Environmental Baseline Survey

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

Culebra, Puerto Rico

Final

2012-2013 Field Data Collection Report

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Culebra, Puerto Rico

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ABBREVIATIONS AND ACRONYMS

2D	two-dimensional
3D	three-dimensional
BTM	Benthic Terrain Modeler
cal	caliber
CTD	conductivity, temperature, depth
DGM	digital geophysical mapping
DGPS	differential GPS
DoD	Department of Defense
EBS	environmental baseline survey
EFH	Essential Fish Habitat
EM	electromagnetic
ESA	Endangered Species Act
FOL	field operations lead
FS	feasibility study
FUDS	Formerly Used Defense Sites
GNSS	Global Navigation Satellite System
GP	General Purpose
GPS	global positioning system
HD	high definition
HIPS	Hydrographic Information Processing System
IMU	inertial measurement unit
MBE	multibeam echosounder
MEC	munitions and explosives of concern
MLLW	mean low lower water
mm	millimeter
MQM	measurement quality metric
MRS	Munitions Response Site
NMFS	National Marine Fisheries Service
MRU	Motion Reference Unit
NAD83	North American Datum 1983
NOAA	National Oceanic and Atmospheric Administration
PM	Project Manager
QC	quality control
QCM	QC manager
R/V	research vessel
RI	remedial investigation
RTK	real-time kinematic

ROV	remotely operated vehicle
SSS	sidescan sonar
T^3ROV	Tetra Tech Towed ROV
T/E	threatened/endangered
TEMA	Towed EM Array
USACE	U.S. Army Corps of Engineers
USBL	ultra-short baseline
UTC	Coordinated Universal Time
UXO	unexploded ordnance
VCF	Vessel Configuration File

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1.0 INTRODUCTION

1.0.01 An environmental baseline survey (EBS) for two underwater Munitions Response Sites (MRSs), MRS 03 and MRS 12, was conducted as the first phase of a remedial investigation (RI). MRS 03, also known as the Flamenco Bay Water Area (Formerly Used Defense Sites [FUDS] Project No. I02PR006803M01), and MRS 12, also known as the Luis Peña Channel Water Area (FUDS Project No. I02PR006812M01), are referred to hereinafter as Flamenco Bay and the Luis Peña Channel, respectively.

1.0.02 The RI for Flamenco Bay and the Luis Peña Channel will be conducted in three phases: Phase 1, the EBS, to develop basemaps to guide the following phases; Phase 2, the digital geophysical mapping, to provide an assessment of the distribution and density of metallic items and debris fields that may be munitions and explosives of concern (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. This document describes the findings for Phase 1 EBS activities. 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 that was used to perform a benthic terrain and habitat assessment. Data from the EBS included in this report will be used to guide the other two phases of the RI by providing information and basemaps that show benthic terrain and delineations of sensitive habitats within these two MRSs. Additional reports will be developed to document subsequent phases of the RI. Following completion of the RI, a feasibility study (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.

1.1 SITE DESCRIPTION

1.1.01 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). Flamenco Bay and the Luis Peña Channel are located offshore east and west-southwest, respectively, of the Northwest Peninsula of Culebra, Puerto Rico.

1.2 USACE'S ASSESSMENT OF THE NORTHWEST PENINSULA AREA

1.2.01 On behalf of the Department of Defense (DoD), a Congressionally mandated study was performed by the U.S. Army Corps of Engineers (USACE) under Public Law 111-383 in 2011 to assess the presence of unexploded ordnance (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.

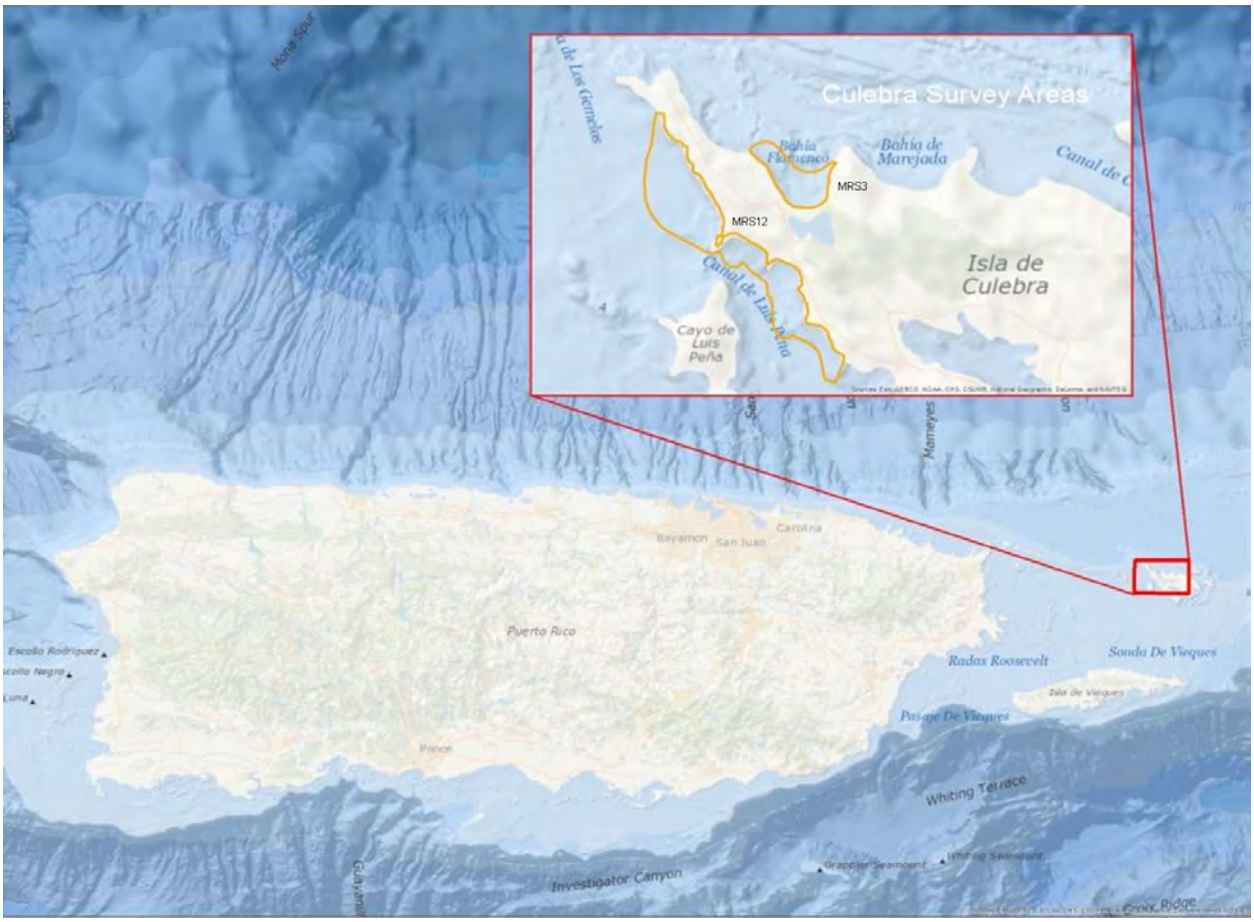


Figure 1a. Environmental Baseline Survey Location

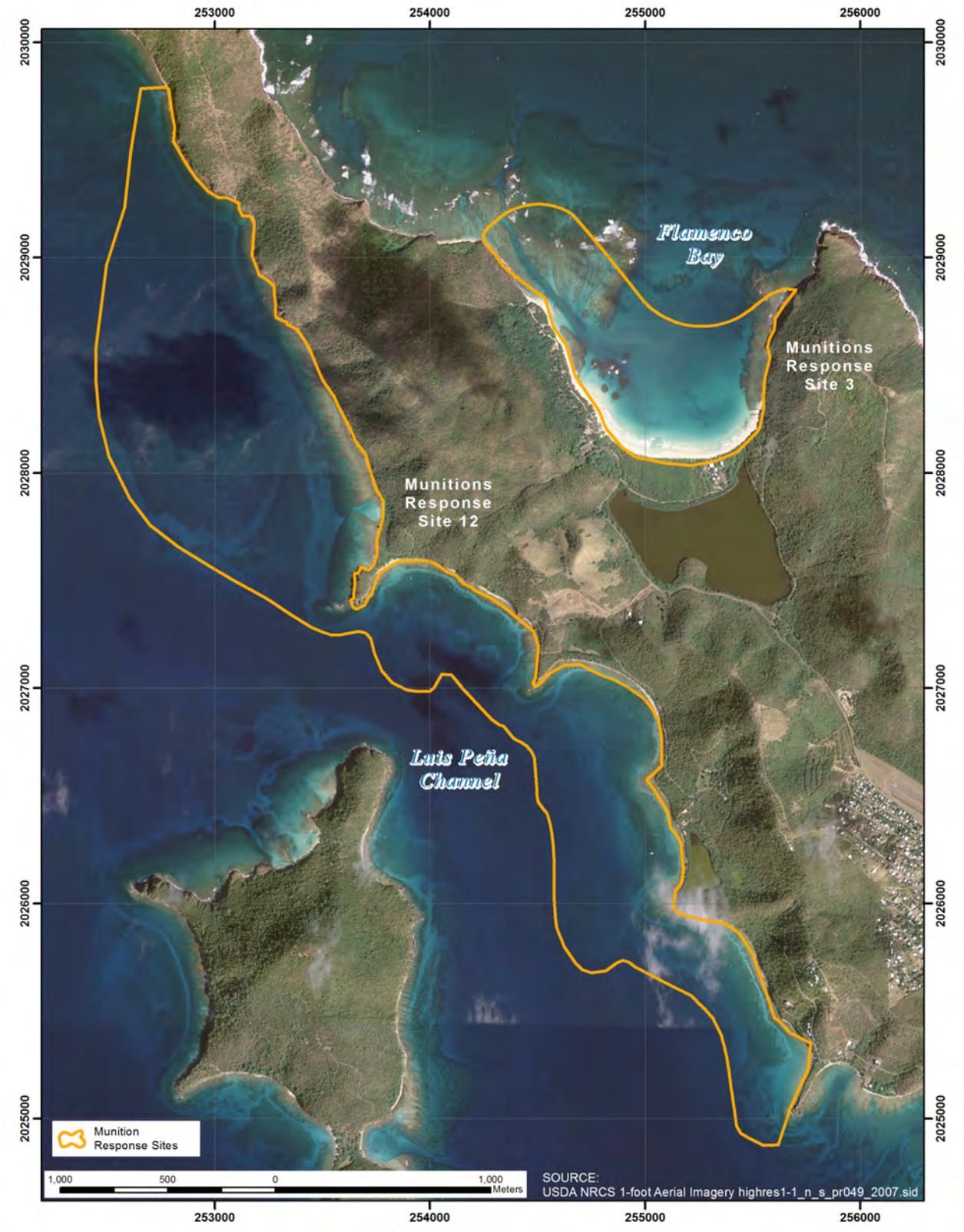
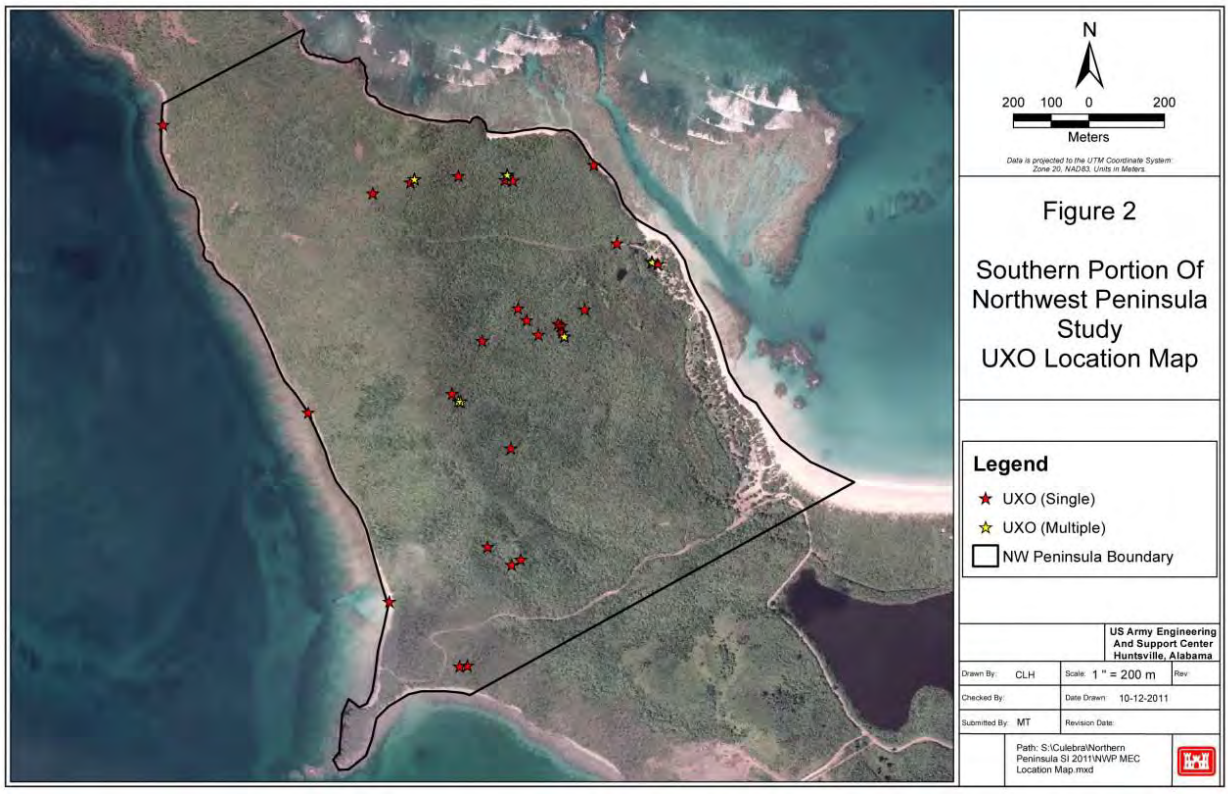


Figure 1b. Environmental Baseline Survey MRS 03 and 12 Boundaries

1.2.1.01 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 (Navy 1973).

1.2.1.02 Since 1995, 70 UXO have been encountered within approximately 19 acres of the 2011 Study Area. This total, which includes 36 UXO discovered during the 2011 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 2.



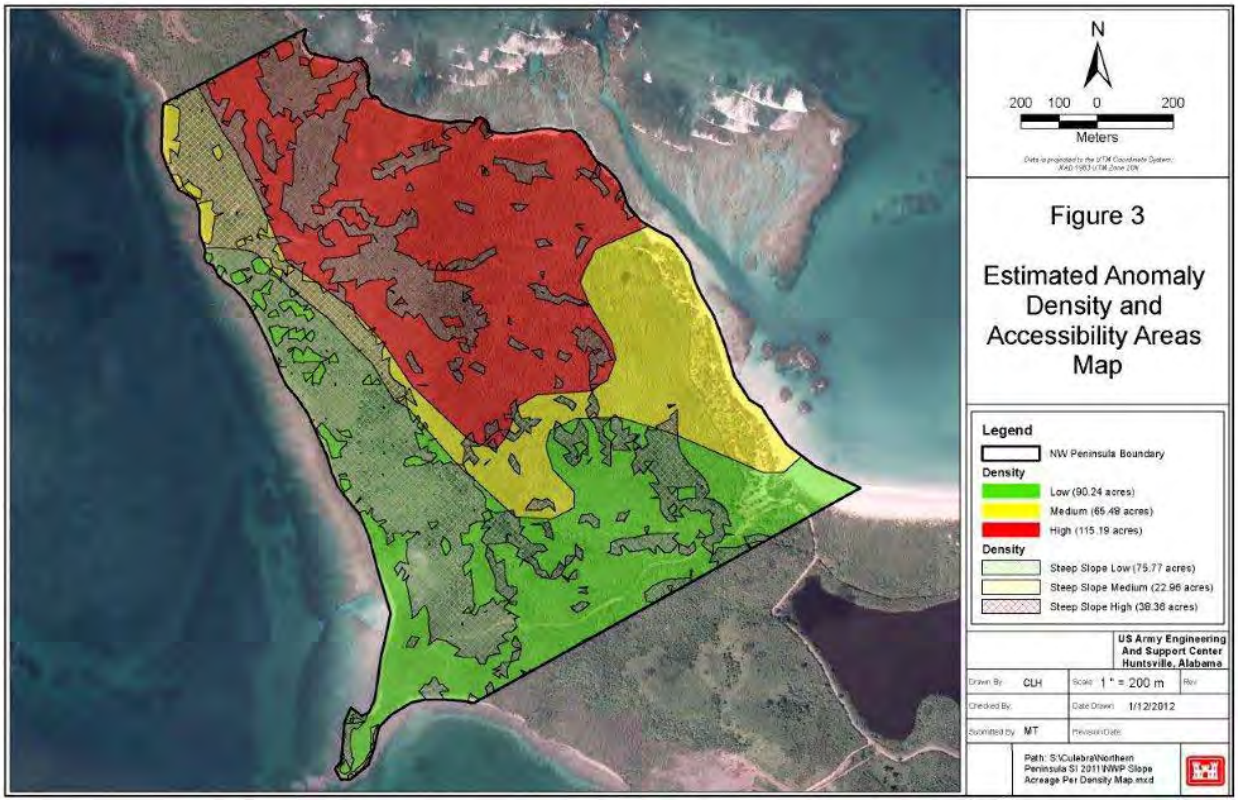
source: DoD (2012)

Figure 2. Locations of Individual or Multiple UXO

1.2.1.03 The predominant military munition encountered within the 2011 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 millimeter (mm) projectiles, 75mm projectiles, 81mm mortars, 100-pound General Purpose (GP) bombs, a 500-pound GP bomb, and Bomb Dummy Unit-33 practice bombs.

1.2.1.04 The USACE divided the Study Area into three areas based upon the number of metallic anomalies they detected during the geophysical survey, USACE's estimate of the density of those metallic anomalies within each area, and the steepness of the terrain (see Figure 3). The three areas reflect an estimated anomaly density of:

- Low (Green): to785 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 3. Estimated Anomaly Density and Accessibility Areas Map

1.3 SURVEY REPORT ORGANIZATION

1.3.01 The sections that comprise the EBS Report are discussed below:

- Section 1, Introduction, details the RI and how this EBS fits into the three phases of the RI; provides a site description that documents the two MRSs covered under the RI and the location of the MRSs; presents the study area objectives and quality objectives of the EBS; and presents the project team involved with the EBS.
- Section 2, Field Operations, discusses the marine geophysical survey and remote sensing tasks, including MBE, SSS, underwater video, and still photography, that were conducted during the EBS, the types of sensitive habitats and listed or candidate threatened or endangered (T/E) species that were evaluated during the EBS, the types and uses of data collected, and a description of survey equipment and the methodology used.
- Section 3, Survey Results, discusses the results of the geophysical survey and remote sensing tasks, including habitat classification and delineations, and calls out the appendices and figures where the results are shown in basemaps and charts that visually represent the data.
- Section 4, Summary and Conclusions, presents the primary conclusions regarding the data and evaluation of the methods used during the EBS, recommended additional data collection efforts, and preliminary opinions regarding future options for follow-on phases of the RI.
- Appendices A through I are provided as shown in the table of contents.

1.4 STUDY AREA AND OBJECTIVES

1.4.01 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 use of towed geophysical sensors and intrusive activities. Underwater investigation activities that were conducted as part of the EBS consisted of visual observations, boat operations, and remote sensing surveys. No intrusive investigation was conducted during the EBS phase of the RI. This report has been developed to describe the results of the EBS activities.

1.5 QUALITY OBJECTIVES

1.5.01 TtEC will used a range of operator data displays, processing tools, and procedures to ensure all survey equipment were functioning correctly and accurately prior to the start of the survey, at the start of survey day, during the course of data collection, and by performing at least preliminary processing of survey data prior to terminating field operations. These checks included periodic

global positioning system (GPS) water level checks, sonar bar checks, real-time monitoring of incoming data by trained operators, and quality checks such as the collection of cross lines (lines set at approximately 45 to 90 degrees to the survey lines). The bathymetry data obtained at the intersection of the survey lines and cross lines were post-processed in CARIS HIPS and Fledermaus Pro to provide a statistical analysis of the correlation between the data from two perpendicular survey lines. The SSS navigation check was performed by surveying two adjacent lines in opposing directions and evaluating the alignment of features. Table 1 summarizes the measurement performance criteria for each survey system. Appendix H contains the log and quality control (QC) forms that were generated for this EBS.

Table 1. Measurement Performance Criteria

Type of Survey Data	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency	Failure Response
Hydrographic Surveys	Precision	Cross line data	Data points common to both survey lines and cross lines will have x, y, z coordinates that are repeatable within SOP 01 specified USACE Hydrographic survey standards (refer to Table 3.3). Hydrographic Survey data shall meet or exceed Special Order Standards. Special Order Standards include the following: Horizontal Accuracy (95% confidence Level) is 2 meters. Depth Accuracy for Reduced Depths (95% Confidence Level) is calculated using the following equation $DARD = +/- [a^2 + (b * d)^2]^{1/2}$ where: a (0.25 meter) is a constant depth error, i.e., the sum of all constant errors, (b = 0.0075)*d is the depth dependent. The near full bottom search is compulsory and system detection capability is measured as cubic features >1 meter.	Minimum one cross line per 20 transects	Root cause analysis will be performed. Source of failure will be identified and corrected.
	Completeness	Visual evaluation of real-time data for verification that intended coverage goals are met	Real-time coverage plots (matrix fills) will be utilized to monitor MBE coverage. 90% of the matrix will be filled in areas that are accessible for survey (i.e., sufficient water depth, lack of obstacles, safe for navigation) and do not fall into shadow areas due to objects proud (slightly above) of the bottom, or due to depressions. Coverage will be confirmed during post processing. It is anticipated that there will be areas that are not covered in shoreline, shoal, and restricted areas	Continuous visual monitoring during data collection	Data gaps will be identified and additional data will be collected to fill in the area.

Table 1. Measurement Performance Criteria (continued)

Type of Survey Data	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency	Failure Response
Hydrographic Surveys cont'd	Sensitivity	Real-time monitoring and use of gains and gate filters, software quality flags.	MBE data collection depth range is optimized to reduce anomalous reflections and provide optimum data, gains are set to provide appropriate bottom tracking. The MBE conducts internal testing to check the validity of each ping based on colinearity and brightness and each ping is tagged with a quality flag of 0-3 based on the these tests. During processing, the pings are filtered based on the quality flags to eliminate all but the data with a quality of 3 unless conditions warrant accepting lower quality pings (such as shorelines or vertical structures).	Continuous visual monitoring during data collection, sonar system quality flags.	Root cause analysis will be performed. Source of failure will be identified and corrected.
	Accuracy	GPS survey crew will check on selected control points with rover GPS.	GPS measurements will match published position to within 0.1 meter x, y, and z.	Daily	Root cause analysis will be performed. Source of failure will be identified and corrected.
		Water level check – Use GPS rover to check water surface elevation. Compare to survey system navigation reported tide level.	GPS water level and survey system tide level will match to within 0.1 meter.	Once at the start and once at the end of survey operations.	
		Bar check and/or lead line check vs. water surface relative depth from sonar.	Nadir bathymetry depths relative to surface, corrected for draft and attitude match to within 0.1 meter.	Once at the Start of MBE Survey Operations	

Table 1. Measurement Performance Criteria (continued)

Type of Survey Data	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency	Failure Response
Sidescan Sonar	Navigation Precision	Reciprocal Survey lines or adjacent survey lines with overlapping coverage collected in opposite directions	Bottom features will align within 2 meters. Conducted at the beginning of the survey once a distinct target has been detected on adjacent lines and throughout the sidescan operations during post-processing. This criterion may be relaxed if the magnetic heading sensor in the sidescan towfish is adversely affected by the magnetic rock present within the survey areas, or if course made good headings are not sufficient.	Minimum of one check per day	Root cause analysis will be performed. Source of failure will be identified and corrected.
	Completeness	Visual evaluation of real-time data for verification that intended coverage goals are achieved	Post-processed will have no along track coverage gaps. Nadir regions will be covered by adjacent survey lines to achieve full coverage in areas that are accessible for survey (i.e., sufficient water depth, lack of obstacles, safe for navigation) and do not fall into shadow areas due to objects proud (slightly above) of the bottom, or due to depressions. Coverage will be confirmed during post processing. It is anticipated that there will be areas that are not covered in shoreline, shoal, and restricted areas.	Daily	Data gaps will be identified and additional data will be collected to fill in the area.
Underwater Video	Quality	Recorded Video	A minimum of 1 minute of recorded and video will be played back at the start of each day to ensure the equipment is functioning properly and providing adequate imagery.	Daily	Root cause analysis will be performed. Source of failure will be identified and corrected.
	Completeness	Tracklines, Data files	Video will be recorded concurrently with MBE and SSS surveys if possible and, if not, at transects of no less than 100 ft apart. Data acquisition coverage plots along with file size monitoring will be used to verify that video has been recorded.	Continuously	Data gaps will be identified and additional data will be collected to fill in the area.

1.6 PROJECT TEAM

1.6.01 Tetra Tech program management was provided by the following individuals:

- Program Manager – Kent Weingardt: The program manager is responsible for ensuring contract requirements are met during the performance of the Task Order.
- Program Safety Manager – Roger Margotto.
- Munitions Response Program and Diving Safety Manager – Steve Neill.
- Program QC Manager – Mark Dollar.
- Lead Hydrographer/Marine Survey QC Manager – Burr Bridge.

1.6.02 An organizational chart is presented in Figure 4.

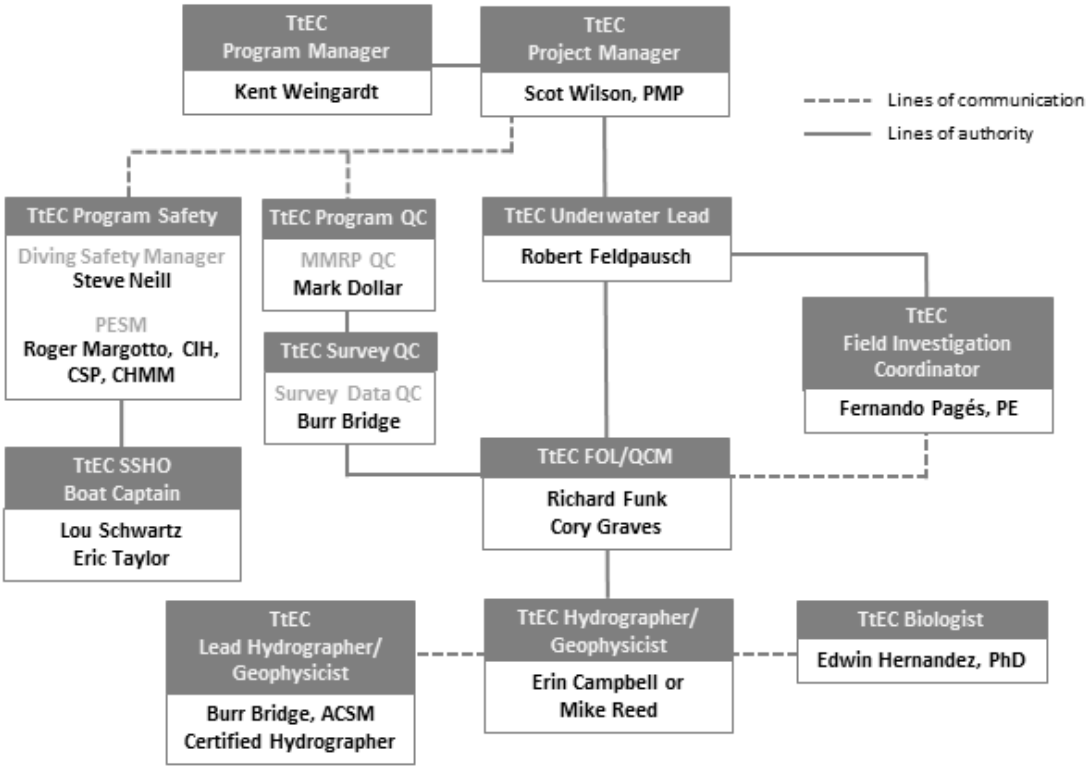


Figure 4. Environmental Baseline Survey Organizational Chart

1.6.1 Project Manager

1.6.1.01 The Project Manager (PM), 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 PM is responsible for the day-to-day management of RI activities, monitoring the RI budget, updating the RI schedule, and ensuring RI compliance.

