tasks for the day. Each survey team member will receive the instructions necessary to perform the assigned work. Attendance at the daily briefing will be documented in the FOL's field logbook/logsheet and/or on daily briefing forms.

3.5.1.2 Tailgate Briefing

3.5.1.2.01 If the survey team is divided into groups working in separate areas of the site or on separate tasks, a tailgate briefing may be required during which the team lead for that activity discusses specific safety hazards or mitigation measures specific to the assigned task or work area. The daily briefing at the site will fulfill the requirement for a tailgate briefing if all relevant information is presented regarding the hazards associated with all assigned work.

3.5.1.3 Equipment Testing and Maintenance

3.5.1.3.01 All equipment used by the survey team will be verified to be working properly prior to use each day. The functionality of marine mapping instrumentation will be ensured by using the calibration and QC testing discussed in Section 4.5.

3.5.1.3.02 All mapping equipment testing will be verified and documented in the field log book or on appropriate field forms by the FOL or designee. If any equipment requires repair or new equipment is brought on-site, it must be inspected and confirmed to be operational by the FOL or designee prior to use. The FOL or designee will also inspect any other equipment, including marine vessels and safety equipment, to be used each day to ensure that the equipment is in proper working order. Inspections will be documented in the filed log book or on appropriate forms.

3.5.2 Positioning

3.5.2.01 All positioning data for the survey will be based on RTK GPS or MarineSTAR differential global satellite navigation system, whichever is more accurate, to provide sub-meter position accuracies both horizontally and vertically.

3.5.2.02 Towfish positioning will be accomplished via GPS for the float configuration, or a combination of GPS and a USBL acoustic positioning system or high-resolution cable counter determined layback. The USBL that will be used is a GPS-aided inertial platform that measures position, heading, roll, pitch, and heave as well as the angle and distance to the transponder, so that it can independently determine the towfish position and attitude. The cable counter is used by the winch operator to monitor the amount of cable that is out. Layback can also be used for backup if the USBL encounters problems (e.g., multipath can be an issue in water shallower than the fish layback, generally under 4 meters).

3.5.3 Site Control Network

3.5.3.01 Geodetic control at the site was established for the hydrographic and underwater video surveys. These control point locations may need to be re-established. They will facilitate GPS base station control for DGM (areas with a sufficient view of the sky that are accessible for base station setup) as well as for QC points for the GPS rover systems.

3.5.4 EM Survey

3.5.4.01 The TEMA survey will be conducted as a series of nominally parallel lines with line spacing between approximately 10 and 250 feet, depending on depth, as defined in Section 2.2. The survey line plans are shown on the charts in Appendix C. All accessible areas of each MRS will be surveyed, but there are a few constraints that will preclude full coverage as addressed in the following sections.

3.5.4.02 The method of deployment of the TEMA will be dependent on site conditions, sea state and weather conditions. Generally it will be floated in water depths less than approximately 1.5 to 2 meters, may be suspended from floats or flown in depths up to approximately 3 meters, or actively flown as a towfish, with the depth controlled by a winch, in water depths greater than 3 meters.

3.5.4.03 Figure 3-2 shows the water depth derived areas where each type of data collection will take place.

- Dark blue areas are where the TEMA will be actively flown.
- The light blue areas are where the TEMA will either be suspended below floats or actively flown, depending on site-specific conditions.
- The yellow areas are the shallowest areas where the floating TEMA-Lite will be deployed.
- The hashed yellow area is where the TEMA is expected to be used as a sled in contact

with the bottom.

- The purple areas show regions with slopes greater than 15 degrees that will either be avoided or where the TEMA will have to be flown at a greater altitude to avoid contact with the bottom.

3.5.4.04 During the bathymetric surveys, areas that were less than 10 feet deep were not surveyed. With a 3-foot draft of the MBE, operation into less than 10 feet of water would not leave the required 4-foot buffer. Therefore, very few areas of less than 10 feet water depth were ensonified by the MBE. The yellow areas on Figure 3-2 are anticipated to be where float surveys may be done.

3.5.4.05 The areas surveyed will be limited by a combination of the need to protect sensitive habitat areas and to ensure the safety of the equipment and operators. For example, much of MRS 03 is very shallow and subject to significant wind and wave action. Surveys of areas of coral and other sensitive habitat with less than approximately 4 feet water depth may be attempted with the hovercraft-pushed TEMA-Lite configuration if wave action permits. Shallow areas that do not contain sensitive habitats and areas with sensitive habitats with somewhat deeper water may not be able to be surveyed unless seas are essentially flat because wave action can result in contact of the vessel or equipment with the bottom.

3.5.4.06 Coverage with the subsurface-towed TEMA will be further restricted in areas with slopes of greater than approximately 15 degrees. There are limits on how quickly the towfish can change depths and in areas of excessive slope, the TEMA either has to be flown too high to reliably detect metallic objects the size of smaller MEC items or there is a very significant risk of contacting the bottom and damaging sensitive habitat and/or the equipment.

3.5.4.07 Due to the challenging and complex nature of the site, a procedure for determination of the appropriate DGM configuration, deployment, and altitude of flight has been developed. The TEMA DGM Decision Tree (Figure 3-8) clearly presents what steps must be taken and which conditions must be met in order to proceed with either the vessel-towed TEMA-MK3 or the hovercraft-deployed TEMA-Lite.

Figure 3-8. DGM Operations Decision Tree

3.5.5 TEMA Data Processing

3.5.5.01 The MBE sounding data collected during the EBS was processed using HYPACK and CARIS Hydrographic Information Processing System (HIPS) software, respectively, to

generate the XYZ soundings in the survey coordinate system and units. Bathymetric surfaces were generated for the EBS report and were used for planning the Phase 2 surveys. Water depth contours were generated, and the 10-foot and 25-foot contours were used to refine the VSP depth zones for the line path determination. The MBE data were also used to determine areas with slopes that are greater than 15 percent. These areas pose a challenge to data collection, and line plan development will take this into account, either by avoidance, line azimuth, or both.

3.5.5.02 The DGM/EM data will be processed through the TtEC-developed programs that accept the raw DGM/EM data files, compute attitude and offset corrected positions for each of the coils, and output the data in a format suitable for further processing in Oasis Montaj. The Oasis software is used to map the data, perform the target picks, and generate output mapping and tabular data products. Final data presentation materials will be generated using a combination of Oasis Montaj and ArcGIS software.

3.5.6 Quality Assurance/Quality Control for TEMA Data

3.5.6.01 TtEC's data quality is established at the time of data collection through proper setup and operation of the survey systems, and cannot be enhanced during processing, other than to remove obviously invalid data. Survey, data processing, and QA procedures will comply with the applicable guidelines provided by the USACE.

3.5.6.02 Data quality will be assessed explicitly: a single data element is compared directly to a standard or known control (as is the case with the GPS check to a known control point to verify that it is functioning correctly). Alternatively, quality can be assessed implicitly: combinations of data elements are compared to members of their own set for internal consistency (as is the case with data spikes, such as in EM data, the spike is compared to the previous and successive data points and determined to be noise). Additionally, quality can be measured quantitatively (numerically, e.g., EM battery voltages need to remain above 10.5V) or qualitatively, requiring interpretation on the part of an operator (e.g., odd behavior of the vessel navigation during data collection, noting that EM readings are excessively noisy).

3.5.6.03 For each step of the setup and operation of the survey system, a series of checks is run on the equipment and data collection software configuration. These checks will be documented in the survey collection logs and a dedicated QC electronic log and the results will be included in the RI Report. Where possible, a quantitative measurement of data quality is identified for each data type acquired. Procedures are constructed to measure this quantity as near as practicable to the point of acquisition. These measurements of quality are continually assessed throughout the acquisition and processing phases of the project. Where a quantitative measure of data quality cannot be developed, an interpretive or qualitative method is contrived to estimate data quality.

3.5.6.04 Field methods used for measuring data quality begin with position accuracy. The GPS system will be checked on a daily basis (once per day) to check that positional accuracy is better than 0.3 meter. The survey crew will check selected terrestrial control points with an RTK

GPS rover. The RTK GPS measurements will match the published position to within 0.1 meter x, y, and z. This check will be conducted prior to the start and at the end of the survey. A daily water level check or a temporary bench mark near the vessel dock(s) will be used to check the GPS units on the vessels. This check is done by comparing the reported temporary benchmark position, or water surface elevation between the survey system navigation reported tide level, and the QC GPS rover. The QC GPS water level and survey system tide level will match to within 0.3 meter. Details on the positioning QC are given in Table 4-2.

3.5.6.05 EM data from the TEMA are subject to interpretive and quantitative measurements of data quality. The daily QC procedure for the TEMA will be as follows:

- After sensor warm up, null the TEMA-MK3 EM61 sensors and perform a function test by inserting a hammer or other large metal object (same object for all coils each day) into each coil individually. The function test will be considered complete when the response from the coils is within ±10 percent of the original values. This is due to the necessity of having the TEMA-MK3 on the deck of the survey vessel during this function check. Since the TEMA-Lite will be beached during the function test, a fixed ±20 percent will be used.
- In order to measure background noise, re-null TEMA-MK3 once launched and at mid-water depth, then perform a pseudo-static test (3-minute duration) and calculate the standard deviation for each coil based on a 30- to 60-second average. Based on previous work, this pseudo-static test works as well as static tests on land and provides better results than attempting to place the TEMA-MK3 on the bottom (see example Daily Quality Control Report [DQCR] in Appendix F). The static test for the TEMA-Lite will be conducted on the beach after the function test.
- Collect TEMA data over the IVS. The TEMA must remain within 1 meter of the bottom. Collect data in both directions sufficient enough to analyze at least one crossing of the IVS item(s) for each of the three coils. A minimum of three lines in alternating directions are required.

3.5.6.06 An IVS letter report will be submitted at the beginning of the project that will include:

- As-built drawing of the IVS,
- Pictures of seed item(s),
- Geophysical data maps,
- Summary of the IVS results,
- Proposed data collection techniques and methodologies, and
- Instrument- and process-specific criteria for defining the quality of the geophysical data.

3.5.6.07 The IVS will contain two 10-foot-long or a single 20-foot-long sections of carbon steel black pipe (or similar). The design is subject to revision to account for site-specific conditions at the installation site for the IVS. The IVS will be emplaced from a surface vessel utilizing snorkelers if needed. IVS items will not be buried, but instead placed on the bottom attached to a line and anchored at both ends.

3.5.6.08 During acquisition, operators monitor data quality on the EM collection and HYPACK acquisition screens. The general noise level of the responses and useable swath width are visible on the displays. These displays require interpretation and are used as the first quality check on EM data.

3.5.6.09 The visualization tools available in the processing software provide clear indications of any problems in the data or in the time correlation of the EM and position data. Any errors in these areas will result in identifiable data artifacts. Conducting at least preliminary processing of the data will allow any problems to be caught and corrected quickly, and will ensure that a full, high-quality data set is collected.

4.0 QUALITY CONTROL PLAN

4.1 GENERAL

4.1.01 This QC Plan has been prepared by TtEC in accordance with Engineer Manual 1110-1-4009, Chapter 4, the PWS, and Contract W912DY-10-D-0015, Task Order 0003 specifications for the performance of an RI/FS at MRS 03 and MRS 12 on Culebra. All QC documentation will be submitted as part of or as supporting documentation for the Final RI Report. All QC records and documentation will be kept on-site and made available for USAESCH's inspection upon request.

4.2 TTEC PERSONNEL AND QC

4.2.01 All TtEC personnel involved in field operations at Culebra will implement this QC Plan per Engineer Manual 1110-1-4009, Chapter 4 and specific TtEC corporate procedures found in TtEC's electronic Corporate Reference Library (CRL). Although the CRL is proprietary, the PjM will make all CRL references available to the USAESCH Commanding Officer (KO). The CRL procedures applicable to the QC effort are listed in Table 4-1.

Table 4-1. TtEC Corporate Procedures

Procedure Number	Subject
PO-8	Document Control
QPM-1	Quality Program Manual
QP-3	Qualification/Certification Quality Program Audit Personnel
QP-9	DOD Contractor Quality Control
QP-10	Control of Measuring and Testing Equipment
QP-11	Control of Nonconforming Conditions
QP-12	Corrective Action
QP-13	Surveillance Procedure
ENG-3	Developing and Issuing Engineering Documents
QP-14	Lessons Learned Procedure

4.3 DUTIES AND RESPONSIBILITIES

4.3.01 Project quality is the responsibility of the entire survey team. The team's comprehension of this QC Plan is of primary significance for quality objectives to be accomplished; thus, the training and indoctrination of the key personnel in the quality objectives will be conducted. The project organization is headed by the PjM, the single focal point for successful accomplishment of all phases of the project. The PjM is given full authority and responsibility for project execution, and the PjM is supported by direct and indirect line managers with the functions and responsibilities outlined below.

4.3.1 Project Manager

4.3.1.01 The PjM, Scot Wilson, approves the QC Plan, implements procedures, and has direct responsibility for day-to-day operations of the project. The PjM's responsibilities related to QC include, but are not limited to:

- Implementation of all applicable TtEC policies and procedures;
- Identification of the qualifications and selection of project staff, subcontractors, and suppliers;
- Submission of all contract deliverables; and
- Analysis of QC failures (with the GQCM and the appropriate QC person) and implementation of corrective actions.

4.3.2 Geophysics Quality Control Manager

4.3.2.01 The GQCM, Elise Goggin, reports directly to the TtEC MMRP QC Manager and has an indirect reporting line to the PjM in terms of deliverables and requirements to comply with the PWS. Although separate and independent from the PjM, the GQCM is part of the problem-resolution process and must maintain close and open communication with the PjM. The GQCM is responsible for:

- Implementing the QC Plan;
- Initiating QC surveillance and inspection consistent with the QC Plan and program QC policies and procedures;
- Identifying, evaluating, initiating, and approving corrective action to ensure work complies with the contract;
- Recommending changes to the QC Plan;
- Providing weekly project QC updates to the Project Manager; and
- Directly communicating with USAESCH QA project oversight.

4.3.3 MMRP Quality Control Manager

4.3.3.01 The MMRP QC Manager, Mark Dollar, approves the QC Plan and is part of the problem-resolution process. The MMRP QC Manager:

- Establishes and maintains the MMRP Quality Program;
- Works directly with TtEC and the USACE to ensure implementation of the Program QC Plans;
- Acts as focal point for coordination of quality matters across all aspects of the project and resolves quality control issues;
- Suspends project activities if quality standards are not maintained;

- Interfaces with USACE on quality-related items;
- Performs review of surveillance reports conducted by project Quality Control personnel; and
- Responds to a field program issue with potential corrective action (verbal, written, or electronic).

4.3.4 Field Operations Lead/Quality Control Manager (FOL/QCM)/Senior Project Geophysicist

4.3.4.01 See discussion of FOL/QCM/Senior Project Geophysicist in Section 2.4.5. The FOL/QCM/Senior Project Geophysicist, Richard Funk, is responsible for:

- Completing reports and other documentation and maintaining a daily log of activities;
- Implementing the three-phase control process: preparatory, initial, and follow-up inspections;
- Implementing the operator proficiency test prior to project operations;
- Conducting QC indoctrination training for project personnel and site visitors;
- Issuing stop-work requests when conditions warrant; and
- Instituting Field Change Requests (FCRs) and nonconformance reports (NCRs).

4.3.4.1 Stop-Work Authority

4.3.4.1.01 The FOL/QCM has the authority to stop work whenever a condition is identified that has a negative effect on the quality of the product being delivered or that is likely to impact a T&E species or habitat as outlined in Section 6 and the Environmental SOPs in Appendix B-1.

4.3.4.2 Stop-Work Request

4.3.4.2.01 A stop-work request may be issued for a portion of a process, limiting the stop-work request to that portion of the process that is not in compliance. The FOL/QCM will document the situation and communicate the issue to the PjM and MMRP QC Manager (within 12 hours via telephone and/or email). The FOL/QCM will document this action on the Stop-Work Request Form and will maintain a compilation of the stop-work actions on the Stop-Work Request Log.

4.4 AUDIT PROCEDURES

4.4.01 Audits will be conducted and audit records maintained per TtEC Procedure QPM-1: Quality Program Manual. Audits will be conducted by personnel qualified in accordance with TtEC Corporate Procedure QP-3: Qualification/Certification of Quality Program Audit Personnel.

4.5 QC PROCESS

4.5.01 QC and QA on this project will be a three-tier process. This three-tier approach uses the three phases of control inspections to ensure all project objectives have been met. The first step (Tier 1) of the QC/QA process incorporates the initial survey team training captured in the preparatory phase inspection. This is followed by the second step (Tier 2), Process QC after implementation of the work activity, formally documented on an Initial Inspection form. Process QC, daily routine QC observations, completes the three-phase control process by conducting initial and follow-up inspections on all the DFWs to ensure processes are in control and opportunities for improving processes are captured and implemented. QC checks are built into the DFW to monitor and identify potential problems before the process goes to the next step—all QC checks are identified in Table 4-2. The last step (Tier 3) is Product QC, which is carried out using surveys to verify the product meets the requirements of the Work Plan. Personnel conducting QC and QA have stop-work authority and are organizationally independent from the processes.

4.5.02 Application of measurement quality objectives developed as part of Phase 2 will ensure high-quality data will be obtained. Table 4-2 provides the measurement quality metrics that will be achieved to ensure project objectives are met.

Table 4-2. Measurement Quality Metrics

Technology Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency	Action if Quality Failure Occurs
Digital Geophysical Mapping – TEMA	Function Check TEMA-MK3	After sensor warm up (2-5 minutes), null the EM61 sensors and perform a function test using a hammer or other large metal object	Large stable signal spike. No particular value is specified as this will change with null due to precise position of TEMA on deck; therefore, a value within ± 10 percent of the original readings will be used.	Once daily	Deck Check cabling. Check for water intrusion into EM coils. Check for foreign objects on TEMA towfish. Re-null and retest system. Repair/replace components as necessary.
	Function Check TEMA-Lite	After sensor warm up (2-5 minutes), null the EM61 sensors and perform a function test using a hammer or other large metal object	Large stable signal spike repeatable to within ± 20 percent of the values.	Once daily	Deck Check cabling. Check for water intrusion into EM coils. Check for foreign objects on TEMA towfish. Re-null and retest system. Repair/replace components as necessary.
	Noise Check TEMA-MK3	Re-null TEMA once launched and at mid-water depth, then perform a pseudo-static test (3-minute duration).	Calculate the standard deviation for each coil based on a 30- to 60-second average. Standard deviation of readings should not exceed 6 mV on channel 2.	Once daily, again after system power is cycled	Check cabling, look for loose cable runs. Check for foreign objects on TEMA towfish. Re-null and retest system. Repair/replace components as necessary.
	Noise Check TEMA-Lite	After Function Check, perform a static test (3-minute duration) with system beached on the shoreline.	Calculate the standard deviation for each coil based on a 30- to 60-second average. Standard deviation of readings should not exceed 6 mV on channel 2.	Once daily, again after system power is cycled	Check cabling, look for loose cable runs. Check for foreign objects on TEMA towfish. Re-null and retest system. Repair/replace components as necessary.

Table 4-2. Measurement Quality Metrics (continued)

Technology Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency	Action if Quality Failure Occurs
	Precision/ Repeatability	Seeded linear metallic target(s) (IVS)	For initial test, run reciprocal headings over seed feature to obtain full coverage of IVS. The TEMA must remain within one meter of the bottom for 90% of the time over the IVS. Collect data in both directions for each sensor. A minimum of three lines in alternating directions are required. IVS items are to be located to within 1 meter of their reported position.	Initial test – once per survey. Subsequent checks daily at the start of the day.	If no detection: 1. Deck test EM system and repair/replace if necessary. If position error: 2. Check vessel navigation (RTK GPS) and USBL and adjust/repair/replace as needed. 3. If a stable offset is noted, recheck seed item location.
	Completeness	Visual evaluation of data real-time for verification that intended coverage goals are met; confirmation in post-processing.	Coverage plots (i.e., matrix fill / coverage plots) will be utilized to monitor coverage completeness in real time. Along Track Sample Spacing – 98% of the down line measures will not exceed 0.25 meter. Survey Height – 90% of the survey altitude readings will be at or below 2 meters.	By dataset	If coverage is not adequate, conduct holiday fill survey to fill in the missing data coverage. Areas that experience along track gaps that do not meet the 98% coverage rule will be re-collected. Areas that experience gaps caused by survey altitude that do not meet the 90% coverage rule will be re-collected. Areas that exceed 0.25 meter along track or 2 meter altitude due to terrain or obstructions will be mapped and removed from the coverage analysis.

Table 4-2. Measurement Quality Metrics (continued)

Technology Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency	Action if Quality Failure Occurs
	Sensitivity	Compare daily IVS results to the initial IVS test data	The TEMA measured response S/N will be compared to the S/N of the initial IVS run. The TEMA S/N level will be within ± 20 percent of the values established during the initial IVS run.	Once per day	1. Re-run IVS. 2. Test EM system and repair/replace if necessary. 3. Check vessel navigation and USBL and adjust/repair/replace as needed.
Geodetic Equipment	Functionality/ Accuracy	1. GPS Positioning – Survey crew will check selected terrestrial control points with RTK GPS rover. 2. Water level check – Use RTK GPS rover or temporary bench mark at vessel dock to check water surface elevation. Compare to survey system navigation reported tide level.	1. RTK GPS measurements will match published position to within 0.1 meter x, y, and z. 2. RTK GPS water level and survey system tide level will match to within 0.3 meter.	1. Prior to the start and at the end of survey 2. Daily	1. Verify system configuration and settings. 2. If using POS MV, post-process position in POSPac and re-check result. 3. Re-test as appropriate. 4. Repair/replace components as required

4.5.1 Tier 1 QC Process

4.5.1.1 Training

4.5.1.1.01 The FOL/QCM will verify site personnel have the following training, as required:

- Work Plan and APP/SSHP training
- 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Course
- 8-hour HAZWOPER Annual Refresher Course (if applicable)
- Site-specific QC procedures and pass/fail criteria
- Supervisors have the appropriate 30-Hour Occupational Safety and Health Administration Supervisor Training
- Ongoing QC training
- Training/briefing by a qualified staff member on the environmental protection requirements and protection of threated and/or endangered species and critical habitat as per Section 6.3 (paragraph 6.3.02) of this plan and the Environmental SOPs in Appendix B-1.

4.5.1.1.02 The FOL/QCM will conduct periodic quality-related briefings during the morning safety meeting. These briefings will cover quality-related topics provided by the TtEC Corporate QC Program Manager and those determined by the FOL/QCM. Suggested topics include, but are not limited to, results from QC activity such as surveillance, inspections, the three-phase control process, process improvement, and changes to procedures and approved FCRs.

4.5.1.2 Preparatory-Phase Inspections

Timing of Preparatory Phase QC

4.5.1.2.01 A preparatory-phase inspection will be performed prior to beginning each DFW, which will include:

- Site-specific training,
- IVS certification, and
- Geophysical survey.

4.5.1.2.02 The specific QC activities performed during the preparatory phase, and the results of those activities, will be documented on the Preparatory Phase Inspection Report, which will be attached to the DQCR. Any checklists used during the preparatory inspection will be attached to the Preparatory Phase Inspection Report. These reports/forms are in Appendix F.

FOL/QCM Actions in Preparatory QC Phase

4.5.1.2.03 The following QC actions are performed by the FOL/QCM for each preparatory-phase inspection:

- Verify appropriate plans and procedures are developed, approved, and available.

- Verify personnel identified are available and meet the requirements and qualifications of PWS for the position.
- Verify the required training has been performed and is documented.
- Verify identified equipment is available, functional, and appropriate for the job.
- Verify the preliminary work and coordination have been accomplished.
- Verify level of quality expected is understood.
- Verify the Work Plan and applicable SOPs have been reviewed and understood by the workers (have field personnel communicate their understood work effort to the FOL/QCM).
- Brief process improvement program.

Discrepancies

4.5.1.2.04 Discrepancies between existing conditions and approved plans/procedures will be resolved and corrective actions taken for unsatisfactory and nonconforming conditions identified during a preparatory-phase inspection.

Job Hazards

4.5.1.2.05 The Site Safety and Health Officer (SSHO) will discuss job hazards with site personnel and verify the necessary safety measures are in place and ready for use. The APP and SSHP are provided in Appendix E and will be reviewed with all team members.

4.5.2 Tier 2 QC Process – Process QC

This component of the QC function is an integral part of each process and will be managed by the FOL/QCM. The FOL/QCM will work closely with the PjM and the field supervisors to identify and meet project and quality objectives. Identified quality criteria for the inputs and outputs of each process will be used as a basis for the assessment of each process. Process QC completes the three-phase control process by conducting initial and follow-up (surveillance) inspections to ensure processes are under control, and opportunities for improving processes are captured and implemented. Use of proactive process QC is a preventative approach to quality.

4.5.2.1 Initial-Phase Inspection

4.5.2.1.01 An initial-phase inspection will be performed by the FOL/QCM the first time a DFW is performed. The purpose of the inspection will be to check the preliminary work for compliance with procedures and contract specifications. Another aim is to establish the acceptable level of workmanship, check safety compliance, review the preparatory-phase inspection, and check for omissions and resolve differences of interpretation. The Initial-Phase Inspection Report is included in Appendix F.

Initial Phase Actions

4.5.2.1.02 The following actions will be performed for each DFW:

- Verify deficiencies identified during the preparatory phase have been corrected.
- Establish requirements of quality of workmanship.
- Resolve differences of interpretation.
- Review Work Plan and applicable documents to ensure requirements are being met.
- Observe performance of work and verify adequacy of work.

Discrepancies

4.5.2.1.03 Discrepancies between site practices and approved plans/procedures will be resolved. Corrective actions for unsatisfactory conditions or practices will be verified by the FOL/QCM, prior to granting approval to proceed.

