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FINAL SITE INSPECTION REPORT MUNITIONS RESPONSE SITES AT DAM NECK ANNEX
AND NAVAL AUXILIARY LANDING FIELD FENTRESS NAS OCEANA VA

02/01/2011
CH2M HILL

Final
Site Inspection Report
Munitions Response Program
Munitions Response Sites at Dam Neck Annex and
Naval Auxiliary Landing Field Fentress
Naval Air Station Oceana
Virginia Beach, Virginia



Prepared for
Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic Division

Contract No.
N62470-08-D-1000
CTO-WE03

February 2011

Prepared by
CH2MHILL

Final

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Munitions Response Program
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Naval Auxiliary Landing Field Fentress**

**Naval Air Station Oceana
Virginia Beach, Virginia**

Contract Task Order WE03

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Under the

**NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000**

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CH2MHILL

Virginia Beach, Virginia

Declaration

Site Name and Location

Moving Target/Mortar Range - North
Naval Air Station (NAS) Oceana Dam Neck Annex
Virginia Beach, Virginia

Statement of Basis and Purpose

This Statement of Basis and Purpose and stakeholder signatures documents the conclusion that no further action (NFA) is necessary to ensure protection of human health and the environment at the Moving Target/Mortar Range - North at NAS Oceana - Dam Neck Annex in Virginia Beach, Virginia. This determination has been made in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the Site Inspection Report and information contained in the Administrative Record for the site. The Navy, in partnership with the Virginia Department of Environmental Quality, concurs with the NFA determination.

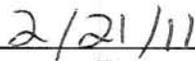
Rationale for No Further Action Determination

Based on the results of the Site Inspection, no potentially unacceptable human health or ecological risks and no CERCLA releases were identified at the Moving Target/Mortar Range - North. Because there are no hazardous substances, pollutants, or contaminants remaining onsite above levels that prevent unlimited use and unrestricted exposure, no further action is necessary for the site to protect human health and the environment.

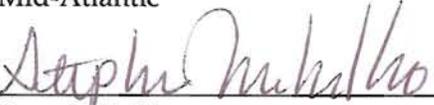
Authorizing Signatures



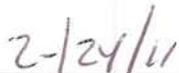
Mary Margaret Kutz
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Date



Steve Mihalko
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Date

Executive Summary

This report summarizes the results of the Site Inspection (SI) conducted at four munitions response (MR) sites associated with Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. The SI was conducted under the United States Navy (Navy) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The primary objective of this investigation was to assess whether or not there is evidence of a release of munitions and explosives of concern (MEC) associated with the historic use of these sites and to determine if additional investigations are needed. This SI Report was prepared under the Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, Comprehensive Long-term Environmental Action – Navy (CLEAN) 1000, Contract Task Order WE03 for submittal to the Virginia Department of Environment Quality (VDEQ), the lead regulatory agency.

The four sites addressed in this SI include the Moving Target/Mortar Range-North (MTMR-North), the Moving Target/Mortar Range-South (MTMR-South), and the Mortar Impact Area (MIA) located at Dam Neck Annex and the Dive Bombing Targets (DBTs) located at Naval Auxiliary Landing Field (NALF) Fentress. Evidence presented in the Preliminary Assessment (PA) (Malcolm Pirnie, 2008) indicated that there is potential for munitions to be present at each of these sites based on their historical use. According to the PA, these sites were identified on archival maps from the 1940s and 1950s, but the exact period of use is unknown. In addition, the PA also indicates that no records documenting the types of munitions used at these sites were found. Based on the range boundaries and period of use, probable munitions used at the MTMR-North and MTMR-South include .30 and .50 caliber small arms projectiles and practice 60 millimeter (mm) and 81mm mortars. Only practice mortars are believed to have been used based on the distance between the probable firing point and impact area. Probable munitions used at the MIA based on the period of use and the size of the range fan include practice and high explosive mortars. Probable munitions used at the DBTs include practice bombs, as well as MK 4 signal cartridges, spotting/witness charges, and bomb signal cartridges. To determine if surface or subsurface anomalies potentially representing MEC exist at these sites, CH2M HILL performed site reconnaissance and digital geophysical mapping (DGM) within the accessible areas of each site.

Based on the results of the site reconnaissance and DGM activities, the following actions are recommended for the sites.

- **MTMR-North:** NFA
- **MTMR-South:** Further investigation, including an intrusive investigation of a selected subset of the anomalies located during the SI excavated to determine if they are MEC. If determined to be MEC, the MEC will be removed as disposed of, then munitions constituents (MC) sampling and additional DGM survey/intrusive investigation activities may be necessary.

- **MIA:** Further investigation, including an intrusive investigation of a selected subset of the anomalies located during the SI will be excavated to determine if they are MEC. If determined to be MEC, then the MEC will be removed and properly disposed of, then MC sampling and additional DGM survey and intrusive investigation activities may be necessary.
- **DBTs:** Further investigation, including site clearing, additional DGM survey activities, and inspection and identification of a selected subset of the anomalies located during the SI will be excavated to determine if they are MEC. If determined to be MEC, the MEC will be removed and properly disposed of, then MC sampling may be necessary.

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Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action – Navy
DBT	dive bomb target
DGM	digital geophysical mapping
FACSFAC	Fleet Area Control and Surveillance Facility
GPS	global positioning system
IVS	Instrument Verification Strip
MC	munitions constituents
MD	munitions debris
MEC	munitions and explosives of concern
MIA	Mortar Impact Area
mm	millimeter
MR	munitions response
MRP	Munitions Response Program
MTMR	moving target/mortar range
NALF	Naval Auxiliary Landing Field
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NFA	no further action
PA	Preliminary Assessment
QC	quality control
SI	Site Inspection
SOP	standard operating procedure
TDEM	time-domain electromagnetic
UXO	unexploded ordnance
VACAPES	Virginia Capes
VDEQ	Virginia Department of Environmental Quality
VMRC	Virginia Marine Resources Commission

Introduction

This report summarizes the Site Inspection (SI) activities conducted at three Munitions Response (MR) sites located at Dam Neck Annex and one MR site located at Naval Auxiliary Landing Field (NALF) Fentress. Dam Neck Annex and NALF Fentress are under the command of Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. This report also includes relevant historical data from the Preliminary Assessment (PA), as applicable, for the purposes of complete data evaluation and making site-specific determinations. The investigation was conducted in accordance with the Draft Abbreviated Site Inspection Work Plans prepared for Dam Neck Annex (CH2M HILL, 2010a) and NALF Fentress (CH2M HILL, 2010b), herein referred to as the Work Plan. Site reconnaissance activities were completed at the Moving Target/Mortar Range-North (MTMR-North), Moving Target/Mortar Range-South (MTMR-South), and Mortar Impact Area (MIA) located at Dam Neck Annex and at the Dive Bombing Targets (DBTs) located at NALF Fentress in October 2009. Digital geophysical mapping (DGM) activities were completed at MTMR-South and MIA in March 2010 and at the DBTs in October 2010.

This SI Report was prepared under Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, Comprehensive Long-term Environmental Action – Navy (CLEAN) 1000, Contract Task Order WE03, for submittal to the Virginia Department of Environment Quality (VDEQ), the lead regulatory agency.

1.1 Problem Definition and Objectives of the Site Investigation

Four sites (MTMR-North, MTMR-South, MIA, and DBTs) have been identified as MR sites associated with NAS Oceana. These sites potentially contain MEC and munitions constituents (MC). All of these sites are located within the perimeter of the Dam Neck Annex or NALF Fentress. While a valid Government identification card is required to enter Dam Neck Annex and NALF Fentress, no site specific security measures are in place; therefore, U.S Navy personnel, civilian employees, visitors, contractors, and trespassers could potentially access these sites. Hazards associated with potential MEC (explosive hazard) or MC (environmental hazard) may be present as a result of the historic use of these sites.

The primary objective of this investigation was to determine the potential presence or suggested absence of MEC at the sites. To accomplish this objective, DGM surveys were performed using a time-domain electromagnetic (TDEM) metal detector to identify locations where MEC could be present at each MEC site. This investigation was performed to serve as an initial gathering of information that will be used to determine the path forward for closure of these sites.

1.2 Organization of the Site Inspection Report

This SI Report is organized as follows:

- **Section 1, Introduction:** Provides the objectives of the SI and overall format of the report.
- **Section 2, Site Background:** Provides a brief description and history of NAS Oceana, including Dam Neck Annex and NALF Fentress and provides site descriptions and history of each of the MR sites. This section also summarizes information from previous investigations at each MR site and provides information associated with hydrogeology, geology, and cultural resources.
- **Section 3, Site Inspection Activities:** Provides a detailed description of the SI and data collection activities.
- **Section 4, Site Inspection Results:** Summarizes the results of the SI activities performed at each site.
- **Section 5, Conclusions and Recommendations:** Summarizes the conclusions and recommendations made for each of the sites.
- **Section 6, References:** Lists the documents used in preparation of this SI Report.

Tables and figures are presented at the end of each section, as applicable. Appendixes are provided at the end of the report.

Site Background

2.1 NAS Oceana Description and History

NAS Oceana is approximately 5,331 acres in size and is located within the southeastern portion of the city of Virginia Beach, Virginia (**Figure 2-1**). The facility has been in existence since 1940 when it was established as a small auxiliary airfield. Since 1940, NAS Oceana has grown to more than 16 times its original size and is now a Master Jet Base supporting a community of more than 9,700 Navy personnel and 12,300 dependents. The primary mission of NAS Oceana is to provide personnel, operations, maintenance, and training facilities to ensure that fighter and attack squadrons on aircraft carriers of the U.S. Atlantic Fleet are ready for deployment.

Principal operations at NAS Oceana include training and deployment of the Navy's fighter/attack squadrons of F/A-18 Hornet and Super Hornet aircraft. NAS Oceana is the only East Coast Master Jet Base and is home to all East Coast strike-fighter squadrons (with the exception of VFA-86, Marine Corps Air Station Beaufort, South Carolina). Currently, pilots fly approximately 219,000 training sorties per year at NAS Oceana. In addition to the fighter squadrons, NAS Oceana is host to several other tenant commands, including the Strike Fighter Weapons and Tactics School, Atlantic; Navy Landing Signal Officer School; Naval Atlantic Meteorology and Oceanography Detachment; Fleet Area Control and Surveillance Facility (FACSFAC), Virginia Capes (VACAPES) Operating Area; Fleet Aviation Specialized Operational Training Group, Atlantic; and Marine Aviation Training Support Group 33 (Malcolm Pirnie, 2008).

2.1.1 Dam Neck Annex Description and History

NAS Oceana, Dam Neck Annex, is located along the Atlantic Ocean, within the southeastern portion of the city of Virginia Beach, Virginia (**Figure 2-1**). The mission of the approximately 1,400-acre installation is to provide force-level engineering solutions, mission-critical and associated testing, and training technologies for the maritime, joint, special warfare and information operations domains (Malcolm Pirnie, 2008).

Moving Target/Mortar Range-North Description and History

MTMR-North is located in the southeastern portion of Dam Neck Annex, east of the Regulus Avenue and Loon Court intersection (**Figure 2-2**). The range was used in the 1940s and 1950s. Portions of the historic range boundary for the MTMR-North are overlapped by the active Drone Launching Area and another MR site, the former Rifle Range.

Approximately 60 percent of the northern portion of the site is covered by parking lots and buildings, and the remainder of the site is undeveloped land. The southern portion of the site is partially within a Dune Management Area and is protected pursuant to the Coastal Primary Sand Dune Protection Act through a program administered by Virginia Marine Resources Commission (VMRC). The portion of the former range that overlaps the active Drone Launching area is not eligible for the MRP because this area is considered to be within the operational footprint of Dam Neck Annex. MRP eligibility does not cover areas

within the operational boundary of an installation. In order to be considered operational by an installation, the land must either be used as an active range or, if not currently used, still considered to be a range for potential future use. The Drone Launch area is an active range that is used for launching drones employed in aircraft maneuvers. Therefore, this acreage has been removed from the MTMR-North boundary. The acreage that is shared by the overlapping MRP sites is assigned to the MTMR-North. As a result, the resulting MRP-eligible portion of the historic MTMR-North is approximately 10 acres. Based on the range boundaries and period of use, probable munitions used at the MTMR-North include .30 and .50 caliber small arms projectiles and practice 60 mm and 81 mm mortars. Only practice mortars are believed to have been used based on the distance between the probable firing point and impact area.

Moving Target/Mortar Range-South Description and History

The MTMR-South is located in the southeastern portion of Dam Neck Annex east of the Regulus Ave and Bullpup Street intersection (**Figure 2-2**). The range was used in the 1940s and 1950s. Approximately 10 percent of the eastern portion of the site is developed and covered by parking lots and buildings. The remainder of the site is undeveloped and heavily wooded. Additionally, a portion of the site is within a Dune Management Area and is protected pursuant to the Coastal Primary Sand Dune Protection Act. This program is administered by the VMRC. The historic range boundary overlaps a small portion another MRP eligible site, the MIA. The acreage that is shared by the overlapping MRP sites is assigned to the MTMR-South. As such, the resulting MRP eligible portion of the historic MTMR-South is approximately 17 acres. Based on the range boundaries and period of use, probable munitions used at the MTMR-South include .30 and .50 caliber small arms projectiles and practice 60 mm and 81 mm mortars and only practice mortars are believed to have been used based on the distance between the probable firing point and impact area.

Mortar Impact Area Description and History

The MIA is a cone-shaped area located in the southernmost portion of the Dam Neck Annex (**Figure 2-2**). The range was used in the 1940s and 1950s. Based on orientation of the range fan as depicted on a historical map, it is assumed that mortars were fired from west to the east, towards the Atlantic Ocean (Malcolm Pirnie, 2008). Regulus Avenue crosses through the eastern portion of the fan. The eastern portion of the site is included in the Beaches/Dunes Natural Resource Management Unit and the western portion is within the Natural Areas Natural Resource Management Unit. Additionally, a portion of the area is within a Dune Management Area and is protected pursuant to the Coastal Primary Sand Dune Protection Act. This program is administered by the VMRC. Building 474 (a control tower) is also located on the eastern portion of site. The western portion of the site is an undeveloped wetland area. The historic range fan also partially overlaps another MRP Site, the MTMR-South. The overlapping acreage was assigned to the MIA. The resulting acreage for the MIA is 24 acres. Probable munitions used at the MIA based on the period of use and the size of the range fan includes practice and high explosive mortars.

2.1.2 NALF Fentress Description and History

NALF Fentress, under the command of NAS Oceana, is located in Chesapeake, Virginia, approximately 7 miles southwest of NAS Oceana (**Figure 2-1**). Established in 1940, the installation encompasses just over 2,500 acres and approximately 8,700 acres in restrictive

easements. The facility is used primarily by squadrons stationed at NAS Oceana or Naval Station Norfolk Chambers Field for field carrier landing practice operations (Malcolm Pirnie, 2008).

Dive Bombing Targets Description and History

Two adjacent DBTs were identified on an archival map dated 1955 (**Figure 2-3**). The first, northernmost target is located at the end of runway 1-19. The second, southernmost target was identified on the 1955 map as the “new” dive bombing target and is located approximately 500 feet southwest of the existing target. Each target is approximately 6.5 acres in size. The area where the former DBTs are located is currently forested and undeveloped with the exception of all terrain vehicle trails cross the southernmost portion of the site. The MRP eligible acreage for the DBTs is approximately 13 acres. Probable munitions used at the DBTs include practice bombs, as well as MK 4 signal cartridges, spotting/witness charges, and bomb signal cartridges.

2.2 Previous Investigations

A Preliminary Assessment (PA) was conducted by Malcolm Pirnie personnel in 2008. These four sites were inspected during the PA field activities to identify possible MEC and any sources of MC-related contamination at the sites. Fragments from three AN-MK 43 miniature practice bombs were found near the site of the southern bombing target in a recently bulldozed trail. The items are considered munitions debris with no remaining explosive hazard. The PA identified MC associated with small arms projectiles (lead, antimony, arsenic, copper, nickel, and zinc) and practice ordnance (nitrocellulose, nitroglycerin, white and black powder, white phosphorus, red phosphorus, and titanium tetrachloride) as the MC potentially present based on the historic use of the sites.