1.6.2 Field Investigation Coordinator

1.6.2.01 Fernando Pagés serves as the Field Investigation Coordinator for the EBS. Fernando is based in Puerto Rico and has knowledge of the personnel and resources for effective implementation of the RI. The Field Investigation Coordinator was responsible for coordinating EBS resources onsite to support the RI field investigation.

1.6.3 Underwater Lead

1.6.3.01 The underwater lead, Robert Feldpausch, oversaw technical management of the field program. The underwater lead ensured timely resolution of RI-related technical, quality, and safety questions associated with in-water survey operations; coordinated and oversaw in-water hydrographic and geophysical work performed by Tetra Tech field and office technical staff, including data collection and interpretation; and coordinates preparation and review of hydrographic and geophysical deliverables.

1.6.4 Field Operations Lead / Quality Control Manager

1.6.4.01 The field operations lead (FOL), Richard Funk, was responsible for implementation of the field program. Toward the end of the survey, Richard Funk was replaced by Cory Graves. The FOL oversaw day-to-day field operations for bathymetric and imagery sonar studies and in-water video and photography, ensured that proper staffing and resources were available on-site, that personnel had reviewed and understood their responsibilities, and that data collection activities were conducted in accordance with the approved plan and cited standards. For the EBS, the FOL served as the field QC manager (QCM) and was responsible for all aspects of data quality. This individual ensured that data collection procedures and data processing and interpretation procedures were observed and that the resulting data met the performance specifications in the approved plan.

Burr Bridge, who did not participate in field operations, provided post-processing and QC services for the collected geophysical and video/imagery data.

1.6.5 Hydrographers and Geophysicists

1.6.5.01 The lead hydrographer for this RI was Burr Bridge, who performed quality control and data review offsite. The on-site hydrographer/geophysics duties were performed by Erin Campbell, Mike Reed, and Ransom White, under the supervision of the FOL/QCM. The hydrographers were responsible for reviewing and understanding their responsibilities as assigned and for general safety at the RI site. They carried out the daily field activities, which included deployment and operation of survey equipment and acquisition of high-quality survey data under the supervision of the FOL.

1.6.6 Biologists

1.6.6.01 Each team performing underwater investigation work was accompanied on the boat, but not necessarily in the water, by qualified, trained, 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 primary Tetra Tech field biologist was Edwin Hernandez-Delgado, Ph.D., with support from Edwin Rodriguez-Class, Ph.D. Both individuals have extensive experience and academic qualifications for observing sea turtles, marine mammals, and coral and seagrass habitat; they also met the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service requirements for observers and were qualified to provide the endangered species briefings to RI personnel. In addition, Tetra Tech identified qualified environmental scientists with experience in marine mammal observation, including Maylene Pérez Robles, Kayla Pacheco, and Ariel Rivera. Training and briefing of RI personnel by the RI biologist was completed prior to performing any in-water work.

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2.0 FIELD OPERATIONS

2.0.01 Non-invasive marine geophysical surveys were conducted in Flamenco Bay and Luis Peña Channel extending from 3 meters mean lower low water (MLLW) to the offshore boundary of each site. The EBS was conducted to evaluate the characteristics of the marine environment and identify endangered species and sensitive areas such as coral reefs that may not be adequately defined. The EBS was conducted using surface-vessel-mounted and/or near-surface-towed sensor systems, and scientific kayakers, to delimit and ensure the preservation of sensitive marine habitats and flora/fauna prior to the use of towed sensors in the water column. The EBS also used hull-mounted and towed sensors and video equipment to investigate and document areas of interest in deeper water. The marine geophysical surveys included the following remote sensing systems: high-resolution MBE, SSS, and underwater video and still photography. Due to the seasonal weather conditions, water clarity was degraded during the EBS, as compared to other seasons. This turbidity negatively impacted the quality of the underwater photos and video. The rougher sea states encountered, especially in MRS 03, caused heave artifacts within the SSS and MBE, and also produced bubble wash that would at times block the sonar's signals, causing data gaps. All data collected met the measurement quality metrics (MQMs) and were collected during the best weather conditions possible.

2.0.02 In areas with less than 10 feet of water, a kayak was used to tow underwater cameras mounted on floats. While these areas were too shallow to map using the sonar systems, the camera data, which was geo-referenced using a GPS system, was used to image and map habitat areas.

2.0.03 The EBS was conducted to identify areas of T/E (listed) corals as well as species of coral proposed for T/E listing (candidate coral species) and other listed or candidate marine mammal or reptile species (including those for which critical habitat has been designated) with the potential to occur in the project area (included in Table 2). All marine mammal species warranted avoidance measures during the fieldwork, though marine mammal species subject to the Endangered Species Act (ESA) were specifically the focus of the EBS. The EBS also was performed to define boundaries to sensitive habitat areas such as seagrass beds or coral reefs to help determine where the magnetometer/electromagnetic system(s) can safely be deployed as part of digital geophysical mapping and intrusive investigations that will follow in separate phases of work without damage to these resources.

Table 2. Listed and Candidate Marine Species Potentially Present in Project Area

Common Name [1/]	Scientific Name	Group	Status	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	Coastal Zones
Hawksbill sea turtle	*Eretmochelys imbricate*	Reptile	E	Coastal Zones

Table 2. Listed and Candidate Marine Species Potentially Present in Project Area (continued)

Common Name [1/]	Scientific Name	Group	Status	Distribution
Antillean manatee	*Trichechus manatus manatus*	Mammal	E	Coastal Zones
Elkhorn coral	*Acropora palmata*	Invertebrate	T[2/] , CH	Coral Reefs
Staghorn coral	*Acropora cervicornis*	Invertebrate	T2[/] , CH	Coral Reefs
Boulder Star coral	*Montastraea annularis*	Invertebrate	CS - E	Coral Reefs
Mountainous Star coral	*Montastraea faveolata*	Invertebrate	CS - E	Coral Reefs
Sister of Mountainous Star coral, unspecified	*Montastraea franksi*	Invertebrate	CS - E	Coral Reefs
Pillar coral	*Dendrogyra cylindrus*	Invertebrate	CS - E	Coral Reefs
Rough Cactus coral	*Mycetophyllia ferox*	Invertebrate	CS - E	Coral Reefs
Whitestar Sheet coral	*Agaricia lamarcki*	Invertebrate	CS - T	Coral Reefs
Elliptical Star coral or Pineapple coral	*Dichocoenia stokesii*	Invertebrate	CS - T	Coral Reefs
Humpback whale	*Megaptera novaeangliae*	Mammal	E	Ocean to offshore reef systems, island, or continental shores
Blue whale	*Balaenoptera musculus*	Mammal	E	Ocean to offshore coastal zones

Status
E=Endangered T=Threatened CH=Critical Habitat CS = Candidate Species for potential listing
[1/] This list does not include terrestrial listed or candidate species of reptile, plant, bird, or other whales that typically occur further offshore and would not typically be found within MRS 3 or 12 (project area).
[2/] In 2012, the National Marine Fisheries Service proposed changing status of Elkhorn and Staghorn coral from threatened to endangered.

2.0.04 Critical habitat for the above listed species has been designated in and around Culebra as follows:

- Green sea turtle – Critical habitat was designated in 1998 for green sea turtles in the coastal waters around Culebra. The seagrass beds around Culebra are an important part of this designated critical habitat.
- Elkhorn and Staghorn corals – Critical habitat was designated in 2008 for these corals in four areas, including Puerto Rico.

2.0.05 Nearshore coral reefs and seagrass beds around Culebra are designated as Essential Fish Habitat (EFH) due to their importance to fishery production. Based on the NMFS proposal to designate seagrass as critical habitat, the USFWS has designated Culebra seagrass beds as Resource Category 1. EFH is identified for species managed in Fishery Management Plans under the Magnuson-Stevens Fishery Conservation and Management Act. The NMFS has interpreted through regulation that EFH must be described and identified for each federally managed species at all life stages for which information is available.

2.0.06 The EBS bathymetric and bottom type mapping included the following components:

- High-resolution MBE bathymetry;
- SSS data collected to provide high-quality imagery and to augment the MBE and

underwater video imagery for bottom type characterization and target identification;

- Underwater video collected concurrently with the MBE and SSS data used to aid RI geologists, biologists, and MEC specialists with bottom type classification, identification of sensitive habitat, and potential identification of MEC.
- Benthic terrain modeling conducted on the MBE bathymetry using the National Oceanic and Atmospheric Administration's (NOAA's) Benthic Terrain Modeler (BTM).

2.0.07 Following review of the MBE bathymetry and SSS imagery, additional visual inspection was conducted using a towed video sled and drop camera (see section 2.4.01 for details on the photographic systems utilized). No environmental sampling was conducted as part of Phase 1.

2.0.08 EBS field operations were conducted in December 2012 and January 2013. The field activities are presented below in Table 3.

Table 3. Survey Activities by Day

Date	Work	Location	MRS
12/2/2012	Fly to PR	San Juan, PR	
12/3/2012	Mobilization	San Juan, PR	
12/4/2012	Mobilization	San Juan, PR	
12/5/2012	Mobilization	Fahardo, PR	
12/6/2012	Mobilization	transit to Culebra	
12/7/2012	Mobilization, Multibeam collection test and processing	Culebra	NA
12/8/2012	Patch Test and Multibeam	Luis Pena Channel in Tamarindo to Punta Melones	12
12/9/2012	Multibeam	Luis Pena Channel in Tamarindo to Punta Melones	12
12/10/2012	Mobilize Sidescan Sonar, Kayak Video	Luis Pena Channel in Tamarindo	12
12/11/2012	Sidescan Sonar, Kayak Video	Luis Pena Channel in Tamarindo	12
12/12/2012	Kayak Video, Mobilization of SV2 system and Patch Test	Luis Pena Channel in Carlos Rosario	12
12/13/2012	Kayak Video, Multibeam	Luis Pena Channel in Carlos Rosario (Video), Tamarindo (MBE)	12
12/14/2012	Kayak Video, Multibeam and Patch Test	Flamenco Bay (Video), Luis Pena Channel in Tamarindo and Carlos Rosario (MBE)	3 & 12
12/15/2012	Kayak Video, Multibeam	Flamenco Bay (Video), Luis Pena in Carlos Rosario (MBE)	3 & 12
12/16/2012	Sidescan Sonar, Kayak Video, Multibeam	Flamenco Bay (Video), Luis Pena in Carlos Rosario (MBE and SSS)	3 & 12
12/17/2012	Sidescan Sonar, Kayak Video, Multibeam	Flamenco Bay (Video and MBE), Luis Pena in Carlos Rosario (SSS)	3 & 12
12/18/2012	Sidescan Sonar, Kayak Video, Multibeam	Luis Pena in Carlos Rosario	12
12/19/2012	Sidescan Sonar, Kayak Video, Multibeam	Luis Pena	12
12/20/2012	Patch and COG Test, and Secure Vessel for Holiday		3 & 12
12/21/2012	Secure Vessel for Holiday		3 & 12
12/22/2012 to 1/1/2013	Holiday Standby		NA
1/2/2013	Travel to Culebra		3 & 12

Table 3. Survey Activities by Day (continued)

Date	Work	Location	MRS
1/3/2012	Mobilize Sidescan Sonar		3 & 12
1/4/2013	Sidescan Sonar, Multibeam	Luis Pena	12
1/5/2013	T^{3}ROV Video and GoPro Stills, Multibeam	Luis Pena	12
1/6/2013	Kayak GoPro stills /weather standby	Luis Pena	12
1/7/2013	T^{3}ROV Video and GoPro Stills, Multibeam	Luis Pena	12
1/8/2013	T^{3}ROV Video and GoPro Stills	Luis Pena	12
1/9/2013	T^{3}ROV Video and GoPro Stills, Multibeam	Luis Pena	12
1/10/2013	Multibeam	Luis Pena	12
1/11/2013	Data Processing		NA
1/12/2013	Sidescan Sonar, Multibeam	Flamenco Bay	3
1/13/2013	Kayak Video	Flamenco Bay	3
1/14/2013	Side Mounted Video, Multibeam	Luis Pena	12
1/15/2013	Data Processing/Demobilization / DNR		NA
1/16/2013	Data Processing/ Demobilization / DNR		NA
1/17/2013	T^{3}ROV Video	Flamenco Bay	NA
1/18/2013	Demobilization		NA

2.1 MOBILIZATION

2.1.01 Upon receipt of the notice to proceed, the field team was alerted, travel and lodging arrangements were made, and the requisite copies of the applicable project and reference documents were assembled. Mobilization of the field team and equipment were conducted based on the sequence of the field tasks. All field personnel attended site-specific training upon mobilization. All personnel received UXO awareness and other related training as required by the Work Plan. The survey team and support personnel mobilized to the site and established the field office and support facilities, received equipment deliveries, and prepared equipment for use. Site preparation activities included establishing support facilities, docking and marine access arrangements, and survey coordinates and parameters. The field crew completed the installation of survey equipment on the vessel and performed required equipment installation and tests prior to the survey.

2.1.1 System Setup

2.1.1.01 Tetra Tech configured their 9-meter (29.5-foot) boat (the research vessel [R/V] *Streak*) with MBE on a retractable side mount (Figure 5). When the pole was lowered into the water, it was bolted into place, allowing the pole to be raised or lowered while maintaining proper orientation. Data collection and navigation software for the bathymetry survey was HYPACK®/HYSWEEP® v.2012. SSS data were collected in EdgeTech Discover software. Equipment used for this survey is listed in Table 4.

Figure 5. RESON SeaBat 7125 Multibeam Survey Vessel – R/V *Streak*

Table 4. Survey Equipment

Sensor Type	Manufacturer and Model
Survey Vessel	R/V *Streak*
Multibeam Sonars	RESON SeaBat 7125 SV, 400 kHz
Sidescan Sonar	EdgeTech 4125 400/900 kHz
Motion Reference Unit (MRU)	Applanix POS MV
Heading	Applanix POS MV
Elevation	Applanix POS MV / Leica 1200 GNSS with base station corrections
Position	Applanix POS MV / Leica 1200 GNSS with base station corrections
Sound Speed Sensors	Seabird MicroCat SBE-37 and YSI CastAway CTD
Underwater Digital Video/Still Imagery	Deep Sea Power & Light Wide-I camera, SplashCam Deep Blue, GoPro HERO3 Black Edition, Panasonic LUMIX TS4

2.1.2 Vessel Offsets

2.1.2.01 An inertial measurement unit (IMU) was used to define the origin and orientation of the X, Y, and Z axes of the vessel's local reference frame. Table 5 provides the sensor offsets which were entered into HYPACK and HYSWEEP to set up the survey hardware. These measurements were also used in the CARIS Hydrographic Information Processing System v7.1 (HIPS) Vessel Configuration File (VCF) for multibeam data processing. Offsets were derived from positions measured by Tetra Tech by leveling the vessel and using measuring tapes and levels.

Table 5. R/V Streak Sensor Offsets

Sensor	Across (Starboard Positive)	Along (Forward Positive)	Vertical (Down Positive)
Motion Sensor / Navigation (POS/MV 320)	0.00	0.00	0.00
SeaBat 7125 (pole mounted starboard)	-1.82	-0.75	0.48
GPS Tide (Leica antenna)	-1.82	-0.62	-3.06

Units of measure are presented in meters.

2.1.3 Geodesy Settings

2.1.3.01 The RI data were horizontally (X, Y) referenced to North American Datum 1983 (NAD83) State Plane, Puerto Rico/Virgin Islands with units of meters. Elevation data were collected in NAD83 ellipsoid and converted to PRVD02 orthometric heights using the NGS 2012A geoid in Caris. Table 6 presents the geodesy settings used for the RI. Horizontal and vertical positioning was achieved using real-time kinematic (RTK) GPS in conjunction with an Applanix POS MV inertial navigation system.

Table 6. Survey Geodesy Settings

Parameter	Setting
Projection	NAD83 State Plane
Zone	PR-5200 Puerto Rico & Virgin Islands Zone 1
Horizontal Datum	NAD-83
Vertical Datum	NAVD88
Distance Unit	Meters
Depth Unit	Meters
Geoid Model	National Geodetic Survey geoid g2012ap0

2.1.4 Position Data and Tides

2.1.4.01 The Applanix POS MV, the primary horizontal and vertical positioning system, was configured to receive two sets of external differential corrections. The primary corrections were provided by radio link from the GPS base station. Secondary corrections were received through the U.S. Coast Guard differential GPS (DGPS) corrections network. A vessel mounted Leica 1200 Global Navigation Satellite System (GNSS) receiver also served as an independent positioning backup system to the POS MV. Following survey acquisition, the real-time POS MV position data were post-processed to kinematic and differential accuracies using POSpac software.

2.1.4.02 Tidal data for the survey were generated using post-processed POS MV data (via POSPac software). The observed tide gauge data that were used to validate the GPS derived tidal data and to fill any data gaps were from NOAA Tide Station ID 9752235, which is near the ferry terminal on Culebra, Puerto Rico (Figure 6).

Figure 6. NOAA Tide Station ID: 9752235, Culebra, Puerto Rico

2.2 BATHYMETRIC SURVEY

2.2.01 The high-resolution bathymetric mapping was conducted to:

- Provide an accurate bathymetric model to support all subsequent survey and sediment sampling efforts (ensuring review of proposed sample locations by the RI biologist so that no coral critical habitat areas are proposed for sampling during the RI);
- Locate potential hazards to the marine towed sensors and survey/sampling vessels;
- Map or delineate features of interest, such as areas of potential sensitive habitat or listed corals, possible debris, areas of sand ripples, and rocky outcrops; and
- Provide detailed bathymetric and depth information to support dive planning.

2.2.02 Bathymetry systems were mounted on a surface vessel, minimizing the risk of physical contact with, or potential damage to, sensitive habitats. Performance standards and acceptance criteria for the calibrations and tests are consistent with the U.S. Army Corps of Engineers (USACE) Hydrographic Survey manual (EM 1110-2-1003; USACE 2002) and industry standards.

2.2.03 Since there have been no previous high-resolution bathymetric surveys of these areas, operational procedures were employed to ensure that the survey vessel(s) did not run aground and damage sensitive habitats. The bottom of the boat (and its draft), as well as any towfish array or other equipment projecting below the bottom of the boat, remained a minimum of 3 meters from the top of the coral and the bottom of the channel or bay.

2.2.04 When entering shallow water, the vessel crew made use of the wide swath of the multibeam sonar to identify and avoid potential grounding sites by surveying from deeper to shallower, and by keeping the boat within areas that have adequate water depth for safe passage.

2.2.05 When operating in shallow areas, one of the crew acted as a bow watch, visually checking for shoal areas and communicating with the vessel captain to avoid grounding or hitting coral.

2.2.1 Survey Procedures

2.2.1.01 High-resolution bathymetry data were collected using a RESON SeaBat 7125 multibeam sonar. The support sensors used to measure vessel attitude (roll, pitch, and heave), position, heading, and sound speed through the water column were selected to ensure that the associated accuracies were commensurate with the accuracy and resolution of the sonar.

2.2.1.02 High-accuracy RTK GPS was used for height (Z), as well as horizontal positioning (X and Y). This system was used to compensate for changes in water surface elevation, vessel squat and settlement, and varying draft caused by vessel loading in real time. Positioning data were post-processed for improved accuracy.

2.2.2 Multibeam Calibration – Patch Test Results

2.2.2.01 During the RI, a standard patch test, also known as an installation calibration test, was carried out to calculate the angular offsets between the MBEs and Motion Reference Unit (MRU). The installation calibration process was used to derive the roll, pitch, and yaw angular offsets between the multibeam sonar and the local reference frame defined by the MRU's IMU. The installation calibration tests were also used to determine latency in the positioning equipment. The sonar, positioning system, and data collection computer were all time-synchronized to GPS Coordinated Universal Time (UTC), which resulted in zero position latency. Patch test results are provided in Table 7.

Table 7. SeaBat 7125 Patch Test Results

Parameter	Value
Roll	-0. 80 degrees
Pitch	-0.57 degrees
Yaw	-0.45 degrees
Latency	0.00 second

2.2.3 Sound Speed Casts

2.2.3.01 Changes in sound speed through the water column affect the MBE's individual beams in both the angle and distance calculated from the time of propagation. To compensate for these effects, data processing must model the effects as a function of beam launch angle and time. To implement these calculations, sound speed profiles were recorded through the water column using conductivity, temperature, depth (CTD) sensors from which sound speeds versus depths were derived. Sound speed casts were performed multiple times a day, with the number depending on survey depth and variations in the profiles within the survey area.

2.2.4 Data Processing

2.2.4.01 The collected bathymetry data were processed using Caris HIPS software to generate the XYZ soundings in the survey coordinate system and units. Data cleaning was also performed in Caris HIPS two-dimensional (2D) and three-dimensional (3D) editing software to eliminate outliers induced by noise in the sensor systems or the acoustic environment. A subsequent area-based cleaning, using the merged data from all the survey lines, was then conducted using the Caris HIPS subset editing tool. Edited sounding data were used to create 1-meter gridded uncertainty surfaces. Uncertainty surfaces were calculated by computing the uncertainty budgets for each sounding based on beam geometry and the accuracies of the position system(s), motion sensor, sonar, and sound speed measurements devices. ASCII XYZ files of the gridded BASE surfaces at 1-meter resolution were then exported out of Caris and are displayed in Appendix A.

2.3 SIDESCAN SONAR SURVEY

2.3.01 High-quality SSS imagery was collected concurrently with the MBE and video imagery within the survey areas to aid in bottom type characterization and identification of bottom features of interest detected in the bathymetric and underwater video data.

2.3.1 Survey Procedures

2.3.1.01 In shallower areas, the SSS system was side-mounted at the surface to minimize risk to coral heads or sensitive habitats. In deeper areas and areas without coral reefs, the towfish was actively flown in the water column to obtain higher quality imagery; the towfish altitude was kept well above the bottom and/or tops of coral heads (more than 4 feet [about 1.2 meters]) as defined by available existing bathymetry data for the area or biologist direction based on observations. The sidescan was positioned with an ultra-short baseline (USBL) acoustic positioning system coupled to the GPS on the vessel. The USBL utilized for this survey was the IXSEA GAPS. This USBL has an integrated inertial positioning system and requires no calibration. The accuracy of this system is among the best available at 0.2 percent of slant range. The sidescan acquisition software displayed information on towfish altitude that was monitored to minimize the risk of physical contact with, or potential damage to, sensitive habitats.

2.3.1.02 SSS range settings were selected to provide overlap of adjacent track lines to provide full coverage of the survey area. Survey lines were planned based on a range setting of 50 meters; the range was kept constant to the extent possible.

2.3.2 Data Processing

2.3.2.01 SSS imagery data collected using the EdgeTech 4125 towfish were acquired in proprietary EdgeTech format (JSF) using EdgeTech's Discover acquisition software, and then imported into Chesapeake SonarWiz 5 for post-processing. Towfish position recorded in HYPACK was input directly into the raw data file, thus geo-referencing all raw data. The SonarWiz processing package allowed the operator to remove erroneous navigation points, apply

gains and conduct other signal processing, bottom track the data to remove the water column, and prepare the sonar data for final export.

2.3.2.02 On import, SonarWiz applied the navigation coordinate data conversions as specified in the import options, applied other import, file-type-specific options such as gains, created the CSF in the project folder, added the file to the project, and displayed the file in the map view. The first step in processing the data was to review the navigation in the navigation editor to remove any erroneous points in the navigation. The data were then bottom-tracked to remove the water column, and gains were applied as necessary to enhance features and bedforms on the seabed. The imagery was then exported from SonarWiz as geotiffs, which are provided on the SSS chart in Appendix B.

2.4 VIDEO SURVEY

2.4.01 A combination of several cameras, mounted on the multibeam survey vessel or towed behind the vessel, was used to provide a visual record of the bottom as well as any species that were encountered. In very shallow areas, these cameras were supplemented with cameras mounted on floats and towed behind a kayak (Figure 7).

- The vessel pole-mounted camera was a SplashCam Deep Blue standard definition video camera.
- The T^3ROV (towed camera system) had both a DeepSea Power and Light Wide-I standard definition video camera and a GoPro HERO3 Black Edition that took high-definition (HD) still images.
- The kayak-towed surface floated camera array contained a pair of Panasonic Lumix TS4 cameras recording HD video.

Figure 7. Kayak Towing Float-Mounted Underwater Cameras

3.0 SURVEY RESULTS

3.0.01 Bathymetry and SSS coverage were obtained in all areas with sufficient water depth. Coverage in Flamenco Bay was limited because of the large percentage of the area with very shallow water depths and the extensive areas of live coral which were avoided to prevent damage to sensitive habitat. Ground truthing and habitat characterization were performed using a combination of vessel-mounted and towed video and still cameras. Coverage in very shallow areas was supplemented through the use of video cameras on floats towed behind a kayak.

3.0.02 The daily QC logs from the survey were reviewed against the survey data and QC parameters defined in the Work Plan; in a couple of instances, the results were outside of the QC parameters as discussed in Sections 3.0.05 and 3.0.06 below.

3.0.03 The work plan called for daily bar and water level checks for bathymetry surveys. These checks were done initially, but subsequently replaced as a means for determining sound speed in the water column by a more accurate method, the use of a calibrated sound speed profiler. The USACE Hydrographic Survey manual (EM 1110-2-1003; USACE 2002) states in section 3-14 that for "General Surveys and Studies," which this EBS would be considered (i.e., not for dredging or navigation), bar checks are one of several methods for determining the sound velocity calibration:

> *a. Sound velocity calibrations. Sound velocities for all acoustic systems shall be observed at the minimum intervals shown in Table 3-1. Velocity measurements by* ***bar check, ball check, and/or velocity meters*** *are mandatory.*

3.0.04 CTD casts were taken between two and three times each day, on every day that multibeam sonar data were collected for more than approximately 2 hours in in a small area (Table 8). In the latter case, where there was very little chance of spatial or temporal change in the profile, a single cast was performed. The conditions for these cases were:

- no thermocline,
- limited tidal range,
- no fresh water lenses from rivers or streams, and
- working in a small area.

3.0.05 Based on the empirical data each day, there was not significant spatial or temporal change (velocities varied less than 2 meters per second within profiles and less than 4 meters per second over the entire project duration).

3.0.06 The casts are usually done in the deepest part of the area being surveyed. The CTD data is loaded into a master SVP file that is used during the multibeam processing. The CARIS software

applies the most appropriate cast that is nearest in time and then distance to correct the data for refraction.