Documentation of Initial QC Phase Actions

4.5.2.1.04 The specific QC activities performed during the initial QC phase, and the results of those activities, will be documented on an Initial-Phase Inspection Report and attached to the DQCR.

4.5.2.2 Follow-up Phase Inspection (Surveillance)

4.5.2.2.01 The FOL/QCM will conduct the follow-up phase inspection on scheduled and unscheduled bases. The purpose of the inspection is to ensure continuous compliance with contract requirements, PWS, and SOPs and to verify the quality of workmanship. The following will be performed for each DFW:

- Inspections/surveillance to ensure the work is in compliance with the PWS and the Work Plan,
- Inspections/surveillance to ensure the required level of workmanship is maintained,
- Inspections/surveillance to ensure each project logbook is properly filled out and maintained,
- Inspections/surveillance to ensure the data management system is properly tracked and backed up, and
- Documentation of follow-up results, either negative or positive, on a QC Surveillance Report (attached to the DQCR).

4.5.2.3 Equipment Calibration, Testing, and Maintenance Requirements

4.5.2.3.01 Each piece of equipment will be listed on field data sheets according to make, model, and serial number. Checklists of equipment tests and calibrations will be filled out and retained in the project files. In addition, calibration and testing procedures may be stored on magnetic media or in field logbooks. If equipment is sent to the manufacturer for repair or

maintenance, it will be recalibrated. Documentation of any recalibrations will be maintained in the project files.

4.5.2.4 Daily Instrument Checks

4.5.2.4.01 Every instrument operator will check the instrument daily for proper functionality. The operator will test the instrument on known anomalies in the IVS. If the instrument does not function properly in accordance with manufacturer's criteria, the instrument operator will notify the TtEC project office and request repair and/or a replacement instrument. Daily instrument checks will be documented in the team logbook and the Daily Instrument Prove-Out Report. The FOL/QCM will inspect during Initial inspection and observe weekly (at minimum) during QC surveillance activities. See Table 4-2 for a breakdown of equipment inspection requirements.

4.5.2.5 Records

4.5.2.5.01 The FOL/QCM will maintain calibration and maintenance records concerning instrument calibration, maintenance, and operator qualification at the TtEC project office. These records will be part of the QC record. All survey teams will maintain a logbook to document individual survey team's activities.

4.5.2.6 Maintenance

4.5.2.6.01 The FOL/QCM will supervise the maintenance and inspection of all other equipment to include vehicles, radios, monitoring equipment, and any personal protective equipment (PPE). The FOL/QCM will maintain the records for all such maintenance and inspection in the TtEC project office.

4.5.2.7 QC Records

4.5.2.7.01 The FOL/QCM will maintain all QC records, including the access database, instrument calibration/maintenance records, instrument operator qualification records, training certificates, vehicle maintenance records, etc. These records will be maintained in the TtEC project office for examination by the USAESCH On-Site Ordnance and Explosives Safety Specialist and other authorized government representatives.

4.5.2.8 Layout of Work

4.5.2.8.01 Layout of the work will be from established base lines and benchmarks indicated on existing site drawings and the project GIS. When no base lines or benchmarks are provided, the establishment of reference benchmarks will be documented in the surveying field books.

4.5.2.9 Subcontractor QC

4.5.2.9.01 Subcontractors performing work on the project will be responsible for complying with the requirements of their respective subcontracts. TtEC has overall responsibility for maintaining conformance to the quality requirements of the contract, including responsibility for subcontracted items and services. The requirements for personnel qualifications, technical

performance levels, QC procedures, acceptability levels, and documentation will be included as part of the subcontract documents.

4.5.2.10 Document Control

4.5.2.10.01 The PjM will establish a document control plan in accordance with TtEC Procedure PO-8: Document Control.

4.5.2.11 Data Management

4.5.2.11.01 The GQCM will implement a three-phase control process to ensure quality data management processes and ongoing QC surveillance. See Table 4-2 for quality inspection points.

4.6 DEFICIENCIES AND NONCONFORMANCE

4.6.01 Deficiencies and nonconforming conditions will be managed in accordance with TtEC Procedures QP-11, Control of Nonconforming Conditions, and QP-12, Corrective Action. Deficiencies discovered during inspection or other Project QC functions will be documented in the DQCR. Nonconforming conditions will be documented on an NCR. All deficiencies will be resolved prior to completion of the project and in the timeliest manner possible. The DQCR will include a report on each deficiency/nonconforming condition and the corrective action(s) completed and closed-out for the day. A corrective action request is required for deficiencies identified from the following sources:

- TtEC quality program audits,
- Management assessments,
- Audits performed by Program QA/QC in accordance with project-specific plans, and
- Audits of TtEC, performed by the client or regulatory agency.

4.6.1 QC Responsibilities

4.6.1.01 It is the responsibility of all personnel on the project to report deficiencies and nonconforming conditions to their supervisors or managers as soon as they are identified. Deficiencies and nonconforming conditions are not necessarily a “bad thing”; however, they do have a negative connotation. Deficiencies and nonconforming conditions should be considered opportunities to improve the process. Notification will be made to the USAESCH Project Manager (PM) and survey team should these conditions occur.

4.6.1.02 The determination of the root cause of a deficiency or nonconformance is an integral part of the QC process. The depth and extent of the root cause analysis depends on the situation. It may be as simple (i.e., minor) as an overlooked step or procedure, or it could be a complicated process. Input will be obtained as necessary from field personnel and technical advisors in order to identify the factors leading to the problem. Root-cause analysis is the

responsibility of the PjM with the assistance of GQCM. Criteria considered in the analysis will include:

- Staff qualifications and training,
- Adequacy of procedures,
- Adequacy of equipment,
- Adequacy of QC measures, and
- Root cause.

4.6.1.03 The root cause is always "upstream" from where the problem was detected. Two strategies that should be employed for determining the root cause of a deficiency for this project are: 1) tracing the problem back to the source, and 2) evaluating the cause using basic questions such as who, what, when, where, why, and how. "Why" is arguably the most beneficial question when attempting to arrive at a root cause. This question may need to be asked multiple times before the cause is identified. For example "Why did 'A' happen?" Answer: "Because of 'B,'"; "Why did 'B' happen?" Answer: "Because of 'C.'" This process is carried on until the ultimate cause is identified.

4.6.2 Corrective Action

4.6.2.01 Following the root-cause analysis, the GQCM will perform analysis of potential solutions (i.e., corrective actions) to determine which remedy could most effectively correct the problem. The process will include all appropriate personnel and will be documented via meeting notes and information listed in the proper sections of both the NCR form and the Corrective Action Request form. Potential remedies considered may include:

- Supplemental personnel training,
- Changes of equipment or modification of equipment currently in use,
- Acquisition of supplemental equipment,
- Implementation of new procedures or modification of existing procedures,
- Rework of the deficient process or a portion of the process, and/or
- Changes in QC procedures.

4.6.2.02 It is the PjM's responsibility to decide the appropriate corrective action to implement. However, all parties involved prior to implementation should agree on this decision. Successful implementation of corrective action will be documented on the NCR and tracked. The GQCM will verify through follow-up-phase surveillance whether the corrective action implemented has corrected the deficiency/nonconforming condition and is sufficient to prevent recurrence.

4.6.2.03 Once the USACE Project Delivery Team and the Contracting Officer have determined that a significant corrective action or field change is required, the USACE PM will notify the regulators via email. It is anticipated that the corrective action/change notification and any supporting documentation, as necessary, will be provided within 48 hours to the regulators.

4.7 LESSONS LEARNED

4.7.01 Lessons learned will be captured, documented, and submitted in the Site-Specific Final Report using TtEC Procedure QP-14: Lessons Learned Procedure. The FOL/QCM will include lessons learned on the daily and weekly QC reports. The FOL/QCM will recap all such lessons learned in the Final Report.

4.8 CONTROL OF CONTRACT SUBMITTALS

4.8.01 The PjM will ensure all contract submittals (e.g., Work Plan, Weekly and Monthly Reports, Records of Meetings and Conversations, Accident Reports) are prepared in compliance with the PWS. The Project Manager will verify conformance of all submittals with the current DIDs.

4.9 CHANGES TO EXISTING DOCUMENTS AND FIELD CHANGE REQUESTS

4.9.01 FCRs will be managed per TtEC Procedure ENG-3: Developing and Issuing Engineering Documents. The PjM will submit all proposed Work Plan changes to the USAESCH Project Manager, who will request concurrence from the Project Delivery Team before forwarding them to the KO for approval. Once approved, the FOL/QCM will conduct, at the earliest opportunity, training and briefings to all field personnel on the approved document changes. This training on changes to existing documents could occur during the daily safety meetings or through a more formal presentation.

5.0 EXPLOSIVES MANAGEMENT PLAN

5.0.01 Section 5 is not applicable to the project and will serve as a placeholder section only.

6.0 ENVIRONMENTAL PROTECTION PLAN

6.1 INTRODUCTION

6.1.01 This EPP was prepared in accordance with Data Item Description MR-005-12, the PWS, and the Environmental SOPs developed by the USACE (Appendix B-1). The purpose of this EPP is to establish general procedures for avoiding, minimizing, and mitigating potential impacts to environmental and cultural resources during RI field activities and comply with substantive requirements of applicable or relevant and appropriate requirements (ARARs). This EPP describes sensitive natural resources specifically within the MRSs Flamenco Bay (MRS 03) and the Luis Peña Channel (MRS 12) and sets forth methods to protect and conserve those resources during the RI field activities. Phase 1 of the RI (the EBS) was completed and included photographing and collecting of video and to performing of bathymetry surveys to document benthic site conditions, define and delineate benthic and coral reef habitats, sensitive or critical habitat areas, and document features of the underwater environment in these two MRSs. Information from the EBS is being used to help identify and protect these areas and the species that inhabit them from harm during towed sensor operations during Phase 2 of the RI. This EPP will be updated as required for inclusion in the work plan for Phase 3 of the RI.

6.1.02 Flamenco Bay is a shallow bay comprising approximately 195 acres that extends up the east side of the Northwest Peninsula and the west side of Flamenco Point in Puerto Rico. Flamenco Bay is currently used for recreational swimming, diving, and snorkeling activities. The Luis Peña Channel is made up of waters that comprise the Luis Peña Water Refuge, approximately 835 acres of water along the west coast of Culebra from the Northwest Peninsula to Scorpion Point. The Luis Peña Water Refuge is managed by the Department of Natural and Environmental Resources (DNER),which has identified 41 types of uses (Valdez-Pizzini et al. 2008), including recreational swimming, boating snorkeling, and diving. Fishing is another use documented in the area (Hernández-Delgado 2003a; Pagán-Villegas et al. 1999), although since 2004 its practice is illegal inside the Reserve (Valdez-Pizzini et al. 2008; DNER 2010a).

6.1.03 Where impacts to sensitive biological resources cannot be avoided, this EPP outlines potential measures that can be implemented to mitigate such impacts. These mitigation measures were developed based upon a site-specific analysis that addresses unique concerns for work within and along the beaches of the Culebra Water Ranges and incorporates best management practices and guidelines that have been implemented for intensive field programs previously performed by other MMRP contractors on Culebra. Several SOPs for conservation of endangered species and their critical habitat during underwater investigations were developed by USACE and comprise:

- A Final February 2014 (Addendum 1, February 2015) Supplemental SOP for Endangered Species Conservation and their Critical Habitat during Underwater Investigations (most up-to-date information is contained in this document related to corals) including three

further SOPs as follows:

- April 2012 Final SOP for Endangered Species Conservation and their Critical Habitat during Underwater Investigations (Appendix A of the 2014 SOP);
- An April 2011 Addendum to the 2008 SOP (contains mainly terrestrial based species information) (Appendix B to the April 2012 SOP); and
- A July 2008 Final SOP for Endangered Species Conservation and their Habitat (Appendix A to the April 2012 SOP).

6.1.04 These SOPs are referenced throughout the EPP and are included in this Work Plan as Appendix B-1. As stated in Section 4.6 of the 2012 SOP, the July 2008 SOP and its 2011 Addendum remain in effect. The February 2014 SOP is meant to supplement, not replace, previous SOPs; it provides the most up-to-date information regarding listed corals.

6.1.05 The following are some of the sources that were consulted for identifying biological and cultural resources known to exist or potentially existing at the Culebra Water Ranges site:

- 2012 SOPs (including sub-appendices A and B) (Appendix B-1);
- 2014 Supplemental SOPs (February 2014 and Addendum 1, February 2015) for Endangered Species Conservation and their Critical Habitat during Underwater Investigations (Appendix B-1)
- Ecological Services in the Caribbean (website) (USFWS 2011a)
- Draft Stock Assessment: West Indian Manatee (*Trichechus manatus*) Puerto Rico Stock (Antillean subspecies, Trichechus manatus manatus) (USFWS 2009)
- Draft Site Inspection Report, Northwest Peninsula of Culebra (Parsons 2011)
- Culebra National Wildlife Refuge (website) (USFWS 2008)
- DNER website (http://www.drna.gobierno.pr/)
- Draft Puerto Rico Coastal and Estuarine Land Conservation Plan (DNER 2010b)
- Elkhorn Coral (website) (NMFS 2011a)
- Sea Turtles (website) (NMFS 2011b)
- Federal Register. Final Rule. Endangered and Threatened Wildlife and Plants: Final Listing Determinations on Proposal to List 66 Reef-Building Coral Species and to Reclassify Elkhorn and Staghorn Corals (NMFS 2014)
- Resource Category 1 Designation: The Seagrass Beds of Culebra Island, Puerto Rico (USFWS 1992)
- Environmental Protection Plan, Non-Time Critical Removal Action, Municipality of Culebra, Puerto Rico Final Work Plan (EEG 2006)
- 2012-2013 Field Data Collection Report for EBS (TtEC 2013)
- National Wetlands Inventory website

(http://107.20.228.18/Wetlands/WetlandsMapper.html)

- National Register Information System (NRIS), National Register of Historic Places
- List of National Historic Landmarks – National Historic Landmarks Program (NHL)
- List of National Heritage Areas (NHAs), National Heritage Areas Program
- Coastal Zone Management Program (National Oceanic and Atmospheric Administration [NOAA])
- NOAA National Marine Fisheries Service (NMFS)
- National Marine Sanctuaries and Marine Protected Areas (NOAA)

6.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

6.2.01 This project is being performed as part of a FUDS Program. Through a site inspection (Parsons 2007), it was determined that MRSs 03 and 12 warrant further investigation under the MMRP. FUDS response activities are conducted in accordance with the DERP statute (10 U.S. Code [USC] Section 2701 et seq.), CERCLA (42 USC Section 9601 et seq.), Executive Orders 12580 and 13016, and the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Regulations Part 300). An RI/FS will be performed by TtEC for the two MRSs that comprise the Culebra Water Ranges. The Phase 2 RI field activities are the subject of this EPP.

6.2.02 The identification of ARARs is an iterative process that must be considered throughout the CERCLA process. As such, the list of identified requirements and their relevance may change as more information is obtained during the RI/FS process. The RI is used to ascertain site conditions and types and extents of contamination. Site remedies are not evaluated until the FS. During the RI, limited ARARs that potentially directly relate to site activities have been determined. Federal ARARs are presented in paragraph 6.2.06; however, coordination with appropriate Commonwealth of Puerto Rico agencies such as DNER and the Environmental Quality Board (EQB) are appropriate for determining requirements and practices that are protective of the environment during this RI and have been included within this EPP, but some of these are not considered to be ARARs.

6.2.03 Federal laws and regulations with substantive requirements must be considered for identification of site-specific ARARs during the RI. ARARs can be:

- Chemical-specific (governing the level or extent of site remediation relative to a specific constituent);
- Location-specific (pertaining to existing site features and location); and
- Action-specific (pertaining to proposed site remedies and implementation of the selected site remedy)

6.2.04 Chemical-specific ARARs are not addressed in this EPP because these will not come into play until the FS if MC are found during sediment sampling and are compared to data quality

objectives that the survey team determines for the FS evaluation. Limited location- and/or action-specific ARARs are listed for the RI. Paragraph 6.2.06 contains the ARARs for the RI.

6.2.05 Following are some notes regarding the ARARs for the RI:

- Chapter 4 of the EPA guidance document entitled *CERCLA Compliance with Other Laws Manual, Part II* (EPA 1989) states that "While EPA interprets CERCLA §121(e) to exempt lead agencies from obtaining Federal, State, or local permits (or documents similar to permits) or from complying with the administrative requirements for on-site remedial activities, it is strongly recommended that lead agencies, nevertheless, consult as specified with administering agencies for on-site actions. The administering agencies have the expertise to determine the impacts of a remedial action on particular aspects of the environment and what steps should be taken to avoid and mitigate adverse impacts."
- EPA guidance recommends that the lead federal agency consult with the state when identifying state ARARs for removal actions (EPA 1988). In essence, the CERCLA/NCP requirements at 40 CFR § 300.515 for removal actions provide that the lead federal agency request that the state identify chemical-, location-, and action-specific state ARARs upon completion of site characterization. At the present time, Puerto Rico–specific ARARs are not identified because site characterization has not been completed. The purpose of the RI is for site characterization.

6.2.06 Federal ARARs for Phase 2 of the RI:

1. **50 CFR 17 or 50 CFR 226, Endangered Species Act of 1973, as amended and 16 USC 1531 et seq. (50 CFR 402).** Seven threatened species of coral are known to be present in these MRSs. In addition, several T&E species of turtle, including critical habitat for several species, are present in these MRSs. Several T&E whale species may also be present. On land, there is one species of tree, one reptile species, and one cactus species listed. These T&E species, including candidate species, are described in Section 6.3 below. Substantive requirements of this regulation require that on-site activities must be conducted in a manner that does not result in a take of these species and actions must not destroy critical habitat. No takes are authorized and penalties may be issued to personnel whose actions result in a "take." Personnel on this project will be trained to recognize these species and their critical habitat as well as the actions that minimize potential for a take to occur and prevent destruction of critical habitat; they will also be informed that penalties may be imposed on persons whose action results in a take.
2. **The Migratory Bird Treaty Act; 16 USC 701-712.** This Act makes it unlawful to (or attempt to) pursue, hunt, take, capture, or kill any migratory bird, part, nest, egg, or product. All but a few bird species naturally occurring in the U.S. are protected under this Act. On-site activities must be conducted in a manner that does not result in a take of these species.

3. **Marine Mammal Protection Act of 1972 (MMPA); 16 USC 1361, 50 CFR 12.** It is unlawful for any person or federal agency to take (harass or kill any marine mammal) on the high seas, in U.S. waters, or on land under the jurisdiction of this Act. On-site activities must be conducted in a manner that does not result in a take of these species.

6.2.07 Puerto Rico Commonwealth ARARs for Phase II of the RI

1. **Puerto Rico Law 147 (Protection, Conservation, and Management of Coral Reefs in Puerto Rico).** This law protects coral reef, seagrass beds and related resources in Commonwealth of Puerto Rico waters.
2. **Puerto Rico Wildlife Law 241 to protect, conserve and enhance the wildlife species both native and migratory in Puerto Rico.** This law would apply to sea turtles, manatees, and other wildlife in and around the marine areas of MRS 3 and 12."

6.3 ENDANGERED AND THREATENED SPECIES

6.3.01 According to the USFWS, in Puerto Rico and the U.S. Virgin Islands there are 78 protected species including 29 animals. According to the Caribbean and U.S. Virgin Islands T&E species database for the Culebra Archipelago, there are seven endangered species (three with critical habitat); three threatened species (one with critical habitat); and one species that has been delisted, but is subject to a monitoring plan (USFWS 2011a). In addition, seven threatened coral species, listed by NMFS, may also be present in the Culebra Water Ranges (NMFS 2014). On October 20, 2009, NMFS received a petition from the Center for Biological Diversity to list 83 species of corals as T&E and to designate critical habitat for these corals. Seven of the 82 coral species have the potential to occur in waters around Culebra and listing of these corals may be warranted. Several endangered whales may be present during certain times of the year around Culebra though they are not likely present in the shallower waters of these MRSs. There are two listed endangered species of plant and two listed reptiles that are not likely to be found in areas of work for the Culebra Water Ranges due to location and project tasks to be performed. On September 2, 2014, NMFS published a Final Rule to list the Central and Southwest Atlantic distinct population segment of scalloped hammerhead shark (*Sphyrna lewini*) as a threatened species under the ESA and is considering critical habitat.

6.3.02 Other than roseate tern and brown pelican, the T&E species listed in Table 6-1 are described in Section 3.0 of the 2012 SOP, in Appendix B of the 2012 SOP, or in the February 2014 SOP (including the Addendum 1, February 2015) along with photographs typical of the species and identification of breeding/nesting behaviors and critical habitat designations. Reptile and plant (terrestrial) species are addressed in Appendix B to the 2012 SOP in Appendix B-1. All project personnel will be fully briefed by a qualified staff member (e.g., project biologist) on this EPP, the 2012 SOP (including Appendices A and B) and the 2014 SOP (and its February 2015 Addendum 1) requirements prior to beginning the RI in order to raise awareness and protect T&E species and sensitive or critical habitats. An emphasis will be made as to the

potential for civil and criminal penalties to be issued to individuals who harm, harass, or kill T&E species. These documents, including this EPP, will be available to all survey teams during the RI/FS.

6.3.03 Threatened and/or endangered species that may be present in the Culebra Water Ranges, including listed corals are included in Table 6-1. Logs will be maintained during the RI detailing endangered or threatened species sightings in both terrestrial and marine habitats as required in Section 4.1.6 of Appendix A of the Environmental SOPs (Appendix B-1).

Table 6-1. Listed or Proposed Threatened or Endangered Species

Common Name	Scientific Name	Group	Status[1/]	Distribution
Loggerhead Sea Turtle	*Caretta caretta*	Reptile	T	Coastal Zones
Green Sea Turtle	*Chelonia mydas*	Reptile	T, CH	Coastal Zones
Leatherback Sea Turtle	*Dermochelys coriacea*	Reptile	E, CH	Coastal Zones
Hawksbill Sea Turtle	*Eretmochelys imbricate*	Reptile	E, CH	Coastal Zones
Brown Pelican	*Pelecanus occidentalis*	Bird	D, MP	Coastal Zones, No Nesting
Roseate Tern	*Sterna dougallii*	Bird	T	Coastal Areas and Offshore Cays, Nesting
Culebra Giant Anole	*Anolis roosevelti*	Reptile	E, CH	Arboreal forest
Virgin Islands Tree Boa	*Epicrates monensis granti*	Reptile	E	Forest and Shrublands
Wheeler's peperomia	*Peperomia sheeleri*	Tree	E	Mesic, Semi-Evergreen Forest
[No Common Name]	*Leptocereus grantianus*	Cactus	E	Subtropical Dry Forest, Rock Substrate
Antillean Manatee	*Trichechus manatus manatus*	Mammal	E	Coastal Zones
Elkhorn Coral	*Acropora palmata*	Invertebrate	T, CH	Coral Reefs
Staghorn Coral	*Acropora cervicornis*	Invertebrate	T, CH	Coral Reefs
Boulder Star Coral	*Orbicella annularis*	Invertebrate	T	Coral Reefs
Mountainous Star Coral, [No common name]	*Orbicella faveolata, Orbicella franksi*	Invertebrate	T	Coral Reefs
Pillar Coral	*Dendrogyra cylindrus*	Invertebrate	T	Coral Reefs
Rough Cactus Coral	*Mycetophyllia ferox*	Invertebrate	T	Coral Reefs
Blue Whale	*Balaenoptera musculus*	Mammal	E	Oceans
Sperm Whale	*Physeter macrocephalus*	Mammal	E	Oceans
Sei Whale	*Balaenoptera borealis*	Mammal	E	Oceans
Fin or Finback Whale	*Balaenoptera physaluis*	Mammal	E,	Oceans
Humpback Whale	*Megaptera novaeangliae*	Mammal	E, De	Oceans
Scalloped Hammerhead Shark	*Sphyrna lewini*	Fish	T	Oceans
Nassau Grouper	*Epinephelus striatus*	Fish	E	Coral Reefs
Goliath Grouper	Epinephelus *itajara*	Fish	E	Coral Reefs

1/ E=Endangered; T=Threatened; CH=Critical Habitat; D=Delisted due to Recovery; MP= Monitoring Plan; Proposed = May be subject to listing as endangered or threatened, but not listed at the present time; De – depleted
Sources:
NMFS 2011a, b, c; USFWS 2011b; NMFS 2014; Environmental SOPs (see Appendix B-1)

6.3.04 Chapter 9 of the ESA prohibits the taking of listed species without special exemption. There is no authorized take of any listed species during this project and no exemptions will be granted. Individuals whose action results in a take may be subject to penalties under the ESA. Taking is defined as harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, collecting, or attempting to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. If any take does occur, work will stop immediately and the take will be reported. Under terms of sections 7(b)(4) and 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided such taking is in compliance with an incidental take statement.

6.4 CRITICAL HABITAT DESIGNATIONS

6.4.01 On Culebra, critical habitat designations for several listed species have been made as follows (USFWS 2011b; NMFS 2008).

6.4.02 Hawksbill Sea Turtle: On Culebra, critical habitat designation has been made for areas of beachfront on the north shore of the island from mean high tide inland to a point 150 meters from shore Playa Resaca, Playa Brava, and Playa Larga. These critical habitat areas are not within the survey areas of Flamenco Bay or the Luis Peña Channel though these turtles may be present.

6.4.03 Elkhorn and Staghorn Coral: The NMFS has designated critical habitat for Elkhorn and Staghorn corals in Puerto Rico that encompasses the entire Island and associated cays of Culebra. Coral is discussed further in Section 6.6.1.