2.3 Hydrology

NAS Oceana, Dam Neck Annex and NALF Fentress lie within the boundaries of three drainage basins: the Chesapeake Bay watershed in the north, the Southern Watersheds Area in the south, and Owls Creek watershed in the east. The Southern Watersheds Area is a collective of the North Landing River, Northwest River and Back Bay watersheds. Surface waters drain into the Chesapeake Bay via Great Neck, Wolfsnare and London Bridge creeks; to the Southern Watersheds Area via West Neck Creek; and to Owls Creek watershed via Owls Creek and its tributaries (Geo-Marine, 2006).

Surface waters at NAS Oceana consist of several small ponds, wetlands, and an extensive network of artificial drainage channels and channeled stream courses. The stations ponds are not naturally occurring, but were formed as a result of borrow pit excavations (Geo-Marine, 2001).

Surface waters that occur on Dam Neck Annex include approximately 51 acres of Redwing Lake in the northern portion of the installation, Sadler Pond, in the central portion, and several small ponds such as Lotus Pond and Lilly Pond and areas of open water that are associated with the extensive marsh system. Lake Tecumseh, also known as Brinson Lake Inlet, forms the southern boundary of Dam Neck Annex. Redwing Lake and Lake Tecumseh are connected through an open drainage channel and are connected to Back Bay.

Surface waters on Dam Neck Annex are joined to off-base water bodies by a number of drainage canals. Surface water flows from Dam Neck Annex to the south into Black Gut, Back Bay, North Bay and Shipps Bay (Malcolm Pirnie, 2008).

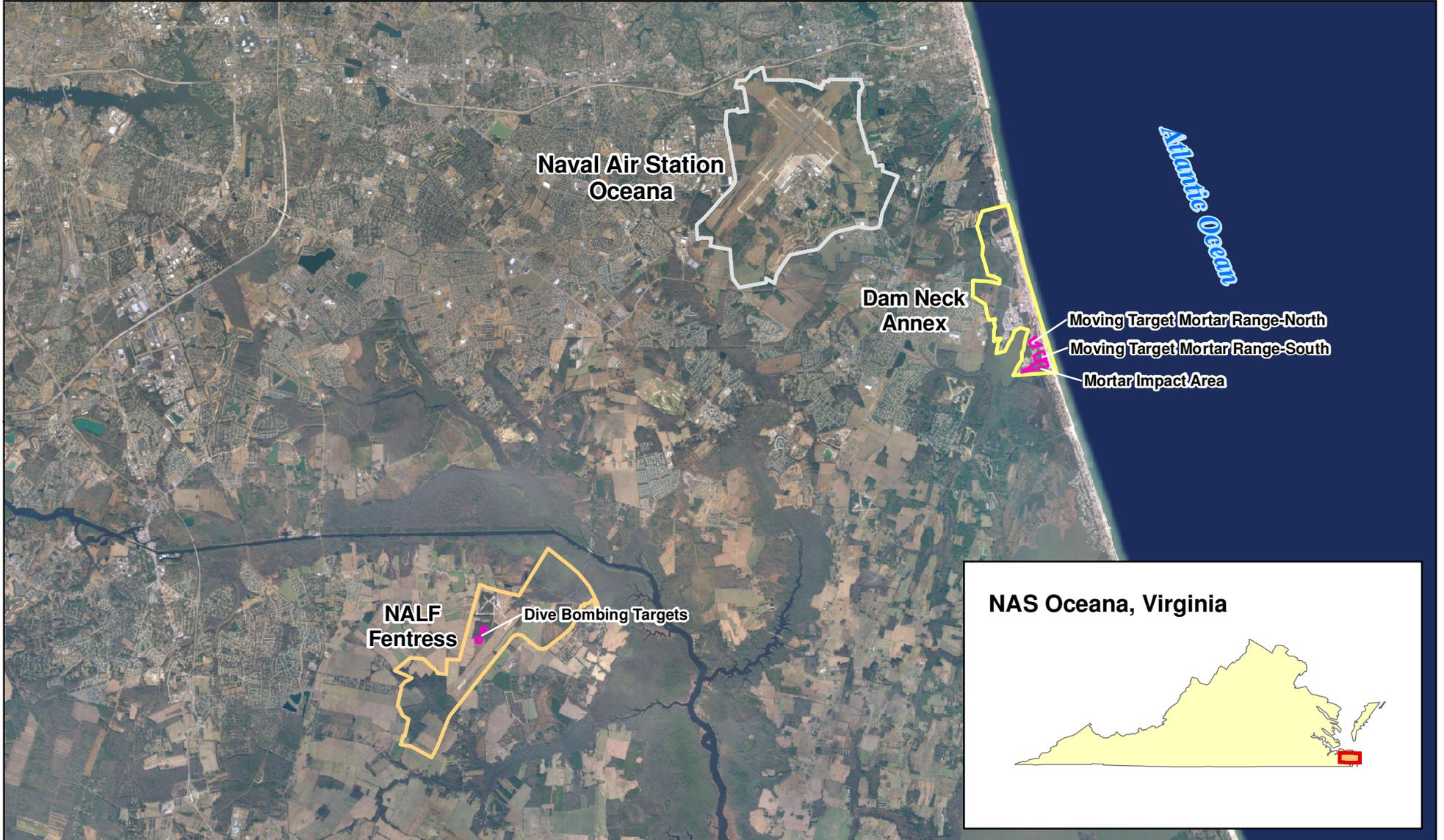
Surface waters at NALF Fentress include extensive wetlands, a network of artificial drainages and channeled streams including a major portion of Pacaty Creek (Malcolm Pirnie, 2008).

2.4 Geology

The MRP sites are located within the Atlantic Coastal Plain physiographic province, which is underlain with unconsolidated sediments generally of Quaternary ages. These surficial deposits include undivided sand, clay, gravel, and peat, which were deposited in marine, fluvial, aeolian, and lacustrine environments (Malcolm Pirnie, 2008).

2.5 Cultural Resources

There are no cultural resources located on the sites (Malcolm Pirnie, 2008); however, portions of each of the three sites located at Dam Neck Annex lie within the Beaches/ Dunes Natural Resource Management Unit, the Natural Areas Natural Resource Management Unit, and the Dune Management Area which is protected pursuant to the Coastal Primary Sand Dune Protection Act.



Legend

-  NAS Oceana Boundary
-  Dam Neck Annex Boundary
-  NALF Fentress Boundary
-  MRP Sites

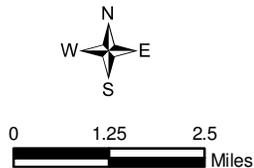


Figure 2-1
Site Inspection Report
Site Location Map
Naval Air Station Oceana and Outlying Fields
Virginia Beach, Virginia



Legend

-  Installation Boundary
-  MRP Site
-  Overlapping MRP Sites

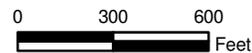


Figure 2-2
Site Inspection Report
Mortar Ranges
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia



Legend

-  MRP Sites
-  Target Areas
-  Target Center



Figure 2-3
Site Inspection Report
Dive Bombing Targets
NALF Fentress - Naval Air Station Oceana
Chesapeake, Virginia

Site Inspection Activities

This section summarizes the field investigation procedures of the SI at NAS Oceana MEC sites: MTMR-North, MTMR-South, MIA, and DBTs. The investigation activities and data presented below summarize the field activities conducted between October 2009 and October 2010. All DGM activities were performed in accordance with the Abbreviated Work Plans (CH2M HILL, 2010a;b) documenting the approach for the DGM activities performed at Dam Neck Annex and NALF Fentress. The investigation activities consisted of site reconnaissance activities at all four sites and a DGM survey of the MTMR-South, MIA, and the DBTs.

3.1 Site Reconnaissance Activities

The following site reconnaissance activities were performed at the sites in October 2009:

- A handheld global positioning system (GPS) was used to locate the site boundaries.
- The field team utilized GPS, field measurements, landmarks, and/or site features identified in the PA to locate the firing point and impact areas (mortar ranges) and the center of the targets (DBTs).
- A visual survey of the accessible areas at the firing point and impact area (mortar ranges) and target centers (DBTs) was performed in order to confirm the findings of the PA and determine if any evidence of MEC or munitions debris (MD) existed.
- An analog hand-held magnetometer (Schonstedt GA-52 Cx) was used to perform a limited geophysical sweep to detect ferrous metallic objects within the areas of interest at the mortar ranges and the DBTs to determine if there is any evidence of geophysical anomalies potentially representing MEC. The limited geophysical sweep began in the central portion of each area and a meandering path or transect approach was used to sweep accessible areas outside of the central portion of each site to attempt to confirm the locations provided in the PA.

3.2 DGM Activities

The following sections describe activities associated with the DGM survey performed at the MTMR-South, MIA, and DBTs. The DGM activities at the MTMR-South and MIA sites were limited to areas accessible to the DGM equipment and surveys within the DBTs were performed as transects in the cardinal directions across the targets. All DGM activities were completed with MEC avoidance support provided by a CH2M HILL Unexploded Ordnance (UXO) Technician. NAEVA Geophysics was subcontracted to perform the DGM survey at the MTMR-South and MIA. A CH2M HILL field team performed the DGM survey at the DBTs.

3.2.1 Mobilization and Site Preparation

DGM activities at the MTMR-South and MIA were performed by NAEVA Geophysics in March 2010 and DGM activities at the DBTs were performed by a CH2M HILL field team in October 2010. A project kickoff meeting was conducted prior to the start of each DGM field event. During the kickoff meetings, all onsite personnel reviewed the applicable Work Plan, as well as the standard operating procedures (SOPs) and health and safety documentation.

All site specific training was verified by CH2M HILL prior to field activities. Prior to the start of field activities, equipment was inspected and tested for functionality and to ensure it was operating properly prior to data collection. Communication requirements for all team members were established before field work began.

3.2.2 Dam Neck Annex DGM Survey Activities

NAEVA Geophysics performed a geophysical investigation at the MTMR-South and MIA at Dam Neck Annex in March 2010. Data collection was performed utilizing an EM61-MK2 TDEM metal detector with GPS positioning with the objective of locating sub-surface metal associated with potential MEC. Data positioning at the MTMR-South and MIA sites was provided by a real-time kinematic GPS (approximately 2 centimeter accuracy) which allows for the reacquisition of anomalies for investigation.

A UXO technician (equipped with an analog metal detector) provided MEC avoidance services where NAEVA DGM personnel traversed. A DGM operator equipped with an EM61-MK2 surveyed all accessible areas at the MTMR-South and MIA sites. Due to the variations in the topography and vegetation at the sites, various methods (visible tracks in the sand, quadrants, or compass) were used to monitor the areal extent of the DGM survey at each site.

A more complete description of the DGM survey equipment and methodology employed during the DGM survey performed at the MTMR-South and MIA is provided in the Draft Abbreviated Site Inspection Work Plans prepared for Dam Neck Annex (CH2M HILL, 2010a) and the NAEVA Geophysics Report included as Appendix A to this document.

Quality Control

The quality control (QC) steps included various instrument tests, including system validation via survey of an Instrument Verification Strip (IVS). Details for the QC steps followed during the DGM survey activities are provided in the following subsections.

IVS Survey The NAEVA field crew performed DGM surveys at an IVS site established at Dam Neck Annex prior to the survey event. The purpose of surveying the IVS site is to demonstrate the system in use is functioning properly and is capable of detecting munitions within industry standards. A background survey was conducted over the IVS to ensure that the area was clear and subsequently two Industry Standard Objects, 1-inch × 4-inch steel pipes, were buried vertically 5 meters apart and at a depth of 6 inches from their center to the surface. The EM61-MK2 was used to survey the IVS and instrument responses over each of the ISOs were compared to response curves for the ISOs developed by the Naval Research Laboratory that demonstrates their standard responses (NRL, 2008).

DGM Instruments Quality Control The EM61-MK2 was field tested per the work plan requirements and all metrics were met.

Quality Control of DGM Data and Deliverables The NAEVA QC geophysicist and CH2M HILL senior geophysicist performed QC of geophysical data and data deliverables at each step of the processing path as described in the Work Plan. Detailed quality control information associated with the data and deliverables is included in Appendix A.

Documentation

Field and instrumentation data were recorded in the Field Data Sheets and in a field logbook and included information specified in the work plan.

Data Processing EM61-MK2-specific software was used for initial data processing and the output was imported into Geosoft Oasis Montaj™ for additional processing, graphical display, anomaly selections and QC. The processing steps performed on the data include the following:

- Leveling and instrument drift corrections
- Lag correction
- Contour level selection with background shading
- Digital filtering and enhancement

Interpretation/Anomaly Selection A NAEVA processing geophysicist, experienced in DGM MEC data processing, used the following criteria for selecting and locating anomalies:

- Maximum amplitude of the response with respect to local background conditions
- Two-dimensional shape of the response
- Decay curve characteristics

The anomalies selected were subsequently prioritized by the CH2M HILL Project Geophysicist with a focus on identifying those that might represent 60mm or 81mm mortars in the top two feet. Prioritization was based on the documented responses for these items (at their worst orientation) in the NRL document “EM61-MK2 Response of Standard Munitions Items” (NRL/MR/6110–08-9155).

Records Management All files were made available for QC verification during the project to verify that the field and data processing procedures were properly implemented. All raw data files, final processed data files, hard copies, and field notes will be maintained for the duration of the project.

3.2.3 NALF Fentress DGM Survey Activities

A CH2M HILL field team performed a geophysical investigation at the DBT site at NALF Fentress in October 2010. Data collection was performed utilizing an EM61-MK2 TDEM metal detector with GPS positioning, with the objective of locating sub-surface metal potentially associated with MEC. Due to the overhead canopy, data collected at the DBT site

was partially positioned by a sub-meter GPS and partially through fiducial positioning, and (by design) is of reconnaissance quality only.

A UXO technician (equipped with an analog metal detector) performed instrument-assisted MEC avoidance in all areas where DGM activities were done. CH2M HILL staff, equipped with an EM61-MK2 (**Photograph 3-1**) performed the DGM survey at the DBT site. Prior to the DGM survey, the team prepared transects leading away from the center of each of the two reported bombing targets in approximately the cardinal directions. Preparation included clearing vegetation using hedge clippers. DGM surveys were then performed along those transects.



PHOTOGRAPH 3-1
CH2M HILL DGM Survey Activities NALF Fentress

A more complete description of the DGM survey equipment and methodology are provided in the CH2M HILL Work Plan.

Quality Control

The QC steps included the instrument tests detailed in the NALF Fentress Work Plan. The CH2M HILL senior geophysicist performed QC of the geophysical data, confirming that all QC metrics specified in the work plan were met.

Documentation

Field and instrumentation data were recorded on a Field Data Sheet and in a field logbook, copies of which are provided in Appendix B.

Data Processing EM61-MK2-specific software was used for initial data download and the output was imported into Geosoft Oasis Montaj™ for additional processing,

graphical display, and QC. The processing steps performed on the data included the following:

- Background leveling
- Data positioning based on GPS points collected at start and end of transects

Data, including figures presenting the DGM profile for each transect, are included in Appendix B. Each profile shows the amplitude of the response (in Channel 3 of the EM61-MK2) from the outer edge of each target towards its center (or vice versa, depending on the direction each profile was collected). Note that multiple profiles were collected along each transect.

Interpretation A CH2M HILL senior geophysicist experienced in DGM MEC data processing overlaid results of the survey transects on site maps to evaluate general densities of anomalies surrounding the targets. Detailed analysis of individual anomalies was not performed as this survey was intended for reconnaissance purposes only.

Records Management All raw data files, final processed data files, hard copies, and field notes will be maintained for the duration of the project.

Site Inspection Findings, Conclusions and Recommendations

This section summarizes the results of the field investigation activities performed at NAS Oceana sites MTMR-North, MTMR-South, MIA, and DBTs during the SI. Conclusions and recommendations are also included within the discussion of each site. All photographs and figures are presented at the end of this section.