Table 8. CTD Cast Time and Location Information

Date	UTC Time	Latitude (dd:mm:ss)	Longitude (dd:mm:ss)
12/8/2012	15:55:11	18:19:04	065:20:18
12/8/2012	18:06:16	18:18:35	065:19:07
12/8/2012	20:43:00	18:18:39	065:19:15
12/9/2012	14:39:00	18:17:54	065:18:40
12/9/2012	16:37:11	18:18:30	065:19:10
12/9/2012	17:30:27	18:18:20	065:19:00
12/9/2012	20:55:39	18:19:05	065:19:30
12/10/2012	20:40:43	18:17:53	065:17:02
12/13/2012	12:18:48	18:17:59	065:18:47
12/13/2012	15:22:30	18:18:31	065:19:7
12/13/2012	18:46:41	18:19:57	065:20:15
12/14/2012	11:36:06	18:17:46	065:16:44
12/14/2012	18:58:13	18:19:20	065:20:03
12/14/2012	16:31:12	18:20:07	065:20:27
12/14/2012	14:59:46	18:19:19	065:19:31
12/15/2012	12:44:49	18:19:01	065:19:41
12/15/2012	14:15:25	18:20:20	065:20:22
12/15/2012	17:12:34	18:20:26	065:20:30
12/16/2012	13:22:02	18:19:16	065:19:45
12/16/2012	15:11:38	18:18:32	065:19:17
12/17/2012	13:15:00	18:19:58	065:19:03
12/18/2012	21:01:34	18:17:57	065:18:18
12/19/2012	21:55:52	18:17:58	065:18:46
12/20/2012	15:53:01	18:17:53	065:16:59
1/4/2013	17:08:08	18:19:05	065:20:11
1/4/2013	18:37:57	18:19:01	065:19:40
1/4/2013	19:48:56	18:18:14	065:18:50
1/5/2013	11:51:29	18:18:56	065:19:26
1/5/2013	13:55:21	18:19:30	065:20:01
1/5/2013	21:19:03	18:18:31	065:19:18
1/7/2013	12:40:59	18:18:35	065:19:12
1/7/2013	15:36:36	18:19:30	065:20:33
1/7/2013	19:33:03	18:19:15	065:20:08
1/9/2013	12:31:40	18:19:12	065:20:04
1/9/2013	14:20:44	18:19:06	065:20:03
1/9/2013	18:36:05	18:19:13	065:18:54
1/10/2013	13:15:10	18:19:13	065:20:01
1/10/2013	17:29:59	18:20:02	065:20:35
1/12/2013	14:01:07	18:19:59	065:18:57
1/15/2013	16:17:38	18:17:48	065:18:55
1/15/2013	19:29:19	18:17:38	065:19:22
1/16/2013	19:47:06	18:18:54	065:20:19
1/16/2013	19:53:00	18:18:51	065:20:25

3.0.07 The water level checks that were found to be out of limits were the result of inaccuracies in the real-time measurements from the POS MV inertial navigation system. When the data were post-processed, following our standard processing procedures, the results were found to be within the specified tolerance. The POS MV will be supplemented with a rover RTK GNSS receiver, which does provide more accurate real-time position data.

3.0.08 Two of the cross line bathymetry tests were out of specification due to an error in the processing. They were re-run correctly and passed. The procedural issues that resulted in the reported out of limits results for the cross line checks have been identified, and corrected.

3.0.09 All of the MQMs were met for all the work that was completed during the EBS (Table 9). The QC logs and test results that document adherence to the MQMs are provided in Appendix H.

Table 9. Measurement Quality Metrics Quality Control Results

Technology Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Results
Hydrographic Survey – Multibeam	Precision/ Repeatability	Cross line data	Hydrographic Survey data shall meet or exceed Special Order standards.	Data met Special Order standards; see Appendix H3.
	Completeness	Visual evaluation of data real-time for verification that intended coverage goals are met	Real-time coverage plots (i.e., matrix fill) will be utilized to monitor coverage completeness. Along-track coverage, which is a function of vessel speed and ping rate, will be evaluated by calculating the percentage of data obtained at less than 6 knots (i.e., 95% of MBE data were obtained at < 6 kts).	Continuous visual monitoring was performed during data collection.

Table 9. Measurement Quality Metrics Quality Control Results (continued)

Technology Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Results
Hydrographic Survey – Multibeam (continued)	Sensitivity	Real-time monitoring and use of gains and gate filters, software quality flags	Data collection depth range is optimized to reduce anomalous reflections and provide optimum data, gains are set to provide appropriate bottom tracking. The data acquisition software is used conduct internal testing to check the validity of each ping based on colinearity and brightness and ensure each ping is tagged with a quality flag of 0-3 based on the these tests. During processing, the pings are filtered based on the quality flags to eliminate all but the data with a quality of 3 unless conditions warrant accepting lower quality pings (e.g., where there are topography discontinuities such as wrecks or piles).	Continuous visual monitoring was performed during data collection, and sonar system quality flags were used to filter the data during processing.
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. 3. Bar check and/or lead line check vs. water surface relative depth from sonar.	1. RTK GPS measurements will match published position to within 0.1 meters x, y, and z. 2. RTK GPS water level and survey system tide level will match to within 0.1 meter. 3. Nadir bathymetry depths relative to surface, corrected for draft and attitude matches to within 0.06 meter.	1. Passed; see table in Appendix H4. 2. Passed; see Table H2 in Appendix H2. 3. Passed; see Table H1 in Appendix H2.

Table 9. Measurement Quality Metrics Quality Control Results (continued)

Technology Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Results
Sidescan Sonar Positioning	Accuracy	Visual evaluation following collection of first lines.	A feature detected in adjacent lines run in opposite directions will be compared to each other and to the location of the feature in the MBE data to determine towfish positioning accuracy.	Passed; see Appendix H5.
	Completeness	Visual evaluation of data real-time for verification that intended coverage goals are met.	Real-time coverage plots will be used to monitor coverage completeness.	Continuous visual monitoring was performed during data collection, and final mosaics were checked for coverage.
Sidescan Sonar Survey	Data Quality/Safety	Maximize data quality while monitoring safety of environment.	To minimize the risk of physical contact with, or potential damage to sensitive habitats, the SSS system will be mounted on the side of the vessel or towed near the surface just aft of the survey vessel. Existing bathymetry and imagery in the area will be assessed prior to deployment of the SSS system. In deeper water where the towfish will be towed at depth, towfish flight altitude and water depth will be continuously monitored during survey operation. To the extent possible, the towfish will be flown at a constant altitude approximately 10-20 percent of range, unless a risk to habitat or equipment, such as irregular or steep terrain, has been determined. To the extent possible, sonar range will be kept constant at 50 meters.	Continuous monitoring was performed during data collection. See Appendix H5 for QC Logs.

Table 9. Measurement Quality Metrics Quality Control Results (continued)

Technology Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Results
Underwater Video Camera	Functionality, Completeness	Visual Inspection	Test the camera prior to deployment to ensure that the unit is working correctly.	Files were collected and reviewed at the beginning of each day that video was recorded. See Appendix H6 for QC Logs, and Figure 8 for video track lines.

3.1 BATHYMETRY DATA PRODUCTS

3.1.01 MBE bathymetry data were used to provide a high-resolution topographic map of the Flamenco Bay and Luis Peña Channel areas. Several products were produced with the bathymetric data, to aid in the characterization of the seafloor and habitat areas. The products were developed using a combination of the surface analysis tools in ArcGIS and the Benthic Terrain Modeler (BTM), an ArcGIS add-on developed by NOAA and Oregon State University.

3.1.02 The charts produced using this method are listed below and are provided in Appendices A through F:

- The bathymetry chart shows the bathymetry surface, color coded for depth, with a sun-illuminated hill shade to make detailed topographic features more visible (Appendix A).
- The slope chart shows the areas where the seafloor is flat or sloping to varying degrees (Appendix C).
- The BTM zone plot displays the different terrain features categorized into flats, slopes and crests (Appendix D).
- The ruggedness chart is another BTM product that shows how smooth or rugged the bottom topography is in each area. This rugosity is often correlated to type of bottom (e.g., coral areas tend to be much more rugged than sand areas) (Appendix E).

3.2 SIDESCAN SONAR MOSAIC

3.2.01 The sidescan mosaic presented on the chart in Appendix B was assembled from the SSS imagery data collected in Flamenco Bay and the Luis Peña Channel. Coverage in Flamenco Bay was limited because of the shallow water depths and the requirement to maintain minimum separation from any coral.

3.2.02 The data show varying levels of intensity based on the aspect of features above the surrounding terrain or depressions in the terrain, and the characteristics of the bottom material. For the latter, hard, rugged seabed tends to provide higher intensity returns than areas of flat sand or soft mud.

3.3 VIDEO AND STILL PHOTOGRAPHY

3.3.01 Extensive video coverage was achieved in both Flamenco Bay and the Luis Peña Channel areas. Generally, the best quality images were obtained in shallow water where the most light penetrated and where the camera was relatively close to the bottom. Figure 8 shows the track lines for the video and photo images that were used from the survey. While there was additional coverage from the vessel-mounted video camera on the bathymetry boat, imagery was degraded in depths beyond 5 to 10 meters due to weather-induced turbidity and lack of light. A selection of still images and stills extracted from video imagery, were compiled into an ArcGIS map with a background from aerial ortho-imagery and a sun-illuminated surface from the bathymetry survey; this map, and free ArcReader software to use to view it, are included in Appendix G on a separate hard drive (which also contains a PDF copy of this entire report; also included on the hard drive is a separate folder of images of MEC items identified during the EBS survey). The map contains point shapes from each of the platform/camera types. After pressing the lightning bolt icon on the ArcReader toolbar, the hyperlinks are activated and clicking on a point shape causes the associated underwater photo to be displayed.

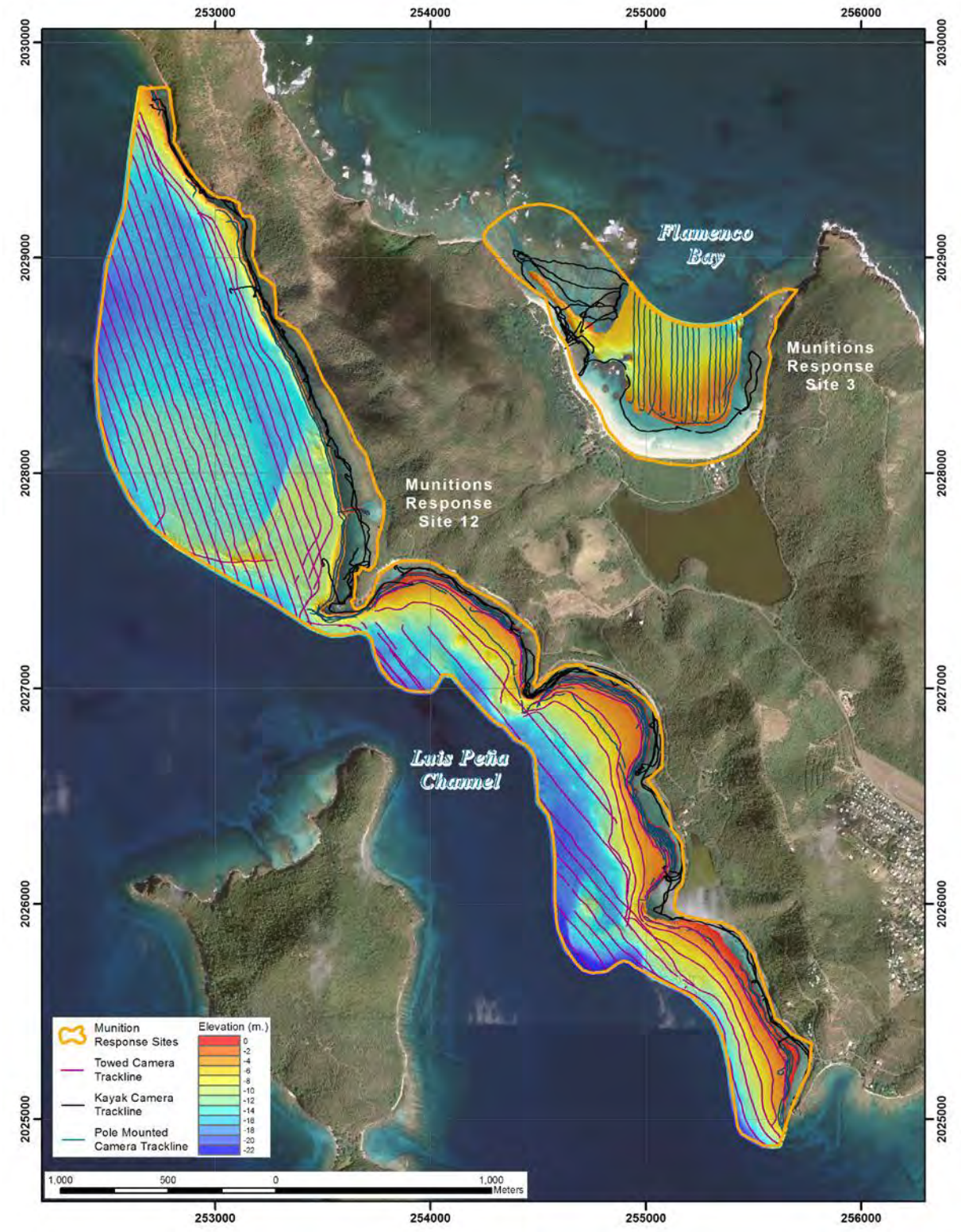

Figure 8. Track Lines for Video and Photo Survey

3.4 BENTHIC HABITAT CLASSIFICATION

3.4.01 The benthic habitat classification map (Appendix F) was based on the marine geophysical survey data collected and interpreted by the RI geophysicists and marine species input provided by the RI biologist. The geological interpretation was performed by overlaying observations from the video survey (including sediment type and habitat descriptions from the video and still images) on the SSS and bathymetry data to delineate habitat areas, areas of sand, areas of seagrass, areas of coral, etc. The results of the bottom and benthic habitat classification are provided in Appendix F, shown as a habitat classification map, and classification into habitat types as described in Section 3.4.1.03 were refined using information provided by the biologist, who reviewed the video and still imagery and identified the major T/E-listed or candidate species present.

3.4.1 Classification Process

3.4.1.01 Datasets imported into the geographic information systems (GIS) project for display and analysis were obtained via the following methods:

- Bathymetry: shaded-relief bathymetry provided detailed information on terrain.
- Georeferenced SSS imagery: areas containing an abundance of coral were readily identified in the SSS data due to the sonar's ability to highlight hard, acoustically reflective bottom types (Figure 9).
- The BTM products described in Section 3.1 showed variations in texture and fine-scale features on the seafloor. The Benthic Zone Classification identified areas of high elevation compared to its surrounding. These areas, labeled crests, assisted in determining the areas with large amounts of coral (Figures 10 and 11).
- The primary datasets used for delineation of habitat types were the aerial imagery and still images extracted from the video dataset. Due to the clarity of the shallow water, large areas of similar texture and color were visible and easily differentiated in the aerial imagery (Figure 9). The still images extracted from the video were imported into the project as a hyperlinked point shapefile, which allowed the viewer to click on the map in an area of interest and easily bring up images of the seabed in that area. After identifying a region based on aerial imagery, the still images confirmed the type and general homogeneity of the benthic habitat within the selected region (Figure 12).

3.4.1.02 The multibeam and BTM products previously mentioned showed variations in texture and fine-scale features on the seafloor. The Benthic Zone Classifications identified areas of high elevation compared to its surrounding. These areas, labeled crests, assisted in determining the areas with large amounts of coral (Figures 12 and 13).

Figure 9. Sidescan Sonar Overlaid with Polygon Indicating Coral

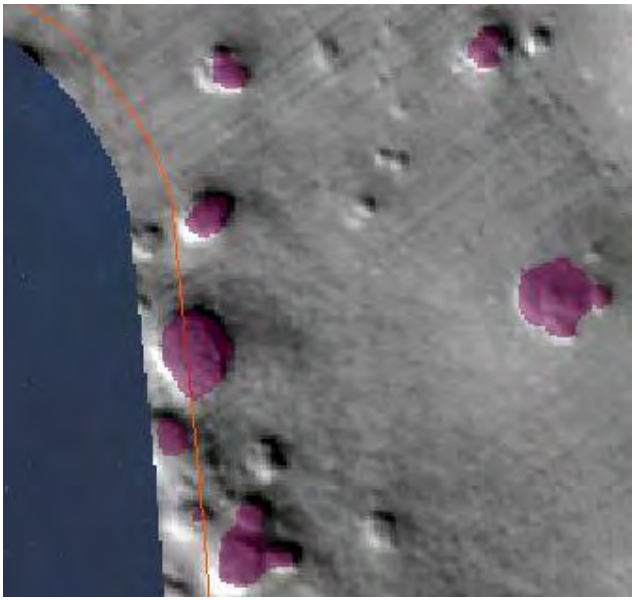

Figure 10. Crests Identified by the Benthic Terrain Modeler

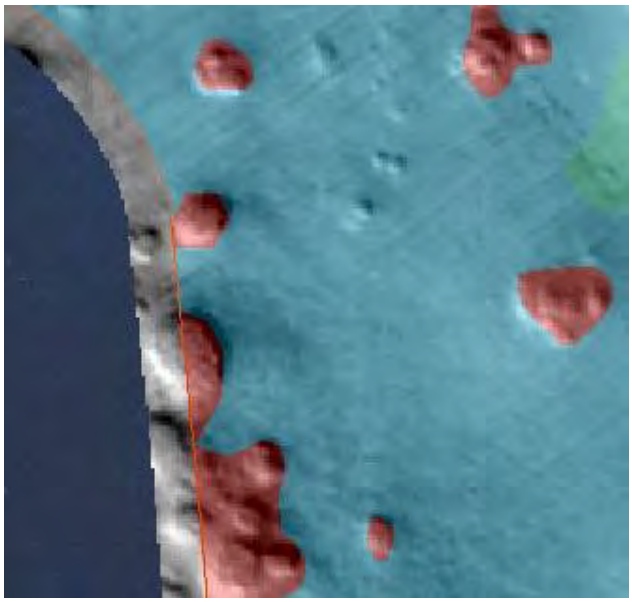

Figure 11. Coral and Scattered Rock (red)

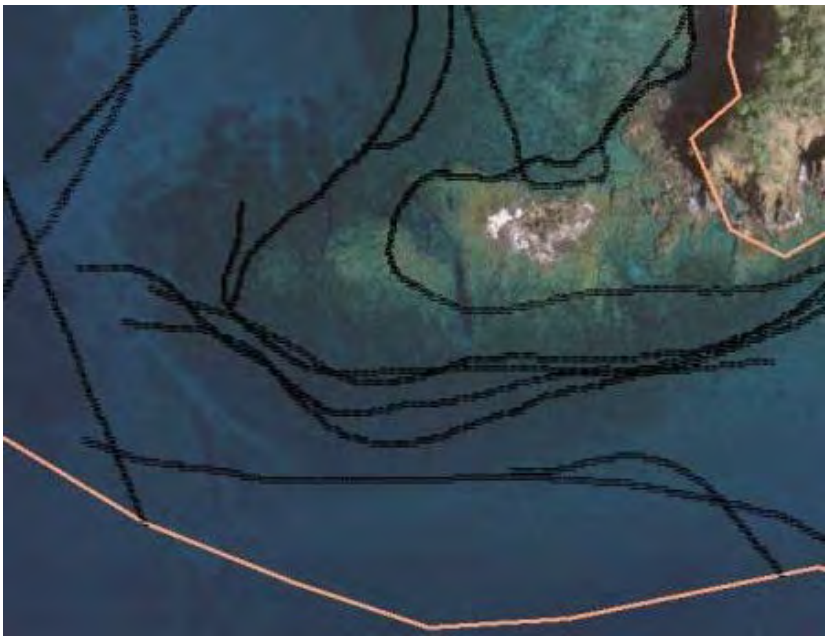

Figure 12. Aerial Imagery with Overlaid Shapefile (black dots) Hyperlinked to Photos

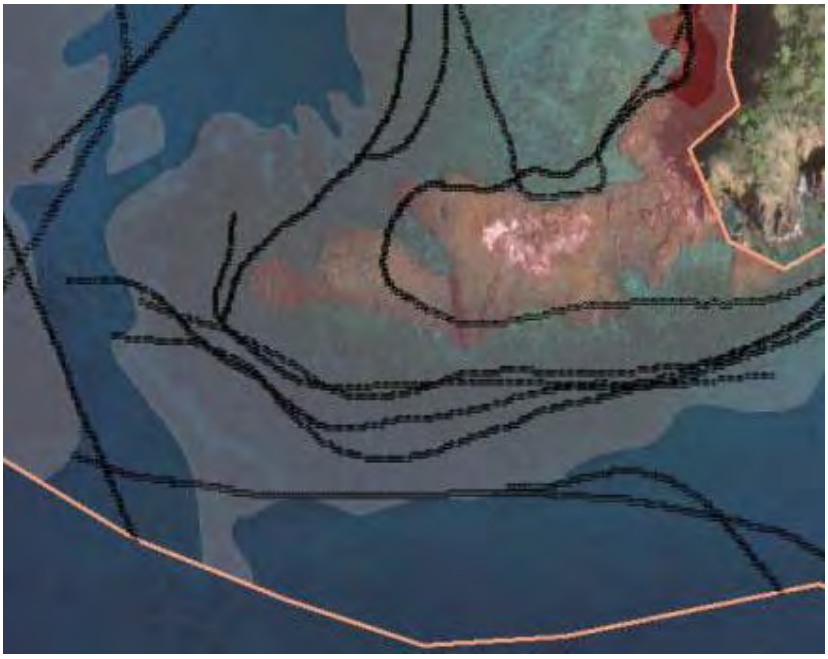

Figure 13. Aerial Imagery Overlaid with Polygons Based on Photos

3.4.1.03 Nine benthic habitat categories were identified through analysis of the data:

1. Continuous seagrass,
2. Patchy seagrass,
3. Colonized bedrock,

4. Colonized pavement (or coral) with sand channels,
5. Colonized pavement,
6. Scattered coral/rock in unconsolidated sediment,
7. Patch reef,
8. Reef rubble, and
9. Sand.

3.4.1.04 The nine benthic habitat categories above (represented visually[1] in Appendix F) were identified based on interpretation of field data following the habitat identification criteria cited in *Methods Used to Map the Benthic Habitats of Puerto Rico and the U.S. Virgin Islands* (Kendall et al. 2001). A description of each habitat type follows below.

- **Submerged Vegetation – Seagrass Habitat:** Habitat with 10 percent or more cover of turtle grass (*Thalassia testudinum)*, manatee grass (*Syringodium filiforme)*, shoal grass (*Halodule wrighti)*, Florida Keys seagrass (*Halophila baillonis)*, or some combination thereof.
    1. *Continuous seagrass* – Seagrass covering 90 percent or more of the substrate. May include blowouts of less than 10 percent of the total area that are too small to be mapped independently. This includes continuous beds of any shoot density (may be a continuous sparse or dense bed.
    2. *Patchy seagrass* – Discontinuous seagrass with breaks in coverage that are too diffuse or irregular, or result in isolated patches of seagrass that are too small to be mapped as continuous seagrass.
- **Coral Reef and Colonized Hardbottom:** Hardened substrate of unspecified relief formed by the deposition of calcium carbonate by reef building corals and other organisms (relict or ongoing) or existing as exposed bedrock.
    1. *Colonized Bedrock* – Exposed bedrock contiguous with the shoreline that has coverage of macroalgae, hard coral, gorgonians, and other sessile invertebrates that partially obscures the underlying rock.
    2. *Colonized Pavement (or Coral) with Sand Channels* – Habitat having alternating sand and colonized pavement formations that are oriented perpendicular to the shore or bank/shelf escarpment. The sand channels of this feature have low vertical relief compared to spur and groove formations. This habitat type occurs in areas exposed to moderate wave surge such as that found in the bank/shelf zone.

[1] The Patch Reef habitat type is not represented visually in Appendix F due to potential for cluttering of the figure amongst areas of coral reefs.

3. *Colonized Pavement* – Flat, low-relief, solid carbonate rock with coverage of macroalgae, hard coral, gorgonians, and other sessile invertebrates that are dense enough to partially obscure the underlying carbonate rock.
4. *Scattered Coral/Rock in Unconsolidated Sediment* – Primarily sand or seagrass bottom with scattered rocks or small, isolated coral heads that are too small to be delineated individually.
5. *Patch Reef* – Coral formations that are isolated from other coral reef formations by sand, seagrass, or other habitats and that have no organized structural axis relative to the contours of the shore or shelf edge. A surrounding halo of sand is often a distinguishing feature of this habitat type when it occurs adjacent to submerged vegetation. Patch reefs may be either individual (distinctive) or aggregate (clustered).

- **Uncolonized Hardbottom:** Hard substrate composed of relict deposits of calcium carbonate or exposed bedrock.

1. *Reef Rubble* – Dead, unstable coral rubble often colonized with filamentous or other macroalgae. This habitat often occurs landward of well-developed reef formations in the reef crest or back reef zone.

- **Unconsolidated Sediment:** Unconsolidated sediment with less than 10 percent cover of submerged vegetation.

1. *Sand* – Coarse sediment typically found in areas exposed to currents or wave energy.

3.4.1.05 Areas within Flamenco Bay and the Luis Peña Channel that were considered to be in the continuous seagrass category based on a combination of the following: the bathymetry data displayed a relatively smooth and flat seafloor, the sidescan data did not show any areas of relatively high reflectivity, the underwater photo displayed an image of seagrass (Figure 14), and in most cases, the aerial imagery showed a green tint throughout the water column.

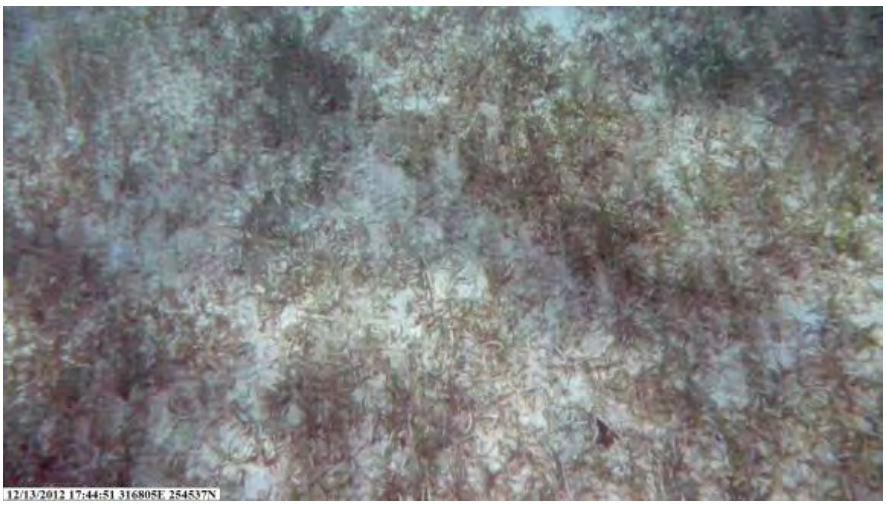

Figure 14. Underwater Image of Continuous Seagrass

3.4.1.06 The patchy seagrass category includes areas where underwater photos showed presence of seagrass interspersed with other hardbottom material such as shells (Figure 15). This region was categorized by the textured bottom clearly seen in the sidescan and bathymetry data.

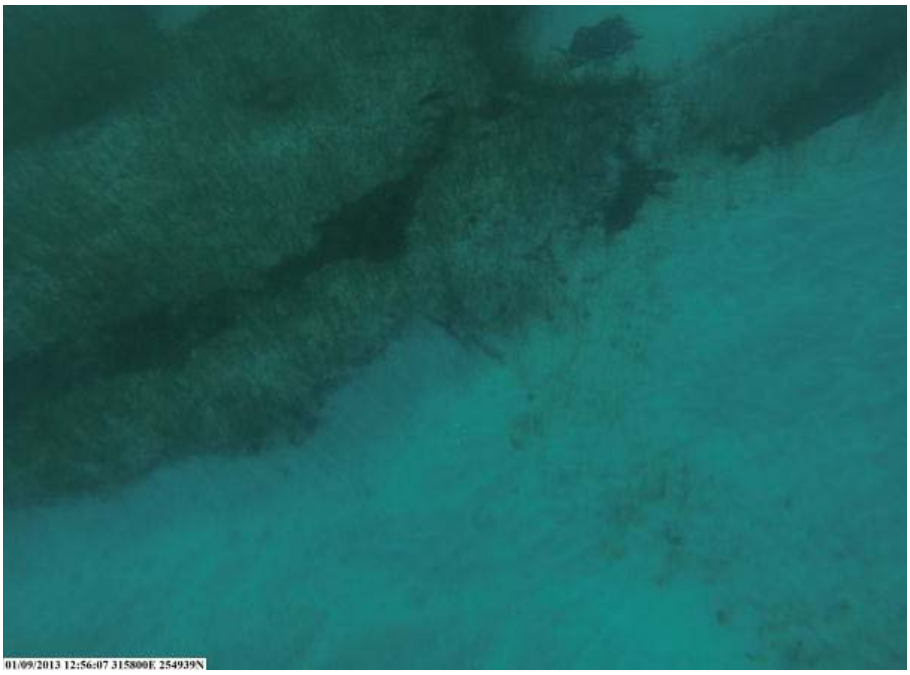

Figure 15. Underwater Image of Patchy Seagrass

3.4.1.07 Areas within Flamenco Bay and the Luis Peña Channel that were considered part of the colonized bedrock category included areas where the aerial imagery showed coral through the shallow water, where bedrock was observed through the water and where coral was present in the still photo (Figure 16).