6.4.04 Green Sea Turtle: On Culebra, critical habitat designation has been made in the waters surrounding the island of Culebra from the mean high water line seaward to 3 nautical miles (5.6 km). The surrounding islands and cays are also critical habitat for green sea turtles. Seagrass beds such as those in the Luis Peña Channel provide shelter and food for green sea turtles. Seagrass beds are discussed further in Section 6.6.2.

6.4.05 Culebra Giant Anole: On Culebra, critical habitat designation has been made under the ESA for most of the remaining forests on Culebra Island, comprising Monte Resaca, Punta Flamenco, Playa Resaca, and Playa Brava.

Methods to Avoid or Minimize Impacts to T&E Species

6.4.06 Site personnel will coordinate closely with the USACE representative as well as federal and Commonwealth of Puerto Rico environmental agencies as required in the Environmental SOPs included as Appendix B-1 to this Work Plan, to avoid and minimize potential impacts to listed species and their habitat. There is no authorized "take" of any of these species during the EBS fieldwork. These SOPs were developed to avoid or minimize impacts take to T&E species listed, pursuant to the ESA including their critical habitats (where identified) during underwater

investigations on Culebra Island and the adjacent cays. If take occurs, work must stop immediately and the take must be reported.

6.4.07 Site personnel will follow the requirements included in these SOPs to avoid and/or minimize possible impacts to T&E species and their habitats. Measures to avoid or minimize possible impacts that TtEC will follow during this work are included in Section 4.2 of the February 2014 Supplemental SOP, Section 4.0 of the 2012 SOP, as well as in both Appendices A and B of the 2012 SOP.

6.4.08 Section 4.1.6 of the April 2012 SOP will be followed. TtEC will maintain a log detailing T&E species sightings in terrestrial and marine habitats. The log will include, but not be limited to, the following information: date and time; location coordinates using a GPS unit; species; one or more photographs, if possible; and any actions taken (e.g., species identification and distance from working area, reasons to cease operation, reasons to determine that operation may be resumed, among others) during the work period. All data shall be provided to USACE.

6.4.09 Descriptions of and specific measures to be taken for protection of various species are identified in the following sections of this EPP as follows:

- Marine mammals, including manatees and sea turtles (Section 6.5)
- Coral reefs and seagrass beds (Sections 6.6.1 and 6.6.2)
- Nesting birds (Section 6.6.3)
- Terrestrial endangered plants (Section 6.11)
- Terrestrial endangered reptiles (Section 6.6.4)

6.4.010 The Puerto Rico DNER has jurisdiction on every resource in Puerto Rico (marine and terrestrial). Project activities will be coordinated with the DNER Bureau of Fisheries and Wildlife. In addition, other agencies also have jurisdiction regarding endangered species and must be coordinated with/consulted as appropriate, if not coordinated through the DNER. The coordinating official on T&E species on Culebra is the Chief of the USFWS, Caribbean Field Office in Boquerón for species under their jurisdiction (sea turtles inland, manatees, birds, and terrestrial species). For aquatic species (sea turtles in water, corals, and marine mammals), the Coordinating Official for NMFS has jurisdiction. For activities being conducted adjacent or within the Culebra National Wildlife Refuge, the Refuge Manager also has jurisdiction.

6.4.011 In the event that a T&E species is harmed or incidentally taken during the RI/FS activities, work will stop, and the TtEC PjM will notify the USACE PM and the DNER coordinating official, and others will be notified as required (e.g., Refuge Manager, NOAA Coordinating Official, USFWS). Following this EPP and the 2014 SOP and its three appended SOPs for work in Flamenco Bay or the Luis Peña Channel will help minimize potential impacts to T&E species and minimize harm to sensitive or critical habitat areas.

6.5 MARINE MAMMALS AND SEA TURTLES

6.5.01 Several species of marine mammal (whales, sea turtles, and manatee) could be present in the offshore or potentially nearshore areas around Culebra.

6.5.02 The MMPA protects all marine mammals and prohibits the take of marine mammals in U.S. waters and by U.S. citizens on the high seas. Additionally, six species (sperm, sei, fin, blue, and humpback whales, and the West Indian manatee) are listed as endangered under the ESA (see Table 6-1). All of these species are managed by NMFS, with the exception of West Indian manatee (*Trichechus manatus*), which is managed by the USFWS. A subspecies of the West Indian manatee, the Antillean manatee (*Trichechus manatus manatus*), occurs in Puerto Rico and is endangered. The following describes these species and the sections of the Environmental SOPs that contain further information.

6.5.03 Whale species listed in Table 6-1 (T&E species) as well as other species that are not endangered or threatened but are protected under the MMPA may be present at times, though their presence around Culebra, especially in the two water ranges, is not likely and work activities are not likely to impact the species. Whales are addressed in Sections 3.6 through 3.10 of the 2012 SOP. There are procedures to follow to minimize potential impacts to marine mammals from project activities which are included in the SOPs.

6.5.04 Manatees have been reported irregularly in Culebra Island through the years, the individuals usually staying only for a couple of weeks. Although Culebra Island has available habitat, it lacks fresh water, which may hinder a longer stay by manatees (USFWS 2009). Manatees are described in Section 3.5 of the 2012 SOP.

6.5.05 Several species of T&E sea turtles—the loggerhead sea turtle (described in Section 3.1 of the 2012 SOP), green sea turtle (described in Section 3.2 of the 2012 SOP), leatherback sea turtle (Section 3.3 of the 2012 SOP), and the hawksbill sea turtle (described in Section 3.4 of 2012 SOP)—may be present in the waters around Culebra. Seagrass beds (see Section 6.6.2 below) and coral reefs (see Section 6.6.1 below) are an important habitat for sea turtles for foraging and feeding. Seagrass beds are designated as critical habitat for the green sea turtle, as is the area surrounding Culebra to 3 nautical miles offshore, including surrounding islands and cays. Damage to seagrass beds and coral reefs must be avoided during field activities and extra vigilance is required when operating boats near these habitats as potential contact with sea turtles is more likely. In addition, during breeding season, turtles make nests and lay eggs on beaches on Culebra Island and the adjacent cays, making them susceptible to boating activities being performed in shallow water or on beaches during particular times of the year.

Measures to Mitigate Potential Impacts to Marine Mammals and Sea Turtles

6.5.06 One major threat to sea turtles includes destruction and alteration of nesting and foraging habitats. Turtles are also vulnerable in their pelagic stages as juveniles and adults, when they may be caught in fishing nets, struck by boats, or caught in debris.

6.5.07 All of the general and specific conservation measures in Section 4.0 of the 2012 SOP will be followed during the RI. Specific conservation measures are identified in Section 4.2 (Staging Area Sea Turtle Nesting Monitoring), Section 4.4 (Marine Mammals and Sea Turtles Avoidance Measures), and Section 4.3 (Coral and Seagrass Avoidance Measures). In addition, Section 4.5 (Diving Operations and Equipment) will also be followed during the RI activities (when diving operations are included in RI activities) in order to avoid harming of sea turtles and marine mammals and habitat during these activities. Some site activities performed in the Luis Peña Channel may require coordination and scheduling around dates of high green sea turtle activity if the seagrass beds are within the work area. More procedures are included in Appendix A to the 2012 SOP. Where information is provided in more than one location in these SOPs, the most stringent is to be applied.

6.5.08 Beach surveys are an important component of sea turtle protection if staging areas are required in beach areas. In order to select staging areas on beaches and minimize potential impacts to sea turtles and their nests from, on, or near shore survey activities, TtEC will coordinate with the DNER Endangered Species Division (Mr. Carlos Diez). Nest monitoring will be performed in accordance with Section 4.2 of the 2012 SOP and Beach Monitoring and Designation of Beach Zones sections in Appendix A to the 2012 SOP (as applicable) based on activities being performed, though the RI does not include MEC clearance or vegetation clearance activities. The standard beach monitoring protocol will include having the Project Biologist perform morning beach patrols to identify the potential presence of new nests prior to and during the nesting season. The priorities for the beach monitoring protocol are to identify and record nesting behavior (tracks), site selection (sand, vegetation, and borderline), and threats to hatch success (predators, poachers, seawater, and desiccation). As part of the protocol, if sea turtle nests are found, the Project Biologist, their supervisor, and/or monitoring personnel will communicate daily with the USFWS Boquerón Endangered Species Specialist and the Culebra Islands National Wildlife Refuge Manager. Communications will help ascertain whether new nests have been located and their locations within the work area.

6.5.09 When it is not nesting season, the Project Biologist or appropriately trained personnel will conduct morning beach surveys prior to crews commencing daily activities to determine whether sea turtle nesting has occurred. The same priorities for the protocol inside a nesting season, and described above, will be followed.

6.5.010 To document the observed marine mammals and sea turtles, the wildlife observers will report the marine mammals and sea turtles seen during the survey in logs, noting the direction of transit when applicable. These logs will be included as part of the final RI report.

6.5.011 Any collisions with or sighting of injured or incapacitated marine mammals or sea turtles will be reported immediately to the USACE, USFWS, NMFS, and DNER as required in Section 4.4.12 of the 2012 SOP.

6.6 SENSITIVE ENVIRONMENTS AND HABITATS

6.6.01 The Culebra National Wildlife Refuge comprises about 1,480 acres, includes 23 islands and rocks in addition to the four tracts on the main island of Culebra and associated cays, including Luis Peña. The refuge is well known as a nesting site for a variety of seabirds and preserves important habitat for endangered sea turtles.

6.6.02 Conservation priority areas for Culebra include all of the lagoons and beaches on Culebra, the Flamenco Peninsula, all cayos and cays around Culebra, and the Canal Luis Peña Natural Preserve. Flamenco Point and the Northwest Peninsula, and all beaches are managed by the USFWS or DNER for wildlife conservation and recreational use.

6.6.03 Flamenco Bay includes the tourist areas most visited in Culebra and endangered turtle nesting areas. The Luis Peña Channel is located in the Marine Natural Reserve and has coral reef barriers and endangered turtle nesting areas.

6.6.04 The following sections address the varieties of sensitive environments that may be found in the Culebra Water Ranges.

6.6.1 Coral Reefs

6.6.1.01 The DNER, through the Bureau of Fisheries and Wildlife Program, is responsible for conservation and management of coral reefs in Puerto Rico under Law 147, July 15, 1999 (Law for the Protection, Conservation, and Management of Coral Reefs in Puerto Rico). At the national level this coral reef program is part of the Coral Reef Initiative under Executive Order 13809 (Coral Reef Protection), which seeks to "preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment." The NMFS Southeast Region's coral reef ecosystem conservation activities in Puerto Rico are managed by the Southeast Fisheries Science Center and the Southeast Regional Office, including the Caribbean Field Office. The activities are also executed pursuant to the Coral Reef Conservation Act, which provides funding for NOAA's Coral Reef Conservation Program. Coral reef ecosystem conservation activities also support and strengthen efforts related to the implementation of NOAA mandates under the Magnuson-Stevens Fishery Conservation and Management Act and the ESA. Hurricanes, namely Hurricane Hugo, caused widespread damage to coral reefs in Puerto Rico; in addition, other factors, such as pollution and damage from commercial and recreational activities, are causing continued decline. Coral reef restoration efforts continue to be made in Puerto Rico, with limited success.

6.6.1.02 Elkhorn coral (*Acropora palmata*) and staghorn coral (*Acropora cervicornis*) are both coral species in the genus Acropora. The NMFS designated critical habitat in Puerto Rico for both elkhorn and staghorn corals in November 2008 and in May 2006, NMFS listed both species as threatened. Staghorn and elkhorn coral are two of the three most important Caribbean corals in terms of their contribution to reef growth and fish habitat. Other corals, including boulder star coral (*Orbicella annularis*), mountainous star coral (*Obicella faveolata, Orbicella franksi*), pillar

coral (*Dendrogyra cylindrus*), and rough cactus coral (*Mycetophyllia ferox*), may also be present, are listed as threatened, and provide essential habitat for fish and reef structure that is protective of inner lagoons and cays.

6.6.1.03 Coral reefs in the Luis Peña Channel are documented since 1927 (Valdez-Pizzini et al. 2008) where most are patch reefs (Pagán-Villegas et al. 1999) and fringing reefs (Vicente 1995) and are described to maintain an extensive development of coral communities healthier than the vast majority of reef communities around Puerto Rico (Hernández-Delgado 2000; Hernández-Delgado and Sabat 2000).

6.6.1.04 Since 1980, populations have collapsed throughout their range from disease outbreaks with losses compounded locally by hurricanes, increased predation, bleaching, elevated temperatures, and other factors. These species are also particularly susceptible to damage from sedimentation.

6.6.1.05 Threats to coral reefs include:

- disease, such as white band disease
- hurricanes
- predation
- bleaching
- algae overgrowth
- sedimentation
- temperature and salinity variation
- low genetic diversity

6.6.1.06 Descriptions, including photographs, of listed corals are included in Sections 3.11 through 3.13.5 of Appendix A of the Environmental SOPs (see Appendix B-1 of this Work Plan).

6.6.2 Seagrass Beds

6.6.2.01 The Culebra seagrass beds have been proposed by the USFWS for designation as Resource Category 1 because these areas are unique and irreplaceable on a national or eco-regional level. Seagrass beds are considered a habitat area of particular concern as a subset of EFH in the U.S. Caribbean under the Magnuson-Stevens Fishery Conservation and Management Act because they provide important ecological functions and/or are especially vulnerable to degradation. Collaboration with NMFS is required for federal projects that may have adverse impacts upon EFH. Seagrass beds are extensive in the Luis Peña Channel (Hernández-Delgado 2003a) comprising the most abundant marine habitat in the Luis Peña Channel (Hernández-Delgado et al. 2002). These beds provide important habitat for a variety of species, including the

endangered green sea turtle. Projects undertaken must not decrease the integrity of this habitat. The Environmental Baseline Survey performed prior to the RI ascertained the location and extents of these seagrass beds so that subsequent survey activities can avoid, or in the case of intrusive activities, minimize damage to these beds. Coordination and collaboration with Puerto Rico DNER is required for any activity occurring within a seagrass bed.

6.6.2.02 The following information is excerpted from Resource Category 1 Designation: The Seagrass Beds of Culebra Island (USFWS 1992).

> "There are about 49 species of plants that have become fully adapted to marine environments. These species are called seagrasses because of their external morphological similarity to terrestrial grasses. These marine flowering plants have undergone very little speciation since and represent less than l % of the 250,000 flowering plants known worldwide. Although little speciation has occurred, seagrasses have developed a necessary adaptation called hydrophilic pollination. There is no equivalent of insect pollinators in aquatic plants.
>
> The association of seagrasses with other tropical or subtropical, shallow marine systems (mangroves and coral reefs) has been known to exist since Cretacean times. However, recent seagrass bed systems developed as the continental and insular shelves became flooded during the Holocene transgression following the Wisconsian Glaciation. Seagrass beds have therefore accumulated and trapped huge amounts of sediments, created and modified shorelines, and probably sustained large turtle, manatee, and fish populations within the West Indian tropics for long periods of time. Seagrass beds continue to keep pace with rising sea levels and fulfill physical and biological functions which ensure the ecological integrity of our coastlines.
>
> There are 4 species of seagrasses within the Culebra archipelago: turtle grass (*Thalassia testudinum*), manatee grass, shoal grass (*Halodule wrightii*), and sea vine (*Halophilia decipiens*). Turtle and manatee grasses are usually found growing together in shallow, protected environments with unconsolidated substrates. Manatee grass occurs as monotypic stands in wave-exposed sandy bottoms. *H. decipiens* is usually found in deeper water but may occur in shallow, turbid water. Shoal grass, with or without manatee grass, is usually found colonizing blowouts or other barren exposed bottoms. *Ruppia maritimea* (widgeon grass) is found only in very shallow semi-enclosed lagoons where salinities of 25 parts per trillion or less may be found because low salinities are required for Ruppia to reproduce sexually. On the other hand, extremely high salinities exclude seagrasses from Flamenco Lagoon, the largest lagoon in Culebra."

6.6.2.03 The seagrass beds of the Culebra archipelago support a large juvenile population of green turtles and are identified as critical habitat for this species.

Measures to Mitigate Potential Impacts to Coral Reefs and Seagrass Beds

6.6.2.04 Coral and seagrass avoidance measures are included in Section 4.3 (Coral and Seagrass Avoidance Measures) of the 2012 SOP, as well as the 2014 (February 2015 Addendum 1) SOP (see Appendix B-1 of this Work Plan). These measures will be followed at all times during the RI/FS activities. Notifications to the NMFS Boquerón Office and DNER will be made in accordance with Section 4.3.9 of the 2012 SOP should any coral be damaged or injured. Any activities causing the damage will be ceased and the coral will be left in place. If any boat runs aground, the boat operator will follow the procedures in Section 4.3.10 of the 2012 SOP. Diving operation procedures are included in Section 4.5 of the 2012 SOP.

6.6.3 Nesting Areas for Birds

6.6.3.01 The cays and coastal areas of Culebra are known nesting areas for shorebirds and seabirds with abundant suitable habitat amongst the rocky shores and cliffs and associated coastal vegetation. The largest seabird nesting colony occurs at Peninsula Flamenco, where 50,000 sooty terns nest. Most of the nesting for birds occurs in the spring and summer months (April through September) though birds may reside year-round. Migratory birds also frequent Culebra along routes of migration and the Culebra National Wildlife Refuge areas provide a haven for these species.

6.6.3.02 Several species of marine birds nest on the island of Culebra and surrounding cays as follows, one of which is listed as threatened species (EEG 2006):

- Brown noddy
- Laughing gull
- Red-billed tropicbird
- White-tailed tropicbird
- Audubon's shearwater
- Bridled tern
- Roseate tern (threatened)
- Cayenne tern
- Sooty tern
- Royal tern
- Sandwich tern

6.6.3.03 It is not anticipated that activities performed during the RI will have adverse impact on nesting seabirds or shorebirds as the nesting areas will not be directly disturbed and disposal

of munitions are not likely to be performed during the RI. Boating operations may be performed near shore where nesting birds are present, which could cause disturbance to nesting birds if present. TtEC will coordinate site activities in consultation through the USACE with USFWS and DNER personnel as required to minimize potential impacts to nesting birds and will attempt to coordinate work schedules so that impacts are lessened for nesting birds.

6.6.4 Terrestrial Reptiles

6.6.4.01 Two endangered and/or threatened species of reptile are present on Culebra and its adjacent cays. Species include the Culebra giant anole (*Anolis roosevelti*) and the Virgin Islands tree boa (*Epicrates monensis granti*). Sections 2.1 and 2.2 of Appendix B to the 2012 SOP contain information and photographs of these species. Critical habitat has been designated for the Culebra giant anole at Monte Resaca, Punta Flamenco, Playa Resaca, and Playa Brava. No critical habitat has been designated for the Virgin Island tree boa on Culebra. Impacts to these species are not likely during the RI/FS because this work will be performed on water, though during travel to and from the sites, these species could be encountered. Sections 3.0, 3.2, and 3.3 of Appendix B to the 2012 SOP will be followed to avoid impacts to these species during the work. The project biologist will brief employees at project start so that these species can be recognized and avoided. All sightings of these species will be recorded on a daily log and reported to the USACE. If the Culebra giant anole is sighted during any field activities, the USACE and USFWS must be notified immediately as specified in Appendix B to the 2012 SOP as these are extremely rare.

6.7 WETLANDS

6.7.01 There are no freshwater wetlands in Culebra. Estuarine and marine wetlands, including conservation priority area lagoons, are the wetland types that could potentially be impacted by work during the RI. Marine wetlands represent 27 percent of the total wetland resources in Puerto Rico. Seagrass beds are included in this category of wetland and are described in Section 6.6.2 above. Long stretches of beach and shore habitats, along with associated buffer areas, are becoming increasingly rare due to agriculture and recreational or commercial activities and development. The principal habitats of concern in Puerto Rico's coastal and estuarine environment are: shoreline, wetland, and adjacent coastal upland areas. Each of these habitats provides a key contribution to the ecological integrity of the overall coastal environment and "ecological significance" is determined by the quality of existing natural habitats, the diversity of species present, and the existence of threatened or endangered species (DNER 2010a).

6.7.02 The USFWS Wetlands Online Mapper was used to identify wetlands within the Culebra Water Ranges. There are several marine and estuarine wetland areas identified in small bays along the Luis Peña Channel of the main island of Culebra and there are extensive seagrass beds in the Luis Peña Channel (Hernández-Delgado 2002; Valdez-Pizzini et al. 2008). Extensive areas of Flamenco Bay are identified as estuarine or marine wetlands. These sensitive areas were

delineated as part of the RI/FS performed by TtEC so that they can be protected during work activities.

6.7.03 It is anticipated that impacts to wetlands will not occur during the Phase 2 of the RI as intrusive investigations will not be performed and conservation measures will be followed for performing work near seagrass beds.

6.8 CULTURAL AND ARCHAEOLOGICAL RESOURCES

6.8.01 The NRIS, NHL list, NHA list, and the National Park Service list one registered property, Faro Isla de Culebritas, which is part of the Lighthouse System of Puerto Rico. This lighthouse is not within the areas that will be worked in during the RI. There are known prehistoric sites on Culebra Island (USFWS n.d.); however, these are documented to be on land and not in the areas where the RI will be conducted. A literature assessment by Valdés Pizzini et al. (2008) showed that there is not extensive information about cultural and archaeological resources for the Luis Peña Channel Reserve.

6.8.02 During the EBS (Phase 1 of the RI), no potential cultural and archaeological artifacts were identified during the course of site activities. During Phase 2 of the RI, if data from geophysical surveys, photos, or video identify potential cultural or archaeological items or structures, the USAESCH PM will be notified. If any known or suspected cultural or archaeological items are found, the location will be marked, a photo will be taken (if possible), and the USAESCH PM will be notified of the finding. Work in the immediate area of an artifact will be halted until a qualified person, typically the State Historic Preservation Officer, can inspect the item.

6.9 WATER RESOURCES

6.9.01 Groundwater on Culebra is scarce and only known to occur in alluvial deposits and in fractures in volcanic and plutonic rocks. Average annual rainfall is 30 to 50 inches, and all aquifer recharge comes from direct rainfall. The public water supply on Culebra comes from a desalination plant located near Lower Town. In some households, municipal water is supplemented with rooftop cisterns or groundwater for non-drinking water uses. There are no permanently flowing surface water streams on Culebra (Parsons 2011).

6.9.02 Groundwater and freshwater resources will not be adversely impacted by project activities and are not the focus of the RI. Care will be exercised to minimize adverse impacts to estuarine or marine wetlands and to preserve sensitive habitats and ecologically and economically important marine and estuarine water resources.

6.10 COASTAL ZONES

6.10.01 The management of the coastal zone was adopted on July 12, 1978, as the Coastal Land Use Plan of Puerto Rico. The lead agency for coastal zone management in Puerto Rico is the DNER, whose primary responsibility is to protect the natural resources of Puerto Rico. The

Planning Board is the government agency responsible for administering the certification process with the Federal Support Program. The NMFS also has jurisdiction in coastal zones. The Coastal Zone of Culebra as described in the Puerto Rico Coastal Zone Management Program (DNER 2008) as "a strip of land one thousand linear meters inland, measured from the coastline, as well as the additional distance necessary to incorporate key natural systems of the coastal environment. In addition, it includes the territorial waters of Puerto Rico and the corresponding submerged lands (three marine leagues, 9 nautical miles or 10.35 land miles), the islands of Vieques, Culebra, Mona, Monito, Desecheo, Caja de Muertos and all keys and small islands within them." All project activities taking place for the Culebra Water Ranges are considered within the Coastal Zone.

6.10.02 In order to access the MRSs, work crews and equipment must be transported by boat. In addition, sonar and marine geophysical detection equipment and snorkeling operations will be used during the RI. Any anchorage areas will be carefully examined following procedures in the 2014 Supplemental SOP and its appendices to protect coral reefs and seagrass beds. Information from bathymetric surveys, snorkel surveys, and remotely operated vehicle photo-documentation collected during the RI will be used to further delineate sensitive habitats and procedures to avoid damage to these resources. Information contained in the 2014 Supplemental SOP and its appendices will be amended as necessary with supplementary information and followed to ensure that anchorage of boats or grounding of boats on sensitive coral reefs does not occur during the follow-on RI. The EBS was performed to help characterize the benthic environment and delineate sensitive habitats and coral reef areas so that provisions to avoid adverse impacts can be planned for during the RI.

6.10.03 TtEC will utilize public or private docks for launching boats. TtEC will not be landing boats onto beaches and will avoid damaging coral reefs, turtle and bird nesting areas, and seagrass beds during this work as outlined in Sections 6.4 through 6.6 of this EPP and the referenced SOPs. Coordination with the USFWS and DNER on this project, as well as meeting regulations or other requirements of the DNER during the RI, will ensure this project adheres to coastal zone management objectives and marine and estuarine water resources. Munitions disposal operations, if they occur (potentially during Phase 3 of the RI but not Phase 2), will be performed in accordance with well-established procedures and through coordination with various agencies.

6.11 TREES AND SHRUBS

6.11.01 There will be no removal of trees or shrubs on this project because this work is being performed wholly within marine areas using existing dock facilities. Beach surveys will not disturb or harm trees and access to work sites will utilize existing docks, roads, trails, and paths whenever possible.

6.11.02 Appendix B to the 2012 SOP, Section 2.3, contains information on Wheeler's peperomia (*Peperomia wheeleri*) and *Leptocereus grantianus*, an unnamed species of spineless cactus, both of which are considered endangered. Information contained in these sections as well as the mitigation measures in Sections 3.0 and 3.4 of this appendix will be communicated to project personnel by the project biologist so that these species can be avoided if there is potential for impact through vegetation disturbance in areas where these species may be present. In addition, association of other canopy species may be an indicator of the potential presence of the Wheeler's peperomia, and particular attention will also be paid to these types of forest canopies. If any of these species are present where work will be conducted or along an intended travel route, the route will be adjusted so that these species are not contacted. Reporting of any finds of these species in work areas or paths will be logged and reported to the USACE as required in Appendix B to the 2014 Supplemental SOP.