4.1 Moving Target/Mortar Range-North

4.1.1 Findings of Site Reconnaissance

The findings of the site reconnaissance activities performed at the MTMR-North are presented in the following bullets:

- The former gun platform and firing line were located in a landscaped area around the parking lot adjacent to the Regulus Avenue and Loon Court intersection. There is no existing structural evidence of the platform or the firing line remaining (**Photograph 4-1**).
- An historic gravesite is also located within the area believed to represent the footprint of the former gun platform and firing line (**Photograph 4-2**).
- No surface MEC or subsurface anomalies were detected during the limited hand-held magnetometer survey performed in the accessible areas of the former range located outside of the current operational range area.
- The south-central portion of the former range is heavily vegetated.
- The suspected target/impact area of the former range lies within the operational range area and is not eligible for investigation under the MRP.

4.1.2 Conclusions and Recommendations

No evidence of surface MEC or subsurface anomalies was found during the site reconnaissance activities and no evidence was reported to have been found during construction or infrastructure installation activities in the developed portion of the range (i.e., firing points). The undeveloped portion of the former range lies outside of the suspected target/impact area and is a heavily forested/vegetated area. The suspected target/impact area of the former range lies within the operational range area and is not eligible for investigation under the MRP.

Based on the above observations, no further action is recommended at the MTMR-North.



PHOTOGRAPH 4-1
Current Conditions of the Firing Line/Platform at the MTMR-North



PHOTOGRAPH 4-2
Historic Gravesite at the Firing Line/Platform at the MTMR-North

4.2 Moving Target/Mortar Range-South and Mortar Impact Area

4.2.1 Findings of Site Reconnaissance

The findings of the site reconnaissance activities performed at the MTMR-South and MIA are presented in the following bullets:

- No surface MEC or subsurface anomalies were detected during the limited hand-held magnetometer survey performed in the portion of each former range located east of Regulus Avenue (suspected target/impact area).
- The portion of each former range located west of Regulus Avenue was not accessible due to the dense vegetation and wetlands.
- The portion of the former range located west of Regulus Avenue because the area is located outside of the target/impact area and is a heavily vegetated wetland.

4.2.2 Findings of DGM Survey

A DGM survey was performed by NAEVA Geophysics in undeveloped and accessible areas in the eastern portion of both sites. In total, approximately 2.2 acres were surveyed.

Although discrimination of MEC from other metallic items using EM61-MK2 data is not feasible to any significant degree, the detected anomalies were subdivided into prioritized groups based on the experience of the CH2M HILL Project Geophysicist (primarily using anomaly size, amplitude and decay parameters). Priority 1 anomalies are those determined to be the most likely to represent subsurface MEC (60mm or 81mm mortars in the top two feet) if present at the site; however, non-munitions related metallic items can create similar responses in the geophysical data. These anomalies are recommended to be first should intrusive investigations be performed. A total of 127 Priority 1 anomalies were identified from the MTMR-South and MIA data (**Figure 4-1**).

4.2.3 Conclusions and Recommendations

The portion of each former range located west of Regulus Avenue is located outside of the target/impact area and is a heavily vegetated wetland. No surface MEC was found in the portion of each former range located east of Regulus Avenue (suspected target/impact area) and the distribution of the anomalies identified during the DGM survey of this area do not appear to be in a pattern that indicates an impact area, although an intrusive investigation would be required to confirm whether the sources of the anomalies are MEC. There is a very low concentration of high density/high millivolt discreet anomalies potentially representing MEC (60mm or 81mm mortars in the top 2 feet) area within the sand dunes; however, again these anomalies could be caused by non-munitions related metallic items.

Based on the above observations, further investigation, including an intrusive investigation to inspect and identify a selected subset of the anomalies located during the SI is recommended at the MTMR-South and MIA to determine if the sources of the anomalies are MEC, but only in the portions of the sites that are east of Regulus Avenue. If determined to be MEC, then the MEC should be removed and properly disposed of, and additional actions potentially including MC sampling, DGM and intrusive investigation activities will be required. Note that there are land use controls in place to restrict or prevent unauthorized

access to this area. In addition, the undeveloped area within the sand dunes is protected under the Coastal Primary Sand Dune Protection Act and a permit may be required from Virginia Marine Resources Commission to perform intrusive investigation to determine the origin of these anomalies.

4.3 Dive Bombing Targets

4.3.1 Findings of Site Reconnaissance

The findings of the site reconnaissance activities performed at the DBTs are presented in the following bullets:

- Bunkers at the DBTs were located and found to be overgrown with dense vegetation.
- Entrance roads to the north and south DBTs were inspected and found to be in poor condition due to erosion and dense vegetation (**Photographs 4-3 and 4-4**).
- At the south DBT center, three AN-MK23 practice bombs and an unfuzed M18 Signal Smoke Grenade were found on the ground surface (**Photographs 4-5, 4-6, and 4-7**).
- Several subsurface anomalies were also identified during the limited hand-held magnetometer survey performed at the south DBT; one subsurface anomaly was identified at the north DBT.



PHOTOGRAPH 4-3

Condition of Entrance roads to the North and South DBTs



PHOTOGRAPH 4-4
Condition of Entrance Roads to the North and South DBTs



PHOTOGRAPH 4-5
AN-MK23 Charged Practice Bomb at Southern DBT



PHOTOGRAPH 4-6
MD at Southern DBT



PHOTOGRAPH 4-7
Unfuzed M18 Signal Smoke Grenade at Southern DBT

4.3.2 Findings of Digital Geophysical Mapping Survey

A reconnaissance level DGM survey was performed in the primary cardinal directions at each DBT by a CH2M HILL field team. In total, 4 transects were surveyed at each DBT.

During the MEC clearance activities completed immediately prior to the start of the DGM survey, the AN-MK23 practice bombs and unfuzed M18 Smoke Signal Grenade found during the PA site reconnaissance activities were reacquired. It was determined that the signal charges in two of the practice bombs were intact. Local Navy Explosives Ordnance Disposal personnel were notified and ultimately responded and removed these items.

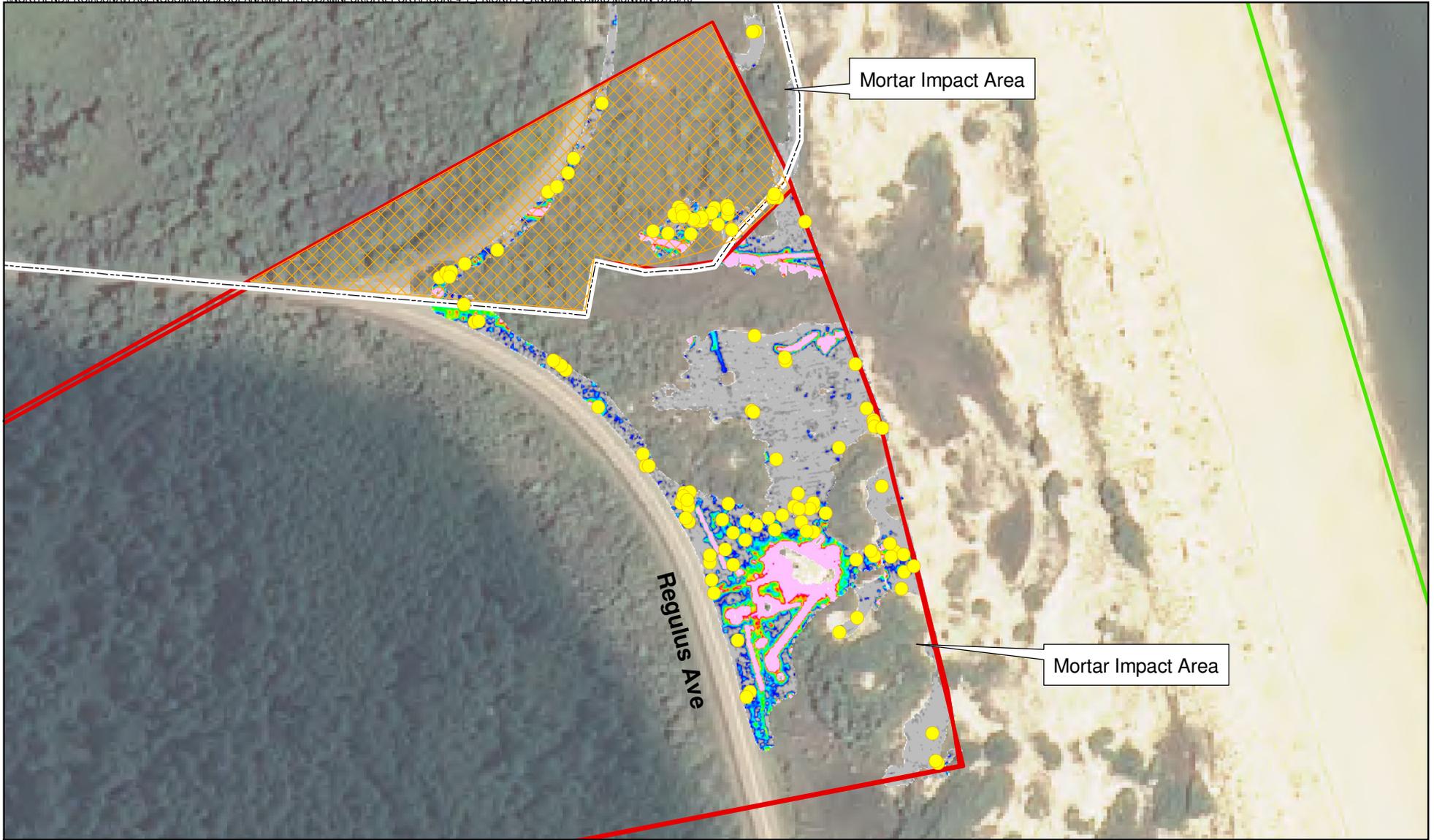
The DGM survey consisted of surveying four directional transects from the center of each target to the outer target boundary. A number of subsurface anomalies were identified at each target during the DGM survey activities at the DBTs, with increasing densities of targets towards the reported centers of the targets. Example DGM profiles for select transects are shown on **Figures 4-2 through 4-4**. Profiles for all transects are presented along with the DGM data in Appendix B.

Both DBTs are located in an undeveloped area of NALF Fentress, so it is likely that these anomalies are not associated with cultural sources. An intrusive investigation is the only means to determine the exact origin of these anomalies.

4.3.3 Conclusions and Recommendations

During the site reconnaissance activities performed at the DBTs, three AN-MK23 practice bombs and an unfuzed M18 Signal Smoke Grenade were found on the ground surface of the southern target. Several subsurface anomalies were also identified at the north and south DBTs. It was determined that the signal charges in two of the AN-MK23 practice bombs found in the southern target were intact during UXO clearance activities performed prior to the DGM survey. Local Navy Explosive Ordnance Disposal personnel responded and removed these items. A number of subsurface anomalies were identified at each target during the DGM survey activities at the DBTs and because the DBTs are located in an undeveloped area of NALF Fentress, it is not likely that these anomalies are associated with cultural sources.

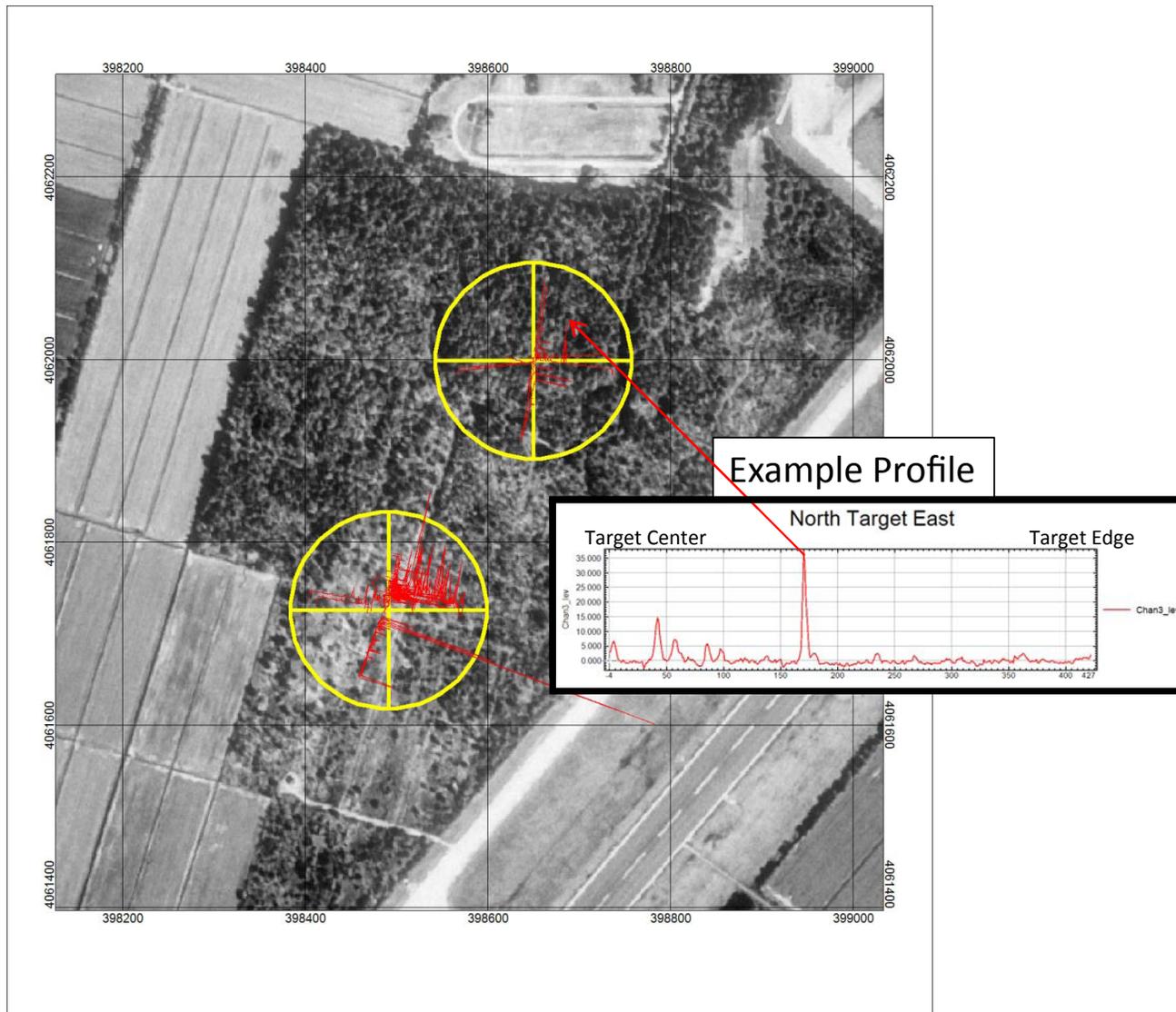
Further investigation, including additional vegetation removal and DGM survey activities with positioning at a high enough accuracy for reacquisition of anomalies, as well as an intrusive investigation to inspect and identify a selected subset of the anomalies, is recommended. If the sources of the anomalies are identified as MEC, sampling for MC will be required.