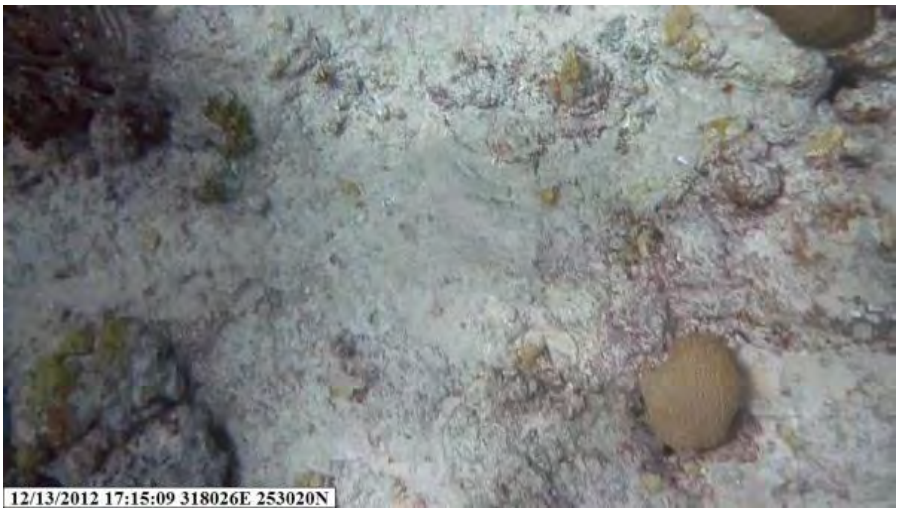

Figure 16. Underwater Image of Colonized Bedrock

3.4.1.08 Sections of the MRS areas were classified as colonized pavement (or coral) with sand channels based on aerial imagery. This category was observed only in areas where the water was shallow and where sand channels could clearly be seen through the water in the aerial imagery. Figure 17 provides an example of this habitat type, though the photo is not from MRS 03 or 12.

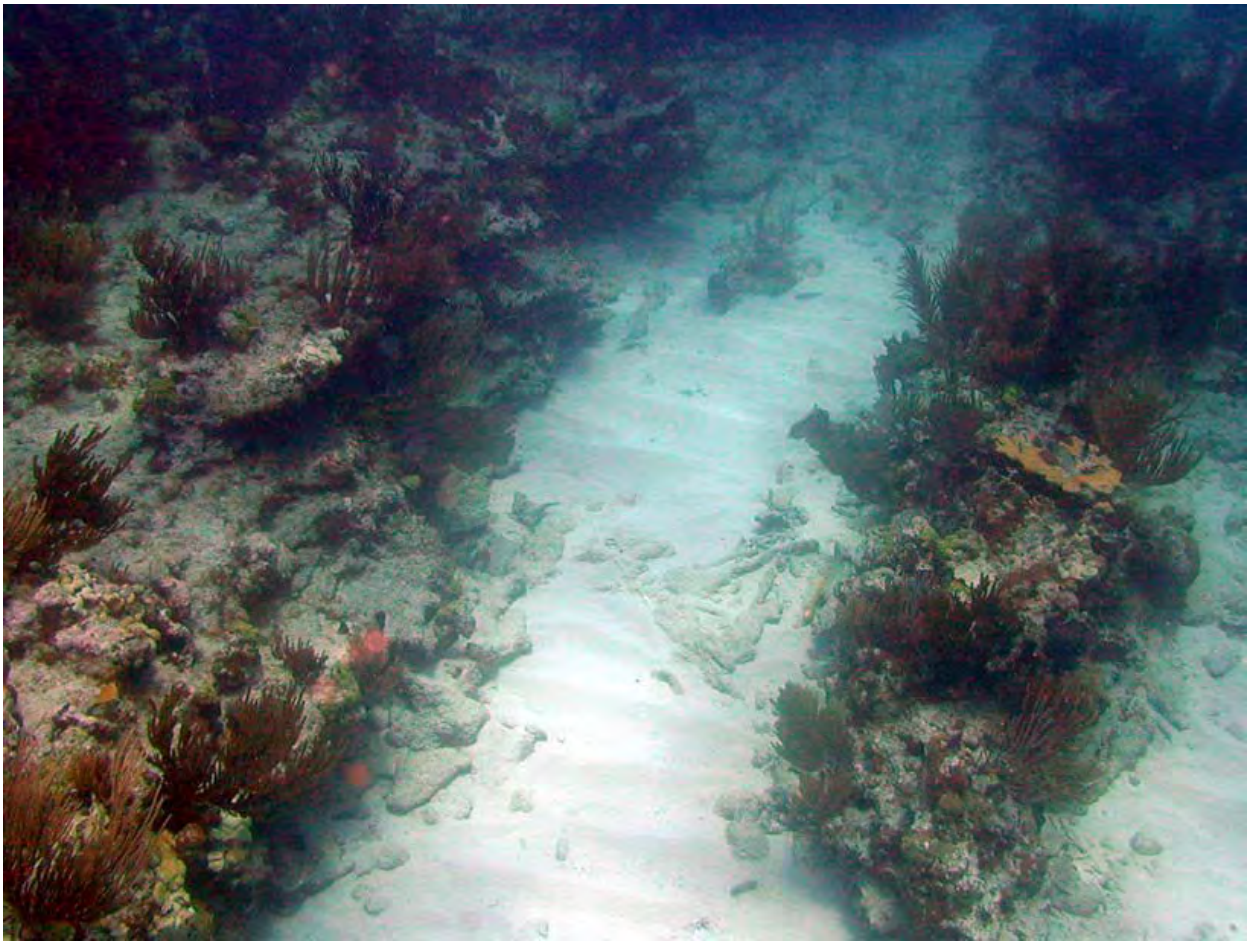

Figure 17. Underwater Image of Colonized Pavement (or Coral) with Sand Channels (Source: Kendall et al. 2001).

3.4.1.09 Sections of the MRS areas were classified as colonized pavement if the aerial imagery showed coral through the shallow water and the coral beds were flat and low-lying (Figure 18).

Figure 18. Underwater Image of Colonized Pavement

3.4.1.010 The scattered coral/rock in unconsolidated sediment– category included scattered rock and coral and possibly sand (Figure 19). These areas tended to be shallow with a gentle slope.

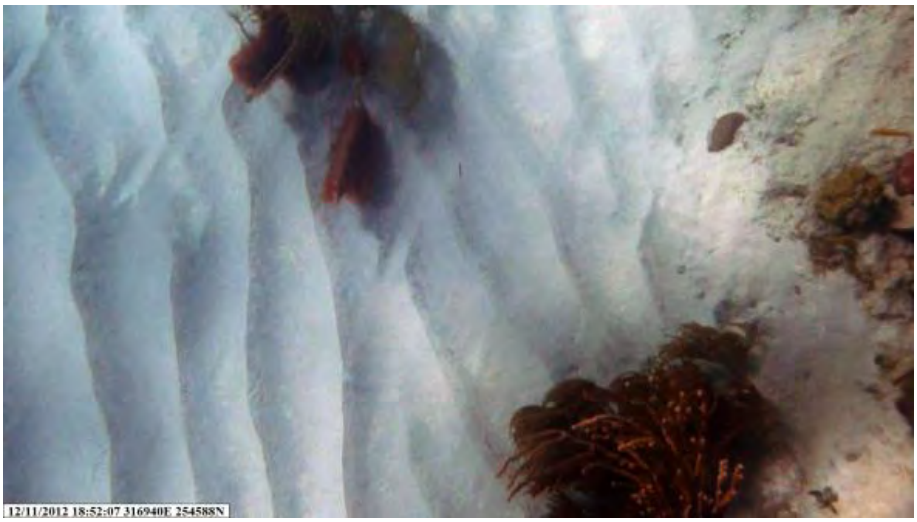

Figure 19. Underwater Image of Scattered Coral/Rock

3.4.1.011 Areas within the MRS boundaries that appeared to exhibit individual or aggregate patch reefs are present. Figure 20 provides an example of this habitat type, though the photo is not from MRS 03 or 12.

Figure 20. Underwater Image of Aggregate Patch Reefs (Source: Kendall et al. 2001)

3.4.1.012 Areas within the MRS boundaries that appeared textured in the bathymetry data and acoustically reflective in the sidescan data were classified as hardbottom/reef rubble. The underwater images taken in these locations were often too murky in the deeper water to distinguish coral; however, the bathymetry and sidescan data show the bottom is hard in these areas. Figure 21 provides an example of this habitat type, though the photo is not from MRS 03 or 12.

Figure 21. Underwater Image of Hardbottom/Reef Rubble (Source: Kendall et al. 2001)

3.4.1.013 Flat, acoustically non-reflective areas were categorized as sand (Figure 22).

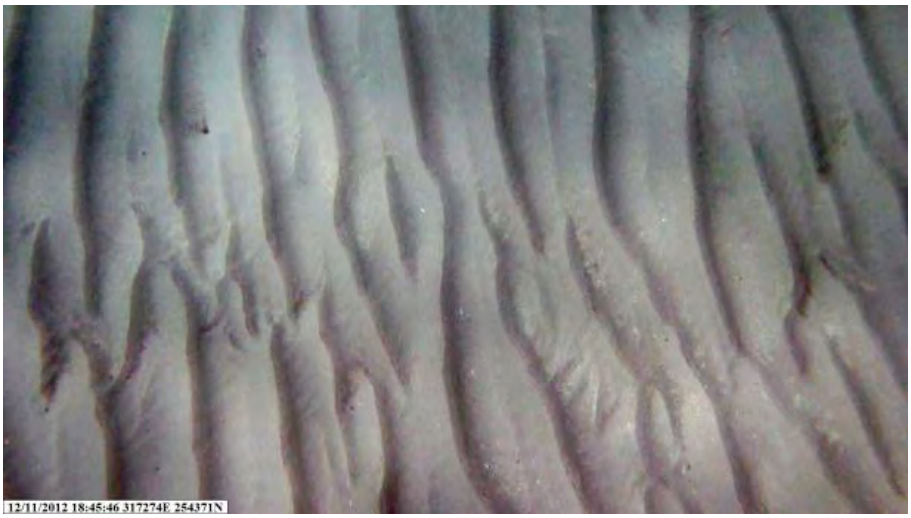

Figure 22. Underwater Image of Sand

3.4.2 Summary of Nearshore Image Analysis

3.4.2.01 The still photo and video survey data were used to determine and quantify the presence of ESA-listed coral species and/or candidate coral species for listing. Data were used to address the spatial pattern of benthic habitats and of listed/candidate coral species across the surveyed sites. The benthic habitats in the surveyed sites were analyzed for the identification of ESA-listed coral species, including threatened Elkhorn coral (*Acropora palmata*) and threatened Staghorn coral (*Acropora cervicornis*). Elkhorn and Staghorn coral have been proposed for listing as endangered rather than threatened as they are currently listed under the ESA. The seven species of coral proposed for listing under the ESA (seven candidate species) were also identified, including five candidate endangered species—the Star corals species complex (Boulder Star coral *[Montastraea annularis])*; Mountainous Star coral (*Montastraea faveolata)*; sister of the Mountainous Star coral, unspecified by common name (*Montastraea franksi*); Pillar coral (*Dendrogyra cylindrus*); and the Rough Cactus coral (*Mycetophyllia ferox*)]. Colonies of two candidate threatened species, including the Whitestar Sheet coral (*Agaricia lamarcki*) and the Elliptical Star coral or Pineapple coral (*Dichocoenia stokesii*) were also analyzed.

3.4.2.02 Review of several thousand nearshore underwater images taken during the survey from the kayak suggested that, in the nearshore region, colonized pavement was the dominant benthic category followed by sand (see Table 10). Reef/rock rubble was the next most common benthic category, followed by colonized pavement with sand channels.

Table 10. Quantitative Analysis of the Benthic Habitat Categories

Habitat Category	MRS 03 Surface Area (acres)	MRS 03 Percent Cover	MRS 12 Surface Area (Acres)	MRS 12 Percent Cover	Total Surface Area (Acres)	Total Percent Cover
Colonized Bedrock	32.74	16.77%	26.16	3.13%	58.9	5.72%
Colonized Pavement	11.16	5.72%	27.05	3.24%	54.05	3.71%
Continuous Seagrass	0.17	0.09%	166.39	19.95%	166.56	16.18%
Coral with Sand Channels	32.10	16.44%	0.00	0.00%	32.1	3.12%
Coral/Scattered Rock	4.26	2.18%	169.59	20.33%	173.85	16.89%
Hardbottom/Reef Rubble	0.00	0.00 %	89.40	10.72%	89.40	8.68%
Patchy Seagrass	0.00	0.00%	227.97	27.33%	227.97	22.15%
Sand	114.78	58.80%	127.62	15.30%	242.4	23.55%
Total	**195.21**	**100.00%**	**834.18**	**100.00%**	**1029.39**	**100.00%**

3.4.2.03 The most common types of coral in the colonized pavement category in order of most abundant to least abundant were Pillar coral, Elkhorn coral, Mountainous Star coral, Boulder Star coral, Staghorn coral, and *Montastraea franksi*. The most common types of coral in the colonized pavement with sand channels were Mountainous Star coral, Boulder Star coral, and Elkhorn coral. On colonized bedrock, the most common types of coral were Pillar coral, Staghorn coral, and Elkhorn coral. The most common types of coral in the patch reefs were Pillar coral, Boulder Star coral, and Elkhorn coral. In hardbottom reef rubble areas, the more common types of coral were Elkhorn coral, Boulder Star coral, Staghorn coral, and Mountainous Star coral.

3.4.2.04 In general, Staghorn coral and *Montastraea franksi* were most commonly documented across scattered coral and rocks while Elkhorn coral, Boulder Star coral, and Mountainous Star coral were most commonly found in areas with colonized pavement. Pillar coral was dominantly found in patch reef areas.

3.4.2.05 Although none of the seagrass species in Puerto Rico are T/E species of plant, 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 ecoregional level. These beds provide important habitat for a variety of species, including the endangered green sea turtle. In addition, seagrass beds, as well as the nearshore coral reefs addressed above, are further designated as EFH due to their importance to fishery production.

3.5 SEA TURTLE AND MARINE MAMMAL MONITORING

3.5.01 Prior to beginning the EBS fieldwork, all RI personnel were briefed by a qualified biologist regarding the presence of and importance of threatened and endangered species, their characteristics, how they can be identified, potential and documented critical habitat, types of

were assigned to maintain watch for threatened and endangered species during field activities and to ensure the proper avoidance procedures were implemented. In addition, the observers documented sightings and avoidance measures taken.

3.5.02 During the months of December 2012 and January 2013, observations/surveys were performed a total of 16 days. The observers reported a total of 43 sightings (events) distributed through the two MRSs. Sea turtles were spotted within the 50-foot safety zone 28 times. During this period, observers detected one individual in 41 events and two individuals in 2 events. During the days of surveying, sea turtle activity at Culebra did show a pattern suggesting a preference for both morning and afternoon hour activities. Additional information regarding sea turtle and marine mammal sightings and avoidance measures during the EBS is included as Appendix I.

4.0 SUMMARY AND CONCLUSIONS

4.1 PRIMARY CONCLUSIONS FROM DATA COLLECTION EFFORTS

4.1.01 The majority of the seafloor located within Flamenco Bay and the Luis Peña Channel is covered by coral and/or sea grass. Areas of high elevation identified in the bathymetric data were also highly reflective in the sidescan data indicating a hard surface such as coral. Areas displaying these qualities were often very close to shore. Similarly, bathymetry of low relief often did not have a high return in the sidescan data which suggests the bottom is relatively soft, possibly with vegetation or sand. These areas were generally located further away from the shoreline.

4.1.02 Video and still photographs of the seafloor were reviewed to ground truth the bottom type interpretation determined from the sidescan data, and to identify benthic communities. Several species listed as threatened by the ESA were identified, including Elkhorn coral (*Acropora palmata*) and Staghorn coral (*Acropora cervicornis*).

4.2 EVALUATION OF METHODS USED

4.2.01 The survey was conducted using a combination of bathymetry and imagery sonar systems, multiple camera systems, a small vessel used for the majority of the survey work, and a kayak used for acquiring underwater video in very shallow water.

4.2.1 Sonar Systems

4.2.1.01 The combination of high resolution multibeam echosounder and sidescan imagery sonar provided very good baseline bathymetry and imagery of the seafloor and were used to identify areas of different bottom types, habitat and areas of concern for planned electromagnetic (EM) surveys. This mapping was critical for planning and performing the EM survey operations due to the very short range capability and correspondingly low flight heights that must be maintained to detect objects the size of smaller MEC items.

4.2.2 Camera Systems

4.2.2.01 The following four camera systems were employed for the underwater video and still photo survey:

- SplashCam
- DeepSea Wide-I SeaCam
- GoPro Hero 3 Black in an underwater housing
- Panasonic Lumix TS-3

4.2.2.02 The DeepSea Wide-I and GoPro Hero 3 were mounted onto the Tetra Tech towed remotely operated vehicle (T^3ROV). The data were either time correlated with GPS on the vessel or kayak, or in the case of the SplashCam and DeepSea cameras, processed though a video overlay

system that included the GPS position, date, and time on the video. For the other cameras, position, date, and time were added to the images in post-processing based on the GPS and image times.

4.2.2.03 The SplashCam system was pole-mounted on the survey launch. This system provided real-time video to the operators on the surface, but at a lower resolution than recorded by the other cameras.

4.2.2.04 The DeepSea Wide-I system was used on a towbody (T^3ROV) in the deeper water areas, providing real-time video to the operators on the surface, but also at a lower resolution video than the other cameras.

4.2.2.05 The GoPro camera provided video or stills at specified intervals. For this survey, this camera was configured to take 12 megapixel still images twice per second. This camera does not run on surface-supplied power, and thus required periodic retrieval to replace batteries; it also provided no real-time output to the operators on the vessel.

4.2.2.06 Because the Panasonic Lumix cameras are waterproof to 40 feet (12.2 m), they were limited to shallow water use on floats towed behind the kayak. They were configured to collect 1080P (1920 x 1080) HD video.

4.2.2.07 The quality of the video from the Panasonic cameras that were surface-towed behind the kayak was very good. The quality of the video from the other cameras varied with water depth, flight height above the bottom, and the brightness of the day. Higher intensity lighting is required for towed video in particular, but would be beneficial for all systems on overcast days.

4.2.2.08 The T^3ROV provided more dense coverage of the site than could be accomplished with a standard ROV in the same amount of time. The T^3ROV worked very well in the areas shallower than 5 meters. In deeper water, the GoPro still camera imagery was dark, and as the T^3ROV was towed deeper, quality and usability degraded. The DeepSea Power and Light Wide-I camera had much better low-light performance; however, the ambient light removed most color information from the video.

4.3 RECOMMENDED ADDITIONAL DATA COLLECTION EFFORTS

4.3.01 While some items that may be MEC are visible in the video and stills, these items are frequently buried or encrusted with marine growth to the point they cannot be distinguished visually. To locate and identify these items, a suitable metal detection system is essential. The Tetra Tech Towed EM Array (TEMA) is a proven modular MEC survey system that provides a 1- to 3-meter-wide detection swath and can be flown and tracked at altitudes down to 1 meter or less above the bottom (benign flat areas) with very good stability and control over flight height. The TEMA incorporates multiple sensors including forward looking cameras and lights with a real-time link to the surface. The video from the cameras provides both additional information that can help identify contacts, and information for the systems operators to help control the towfish. Additional higher resolution cameras can also be installed on the towfish (i.e., the GoPro Hero).

4.4 PRELIMINARY OPINIONS REGARDING FUTURE OPTIONS

1. The baseline environmental survey has shown that a large percentage of Flamenco Bay and the Luis Peña Channel areas are covered with coral and other sensitive habitat types.

2. The only type of system currently available that can reliably detect buried and obscured MEC items is a metal detection system, either a magnetometer (which is limited to detection of ferrous metals and adversely affected by volcanic rock) or an EM system. The tradeoff between the improved detection with a magnetometer vs. the increased geologic influence of the volcanic rock of the area does not make the magnetometer a more viable system than an EM system. The TEMA utilizes high-power EM units, as opposed to the standard EM units used on land. This yields an improved detection distance for the TEMA. The effective detection standoff will be similar between the two systems (mag and TEMA) with fewer false positives should an EM-based system be utilized.

   The digital geophysical mapping (DGM) instrument (i.e., EM) was not chosen solely to minimize false positives, however, but also to reduce false negatives. False negatives equate to missing metal targets and would exclude investigating areas that could have metal during Phase 3. False positives equate to detected targets that are not metal, but rather noise or geologic targets. False positives would add targets to the Phase 3 investigation that are not due to UXO/MEC, excluding some digs on potential UXO/MEC during Phase 3. The following table compares the two systems.

DGM Tool	False Positive Rate Magnetic Geology	False Negative Rate Magnetic Geology	Detection Range in Magnetic Geology
EM61MK2-HP	lower	lower	~ equal to mag
Magnetometer	higher	higher	~ equal to EM (HP)

   Due to the site geology consisting of magnetic volcanic rocks (“hot rocks”) and the results of previous magnetometer and EM UXO DGM surveys (Hawaii, Puerto Rico, and others), the EM system was chosen. Were metallic items to be sitting on top of “hot rocks,” the signal could be masked and not detected by a magnetometer. For more information on the effect of “hot rocks,” see the Strategic Environmental Research and Development Program MR-1414 Final Report (SERDP 2010).

   The IVS and static tests will verify that the system is working, and an altitude metric has been added to help minimize false negatives. A selection criterion for anomaly investigations has not yet been determined and will be presented in the Phase 3 Work Plan after analyzing the Phase 2 data.

3. The physics of these systems provides only very short range detections for the smaller MEC items.

4. A free-flying towfish such as the TEMA may be very restricted in altitude by the presence of Staghorn and Elkhorn corals and other habitat features that can be damaged by physical

contact. The use of active flight control, high-resolution topography from the multibeam survey, and on-board video will, to a large extent, mitigate the risks of habitat damage, but complete avoidance cannot be guaranteed. Work plans for follow-on fieldwork during Phases 2 and 3 will reference and utilize the information collected during the EBS, including the habitat survey data and maps in Appendix F, and will include the Final Standard Operating Procedures for Endangered Species Conservation and their Critical Habitat during Underwater Investigations (USACE 2012) to help mitigate risk of habitat and endangered species damage.

5. Covering areas with a reasonable probability of detection of items of interest may require a longer phased approach with multiple surveys at progressively lower altitudes. In shallow areas, the EM survey can be done with the TEMA in its float configuration. In slightly deeper areas, multiple passes could be performed, starting with a floating system, to detect larger items, then stepping down in depth/altitude with suspended, then free-flying towfish operations. Free-flying towfish operations should be focused on areas categorized as continuous seagrass, patchy seagrass, and sand, in order to best protect the equipment and environment.
6. Another alternative would be to define a minimum safe altitude by area and accept the detection of only the larger items that can be detected at those ranges. In areas with a lot of depth variation, this may result in very low probability of detection of any but the largest MEC items. Given calm conditions, all areas with at least 2 feet (0.6 meter) water depth can be surveyed with a surface-towed EM system.
7. A platform with greater dynamic control, such as an ROV, can be used to minimize risk to habitat; however, this method typically has lower survey efficiency and higher cost than can be achieved with the TEMA.
8. A combination EM survey approach may be required to achieve reasonable probability of detection and a high percentage of the area surveyed.

5.0 REFERENCES

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5.0.03 SERDP (Strategic Environmental Research and Development Program). 2010. Improving UXO Detection and Discrimination in Magnetic Environments. Final Report. SERDP Project MM-1414. May.

5.0.04 U.S. Navy. 1973. Time-Phased Plan for Relocation of Training Activities from the Culebra Complex to the Islands of Desecheo and Monito. Memorandum from Commander in Chief U.S. Atlantic Fleet to Chief of Naval Operations. June. (As cited in DoD 2012.)

5.0.05 USACE (U.S. Army Corps of Engineers). 2002. Hydrographic Survey manual (EM 1110-2-1003).

5.0.06 USACE. 2012. Final Standard Operating Procedures for Endangered Species Conservation and their Critical Habitat during Underwater Investigations. DERP-FUDS Property No. I02PR0068 Culebra, Puerto Rico. April 2012.

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APPENDIX A

BATHYMETRY

316000 317000 318000

256000 255000 254000 253000 252000

Flamenco Bay

Munitions Response Site 3

Munitions Response Site 12

Luis Peña Channel

1,000 500 0 1,000
Meters

Elevation (m.)