6.12 EXISTING WASTE DISPOSAL SITES

6.12.01 There are no known munitions waste disposal sites within the Culebra Water Ranges of Flamenco Bay or the Luis Peña Channel. MEC was used during training exercises and is considered UXO. Discarded military munitions, which are military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal, are not known to be present in these MRSs.

6.13 PROJECT WASTE MANAGEMENT

6.13.01 The following sections describe wastes that may be generated during the RI and the disposition of these wastes. Wastes will be managed, transported, and disposed of in accordance with federal and Commonwealth of Puerto Rico regulations and requirements.

6.13.1 Unexploded Ordnance

6.13.1.01 It is anticipated that MEC, if discovered during the RI, will be identified, photographed, and left in place and position documented.

6.13.1.02 Phase 2 of the RI is a marine EM survey by surface vessel and hovercraft of MRS 3 and MRS 12. These sites are public recreational areas with no restrictions on use or activities. There is no potential for UXO contact or exposure during Phase 2 field activities. However, if the survey team identifies an item that is MEC and it is determined that disposal activities for the MEC are warranted (explosive hazard poses a high risk to site receptors), the related work and its conservation measures plan will be closely developed and coordinated with the TPP Team.

6.13.2 Common Trash

6.13.2.01 Common trash such as food wastes, food containers, and office-related trash will be collected off boats on a daily basis and disposed of in the office trash receptacle. This receptacle will be regularly picked up and disposed of in a local sanitary waste facility as arranged with the Municipality of Culebra.

6.13.3 Vehicle and Boat Maintenance Fluids

6.13.3.01 Project vehicle and boat maintenance (e.g., oil changes), if required during the project, will be performed by TtEC personnel, or a vendor on Culebra. Disposal and/or recycling of waste materials will be performed in accordance with local rules and regulations.

6.13.4 Sanitary Wastes

6.13.4.01 Sanitary wastes from boats equipped with U.S. Coast Guard–approved marine sanitation devices and grey water from hand washing will be regularly pumped out at/by an approved facility at a public or private dock.

6.14 WASTE TRANSPORTATION AND DISPOSAL

6.14.01 Waste profile sheets are not anticipated to be required based on the anticipated wastes that will be generated during the RI because no special waste or hazardous waste will be generated.

6.14.02 If required (e.g., if unanticipated contaminated wastes require special waste disposal), profile sheets will be coordinated with the intended facility based on their waste acceptance criteria. Waste profile sheets will be submitted for review and signature by the USACE representative. If the disposal facility issues permits for receiving waste, the permit will accompany the waste to the disposal facility when shipped.

6.14.03 Likewise, based on anticipated wastes that will be generated during the RI, manifests are not required, though straight bills of lading may be used to track shipments or for payment purposes.

6.14.04 Munitions are regulated for transportation on public roads though there will be no transportation of MEC items from their in situ location to any land-based disposal area during the RI. No other wastes listed above are regulated for transport on public roadways by the U.S. Department of Transportation, Hazardous Material Regulations. As such, these wastes may either be self-transported to the disposal/recycling facility or a local solid waste vendor affiliated by contract for disposal to the intended facility by contract.

6.14.05 All waste generated during field activities will be properly containerized and disposed of in accordance with all applicable federal and Puerto Rico regulations and through approved channels.

6.14.06 Solid waste facilities will be chosen based on their waste handling permit and waste acceptance criteria. Wastes will only be sent to facilities that are operating in compliance with their permits and applicable federal and Puerto Rico regulatory requirements.

6.15 CONTINGENCY FOR UNANTICIPATED WASTE

6.15.01 If unanticipated wastes are generated during project activities, TtEC will notify the PjM and Safety and Health Manager (SHM), as well as the USACE PM to determine the proper

and safe course of action to properly characterize, containerize, transport, and dispose of the waste. The SHM will ensure hazardous waste trained personnel are identified, and will initiate and identify appropriate sampling and analysis, containerization requirements, waste storage requirements, proper shipping descriptions per the U.S. Department of Transportation, Hazardous Material Regulations, initiate waste profile sheets and manifests for the appropriate Resource Conservation and Recovery Act licensed and permitted facilities, and ensure that the paperwork is completed from point of generation to disposal in accordance with federal and Puerto Rico regulations.

6.15.02 If a waste is discovered during the RI and the waste is not related to project activities, TtEC will notify the PjM, SHM, and the USACE PM. The USACE PM will determine proper federal and local agency notifications to make (e.g., if the waste is not the result of project activities). TtEC will not handle the waste if it is not generated as part of the project.

6.15.03 Depending on the USACE generator status (large, small, or conditionally exempt small quantity generator), hazardous waste disposal (if hazardous wastes are generated) must occur within the required timeframes specified under the regulations (e.g., large quantity generators have 90 days and small quantity generators have 180 days from accumulation start date).

6.15.04 TtEC will also notify the client representative, the Contracting Officer as the Generator of Record, to ensure provisions are made for signature of the waste profile sheet, land disposal restriction, and uniform hazardous waste manifest, and to determine the generator category and disposal timeframe requirements. TtEC personnel cannot sign any of these Generator of Record documents as TtEC or as Agents of the Government unless designated specifically in the contract agreement.

6.16 IMPACT MINIMIZATION MEASURES

6.16.01 Impact minimization procedures, in addition to those discussed throughout this EPP, will include briefing all on-site personnel on applicable health and safety issues as well as the need for minimizing impacts on sensitive biological resources as outlined in this EPP. Methods for recognizing, avoiding, and minimizing potential impacts on the plant and animal species and habitats of concern will be stressed during the on-site training.

6.16.02 Close coordination with environmental resource agencies before and during the project will help ensure impacts to sensitive environments, critical habitats, T&E species, as well as impacts to recreational activities are minimized throughout this project.

6.16.03 Areas disturbed during the RI activities will be kept to the minimum required to accomplish the project tasks.

6.17 BURNING

6.17.01 Burning of materials within or around the Culebra Water Ranges will not be performed during the RI.

6.18 DUST AND AIR POLLUTION CONTROL

6.18.01 Widespread dust control is not anticipated on this project because much of the project takes place on the water. However, control of fugitive dust on the project may include best management practices such as keeping speeds down on dirt or gravel roads to minimize generation of dusts and housekeeping efforts to prevent buildup of dirt or mud on boat decks, equipment, docks, and ramps to prevent the dirt or mud from drying out and causing dust in work areas.

6.18.02 Other emissions sources include vehicles and boats used to transport personnel. All vehicles and equipment will be in good working order, inspected, and will meet applicable vehicle emissions requirements. Vehicles will not be left idling for extended periods of time.

6.19 SPILL CONTROL PLAN

6.19.01 Reporting of spills to state agencies will occur only after discussions with the TtEC PjM and USAESCH PM. Spills on the water are immediately reportable.

6.19.02 For oil or chemical spill notification, call the National Response Center at **800-424-8802.**

6.19.1 Spill Potential

6.19.1.01 Due to the nature of the operations, a spill of pollutants to the environment could occur. The most likely spill is a spill of fuel to water which could occur during operation of boats, primarily during refueling operations. Refueling operations, however, will not be done on the water, other than at the dock. Refueling will be performed following best management practices, including slowing down when filling fuel tanks; knowing the size of the tank, and avoiding topping off the tank. Fuel collars, absorbent pads, and fuel/air separators are tools that can be used to help avoid spills or to contain excess fuel that has accidentally spilled. A fuel collar is a doughnut of absorbent material that fits around the fueling nozzle and catches splashes or drips during refueling. Absorbent pads can be used to wipe up excess fuel or to capture fuel from leaks. A fuel/air separator can prevent the escape of fuel from the air vent during filling.

6.19.1.02 In addition, boats will be maintained in proper working order and subject to a preventative maintenance schedule. Boat operators will also conduct a pre-launch boat inspection every day.

6.19.1.03 In the event of a spill, the largest quantity of pollutant (gasoline) that can reasonably be lost at any one time during refueling is 10 gallons of fuel. If a leak of fuel or other fluids,

such as hydraulic or transmission fluid, occurs on a boat, field personnel will promptly attempt to plug the hole and/or turn off pumps if safe to do so.

6.19.1.04 If the spill occurs on the ground, the material spilled will be bermed with dirt so that the fluid does not spread along the ground surface. Any spills originating from small containers (e.g., fuel cans) will be contained by the use of absorbent materials. Any spill cleanup materials will be contained and managed for disposal according to federal and Puerto Rico regulations.

6.19.2 Other Preventive Spill Control Measures

6.19.2.01 Containers of liquids containing petroleum products (e.g., gas or diesel) or other chemicals with potentially hazardous constituents (paints, lubricants, etc.) will be kept closed when not in use, maintained in original containers with labels affixed, and will be kept in appropriate storage areas (e.g., flammable storage cabinets).

6.19.2.02 TtEC plans to conduct all fueling, maintenance, and repair of vehicles and boats off-site. This practice will decrease the amount of pollutants that need to be stored on the site. Those liquids of a hazardous nature that are absolutely necessary to conduct field operations will be stored in the minimum required quantities.

6.19.2.03 Any spills originating from small containers (e.g., fuel cans) will be contained by the use of absorbent materials.

6.19.3 Emergency Spill Response and Notification

6.19.3.01 The procedures described below will be followed in the event of a spill on-site.

6.19.3.02 All spills, leaks, and fires involving oil or hazardous substances must be reported to the PjM and the SHM as well as the client representative and the National Response Center. The person reporting the leak or spill is required to provide the following information:

- His/her name
- Location of spill and facility number, if known
- Number of injured personnel and nature of injuries, if known
- Substance spilled
- Estimated amount spilled
- Extent of spill
- Estimated rate at which the substance is currently being released
- Estimated time the spill occurred
- Any other pertinent information

6.19.3.03 Minor and major spill procedures are outlined below.

6.19.3.1 Minor Spill Procedure

6.19.3.1.01 A minor spill would involve no immediate threat to human health or the environment (e.g., not cause sheen or discoloration on the water), cause minimal property damage, be readily cleaned up by TtEC crewmembers, be a known substance, and not exceed the reportable quantity for that material. In the event of a minor spill, the appropriate response action is for the responsible person to notify the client and the PjM as well as the National Response Center and supply the responders with as much information as possible. In the case of a spill of contaminated or hazardous materials, the following procedures will be followed:

- Stop the source of the spill if safe to do so (e.g., upright a container, shut off valve, etc.).
- Notify a supervisor (FOL, SSHO).
- SSHO or FOL will immediately notify the PjM, SHM, and client and relay pertinent information. Notify the National Response Center, U.S. Coast Guard, and EQB as required (contact information for agencies is included in Section 6.19.3.3).
- Identify protective clothing or equipment required to respond.
- Contain the spill.
- Neutralize and/or solidify any product.
- Transfer material into appropriate waste containers as directed by the FOL or PjM. Transfer the waste to the appropriate storage area for management and disposal at the direction of the FOL or PjM.
- Document the incident.

6.19.3.2 Major Spill Procedure

6.19.3.2.01 In the event of a major spill where human health and/or the environment is at risk (e.g., spill is to a surface water, persons are injured, there is a risk of fire or explosion from the materials, material spilled is not known, the spilled material is more than can be reasonably handled with on hand resources in a few minutes time, or spills that have or are likely to enter a storm drain or other conveyance), the following procedures shall be followed.

- A spill to surface water may not constitute an immediate hazard to workers; however any spill to surface water is agency reportable and is to be treated as an emergency.
- Isolate the spill area, shut down equipment if safe to do so, and evacuate upwind.
- Keep others from entry into the area.
- If anyone is injured, at risk, or there is a fire or explosion, call 911.
- Notify the FOL and/or SSHO.
- SSHO or FOL will immediately notify the PjM, SHM, and client and relay pertinent information. Notify the National Response Center, U.S. Coast Guard, and EQB (contact

information for agencies is included in Section 6.19.3.3).

- If source of spill is not unknown and other hazards are not likely to exist (e.g., fires, exposures, or explosions), assess extent of spill and identify potential pathways of dispersion. Cover or isolate these pathways in advance of the spill, if feasible, but only if exposures can be avoided.
- Note type, amount, and location of material released. Provide Material Safety Data Sheets for response personnel.

6.19.3.3 Agency Contact Information for Spills

6.19.3.3.01 In the event of a reportable spill, TtEC will notify the following:

- U.S. Coast Guard Sector San Juan (1-787 289-2041)
- National Response Center (1-800-424-8802)
- EQB (1-787-767-8031)

6.20 STORAGE AREAS AND TEMPORARY FACILITIES

6.20.01 A temporary office facility and equipment storage space will be located for use (location is to be determined).

6.21 ACCESS ROUTES

6.21.01 Existing roads will be used to access and transport personnel to dock facilities.

6.22 CONTROL OF WATER RUN-ON AND RUN-OFF

6.22.01 This investigation involves work within marine waters and not land-based activities. There will not be any drainage patterns that are altered by site activities and therefore mitigation procedures will not be required to control water run-on or run-off. Furthermore, TtEC will not conduct any activities that discharge pollutants into waterways or waterbodies. Spill prevention practices and response procedures will be in place to minimize the chances for spills and releases. Waste management and disposal will comply with federal and Puerto Rico regulations.

6.23 DECONTAMINATION OF EQUIPMENT

6.23.01 There is no anticipated decontamination required on this project.

6.24 MINIMIZING AREAS OF DISTURBANCE

6.24.01 Boating activities will be performed to the extent required to map and survey the benthic environment while minimizing harm through direct contact with coral reefs, seagrass beds, and marine mammals or sea turtles. Work areas will be planned in advance so that appropriate resource agencies can review them and scheduled activities will cause minimal potential for impact to the environment. Maps, charts, and aerial photos will help ensure that the areas worked in are minimally disturbed and sensitive areas (coral reefs and seagrass beds) can be avoided. Equipment checks will be performed daily before and during work to ensure data

collection is completed with minimal amount of potential rework. Boat trips to and from the launch will be minimized to the extent possible through proper pre-trip planning to minimize boat traffic overall and the most direct routes with the least potential for impacts to coral reefs and seagrass beds will be used to access the work areas.

6.25 POST-ACTIVITY CLEANUP

6.25.01 Following completion of both daily work and the project, all boats and equipment will be properly secured and stowed. Periods of potential severe weather will require paying particular attention to securing and stowing of gear as required to minimize the potential for damage or materials to be dispersed by wind or rain. Cleaning of boats will only be done in a designated onshore location and laydown area. Trash and sanitary waste will be removed and placed in designated waste receptacles. All waste will be properly disposed of prior to demobilization from the project.

7.0 PROPERTY MANAGEMENT PLAN

7.0.01 This Property Management Plan has been prepared in accordance with DID MR-005-09 and Federal Acquisition Regulations (FAR), Part 45.5 and it supplements to provide detailed information on the types, quantities, and sources of equipment and materials that will be required to perform field and office operations on this Task Order. Field operations include all activities to be performed to complete the fieldwork. Office operations include all tasks performed in support of project management and the implementation of project work in the field through completion consistent with the requirements of the Scope of Work (Appendix A). The types of equipment recommended, selected, and proposed for this work are those that have been tested and proven in the industry and, therefore, are reliable to use in performing the various activities associated with this project. The quantities proposed are needed to help perform the work in a timely and cost-effective manner as dictated by the project schedule.

7.1 FIELD EQUIPMENT

7.1.1 Survey Equipment

7.1.1.01 Survey vessel and equipment that will be used during the Phase 2 RI are described in detail in Section 3, Field Investigation Plan.

7.1.2 Transportation Equipment

7.1.2.01 Various types of transportation equipment will be required during field operations. Vehicles required during the project may include standard automobiles and pickup trucks with vessel trailers.

7.1.3 Safety Gear

7.1.3.01 The RI is non-invasive and no contact with potential MEC is expected. Appropriate PPE for vessel operations will be worn and may include, but is not limited to, boots, leather work gloves, latex or nitrile gloves, hardhats, and safety glasses. Personnel will typically conduct their operations in Level D PPE consisting of standard work clothes with long pants, safety boots (as needed), hard hats (when overhead hazard is present), safety glasses or face shields (as needed), and hearing protection (as needed). Personnel working away from active field investigations will not be required to wear safety boots or hard hats.

7.1.4 Communication Equipment

7.1.4.01 Communications equipment to be used includes handheld two-way radios, very high frequency (VHF) radios, and cellular telephones.

7.1.5 Office Equipment

7.1.5.01 The majority of the survey equipment to be used on this project, including the vessel, will be brought to the site from the TtEC office in Bothell, Washington, with support from the office in TtEC office in Carolina, Puerto Rico. Most of the equipment (for example,

vessel, TEMA-MK3, TEMA-Lite, hovercraft, underwater video, GPS equipment, radios, computer-aided design and drafting or GIS workstations, computers, printers, plotters, etc.) is owned by TtEC, and the charges to the project will be as proposed for this Task Order. However, some items may need to be rented or purchased for fieldwork.

7.1.6 Consumable Supplies

7.1.6.01 Consumable supplies planned for the purchase in support of the RI/FS include but are not limited to:

- Fuel for vessels, vehicles and equipment;
- Disposable gloves and leather work gloves;
- Potable water;
- Eye wash;
- First aid kits;
- Fire extinguishers;
- Log books; and
- Ink cartridges for printers and copy paper.

7.1.7 Vendors and Associated Costs

7.1.7.01 TtEC will provide the majority of the field and office equipment; however, certain types of equipment and materials will be rented, leased, or purchased from vendors with proven records of furnishing well-maintained, reliable, and updated equipment that can be used to successfully complete the field and office operations. General cost estimates on the types, quantities, and sources of equipment proposed for the RI/FS are summarized in Table 7-1. The majority of consumable supplies will be provided by local vendors; however, some consumables may be purchased from specialty vendors.

Table 7-1. List of Equipment

Office/Field Operations	Equipment Type (or equivalent)	Number of Units	Anticipated Source	Status
Communication during fieldwork	VHF radios, Motorola handheld radios and cellular telephones	8-15	TtEC	Own*
Interpretation of field data and information processing	Field laptop computers, printer, scanner	3	TtEC and local vendor	Own* and purchase
Survey Operations	TEMA-MK3	1	TtEC	Own*
	TEMA-Lite	1	TtEC	Own*
	underwater cameras	4-10	TtEC	Own*
	GPS	4-6	TtEC	Own*
	USBL	1	TtEC	Own*
Survey Operations	Vessels	2-3	TtEC	Own*

Table 7-1. List of Equipment (continued)

Office/Field Operations	Equipment Type (or equivalent)	Number of Units	Anticipated Source	Status
Transportation of personnel and equipment	Jeep, pickup, golf cart, etc.	4-6	Local Vendor	Lease
	Pickup truck(s)	1-2	TtEC	Own*
	Vessel trailer(s)	2	TtEC	Own*
	Equipment trailer	1	TtEC	Own*
Field office	Portable trailer/rental house or apartment	1	Local Vendor	Lease
Sanitation	Portable toilets	3	Local Vendor	Rent
Remote office processing of data and development of maps/graphics	Desktop computers, laptop computers, GIS workstation, printers/copiers/plotters	4	TtEC	Own*
Photo documentation of fieldwork	Digital cameras	2	TtEC	Own*
Field safety	AED	1	TtEC	Own*

* Equipment is owned and maintained by TtEC and will be rented to the project at the contract rates.

7.1.8 Procurement Procedures

7.1.8.01 Equipment will be leased or rented, and consumables and supplies will be purchased in a procurement process in strict conformance with the FAR and Defense Federal Acquisition Regulations. There are no known instances where purchase of equipment on behalf of the government will be required on this project. TtEC will follow standard procurement procedures for all purchases. TtEC will acquire at least three quotes for each item and a comparison of rental versus purchase of each item will be performed in accordance with FAR thresholds.

7.1.9 Leased and Rented Vehicles

7.1.9.01 The leased vehicles will be selected using the comparison of rate quotes from at least three commercial vendors. The number of vehicles will be determined by one vehicle for approximately four personnel working on-site. The type of vehicles used will be determined by the site's physical conditions, such as terrain, weather conditions, and distances between lodging, the site office, and the fieldwork area. Any exceptions will be justified by TtEC and approved by the Contracting Officer.

7.1.10 Consumable Supplies and Personal Property

7.1.10.01 TtEC's disclosed accounting practices prescribe that all materials and supplies required for the performance of the contract and Task Order will be direct charged to that order, and such materials and supplies are not included in the basis for overhead computation. The only exception is limited to home office supplies and equipment such as letterhead, pens, pencils, standard personal computers, office furnishings, etc. Field office supplies are typically direct charged to the project and not included in the overhead computation.

7.1.11 Property Storage Plan

7.1.11.01 The site office will be used to store purchased items for the RI/FS. If needed, an off-site storage unit will be rented. TtEC-owned property will be segregated from government property.

7.1.12 Ultimate Disposal Plan

7.1.12.01 Non-consumable items purchased on time and material (T&M) tasks will be reassigned to other government projects at the end of the project. TtEC will provide an inventory to USAESCH and request further direction for transfer/disposal details.

7.1.13 Property Tracking Plan

7.1.13.01 An inventory list will be maintained by TtEC for the non-consumable items purchased on T&M tasks for the RI/FS. When applicable, the serial number, model or manufacturer, date purchased, present location of item, cost, current status (functional, need of repair, needs batteries, etc.), and a description of the item are recorded on the inventory list. A property tracking log report will be submitted to USAESCH that will list all TtEC-acquired property that is directly charged to the Task Order on T&M tasks. The property tracking log report will be submitted at the conclusion of the field investigation.

7.1.14 Loss Notification

7.1.14.01 For all non-consumable items purchased on the inventory for the RI/FS, TtEC will notify the Contracting Officer if the item is lost, damaged, stolen, or destroyed.

8.0 INTERIM HOLDING FACILITY SITING PLAN FOR RECOVERED CHEMICAL WARFARE MATERIEL (RCWM) PROJECTS

8.0.01 Section 8 is not applicable to this project and will serve as a placeholder section only.

9.0 PHYSICAL SECURITY PLAN FOR RCWM PROJECT SITES

9.0.01 Section 9 is not applicable to the project and will serve as a placeholder section only.

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APPENDIX A

SCOPE OF WORK

SCOPE OF WORK

This work plan describes the EM survey to be conducted in accordance with paragraph 3.4.1.4, Optional Task 4.a4 (Magnetometer/EM Survey), and 3.4.2.4, Optional Task 4.b4 (Magnetometer Survey) of the Performance Work Statement (PWS) for the Remedial Investigation / Feasibility Study, Culebra Water Ranges, Culebra, Puerto Rico, I02PR0068. The relevant section from the PWS is excerpted below.

3.4 Task 4, RI/FS Field Activities: This is a Cost Plus Fixed Fee Price task.

Objective: Conduct a remedial investigation in accordance with CERCLA, characterizing the nature and extent of MEC contamination at the required munitions response sites (MRS) meeting the project DQOs as defined during the TPP process. This task shall include all field activities necessary to execute this task except MC sampling. MC sampling requirements are covered under Task 12, Environmental Sampling & Analysis.

3.4.1 Task 4a, MRS 03 Flamingo Bay Water Area (195 acres), FUDS Project No. I02PR006803M01. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.1.1 Optional Task 4a1, Bathymetry. This task is Cost Plus Fixed Fee (CPFF).

3.4.1.2 Optional Task 4a2, Side Scan Sonar. This task is Cost Plus Fixed Fee (CPFF).

3.4.1.3 Task 4.a3, ROV/AUV Underwater Video. This task is Cost Plus Fixed Fee (CPFF).

3.4.1.4 Optional Task 4.a4, Magnetometer/ EM Survey. This task is Cost Plus Fixed Fee (CPFF).

3.4.1.5 Optional Task 4.a5, Intrusive Investigation. This task is Cost Plus Fixed Fee (CPFF).

3.4.2 Optional Task 4b, MRS 12 Luis Pena Channel Water Areas (835 acres), FUDS Project No. I02PR006812M01. Refer to historical project documentation of site location, historical information, and boundaries

3.4.2.1 Optional Task 4b1, Bathymetry. This task is Cost Plus Fixed Fee (CPFF).

3.4.2.2 Optional Task 4b2, Side Scan Sonar. This task is Cost Plus Fixed Fee (CPFF).

3.4.2.3 Optional Task 4.b3, Remote Operated Vehicle. This task is Cost Plus Fixed Fee (CPFF).

3.4.2.4 Optional Task 4.b4, Magnetometer/ EM Survey. This task is Cost Plus Fixed Fee (CPFF).

3.4.2.5 Optional Task 4.b5, Intrusive Investigation. This task is Cost Plus Fixed Fee (CPFF).

3.4.3 The following applies to all MRSs:

Performance Standard: Field work, data quantity and quality, and analysis of said data (does not include area where Rights-of-entry were not obtained) provides the following results in the RI report:

- Demonstrate that the work was performed in accordance with the applicable laws, regulations, and guidance documents;
- Demonstrate that areas with elevated anomaly density or with potential to contain MEC are traversed and that there is at least 90% chance of detecting these areas.
- Demonstrate that the boundaries of all identified MEC contaminated areas have been delineated to an accuracy of at least +/- half the transect spacing, maximum 250 feet.
- Demonstrate that data inputs from the RI into the FS will enable remediation cost estimates with an accuracy of +50%/-30%. The work and reporting shall address the surface and sub-surface metallic anomaly density distribution (anomaly/acre) across identified MEC contaminated areas and other remediation cost drivers such as vegetation type and density, terrain conditions, soil type, exclusion zone evacuation costs, etc each to a level of accuracy within the range specified herein.