- Legend**
- Priority 1 Anomalies
 - Installation Boundary
 - MRP Site
 - - - Historical Range Location
 - ▨ Overlapping MRP Sites



Figure 4-1
Site Inspection Report
Priority 1 Anomalies - Moving Target Mortar Range South
and Mortar Impact Area
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia



Fentress
EM61-MK2 Recon
Transects

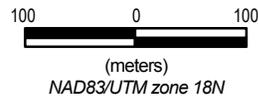
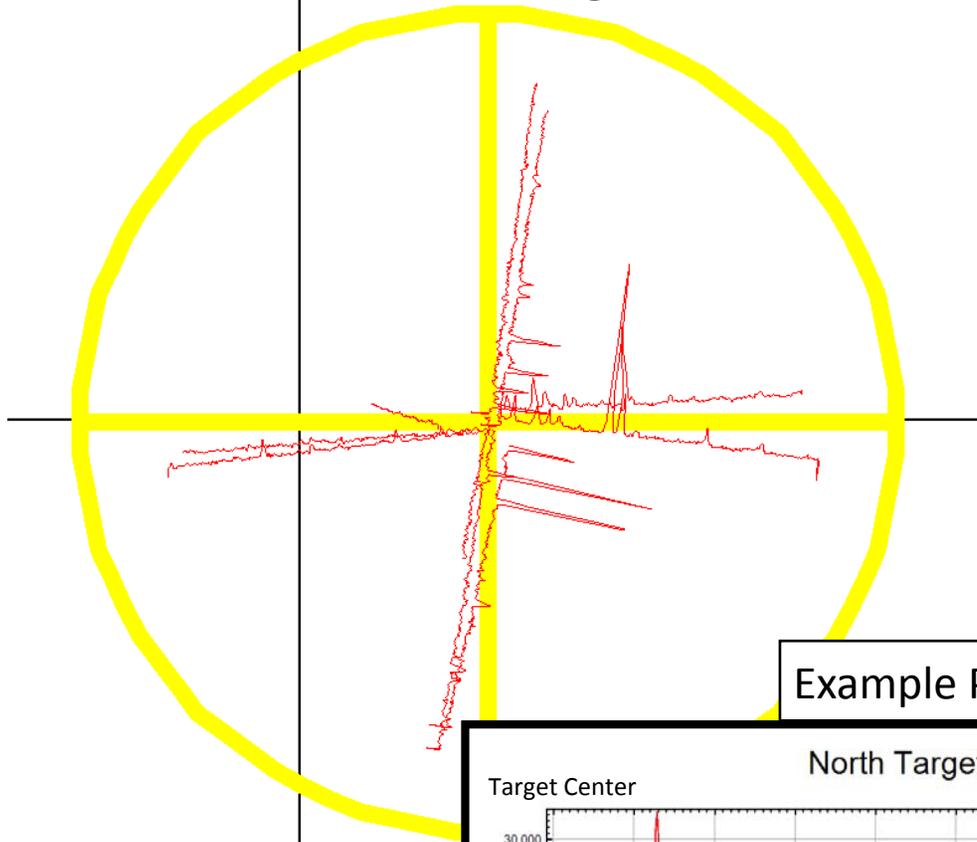
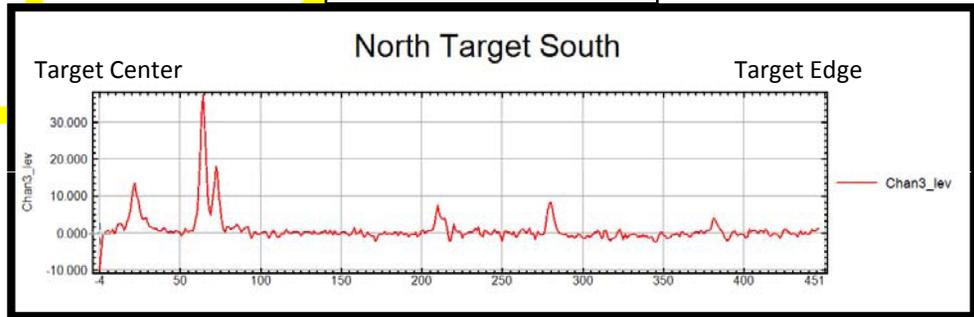


Figure 4-2
Site Inspection Report
DGM Transects - Dive Bombing Targets
NALF Fentress - Naval Air Station Oceana
Virginia Beach Virginia

North Target



Example Profile

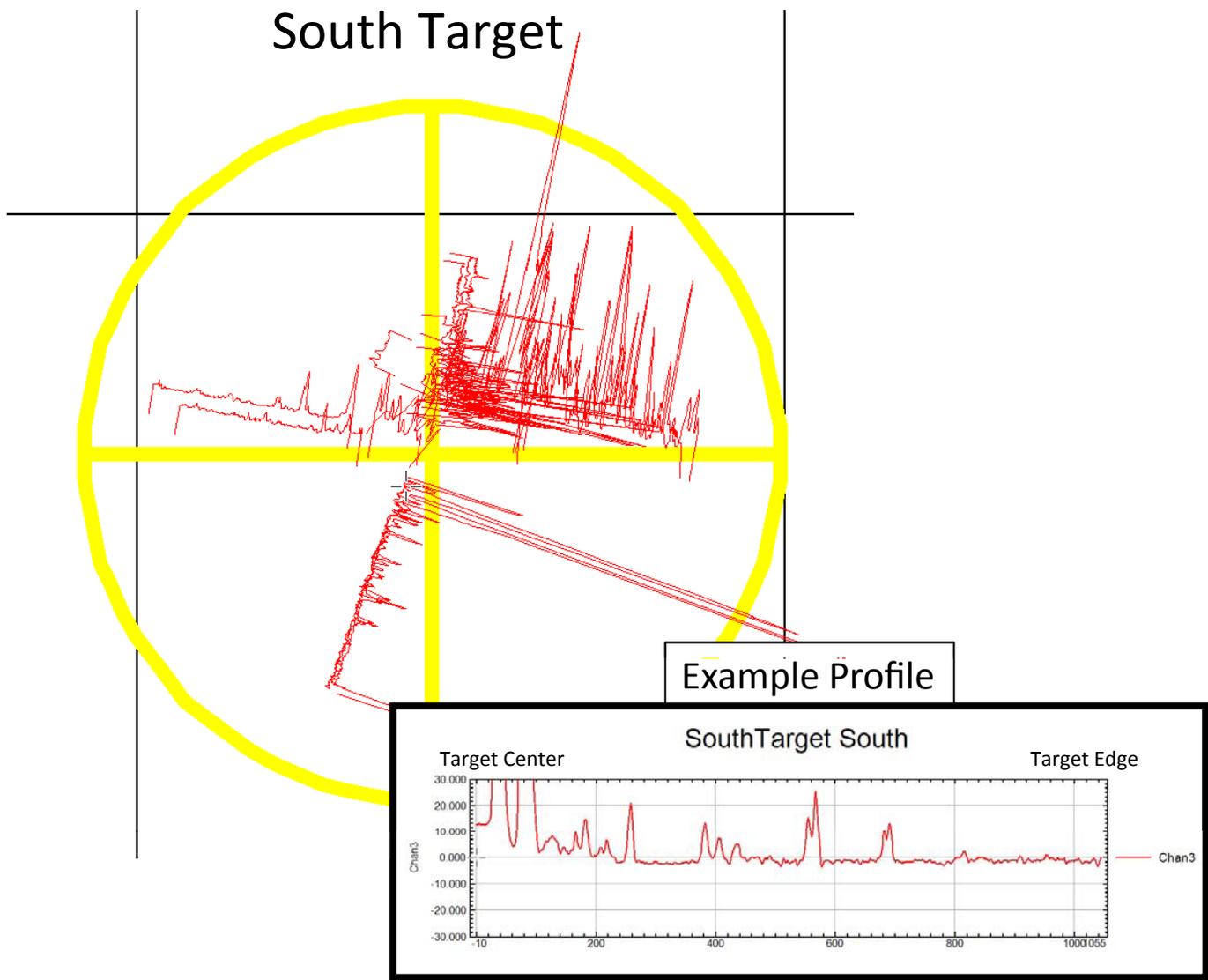


Fentress
EM61-MK2 Recon
Transects



Figure 4-3
Site Inspection Report
DGM Results - North Dive Bombing Target
NALF Fentress - Naval Air Station Oceana
Virginia Beach Virginia

South Target



Fentress
EM61-MK2 Recon
Transects



Figure 4-4
Site Inspection Report
DGM Results - South Dive Bombing Target
NALF Fentress - Naval Air Station Oceana
Virginia Beach Virginia

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Appendix A
NAEVA Geophysical Investigation Report –
Dam Neck Annex

GPR
MAGNETICS
ELECTROMAGNETICS
SEISMICS
RESISTIVITY
UTILITY LOCATION
UXO DETECTION
BOREHOLE CAMERA
STAFF SUPPORT

GEOPHYSICAL INVESTIGATION REPORT

Fleet Combat Training Center, Dam Neck Annex Virginia Beach, Virginia

Contract Task Order WE03

Date of Investigation:

March 23rd, 2010

Final Submittal
January 04th, 2011

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FIGURES AND TABLES

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Figure 2: Fleet Combat Training Center, Dam Neck Annex footprint

Figure 3: Static Test with small ISO

PLATES

Plate 1: EM61-MK2 Bottom Coil Mosaic

APPENDICES & CD

Appendix A: IVS color contour maps

Appendix B: Example QC test results

Contents of CD: Project deliverables

ACRONYMS AND ABBREVIATIONS

AHA	Activity Hazard Analysis
CTO	Contract Task Order
DGM	Digital Geophysical Mapping
DQOs	Data Quality Objectives
GPS	Global Positioning Satellites
GSV	Geophysical System Verification
ISO	Industry Standard Object
IVS	Instrument Verification Strip
MEC	Munitions and Explosives of Concern
mV	Millivolts
NAD83	North American Datum of 1983
NRL	Naval Research Laboratory
QA/QC	Quality Assurance / Quality Control
QC	Quality Control
RTK	Real Time Kinematic
SI	Site Inspection
SOPs	Standard Operating Procedures
SRA	Saturated Response Area
SOW	Scope of Work
UTM	Universal Transverse Mercator

1.0 INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

The Mortar Impact Area is a cone-shaped area located in the southernmost portion of the Dam Neck Annex. Based on orientation of the range fan as depicted on a historical map, it is assumed that mortars were fired from west to the east, towards the Atlantic Ocean (CH2M HILL, 2010). The site is made up of a Dune Management Area, Regulus Avenue, and Building 474 on the east; and on the west the Regulus Avenue Landfill and an undeveloped wetland area. The historic range fan also partially overlaps another MRP Site, the Moving Target/Mortar Range South. The overlapping acreage was assigned to the Mortar Impact Area. The resulting acreage for the Mortar Impact Area is 24 acres. No evidence of MEC was noted during site visits performed by Malcolm Pirnie in 2007 or by CH2M HILL personnel in October of 2009. However, because no investigations have been performed at the Mortar Impact Area, the site is considered a suspect MEC area based on the historical use of mortars at the site. The overall purpose of the investigation is to move towards securing future unrestricted use of the land by the Navy.

NAEVA's objective was to collect geophysical data in non-vegetated areas of the Mortar Impact Area and the Moving Target/Mortar Range South. A CH2M HILL representative directed NAEVA as to which areas should be surveyed.

1.2 SCOPE OF WORK

NAEVA Geophysics provided personnel and geophysical survey equipment for a Site Inspection (SI) at Dam Neck Annex for a geophysical survey to include a minimum of 5% of the proposed six acre footprint. Survey stakes and grids were not to be utilized. NAEVA made the best effort to collect complete coverage based on tracks in the sand. Vegetation removal was not conducted from the sand dunes and data was only collected from open and accessible portions of the site. Previous site visits anticipated open "patches" were available across most of the suspected impact area allowing for a representative Digital Geophysical Mapping (DGM) coverage. All production data was processed, interpreted and delivered to the CH2M HILL Project Geophysicist on the schedule and in the formats specified in the DGM Scope of Work (SOW).

1.3 Site Location and Description

Dam Neck Annex is located approximately five miles southeast of NAS Oceana, in Virginia Beach, Virginia and covers approximately 1,400 acres (**Figure 1**). The DGM survey was performed in the suspected impact areas of the Mortar Impact Area and the Moving Target Mortar Range (South), which are adjacent to each other. The accessible areas of the suspected impact area

at the Mortar Impact Area and a small portion of undeveloped land in the southern end of the suspected impact area of the Moving Target Mortar Range (South) were included in the DGM survey. The areal extent of the DGM survey is shown shaded in green on **Figure 2** and encompasses approximately 6 acres. A parking area, several large buildings, and a helipad occupy the majority of the eastern portion of the site. The western portion of the site is a heavily wooded undeveloped wetland area not used by the installation.

2.0 EQUIPMENT

2.1 GEONICS EM61-MK2

The geophysical instrument used for the investigation at MCB Camp Lejeune is the Geonics EM61-MK2 metal detector. The EM61-MK2 is a high resolution time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. In comparison with other metal detectors, especially magnetometers, it is much better suited for work in close proximity to man-made structures and in areas of dense subsurface metallic debris (i.e., impact ranges).

The EM61-MK2 system consists of two 1 meter by 0.5 meter air-cored coils, a digital data recorder, batteries and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. The receivers either measure the eddy currents at three distinct time intervals in the bottom coil and one time interval in the top coil or four intervals in the bottom coil if no top coil measurements are recorded. For the work at Dam Neck Annex the latter method was chosen. Earlier time gates provide enhanced detection of smaller metallic objects. Secondary voltages induced in both coils are measured in millivolts (mV). The arrangement of coils is such that there is a vertical separation of 40 cm from the ground to the bottom coil. Assuming accurate data positioning, target resolution of approximately 0.5 meters can be expected. The data are collected using Geonics' EM61-MK2 program and temporarily stored in a Juniper Allegro CX data logger prior to downloading to a laptop computer.

3.0 METHODOLOGY

3.1 DGM SURVEY ACTIVITIES

Data collection at Fleet Combat Training Center, Dam Neck Annex utilized an EM61-MK2 with Real Time Kinematic (RTK) Global Positioning System (GPS) positioning surveys over 2.5 field days with the objective of locating sub-surface metal associated with potential Munitions and Explosives of Concern (MEC).

3.1.1 Wheel Mode

In wheel configuration, the coils were operated in wheel mode with the bottom coil 40 cm above the ground surface. The electronics included the data logger and backpack controlled by the operator to the rear of the system. Coil height was maintained at 40 cm throughout DGM operations.

3.1.2 Trimble R8 Real Time Kinematic Global Positioning System

A Trimble R8 RTK GPS system was used for the real-time acquisition of positional data during geophysical data collection. A GPS base station, utilizing a Trimble R8 receiver, was used in conjunction with a R8 rover mounted over the center of the EM61-MK2 coils for data collection. Real-time corrections were broadcast to the roving GPS unit via a radio link using a Pacific Crest HPB450 radio modem. This system provides positional updates at a rate of 1 Hz, with an accuracy of 3-cm horizontal. During data collection, the positional data were stored along with the EM61-MK2 readings in a single file on a Juniper Allegro handheld computer for later downloading and editing.

The base station and grid corner positions were supplied by CH2M HILL based on digitized maps of monitoring wells near the site. The coordinates provided were in the Virginia State Plane coordinate system, which NAEVA converted into the Universal Transverse Mercator (UTM) system, North American Datum of 1983 (NAD83), Zone 18 North. The coordinates provided for the unlabelled monitoring wells were not accurate and NAEVA established a new base station control point by logging GPS data in a static position for more than two hours and post-processing the recorded data for accurate positioning.

3.2 DATA PROCESSING AND INTERPRETATION

3.2.1 Data Storage and Initial Editing

EM61-MK2 data are temporarily stored in an Allegro data logger via Geonics's NAV61MK2 software and then downloaded into a laptop computer for further on-site processing using Geonics's TrackMaker61MK2 software version 1.64a.

All daily logs, field notes, and sketches were input digitally into a Hewlett Packard IPAQ personal digital assistant (PDA). At the end of each day, this information was uploaded in compressed format to the CH2M HILL project FTP site for use in processing the geophysical data.

Initial data processing was performed by the field team, which included reviewing data for integrity and repeatability.

3.2.2 Preprocessing

Converted raw data files were imported into Geosoft's Oasis Montaj to perform the following:

- Review and finalize all Quality Control (QC) tests (cable shake, personnel and static) prior to processing of the DGM data for that day
- Convert local coordinates to projected NAD83 UTM Zone 18 North coordinates
- Evaluate data density
- Apply auto leveling and instrument drift corrections
- Apply default lag correction
- Generate preliminary contour map(s) from gridded data
- Generate preliminary original vs. repeat profiles by block
- Generate formatted ASCII files containing preprocessed data by block

3.2.3 Final Processing

After completion of preprocessing, the data were further evaluated and processed to generate final processed data files. Final processing steps included:

- Evaluation and refinement of auto leveling and instrument drift corrections in the channel selected for target analysis (Channel 2)
- Evaluation and refinement of lag correction in the channel selected for target analysis (Channel 2)
- Additional digital filtering and enhancement, as necessary, in the channel selected for target analysis (Channel 2)
- Targeting of data, as described in Section 3.2.4
- Generation of formatted ASCII files containing processed data by block
- Generation of final maps for each block showing contoured gridded data, target locations, and culture
- Generation of final original vs. repeat profiles by block

3.2.4 Analysis and Target Selection

The UX-Detect module within Oasis Montaj identifies peak amplitude responses from metallic items. Initial target selections were made based on the Kriging gridded data, a robust statistical gridding method used to determine a value at each grid node based on XYZ data. Data profiles corresponding to the anomalies selected by Geosoft were then analyzed by trained geophysicists, with the targets evaluated as to their validity and position, as single-source anomalies may generate multiple target designations depending on shape and orientation. Targets found to be invalid or incorrectly located were removed or adjusted. Additionally, anomalies that were not selected by the UX-Detect module, yet deemed to represent a potential metallic target, were manually selected. All target selection was performed on final processed data from Channel 2 of the bottom coil of the EM61-MK2.