- -1 - 0
- -3 - -2
- -5 - -4
- -7 - -6
- -9 - -8
- -11 - -10
- -13 - -12
- -15 - -14
- -17 - -16
- -19 - -18
- -21 - -20
- -23 - -22

3

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
CULEBRA WATER RANGES, CULEBRA, PUERTO RICO
EXPLOSIVES SAFETY SUBMISSION

BATHYMETRY - MUNITIONS RESPONSE SITES 3 AND 12

Tetra Tech
19803 North Creek Parkway
Bothell, WA 98011

TETRA TECH

PROJECT NUMBER 44070003

FILE NAME
\\mmg_archive_02\2012_Culebra\ArcGIS\Culebra_BTM\MXD\Udated_Charts\Bathy_11x17.mxd

APPENDIX B

SIDESCAN SONAR

316000 317000 318000

256000 255000 254000 253000 252000

Munitions Response Site 3

Munitions Response Site 12

Flamenco Bay

Luis Peña Channel

1,000 500 0 1,000

Meters

3

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
CULEBRA WATER RANGES, CULEBRA, PUERTO RICO
EXPLOSIVES SAFETY SUBMISSION

SIDE SCAN SONAR - MUNITIONS RESPONSE SITES 3 AND 12

Tetra Tech
19803 North Creek Parkway
Bothell, WA 98011

TETRA TECH

PROJECT NUMBER 44070003

FILE NAME
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APPENDIX C

SLOPE

316000 317000 318000

256000 255000 254000 253000 252000

Flamenco Bay

Munitions Response Site 3

Munitions Response Site 12

Luis Peña Channel

1,000 500 0 1,000
Meters

Slope (degrees)

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60

3

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
CULEBRA WATER RANGES, CULEBRA, PUERTO RICO
EXPLOSIVES SAFETY SUBMISSION

SLOPE - MUNITIONS RESPONSE SITES 3 AND 12

Tetra Tech
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Bothell, WA 98011

TETRA TECH

PROJECT NUMBER 44070003

FILE NAME
\\mmg_archive_02\2012_Culebra\ArcGIS\Charts\Sites_1mBathy.mxd

APPENDIX D

BENTHIC TERRAIN MODELER ZONE CLASSIFICATION

316000 317000 318000

256000 255000 254000 253000 252000

Flamenco Bay

Munitions Response Site 3

Munitions Response Site 12

Luis Peña Channel

1,000 500 0 1,000
Meters

Benthic Terrain Modeler Zones

3

- Crests
- Flats
- Slopes

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
CULEBRA WATER RANGES, CULEBRA, PUERTO RICO
EXPLOSIVES SAFETY SUBMISSION

BENTHIC TERRAIN MODELER ZONES
MUNITIONS RESPONSE SITES 3 AND 12

Tetra Tech
19803 North Creek Parkway
Bothell, WA 98011

TETRA TECH

PROJECT NUMBER 44070003

FILE NAME
\\mmg_archive_02\2012_Culebra\ArcGIS\Charts\Sites_1mBathy.mxd

APPENDIX E

VECTOR RUGGEDNESS MEASURE

316000 317000 318000

256000 255000 254000 253000 252000

Munitions Response Site 12

Munitions Response Site 3

Flamenco Bay

Luis Peña Channel

1,000 500 0 1,000
Meters

Vector Ruggedness Measure

High : 0.1

Low : 1.8e-5

3

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
CULEBRA WATER RANGES, CULEBRA, PUERTO RICO
EXPLOSIVES SAFETY SUBMISSION

VECTOR RUGGEDNESS MEASURE MUNITIONS RESPONSE SITES 3 AND 12

Tetra Tech
19803 North Creek Parkway
Bothell, WA 98011

TETRA TECH

PROJECT NUMBER 44070003

FILE NAME
\\mmg_archive_02\2012_Culebra\ArcGIS\Charts\Sites_1mBathy.mxd

APPENDIX F

BENTHIC HABITAT CLASSIFICATION

316000 317000 318000

256000 255000 254000 253000 252000

Flamenco Bay

Munitions Response Site 3

Munitions Response Site 12

Luis Peña Channel

1,000 500 0 1,000
Meters

Benthic Habitat Classification

- Continuous Seagrass
- Colonized Bedrock
- Coral with Sand Channels
- Colonized Pavement
- Coral/Scattered Rock
- Hardbottom/Reef Rubble
- Patchy Seagrass
- Sand

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
CULEBRA WATER RANGES, CULEBRA, PUERTO RICO
EXPLOSIVES SAFETY SUBMISSION

BENTHIC HABITAT CLASSIFICATION MUNITIONS RESPONSE SITES 3 AND 12

Tetra Tech
19803 North Creek Parkway
Bothell, WA 98011

TETRA TECH

PROJECT NUMBER 44070003

FILE NAME
\\mmg_archive_02\2012_Culebra\ArcGIS\Charts\benthic_classification_11x17_opaque_062413.mxd

APPENDIX G

SURVEY IMAGERY DATA SET

[ON SEPARATE HARD DRIVE]

The data deliverables hard drive contains the following directories and contents:

1. **Culebra_Underwater_Photo_Map_110813** – This directory contains geo-referenced photos and still images extracted from underwater video. The ArcReader_Photo_Map sub-directory contains a photo map, developed with ArcGIS, that has a point shape at each geo-referenced image location. To display the image at a location, select the lightning bolt icon on the map toolbar to activate the hyperlinks, and click on a point to bring up the associated image. If a list of images pops up when a site is selected, click on one image in the list to display it.

   The map can be viewed using the free ArcReader software application from ESRI.

2. **Potential_MEC_Photos** – This is a set of photos containing potential MEC items selected during a review of the full data set. Geo-referencing data for these images will be provided at a later date.

3. **ArcReader101Windows.zip** – This zip file contains the installation software for ArcReader.

4. **ReadMe.txt** – Brief description of the contents of the drive.

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APPENDIX H

QUALITY CHECK LOGS AND RESULTS

- Appendix H1 – Daily MBE Survey Standard Operating Procedure Checklists
- Appendix H2 – Survey QC Check Results
- Appendix H3 – Comparison of Survey Main and Cross Line Data
- Appendix H4 – RTK GPS Base Station and Rover Quality Control Log
- Appendix H5 – Sidescan Sonar Quality Control Results and Quality Control Logs
- Appendix H6 – Video Data Collection Quality Control Logs

H1
DAILY MBE SURVEY STANDARD OPERATING PROCEDURE CHECKLISTS

Personnel on Board

☐Erin Campbell	☐Lou Schwartz	☐	☐
☐Richard Funk	☐Omi	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
☒ Click *Start* to launch the user interface

PPS, Sound speed, Attitude Connections

☒ Confirm PPS is and ZDA is being received. Look for any alarms.
Confirm Sound Velocity data is being received and is a reasonable value: ~1500 m/s
Confirm Attitude data is being received. Turn on role stabilization.

Ocean Menu Tab

☒ Verify Absorption value is set correctly for the environment.
☒ Verify Spreading value is set correctly for the environment.

Applanix MRU (POSView software)

☒ Click the connect button
☒ Select Ethernet Real-time Output Control from the Logging menu
☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
22:15 GMT START TIME
22:52 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☒Yes ☐No
Comments: MBE Pole moved. Readjust and tighten brackets.

Personnel on Board

☐Erin Campbell	☐Lou Schwartz	☐	☐
☐Richard Funk	☐Omi	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
☒ Click *Start* to launch the user interface

PPS, Sound speed, Attitude Connections

☒ Confirm PPS is and ZDA is being received. Look for any alarms.
Confirm Sound Velocity data is being received and is a reasonable value: ~1500 m/s
Confirm Attitude data is being received. Turn on role stabilization.

Ocean Menu Tab

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Applanix MRU (POSView software)

☒ Click the connect button
☒ Select Ethernet Real-time Output Control from the Logging menu
☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
15:56 GMT START TIME
22:06 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☒Yes ☐No
Comments: MBE Pole moved. Readjust and tighten brackets.

Personnel on Board

☐Erin Campbell	☐Lou Schwartz	☐	☐
☐Richard Funk	☐Omi	☐	☐

Reson SeaBat 7125 SV2

Start-up

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☒ Select the operating frequency and number of beams (400kHz use best coverage)
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PPS, Sound speed, Attitude Connections

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Ocean Menu Tab

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Applanix MRU (POSView software)

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☒ Select Ethernet Real-time Output Control from the Logging menu
☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
13:42 GMT START TIME
20:42 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments: .

Personnel on Board

☐ Erin Campbell	☐ Lou Schwartz	☐	☐
☐		☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
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PPS, Sound speed, Attitude Connections

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☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
20:59 GMT START TIME
21:24 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
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Quality Control

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☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☐ Erin Campbell	☐ Lou Schwartz	☐	☐
☐		☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
☒ Click *Start* to launch the user interface

PPS, Sound speed, Attitude Connections

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Ocean Menu Tab

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☒ Select POSpac
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☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
20:59 GMT START TIME
21:24 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
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☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☐ Erin Campbell	☐ Lou Schwartz	☐	☐
☐ Richard Funk	☐ Maylene Perez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
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☐ Set output rate to 50 Hz
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☐ Select Ethernet Logging from the Logging menu
☐ Set output rate to 25 through 100 Hz (50Hz recommended)
☐ Select POSpac
☐ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☐ Select a file size control of 64 MB
☐ START LOGGING: Enter times here

13:02 GMT START TIME
hh:mm GMT END TIME

☐ Record the Status Indicators and Accuracy LEDs

POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
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☒ Check for audible and visual alarms
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Quality Control

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☐ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☐ Erin Campbell	☐ Lou Schwartz	☐	☐
☐ Richard Funk	☐ Melene Perez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
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☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
12:49 GMT START TIME
19:42 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
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☒ Verify measurement units
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Quality Control

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Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☐Erin Campbell	☐Lou Schwartz	☐Alex Beale-Caballero	☐
☐Richard Funk	☐Melene Perez	☐	☐

Reson SeaBat 7125 SV2

Start-up

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☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
10:44 GMT START TIME
21:45:mm GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
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Quality Control

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☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☒Yes ☐No
Comments: MBE Pole moved. Readjust and tighten brackets.

Personnel on Board

☐Erin Campbell	☐Lou Schwartz	☐Alex Beale-Caballero	☐
☐Richard Funk	☐Kayla Pacheco	☐	☐

Reson SeaBat 7125 SV2

Start-up

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☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
11:43 GMT START TIME
21:31 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
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Quality Control

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Problems experienced? ☒Yes ☐No
Comments: MBE Pole moved. Readjust and tighten brackets.

Personnel on Board

☐ Erin Campbell	☐ Lou Schwartz	☐ Alex Beale-Caballero	☐
☐ Richard Funk	☐ Kayla Pacheco	☐	☐

Reson SeaBat 7125 SV2

Start-up

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☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
12:07 GMT START TIME
21:36 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☒Yes ☐No
Comments: MBE Pole moved. Readjust and tighten brackets.

Personnel on Board

☐ Erin Campbell	☐ Lou Schwartz	☐ Alex Beale-Caballero	☐
☐ Richard Funk	☐ Kayla Pacheco	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
☒ Click *Start* to launch the user interface

PPS, Sound speed, Attitude Connections

☒ Confirm PPS is and ZDA is being received. Look for any alarms.
Confirm Sound Velocity data is being received and is a reasonable value: ~1500 m/s
Confirm Attitude data is being received. Turn on role stabilization.

Ocean Menu Tab

☒ Verify Absorption value is set correctly for the environment.
☒ Verify Spreading value is set correctly for the environment.

Applanix MRU (POSView software)

☒ Click the connect button
☒ Select Ethernet Real-time Output Control from the Logging menu
☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
15:33 GMT START TIME
22:12 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☒Yes ☐No
Comments: MBE Pole moved. Readjust and tighten brackets.

Personnel on Board

☐ Erin Campbell	☐ Lou Schwartz	☐	☐
☐ Richard Funk	☐ Omi Rodriguez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
☒ Click *Start* to launch the user interface

PPS, Sound speed, Attitude Connections

☒ Confirm PPS is and ZDA is being received. Look for any alarms.
Confirm Sound Velocity data is being received and is a reasonable value: ~1500 m/s
Confirm Attitude data is being received. Turn on role stabilization.

Ocean Menu Tab

☒ Verify Absorption value is set correctly for the environment.
☒ Verify Spreading value is set correctly for the environment.

Applanix MRU (POSView software)

☒ Click the connect button
☒ Select Ethernet Real-time Output Control from the Logging menu
☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
12:00 GMT START TIME
hh:mm GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☒Yes ☐No
Comments: MBE Pole moved. Readjust and tighten brackets.

Personnel on Board

☐ Erin Campbell	☐ Eric Taylor	☐	☐
☐ Richard Funk	☐ Omi Rodriguez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
☒ Click *Start* to launch the user interface

PPS, Sound speed, Attitude Connections

☒ Confirm PPS is and ZDA is being received. Look for any alarms.
Confirm Sound Velocity data is being received and is a reasonable value: ~1500 m/s
Confirm Attitude data is being received. Turn on role stabilization.

Ocean Menu Tab

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☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
11:07 GMT START TIME
hh:mm GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☒Yes ☐No
Comments:

Personnel on Board

☐ Erin Campbell	☐ Eric Taylor	☐	☐
☐ Richard Funk	☐ Omi Rodriguez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
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PPS, Sound speed, Attitude Connections

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Ocean Menu Tab

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Applanix MRU (POSView software)

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☒ Select Ethernet Real-time Output Control from the Logging menu
☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
11:07 GMT START TIME
22:50 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☐ Erin Campbell	☐ Eric Taylor	☐	☐
☐ Richard Funk	☐ Maylene Perez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
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PPS, Sound speed, Attitude Connections

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Ocean Menu Tab

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Applanix MRU (POSView software)

☒ Click the connect button
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☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
11:39 GMT START TIME
19:15 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☐ Erin Campbell	☐ Eric Taylor	☐	☐
☐ Cory Graves	☐ Maylene Perez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
☒ Click *Start* to launch the user interface

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Ocean Menu Tab

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Applanix MRU (POSView software)

☒ Click the connect button
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☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
13:19 GMT START TIME
19:34 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☐ Erin Campbell	☐ Eric Taylor	☐	☐
☐ Cory Graves	☐ Maylene Perez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
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PPS, Sound speed, Attitude Connections

☒ Confirm PPS is and ZDA is being received. Look for any alarms.
Confirm Sound Velocity data is being received and is a reasonable value: ~1500 m/s
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Ocean Menu Tab

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Applanix MRU (POSView software)

☒ Click the connect button
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☒ Set output rate to 50 Hz
☒ Select POSpac and groups
☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
13:45 GMT START TIME
19:44 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☐ Erin Campbell	☐ Eric Taylor	☐	☐
☐ Cory Graves	☐ Maylene Perez	☐	☐

Reson SeaBat 7125 SV2

Start-up

☒ Energize the system. (Press the On / Reset switch UP towards the On position)
☒ Start the sonar by clicking the 7K Control Center icon on the 7-P operator desktop
☒ Select the operating frequency and number of beams (400kHz use best coverage)
☒ Click *Start* to launch the user interface

PPS, Sound speed, Attitude Connections

☒ Confirm PPS is and ZDA is being received. Look for any alarms.
Confirm Sound Velocity data is being received and is a reasonable value: ~1500 m/s
Confirm Attitude data is being received. Turn on role stabilization.

Ocean Menu Tab

☒ Verify Absorption value is set correctly for the environment.
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Applanix MRU (POSView software)

☒ Click the connect button
☒ Select Ethernet Real-time Output Control from the Logging menu
☒ Set output rate to 50 Hz
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☒ Select Ethernet Logging from the Logging menu
☒ Set output rate to 25 through 100 Hz (50Hz recommended)
☒ Select POSpac
☒ Browse to correct file path and set file name (ex: CU_mmddyy_MB)
☒ Select a file size control of 64 MB
☐ START LOGGING: Enter times here
13:19 GMT START TIME
19:34 GMT END TIME
☐ Record the Status Indicators and Accuracy LEDs
POS MODE:Nav: Full, IMU STATUS:OK, NAV STATUS:FIXED RTK, GAMS:Online
**Full or initial setup would require checking equipment and GAMS offsets and I/O port settings*

Hypack

☒ Create new project (Project_mmddyy_Type_Boat#) Ex: CU_MMDDYY_MB_#
☒ Verify Hypack and Hysweep hardware settings and enter in log sheet
☒ Verify Geodesy settings
☒ Verify measurement units
☒ Enable all desired layers (targets, lines, backgrounds, matrix, etc.)
☒ Start Hypack Survey and Hysweep Survey
☒ Check for audible and visual alarms
☒ Verify POS timing is PPS in POS device window

Quality Control

☐ Set the Bar Check at a fixed depth below the sonar. Use the bar check utility in Hysweep to record multiple measurements.
☒ If using RTK GPS for water level determination, measure the WL with a GPS rover. Record this value and the vessel water level reading in the Water Level QC sheet.

Problems experienced? ☐Yes ☒No
Comments:

H2
SURVEY QC CHECK RESULTS

Table H1. MBE Sonar Bar Check Results

Daily Bar Check

Note: Hysweep bar check results are stored within each hypack project as "Barcheck.txt"
Note: PITCH CORRECTION APPLIED IN HYSWEEP!

Project Avg.	-0.02
Project Stdv.	0.05
Project Min	0.00
Project Max	0.12

Date	Bar Depth	Meas. Depth	Sonar Draft	Corr. Depth	Diff.	ABS(Diff.	Notes
mm/dd/yyyy	10.00	9.37	0.75	10.12	-0.12	0.12	EXAMPLE
12/8/2012	3.00	2.20	0.82	3.02	-0.02	0.02	
		2.72					
12/8/2012	3.00	2.18	0.82	3.00	0.00	0.00	
12/8/2012	5.00	4.17	0.82	4.99	0.01	0.01	
12/14/2012	5.00	4.17	0.82	4.99	0.01	0.01	

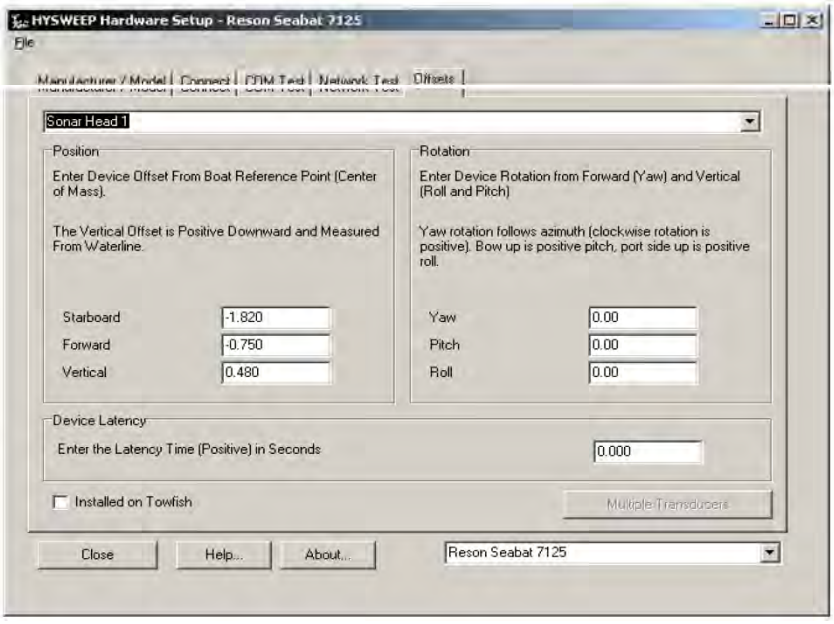


Table H2. BNSS Rover vs. Vessel Navigation Water Level Checks

Daily Water Level Check

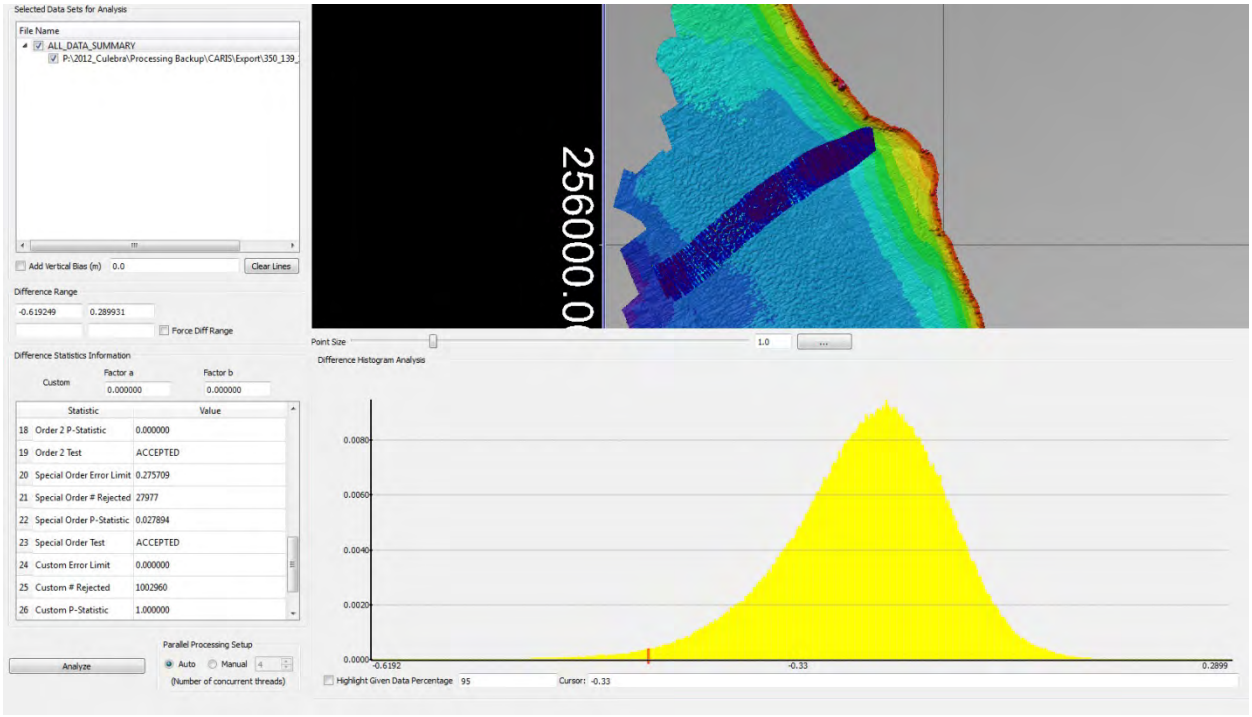
Project Avg.	0.057
Project Stdv	0.046
Project Min	0.000
Project Max	0.165

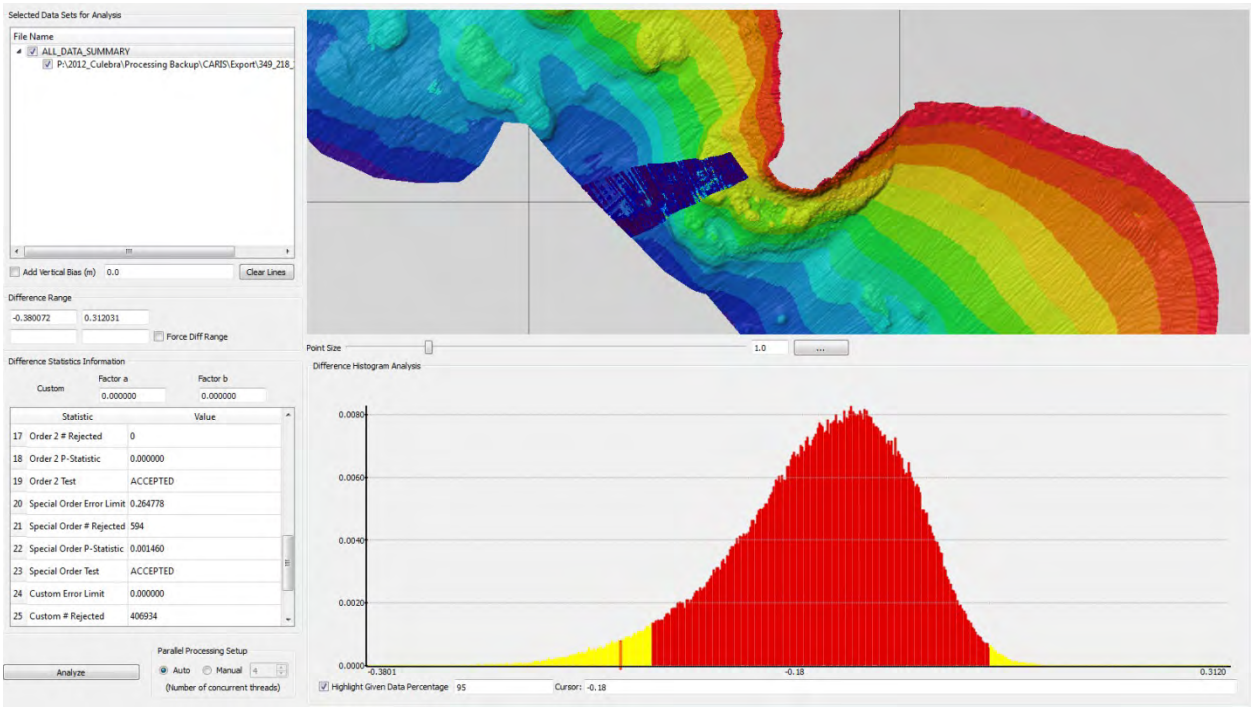
Date	Time	Leica Rover Waterline Ellip. Ht.	POS Altitude	Port Draft	Stbd Draft	Avg Draft	Corr. Tide	Diff	ABS(Diff)	Notes
mm/dd/yyyy	hh:mm	10.000	-9.400	0.6	0.8	0.70	10.10	-0.10	0.100	EXAMPLE
12/8/2012	13:46	0.078	0.130	0	0	0.00	-0.13	-0.05	0.052	
12/8/2012	14:04		0.120	0	0	0.00	-0.12	-0.12	0.120	
				0	0	0.00	0.00	0.00	0.000	
12/10/2012	14:11	41.738	42.000	0	0	0.32	41.68	0.06	0.058	
12/13/2012	11:14	41.619	41.875	0	0	0.32	41.56	0.06	0.064	
12/14/2012	13:45	41.512	41.780	0	0	0.32	41.46	0.05	0.052	
12/15/2012	11:58	41.634	41.932	0	0	0.32	41.61	0.02	0.022	
12/16/2012	13:40	41.356	41.700	0	0	0.32	41.38	-0.02	0.024	
12/17/2012		41.776	42.070	0	0	0.32	41.75	0.03	0.026	
12/18/2012	11:38	41.811	42.108	0	0	0.32	41.79	0.02	0.023	
12/19/2012	15:24	41.677	41.984	0	0	0.32	41.66	0.01	0.013	
1/4/2013	12:33	41.660	41.945	0	0	0.32	41.63	0.03	0.035	
1/5/2013	10:39	41.68	41.95	0	0	0.32	41.63	0.05	0.050	
1/7/2013	11:04	41.649	41.82	0	0	0.32	41.50	0.15	0.149	
1/8/2012	10:35	41.718	41.94	0	0	0.32	41.62	0.10	0.098	
1/9/2013	11:21	41.58	41.735	0	0	0.32	41.42	0.16	0.165	
1/10/2013	12:59	41.676	41.974	0	0	0.32	41.65	0.02	0.022	
1/12/2013	11:14	41.619	41.875	0	0	0.32	41.56	0.06	0.064	
1/14/2012	12:18	41.628	41.978	0	0	0.32	41.66	-0.03	0.030	
1/17/2012	13:18	41.631	41.930	0	0	0.32	41.61	0.02	0.021	

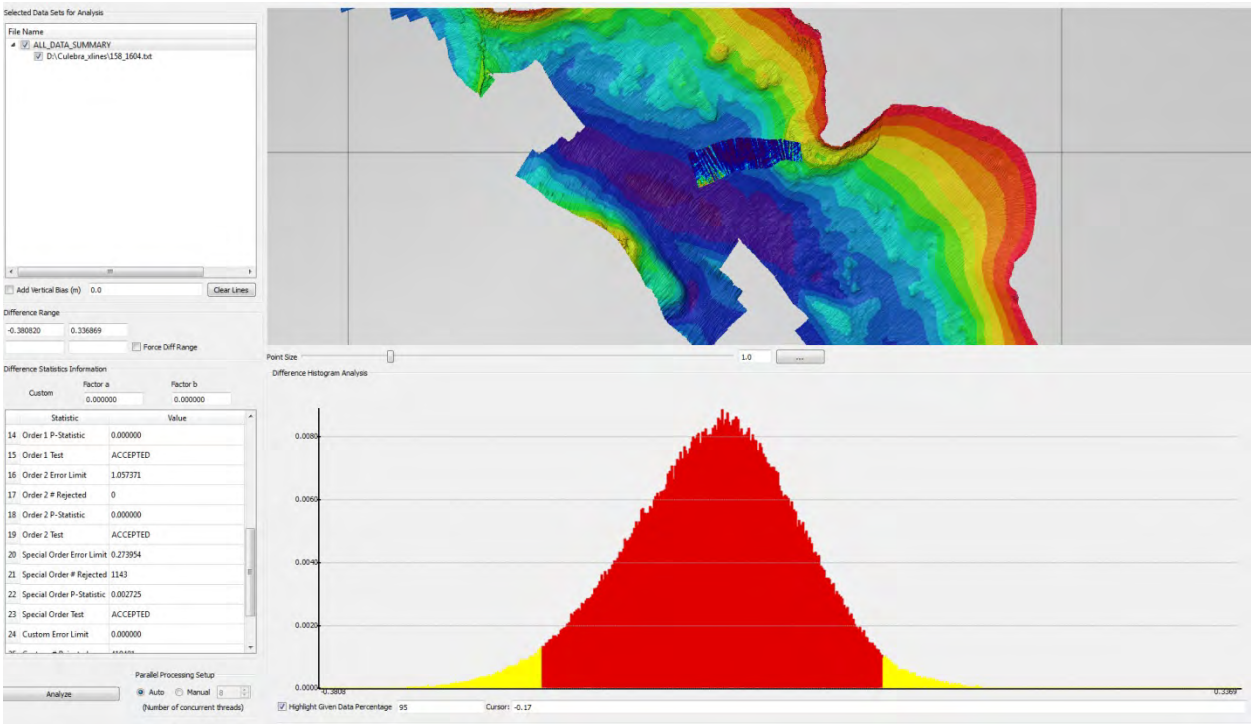
BNSS Rover vs. Post-Processed Vessel Navigation Water Level Checks