Additionally:

- Perform the RI field activities in accordance with the accepted Work Plan, QASP and UFP-QAPP.
- Proper processing and disposition of UXO, DMM and MC encountered in accordance with approved plan(s).
- All Material Potentially Presenting an Explosive Hazard (MPPEH) and munitions debris processed in accordance with Chapter 14, EM 1110-1-4009 and Errata Sheet No. 2.
- Meet the project DQOs as defined by the TPP process.
- All geophysics shall be IAW geophysics DID or as agreed to by the PDT Marine field work QC shall be recommended by the Contractor in the QCP. Government QA is expected to be limited to visual observation of the Contractors field work and QC operations due to the dynamics of this high energy environment. The government recognizes that submerged metallic items have the potential to move great distances due to the local current and surf conditions and that prolonged seeding of test items may not be feasible. The government requests that the Contractor submit a modified QC Requirements table for government acceptance for the marine and beach portions of the project to meet the needs of the project and still insure acceptable data quality to meet the project objectives. For this task order 1 acre of transects equals 14,520 lf (2.75 miles) of transects 3 feet wide. One acre's worth of grids equals seventeen (17) 2500 sf grids or four (4) 10,000 sf grids.

AC: Conduct the RI in accordance with the accepted/approved WP, UFP-QAPP, and ESP. QC data submitted meets requirement described in the most recent geophysics and chemistry DIDs or QCP that has been accepted by the PDT.

- No more than 3-4 CARs/948s for non-critical violations and/or 1 CAR/948 for critical violation. No unresolved corrective action requests.
- All final data and QC tests/documentation submitted. Government QA acceptance of QC tests/documentation gained.
- No Class "A" Safety accidents, contractor at fault; <1 non-explosive Class C accidents; and <2 non-explosive related Class D accidents, IAW AR 385-40.
- Major safety violations, no more than 1 non-explosive related safety violation.
- Minor safety violations, no more than 2 safety violations.
- Zero letters of reprimand, grievances, or formal complaints.

Measurement / Monitoring: Period inspection/review of field work. Verify compliance with accepted WP, UFP-QAPP and Dive Plans as applicable. Quality control tests/documentation submitted per the QASP for government review. Additionally, statistical confidence will be calculated using the Visual Sampling Plan software, UXO Estimator or other approved statistical method. Boundary precision will be determined by evaluation of the sampling footprint as it relates to the reported contaminated/uncontaminated areas in question. Anomaly density profile and other remediation cost driver precision will be verified by QA of methods used.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements:

- Restore all areas to their original condition; all access/excavation/detonation holes shall be backfilled.
- Maintain a detailed accounting of all UXO, DMM, MD and range-related debris encountered per DID WERS-004.01. This accounting shall include: amounts of UXO, DMM and MD; nomenclature; location and depth of UXO/DMM; location of MD; and final disposition. The accounting system shall also account for all demolition materials utilized on-site. Digital photographs of UXO and DMM and examples of MD found during the investigation are to be taken.
- All UXO, DMM and MC encountered during this munitions response shall be processed in accordance with the approved work and safety plans.
- To the maximum extent practicable, the permanent record shall include sensor data that is digitally-recorded and geo-referenced. Exceptions to the collection of sensor data that is digitally-recorded and geo-referenced should be limited primarily to cases where impracticable.
-Perform visual survey of surface MEC
-Perform biological survey of all species of coral and other threatened and endangered plant species.

APPENDIX B

STANDARD OPERATING PROCEDURES

Appendix B-1	Supplemental Standard Operating Procedures for Endangered Species Conservation and Their Critical Habitat, February 2014 (Addendum 1, February 2015); also includes 2012 and 2008 SOPs
Appendix B-2	Standard Operating Procedure – Hovercraft Operations
Appendix B-3	Final Standard Operating Procedure for Digital Geophysical Mapping
Appendix B-4	Standard Operating Procedure for Geophysical Data Processing and Management
Appendix B-5	Geophysical System Verification and Instrument Verification Strip Plan

APPENDIX B-1

SUPPLEMENTAL STANDARD OPERATING PROCEDURES FOR ENDANGERED SPECIES CONSERVATION AND THEIR CRITICAL HABITAT, FEBRUARY 2014 (FEBRUARY 2015 ADDENDUM 1)

This Appendix contains the following:

- February 2015 Addendum 1 to the Supplemental Standard Operating Procedures for Endangered Species Conservation and Their Critical Habitat, February 2014
- Supplemental Standard Operating Procedures for Endangered Species Conservation and Their Critical Habitat, February 2014
  - Appendix A: SOPs for Endangered Species Conservation and their Critical Habitat during Underwater Investigations – April 2012
    - *Appendix A*—SOPs for Endangered Species Conservation and their Habitat (July 2008)
    - *Appendix B*—Addendum to the 2008 SOPs (April 2011)
  - Appendix B: Guide with the Minimum Information Required for the Daily Observer Log Sheet
  - Appendix C: Recommended Coral Relocation and Reattachment Protocol
  - Appendix D: List of seabirds that occur in the Project Area
  - Appendix E: Equation to calculate the potential extent of acoustic impacts from underwater detonations

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

CESAJ-PM-M

FEB 25 2015

MEMORANDUM FOR SEE DISTRIBUTION LIST

SUBJECT: Final Supplemental Standard Operating Procedures (SOP) for Endangered Species Conservation and their Critical Habitat (Addendum 1 – February 2015), Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS) Property No. I02PR0068, Culebra, Puerto Rico

The Jacksonville District, U.S. Army Corps of Engineers is enclosing for your records a copy of the Final Supplemental SOP for Endangered Species Conservation and their Critical Habitat (Addendum 1 – February 2015). A copy of the draft Addendum was provided to the resource agencies via e-mail for review and comment on December 1st, 2014. Review comments from the National Marine Fisheries Service (NMFS) and the Puerto Rico Environmental Quality Board (EQB) were received on December 5th, 2014 and January 7th, 2015, respectively. Responses to comments as well as the revised Addendum 1 were provided to NMFS and EQB on February 13, 2015.

Should you need additional information, please contact me at 904-232-1758 or by e-mail at John.E.Keiser@usace.army.mil or Mr. Wilberto Cubero at 904-232-1426 or by e-mail at Wilberto.Cubero-Deltoro@usace.army.mil.

Sincerely,

Encls

John E. Keiser, P.E.
FUDS Program Manager
Military/Interagency &
International Service Branch

Distribution List Final Supplemental SOP for Endangered Species Conservation and their Critical Habitat (Addendum 1 – February 2015), DERP-FUDS Property No. I02PR0068, Culebra, Puerto Rico	
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FINAL

Supplemental Standard Operating Procedures for Endangered Species Conservation and their Critical Habitat

DERP-FUDS Property No. I02PR0068
Culebra, Puerto Rico

US Army Corps of Engineers
Jacksonville District

February 2014
(Addendum 1 February 2015)

ADDENDUM 1

SUPPLEMENTAL STANDARD OPERATING PROCEDURES
ENDANGERED SPECIES CONSERVATION AND HABITAT PROTECTION
DERP-FUDS PROJECT NO. I02PR0068, CULEBRA, PUERTO RICO

1.0 PURPOSE AND NEED

The purpose of this document is to 1) supplement, not replace, the *February 2014 Supplemental Standard Operating Procedures (SOPs) for Underwater Investigations for Defense Environmental Restoration Program for Formerly Used Defense Site (DERP-FUDS) Project No. I02PR006802, Culebra, Puerto Rico*, 2) serve as guidance for USACE and its Contractors in order to avoid or minimize impacts to listed species and their designated critical habitat and species proposed for Endangered Species Act (ESA) listing during geophysical surveys, intrusive investigations/MC environmental sampling, and controlled detonation activities, 3) satisfy the substantive requirements of the ESA, 4) incorporate newly listed species, and 5) update the POC list for coordination and reporting.

2.0 LISTED OR PROPOSED FOR LISTING SPECIES

A description of threatened or endangered species and their habitat as well as species proposed for listing that are known to occur or have the potential to occur in the waters around Culebra Island and adjacent cays have been discussed in the previously developed and coordinated SOPs listed below.

a. SOPs for Endangered Species Conservation and their Habitat – July 2008

b. Addendum to the July 2008 SOPs – April 2011

c. SOPs for Endangered Species Conservation and their Critical Habitat during Underwater Investigations – April 2012

d. Supplemental SOPs for Endangered Species Conservation and their Critical Habitat during Underwater Investigations – February 2014

Subsequent to the February 2014 supplement, ESA listing decisions became final and additional species have been proposed for listing as threatened or endangered under the ESA. The species for which ESA listing decisions are now final and additional species now proposed for ESA-listing are discussed below:

a. On September 10, 2014, the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (79 FR 53851) to list 20 coral species as threatened under the ESA (effective date October 10, 2014). Five of these species are known to occur in Puerto Rico including: Pillar Coral (*Dendrogyra cylindrus*), Rough Cactus Coral (*Mycetophyllia ferox*), Lobed Star Coral (*Orbicella annularis*), Mountainous Star Coral (*Orbicella faveolata*), and Boulder Star Coral (*Orbicella franksi*)(genus *Orbicella* formerly known as *Montastraea*). In addition, the determination to maintain the status of Elkhorn Coral (*Acropora palmata*) and Staghorn Coral (*Acropora cervicornis*) as threatened rather than changing their listing to endangered was included in this final rule. Please note: the listed species common names above were taken from the final rule (79 FR 53851) and supersede those in 2012 SOPs for Endangered Species Conservation and their Critical Habitat during Underwater Investigations – April 2012, Page 21 Section 3.13 Species of Corals Proposed for Listing under the ESA, Page 23: Section 3.13.2.1, and Page 24 Section 3.13.2.3.

b. On September 2, 2014, NMFS published a final rule in the Federal Register (79 FR 38213) to list the Central and Southwest (SW) Atlantic Distinct Population Segment (DPS) of Scalloped Hammerhead Shark (*Sphyrna lewini*) as a threatened species under the ESA. NMFS is also considering critical habitat for the Central & SW Atlantic DPSs. These DPSs include the U.S. Caribbean. NMFS does not currently have any explosive guidelines specific to sharks. For the scalloped hammerhead a conservative estimate is application of the predictive equations and example calculations for fish from 2014 SOPs, Appendix E, Section 4.2. However, this species isn't expected to be common in the work area given the shallow depths and overfishing. Because this is an underwater species that doesn't need to surface to respire, perhaps the highest potential for observation would be through diver survey prior to any intrusive work. However, sharks could still swim into the area and not be seen. Sharks should be far more resilient to pressure wave injury than air bladdered fish, turtles, and marine mammals because they have no swim bladder (or air containing organs). External injury (eyes, gills, scale loss, contusions) or auditory damage could occur if the shark is fairly close to the blast. However, mortal injury or death is unlikely. Therefore, the acoustic impact calculations for fish from the 2014 SOPs will be used to establish zones of influence for sharks during in-water detonation/blow-in-place activities.

c. On September 2, 2014, NMFS issued a proposed rule and request for comments (79 FR 51929) and announced a 12-month finding and listing determination on a petition to list the Nassau Grouper (*Epinephelus striatus*)

as threatened or endangered under the ESA. The 105 day document comment period ends on December 31, 2014.

d. On November 5, 2014, NMFS announced a 12-month finding (79 FR 65628) and listing determination on a petition to list the Queen Conch (*Strombus gigas*) as threatened or endangered under the ESA. NMFS completed the status review and determined that there was not enough evidence to warrant listing at this time.

3.0 MEASURES TO AVOID OR MINIMIZE POTENTIAL IMPACTS

The measures in the SOPs listed in Section 2.0 above will be implemented to minimize the risk of unintended impacts to these newly listed species, species proposed for ESA-listing, and all other threatened or endangered species and their habitat during RI/FS underwater investigation. Activities that may pose potential impacts to listed species include, but are not limited to running aground, accidental collision or vessel strike, personnel during snorkeling and diving operations, equipment [e.g. multi-beam, side scan sonar, remotely operated vehicle (ROV), hand-held magnetometers, electromagnetic (EM) platforms, and video cameras], intrusive investigations requiring excavation of the marine bottom, removal and transport of anomalies from underwater locations to terrestrial collection points, and accidental detonation.

By implementation of these measures, adverse impacts to listed species or their habitats are expected to be avoided or minimized. It should be noted that the Contractor will be required to implement these SOPs during any underwater work.

The POC list for coordination and reporting from the February 2014 Supplemental SOP has been updated and is presented below.

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US Army Corps of Engineers
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D. List of seabirds that occur in the Project Area

E. Equation to calculate the potential extent of acoustic impacts from underwater detonations

LIST OF ACRONYMS

DERP	Defense Environmental Restoration Program
DM	Decision Matrix
DNER	Department of Natural and Environmental Resources
EBS	Environmental Baseline Survey
EQB	Environmental Quality Board
EM	Electromagnetic
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESP	Explosives Site Plan
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
FWS	U.S. Fish and Wildlife Service
GPS	Global Positioning System
MC	Munitions Constituent
MD	Munitions Debris
MDAS	Material Documented as Safe
MEC	Munitions and Explosives of Concern
MPPEH	Material Potentially Presenting an Explosive Hazard
MRA	Munitions Response Area
MRS	Munitions Response Sites
Navy	Department of Navy
NMFS	National Marine Fisheries Service
QC	Quality Control
RI	Remedial Investigation
ROV	Remote Operated Vehicle
SCUBA	Self Contained Underwater Breathing Apparatus
SLRA	Screening Level Risk Assessment
SOPs	Standard Operating Procedures
TPP	Technical Project Planning
UIT	Underwater Investigation Team
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
UXO	Unexploded Ordnance
WP	Work Plan

SUPPLEMENTAL STANDARD OPERATING PROCEDURES
ENDANGERED SPECIES CONSERVATION AND HABITAT PROTECTION
DERP-FUDS PROJECT NO. I02PR0068, CULEBRA, PUERTO RICO

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) is conducting Environmental Baseline Surveys (EBS) on Culebra Island Munition Response Sites (MRSs) underwater portions. The EBS is the first of three (3) phases of the Remedial Investigation (RI) being conducted within these areas. The RI is comprised of the following phases:

a. Phase I – Hydrographic Survey and Underwater Visual Surveys.

b. Phase II - Geophysical Surveys to detect metallic anomalies.

c. Phase III - Intrusive Investigations/Munitions Constituents (MC) Environmental Sampling.

The overall objective of the RI/Feasibility Study (FS) is to determine the nature and extent of any contamination related to munitions and explosives of concern (MEC) and/or MC within the underwater portions of these MRSs. The main objectives of the underwater investigations are to a) characterize and map benthic habitats within investigation areas, b) determine, identify and map endangered or threatened species, in particular coral colonies, c) gather the necessary information to determine potential effects (e.g. location of species versus location of suspected MEC) on endangered or threatened species during remedial investigations and cleanup activities, d) determine presence or absence of MC and MEC, e) characterize the nature and extend of MC and MEC presence, and f) determine if the MC or MEC pose an unacceptable risk to human health and the environment, which would require further considerations or a response action.

2.0 PURPOSE AND NEED

The purpose of this document is to 1) supplement, not replace, the *April 2012 Standard Operating Procedures (SOPs) for Underwater Investigations for Defense Environmental Restoration Program for Formerly Used Defense Site (DERP-FUDS) Project No. I02PR006802, Culebra, Puerto Rico* 2) serve as guidance for USACE and its Contractors in order to avoid or minimize impacts to listed, or proposed for listing, species and their designated critical habitat during geophysical surveys, intrusive investigations/MC environmental sampling, and controlled detonation activities, and 3) satisfy the substantive requirements of the Endangered Species Act (ESA).

3.0 LISTED OR PROPOSED FOR LISTING SPECIES

A description of threatened or endangered species and their habitat as well as species proposed for listing that are known to occur or have the potential to occur in the waters around Culebra Island and adjacent cays have been discussed in previously developed and coordinated SOPs. The following SOPs are being incorporated by reference into this document and they can be found in **Appendix A**:

a. SOPs for Endangered Species Conservation and their Habitat – July 2008

b. Addendum to the July 2008 SOPs – April 2011

c. SOPs for Endangered Species Conservation and their Critical Habitat during Underwater Investigations – April 2012

4.0 MEASURES TO AVOID OR MINIMIZE POTENTIAL IMPACTS

The following measures will be implemented to minimize the risk of unintended impacts to threatened or endangered species and their habitat during RI/FS underwater investigation. Activities that may pose potential impacts to listed species are, but not limited to running aground, accidental collision or vessel strike, personnel, snorkeling and diving operations, equipment (e.g. multi-beam, side scan sonar, remotely operated vehicle (ROV), hand-held magnetometers, electromagnetic (EM) platforms, and video camera), intrusive investigations requiring excavation of the marine bottom, removal and transport of anomalies from underwater locations to terrestrial collection points and accidental detonation.

By implementation of these measures, adverse impacts to listed species or their habitats are expected to be avoided or minimized. It should be noted that the Contractor will be required to implement these SOPs during any underwater work as well as the previously coordinated SOPs included in Appendices A.

4.1 General Conservation Measures

4.1.1 Date of Commencement: The Contractor will provide USACE with a written notification of the date of commencement of underwater investigation work and a detailed description of the work to be implemented based on the Work Plan (WP) that will be coordinated and reviewed by Technical Project Planning (TPP) Team. USACE will provide the date of commencement to the TPP Team at least 10 days prior to initiating fieldwork.

4.1.2 Training/Briefing: Prior to initiating work all personnel shall receive training or briefings regarding the importance of endangered species, their characteristics, how they can be identified, potential and critical habitats, types of material in which they may hide, actions

to take if are sighted, and avoidance measures to be followed as detailed in the SOPs. For additional information refer to **Appendix A**. This training or briefing shall be prepared and offered by qualified personnel (e.g. biologist, marine biologist, environmental scientist, among others). The Contractor shall submit their qualifications to the USACE for review and approval. The training or briefing will also include safety and emergency procedures.

4.1.3 Civil and Criminal Penalties: The Contractor shall instruct all personnel associated with the project of the potential presence of threatened or endangered species. All personnel shall be advised that there are civil and criminal penalties for harming, harassing, killing or otherwise altering the natural behavior or condition of threatened or endangered species protected under the ESA, the Puerto Rico Wildlife Law, the Puerto Rico Coral Reef Conservation Law and the Regulation to Govern the Endangered and Threatened Species of the Commonwealth of Puerto Rico. ESA gives both the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) responsibility for enforcing its provisions. The Commonwealth regulations to protect endangered and threatened species are enforced by the Puerto Rico Department of Natural and Environmental Resources (DNER).

4.1.4 Qualified Personnel: Each team performing underwater investigation work shall be accompanied on the boat, but not necessarily in the water, by qualified and experienced personnel (e.g. biologist, marine biologist, environmental scientist, among others) in order to identify the presence or absence of threatened or endangered species. The Contractor shall submit their qualifications to the USACE. The self contained underwater breathing apparatus (SCUBA) divers or snorkelers can request that the designated and qualified personnel on the boat to enter the water to identify and determine if a suspected threatened or endangered species is present in the study area.

4.1.5 Reports: The Contractor shall maintain a log detailing endangered or threatened species sightings in terrestrial and marine habitats. The log shall include, but not be limited to, the following information: date and time, location coordinates using a Global Positioning System (GPS) unit, species, one or more photographs, if possible, and any actions taken (e.g. species identification and distance from working area, reasons to cease operation, reasons to determine that operation may be resumed, among others) during the work period. All data shall be provided to USACE to be shared with the TPP. **Appendix B** includes a guide with the minimum information required for the Daily Observer Log Sheet.

4.2 Non-Intrusive Geophysical Underwater Investigation Conservation Measures

The following supplements but does not replace conservation measures established in the SOPs listed in Section 3.0 above.

4.2.1 All transect sections with scattered coral, reef, or colonized hard bottom will be surveyed with a method which results in no contact with the sea floor or with coral heads that

extend close to the water surface. Detailed information on the appropriate equipment selection process will be provided in the WP and coordinated with the TPP Team. The equipment/system used in any underwater MRS portion will depend primarily on personnel safety, depth of water, and type of habitat present.

4.2.2 While several systems and EM platforms may be used during geophysical surveys, it is possible that in areas with varying amounts of submerged aquatic vegetation (e.g. seagrass) a system that is designed to come in contact with the sea floor may be used. For Quality Control (QC) purposes, prior to conducting the survey, a single transect across an area of submerged aquatic vegetation coverage will be surveyed using the proposed system. Qualified personnel will perform an assessment of the test area to determine if any adjustment is necessary to minimize disturbance to sand, macro algae and seagrass. After work is complete, the surveyed area will be inspected to ensure no impact to submerged aquatic vegetation has occurred.

4.2.3 In shallow water areas (1 to 4 feet) where contact with the bottom is not desired, the EM coil will be floated or will be suspended beneath a floating platform.

4.2.4 In areas with coral that are too deep for the floated system, or in areas containing coral heads with high relief, an ROV platform may be used to propel the EM coil along the transect while ensuring contact with the coral head is avoided. If the ROV EM platform is not suitable for selected transect segments these segments will be surveyed by divers or snorkelers as an instrument aided visual transect.

4.2.5 Divers/snorkelers will use handheld magnetometers to identify metallic anomalies, which may represent MEC or MPPEH. All equipment shall be used in a manner to avoid physical contact with corals.

4.2.6 QC will be established at all times to ensure appropriate pre-selected equipment is used throughout underwater investigation work as coordinated with TPP Team.

4.2.7 Anomalies along transects may be investigated upon discovery. Intrusive investigation will be conducted following measures listed in the next section (4.3).

4.3 Intrusive Underwater Investigation and Material Potentially Presenting an Explosive Hazard (MPPEH) Relocation Conservation Measures

Certified unexploded ordnance (UXO) divers/snorkelers will conduct the anomaly intrusive investigations. If the anomaly is at the surface, the investigation will be completed without disturbing the area or item, and if the anomaly is buried in sediments it will be uncovered by excavating down to the anomaly using hand tools, then the investigation will be performed to determine the vertical extent and boundaries of contamination and possible remedial actions.

Following are the measures to be implemented to protect listed species and their habitat during intrusive investigation. It should be noted that during all intrusive investigation phases qualified observers shall be present to scan the work area for sea turtles and marine mammals and take necessary measures to protect the species.

4.3.1 Excavations will be conducted in unconsolidated sediments and seagrass areas only. If the anomaly is located within coral or hardbottom areas the anomaly will be investigated visually only. However, if the anomaly is not encrusted in hardbottom or coral and can be easily removed by hand and has no coral colonization by listed or proposed corals, it can be removed and relocated to the designated processing area.

4.3.2 Divers will film and take pictures of the area around the anomaly to be investigated. If the anomaly is located in corals or hardbottom areas, divers will investigate an area with a three (3) meter radius, the center of which is the anomaly. Within that area, divers will determine the distance to and location of all listed and proposed coral. The pictures shall include measurements of distance between anomalies and listed or proposed corals and size of item. Care will be taken to avoid damaging corals or seagrass, if present.

4.3.3 If the anomaly is suspected to be MPPEH, a visual device will be placed temporarily next to the munition to provide a reference point for later investigation. This device shall have enough weight to remain in place without skipping along the bottom to avoid impact to corals until the investigation is complete. Once the investigation is complete, it will be removed.

4.3.4 UXO divers/snorkelers investigating anomalies within seagrass areas will be careful to maintain root systems as much as possible. Pre and post pictures shall be taken and shall include a measurement of the area investigated. Should intact plugs of seagrass be removed they will be replanted following the removal of the anomaly. As a possible method, the seagrass can be cut on three sides and rolled up. After work is complete, the excavated area will be filled with sand, if necessary, then the seagrass will be rolled back into place and staked with biodegradable stakes to enable the grass to reestablish quickly.

4.3.5 Each MPPEH item will be evaluated as a separate scenario. A Decision Matrix (DM) will be developed to provide timely decisions and methods of relocation and disposal. The DM will be included in the RI Phase III WP.

4.3.6 When feasible, if the anomaly is not munition related, the anomaly is not cemented in hard substrate, and ESA-listed or proposed corals are not attached to it, it will be brought to the surface and relocated to the designated terrestrial processing area for appropriate disposal. If non listed corals are attached, as feasible and as detailed in **Appendix C**, the recommended Coral Relocation and Reattachment Protocol will be followed.

4.3.7 No intrusive investigation, MEC/MPPEH removal, or MEC/MPPEH handling in MRSs adjacent to beaches will be conducted during the 48-hour period following the emergence of sea turtle hatchlings.

4.3.8 Anomalies or MPPEH Acceptable to Move: Anomalies that are 1) exposed or only shallowly buried in soft sediments, 2) are acceptable to move, and 3) its removal will not cause damage to listed species (e.g. listed corals are not attached) or their designated critical habitat will be relocated to the designated terrestrial processing site for disposal (see Section 4.4 for more information). Prior to removal, the UXO team must agree that the MEC/MPPEH is acceptable to move.

4.3.8.1 Prior to the anomaly/MEC/MPPEH removal effort, qualified personnel will verify the locations of listed and proposed corals, designated critical habitat and seagrass within the immediate vicinity. Listed and proposed coral species location will be identified with temporary underwater buoys or visual devices as a visual aid for the UXO team while setting up equipment for the removal. All removal actions shall be documented. Pre and post pictures of the area shall be taken with a scale measure next to the anomaly/MEC/MPPEH.