Final processed XYZ (ASCII) files were created for the block, and individual geophysical maps and target lists were created for each grid. When all data at the site had been collected a mosaic map was created by combining color contour maps from all the blocks at that site (see Plate 1). All anomalies occurring at or above the targeting threshold of 3 mV in Channel 2 were identified using a unique ID number.

Each target list provides a Target ID, Grid ID, Easting (x) and Northing (y) UTM coordinate location for each target, the recorded peak response in millivolts, and any processor comments. The target IDs were prioritized by designating the highest amplitude response as the number one target in each grid.

All raw, preprocessed, and processed data have been submitted to CH2M HILL's project geophysicist and can be found on the enclosed CD (see Contents of CD).

4.0 RESULTS

4.1 SUMMARY OF WORK PERFORMED

The digital geophysical mapping of the Fleet Combat Training Center, Dam Neck Annex footprint site took place on March 23-25th, 2010. Ultimately, the Dam Neck Annex DGM consisted of two blocks which were mapped during three work days with an acreage of 2.214 acres. Several buildings and a helipad border the site to the north. Sand dunes, swamps and vegetated areas are within the site footprint and there is a building with parking lots to the southwest. Sand dunes lay to the east of the area boundary and roads are on the western border.

Plate 1 displays the EM61-MK2 bottom coil mosaic map for the Dam Neck Annex footprint.

4.2 MOBILIZATION AND SITE SETUP

Prior to mobilization an Activity Hazard Analysis (AHA) and Standard Operating Procedures (SOPs) were provided to CH2M HILL, and all personnel had current 8-hour and/or 40-hour OSHA HAZWOPER training.

NAEVA mobilized one field crew to Virginia Beach, Virginia on March 22nd, 2010. Following completion of the Instrument Verification Strip (IVS), as described in Section 5.1, DGM began at site on March 24th, 2010 and finished work of that site on March 25th, 2010. All geophysical equipment had been qualified at the IVS for field operations at the Dam Neck Annex project. Site-specific health and safety briefs were given each morning by the CH2M HILL site manager. No equipment was staged on site.

4.3 DGM SURVEY ACTIVITIES

Within the 2.214 acres mapped, 705 point source targets were selected above the targeting threshold of 3 mV in Channel 2. Forty-three point source targets were selected inside Saturated Response Area's (SRA's) and cultural objects present on the site and 31 targets appear to be related to culture. Noise levels were generally low in most areas but power lines along the road caused some electrical background noise.

4.4 DATA PROCESSING AND INTERPRETATION

All data were processed as described in-depth in Section 3.2. Part of the process included analyzing signal decay in order to identify possible noise or other false positive responses. Any anomalies suspected as originating from culture objects (e.g., power lines) are noted in the processing reports included on the CD. Any anomalies suspected as originating from noise (e.g., channel readings out of phase) and non-metallic and/or cultural objects are noted and referenced by an identification numbers (Type One is assigned to culture, Type Two is assigned to suspected culture, Type Three is assigned to a heavily saturated feature, Type Four is assigned to a target within a polygon feature and Type Five is assigned to a terrain response or ambient noise), on the target lists and in the processing reports included on the CD. These reports list down-line data density statistics, leveling, lag, and gridding parameters used in processing each block.

5.0 QUALITY CONTROL

To establish confidence in the data reliability, Quality Control (QC) tests were conducted during the project. Tests were conducted prior to, during, and after all data collection sessions. All QC tests for the EM61-MK2 were conducted after a minimum 15 minute warm-up period for the electronics. Sample graphical displays of QC data are included in Appendix B.

5.1 SYSTEM VALIDATION – INSTRUMENT VERIFICATION STRIP (IVS)

As previously stated in Section 4.2, the NAEVA field crew performed DGM surveys at the IVS on March 23rd, 2010 for site Dan Neck Annex. The purpose of surveying the IVS is to demonstrate the system in use is capable of detecting munitions within industry standards and the coordinates being obtained from the positioning system are of sufficient accuracy to allow for reacquisition of targets.. Serial number identifications were recorded for all instrumentation (i.e. data logger, coils, EM61-MK2 electronics), and the IVS was mapped using the same personnel, equipment, and methodologies to be employed for the DGM survey.

A new IVS was established outside the DGM work area boundary once the NAEVA team arrived on site. A background survey was conducted to ensure that the area was clear or that any existing anomalies were avoided. Two small Industry Standard Objects (ISO), 1" x 4" steel pipes, were buried vertically five meters apart and at a depth of six inches from their center to the surface in order to test the detection capabilities of the instrument. Response curves for ISOs have been developed by the Naval Research Laboratory (NRL) that demonstrates their standard responses (Naval Research Laboratory, 2009). Burying the ISO items vertically instead of horizontally differed from the Geophysical System Verification Plan, and was a lesson learned by NAEVA personnel to more closely read the details in the Geophysical System Verification (GSV) Plan. The IVS was established using the UTM coordinate system with the NAD83 datum, Zone North 18.

The EM61-MK2 was used to survey the IVS in wheel mode using RTK GPS. The EM61-MK2 was chosen based on its ability to detect small, near-surface ferrous and non-ferrous munitions and its high data resolution. The unconsolidated sands at Dam Neck Annex should not adversely affect the instrument response, however the EM61-MK2 is susceptible to interference from power lines or other objects that create an electromagnetic field (e.g., junction boxes, radios in transmit mode).

It was determined that a threshold of 3 mV in Channel 2 would detect the MEC items of interest. See Appendix A for color contour maps of the wheeled mode configuration with GPS collected IVS.

5.2 QC TEST DESCRIPTIONS AND ACCEPTANCE CRITERIA

The following QC procedures were performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis:

IVS Line: Following the morning static test, a single line was collected over an IVS. This test was used to document the repeatable responses of known objects at known depths.

Static Background and Static Spike: Static tests were performed by positioning the survey equipment in an area free of metallic response and collecting data for a 3-minute period. During this time, the instrument was held in a fixed position. A static test is the primary measurement of instrument functionality and consists of one minute without a spike, one minute with a spike (a wooden board fitted to the bottom coil with a small ISO suspended 21 inches above it), see **Figure 3**, and then one minute without a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. Acceptance criteria of $\pm 20\%$ of the spike

response after background correction and less than ± 2 mV of response fluctuation were used to the published results in the EM61-MK2 Response of Three Munitions Surrogates by the Naval Research Laboratory,(Naval Research Laboratory, 2009).The static background and static spike tests were conducted at the beginning and end of each block.

Cable Shake Test: On a daily basis, the instrument connections were checked for their response to vibrations in the cables. The response was observed in the field for immediate corrective action, transmitted back to a processor, analyzed, and checked for spikes in the data that can possibly create false anomalies. Any data spike greater than 2 mV from the mean would constitute a QC failure. The cable shake test was conducted at the beginning of the survey operation for each workday, and cables were not disconnected during the day.

Personnel Test: This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the instrument was checked for its response to the personnel operating the system. The response was observed in the field for immediate corrective action and transmitted back to a processor, analyzed, and checked for spikes in the data that can possibly create false anomalies. Any data spike greater than 2 mV from the mean would constitute a QC failure. The personnel test was conducted at the beginning of the survey operation for each workday.

Repeat Data: This test is performed to verify repeatability of the data and was performed at the end of each block. At least 2% of the survey lines were repeated and evaluated for consistency. Since small deviations in line path can affect the instrument response the profiles were evaluated qualitatively. Also the spike test is used to assess quantitative repeatability.

5.3 QC TEST RESULTS

QC data were evaluated using Geosoft's Quality Assurance (QA)/Quality Control software. Static, cable shake, and personnel test profiles were plotted with an acceptance criterion of ± 2 mV from the mean. Any readings outside this range were flagged on the profiles, and an associated failure percentage was reported. The following provides a summary of the QC results:

1. **Static Background / Spike Test:** All static and spike tests were within acceptance criteria; stable, repeatable, and without spikes.
2. **Cable Shake Test:** No spikes were observed in any of the tests.
3. **Personnel Test:** No deviation from background response was observed.
4. **Repeat Data:** Repeat lines generally showed good repeatability. Discrepancies in repeat lines were often a result of line path deviation or noise in the data.
5. **IVS Test:** IVS tests were plotted showing the line path and gridded response. A comparison of tests shows that response amplitudes are consistent and test item positions are accurate.

All QC tests were well within acceptance criteria and were conducted in the vicinity of the block. Most static spike tests show an initial drop in response at the beginning of the collection period, likely due to software behavior, as readings were completely stable in monitoring mode, yet when data collection was started the recorded values dropped. This behavior was observed on multiple occasions, but the effect was reduced during data leveling and did not result in any QC failures.

6.0 CONCLUSIONS

NAEVA mapped approximately 2.2 acres in two blocks with a total of 705 single point targets. Block named 0324BLOCK1 consists of 0.837 acres surveyed and has the least amount of anomaly density with 156 targets in total. Included in 0324BLOCK1 are three SRA's with six point source targets selected within the SRA polygons. Of the 156 targets in this block, 13 appear to be related to suspected cultural features and 12 targets appear to be related to background noise.

Block 0325BLOCK2, consisting of approximately 1.4 acres surveyed, has a higher anomaly density compared to block 0324BLOCK1, with a total of 549 point source targets and five SRA's with 37 targets selected within the SRA's. Eighteen targets appear to be related to cultural features and 122 appear to be related to background noise from possible electrical sources.

Several linear features appear in the mosaic map and due to the proximity to the building and manhole covers it is possible these are underground utilities. Two linear features running north-south closest to the parking areas are almost certainly concrete parking stalls on the parking lot surface.

The areas surveyed in the sandy dunes were relatively free of brush and metal but multiple cultural features were observed along the edge of the road and near the vicinity of the building.

7.0 REFERENCES

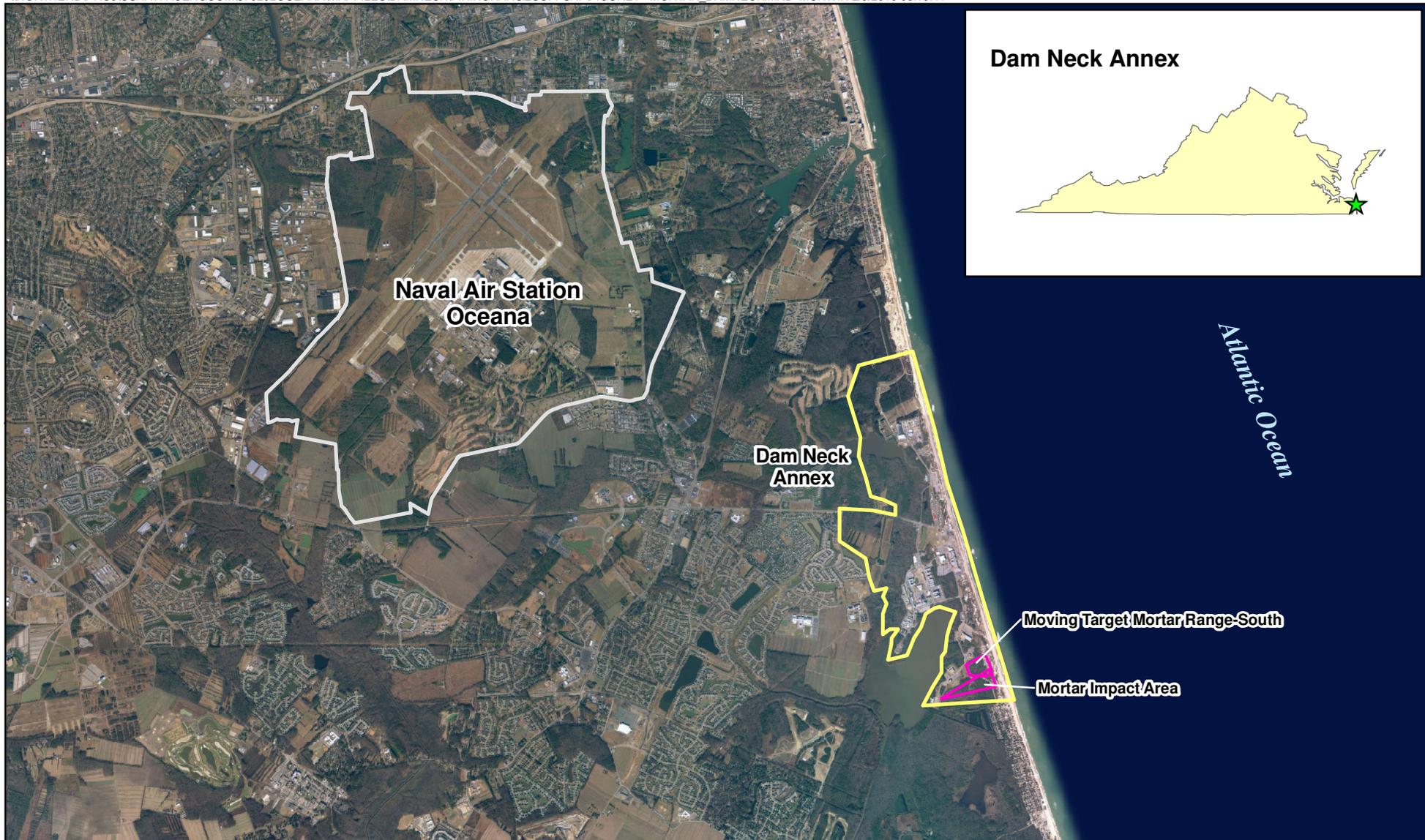
CH2M HILL. 2010. *Geophysical Investigation Plan Site Inspection Munitions Response Program Sites in Virginia (Final Draft)*. Prepared for Department of the Navy, Naval Facilities Engineering Command Mid- Atlantic. March.

CH2M HILL. 2010. *Scope of Work, Digital Geophysical Mapping Dam Neck Annex Naval Air Station Oceana, Virginia Beach, VA.,.* April.

Geonics Limited. 2005. *EM61-MK2 and EM61-MK2HP 4 Channel High Sensitivity Metal Detectors Operating Manual*. July.

Naval Research Laboratory. 2009. *EM61-MK2 Response of Three Munitions Surrogates. NRL/MR/6110—08-9155*. Washington, D.C. March.