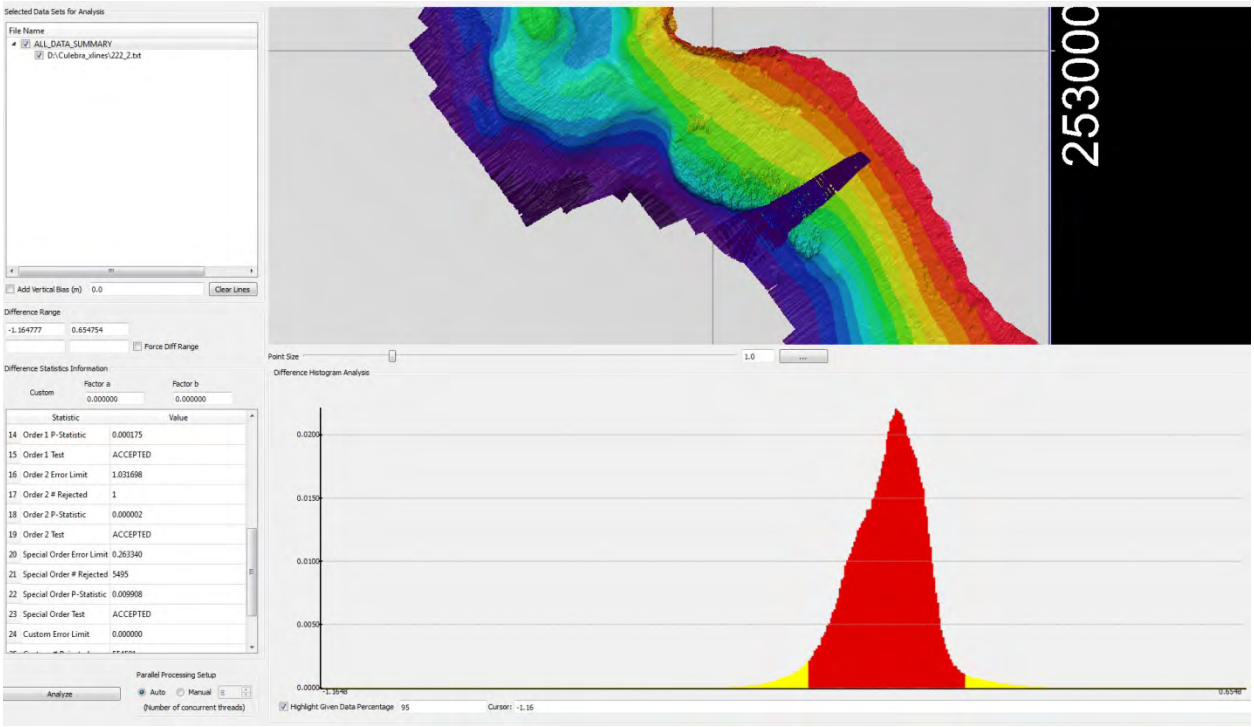
Date	Time	Waterline Ellip Ht. NOAAStation ID 9752235	Real Time POS Altitude (Failed Initial QC)	Post Processed POS Altitude	Avg Draft	Corr. Tide	Diff.	ABS(Diff)
mm/dd/yyyy	hh:mm	m	m	m	m	m	m	m
12/8/2012	16:30	41.931	N/A	41.672	0.32	41.99	0.06	0.061
1/7/2012	14:30	42.349	41.82	41.990	0.32	42.31	-0.04	0.039
1/9/2012	13:30	42.347	41.735	41.945	0.32	42.27	-0.08	0.082

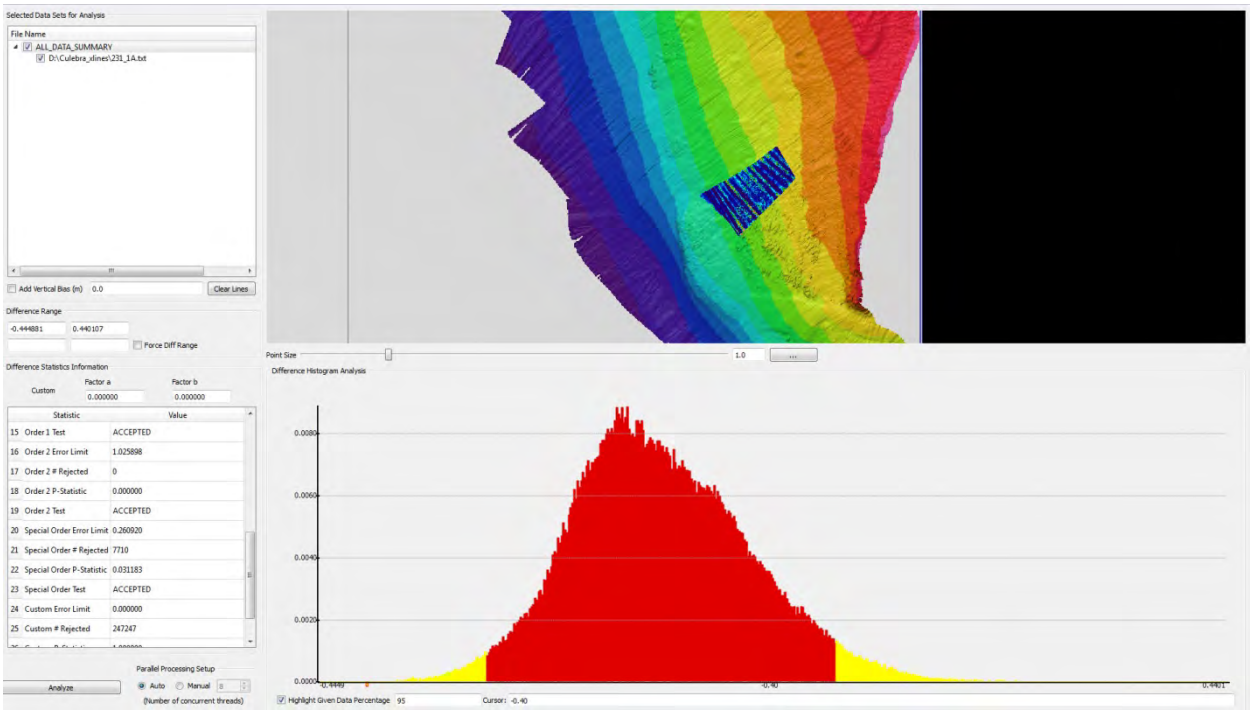
H3
COMPARISON OF SURVEY MAIN AND CROSS LINE DATA

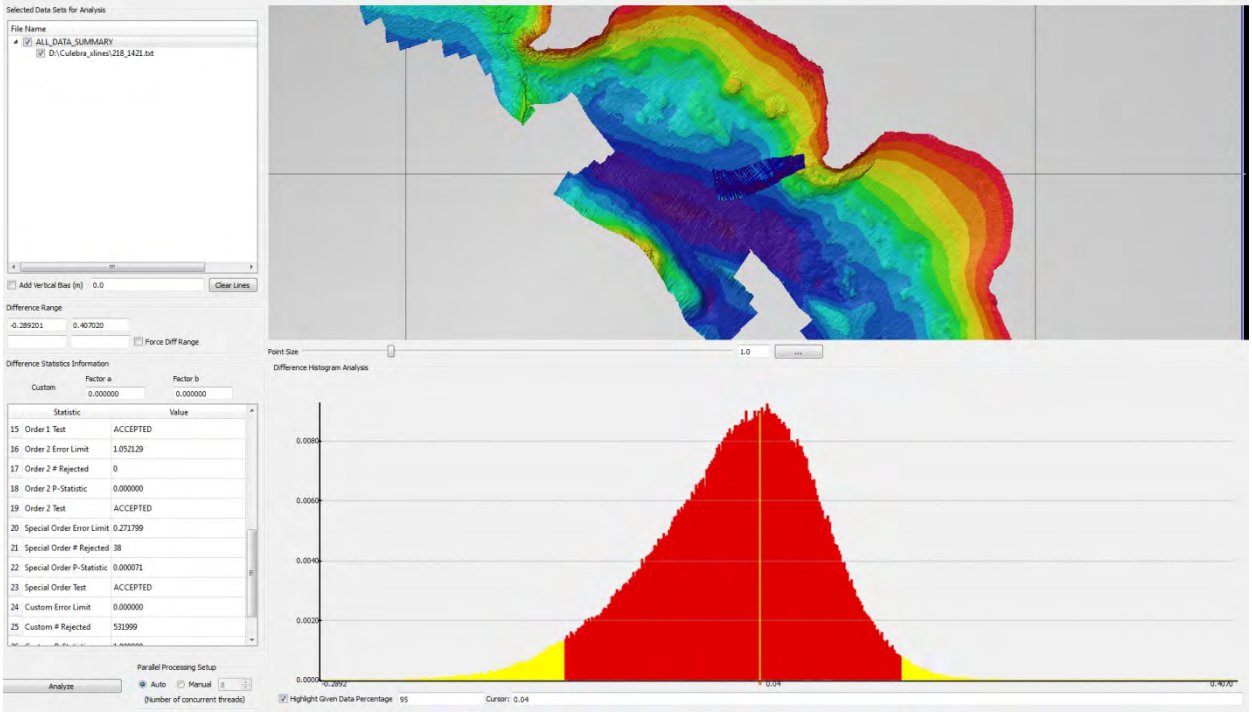

Selected Data Sets for Analysis
File Name
ALL_DATA_SUMMARY
P:\2012_Culebra\Processing Backup\CARIS\Export\350_139_
Add Vertical Bias (m) 0.0
Clear Lines
Difference Range
-0.619249
0.289931
Force Diff Range
Difference Statistics Information
Custom
Factor a
0.000000
Factor b
0.000000
Statistic
Value
18 Order 2 P-Statistic 0.000000
19 Order 2 Test ACCEPTED
20 Special Order Error Limit 0.275709
21 Special Order # Rejected 27977
22 Special Order P-Statistic 0.027894
23 Special Order Test ACCEPTED
24 Custom Error Limit 0.000000
25 Custom # Rejected 1002960
26 Custom P-Statistic 1.000000
Analyze
Parallel Processing Setup
Auto
Manual
(Number of concurrent threads)
256000.0
Point Size
1.0
Difference Histogram Analysis
0.0080
0.0060
0.0040
0.0020
0.0000
-0.6192
-0.33
0.2899
Highlight Given Data Percentage 95
Cursor: -0.33

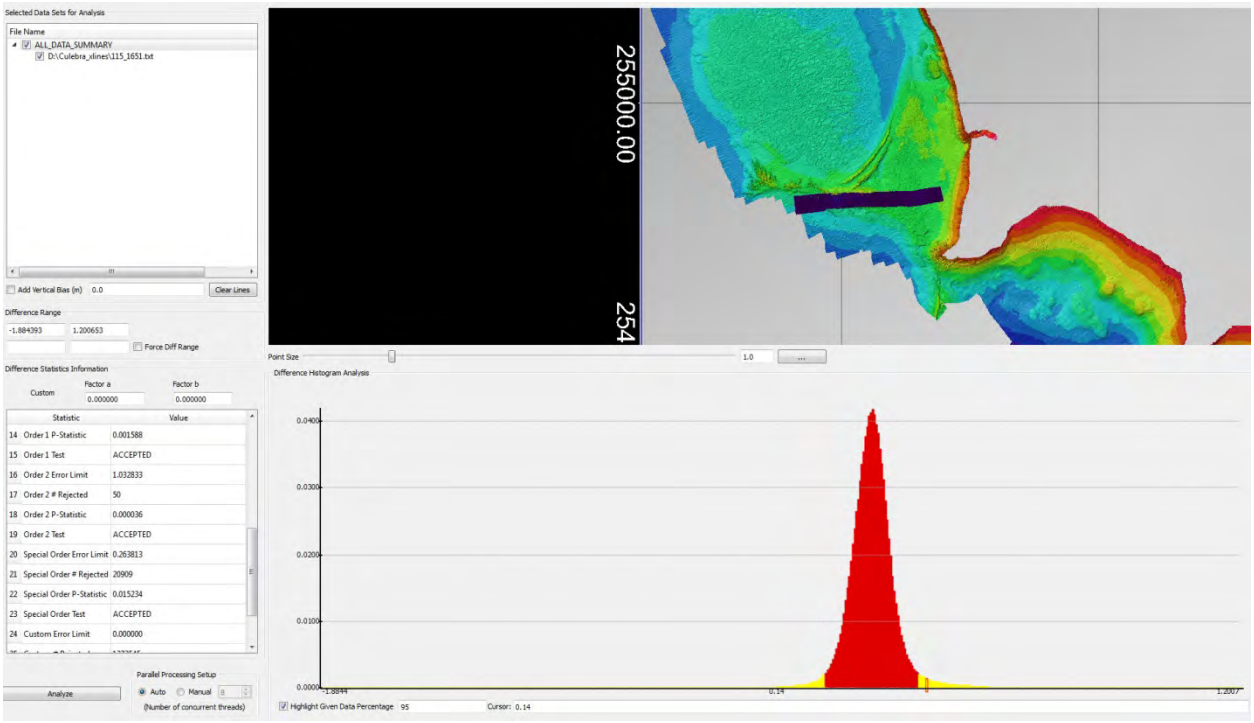

Selected Data Sets for Analysis
File Name
ALL_DATA_SUMMARY
P:\2012_Culebra\Processing Backup\CARIS\Export\349_218_
Add Vertical Bias (m) 0.0
Clear Lines
Difference Range
-0.380072
0.312031
Force Diff Range
Difference Statistics Information
Custom
Factor a
0.000000
Factor b
0.000000
Statistic
Value
17 Order 2 # Rejected 0
18 Order 2 P-Statistic 0.000000
19 Order 2 Test ACCEPTED
20 Special Order Error Limit 0.264778
21 Special Order # Rejected 594
22 Special Order P-Statistic 0.001460
23 Special Order Test ACCEPTED
24 Custom Error Limit 0.000000
25 Custom # Rejected 406934
Analyze
Parallel Processing Setup
Auto
Manual
(Number of concurrent threads)
Point Size
1.0
Difference Histogram Analysis
0.0080
0.0060
0.0040
0.0020
0.0000
-0.3801
-0.18
0.3120
Highlight Given Data Percentage 95
Cursor: -0.18

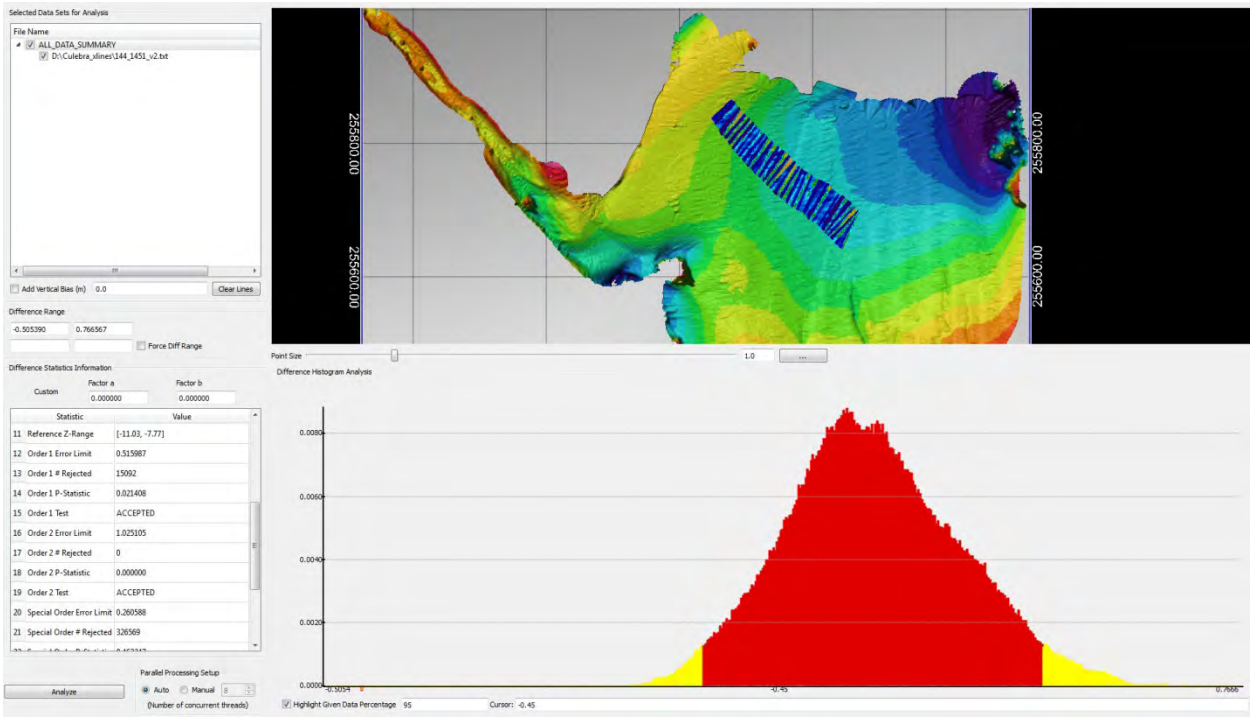

Selected Data Sets for Analysis
File Name
ALL_DATA_SUMMARY
D:\Culebra_xlines\158_1604.txt
Add Vertical Bias (m) 0.0
Clear Lines
Difference Range
-0.380820
0.336869
Force Diff Range
Difference Statistics Information
Custom
Factor a
0.000000
Factor b
0.000000
Statistic
Value
14 Order 1 P-Statistic 0.000000
15 Order 1 Test ACCEPTED
16 Order 2 Error Limit 1.057371
17 Order 2 # Rejected 0
18 Order 2 P-Statistic 0.000000
19 Order 2 Test ACCEPTED
20 Special Order Error Limit 0.273954
21 Special Order # Rejected 1143
22 Special Order P-Statistic 0.002725
23 Special Order Test ACCEPTED
24 Custom Error Limit 0.000000
Parallel Processing Setup
Analyze
Auto
Manual
(Number of concurrent threads)
Point Size
1.0
Difference Histogram Analysis
0.0080
0.0060
0.0040
0.0020
0.0000
Highlight Given Data Percentage 95
Cursor: -0.17


Selected Data Sets for Analysis
File Name
ALL_DATA_SUMMARY
D:\Culebra_xlines\222_2.txt
Add Vertical Bias (m) 0.0
Clear Lines
Difference Range
-1.164777
0.654754
Force Diff Range
Difference Statistics Information
Custom
Factor a
0.000000
Factor b
0.000000
Statistic
Value
14 Order 1 P-Statistic 0.000175
15 Order 1 Test ACCEPTED
16 Order 2 Error Limit 1.031698
17 Order 2 # Rejected 1
18 Order 2 P-Statistic 0.000002
19 Order 2 Test ACCEPTED
20 Special Order Error Limit 0.263340
21 Special Order # Rejected 5495
22 Special Order P-Statistic 0.009908
23 Special Order Test ACCEPTED
24 Custom Error Limit 0.000000
Parallel Processing Setup
Analyze
Auto
Manual
(Number of concurrent threads)
253000
Point Size
1.0
Difference Histogram Analysis
0.0200
0.0150
0.0100
0.0050
0.0000
Highlight Given Data Percentage 95
Cursor: -1.16


Selected Data Sets for Analysis
File Name
ALL_DATA_SUMMARY
D:\Culebra_xlines\231_1A.txt
Add Vertical Bias (m) 0.0
Clear Lines
Difference Range
-0.444881
0.440107
Force Diff Range
Difference Statistics Information
Custom
Factor a
0.000000
Factor b
0.000000
Statistic
Value
15 Order 1 Test ACCEPTED
16 Order 2 Error Limit 1.025898
17 Order 2 # Rejected 0
18 Order 2 P-Statistic 0.000000
19 Order 2 Test ACCEPTED
20 Special Order Error Limit 0.260920
21 Special Order # Rejected 7710
22 Special Order P-Statistic 0.031183
23 Special Order Test ACCEPTED
24 Custom Error Limit 0.000000
25 Custom # Rejected 247247
Parallel Processing Setup
Analyze
Auto
Manual
(Number of concurrent threads)
Point Size
1.0
Difference Histogram Analysis
0.0080
0.0060
0.0040
0.0020
0.0000
Highlight Given Data Percentage 95
Cursor: -0.40


Selected Data Sets for Analysis
File Name
ALL_DATA_SUMMARY
D:\Culebra_xlines\218_1421.txt
Add Vertical Bias (m) 0.0
Clear Lines
Difference Range
-0.289201
0.407020
Force Diff Range
Difference Statistics Information
Custom
Factor a
0.000000
Factor b
0.000000
Statistic
Value
15 Order 1 Test ACCEPTED
16 Order 2 Error Limit 1.052129
17 Order 2 # Rejected 0
18 Order 2 P-Statistic 0.000000
19 Order 2 Test ACCEPTED
20 Special Order Error Limit 0.271799
21 Special Order # Rejected 38
22 Special Order P-Statistic 0.000071
23 Special Order Test ACCEPTED
24 Custom Error Limit 0.000000
25 Custom # Rejected 531999
Parallel Processing Setup
Analyze
Auto
Manual
(Number of concurrent threads)
Point Size
1.0
Difference Histogram Analysis
0.0080
0.0060
0.0040
0.0020
0.0000
Highlight Given Data Percentage 95
Cursor: 0.04


Selected Data Sets for Analysis
File Name
ALL_DATA_SUMMARY
D:\Culebra_xlines\115_1651.txt
Add Vertical Bias (m) 0.0
Clear Lines
Difference Range
-1.884393
1.200653
Force Diff Range
Difference Statistics Information
Custom
Factor a
Factor b
0.000000
0.000000
Statistic
Value
14 Order 1 P-Statistic 0.001588
15 Order 1 Test ACCEPTED
16 Order 2 Error Limit 1.032833
17 Order 2 # Rejected 50
18 Order 2 P-Statistic 0.000036
19 Order 2 Test ACCEPTED
20 Special Order Error Limit 0.263813
21 Special Order # Rejected 20909
22 Special Order P-Statistic 0.015234
23 Special Order Test ACCEPTED
24 Custom Error Limit 0.000000
Parallel Processing Setup
Analyze
Auto
Manual
(Number of concurrent threads)
255000.00
254
Point Size
1.0
Difference Histogram Analysis
0.0400
0.0300
0.0200
0.0100
0.0000
-1.8844
0.14
1.2007
Highlight Given Data Percentage 95
Cursor: 0.14


Selected Data Sets for Analysis
File Name
ALL_DATA_SUMMARY
D:\Culebra_xlines\144_1451_v2.txt
Add Vertical Bias (m) 0.0
Clear Lines
Difference Range
-0.505390
0.766567
Force Diff Range
Difference Statistics Information
Custom
Factor a
Factor b
0.000000
0.000000
Statistic
Value
11 Reference Z-Range [-11.03, -7.77]
12 Order 1 Error Limit 0.515987
13 Order 1 # Rejected 15092
14 Order 1 P-Statistic 0.021408
15 Order 1 Test ACCEPTED
16 Order 2 Error Limit 1.025105
17 Order 2 # Rejected 0
18 Order 2 P-Statistic 0.000000
19 Order 2 Test ACCEPTED
20 Special Order Error Limit 0.260588
21 Special Order # Rejected 326569
Parallel Processing Setup
Analyze
Auto
Manual
(Number of concurrent threads)
255600.00
255600.00
255800.00
255600.00
Point Size
1.0
Difference Histogram Analysis
0.0080
0.0060
0.0040
0.0020
0.0000
-0.3054
-0.45
0.7668
Highlight Given Data Percentage 95
Cursor: -0.45

H4
RTK GPS BASE STATION AND ROVER QC LOG

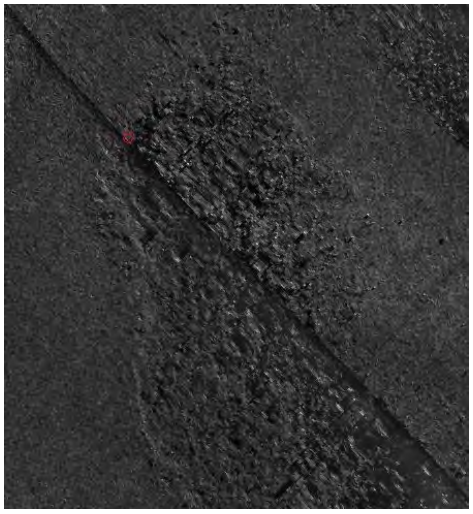
GPS Base Station and QC Log

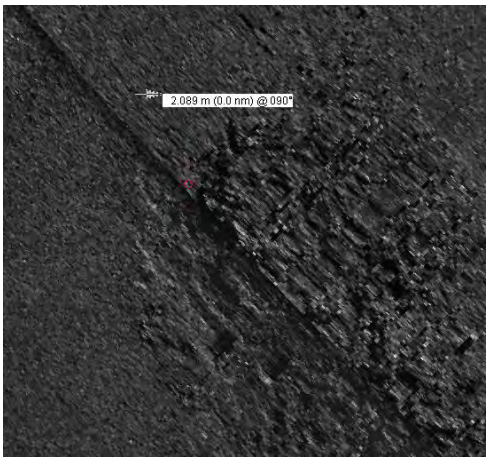
				Observed			Difference		
Date	**Time**	**Location**	**File Name**	**Easting**	**Northing**	**Elev.**	**Easting**	**Northing**	**Elev.**
12/8/2012	14:13:36	BiDOT	BiDOT	319405.176	253338.738	-38.458	0.014	0.013	-0.042
12/8/2012	16:14:14	Singing House	QC 120812	320616.382	252983.591	-38.806	-0.006	0.030	-0.015
12/9/2012	7:51:30	Singing House	Sing-120912	320616.383	252983.608	-38.807	-0.007	0.013	-0.014
12/10/2012	14:42:12	BiDOT	BiDOT 121012	319405.185	253338.747	-38.493	0.005	0.004	-0.008
12/11/2012	10:13:52	BiDOT	BiDOT 121112	319405.187	253338.728	-38.505	0.003	0.023	0.005
12/12/2012	11:58:55	BiDOT	BiDOT 121113	319405.188	253338.735	-38.492	0.002	0.016	-0.008
12/13/2012	6:59:32	BiDOT	BiDOT 121114	319405.195	253338.733	-38.492	-0.005	0.018	-0.008
12/14/2012	7:17:32	BiDOT	BiDOT 121115	319405.202	253338.759	-38.498	-0.012	-0.008	-0.002
12/15/2012	7:46:43	BiDOT	BiDOT 121116	319405.214	253338.739	-38.475	-0.024	0.012	-0.025
12/16/2012	9:27:32	BiDOT	BiDOT 121117	319405.193	253338.765	-38.499	-0.003	-0.014	-0.001
12/17/2012	7:40:10	BiDOT	BiDOT 121118	319405.182	253338.752	-38.496	0.008	-0.001	-0.005
12/18/2012	7:29:58	BiDOT	BiDOT 121119	319405.192	253338.764	-38.501	-0.002	-0.013	0.001
12/19/2012	7:29:27	BiDOT	BiDOT 121120	319405.193	253338.765	-38.500	-0.003	-0.014	0.000
12/20/2012	8:12:26	BiDOT	BiDOT 121121	319405.212	253338.749	-38.492	-0.022	0.002	-0.008
1/4/2013	9:05:04	BiDOT	BiDOT 130104	319405.201	253338.750	-38.493	-0.011	0.001	-0.007
1/5/2013	7:06:06	BiDOT	BiDOT 130105	319405.186	253338.765	-38.499	0.004	-0.014	-0.001
1/7/2013	7:48:59	BiDOT	BiDOT 130107	319405.192	253338.741	-38.499	-0.002	0.010	-0.001
1/9/2013	6:59:11	BiDOT	BiDOT 130109	319405.178	253338.735	-38.490	0.012	0.016	-0.010
1/10/2013	8:40:40	BiDOT	BiDOT 130110	319405.184	253338.738	-38.483	0.006	0.013	-0.017
1/12/2013	10:11:36	PK-201	PK-201 130112	317593.143	255163.518	-40.092	-0.005	0.000	-0.012
1/14/2013	9:47:21	BiDOT	BiDOT 130114	319405.191	253338.752	-38.488	-0.001	-0.001	-0.012
1/15/2013	9:22:36	BiDOT	BiDOT 130115	319405.193	253338.746	-38.495	-0.003	0.005	-0.005
1/16/2013	7:54:49	BiDOT	BiDOT 130116	319405.170	253338.758	-38.477	0.020	-0.007	-0.023
1/17/2013	8:13:14	BiDOT	BiDOT 130117	319405.183	253338.746	-38.487	0.007	0.005	-0.013
1/18/2013	8:32:14	BiDOT	BiDOT 130118	319405.191	253338.741	-38.481	-0.001	0.010	-0.019

H5
SIDESCAN SONAR QUALITY CONTROL RESULTS AND QUALITY CONTROL LOGS

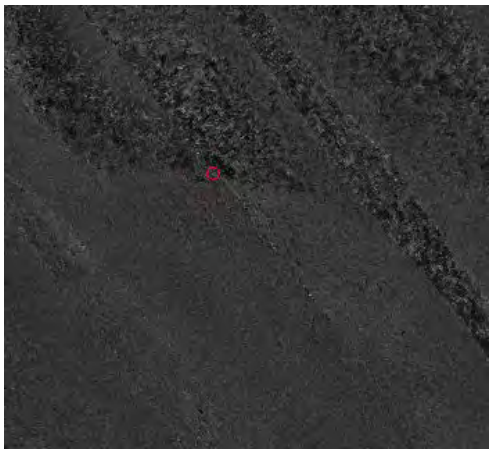
Sidescan Sonar Positioning QC

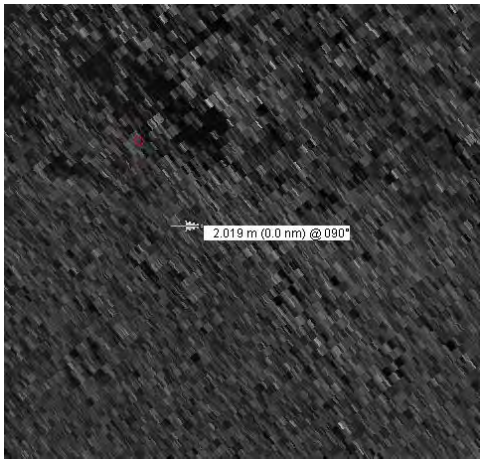
- MRS-12
  - 12/11/12 Bottom feature. Lines cu_121112.009-ch12 and cu_121112.007-ch12 agreement within 2 meters in the Luis Pena region of MRS-12.