4.3.8.2 For soft sediment and seagrass areas, once an anomaly is reacquired, the MEC/MPPEH UXO investigation team will expose and recover the anomaly source using hand tools (such as spades, trowels, shovels). For coral and hardbottom areas, if the anomaly is not encrusted in hardbottom or coral and can be easily removed by hand and has no coral colonization by listed or proposed corals, it can be removed and relocated to the designated processing area. If non listed corals are attached, as feasible and as detailed in **Appendix C**, the recommended Coral Relocation and Reattachment Protocol will be followed. The MEC/MPPEH UXO investigation team will transfer recovered MEC/MPPEH to the shore or designated terrestrial location for processing and disposal.

4.3.8.3 Removal may occur by hand or by using lifting equipment (e.g. remotely with a lifting balloon). MEC that are acceptable to move but will cause an unacceptable risk to diver due size and weight of MEC will be moved remotely. Care will be taken to avoid damaging corals or seagrass during removal. However, corals that are not listed or proposed for listing, although it is not desired, may be damaged during MEC removal or disposal as a necessity. This may happen if corals are attached or in contact with the MEC item. As feasible and as detailed in **Appendix C**, the recommended Coral Relocation and Reattachment Protocol will be followed.

4.3.8.4 The terrestrial processing site will be located within the boundaries of the Munition Response Area (MRA). Its potential location will be provided in WP to the TPP. MPPEH items will not be transported out of the MRA.

4.3.9 Anomalies or MPPEH Not Acceptable to Move: Anomalies or MPPEH that are deeply buried or that are located in areas where removal of the item could result in damage to listed or proposed coral species or destruction or adverse modification of designated critical habitat will be accurately mapped by GPS and left in place.

4.3.9.1 These items will be marked by the placement of a solid clump next to it to provide a reference point for later investigation/action. For the purposes of these SOPs, a clump is defined as a heavy weight (such as a 7 pound mushroom anchor) that is placed 12-inches north of the item. The clump is not attached to a line or buoy but provides the divers with a visual reference for future identification. The clump location and placement shall not impact listed or proposed coral species. If the placement of a solid clump is not feasible (e.g. presence of listed species), the item will be accurately mapped by GPS.

4.3.9.2 The areas surrounding the anomaly or MPPEH will be filmed paying particular attention to corals and biology in the immediate vicinity. If the anomaly is located in corals or hardbottom areas, divers will investigate an area with a three (3) meter radius, the center of which is the anomaly. Within that area divers will determine the distance to and location of all listed and proposed coral. The pictures shall include measurements of distance between anomalies and listed or proposed corals and size of item. These films will be used later when identifying a suitable method for disposal. If it is determined that BIP is required and it is estimated that the potential blast impact radius is greater than 3 meters, additional investigation may be required.

4.3.10 Environmental Sampling: Samples will be taken at locations where Munition Debris (MD) or suspected MPPEH items are observed. Detailed information on the environmental sampling will be provided in the WP to the TPP Team. Any sampling work shall avoid impacts to protected species.

4.4 MEC/MPPEH Disposal/Detonation Site Conservation Measures

4.4.1 Prior to removal of MEC/MPPEH from underwater locations, the Contractor in coordination with USACE will establish a designated terrestrial MEC/MPPEH disposal/detonation site. All recovered underwater MEC/MPPEH will be transferred to this site for processing and inspection to determine disposal method. Following appropriate inspection procedures, items that do not pose a risk will be designated or reclassified to Material Documented as Safe (MDAS) and transported off of Culebra for final disposal.

4.4.2 The MEC/MPPEH processing and disposal/detonation site will be established on a beach to provide convenient access by UXO removal teams working in the offshore waters and to minimize disturbance of vegetation and protected species on Culebra. The site will not be located in lagoon areas.

4.4.3 Qualified and experienced personnel will inspect the beach that would be used for MEC/MPPEH processing and detonation for the presence of sea turtles, sea turtle nests, and signs of recent sea turtle activity. An area not recently used by sea turtles and at least 100 meters from any place of active sea turtle use would be selected as the detonation site to the maximum extent practicable. Daily beach surveys will be conducted by qualified personnel to determine whether sea turtles are using beaches within the MRS. It should be noted that the contactor shall follow additional conservation measures provided in the July 2008 (pages 6-9) and April 2012 (Section 4.2) SOPs.

4.4.4 During MEC/MPPEH transfer and processing, qualified observer would continue to survey the beaches for signs of sea turtle activity. No human activity would occur until beaches are clear of sea turtles. Any active sea turtle nests will be marked and a 100-meter protection zone will be created around each nest to prevent incidental damage during detonation. It should be noted that the contactor shall follow additional conservation measures provided in the July 2008 (pages 6-9) and April 2012 (Section 4.2) SOPs.

4.4.5 All MEC/MPPEH detonation/processing will be performed during daylight hours to minimize the possibility that hatchlings would emerge from the nests during working hours. Detonation will be delayed until 48 hours have passed from the time of hatchling observation on the beach.

4.4.6 There are listed and migratory seabird species that have the potential to occur in the project area. The Roseate Tern (*Sterna dougallii*) is listed as threatened and the Brown Pelican (*Pelecanus occidentalis*) was delisted due to recovery but is being monitored. A complete list of seabirds that occur in the project area is included in **Appendix D**. Prior to detonation, a qualified observer will check the beach and adjacent waters for the presence of protected and listed seabird species by scanning the area with 10 X 50 binoculars. The qualified observer will also survey the beaches for signs of bird nesting. If bird nests are found within the detonation site and/or blast impact area, no detonation will be conducted in that area. If any protected bird species are within 200 meters of the detonation site, MEC detonation will be delayed until after the animal(s) leave the area. In addition, if blast impacts will extend into nearshore waters, a qualified observer for sea turtles and marine mammals shall be required. If these species are observed the detonation shall be postponed until the animal has left the impact zone or more than 30 minutes have elapsed since it was last sighted.

4.4.7 Immediately prior to detonation, a qualified observer will scan the overhead sky for the presence of any birds. If birds are in flight within 100 meters of the detonation site, the detonation will be delayed until no birds are within 100 meters of the detonation site.

4.4.8 The MEC/MPPEH will be demolished and/or demilitarized by controlled detonation using explosives to be provided by local vendors on as-needed basis. When feasible, all demolition events will be covered with sandbags to mitigate the blast effects and to reduce the risk of shrapnel being ejected. Additional measures may be implemented based on the calculations to adjust and establish exclusion areas. Munition debris (MD) will be recovered after detonation for appropriate disposal.

4.5 In-Water Detonation/Blow-in-Place (BIP) Conservation Measures

In-water detonations of MEC/MPPEH, including BIP, may occur during this project. All BIPs shall be closely coordinated with TPP Team. In-water detonations present unique challenges to the avoidance of unintended adverse impacts on protected marine species. As such, in addition to the measures listed above and established in previous SOPs, special conservation measures are described in this section to reduce the potential for adverse impacts should underwater detonations occur. Additional measures will be provided in the WP and/or Explosive Site Plan (ESP) to the TPP Team.

4.5.1 When possible, the MEC/MPPEH will be relocated to the designated terrestrial processing site for disposal as long as it is acceptable to move and it can be physically moved. The Senior UXO Supervisor and UXO Safety Officer must agree that the item is acceptable to move.

4.5.2 Appropriate sand substrate areas will be chosen during all phases of the investigation as potential MEC disposal sites based on safety considerations and minimizing impacts to resources of concern to the maximum extent practicable. These areas will be used only if MEC/MPPEH are unstable or represent a safety concern.

4.5.3 Prior to any detonation (24 hours minimum), the Contractor, in coordination with USACE staff, shall contact NMFS, FWS, the Environmental Protection Agency (EPA), the Puerto Rico Environmental Quality Board (EQB), the Puerto Rico Department of Natural and Environmental Resources (DNER) and the U.S. Coast Guard (USCG) to inform them of a planned underwater detonation.

4.5.4 Detonations will be done during daylight hours only, and under conditions of good visibility that ensure the exclusion zone is clear of marine mammals and sea turtles.

4.5.5 No detonation shall occur when protected marine species (marine mammals, sea turtles and corals) are known or suspected within the exclusion zone. The exclusion zone

delineation will also consider the potential level of acoustic impacts following the Young's (1991) equation in **Appendix E**. It should be noted that the excerpts from NMFS's explosive guidance provided in Appendix E are in draft form and a complete review and approval process is still pending. The guidance is provided to assist with determinations of the potential extent of acoustic impacts to sea turtles and marine mammals so that decisions can be made as to which items cannot be detonated without further coordination with the TPP Team. The water surface within the entire exclusion zone will undergo a visual search for protected marine species a minimum of 30 minutes prior to detonation. Should a protected marine mammal or sea turtle species be observed, the detonation shall be postponed until the animal has been observed outside of the exclusion zone, or more than 30 minutes have elapsed since it was last sighted.

4.5.4 Constant vigilance over the exclusion zone will be maintained for a minimum of 30 minutes following a detonation, and a thorough water surface inspection of the zone shall be completed immediately following a detonation to search for injured or dead protected marine species and surrounding coral and hardbottom habitat impacts. Impacts to coral and hardbottom habitat will be documented using pictures and measures and the information provided to the TPP Team. Should an injured or dead protected species be observed, immediately contact the appropriate response hotline (Marine Mammals: (877) 433-8299; Sea Turtles: (727) 824-5312; and DNER (787) 645-5593). Emergency handling procedures for an injured sea turtle or mammal will be provided by NOAA.

4.5.5 All observed stranding of protected marine species should be reported to the appropriate hotline, regardless of whether or not the stranding is the result of a detonation or other component of the project.

4.5.6 Constant vigilance for the presence of protected marine species during all aspects of the project, particularly in-water activities, is required.

4.5.7 Visual surveys within the vicinity of the work areas for that day shall be made prior to the start of work each day, and prior to resumption of work following any break of more than one half hour.

4.5.8 To the extent practicable and depending the ordnance type, appropriate techniques will be implemented to avoid and minimize damage to marine habitat. Detailed information will be provided in the ESP to the TPP Team.

4.5.9 All in–water work shall be conducted following the marine mammals and sea turtles avoidance measures established above and in previously coordinated SOPs.

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APPENDIX A

SOPs for Endangered Species Conservation and their Critical Habitat during Underwater Investigations – April 2012

FINAL

Standard Operating Procedures for Endangered Species Conservation and their Critical Habitat during Underwater Investigations

DERP-FUDS Property No. I02PR0068

Culebra, Puerto Rico

US Army Corps of Engineers

Jacksonville District

April 2012

US Army Corps of Engineers
Jacksonville District

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LIST OF ACRONYMS

DERP	Defense Environmental Restoration Program
DNER	Department of Natural and Environmental Resources
EBS	Environmental Baseline Survey
EQB	Environmental Quality Board
ESA	Endangered Species Act
FUDS	Formerly Used Defense Sites
FWS	U.S. Fish and Wildlife Service
MC	Munitions Constituent
MEC	Munitions and Explosives of Concern
MRS	Munitions Response Sites
Navy	Department of Navy
NMFS	National Marine Fisheries Service
SOPs	Standard Operating Procedures
TPP	Technical Project Planning
UIT	Underwater Investigation Team
USACE	U.S. Army Corps of Engineers

STANDARD OPERATING PROCEDURES FOR ENDANGERED SPECIES CONSERVATION AND THEIR CRITICAL HABITAT DURING UNDERWATER INVESTIGATIONS AT DERP-FUDS PROPERTY No. I02PR0068, CULEBRA ISLAND, PUERTO RICO

1.0 INTRODUCTION

Culebra Island is located approximately 17 miles east of the island of Puerto Rico and is approximately 9 miles from the Island of Vieques (**Figure 1**).

Figure 1. Location Map of Culebra.

In 1901, Culebra's public land was placed under the Department of Navy (Navy) control. The Island and adjacent cays were used as impact areas and firing ranges for aerial bombs and rockets, missiles, mortars, small arms, artillery rounds, and naval projectiles by the Navy and U.S. Marine Corps from 1903 until 1975. In 1978, part of the public land was transferred to the Commonwealth of Puerto Rico and the rest to the U.S. Fish and Wildlife Service (FWS).

Lands were transferred to the Commonwealth through a Quitclaim Deed and a Cooperative Management Agreement signed by the Government of Puerto Rico and the Department of the Interior in 1982.

The Finding and Determination of Eligibility, dated December 24, 1991, qualified 2,660 acres of Culebra Island and adjacent cays as eligible for consideration under the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS). However, upon subsequent review of historical material from the National Archives, it was determined that all of Culebra Island and the adjacent cays should be considered a FUDS, except the Northwest Peninsula which is not eligible under the 1982 Quitclaim Deed and Public Law 93-166, and the tract that was controlled by the Navy after 1986. The revised area covered by the DERP-FUDS projects for Culebra Island and adjacent cays consists of approximately 8,430 acres. **Figure 2** shows the DERP-FUDS project for Culebra.

Figure 2. DERP-FUDS Projects for Culebra.

The objectives of all the DERP-FUDS projects are to reduce risk to human health and the environment and reduce the hazards to public safety presented by military munitions through implementation of effective, legally compliant, and cost-effective response actions. In order to gather additional information that would help to determine the nature and extent of munitions constituent (MC) or munitions and explosive of concern (MEC) contamination on Culebra Island Munitions Response Sites (MRS), it was agreed by the Technical Project Planning Team (TPP Team) comprised of Federal and Commonwealth of Puerto Rico agencies to conduct underwater investigations and to prepare an Environmental Baseline Survey (EBS). The main objectives of the underwater investigations are: a) characterize and map benthic habitats within investigation areas, b) determine, identify and map endangered or threatened species, in particular coral colonies, c) gather the necessary information to determine potential effects (e.g. location of species versus location of suspected MEC) on endangered or threatened species during remedial investigations and cleanup activities, d) determine presence or absence of MC and MEC, e) characterize the nature and extend of MC and MEC presence, and f) determine if the MC or MEC pose an unacceptable risk to human health and the environment, which would require further considerations or a response action.

2.0 PURPOSE AND NEED

The purpose of this document is to develop a series of Standard Operating Procedures (SOPs) to avoid or minimize impacts to threatened and endangered species listed, pursuant to the Endangered Species Act (ESA), and their critical habitats during the DERP-FUDS underwater investigations on Culebra Island and adjacent cays. Also, serve as a guide for the underwater investigation team (UIT) providing them a general description of the listed species known to be found in the waters around Culebra and for which the surrounding waters and marine substrate were designated as critical habitat.

For the purpose of this document underwater investigation activities consist of visual observations, boating and diving operations, and remote sensing surveys. No intrusive investigation will be conducted. Based on the EBS results, additional SOPs or other measures would be developed and coordinated with the TPP for further investigation phases.

The information used to describe the listed species and their habitat was obtained from state/federal agencies fact sheets, recovery and management plans, petitions, the Federal Register and internet search, among other sources.

3.0 LISTED THREATENED OR ENDANGERED SPECIES

The purpose of this section is to provide a general description of threatened and endangered species that are known to occur or have the potential to occur in the waters around Culebra Island and adjacent cays. Species include the Loggerhead (*Caretta caretta*), Green (*Chelonia*

mydas), Leatherback (*Dermochelys coriacea*) and Hawksbill (*Eretmochelys imbricata*) sea turtles, West Indian manatee (*Trichechus manatus manatus*), Humpback (*Megaptera novaeangliae*), Finback (*Balaenoptera physalus*), Sei (*Balaenoptera borealis*), Sperm (*Physeter macrocephalus*) and Blue (*Balaenoptera musculus*) whales and Elkhorn (*Acropora palmata*) and Staghorn (*Acropora cervicornis*) corals.

3.1 Loggerhead Sea Turtle (*Caretta caretta*)

Description: The loggerhead is characterized by a large head with blunt jaws. The carapace and flippers are a reddish-brown color; the plastron is yellow. The carapace has five pairs of costal scutes with the first touching the nuchal scute. There are three large inframarginal scutes on each of the bridges between the plastron and carapace. Adults grow to an average weight of about 200 pounds (**Figure 3**). This species was listed as threatened on July 28, 1978.

Figure 3. Loggerhead Sea Turtle
Source: http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.htm

Nesting Season and Development: Nesting season extends from about May through August with nesting occurring primarily at night and it is infrequent in Puerto Rico. Loggerheads are known to nest from one to seven times within a nesting season (mean is about 4.1 nests per season) at intervals of approximately 14 days. Mean clutch size varies from about 100 to 126 along the southeastern U.S. coast. Incubation ranges from about 45 to 95 days, depending on incubation temperatures, but averages 55 to 60 days for most clutches in Florida. Hatchlings generally emerge at night. Remigration intervals of 2 to 3 years are most common in nesting loggerheads, but remigration can vary from 1 to 7 years. Age at sexual maturity is believed to be about 20 to 30 years. The species feeds on mollusks, crustaceans, fish, and other marine animals.

Distribution/Habitat: The loggerhead sea turtle can be found throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. It may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky places, and ship wrecks are often used as feeding areas. Loggerheads nest on ocean beaches and occasionally on estuarine shorelines with suitable sand. Nests are typically made between the high tide line and the dune front. Most loggerhead hatchlings originating from U.S. beaches are believed to lead a pelagic existence in the North Atlantic gyre for an extended period of time, perhaps as long as 10 to 12 years, and are best known from the eastern Atlantic near the Azores and Madeira. Post-

hatchlings have been found floating at sea in association with *Sargassum* rafts. Once they reach a certain size, these juvenile loggerheads begin recruiting to coastal areas in the western Atlantic where they become benthic feeders in lagoons, estuaries, bays, river mouths, and shallow coastal waters. These juveniles occupy coastal feeding grounds for a decade or more before maturing and making their first reproductive migration, the females returning to their natal beach to nest.

3.2 Green Sea Turtle (*Chelonia mydas*)

Description: The green sea turtle grows to a maximum size of about 4 feet and a weight of 440 pounds. It has a heart-shaped shell, small head, and single-clawed flippers. Color is variable. Hatchlings generally have a black carapace, white plastron, and white margins on the shell and limbs. The adult carapace is smooth, keelless, and light to dark brown with dark mottling; the plastron is whitish to light yellow. Adult heads are light brown with yellow markings. Identifying characteristics include four pairs of costal scutes, none of which borders the nuchal scute, and only one pair of prefrontal scales between the eyes (**Figure 4**). This species was listed under the ESA on July 28, 1978. The breeding populations in Florida and the Pacific coast of Mexico are listed as endangered; elsewhere the species is listed as threatened.

Figure 4. Green Sea Turtle
Photo: Andy Bruckner, NOAA
Source: http://www.nmfs.noaa.gov/pr/species/turtles/green.htm

Nesting Season and Development: The nesting season varies with the locality. In Puerto Rico, it is roughly June through October. Nesting occurs nocturnally at 2, 3, or 4-year intervals. Only occasionally do females produce clutches in successive years. A female may lay as a many as nine clutches within a nesting season (overall average is about 3.3 nests per season) at about 13-day intervals. Clutch size varies from 75 to 200 eggs, with an average clutch size of 136 eggs reported for Florida. Incubation ranges from about 45 to 75 days, depending on incubation temperatures. Hatchlings generally emerge at night. Age at sexual maturity is believed to be 20 to 50 years.

Distribution/Habitat: The green turtle is globally distributed and generally found in tropical and subtropical waters along continental coasts and islands between 30° North and 30° South. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found in inshore and nearshore

(reefs and seagrass beds) waters from Texas to Massachusetts, the U.S. Virgin Islands, and Puerto Rico.

Critical habitat was designated in 1998 for green turtles in coastal waters around Culebra (**Figure 5**).

Figure 5. Green Sea Turtle Critical Habitat.

3.3 Leatherback Sea Turtle (*Dermochelys coriacea*)

Figure 6. Leatherback Sea Turtle
Source: http://en.wikipedia.org/wiki/Leatherback_sea_turtle

Description: The leatherback is the largest, deepest diving, and most migratory and wide ranging of all sea turtles. The adult leatherback can reach 4 to 8 feet in length and 500 to 2000 pounds in weight. Its shell is composed of a mosaic of small bones covered by firm, rubbery skin with seven longitudinal ridges or keels. The skin is predominantly black with varying degrees of pale spotting; including a notable pink spot on the dorsal surface of the head in adults. A toothlike cusp is located on each side of the gray upper jaw; the lower jaw is hooked anteriorly. The paddle-like clawless limbs are black with white margins and pale spotting (**Figure 6**). Hatchlings are predominantly black with white flipper margins and keels on the carapace. Jellyfish are the main staple of its diet, but it is also known to feed on sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed. The leatherback turtle was listed under the ESA as endangered in 1970.

Breeding Season and Development: On Culebra nesting occurs from about February to August with the peak occurring around April to May. Female leatherbacks nest an average of 5 to 7 times within a nesting season, with an observed maximum of 11 nests. The average interesting interval is about 9 to 10 days. The nests are constructed at night in clutches of about 70 to 80 yolked eggs. The white spherical eggs are approximately 2 inches in diameter. Typically incubation takes from 55 to 75 days, and emergence of the hatchlings occurs at night. Most leatherbacks return to their nesting beaches at 2 to 3-year intervals. Leatherbacks are believed to reach sexual maturity in 6 to 10 years.

In the U.S., small nesting populations occur on the Florida east coast (35 females/year), Sandy Point, U.S. Virgin Islands (50 to 100 females/year), and Puerto Rico (30 to 90 females/year). The leatherback is the most pelagic of the sea turtles. Adult females require sandy nesting beaches backed with vegetation and sloped sufficiently so the crawl to dry sand is not too far. The preferred beaches have proximity to deep water and generally rough seas. Culebra beaches most used by the species are Flamenco, Brava, Resaca and Soni Beach.

Distribution/Habitat: The leatherback turtle is distributed worldwide in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans. It is also found in small numbers as far north as British Columbia, Newfoundland, and the British Isles, and as far south as Australia, Cape of Good Hope, and Argentina.

3.4 Hawksbill Sea Turtle (*Eretmochelys imbricata*)

Description: The Hawksbill Turtle (*Eretmochelys imbricate*) is small to medium-sized compared to other sea turtle species. Adults weigh 100 to 150 lbs (45 to 68 kg) on average, but can grow as large as 200 lbs (91 kg). Hatchlings weigh about 0.5 oz (14 g). The carapace (top shell) of an adult ranges from 25 to 35 inches (63 to 90 cm) in length and has a "tortoiseshell" coloring, ranging from dark to golden brown, with streaks of orange, red, and/or black. The shells of hatchlings are 1-2 inches (about 42 mm) long and are mostly brown and somewhat heart-shaped. The plastron (bottom shell) is clear yellow. The rear edge of the carapace is almost always serrated, except in older adults, and has overlapping "scutes". The hawksbill turtle's head is elongated and tapers to a point, with a beak-like mouth that gives the species its name. Hawksbill turtles are unique among sea turtles in that they have two pairs of prefrontal scales on the top of the head and each of the flippers usually has two claws (**Figure 7**). This species was listed under the ESA as endangered in 1970.

Figure 7. Hawksbill Sea Turtle
Photo: Caroline Rogers, USGS
Source: http://www.nmfs.noaa.gov/pr/species/turtles/hawksbill.htm

Nesting Season and Development: The nesting season varies with locality, nesting occurs all year long. Hawksbills nest at night and, on average, about 4.5 times per season at intervals of approximately 14 days. In Florida and the U.S. Caribbean, clutch size is approximately 140 eggs, although several records exist of over 200 eggs per nest. They nest under the vegetation on the high beach and nests have been observed having the last eggs of the clutch as close as 3 inches from the sand's surface. Remigration intervals of 2 to 3 years predominate. The incubation period averages 60 days. Hawksbills recruit into the reef environment at about 35 cm in length and are believed to begin breeding about 30 years later. However, the time required to reach 35 cm in length is unknown and growth rates vary geographically. As a result, actual age at sexual maturity is not known.

Distribution/Habitat: Hawksbill turtles use different habitats at different stages of their life cycle, but are most commonly associated with healthy coral reefs. The ledges and caves of coral reefs provide shelter for resting hawksbills both during the day and at night. Hawksbills are known to inhabit the same resting spot night after night. Hawksbills are also found around rocky outcrops and high energy shoals. These areas are optimum sites for sponge growth, which certain species are the preferred food of hawksbills. They are also known to inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent.

3.5 Antillean Manatee (*Trichechus manatus manatus*)

Description: Manatees are marine mammals found in marine, estuarine, and freshwater environments. The West Indian manatee, *Trichechus manatus*, includes two distinct subspecies, the Florida manatee (*Trichechus manatus latirostris*) and the Antillean manatee (*Trichechus manatus manatus*). While morphologically distinctive, both subspecies have many common features. Manatees have large, seal-shaped bodies with paired flippers and a round, paddle-shaped tail. They are typically grey in color (color can range from black to light brown) and occasionally spotted with barnacles or colored by patches of green or red algae. The muzzle is heavily whiskered and coarse, single hairs are sparsely distributed throughout the body. Adult manatees, on average, are about nine feet long (3 meters) and weigh about 1,000 pounds (200 kilograms). At birth, calves are between three and four feet long (1 meter) and weigh between 40 and 60 pounds (30 kilograms) (**Figure 8**). This species was listed under the ESA as endangered in 1967.

Figure 8. Antillean Manatee
Source: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A007

Behavior, Development and Diet: The manatee maneuvers through the water moving its paddle-like tail up and down and steering with its flippers. It often rests suspended just below the water's surface with only the snout above water. It feeds underwater, but must surface periodically to breathe. Although the manatee can remain underwater for as long as 12 minutes, the average time is 4-1/2 minutes.

Manatees reach breeding maturity between 3 and 10 years of age. The gestation period is approximately 13 months. Calves may be born at any time during the year. Usually a single

calf is born, but twins do occur. An adult manatee will usually give birth to a calf every 2 to 5 years. The low reproductive rate makes the species less capable of rebounding from threats to its survival. They nurse underwater for about three minutes at a time from a nipple located behind their mother's forelimb. Born with teeth, calves begin eating plants within a few weeks but remain with their mother for up to 2 years. Manatees may live for several decades.