Figure 1:
Site Map



Legend

- NAS Oceana Boundary
- Dam Neck Annex Boundary
- MRP Sites

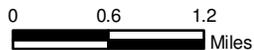


Figure 1
Site Location Map for the Mortar Ranges
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

Figure 2:
Dam Neck Annex
footprint



Legend

-  Installation Boundary
-  MRP Site
-  Historical Range Location
-  Overlapping MRP Sites



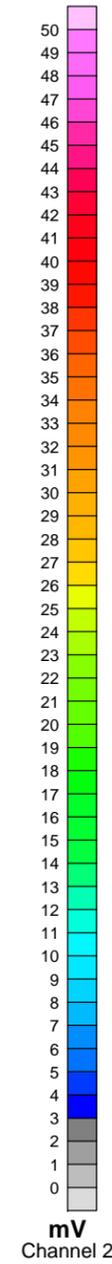
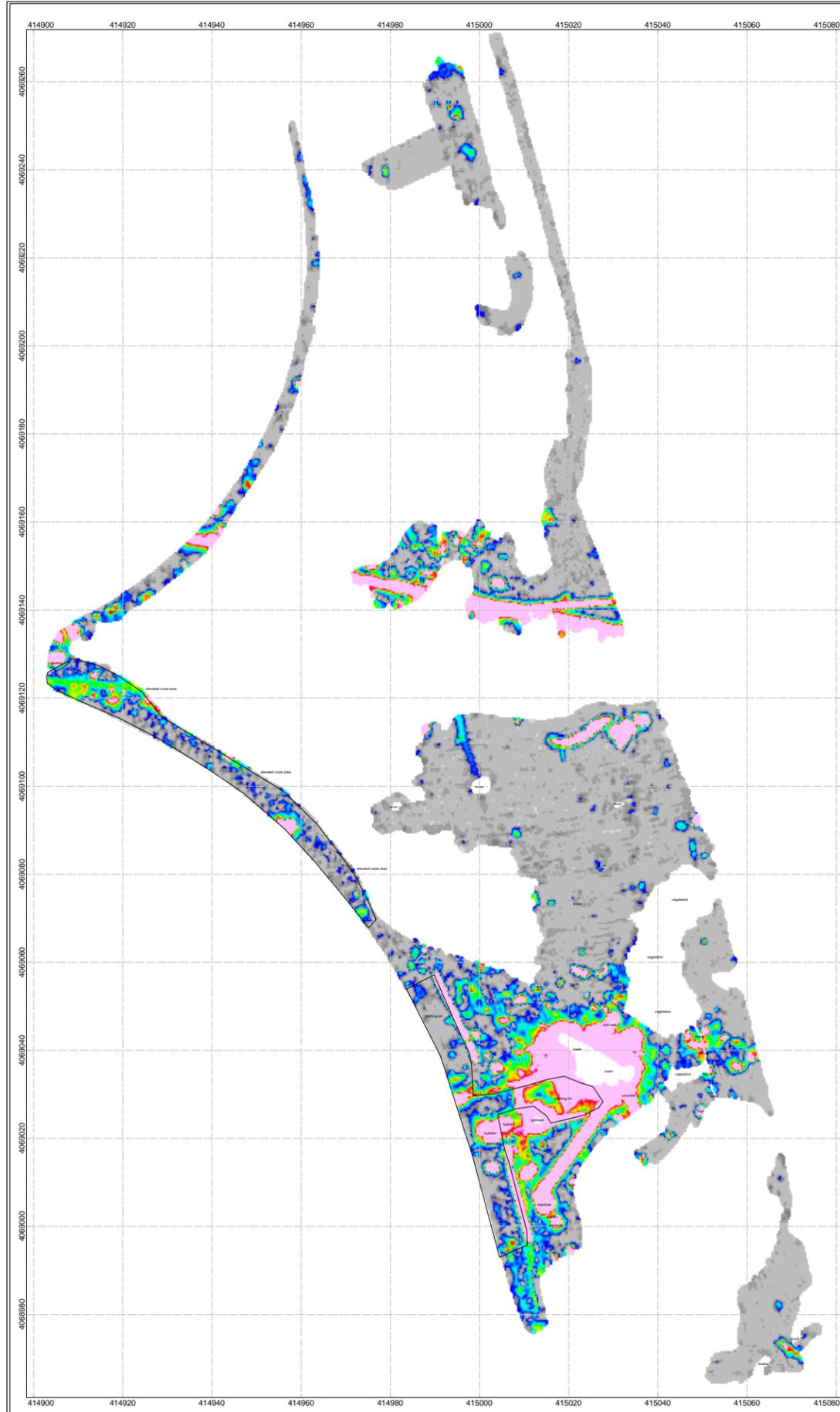
Figure 2
DGM Survey Area for the Mortar Ranges
Dam Neck Annex
Virginia Beach, Virginia

Figure 3:
Static Test with small
ISO item.



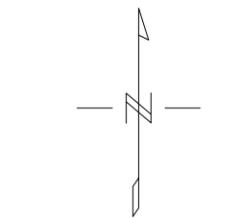
Plate 1:

Mosaic



Legend

- brush
- Culture (if positioned, just labels used otherwise)
- Culture Polygons



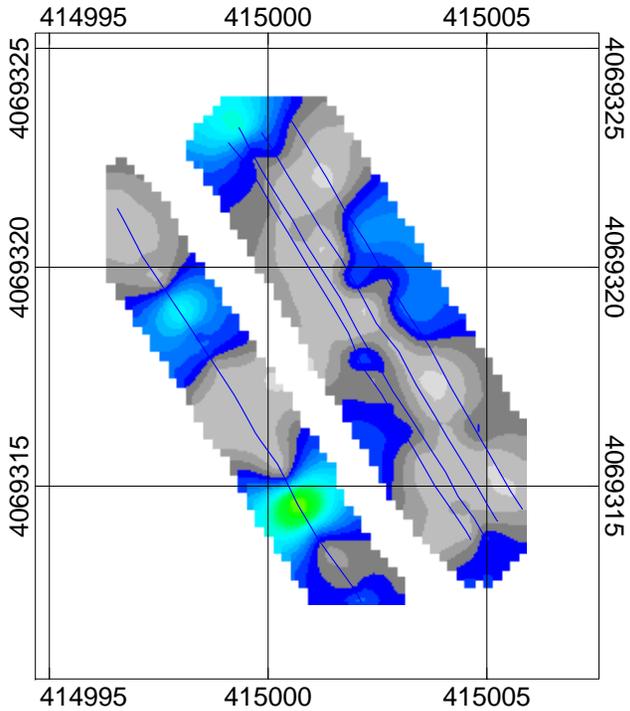
CH2M HILL

EM61 MK2 Bottom Coil
 Mosaic
 NAS Oceana - Dam Neck Annex Virginia
 Date of Survey 03/24 & 25/2010
 Date of Creation 03/26/2010

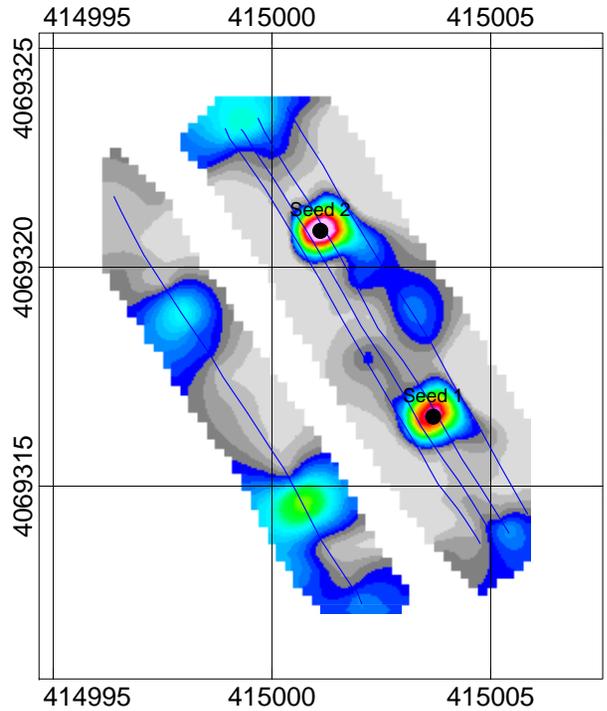
Map Approver: Jon Guillard

Appendix A:
IVS Color Contour Map

IVS Background

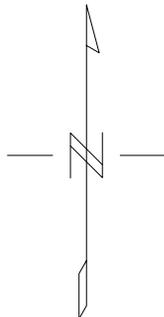
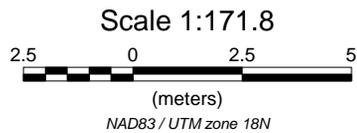


IVS with Seeds



Legend

- Seed Location
IVS Seed Depth 15.24cm
- /// Line Path



CH2M HILL
EM61 MK2 Bottom Coil Block 0323IVS (IVS Test-5 Lines/5 Background Lines) NAS Oceana - Dam Neck Annex Virginia
Date of Survey: 03/23/2010 Date of Map Creation: 03/25/2010
Map Approver: J. Guillard

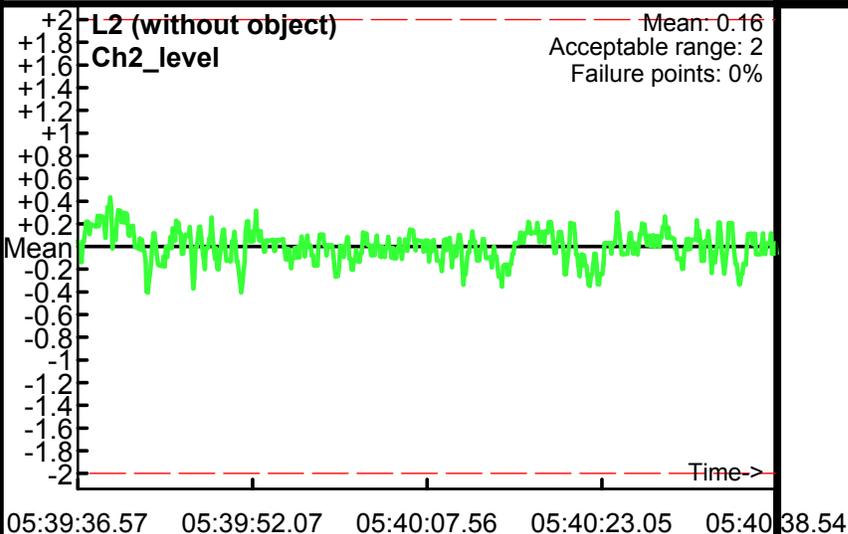
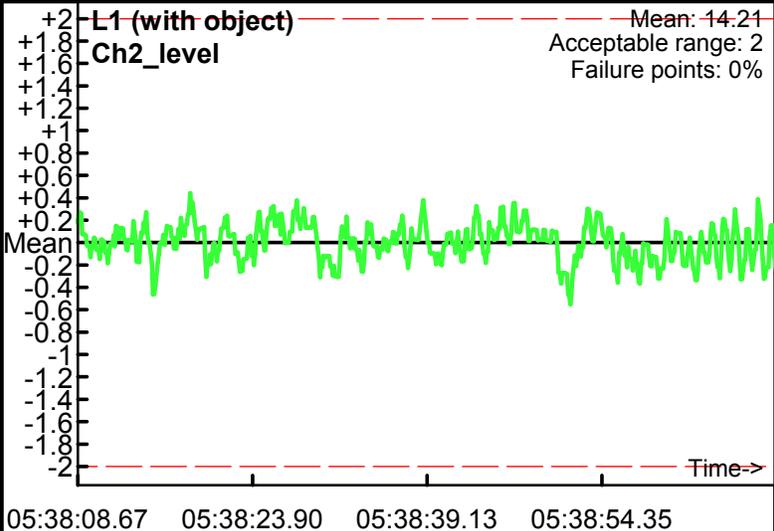
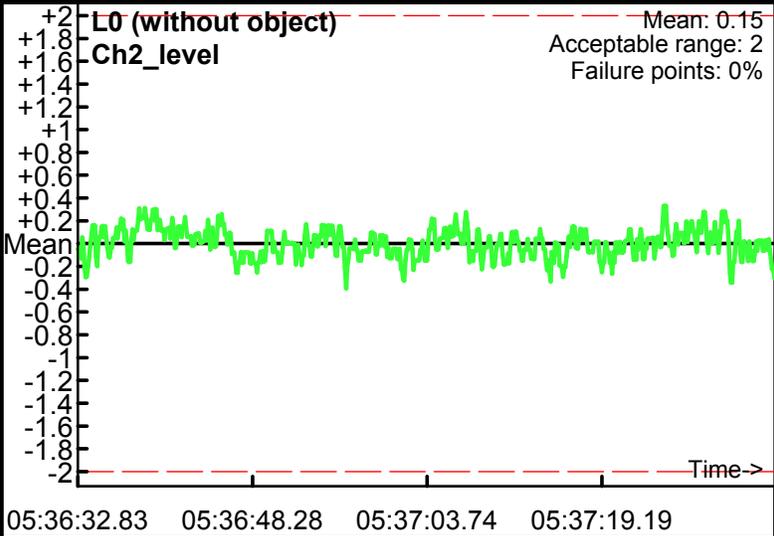
Appendix B:
Example EM61-MK2
Data QC Tests

Static Calibration Test

Project: NAS Oceana - Damneck Annex Virginia
Equipment: EM-61 Mark II
Grid/Location: 0325Block2

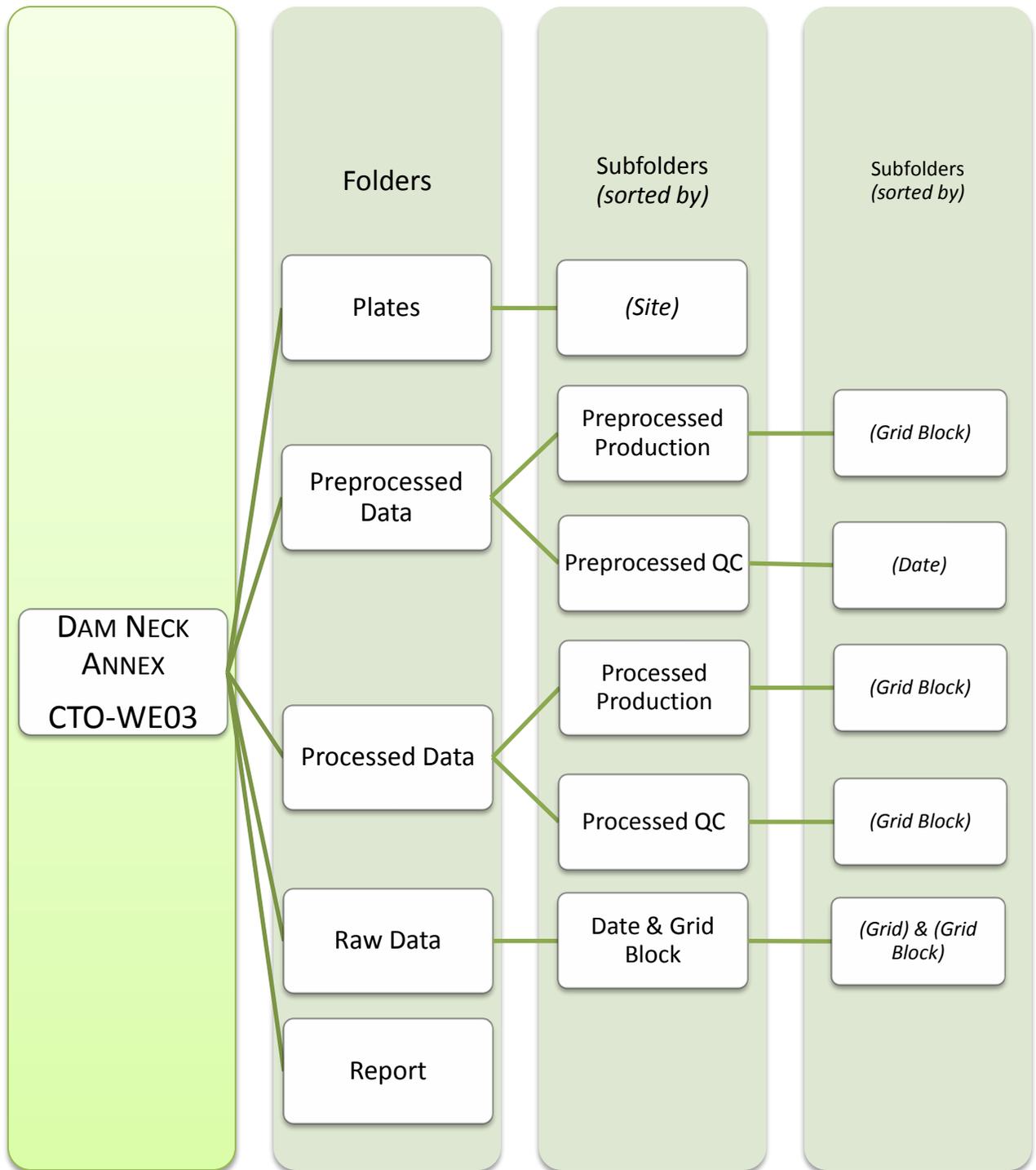
AM test
Operator: GeoA
Date: 3/25/2010

● Outside range
--- Acceptable limits



CD-ROM containing
Grid Maps, Target
Lists, EM61-MK2 Data

CONTENTS OF CD



Appendix B
CH2M HILL Geophysical Investigation Field
Documentation – NALF Fentress