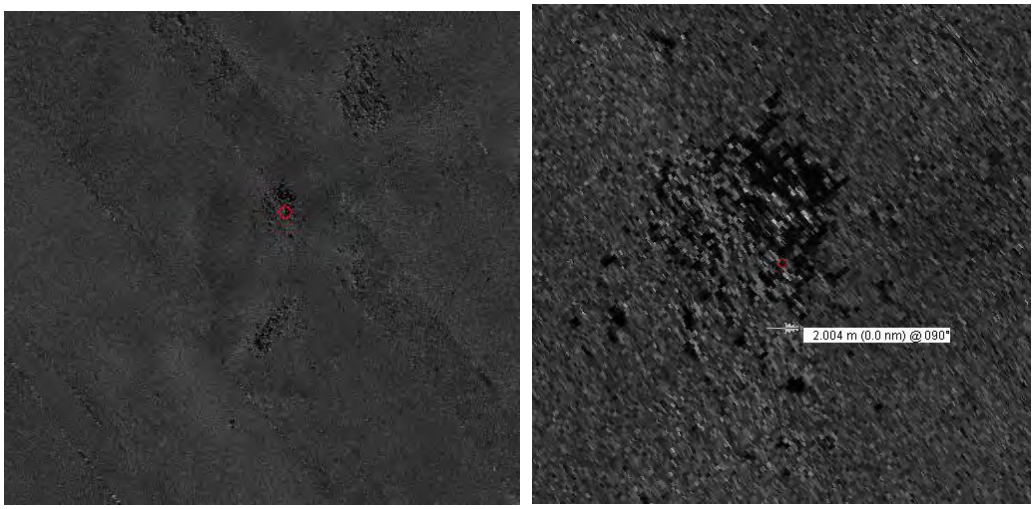
  - 12/16/12 Change in bottom type. Lines cu_121612.006-ch12 and cu_121612.004-ch12 agreement within 2 meters in the Luis Pena region of MRS-12.





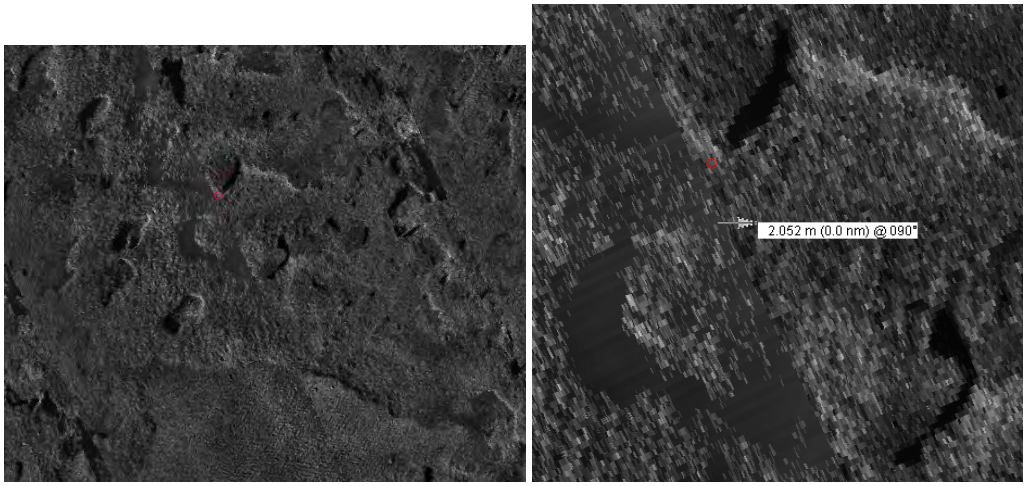
- 12/17/12

  Change in bottom type feature. Lines 20121217190743-ch12 and 2012121719140-ch12 agreement within 2 meters in the Luis Pena region of MRS-12.

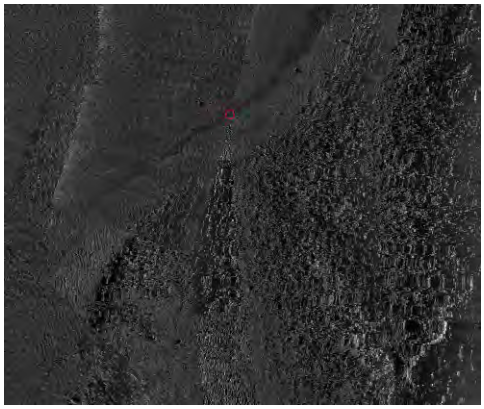


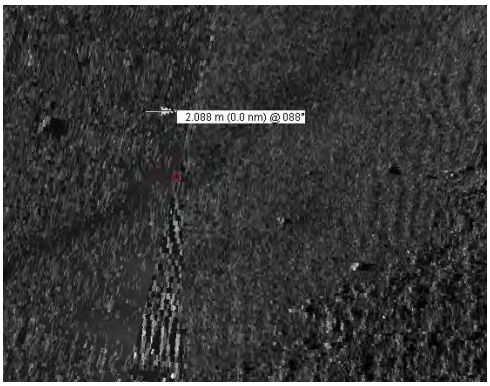
- 12/18/12

  Bottom feature. Lines cu_121812.012-ch12 and cu_121812.015-ch12 agreement within 2 meters in the Carlos Rosario region of MRS-12.



- 12/19/12
  Bottom feature. Lines cu_121912.011-ch12 and cu_121912.009-ch12 agreement within 2 meters in the Luis Pena region of MRS-12.





- MRS-03
  - 01/12/13
    Bottom feature. Lines 20130112141716 and 20130102043157 agreement within 2 meters in the Flamenco Bay region of MRS-03.

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☒Omi Rodrigues	☒Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☐Maylele Perez	☐

Edgetech 4125

Start-up

☒ Power on the towfish and acquisition computer
☒ Connect to the Sonar
☒ Start Edgetech Discover software
☒ Test and Turn on GAPS Transponder
☒ Launch the towfish
☒ Confirm sound speed is set correctly
☒ Set the sonar range
☒ Turn on the sonar
☒ Set the record file path

GAPS USBL Tracking

☒ Power on the GAPS
☒ Launch the MMI and start tracking
☒ Start the "MMI to GGA" python script

GPS input

☒ Confirm GGA message from the GAPS is being received in Discover (output from GAPS2GGA)

Bottom Tracking and Alarms

☐ Adjust the automatic bottom tracking and set an audible minimum altitude alarm.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor sonar coverage during acquisition.

Quality Control

☒ Collect data on adjacent lines in opposite directions with overlapping data. Data must image a distinct target that can be used for navigation precision verification.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☐Omi Rodrigues	☒Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☐Maylele Perez	☐

Edgetech 4125

Start-up

☒ Power on the towfish and acquisition computer
☒ Connect to the Sonar
☒ Start Edgetech Discover software
☒ Test and Turn on GAPS Transponder
☒ Launch the towfish
☒ Confirm sound speed is set correctly
☒ Set the sonar range
☒ Turn on the sonar
☒ Set the record file path

GAPS USBL Tracking

☒ Power on the GAPS
☒ Launch the MMI and start tracking
☒ Start the "MMI to GGA" python script

GPS input

☒ Confirm GGA message from the GAPS is being received in Discover (output from GAPS2GGA)

Bottom Tracking and Alarms

☐ Adjust the automatic bottom tracking and set an audible minimum altitude alarm.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor sonar coverage during acquisition.

Quality Control

☒ Collect data on adjacent lines in opposite directions with overlapping data. Data must image a distinct target that can be used for navigation precision verification.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☐Omi Rodrigues	☒Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☐Maylele Perez	☐

Edgetech 4125

Start-up

☒ Power on the towfish and acquisition computer
☒ Connect to the Sonar
☒ Start Edgetech Discover software
☒ Test and Turn on GAPS Transponder
☒ Launch the towfish
☒ Confirm sound speed is set correctly
☒ Set the sonar range
☒ Turn on the sonar
☒ Set the record file path

GAPS USBL Tracking

☒ Power on the GAPS
☒ Launch the MMI and start tracking
☒ Start the "MMI to GGA" python script

GPS input

☒ Confirm GGA message from the GAPS is being received in Discover (output from GAPS2GGA)

Bottom Tracking and Alarms

☐ Adjust the automatic bottom tracking and set an audible minimum altitude alarm.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor sonar coverage during acquisition.

Quality Control

☒ Collect data on adjacent lines in opposite directions with overlapping data. Data must image a distinct target that can be used for navigation precision verification.

Problems experienced? ☐Yes ☒No
Comments:

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☐Omi Rodrigues	☒Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☐Maylele Perez	☐

Edgetech 4125

Start-up

☒ Power on the towfish and acquisition computer
☒ Connect to the Sonar
☒ Start Edgetech Discover software
☒ Test and Turn on GAPS Transponder
☒ Launch the towfish
☒ Confirm sound speed is set correctly
☒ Set the sonar range
☒ Turn on the sonar
☒ Set the record file path

GAPS USBL Tracking

☒ Power on the GAPS
☒ Launch the MMI and start tracking
☒ Start the "MMI to GGA" python script

GPS input

☒ Confirm GGA message from the GAPS is being received in Discover (output from GAPS2GGA)

Bottom Tracking and Alarms

☐ Adjust the automatic bottom tracking and set an audible minimum altitude alarm.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor sonar coverage during acquisition.

Quality Control

☒ Collect data on adjacent lines in opposite directions with overlapping data. Data must image a distinct target that can be used for navigation precision verification.

Problems experienced? ☒Yes ☐No
Comments: Lost telemetry once.

Personnel on Board

☒ Richard Funk	☒ Lou Schwartz	☐ Omi Rodrigues	☒ Kayla Pacheco
☒ Erin Campbell	☐ Alejandro Beale	☐ Maylele Perez	☐

Edgetech 4125

Start-up

☒ Power on the towfish and acquisition computer
☒ Connect to the Sonar
☒ Start Edgetech Discover software
☒ Test and Turn on GAPS Transponder
☒ Launch the towfish
☒ Confirm sound speed is set correctly
☒ Set the sonar range
☒ Turn on the sonar
☒ Set the record file path

GAPS USBL Tracking

☒ Power on the GAPS
☒ Launch the MMI and start tracking
☒ Start the "MMI to GGA" python script

GPS input

☒ Confirm GGA message from the GAPS is being received in Discover (output from GAPS2GGA)

Bottom Tracking and Alarms

☐ Adjust the automatic bottom tracking and set an audible minimum altitude alarm.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor sonar coverage during acquisition.

Quality Control

☒ Collect data on adjacent lines in opposite directions with overlapping data. Data must image a distinct target that can be used for navigation precision verification.

Problems experienced? ☐Yes ☐No

Personnel on Board

☐ Richard Funk	☐ Lou Schwartz	☐ Omi Rodrigues	☐ Kayla Pacheco
☐ Erin Campbell	☐ Alejandro Beale	☐ Maylele Perez	☐

Edgetech 4125

Start-up

☒ Power on the towfish and acquisition computer
☒ Connect to the Sonar
☒ Start Edgetech Discover software
☒ Test and Turn on GAPS Transponder
☒ Launch the towfish
☒ Confirm sound speed is set correctly
☒ Set the sonar range
☒ Turn on the sonar
☒ Set the record file path

GAPS USBL Tracking

☒ Power on the GAPS
☒ Launch the MMI and start tracking
☒ Start the "MMI to GGA" python script

GPS input

☒ Confirm GGA message from the GAPS is being received in Discover (output from GAPS2GGA)

Bottom Tracking and Alarms

☐ Adjust the automatic bottom tracking and set an audible minimum altitude alarm.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor sonar coverage during acquisition.

Quality Control

☐ Collect data on adjacent lines in opposite directions with overlapping data. Data must image a distinct target that can be used for navigation precision verification.

Problems experienced? ☐ Yes ☐ No

Personnel on Board

☐ Richard Funk	☐ Lou Schwartz	☐ Omi Rodrigues	☐ Kayla Pacheco
☐ Erin Campbell	☐ Alejandro Beale	☐ Maylele Perez	☐

Edgetech 4125

Start-up

☒ Power on the towfish and acquisition computer
☒ Connect to the Sonar
☒ Start Edgetech Discover software
☒ Test and Turn on GAPS Transponder
☒ Launch the towfish
☒ Confirm sound speed is set correctly
☒ Set the sonar range
☒ Turn on the sonar
☒ Set the record file path

GAPS USBL Tracking

☒ Power on the GAPS
☒ Launch the MMI and start tracking
☒ Start the "MMI to GGA" python script

GPS input

☒ Confirm GGA message from the GAPS is being received in Discover (output from GAPS2GGA)

Bottom Tracking and Alarms

☐ Adjust the automatic bottom tracking and set an audible minimum altitude alarm.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor sonar coverage during acquisition.

Quality Control

☒ Collect data on adjacent lines in opposite directions with overlapping data. Data must image a distinct target that can be used for navigation precision verification.

Problems experienced? ☐ Yes ☐ No

H6
VIDEO DATA COLLECTION QUALITY CONTROL LOGS

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☒Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☐Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

GAPS USBL Tracking (if video camera is towed)

☐ Power on the GAPS
☐ Start the MMI software and start tracking
☐ Start the "MMI to GGA" python script

GPS overlay

☒ Confirm position and time stamp overlay is being written (check time sync with computer)
☐ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☐ Configure and display the towfish location using both the USBL and layback for verification.
☐ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐Yes ☒No
Comments: MBE pole mounted video collected today

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☐Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☒Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

GAPS USBL Tracking (if video camera is towed)

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☐ Start the MMI software and start tracking
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Hypack Navigation Software

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☐ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐Yes ☒No
Comments: MBE pole mounted video collected today

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☐Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☒Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

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☐ Start the MMI software and start tracking
☐ Start the "MMI to GGA" python script

GPS overlay

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Hypack Navigation Software

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☐ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐Yes ☒No
Comments: MBE pole mounted video collected today

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☐Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☒Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

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☐ Start the MMI software and start tracking
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GPS overlay

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☐ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☐ Configure and display the towfish location using both the USBL and layback for verification.
☐ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐Yes ☒No
Comments: MBE pole mounted video collected today

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☐Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☒ Alejandro Beale	☒Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

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☐ Start the MMI software and start tracking
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GPS overlay

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Hypack Navigation Software

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☐ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐Yes ☒No
Comments: MBE pole mounted video collected today

Personnel on Board

☒Richard Funk	☒Lou Schwartz	☐Omi Rodrigues	☒Kayla Pacheco
☒Erin Campbell	☒ Alejandro Beale	☐Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

GAPS USBL Tracking (if video camera is towed)

☐ Power on the GAPS
☐ Start the MMI software and start tracking
☐ Start the "MMI to GGA" python script

GPS overlay

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☐ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☐ Configure and display the towfish location using both the USBL and layback for verification.
☐ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐Yes ☒No
Comments: MBE pole mounted video collected today

Personnel on Board

☒Richard Funk	☒Eric Taylor	☒Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☐Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

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☐ Start the MMI software and start tracking
☐ Start the "MMI to GGA" python script

GPS overlay

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☒ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☒Yes ☐No

Splash cam had vibrated loose within the underwater housing so image is no longer "forward up"

Comments: MBE pole mounted video collected in the morning today, then switched to Towed ROV WideEye and GoPro (0.5 Hz 12MP stills)

Personnel on Board

☒Richard Funk	☒Eric Taylor	☒Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☒Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

GAPS USBL Tracking (if video camera is towed)

☒ Power on the GAPS
☒ Start the MMI software and start tracking
☒ Start the "MMI to GGA" python script

GPS overlay

☒ Confirm position and time stamp overlay is being written (check time sync with computer)
☒ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐Yes ☒No

Comments: Towed ROV WideEye and GoPro (0.5 Hz 12MP stills)

Personnel on Board

☒Richard Funk	☒Eric Taylor	☒Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☒Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

GAPS USBL Tracking (if video camera is towed)

☒ Power on the GAPS
☒ Start the MMI software and start tracking
☒ Start the "MMI to GGA" python script

GPS overlay

☒ Confirm position and time stamp overlay is being written (check time sync with computer)
☒ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐Yes ☒No

Comments: Towed ROV WideEye and GoPro (0.5 Hz 12MP stills)

Personnel on Board

☒Richard Funk	☒Eric Taylor	☒Omi Rodrigues	☐Kayla Pacheco
☒Erin Campbell	☐ Alejandro Beale	☒Maylele Perez	☒Kelly Enriquez

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

GAPS USBL Tracking (if video camera is towed)

☒ Power on the GAPS
☒ Start the MMI software and start tracking
☒ Start the "MMI to GGA" python script

GPS overlay

☒ Confirm position and time stamp overlay is being written (check time sync with computer)
☒ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☒Yes ☐No

Winch gearbox slipping occasionally at higher speeds 5knots+
GoPro2 initialized pointed at the sun and all the photos were black under water. Seems to have gotten stuck at that exposure.

Comments: Towed ROV WideEye and GoPro (2 Hz 12MP stills)

Personnel on Board

☐ Richard Funk	☐ Eric Taylor	☐ Omi Rodrigues	☐ Kayla Pacheco
☐ Erin Campbell	☐ Alejandro Beale	☐ Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

GAPS USBL Tracking (if video camera is towed)

☐ Power on the GAPS
☐ Start the MMI software and start tracking
☐ Start the "MMI to GGA" python script

GPS overlay

☒ Confirm position and time stamp overlay is being written (check time sync with computer)
☒ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐ Yes ☒ No

TETRA TECH

Personnel on Board

☐ Richard Funk	☒ Eric Taylor	☐ Omi Rodrigues	☐ Kayla Pacheco
☐ Erin Campbell	☐ Alejandro Beale	☐ Maylele Perez	☐

Underwater Camera

Start-up

☒ Power on the camera
☒ Start the video acquisition software
☒ Set the data file path and name
☒ Examine video for acceptable image quality
☒ Start Recording (run short test at dock, play back file to confirm system is working properly)

GAPS USBL Tracking (if video camera is towed)

☒ Power on the GAPS
☒ Start the MMI software and start tracking
☒ Start the "MMI to GGA" python script

GPS overlay

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☒ If the camera is towed, confirm the overlay position is that of the camera.

Hypack Navigation Software

☒ Configure and display the towfish location using both the USBL and layback for verification.
☒ Use the coverage driver to monitor video coverage during acquisition.

Quality Control

☒ Collect and review a minimum of one minute of data to ensure the equipment is functioning properly and providing adequate imagery.

Problems experienced? ☐ Yes ☒ No

Comments: Towed ROV WideEye and GoPro (0.5 Hz 12MP stills)

APPENDIX I

THREATENDED AND ENDANGERED SPECIES SIGHTING REPORT FOR BATHYMETRIC SURVEY OPERATIONS, DECEMBER 2012 TO JANUARY 2013

ENDANGERED SPECIES SIGHTING REPORT FOR BATHYMETRIC SURVEY OPERATIONS DECEMBER 2012 TO JANUARY 2013

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

August 2013

Prepared under:

Contract Task Order 0003
Contract No. W912DY-10-D-0015

Prepared for:

U.S. Army Corps of Engineers
Engineering and Support Center, Huntsville
4820 University Square
Huntsville, AL 35816-1822

Prepared by:

TETRA TECH EC, INC.
1050 NE Hostmark Street, Suite 202
Poulsbo, Washington 98370

INTRODUCTION

Standard operating procedures (SOPs) for endangered species conservation and their habitat at Culebra[1] were developed by the U.S. Army Corps of Engineers (USACE) and followed during the bathymetric surveys performed in Culebra as part of the Environmental Baseline Survey (EBS). These SOPs were developed to identify listed and candidate endangered or threatened species and their critical habitat pursuant to the Endangered Species Act. The SOPs also included procedures to follow to avoid or minimize impacts to these species and their critical habitat during the Defense Environmental Restoration Program Formerly Used Defense Site (DERP-FUDS) underwater investigations on Culebra Island and adjacent cays.

METHODOLOGY

Prior to initiating work, all personnel received 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 USACE SOPs. Once the activities started, one (1) observer surveyed a 50-foot perimeter, or safety zone, around the survey vessel every day of field work. Shifts usually lasted around 12 hours per day. The observer was stationed on the roof of the vessel. This setting provided a 360° visibility survey area. Data were recorded daily and written in a logbook and then included in a special data field sheet. The location of any threatened and endangered species within the work area was plotted on a nautical map. The observer recorded weather, visibility, and sea conditions, as well as information related to the sightings, e.g., behavior, number of individuals, time of observation. Copies of the data sheets are included in Attachment 1.

Once an observer made the initial contact with the threatened and endangered species, he/she communicated with the vessel crew. When a threatened and endangered species was confirmed to be within the 50-foot safety zone, immediate orders were given to stop the operation. Operation reinitiated after a 20-minute wait period once all threatened and endangered species had left the safety zone.

GENERAL RESULTS

During the months of December 2012 and January 2013, observations/survey were performed a total of 16 days. The observers reported a total of 43 sightings (events) distributed through two sites. Sea turtles were spotted within the 50-foot safety zone 28 times. During this period,

[1] USACE (U.S. Army Corps of Engineers). 2012. Final Standard Operating Procedures for Endangered Species Conservation and their Critical Habitat during Underwater Investigations. DERP-FUDS Property No. I02PR0068 Culebra, Puerto Rico. April 2012.

observers detected one individual in 41 events and two individuals in 2 events. During the days of surveying, sea turtle activity at Culebra did show a pattern suggesting a preference for both morning and afternoon hour activities. Table 1 provides a summary of all events.