Manatees are herbivores that feed opportunistically on a wide variety of marine, estuarine, and freshwater plants, including submerged, floating, and emergent vegetation. Common forage plants include and are not limited to: cord grass, alga, turtle grass, shoal grass, manatee grass, eel grass, and other plant types. Manatees also require sources of freshwater, obtained from both natural and anthropogenic sources.

Distribution/Habitat: All of the studies suggest that manatees in Puerto Rico are more commonly observed in coastal areas from San Juan, eastward to the east coast, (and including Culebra and Vieques Islands) and then south and west, past Jobos Bay, to the west coast, and then about as far to the northwest as Rincon. Manatees are concentrated in several "hot spots" including Ceiba, Vieques Island, Jobos Bay and Boquerón Bay, and are less abundant along the north coast, between Rincón and Dorado.

3.6 Humpback Whale (*Megaptera novaeangliae*)

Description: Humpback whales are well known for their long "pectoral" fins, which can be up to 15 feet (4.6 m) in length. Their scientific name, *Megaptera novaeangliae,* means "big-winged New Englander" as the New England population was the one best known to Europeans. These long fins give them increased maneuverability; they can be used to slow down or even go backwards.

Figure 9. Humpback Whale
Source: http://www.nmfs.noaa.gov/pr/images/cetaceans/humpbackwhale_noaa_large.jpg

Similar to all baleen whales, adult females are larger than adult males, reaching lengths of up to 60 feet (18 m). Their body coloration is primarily dark grey, but individuals have a variable amount of white on their pectoral fins and belly. This variation is so distinctive that the pigmentation pattern on the undersides of their "flukes" is used to identify individual whales, similar to a humans fingerprint (**Figure 9**).

In June 1970, humpback whales were designated as "endangered" under the Endangered Species Conservation Act (ESCA). In 1973, the ESA replaced the ESCA, and continued to list humpbacks as endangered.

Behavior, Development and Diet: Humpback whales travel great distances during their seasonal migration, the farthest migration of any mammal. The longest recorded migration was 5,160 miles (8,300 km). This trek from Costa Rica to Antarctica was completed by seven animals, including a calf. One of the more closely studied routes is between Alaska and Hawaii, where humpbacks have been observed making the 3,000 mile (4,830 km) trip in as few as 36 days.

During the summer months, humpbacks spend the majority of their time feeding and building up fat stores (blubber) that they will live off of during the winter. Humpbacks filter feed on tiny crustaceans (mostly krill), plankton, and small fish and can consume up to 3,000 pounds (1360 kg) of food per day. Several hunting methods involve using air bubbles to herd, corral, or disorient fish. One highly complex variant, called "bubble netting," is unique to humpbacks. This technique is often performed in groups with defined roles for distracting, scaring, and herding before whales lunge at prey corralled near the surface.

In their wintering grounds, humpback whales congregate and engage in mating activities. Humpbacks are generally "polygynous" with males exhibiting competitive behavior on wintering grounds. Aggressive and antagonistic behaviors include chasing, vocal and bubble displays, horizontal tail thrashing, and rear body thrashing. Males within these groups also make physical contact; striking or surfacing on top of one another. These bouts can cause injuries ranging from bloody scrapes to, in one recorded instance, death. Also on wintering grounds, males sing complex songs that can last up to 20 minutes and be heard 20 miles (30 km) away. A male may sing for hours, repeating the song several times. All males in a population sing the same song, but that song continually evolves over time.

Gestation lasts for about 11 months. Newborns are 13 to 16 ft (4 to 5 m) long and grow quickly from the highly nutritious milk of their mothers. Weaning occurs between 6 and 10 months after birth. Mothers are protective and affectionate towards their calves, swimming close and frequently touching them with their flippers. Males do not provide parental support for calves. Breeding usually occurs once every two years, but sometimes occurs twice in three years.

Distribution/Habitat: Humpback whales live in all major oceans from the equator to sub-polar latitudes. In the western North Atlantic ocean, humpback whales feed during spring, summer, and fall over a range that encompasses the eastern coast of the U.S. (including the Gulf of Maine), the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland. In winter, whales from the Gulf of Maine mate and calve primarily in the West Indies. Not all

whales migrate to the West Indies every winter, and significant numbers of animals are found in mid- and high-latitude regions at this time.

During migration, humpbacks stay near the surface of the ocean. While feeding and calving, humpbacks prefer shallow waters. During calving, humpbacks are usually found in the warmest waters available at that latitude. Calving grounds are commonly near offshore reef systems, islands, or continental shores. Humpback feeding grounds are in cold, productive coastal waters (**Figure 14**).

3.7 Fin or Finback Whale (*Balaenoptera physalus*)

Description: Fin or finback whales are the second-largest species of whale, with a maximum length of about 75 ft (22 m) in the Northern Hemisphere, and 85 ft (26 m) in the Southern Hemisphere. Fin whales show mild sexual "dimorphism", with females measuring longer than males by 5-10%. Adults can weigh between 80,000-160,000 lbs (40-80 tons).

Figure 10. Fin or Finback Whale
Source: http://www.cetaceanalliance.org/cetaceans/Bp_home.htm
Photos © Tethys Research Institute.

Fin whales have a sleek, streamlined body with a V-shaped head. They have a tall, "falcate" dorsal fin, located about two-thirds of the way back on the body, that rises at a shallow angle from the animal's back. The species has a distinctive coloration pattern: the back and sides of the body are black or dark brownish-gray, and the ventral surface is white. The unique, asymmetrical head color is dark on the left side of the lower jaw, and white on the right side. Many individuals have several light-gray, V-shaped "chevrons" behind their head, and the underside of the tail flukes is white with a gray border (**Figure 10**).

Within the U.S., the fin whale is listed as endangered throughout its range under the ESA and is listed as "depleted" throughout its range under the Marine Mammal Protection Act of 1972.

Behavior, Development and Diet: Fin whales can be found in social groups of 2-7 whales and in the North Atlantic are often seen feeding in large groups that include humpback whales, minke whales, and Atlantic white-sided dolphins. Fin whales are large, fast swimmers and the killer whale (*Orcinus orca*) is their only non-human predator.

During the summer, fin whales feed on krill, small schooling fish (e.g., herring, capelin, and sand lance), and squid by lunging into schools of prey with their mouth open, using their 50-100 accordion-like throat pleats to gulp large amounts of food and water. They then filter the food particles from the water using the 260-480 "baleen" plates on each side of the mouth. Fin whales fast in the winter while they migrate to warmer waters.

Little is known about the social and mating systems of fin whales. Similar to other baleen whales, long-term bonds between individuals are rare. Males become sexually mature at 6-10 years of age; females at 7-12 years of age. Physical maturity is attained at approximately 25 years for both sexes. After 11-12 months of gestation, females give birth to a single calf in tropical and subtropical areas during midwinter. Newborn calves are approximately 18 ft (6 m) long, and weigh 4,000-6,000 lb (2 tons). Fin whales can live 80-90 years.

Distribution/Habitat: Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes, and less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally (**Figure 14**).

3.8 Sei Whale (*Balaenoptera borealis*)

Description: Sei whales are members of the baleen whale family and are considered one of the "great whales" or rorquals. Two subspecies of sei whales are recognized, *B. b. borealis* in the Northern Hemisphere and *B. B. schlegellii* in the Southern Hemisphere.

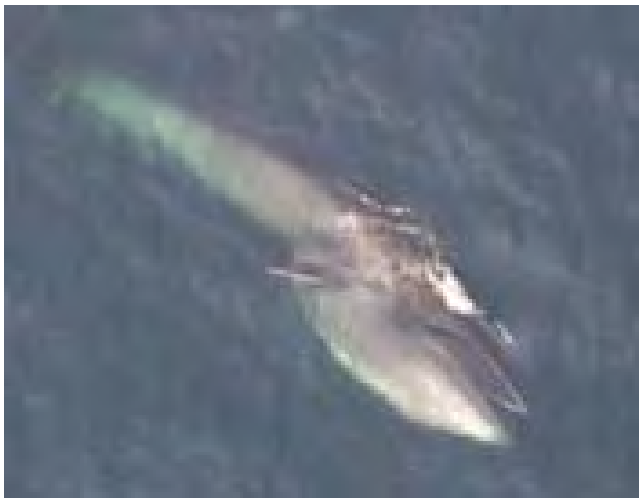

Figure 11. Sei Whale
Source: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/seiwhale.htm#more

These large animals can reach lengths of about 40-60 ft (12-18 m) and weigh 100,000 lbs (45,000 kg). Females may be slightly longer than males. Sei whales have a long, sleek body that is dark bluish-gray to black in color and pale underneath. The body is often covered in oval-shaped scars (probably caused from cookie-cutter shark and lamprey bites) and sometimes has subtle "mottling". This species has an erect "falcate", "dorsal" fin located far down (about two-thirds) the animals back. They often look similar in appearance to Bryde's whales, but can be distinguished by the presence of a single ridge located on the animal's "rostrum". Bryde's whales, unlike other rorquals, have three distinct prominent longitudinal ridges on

their rostrum. They have 219-410 baleen plates that are dark in color with gray/white fine inner fringes in their enormous mouths. They also have 30-65 relatively short ventral pleats that extend from below the mouth to the naval area. The number of throat grooves and baleen plates may differ depending on geographic population (**Figure 11**).

When at the water's surface, sei whales can be sighted by a columnar or bushy blow that is about 10-13 feet (3-4 m) in height. The dorsal fin usually appears at the same time as the blowhole, when the animal surfaces to breathe. This species usually does not arch its back or raise its flukes when diving.

This species was listed under the ESA as endangered in 1970.

Behavior, Development and Diet: They are usually observed singly or in small groups of 2-5 animals, but are occasionally found in larger (30-50) loose aggregations. Sei whales are capable of diving 5-20 minutes to opportunistically feed on plankton (e.g., copepods and krill), small schooling fish, and cephalopods (e.g., squid) by both gulping and skimming. They prefer to feed at dawn and may exhibit unpredictable behavior while foraging and feeding on prey. Sometimes seabirds are associated with the feeding frenzies of these and other large whales.

Sei whales become sexually mature at 6-12 years of age when they reach about 45 ft (13 m) in length, and generally mate and give birth during the winter in lower latitudes. Females breed every 2-3 years, with a gestation period of 11-13 months. Females give birth to a single calf that is about 15 ft (4.6 m) long and weighs about 1,500 lbs (680 kg). Calves are usually nursed for 6-9 months before being weaned on the preferred feeding grounds. Sei whales have an estimated lifespan of 50-70 years.

Distribution/Habitat: Sei whales have a cosmopolitan distribution and occur in subtropical, temperate, and subpolar waters around the world. They prefer temperate waters in the mid-latitudes, and can be found in the Atlantic, Indian, and Pacific Oceans. During the summer, they are commonly found in the Gulf of Maine, and on Georges Bank and Stellwagen Bank in the western North Atlantic. The entire distribution and movement patterns of this species is not well known. This species may unpredictably and randomly occur in a specific area, sometimes in large numbers. These events may occur suddenly and then not occur again for long periods of time. Populations of sei whales, like other rorquals, may seasonally migrate toward the lower latitudes during the winter and higher latitudes during the summer. They prefer subtropical to subpolar waters on the continental shelf edge and slope worldwide and they are usually observed in deeper waters of oceanic areas far from the coastline (**Figure 14**).

3.9 Sperm Whale (*Physeter macrocephalus*)

Description: Sperm whales are the largest of the odontocetes (toothed whales) and the most sexually dimorphic cetaceans, with males considerably larger than females. Adult females may grow to lengths of 36 feet (11 m) and weigh 15 tons (13607 kg). Adult males, however, reach about 52 feet (16 m) and may weigh as much as 45 tons (40823 kg). It is distinguished by its extremely large head, which takes up to 25 to 35% of its total body length. It is the only living cetacean that has a single blowhole asymmetrically situated on the left side of the head near the tip. Sperm whales have the largest brain of any animal (on average 17 pounds (7.8 kg) in mature males), however, compared to their large body size, the brain is not exceptional in size.

Figure 12. Sperm Whale
Source: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm

There are between 20-26 large conical teeth in each side of the lower jaw. The teeth in the upper jaw rarely erupt and are often considered to be vestigial. It appears that teeth may not be necessary for feeding, since they do not break through the gums until puberty, if at all, and healthy sperm whales have been caught that have no teeth.

Sperm whales are mostly dark gray, but oftentimes the interior of the mouth is bright white, and some whales have white patches on the belly. Their flippers are paddle-shaped and small compared to the size of the body, and their flukes are very triangular in shape. They have small dorsal fins that are low, thick, and usually rounded (**Figure 12**).

This species was listed under the ESA as endangered in 1970.

Behavior, Development and Diet: Because sperm whales spend most of their time in deep waters, their diet consists of many larger organisms that also occupy deep waters of the ocean. Their principle prey are large squid weighing between 3.5 ounces and 22 pounds (0.1 kg and 10 kg), but they will also eat large demersal and mesopelagic sharks, skates, and fishes. The average dive lasts about 35 minutes and is usually down 1,312 feet (400 m), however dives may last over an hour and reach depths over 3280 feet (1000 m).

Female sperm whales reach sexual maturity around 9 years of age when they are roughly 29 feet (9 m) long. At this point, growth slows and they produce a calf approximately once every five years. After a 14-16 month gestation period, a single calf about 13 feet (4 m) long is born. Although calves will eat solid food before one year of age, they continue to suckle for several years. Females are physically mature around 30 years and 35 feet (10.6 m) long, at which time they stop growing. For about the first 10 years of life, males are only slightly larger than females, but males continue to exhibit substantial growth until they are well into their 30s. Males reach physical maturity around 50 years and when they are 52 feet (16 m) long. Unlike females, puberty in males is prolonged, and may last between ages 10 to 20 years old. Even though males are sexually mature at this time, they often do not actively participate in breeding until their late twenties.

Most females will form lasting bonds with other females of their family, and on average 12 females and their young will form a family unit. While females generally stay with the same unit all their lives in and around tropical waters, young males will leave when they are between 4 and 21 years old and can be found in "bachelor schools", comprising of other males that are about the same age and size. As males get older and larger, they begin to migrate to higher latitudes (toward the poles) and slowly bachelor schools become smaller, until the largest males end up alone. Large, sexually mature males that are in their late 20s or older, will occasionally return to the tropical breeding areas to mate.

Distribution/Habitat: They inhabit all oceans of the world. They can be seen close to the edge of pack ice in both hemispheres and are also common along the equator, especially in the Pacific. Sperm whales are found throughout the world's oceans in deep waters between about 60° N and 60° S latitudes. Their distribution is dependent on their food source and suitable conditions for breeding, and varies with the sex and age composition of the group. It migrations are not as predictable or well understood as migrations of most baleen whales. In some mid-latitudes, there seems to be a general trend to migrate north and south depending on the seasons (whales move poleward in the summer). However, in tropical and temperate areas, there appears to be no obvious seasonal migration.

Sperm whales tend to inhabit areas with a water depth of 1968 feet (600 m) or more, and are uncommon in waters less than 984 feet (300 m) deep. Female sperm whales are generally found in deep waters (at least 3280 feet, or 1000 m) of low latitudes (less than 40°, except in the North Pacific where they are found as high as 50°). These conditions generally correspond to sea surface temperatures greater than 15°C, and while female sperm whales are sometimes seen near oceanic islands, they are typically far from land (**Figure 14**).

Immature males will stay with female sperm whales in tropical and subtropical waters until they begin to slowly migrate towards the poles, anywhere between ages 4 and 21 years old. Older, larger males are generally found near the edge of pack ice in both hemispheres. On

occasion, however, these males will return to the warm water breeding area. No critical habitat has been designated for this species.

3.10 Blue Whale (*Balaenoptera musculus*)

Description: The blue whale is a cosmopolitan species of baleen whale. In the Northern Hemisphere, they are generally smaller than those in the Southern Ocean. Maximum body length in the North Atlantic was about 88.5 feet (27 m) and the largest blue whale reported from the North Pacific was about 88 feet (26.8 m). Adults in the Antarctic can reach a maximum body length of about 108 feet (33 m) and can weigh more than 330,000 pounds (150,000 kg). As is true of other baleen whale species, female blue whales are somewhat larger than males. Blue whales are identified by the following characteristics: a long-body and comparatively slender shape; a broad, flat "rostrum" when viewed from above; a proportionately smaller dorsal fin than other baleen whales; and a mottled gray color pattern that appears light blue when seen through the water (**Figure 13**).

Figure 13. Blue Whale
Source: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/bluewhale.htm

This species was listed under the ESA as endangered in 1970.

Behavior, Development and Diet: Scientists have yet to discern many details regarding the life history of the blue whale. The best available science suggests the gestation period is approximately 10-12 months and that blue whale calves are nursed for about 6-7 months. Most reproductive activity, including births and mating, takes place during the winter. Weaning probably occurs on, or en route to, summer feeding areas. The average calving interval is probably two to three years. The age of sexual maturity is thought to be 5-15 years. There are no known differences in the reproductive biology of blue whales in the North Pacific and North Atlantic oceans.

The primary and preferred diet of blue whales is krill (euphausiids). In the North Atlantic, blue whales feed on two main euphausiid species: *Thysanoëssa inermis*and and *Meganyctiphanes norvegica*. In addition, *T. raschii*and and *M. norvegica* have been recorded as important food sources of blue whales in the Gulf of St. Lawrence. In the North Pacific, blue whales prey mainly on *Euphausia pacifica*and secondarily on *T. spinifera*. While other

prey species, including fish and copepods, have been mentioned in the scientific literature, these are not likely to contribute significantly to the diet of blue whales.

Distribution/Habitat: They are found in oceans worldwide and are separated into populations by ocean basin in the North Atlantic, North Pacific, and Southern Hemisphere. They follow a seasonal migration pattern between summering and wintering areas, but some evidence suggests that individuals remain in certain areas year-round. The extent of knowledge concerning distribution and movement varies with area and migratory routes are not well known but, in general, distribution is driven largely by food requirements.

Blue whales inhabit sub-polar to sub-tropical latitudes. Poleward movements in spring allow the whales to take advantage of high zooplankton production in summer. Movement towards the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting, avoid ice entrapment in some areas, and engage in reproductive activities in warmer waters of lower latitudes. Although the species is often found in coastal waters, blue whales are thought to occur generally more offshore than humpback whales, for example (**Figure 14**).

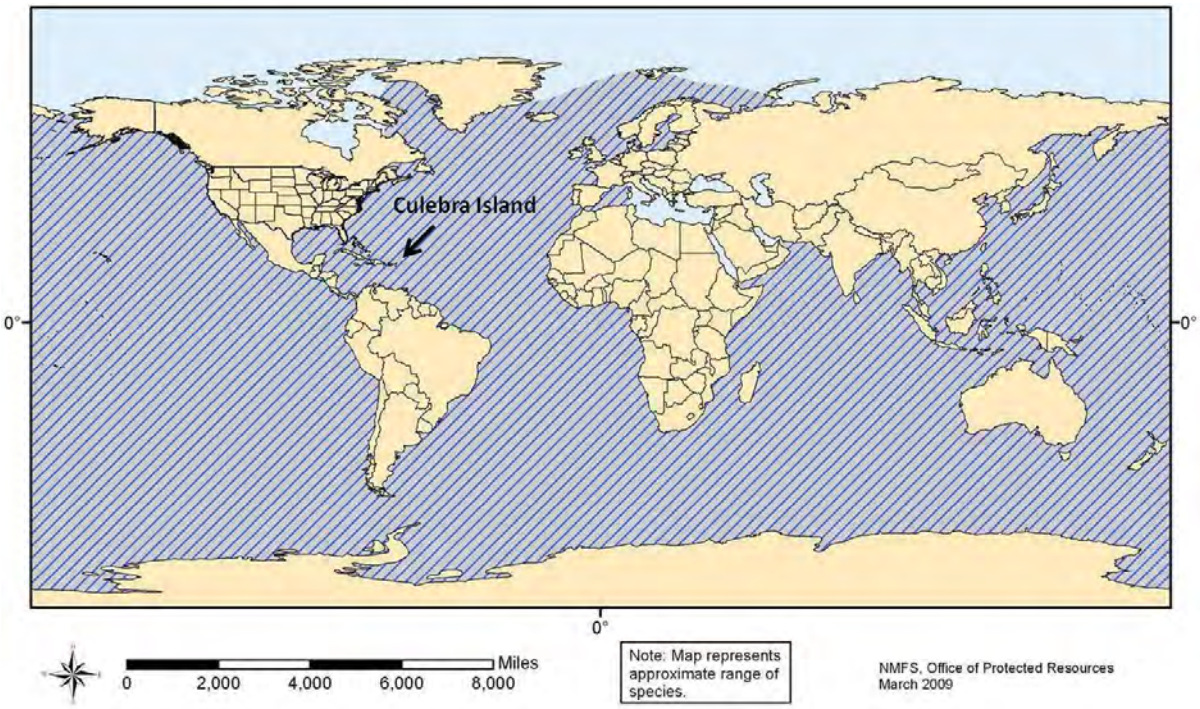

Figure 14. Approximate range map for Humpback, Sei, Sperm and Blue whales.

3.11 Elkhorn coral (*Acropora palmata*)

Description: It is a large, branching coral with thick and sturdy antler-like branches (**Figure 15**) and is found in shallow reefs, typically in water depths from 0-35 feet, as these corals prefer areas where wave action causes constant water movement. Colonies are fast growing: branches increase in length by 2-4 inches (5-10 cm) per year, with colonies reaching their maximum size in approximately 10-12 years. Over the last 10,000 years, elkhorn coral has been one of the three most important Caribbean corals contributing to reef growth and development and providing essential fish habitat. This species was listed under the ESA as endangered on May 4, 2006.

Figure 15. Elkhorn Coral
Source: http://www.nmfs.noaa.gov/pr/species/invertebrates/elkhorncoral.htm

Color: Living colonies are yellow, brown or golden with light rims.

Habitat: Elkhorn coral was formerly the dominant species in shallow water (3 ft-16 ft [1-5 m] deep) throughout the Caribbean and on the Florida Reef Tract, forming extensive, densely aggregated thickets (stands) in areas of heavy surf. Coral colonies prefer exposed reef crest and fore reef environments in depths of less than 20 feet (6 m), although isolated corals may occur to 65 feet (20 m).

Distribution/Reproduction: Elkhorn coral is found on coral reefs in southern Florida, the Bahamas, and throughout the Caribbean.

The dominant mode of reproduction for elkhorn coral is asexual, with new colonies forming when branches break off of a colony and reattach to the substrate. Sexual reproduction occurs via broadcast spawning of gametes into the water column once each year in August or September. Individual colonies are both male and female (simultaneous hermaphrodites) and will typically release millions of "gametes". The coral larvae (planula) live in the plankton for several days until finding a suitable area to settle, but very few larvae survive to settle and metamorphose into new colonies. The preponderance of asexual reproduction in this species raises the possibility that genetic diversity may be very low in the remnant populations.

3.12 Staghorn coral (*Acropora cervicornis*)

Description: It is a branching coral with cylindrical branches ranging from a few centimeters to over 6.5 feet (2 m) in length (**Figure 16**). This coral exhibits the fastest growth of all known western Atlantic corals, with branches increasing in length by 4-8 inches (10-20 cm) per year. This species was listed under the ESA as endangered on May 4, 2006.

Figure 16. Staghorn Coral
Source: http://www.nmfs.noaa.gov/pr/species/invertebrates/staghorncoral.htm

Color: Living colonies are light, grayish to yellowish-brown.

Habitat: Staghorn coral occur in back reef and fore reef environments from 0-100 feet (0 to 30 m) deep. The upper limit is defined by wave forces, and the lower limit is controlled by suspended sediments and light availability. Fore reef zones at intermediate depths of 15-80 feet (5-25 m) were formerly dominated by extensive single species stands of staghorn coral until the mid 1980s.

Distribution/Reproduction: Staghorn coral is found in the Atlantic Ocean, Caribbean Sea, and western Gulf of Mexico. Specifically, staghorn coral is found throughout the Florida Keys, the Bahamas, the Caribbean islands, and Venezuela. The northern limit of staghorn coral is around Boca Raton, FL.

The dominant mode of reproduction for staghorn coral is asexual fragmentation, with new colonies forming when branches break off a colony and reattach to the substrate. Sexual reproduction occurs via broadcast spawning of gametes into the water column once each year in August or September. Individual colonies are both male and female (simultaneous hermaphrodites) and will release millions of "gametes". The coral larvae (planula) live in the plankton for several days until finding a suitable area to settle, but very few larvae survive to settle and metamorphose into new colonies. The preponderance of asexual reproduction in this species raises the possibility that genetic diversity is very low in the remnant populations

The NMFS has designated critical habitat for elkhorn and staghorn corals in four areas: Florida, Puerto Rico, St. John/St. Thomas, and St. Croix. **Figure 17** shows the designated areas for Puerto Rico. In addition, a 4(d) rule (50 CFR Part 223) establishing “take” prohibitions for elkhorn and staghorn corals went into effect on November 28, 2008. Take

includes collect, bother, harm, harassment, damage to, death, or other actions that affect health and survival of listed species.

Figure 17. Elkhorn and Staghorn Corals Critical Habitat.