Fentress DGM Survey - Field Data Sheets

CH2M HILL: Field Data Sheet 2

Single Coil Geonics MK2

Date: 10/24/10

Project # _____

Field Personnel: Nelson Figeac
Kenji Butler

System: EM61 MK2

Array size: 1 Coil

Coil: Bottom Only _____ Top and Bottom

Data Collection Mode: 4 D _____

QC1 Test (Equipment/Electronics)

Equipment Serial Numbers

** See Day One !!MUST NOTE IF THIS CHANGES!!

Pre-Survey Checklist

Warm-up (15 minutes) Start time: 0929

End Time: 0944

Check Batteries:

Battery Voltage:

Check Gasoline Levels: _____

Check Cable Connections:

Visual Inspection of EM Coils:

Visual Inspection of GPS Antenna:

QC2 Test (Sensor Positions)

Height to Bottom of Sensor: _____

Height to Top of Sensor: _____

GPS Frequency: _____ MHz

GPS Base Location: NA

QC3 Test (Personal Test)

Operator has removed personal effects that may cause instrument interference:

QC4 (Cable Shake Test)

File name: 102910 QLS

Line: _____

Check Cable Connections:

Shake Cables:

QC5_AM Test (Static/Standard)

File Name: 102810 QCS

Battery Voltage: 12.75V

QC7_PM Test (Static/Standard)

File Name: 102810 QCS PM2

Battery Voltage: 13.05V (new battery)

Channel 3

Static (1 min)	Standard (3 min)	Static (1 min)
3.4	44.6	4.2

Static (1 min)	Standard (3 min)	Static (1 min)
0.3	4.1	0.1

QC6_AM Latency Test

File Name: _____

Line Length: _____

Target Northing: _____

Target Easting: _____

Moved: _____

Object changed: _____

QC8_PM Latency Test

File Name: _____

Line Length: _____

Target Northing: _____

Target Easting: _____

Moved: _____

Object changed: _____

Fentress DGM Survey - Field Notes

- 0730 Arrive onsite, check in with front office. No
Flight Ops until 1800 hrs. Head at to site
- 0750 Hold tailgate meeting,
- 0810 Flight Ops meeting, remains, will wait for the week
to clear before heading out
- 0900 Head to where items were found to take picture & GPS points
- 0920 Back at vehicle, start setting up PENEK MKC-2
- 0929 Start up machine, will fill out form for setup data
- 1010 Head into South target location, file name: 102810ST
- 1025 Start Recording data

Track #	From	To	Track #	From	To
0	Center	South	1	South	Center
2	Center	South	3	South	100ft S from center
4	100ft S of center	South	4	cont. of 4	119ft S of center
5	119ft S of center	South			

1100 Complete South Tracet

1102 Head to North Tracet

1110 start file 102810ST2, North Tracet

Track #	From	To	Track #	From	To
0	Center	North	1	North	Center
2	Center	North	3	North	Center
4	Center	North	5	North	Center
6	Center	North	7	North	Center
8	Center	North	9	North	Center
10	Center	North			

Location NALF Featress Date 10/28/2010

Project / Client _____

- 1140 2 Visitors onsite Captain Densely & Lt Grimstead from NALF
- 1153 Finished North Truncat of Southern Target area
- 1200 7 more Navy personal onsite. Lt. Sparkman: 257-650 8848
- 1218 Everyone leaving EOD Norfolk will be on site in an hour.
- 1225 Breakfast Lunch
- 1245 head back in to do East truncat of Southern target
- 1254 File 102810 STE visit for East Truncat

Track #	From	To	Track #	From	To
0	C	East 1/4 way	1	East Ditch	Center
—	—	—	—	—	—

There is a metal pipe going East west thru the ditch giving a signal. Pipe goes under N/S road

2	East Ditch	East	3	East	East Ditch
---	------------	------	---	------	------------

1371 Finish East Truncat going to west truncat File

102810STW	Track #	From	To	Track #	From	To
	3	Center	west ditch	4	west ditch	Center
	5	west ditch	West	6	West	west ditch
	7	west ditch	West	8	West	West Ditch

1325 Senior Chief Philips and EOD personal visit to remove 2 MK23, and one Signal smoke container.

1345 EOD folks off site.

1422 At North Target area, will start on south Truncat

Location NALF Featress Date 10/28/2010

Project / Client _____

- 1425 File num: 102810 NTS
- | Track # | From | To | Track # | From | To |
|---------|-------|--------|---------|--------|---------------|
| 9 | South | Center | 10 | Center | South |
| 11 | South | Center | 12 | Center | 1/2 way South |
- 1436 Finish going down South Truncat, going North next
- 1439 File: 102810 NTN

Track	From	To	Track #	From	To
13	Center	North	14	North	Center
15	Center	North	16	3/4 North	1/2 to Center

1451 Finished North Truncat, heading to vehicle for fuel

1535 File num: 102810 NTE

Track	From	To	Track	From	To
17	Center	East	18	East	Center

1545 Start going West. File: 102810 NTW

Track	From	To	Track	From	To
19	Center	West	20	West	Center
21	Center	1/4 West			

1600 Head back to vehicle, pick-up equipment left along the way

1620 change out battery on EM61.

1635 Start PM check

1655 Finished on site, head back to office to check out

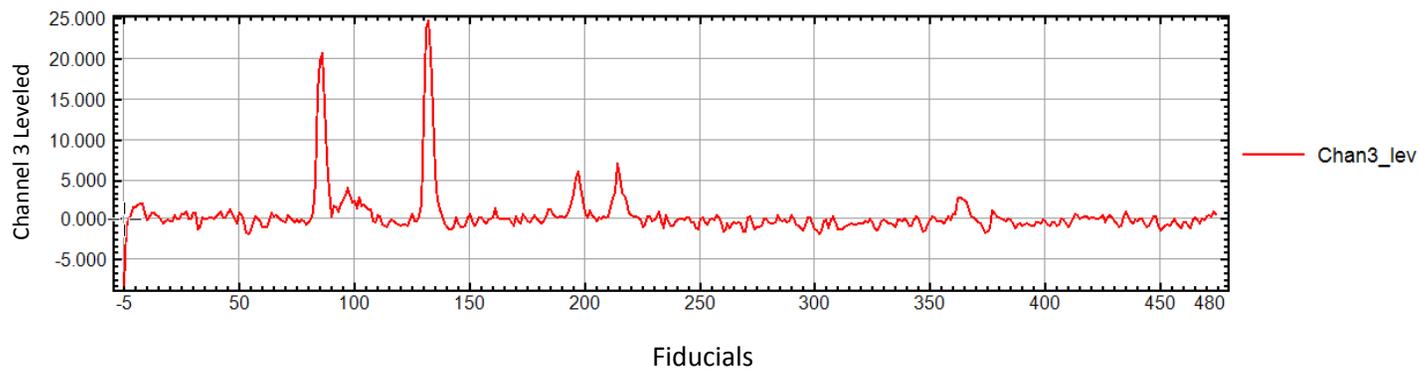
EM61-MK2 Reconnaissance Data

Naval Auxiliary Landing Field Fentress
Virginia

North Target – North Profile #1

South (Target Center)

North (Target Edge)



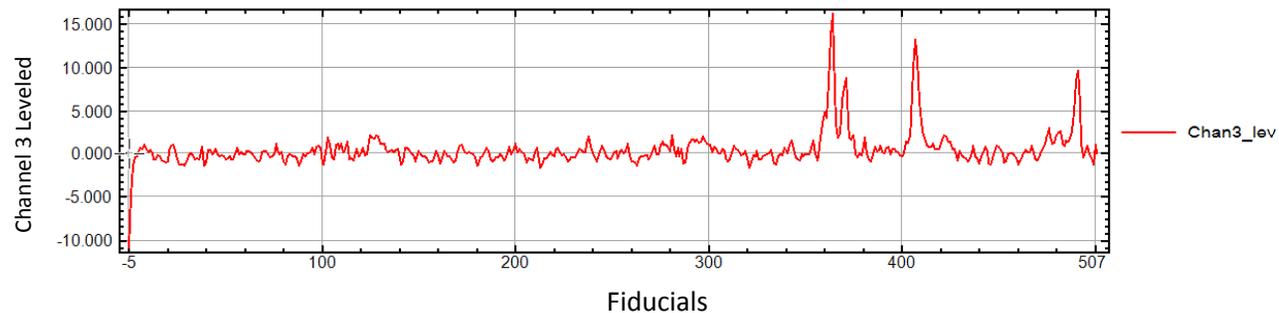
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2011/01/11

North Target – North Profile #2

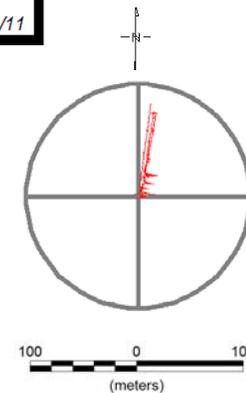
North (Target Edge)

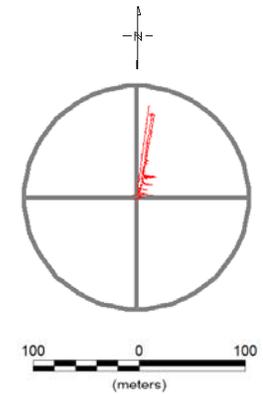
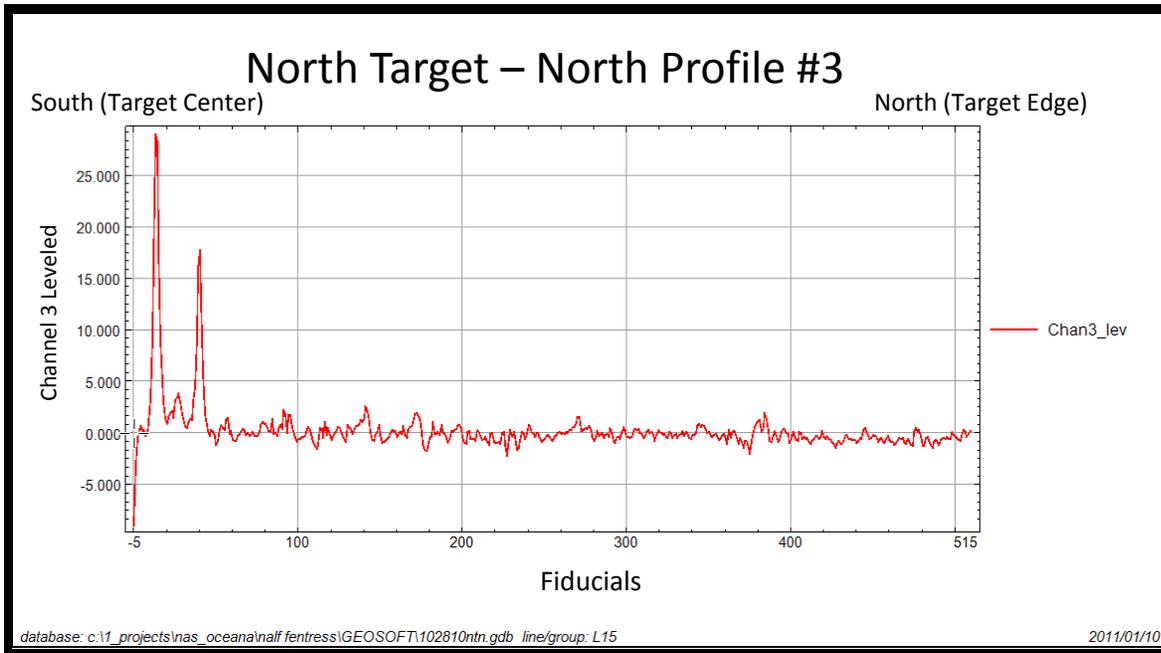
South (Target Center)

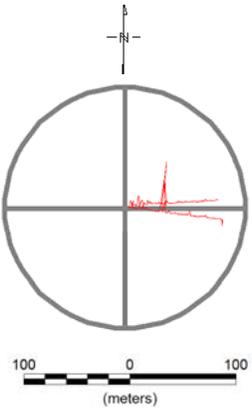
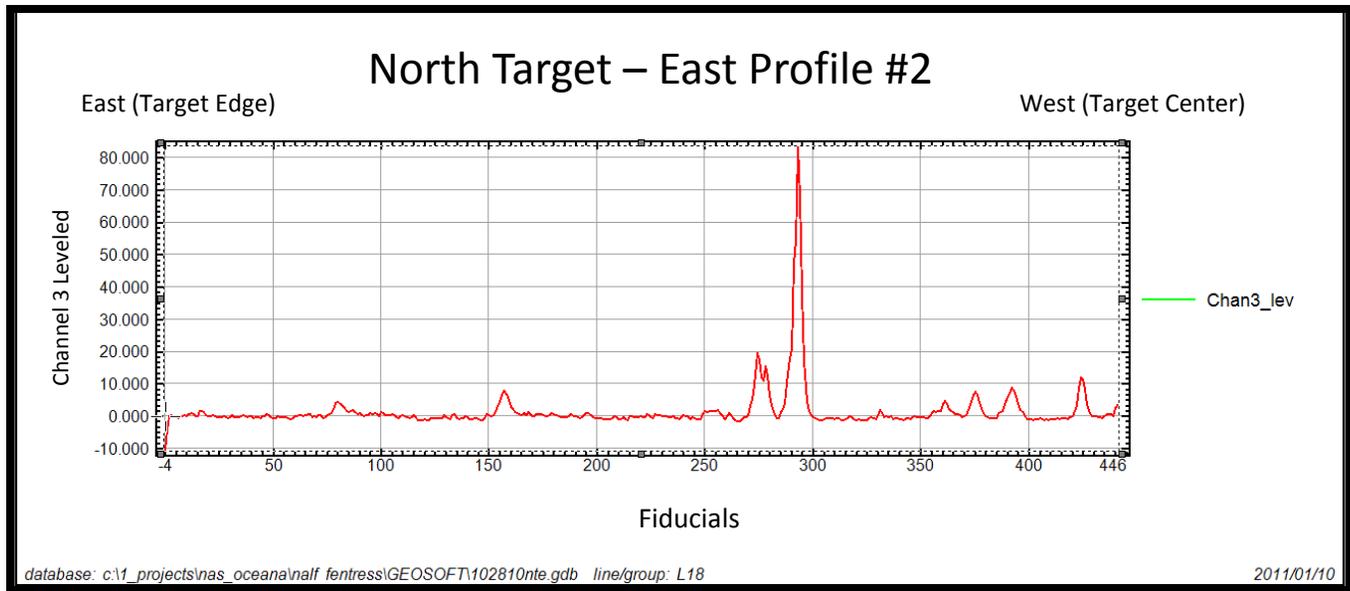
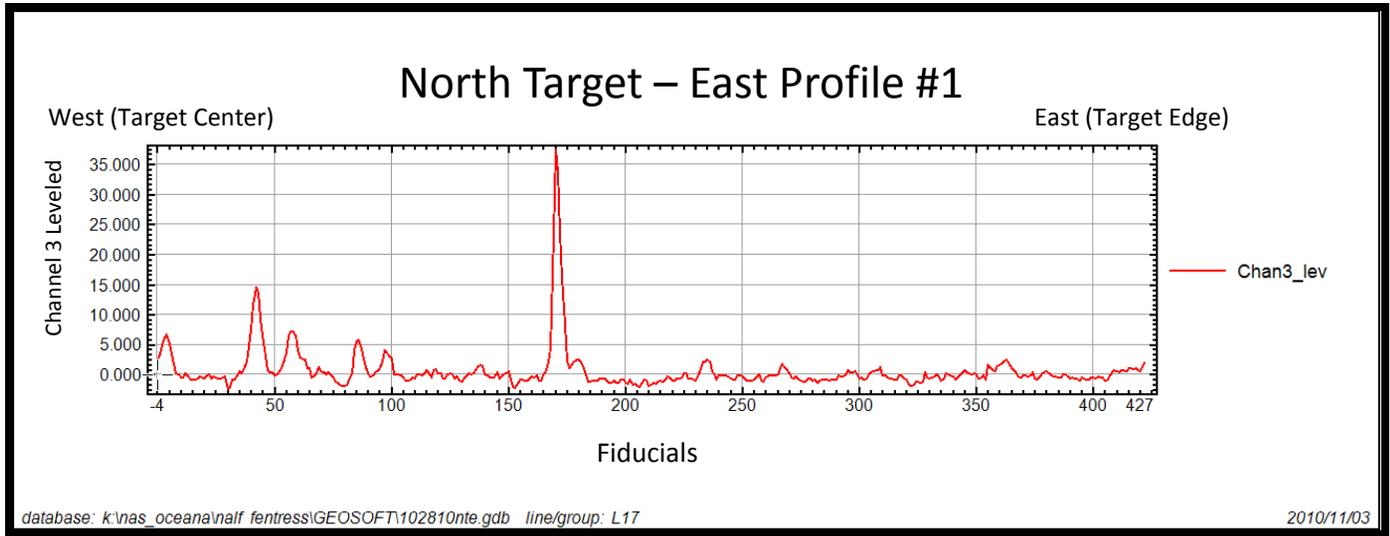