Table 1. Summary of Endangered Species Sightings at Culebra during Bathymetric Survey Operations between December 8, 2012, and January 2013

Date	Time	No. of Individuals	Inside 50 feet radius	Behavior	Observer
12/08/2012	1510-1525	1	No	A single hawksbill sea turtle appeared 200 feet from survey vessel near Tamarindo Beach. Coordinates and behavior were documented. It resurfaced at 1512. Vessel slowed down as the individual was seen swimming away in the opposite direction. As the individual was out of sight we continued surveying.	Edwin Omar Rodríguez
12/08/2012	1550-1605	1	Yes	A single hawksbill sea turtle appeared 45 feet from survey vessel near Punta Melones as vessel was been tied to a mooring buoy for equipment maintenance. Coordinates and behavior were documented. All equipment was shut down as the individual floated for 10 seconds besides vessel and went underwater. We waited 15 minutes; as soon as the individual was out of sight we continued surveying.	Edwin Omar Rodríguez
12/09/2012	1450-1510	1	Yes	A single hawksbill sea turtle appeared 20 feet from survey vessel. Vessel was shut down as the individual was seen swimming away in the opposite direction. We waited 15 minutes as the individual took a breath, went underwater, and was not seen again and then surveying continued.	Edwin Omar Rodríguez
12/09/2012	1525 - 1545	1	Yes	A single hawksbill sea turtle appeared 25 feet from survey vessel. Vessel was shut down as the individual was seen swimming away (traveling) in the opposite direction. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again and then surveying continued.	Edwin Omar Rodríguez
12/09/2012	1613	1	Yes	A single hawksbill sea turtle appeared 40 feet from survey vessel. Vessel was shut down as the individual was seen swimming away (traveling) in the opposite direction and went underwater. Individual surfaced again at 1617 at 100 feet from vessel and went underwater again. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Edwin Omar Rodríguez
12/10/2012	No survey	No survey	No survey	No survey	NA

Table 1. Summary of Endangered Species Sightings at Culebra during Bathymetric Survey Operations between December 8, 2012, and January 2013 (continued)

Date	Time	No. of Individuals	Inside 50 feet radius	Behavior	Observer
12/11/2012	1422-1442	1	Yes	A single green sea turtle appeared 25 feet from survey vessel. Vessel was shut down as the individual was seen swimming away (traveling) by the portside (left) in the opposite direction and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Keyla Pacheco
12/11/2012	1443-1503	1	Yes	A single green sea turtle appeared 50 feet from survey vessel. Vessel was shut down as the individual was seen swimming away (traveling) by the starboard (right) in the opposite direction and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Keyla Pacheco
12/12/2013	No survey	No survey	No survey	No survey	No survey
12/13/2012	0912	1	N/A	*Spotted eagle ray was observed jumping out of the water	Maylene Pérez
12/13/2012	1150	1	Yes	A single hawksbill sea turtle (about 2 feet long) appeared 25 feet from survey vessel. Vessel was shut down as the individual was seen swimming away went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Maylene Pérez
12/14/2012	1005	1	Yes	A single hawksbill sea turtle (about 2 feet long) appeared 25 feet from survey vessel. Vessel was shut down as the individual was seen swimming away (traveling) by the Bow of the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Maylene Pérez
12/14/2012	1133	2	No	*2 bottlenose dolphins, approximately 100 feet from portside of the vessel.	Maylene Pérez
12/14/2012	1255	1	Yes	A single hawksbill sea turtle appeared 50 feet from survey vessel. Vessel was shut down as the individual was seen swimming away (traveling) by starboard side (right) of the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Maylene Pérez

Table 1. Summary of Endangered Species Sightings at Culebra during Bathymetric Survey Operations between December 8, 2012, and January 2013 (continued)

Date	Time	No. of Individuals	Inside 50 feet radius	Behavior	Observer
12/14/2012	1230	1	Yes	A single hawksbill sea turtle appeared 25 feet from survey vessel. Vessel was shut down as the individual was seen swimming away (traveling) starboard side (right) of the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Maylene Pérez
12/15/2012	1005	1	No	A single hawksbill sea turtle appeared 50-75 feet from survey vessel (bow). Coordinates and behavior were documented. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out of sight we continued surveying.	Maylene Pérez
12/15/2012	1210	1	Yes	A single hawksbill sea turtle appeared 50 feet from survey vessel (bow). Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) starboard side (right) of the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Maylene Pérez
12/16/2012	0945	1	Yes	A single hawksbill sea turtle appeared 25 feet from portside of survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) starboard side (right) of the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Maylene Pérez
12/16/2012	1000	1	Yes	A single hawksbill sea turtle appeared 20 feet from survey vessel (bow) between two sailboats. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) starboard side (right) of the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Maylene Pérez
12/16/2012	1245	1	Yes	A single hawksbill sea turtle appeared 25 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) starboard side (right) of the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Keyla Pacheco

Table 1. Summary of Endangered Species Sightings at Culebra during Bathymetric Survey Operations between December 8, 2012, and January 2013 (continued)

Date	Time	No. of Individuals	Inside 50 feet radius	Behavior	Observer
12/17/2012	1320	1	Yes	A single hawksbill sea turtle appeared 50 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling). We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Keyla Pacheco
12/17/2012	1605	1	No	A single hawksbill sea turtle appeared 100 feet from survey vessel (portside). Coordinates and behavior were documented. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out of sight we continued surveying.	Keyla Pacheco
12/17/2012	1608	2	No	Two hawksbill sea turtle appeared 75 feet from survey vessel (portside). Coordinates and behavior were documented. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individuals were out of sight we continued surveying.	Keyla Pacheco
12/17/2012	1615	1	No	A single hawksbill sea turtle appeared 75 feet from survey vessel (portside). Coordinates and behavior were documented. Vessel slowed down as the individual was seen swimming away in the opposite direction. As the individual was out of sight we continued surveying.	Keyla Pacheco
12/17/2012	1618	1	No	A single hawksbill sea turtle appeared 75 feet from survey vessel (portside). Coordinates and behavior were documented. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out if sight we continued surveying.	Keyla Pacheco
12/17/2012	1625	1	No	A single hawksbill sea turtle appeared 75 feet from survey vessel (portside). Coordinates and behavior were documented. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out of sight we continued surveying.	Keyla Pacheco
12/18/2012	No sightings	No sightings	No sightings	No sightings	Keyla Pacheco

Table 1. Summary of Endangered Species Sightings at Culebra during Bathymetric Survey Operations between December 8, 2012, and January 2013 (continued)

Date	Time	No. of Individuals	Inside 50 feet radius	Behavior	Observer
12/19/2012	1350	1	Yes	A single hawksbill sea turtle appeared 25 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) starboard side (right) of the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Edwin Omar Rodríguez
12/19/2012	1406	1	Yes	A single hawksbill sea turtle appeared 40 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) from the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Edwin Omar Rodríguez
12/19/2012	1447	1	Yes	A single green sea turtle appeared 30 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) from the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Edwin Omar Rodríguez
12/19/2012	1506	2	Yes	Two hawksbill sea turtle appeared 30 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individuals were seen swimming away (traveling) from the boat and went underwater. We waited 20 minutes as the individual took a breath, went underwater, and surfaced again out of 50 feet radius. Individuals went underwater again and were not seen again.	Edwin Omar Rodríguez
12/19/2012	1607	1	Yes	A single hawksbill sea turtle appeared 10 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) from the boat and went underwater. Individual left 50 feet radius in about 1 minute after being spotted. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Edwin Omar Rodríguez
1/04/2013	1130	1	No	*Spotted eagle ray jumping out of water	Edwin Omar Rodríguez

Table 1. Summary of Endangered Species Sightings at Culebra during Bathymetric Survey Operations between December 8, 2012, and January 2013 (continued)

Date	Time	No. of Individuals	Inside 50 feet radius	Behavior	Observer
1/04/2013	1155	1	Yes	A single hawksbill sea turtle appeared 10 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) from the boat and went underwater. Individual left 50 feet radius in about 1 minute after being spotted. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Edwin Omar Rodríguez
1/04/2013	1415	1	Yes	A single hawksbill sea turtle (about 3 feet long) appeared 30 feet from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away (traveling) from the boat and went underwater. Individual left 50 feet radius in about 1 minute after being spotted. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Edwin Omar Rodríguez
1/05/2013	0810	1	No	A single green sea turtle appeared 100 feet from survey vessel. Coordinates and behavior were documented. Individual was seen taking a breath and swimming away (traveling) from the boat. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out of sight we continued surveying.	Edwin Omar Rodríguez
1/05/2013	0905	1	No	*Nurse shark swimming. Tamarindo Beach	Edwin Omar Rodríguez
1/05/2013	1202	1	No	A single hawksbill sea turtle appeared 100 feet from survey vessel. Coordinates and behavior were documented. Individual was seen taking a breath and swimming away (traveling) from the boat. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out of sight we continued surveying.	Edwin Omar Rodríguez
1/05/2013	1433	1	No	A single hawksbill sea turtle appeared 150 feet from survey vessel. Coordinates and behavior were documented. Individual was seen taking a breath and swimming away (traveling) from the boat. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out of sight we continued surveying.	Edwin Omar Rodríguez
1/05/2013	1505	1	No	*spotted eagle ray jumping out of the water	Edwin Omar Rodríguez

Table 1. Summary of Endangered Species Sightings at Culebra during Bathymetric Survey Operations between December 8, 2012, and January 2013 (continued)

Date	Time	No. of Individuals	Inside 50 feet radius	Behavior	Observer
1/06/2013	No survey	No survey	No survey	No survey	
1/07/2013	1200	1	Yes	A single hawksbill sea turtle appeared 25 feet from survey vessel. Coordinates and behavior were documented Vessel was shut down as the individual was seen swimming away (traveling) starboard side (right) of the boat and went underwater. Individual left 50 feet radius in about 1 minute after being spotted. We waited 20 minutes as the individual took a breath, went underwater, and was not seen again.	Maylene Pérez
1/07/2013	1500	1	No	A single hawksbill sea turtle appeared more than 50 feet from survey vessel. Coordinates and behavior were documented. Individual was seen taking a breath and swimming away (traveling) from the boat. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out of sight we continued surveying.	Maylene Pérez
1/07/2013	1630	1	No	A single hawksbill sea turtle appeared more than 50 feet from survey vessel. Coordinates and behavior were documented. Individual was seen taking a breath and swimming away (traveling) from the boat. Vessel slowed down as the individual was seen swimming away in the opposite direction. As the individual was out of sight we continued surveying.	Maylene Pérez
1/08/2013	No survey	No survey	No survey	No survey	No survey
1/09/2013	1200	1	Yes	A single hawksbill sea turtle appeared 25 feet from survey vessel. Coordinates and behavior were documented Vessel was shut down as the individual was seen swimming away (traveling) starboard side (right) of the boat and went underwater. Individual left 50 feet radius in about 1 minute after being spotted.	Maylene Pérez
1/09/2013	1205	1	No	A single hawksbill sea turtle appeared more than 50 feet from survey vessel. Coordinates and behavior were documented. Individual was seen taking a breath and swimming away (traveling) from the boat. Vessel slowed down as the individual was seen swimming away in the opposite direction. As soon as the individual was out of sight we continued surveying.	Maylene Pérez

Table 1. Summary of Endangered Species Sightings at Culebra during Bathymetric Survey Operations between December 8, 2012, and January 2013 (continued)

Date	Time	No. of Individuals	Inside 50 feet radius	Behavior	Observer
1/09/2013	1220-1303	1(15 sightings)	Yes	A single hawksbill sea turtle measuring approximately 1.5 feet appeared at: · 1220 at 25' to the left side of the boat near the mooring buoy. · 1225 at 25' to the left side of the boat near the mooring buoy. · 1240 at 50' to the left side of the boat in deeper water. · 1245 at 25' to the right side of the boat. · 1250 floating at 20' to the left side of the boat. · 1255 at 35' to the left side of the boat. · 1300 at 20' to the left side of the boat. · 1303 at 25' to the left side of the boat. · 1305 at 35' to the left side of the boat. · 1310 at 25' to the left side of the boat. · 1320 at 20' to the left side of the boat. · 1325 at 50' to the right side of the boat. · 1345 at 25' to the left side of the boat. · 1355 at 50' to the right side of the boat. · 1400 at 75' to the left side of the boat. As soon as the individual was out of sight we continued surveying.	Maylene Pérez
1/10/2013	No sightings	No sightings	No sightings	No sightings	Maylene Pérez
1/11/2013	No survey	No survey	No survey	No survey	No survey
1/12/2013	1015	1	Yes	A single leatherback sea turtle appeared inside 50 feet radius from survey vessel. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away. As soon as the individual was out of sight we continued surveying.	Fernando Pagés
1/12/2013	1226	1	Yes	A single hawksbill sea turtle appeared inside 50 feet radius from survey vessel close to reef. Coordinates and behavior were documented. Vessel was shut down as the individual was seen swimming away. As soon as the individual was out of sight we continued surveying.	Fernando Pagés

Note:

* Spotted eagle rays, nurse sharks, and bottlenose dolphins are not species specifically addressed in the SOP.

ATTACHMENT 1 – STANDARD OPERATING PROCEDURE FIELD DATA SHEETS

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/8/2012

Observer: Edwin Omar Rodriguez

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell, Alejandro Beale

Time:

Started 1030

Finished 1733

Place:

Roof	X
Other	

Weather Conditions:

Clear Blue sky	
Partly Cloudy	
Cloudy	X
Rain	
Hazy	

Sea Conditions: Surf 2-3' ft

Visibility:

Good (10ft +)	X
Fair (5-10ft)	
Low (1-5ft)	
None (Surface - 1ft)	

Color:

Blue	
Green	X
Gray	
Brown	

Glare:

Yes	
No	X

Turbidity:

High	
Low	X

Conditions on Land:

Clear Blue sky	
Partialy Cloudy	
Cloudy	X
Rain	
Hazy	

Visibility:

Good	X
Fair	
Low	
None	

Wind: 10-15 knots

Sighting

Sea turtle:

Yes	X
No	

Inside Perimeter:

Yes	1
No	1

Number of Total Sightings: 2

Other Notable species:

Remarks:

2 sightings were of hawksbill sea turtle species

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/9/2012

Observer: Edwin Omar Rodriguez

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell, Roland Below (USACE)

Time:

Started 1039

Finished 1730

Place:

Roof [X]

Other [ ]

Weather Conditions:

Clear Blue sky [X]
Partly Cloudy [ ]
Cloudy [ ]
Rain [ ]
Hazy [ ]

Sea Conditions: Surf 1' ft

Visibility:		Color:		Glare:		Turbidity:	
Good (10ft +)	X	Blue	X	Yes	X	High	
Fair (5-10ft)		Green		No		Low	X
Low (1-5ft)		Gray					
None (Surface - 1ft)		Brown					

Conditions on Land:		Visibility:		Wind: 10-15 knots
Clear Blue sky	X	Good	X	
Partialy Cloudy		Fair		
Cloudy		Low		
Rain		None		
Hazy				

Sighting

Sea turtle:		Inside Perimeter:		Number of Total Sightings: 3
Yes	X	Yes	3	
No		No		

Other Notable species:

Remarks:

3 sightings were of hawksbill sea turtle species

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TE

Date: 12/11/2012

Observer: Keyla Pacheco

Site Los Peñis Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell

Time:

Started 830

Finished 1730

Place:

Reef [X]

Other [ ]

[ ]

Weather Conditions:

Clear Blue sky [X]

Partly Cloudy [ ]

Cloudy [ ]

Rain [X]

Hazy [ ]

Sea Conditions: **Surf** 1' ft

Visibility:

Good (10ft +) [X]

Fair (5-10ft) [ ]

Low (1-5ft) [ ]

None (Surface 1ft) [ ]

Color:

Blue [X]

Green [ ]

Gray [ ]

Brown [ ]

Glare:

Yes [X]

No [ ]

Turbidity:

High [ ]

Low [X]

Conditions on Land:

Clear Blue sky [X]

Partialy Cloudy [ ]

Cloudy [ ]

Rain [ ]

Hazy [ ]

Visibility:

Good [X]

Fair [ ]

Low [ ]

None [ ]

Wind: 10-15 knots

Sighting

Sea turtle:

Yes [X]

No [ ]

Inside Perimeter:

Yes [2]

No [ ]

Number of Total Sightings: 2

Other Notable species

Remarks:

2 sightings were of green sea turtle species

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/13/2012

Observer: Maylene Perez

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell

Time:

Started 745

Finished 1730

Place:

Reef [X]

Other [ ]

[ ]

Weather Conditions:

Clear Blue sky [ ]

Partly Cloudy [ ]

Cloudy [X]

Rain [X]

Hazy [ ]

Sea Conditions: **Surf** 1' ft

Visibility:		**Color:**		**Glare:**		**Turbidity:**	
Good (10ft +)	[ ]	Blue	[ ]	Yes	[X]	High	[X]
Fair (5-10ft)	[X]	Green	[X]	No	[X]	Low	[ ]
Low (1-5ft)	[ ]	Gray	[X]				
None (Surface - 1ft)	[ ]	Brown	[ ]				

Conditions on Land:		**Visibility:**	
Clear Blue sky	[X]	Good	[X]
Partialy Cloudy	[ ]	Fair	[ ]
Cloudy	[ ]	Low	[ ]
Rain	[ ]	None	[ ]
Hazy	[ ]		

Wind: 10-15 knots

Sighting

Sea turtle:		**Inside Perimeter:**		**Number of Total Sightings:**	2
Yes	[X]	Yes	[2]		
No	[ ]	No	[ ]		

Other Notable species

Remarks:

2 sightings were of green sea turtle species. Spotted eagle ray jumping

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/14/2012

Observer: Maylene Perez

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell

Time:

Started 745

Finished 1730

Place:

Roof [X]

Other [ ]

[ ]

Weather Conditions:

Clear Blue sky [X]

Partly Cloudy [ ]

Cloudy [ ]

Rain [ ]

Hazy [ ]

Sea Conditions: Surf 1' ft

Visibility:		Color:		Glare:		Turbidity:	
Good (10ft +)	X	Blue	X	Yes	X	High	
Fair (5-10ft)		Green		No		Low	X
Low (1-5ft)		Gray					
None (Surface - 1ft)		Brown					

Conditions on Land:		Visibility:		Wind: 10-15 knots
Clear Blue sky	X	Good	X	
Partialy Cloudy		Fair		
Cloudy		Low		
Rain		None		
Hazy				

Sighting

Sea turtle:		Inside Perimeter:		Number of Total Sightings: 4
Yes	X	Yes	3	
No	X	No	1	

Other Notable species:

Remarks:

4 sightings were of hawksbill sea turtle species.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/15/2012

Observer: Maylene Perez

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell

Time:

Started 808

Finished 1805

Place:

Roof [X]

Other [ ]

[ ]

Weather Conditions:

Clear Blue sky [X]

Partly Cloudy [ ]

Cloudy [ ]

Rain [ ]

Hazy [ ]

Sea Conditions: Surf 1' ft

Visibility:		**Color:**		**Glare:**		**Turbidity:**	
Good (10ft +)	X	Blue	X	Yes	X	High	
Fair (5-10ft)		Green		No		Low	X
Low (1-5ft)		Gray					
None (Surface - 1ft)		Brown					

Conditions on Land:		**Visibility:**	
Clear Blue sky	X	Good	X
Partialy Cloudy		Fair	
Cloudy		Low	
Rain		None	
Hazy			

Wind: 10-15 knots

Sighting

Sea turtle:		**Inside Perimeter:**		**Number of Total Sightings:**	2
Yes	X	Yes	1		
No	X	No	1		

Other Notable species:

Remarks:

2 sightings were of hawksbill sea turtle species.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/16/2012

Observer: Maylene Perez/Keyla Pacheco

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell, Alejandro Beale

Time:		**Place:**		**Weather Conditions:**	
Started	700	Rod	X	Clear Blue sky	X
		Other		Partly Cloudy	
				Cloudy	
Finished	1800			Rain	
				Hazy	

Sea Conditions: **Surf** 1' ft

Visibility:		**Color:**		**Glare:**		**Turbidity:**	
Good (10ft +)	X	Blue	X	Yes	X	High	
Fair (5-10ft)		Green		No		Low	X
Low (1-5ft)		Gray					
None (Surface - 1ft)		Brown					

Conditions on Land:		**Visibility:**		**Wind:** 10 knots
Clear Blue sky	X	Good	X	
Partialy Cloudy		Fair		
Cloudy		Low		
Rain		None		
Hazy				

Sighting

Sea turtle:		**Inside Perimeter:**		**Number of Total Sightings:**	3
Yes	X	Yes	3		
No		No			

Other Notable species

Remarks:

3 sightings were of hawksbill sea turtle species.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/17/2012

Observer: Edwin Omar Rodriguez

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell, Alejandro Beale/Roland Belew (USACE)

Time:		**Place:**		**Weather Conditions:**	
Started	808	Rod	X	Clear Blue sky	X
		Other		Partly Cloudy	
				Cloudy	
Finished	1715			Rain	
				Hazy	

Sea Conditions: Surf 2-3' ft

Visibility:		**Color:**		**Glare:**		**Turbidity:**	
Good (10ft +)	X	Blue	X	Yes	X	High	
Fair (5-10ft)		Green		No		Low	X
Low (1-5ft)		Gray					
None (Surface - 1ft)		Brown					

Conditions on Land:		**Visibility:**		**Wind:** 10 knots
Clear Blue sky	X	Good	X	
Partialy Cloudy		Fair		
Cloudy		Low		
Rain		None		
Hazy				

Sighting

Sea turtle:		**Inside Perimeter:**		**Number of Total Sightings:**	6
Yes	X	Yes	1		
No	X	No	5		

Other Notable species

Remarks:

6 sightings were of hawksbill sea turtle species.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/18/2012

Observer: Keyla Pacheco

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell, Alejandro Beale/Roland Belew (USACE)

Time:		**Place:**		**Weather Conditions:**	
Started	800	Rod	X	Clear Blue sky	X
		Other		Partly Cloudy	
				Cloudy	
Finished	1739			Rain	
				Hazy	

Sea Conditions: Surf 2-3' ft

Visibility:		**Color:**		**Glare:**		**Turbidity:**	
Good (10ft +)	X	Blue	X	Yes	X	High	
Fair (5-10ft)		Green		No		Low	X
Low (1-5ft)		Gray					
None (Surface - 1ft)		Brown					

Conditions on Land:		**Visibility:**		**Wind:** 10 knots
Clear Blue sky	X	Good	X	
Partialy Cloudy		Fair		
Cloudy		Low		
Rain		None		
Hazy				

Sighting

Sea turtle:		**Inside Perimeter:**		**Number of Total Sightings:**
Yes		Yes		
No	X	No		

Other Notable species

Remarks:

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 12/19/2012

Observer: Edwin Omar Rodriguez

Site Luis Peña Channel

Crew Richard Funk, Lou Schwartz (Capt), Erin Campbell, Alejandro Beale/Roland Belew (USACE)

Time:

Started 808

Finished 1715

Place:

Roof	X
Other	

Weather Conditions:

Clear Blue sky	
Partly Cloudy	
Cloudy	X
Rain	
Hazy	

Sea Conditions: Surf 1' ft

Visibility:

Good (10ft +)	X
Fair (5-10ft)	
Low (1-5ft)	
None (Surface - 1ft)	

Color:

Blue	
Green	X
Gray	X
Brown	

Glare:

Yes	X
No	

Turbidity:

High	
Low	X

Conditions on Land:

Clear Blue sky	
Partialy Cloudy	
Cloudy	X
Rain	
Hazy	

Visibility:

Good	
Fair	X
Low	
None	

Wind: 3 knots

Sighting

Sea turtle:

Yes	X
No	

Inside Perimeter:

Yes	5
No	

Number of Total Sightings: 5

Other Notable species:

Remarks:

5 sightings were of hawksbill sea turtle species.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 1/4/2013

Observer: Edwin Omar Rodriguez

Site Luis Peña Channel

Crew Richard Funk, Erik Taylor (Capt), Erin Campbell

Time:

Started 844

Finished 1630

Place:

Roof [X]
Other [ ]
[ ]

Weather Conditions:

Clear Blue sky [ ]
Partly Cloudy [ ]
Cloudy [X]
Rain [ ]
Hazy [ ]

Sea Conditions: Surf 1' ft

Visibility:		Color:		Glare:		Turbidity:	
Good (10ft +)	X	Blue		Yes	X	High	
Fair (5-10ft)		Green	X	No		Low	X
Low (1-5ft)		Gray	X				
None (Surface - 1ft)		Brown					

Conditions on Land:		Visibility:		Wind: 3 knots
Clear Blue sky		Good		
Partialy Cloudy		Fair	X	
Cloudy	X	Low		
Rain		None		
Hazy				

Sighting

Sea turtle:		Inside Perimeter:		Number of Total Sightings:	3
Yes	X	Yes	2		
No	X	No	1		

Other Notable species: Spotted eagle ray jumping out of water

Remarks:

3 sightings were of hawksbill sea turtle species.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 1/5/2013

Observer: Edwin Omar Rodriguez

Site Luis Peña Channel

Crew Richard Funk, Erik Taylor (Capt), Erin Campbell

Time:

Started 810

Finished 1800

Place:

Roof	X
Other	

Weather Conditions:

Clear Blue sky	X
Partly Cloudy	
Cloudy	
Rain	
Hazy	

Sea Conditions: Surf 3-4' ft

Visibility:

Good (10ft +)	X
Fair (5-10ft)	
Low (1-5ft)	
None (Surface - 1ft)	

Color:

Blue	X
Green	
Gray	
Brown	

Glare:

Yes	X
No	

Turbidity:

High	
Low	X

Conditions on Land:

Clear Blue sky	
Partialy Cloudy	
Cloudy	X
Rain	
Hazy	

Visibility:

Good	
Fair	X
Low	
None	

Wind: 10-15 knots

Sighting

Sea turtle:

Yes	
No	X

Inside Perimeter:

Yes	
No	3

Number of Total Sightings: 3

Other Notable species: Spotted eagle ray jumping out of water. Nurse shark swimming. Tamarindo Beach

Remarks:

3 sightings were of hawksbill sea turtle species.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 1//2013

Observer: Maylene Pérez

Site Luis Peña Channel

Crew Richard Funk, Erik Taylor (Capt), Erin Campbell

Time:

Started 730

Finished 1800

Place:

Roof	X
Other	

Weather Conditions:

Clear Blue sky	X
Partly Cloudy	
Cloudy	
Rain	
Hazy	

Sea Conditions: Surf 3-4' ft

Visibility:

Good (10ft +)	X
Fair (5-10ft)	
Low (1-5ft)	
None (Surface - 1ft)	

Color:

Blue	X
Green	
Gray	
Brown	

Glare:

Yes	X
No	

Turbidity:

High	
Low	X

Conditions on Land:

Clear Blue sky	X
Partialy Cloudy	
Cloudy	
Rain	
Hazy	

Visibility:

Good	X
Fair	
Low	
None	

Wind: 10-15 knots

Sighting

Sea turtle:

Yes	X
No	X

Inside Perimeter:

Yes	1
No	2

Number of Total Sightings: 3

Other Notable species: Spotted eagle ray jumping out of water. Nurse shark swimming. Tamarindo Beach

Remarks:

3 sightings were of hawksbill sea turtle species.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 1/9/2013

Observer: Maylene Pérez

Site Luis Peña Channel

Crew Richard Funk, Erik Taylor (Capt), Erin Campbell, Kelly (USACE)

Time:

Started 800

Finished 1530

Place:

Roof [X]

Other [ ]

[ ]

Weather Conditions:

Clear Blue sky [X]

Partly Cloudy [ ]

Cloudy [ ]

Rain [ ]

Hazy [ ]

Sea Conditions: 1' ft

Visibility:		**Color:**		**Glare:**		**Turbidity:**	
Good (10ft +)	X	Blue	X	Yes	X	High	
Fair (5-10ft)		Green		No		Low	X
Low (1-5ft)		Gray					
None (Surface - 1ft)		Brown					

Conditions on Land:		**Visibility:**		**Wind:** 10-15 knots
Clear Blue sky	X	Good	X	
Partialy Cloudy		Fair		
Cloudy		Low		
Rain		None		
Hazy				

Sighting

Sea turtle:		**Inside Perimeter:**		**Number of Total Sightings:**	3
Yes	X	Yes	2		
No	X	No	1		

Other Notable species: Spotted eagle ray jumping out of water. Nurse shark swimming. Tamarindo Beach

Remarks:

3 sightings were of hawksbill sea turtle species. Las sighting was of individual roaming in the same area moving around the vessel.

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 1/10/2013

Observer: Maylene Pérez

Site Luis Peña Channel

Crew Cory Graves, Eric Taylor (Capt), Erin Campbell

Time:

Started 845

Finished 1530

Place:

Roof [X]

Other [ ]

[ ]

Weather Conditions:

Clear Blue sky [ ]

Partly Cloudy [ ]

Cloudy [X]

Rain [ ]

Hazy [ ]

Sea Conditions: Surf 2-3' ft

Visibility:		**Color:**		**Glare:**		**Turbidity:**	
Good (10ft +)	X	Blue	[ ]	Yes	[ ]	High	[ ]
Fair (5-10ft)	[ ]	Green	[ ]	No	X	Low	X
Low (1-5ft)	[ ]	Gray	X				
None (Surface - 1ft)	[ ]	Brown	[ ]				

Conditions on Land:		**Visibility:**		**Wind:** 10-15 knots
Clear Blue sky	[ ]	Good	[ ]	
Partialy Cloudy	[ ]	Fair	X	
Cloudy	X	Low	[ ]	
Rain	[ ]	None	[ ]	
Hazy	[ ]			

Sighting

Sea turtle:		**Inside Perimeter:**		**Number of Total Sightings:**
Yes	[ ]	Yes	[ ]	
No	X	No	[ ]	

Other Notable species:

Remarks:

SOP Endangered Specie /Critical Habitat Field Data Sheet

TETRA TECH

Date: 1/12/2013

Observer: Fernando Pagés

Site Flamenco Beach

Crew Richard Funk, Erik Taylor (Capt), Erin Campbell, Kelly (USACE)

Time:

Started 730

Finished 1315

Place:

Roof [X]

Other [ ]

[ ]

Weather Conditions:

Clear Blue sky [X]

Partly Cloudy [ ]

Cloudy [ ]

Rain [ ]

Hazy [ ]

Sea Conditions: 3' ft

Visibility:		**Color:**		**Glare:**		**Turbidity:**	
Good (10ft +)	X	Blue	X	Yes	X	High	
Fair (5-10ft)		Green		No		Low	X
Low (1-5ft)		Gray					
None (Surface - 1ft)		Brown					

Conditions on Land:		**Visibility:**		**Wind:** 10-15 knots. E-NE
Clear Blue sky	X	Good	X	
Partialy Cloudy		Fair		
Cloudy		Low		
Rain		None		
Hazy				

Sighting

Sea turtle:		**Inside Perimeter:**		**Number of Total Sightings:** 2
Yes	X	Yes	2	
No		No		

Other Notable species:

Remarks:

1 sightings was of hawksbill sea turtle species and the other of leatherback