3.13 Species of Corals Proposed for Listing under the ESA

On 20 October 2009, the National Marine Fisheries Service (NMFS) received a petition from the Center for Biological Diversity to list 83 species of corals as threatened or endangered under the Endangered Species Act (ESA) and to designate critical habitat for these corals. NMFS reviewed the petition and determined that the requested listing actions may be warranted for 82 of the 83 coral species. All of the Atlantic coral species have the potential to be found in waters around Culebra. These species are: Lamarck's Sheet Coral (*Agaricia lamarcki*), Boulder Star Coral (*Montastraea annularis*), Mountainous Star Coral (*Montastrae faveolata*), *Montastraea franksi*, Pillar Coral (*Dendrogyra cylindrus*), Elliptical Star Coral or Pineapple Coral (*Dichocoenia stokesii*) and Rough Cactus Coral (*Mycetophyllia ferox*). As of the day of this document, no final decision on whether to list these species has been made by NMFS. **Figure 18** shows a range map for the seven species of coral proposed for listing under ESA.

Figure 18. Range map for the seven species of coral proposed for listing under ESA.

3.13.1 Lamarck's Sheet Coral (*Agaricia lamarcki*)

Description: Colonies form large, mostly thick plates, broad, rounded or acute, often overlapping each other. The upper surface bears concentric rows of ridges with relatively wide, straight or reticulate, valleys. The white, star-like, polyps are in the valleys' center. The septa alternate in height and thickness. Generally, the taller and thicker primary septa extend close to the columella before dropping sharply into the corallite pit, while the thinner secondary septa appear shorter, because they slope

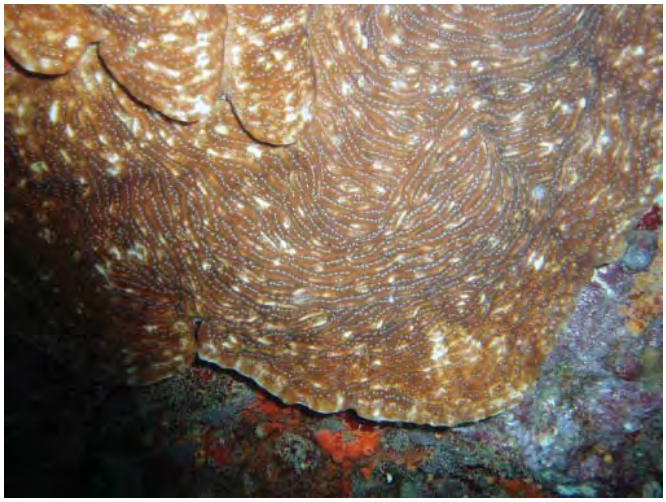

Figure 19. Lamarck's Sheet Coral
Source: http://coralpedia.bio.warwick.ac.uk/en/corals/agaricia_lamarcki.html

gradually into the corallite pit. The underside of the colony is smooth, without polyps (**Figure 19**).

Color: Yellow-brown to golden-brown to brown, sometimes with bluish or grayish tints, with contrasting white polyps (**Figure 19**).

Habitat: On sloping reefs and along walls, between 16-165 feet (5-50 m), but most common between 65-115 feet (20 and 35 m).

Distribution: Occasional in Florida and the Bahamas, common in the Caribbean (**Figure 18**).

3.13.2 *Montastraea* Complex

3.13.2.1 Boulder Star Coral (*Montastraea annularis*)

Description: The colonies grow in several morphotypes that were originally described as separate species. The species occurs as long, thick columns with enlarged, dome-like tops; large, massive mounds; sheets with skirt-like edges; irregularly bumpy mounds and plates or as smooth plates. Colonies up to 10 feet (3 m) in diameter. The surface is covered with distinctive, often somewhat raised, corallites (**Figure 20**).

Figure 20. Boulder Star Coral
Source: http://coralpedia.bio.warwick.ac.uk/images/Montastraea%20annularis01.JPG

Color: Shades of green to brown, yellow-brown and gray.

Habitat: Inhabit most reef environments and the species is often the predominant coral between 22-82 feet (7-25 m). The flattened plates are most common at deeper reefs, down to 165 feet (50 m).

Distribution: Common to abundant Florida, Bahamas and Caribbean (**Figure 18**).

3.13.2.2 Mountainous Star Coral (*Montastraea faveolata*)

Description: This species has been called the "dominant reef-building coral of the Atlantic". *Montastraea faveolata* buds extratentacularly to form head or sheet colonies with corallites that are uniformly distributed and closely packed, but sometimes unevenly exsert. Septa are highly

exsert, with septocostae arranged in a variably conspicuous fan system, and the skeleton is generally far less dense than those of its sibling species. Active growth is typically found at the edges of colonies, forming a smooth outline with many small polyps (**Figure 21**).

Figure 21. Mountainous Star Coral
Source: http://coralpedia.bio.warwick.ac.uk/images/Montastraea%20faveolata01.JPG

Color: It is usually pale brown but may be bright, fluorescent green over the dark brown.

Habitat: *M. faveolata* is found from 3-100 feet (1-30 m) in backreef and fore-reef habitats, and is often the most abundant coral between 30-65 feet (10-20 m) in fore-reef environments.

Distribution: This species occurs in the Caribbean, the Gulf of Mexico, Florida, and the Bahamas. May also be present in Bermuda, but this requires confirmation (**Figure 18**).

3.13.2.3 *Montastraea franksi*

Description: This species builds massive, encrusting plate or subcolumnar colonies via extratentacular budding. The characteristically bumpy appearance of this species is caused by relatively large, unevenly exsert, and irregularly distributed corallites. *M. franksi* is distinguished from its sibling *Montastraea* species by this irregular or bumpy appearance; a relatively dense, heavy, and hard skeleton (corallum); thicker septo-costae with a conspicuous septocostal midline row of lacerate teeth; and a greater degree of interspecies aggression (**Figure 22**).

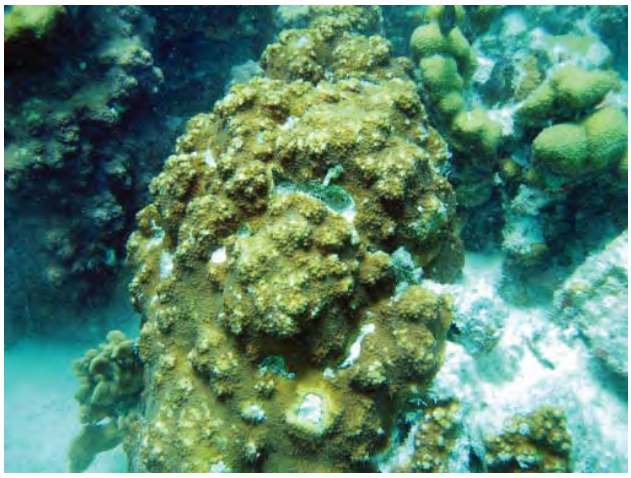

Figure 22. *Monstastraea franki*
Source: http://coralpedia.bio.warwick.ac.uk/images/Montastraea%20franksi01.JPG

Color: It is basically orange-brown with many pale patches on the lumpy surface, but may be grey or greenish-brown (**Figure 22**).

Habitat: This species mostly grows in the open like other species of this genus but smaller, encrusting colonies are common in shaded overhangs. It is uncommon in very shallow water, but becomes common deeper.

Distribution: This species occurs in the Caribbean, the Gulf of Mexico, Florida, and the Bahamas (**Figure 18**).

3.13.3 Pillar Coral (*Dendrogyra cylindrus*)

Description: Colonies form numerous, heavy, cylindrical spires, that grow upwards from an encrusting base mass. The colonies can attain a height of 10 feet (3 m), with a pillar diameter of more than 4 inches (10 cm). Polyps are normally extended during the day, giving the colony a fuzzy appearance and obscuring the long, meandroid, corallite series (**Figure 23**).

Figure 23. Pillar Coral
Source: http://coralpedia.bio.warwick.ac.uk/en/corals/dendrogyra_cylindrus.html

Color: Light tan to golden brown and chocolate brown.

Habitat: Colonies are typically found on flat gently sloping back reef and fore reef environment in depths of 3-82 feet (1-25 m). The species does not occur in extremely exposed locations.

Distribution: This species occurs in the Caribbean, the southern Gulf of Mexico, Florida, and the Bahamas (**Figure 18)**.

3.13.4 Elliptical Star Coral or Pineapple Coral (*Dichocoenia stokesii*)

Description: Colonies form rounded heads, domes or flattened plates. The distinctive character of this species is the oval corallites which protrude conspicuously above the surface between the corallites (coenesteum). Corallites are markedly oval and become elongated, almost meandroid, before dividing. Corallites are well separated from each other, and the surface between them is granular (**Figure 24**).

Color: Though sometimes green, they are usually orange-brown with white septo-costae.

Habitat: It is uncommon but has been found in most reef environments within its range, including both back and fore reef environments, rocky reefs, lagoons, spur and groove formations, channels, and occasionally at the base of reefs. This species occurs in depths from 6-236 feet (2-72 m); when found in exposed reefs at depths less than 65 feet (20 m), its hemispherical heads are more abundant than usual.

Figure 24. Elliptical/Pineapple Coral
Source: http://coralpedia.bio.warwick.ac.uk/en/corals/dichocoenia_stokesii.html

Distribution: This species occurs in the Caribbean, the Gulf of Mexico, Florida (including the Florida Middle Grounds), the Bahamas, and Bermuda (**Figure 18**).

3.13.5 Rough Cactus Coral (*Mycetophyllia ferox*)

Description: Colonies consist of flat plates with radiating valleys. It is a widely recognized valid species with colonies comprised of thin, weakly attached plates with interconnecting, slightly sinuous, narrow valleys. Tentacles are generally absent and corallite centers tend to form single rows. The walls of the valleys commonly join to form closed valleys, a feature not seen in other members of *Mycetophyllia*. The ridges are usually small and square, with a groove on top. The ridges, or walls between valleys, are commonly quite thin, and are irregular, and valleys are narrower (**Figure 25**).

Figure 25. Rough Cactus Coral
Source: http://coralpedia.bio.warwick.ac.uk/en/corals/mycetophyllia_ferox.html

Color: Valleys and walls are contrasting shades of grays and browns.

Habitat: This species is most common in fore reef environments from 5-30 meters (but is more abundant from 10-20 meters), but also occurs at low abundance in certain deeper back reef habitats and deep lagoons.

Distribution: This species occurs in the Caribbean, southern Gulf of Mexico, Florida, and the Bahamas (**Figure 18**).

4.0 MEASURES TO AVOID OR MINIMIZE POSSIBLE IMPACTS

The following measures will be implemented to avoid or minimize impacts to threatened or endangered species and their habitat during underwater investigation activities. Because the proposed action consists of data collection, no intrusive work will be performed and munitions disposal are not considered. Adverse impacts to protected species or their habitats are not expected.

The Contractor will be required to implement these SOPs, as well as the previously developed SOPs included in the attached Appendices A and B as part of any underwater work.

4.1 General Conservation Measures

4.1.1 Date of Commencement: The Contractor will provide to the U.S. Army Corps of Engineers (USACE) with a written notification of the date of commencement of underwater investigation work and a detailed description of the work to be implemented based on the Work Plan (WP) that will be coordinated and reviewed by TPP Team. USACE will provide the date of commencement to the TPP Team at least 10 days prior to initiating fieldwork.

4.1.2 Training/Briefing: Prior to initiating work all personnel shall receive training or briefings regarding the importance of endangered species, their characteristics, how they can be identified, potential and critical habitats, types of material in which they may hide, actions to take if are sighted, and avoidance measures to be followed as detailed in these SOPs. This training or briefing shall be prepared and offered by qualified personnel (e.g. biologist, marine biologist, environmental scientist, among others). The Contractor shall submit their qualifications to the USACE for review and approval. The training or briefing will also include safety and emergency procedures.

4.1.3 Civil and Criminal Penalties: The Contractor shall instruct all personnel associated with the project of the potential presence of threatened or endangered species. All personnel shall be advised that there are civil and criminal penalties for harming, harassing, killing or otherwise altering the natural behavior or condition of threatened or endangered species protected under the ESA, the Puerto Rico Wildlife Law, and the Regulation to Govern the Endangered and Threatened Species of the Commonwealth of Puerto Rico. ESA gives both

the FWS and NMFS responsibility for enforcing its provisions. The Commonwealth regulations to protect endangered and threatened species are enforced by the Puerto Rico Department of Natural and Environmental Resources (DNER).

4.1.4 Qualified Personnel: Each team performing underwater investigation work shall be accompanied on the boat, but not necessarily in the water, by qualified and experienced personnel (e.g. biologist, marine biologist, environmental scientist, among others) in order to identify the presence or absence of threatened or endangered species. The Contractor shall submit their qualifications to the USACE. The divers can request to the designated and qualified personnel on the boat to enter in the water to identify and determine if a suspected threatened or endangered species is present in the study area.

4.1.5 Coordination: All related work will be coordinated with the TPP Team prior to initiation as described in Part 4.1.1. The Contractor will provide a preliminary schedule and the areas (including the proposed transects and grids) where investigation will be performed and all the equipment to be used. Changes to the schedule and working areas will be provided to the TPP Team. The Contractor will make any required project notifications to the appropriate USACE personnel, who will in turn notify the regulators and resource agencies.

4.1.6 Reports: The Contractor shall maintain a log detailing endangered or threatened species sightings in terrestrial and marine habitats. The log shall include, but not limited to, the following information: date and time, location coordinates using a Global Positioning System (GPS) unit, species, one or more photographs, if possible, and any actions taken (e.g. species identification and distance from working area, reasons to cease operation, reasons to determine that operation may be resumed, among others) during the work period. All data shall be provided to USACE to be shared with the TPP.

4.1.7 Detonation Activities: Because the proposed action consists of data collection and characterization of benthic habitats, intrusive investigation or munitions detonations will not be conducted under this phase. If MECs are indentified during underwater work, they will be left in place and GPS coordinates of the MEC's location will be obtained for further investigations. MEC location will be shared with the TPP as "Privilege and Confidential." Due to public safety concerns, the MEC location shall not be released to the public. Based on the EBS results, additional SOPs or other conservation measures will be closely developed and coordinated with the TPP for further investigation phases and disposal activities.

4.1.8 If the UIT determines that weather conditions are unsafe (e.g. heavy rain, strong wind and rough seas), underwater investigation will not be conducted in order to minimize the potential for accidental groundings.

4.1.9 Underwater investigation activities will be conducted during day time hours (7:00am-5:00pm) only.

4.1.10 If during underwater activities the Contractor observes items that may have historic or archeological value, the Contractor will obtain GPS coordinates of the items' locations and notify the USACE of the observation. In consultation with the State Historic Preservation Officer, the USACE will use this information to assess the significance of the items in compliance with the National Historic Preservation Act.

4.2 Staging Area and Sea Turtle Nesting Monitoring

4.2.1 Contractor shall identify any onshore staging areas needed for execution of these investigations so that sea turtle nest monitoring can be conducted prior to initiating mobilization to ensure no impacts occur to this species.

4.2.2 The sea turtle nests monitoring will be limited to the areas used by the Contractor personnel. The beach monitoring efforts will consist of nests sighting and identification. The Contractor will avoid any sea turtle nests that are encountered. Any nest encountered shall be clearly marked (e.g. using flagging). The Contractor personnel shall stay at least 26 feet (8 meters) away from the marked area to avoid impacts to the nest(s). All nest sightings and actions taken shall be documented as described in Part 4.1.6. Additional conservation measures are provided in Appendices A and B.

4.2.3 Staging areas shall not require any removal of coastal vegetation. These areas shall consist of temporary tents or similar structures that can be easily removed.

4.2.4 Any areas proposed for use as staging area that form part of the Culebra National Wildlife Refuge shall be closely coordinated with the refuge manager. Points of contact are provided in Part 5.0.

4.2.5 The smaller offshore cays should not be used as staging areas; only cays that can be safely accessed by boats should be identified for use. Temporary mooring buoys should be employed to access staging areas to avoid repeated anchoring and impacts to marine bottom as per previous SOPs (refer to Parts 4.3 - 4.4 and Appendix A for more information).

4.2.6 Monitoring shall be conducted daily by qualified personnel (e.g. biologist, marine biologist, environmental scientist, among others) to identify the potential presence of new nests or sea turtle tracks during the activity period (refer to Appendix A for detailed information).

4.2.7 If sea turtle nests are found, the Contractor personnel will notify USACE, who will notify the FWS Boquerón Endangered Species Specialist, NMFS Boquerón Office and DNER

POC. If agreed the nest locations will be clearly marked and the staging area will be relocated. This information shall be documented as described in Part 4.1.6.

4.3 Coral and Seagrass Avoidance Measures

4.3.1 Prior to initiation of field activities the UIT shall receive a boating safety briefing and information regarding location and identification of coral reefs, colonized hardbottom and seagrass (refer to Part 4.1.2 for more information). Also, the information contained in these SOPs and its Appendices, and the types of actions that constitute a violation to the 4(d) rule (50 CFR Part 223) shall be discussed.

4.3.2 Vessel operator shall carry and consult appropriate NOAA nautical charts, NOAA benthic habitat maps and aerial photographs to locate potential coral reefs, colonized hardbottom and seagrass areas. Combining information from aerial photographs with hydrographic data will help to ensure that nautical charts are accurate.

4.3.3 Real-time data (e.g. GPS with nautical chart and depth finder on boat) will be continuously observed to verify water depths and vessel location. For additional information, please refer to Parts 4.3.5 and 4.4.3.

4.3.4 Vessel operator and UIT shall maintain a vigilant watch for coral reefs, colonized hardbottom and seagrass areas to avoid running aground or striking protected species. As part of the WP for conducting the underwater investigations and EBS, the Contractor shall provide and specify the type of equipment to be used and their recommended safety depths to avoid impacts to endangered and threatened species.

4.3.5 From the water's surface, some coral areas appear golden-brown. These areas should be avoided to keep from running aground. The operator shall stay at a minimum of 4 feet from the bottom of the vessel to the top of coral areas.

4.3.6 If no moorings are available, the vessel will be anchor in unvegetated sandy areas away from corals and seagrasses, so the anchor, chain and line do not contact or damage coral or seagrass areas.

4.3.7 Vessels shall be maintained away from areas with corals and seagrasses (see Part 4.3.5). Operations shall be conducted in such manner that bottom scour or prop dredging will be avoided when corals or seagrasses are present.

4.3.8 The following actions are prohibited:

a. Walk on, sit on or stand on coral
b. Collect coral (dead or alive)
c. Anchoring on coral/seagrass
d. Touch coral with hands or equipment
e. Discharge any pollutant or contaminant
f. Dump trash

4.3.9 If during the underwater investigation work any coral is injured, whatever activity causing the damage will be stopped, the injured coral will be left in place and the U.S. Coast Guard (USCG), NMFS Boquerón Office and DNER should be immediately notified. If listed corals are injured, the Contractor shall also contract the NOAA Office of Law Enforcement at 1-800-853-1964. The following information must be provided:

a. The time, date, and location (latitude/longitude) of the incident.
b. The name and type of the vessel involved.
c. The vessel's speed during the incident.
d. A description of the incident.
e. Water depth.
f. Environmental conditions (e.g. wind speed and direction, sea state, cloud cover, and visibility).
g. The type of coral or description, if possible.
h. A description of the damage caused to any coral, if possible.

4.3.10 If the vessel runs aground, the operator shall perform the following:

a. Turn of the engine.
b. Do not try to use the engine to power off the reef, hardbottom or seagrass.
c. Raise the propeller, and allow the boat to drift free.
d. Radio the Coast Guard, Marine Patrol or VHF Channel 16 for assistance.
e. If any coral or seagrass is injured the Contractor shall follow the procedures described in Part 4.3.9.

4.4 Marine Mammals and Sea Turtles Avoidance Measures

4.4.1 Vessel strike avoidance measures were also provided in Appendix A, page 12, items 1-6. These measures have been updated and for the purpose of underwater investigation activities, the Contractor shall follow and implement the avoidance measures provided under this section.

4.4.2 The Contractor shall instruct all personnel associated with the underwater investigation work of the potential presence of marine mammals (e.g. manatees and whales) and sea turtles and the need to avoid collisions with these species. The Contractor shall be held responsible

for any marine mammal and sea turtle harmed, harassed, or killed as a result of underwater activities (including vessel operations supporting these activities) and general boating activities needed to go to and from the study areas. All appropriate precautions shall be followed and the operator will avoid excessive speed as described in Parts 4.4.7 and 4.4.8.

4.4.3 All vessels associated with the underwater investigations shall operate at "no wake/idle" speeds at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes whenever possible. Boats used to transport personnel shall be shallow-draft vessels, preferably of the light-displacement category, where navigational safety permits.

4.4.4 Mooring bumpers shall be placed on all vessels wherever and whenever there is a potential for marine mammal or sea turtle to be crushed between two moored vessels. The bumpers shall provide a minimum stand-off distance of four feet.

4.4.5 Vessel operator and UIT should maintain a vigilant watch for marine mammals and sea turtles to avoid striking sighted protected species.

4.4.6 If a marine mammal or sea turtle is sighted within 300 feet (100 yards) of the project area, all appropriate precautions shall be implemented by the Contractor to ensure protection of these species. These precautions shall include the operation of all moving equipment no closer than 150 feet (50 yards) of a marine mammal or sea turtle. If a marine mammal or sea turtle is closer than 150 feet (50 yards) to moving equipment or the study area, the equipment shall be shut down and all activities shall cease to ensure protection of the species. Underwater activities shall not resume until the marine mammal(s) or sea turtle(s) have left the study area naturally. Animals must not be herded away or harassed into leaving.

4.4.7 When marine mammals or sea turtles are sighted while a vessels is underway, the operator will remain parallel to the animal's course. Vessel operator will avoid excessive speed or abrupt changes in direction until the animal has left the area.

4.4.8 Vessel operator will reduce vessel speed to 10 knots or less when mother/calf pairs, groups, or large assemblages of marine mammals are observed near an underway vessel, when safety permits. A single marine mammal at the surface may indicate the presence of submerged animals in the vicinity; therefore, prudent precautionary measures will be exercised. The vessel should attempt to route around the animals, maintaining a minimum distance of 300 feet whenever possible.

4.4.9 Marine mammals and sea turtles may surface in unpredictable locations or approach slowly moving vessels. When an animal is sighted in the vessel's path or in close proximity to a moving vessel and when safety permits, the vessel operator will reduce speed and shift the

engine to neutral. Vessel operator will not engage the engines until the animals are clear of the area.

4.4.10 Monitoring: The UIT shall monitor for the presence of marine mammals and sea turtles.

4.4.11 All sightings and actions taken shall be reported as described in Part 4.1.6.

4.4.12 Injured or Dead Protected Species Reporting: Any collisions or sighting of any injured or incapacitated marine mammals or sea turtles shall be reported immediately to the USACE, FWS, NMFS, and DNER and information listed in Part 4.3.9 must be provided. For additional contact information, please refer to Section 5.0.

- Report stranded marine mammals to Southeast U.S. Stranding Hotline: (305) 862-2850
- Report stranded sea turtles to the NMFS Southeast Regional Office: (727) 824-5312
- NMFS Boquerón Office: (787) 851-3700
- FWS Boquerón Office: (787) 851-7297
- FWS Culebra NWR Office: (787) 742-0115
- DNER: (787) 645-5593

4.5 Diving Operations and Equipment

4.5.1 All underwater investigation work will be conducted by qualified and trained divers and will be planned in a manner that avoids direct impacts to threatened or endangered species and sensitive habitats within the project area. Anchoring practices described in Part 4.3 shall be implemented.

4.5.2 Prior to initiation of daily operations the UIT will check the weather conditions, inspect the vessel and verify that all the required equipment is available, in good condition, working correctly, and calibrated. The Contractor will maintain a log detailing equipment inspections.

4.5.3 The UIT will make sure that underwater conditions (e.g. visibility, current speeds) and weather are suitable for diving to ensure safety for divers and for sensitive underwater habitats.

4.5.4 Based on dive site conditions, the amount of divers in the water will be determined by the Contractor.

4.5.5 The following general "best diving practices" will be followed:

a. The point of entry and exit will be carefully selected to avoid coral or underwater sensitive areas.
b. Divers will make sure that all equipment is well secured before entering in the water.
c. Divers will make sure that they are neutrally buoyant at all times.
d. Safe distance from coral areas to be provided in the WP shall be maintained.
e. Good finning practice and body control will be followed to avoid accidental contact with coral or stirring up the sediment.
f. Divers will stay off the bottom and will never stand or rest on corals or other sessile benthic invertebrates.

4.5.6 To support or supplement the underwater investigation activities the following equipment, but not limited to, will be used: remotely operated vehicle (ROV), side scan sonar towfish, underwater metal detectors, benthic/diver sleds, towing cables and lifting lines, underwater cameras, marking buoys and floats, and GPS. The Contractor shall provide and specify the type of equipment to be used and their recommended safety depths to avoid impacts to endangered and threatened species (see Parts 4.1.1 and 4.1.5).

4.5.7 All equipment will be used in a manner to avoid physical contact or harassment of any protected species and it shall not interfere with diving operations. Hand-held equipment that would be carried by divers shall not contact corals or disturb the bottom or seagrasses in the area.

4.5.8 Site conditions, marine structures present, real-time information and existing water depth will be constantly monitored by trained operators to determine the appropriate use of equipment needed to minimize the risk of physical contact with protected species and sensitive habitats.

4.5.9 Any unintentional injury to protected species during diving operations will be reported immediately as described in Parts 4.3.9 and 4.4.12.

4.6 Supplemental Information

The July 2008 SOPs developed for Culebra DERP-FUDS and its April 2011 Addendum remain in effect. Copies of these documents are included in the attached Appendices A and B. The SOPs in the current document are meant to supplement, not replace, previous SOPs and are directed toward underwater investigation activities. The SOPs in the current document also provide the most up-to-date information regarding listed corals.

5.0 POINTS OF CONTACT FOR SOPs COORDINATION AND REPORTING

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LIST OF APPENDICES

A. SOPs for Endangered Species Conservation and their Habitat (July 2008)

B. Addendum to the 2008 SOPs (April 2011)