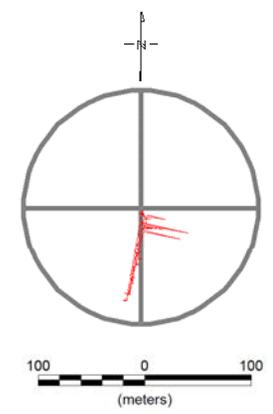
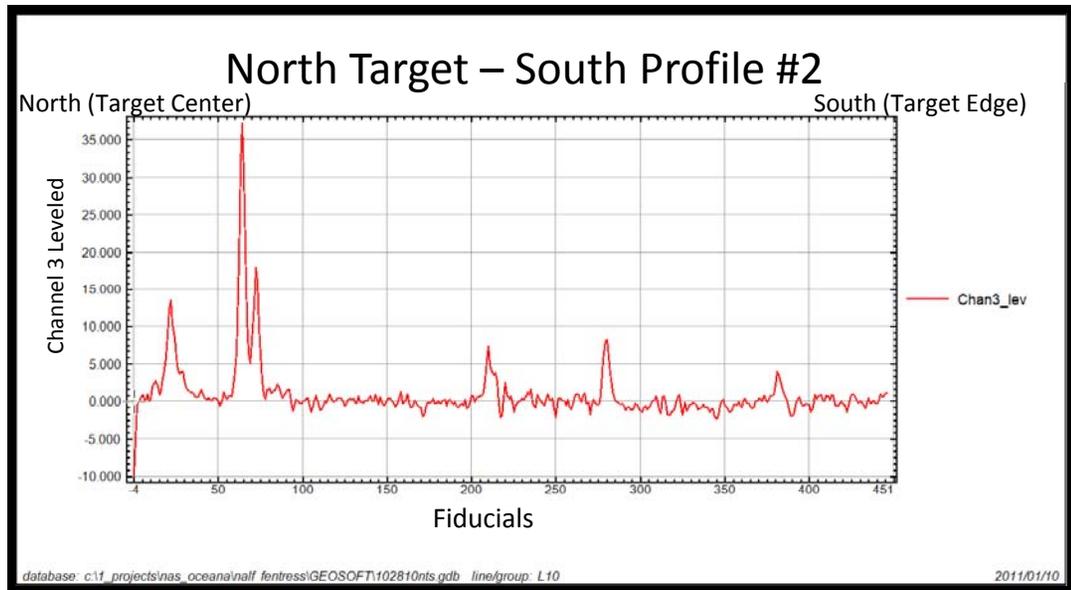
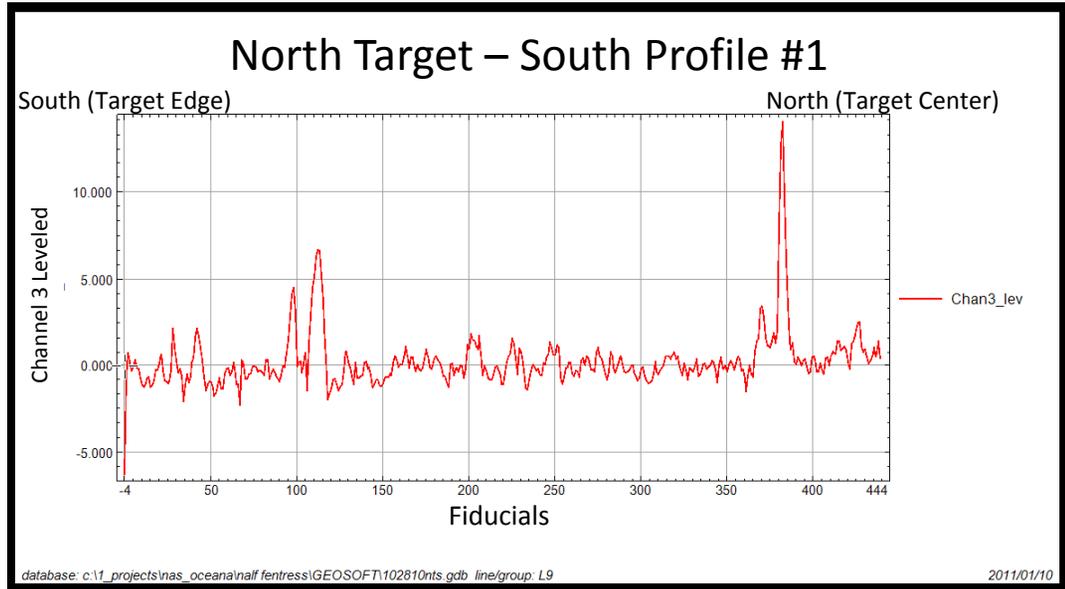
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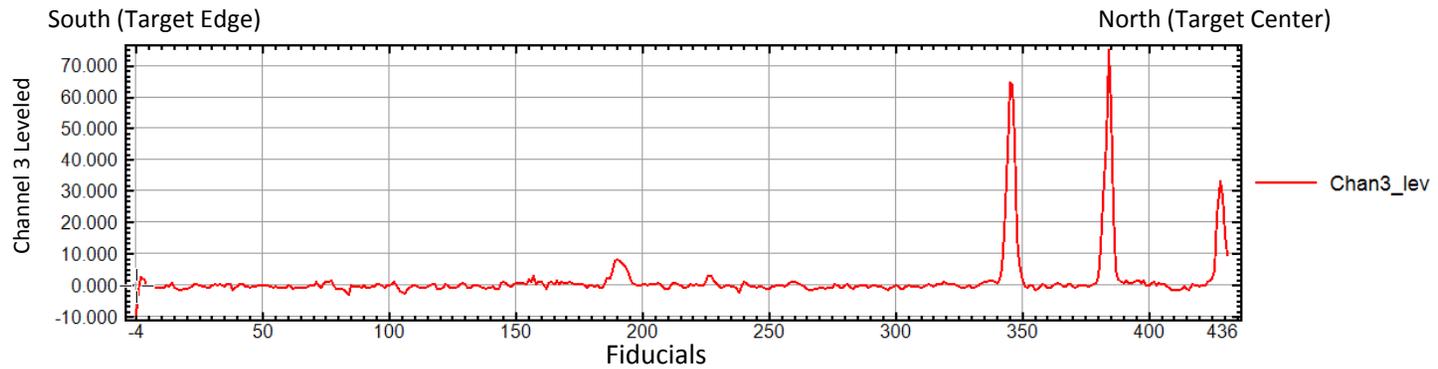






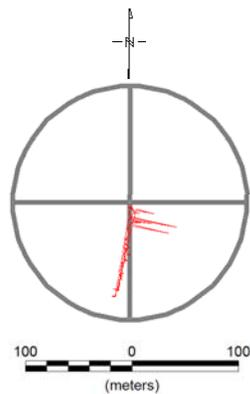
Naval Auxiliary Landing Field Fentress -
EM61-MK2 Reconnaissance Data

North Target – South Profile #3

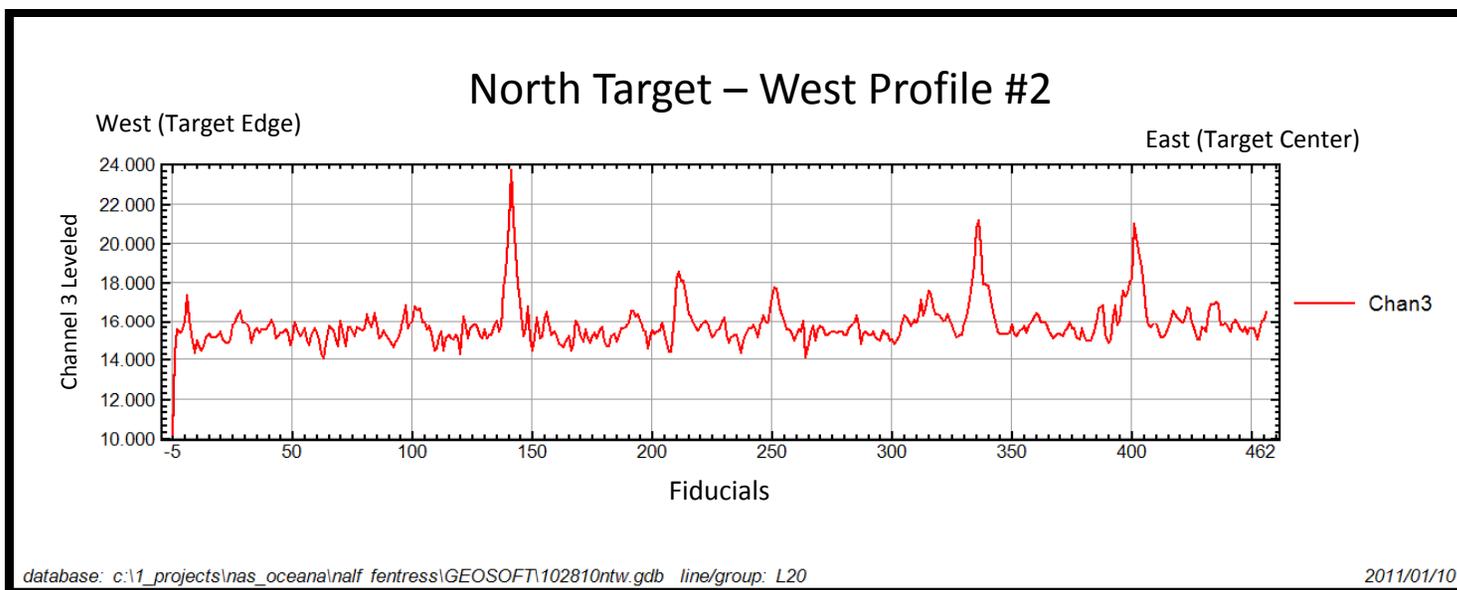
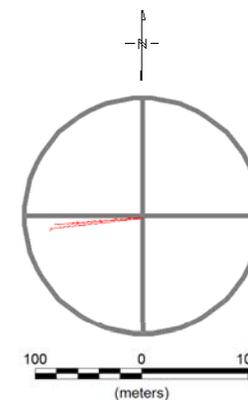
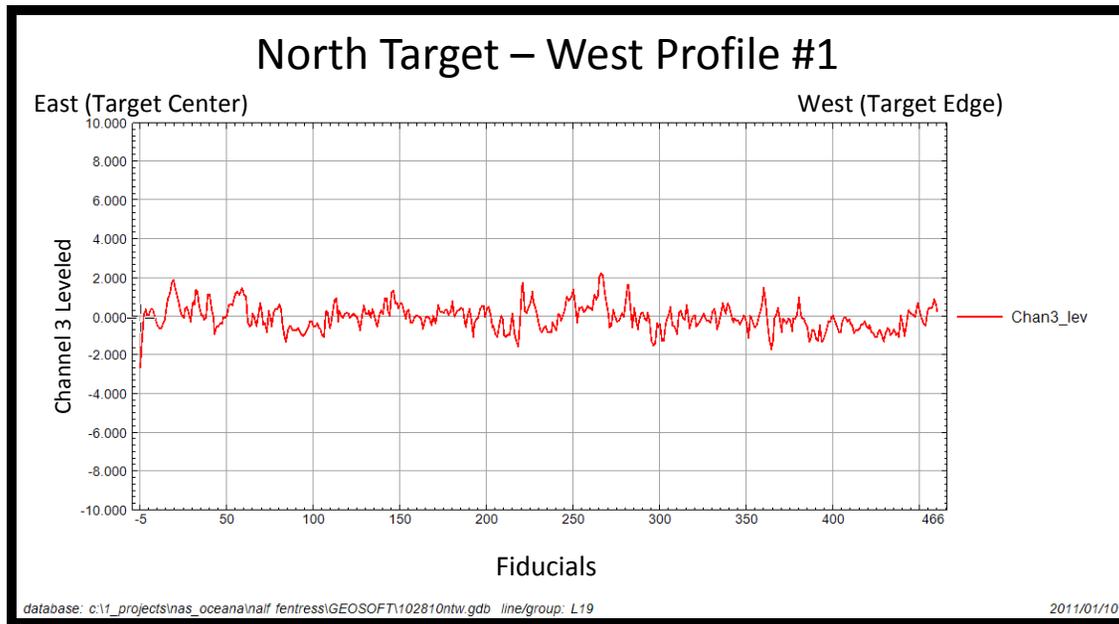


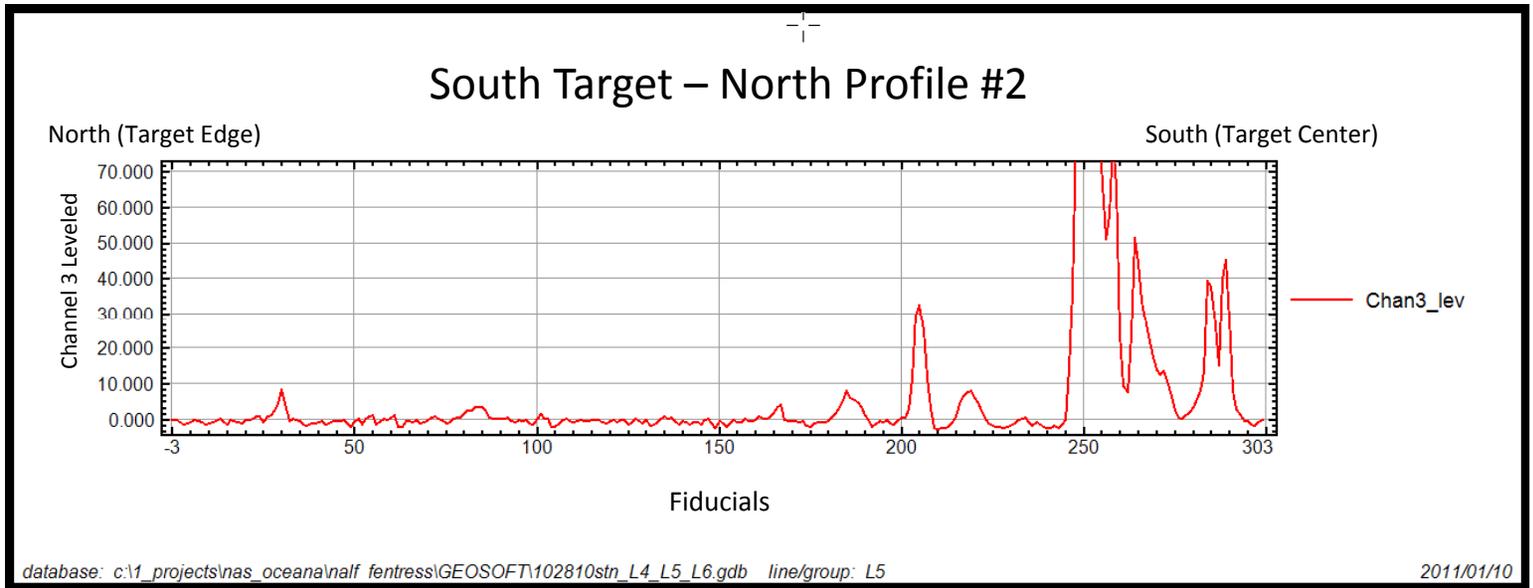
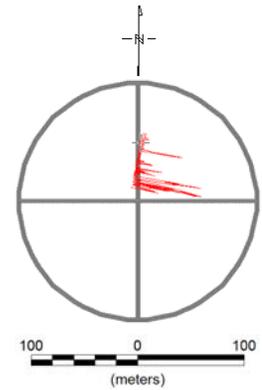
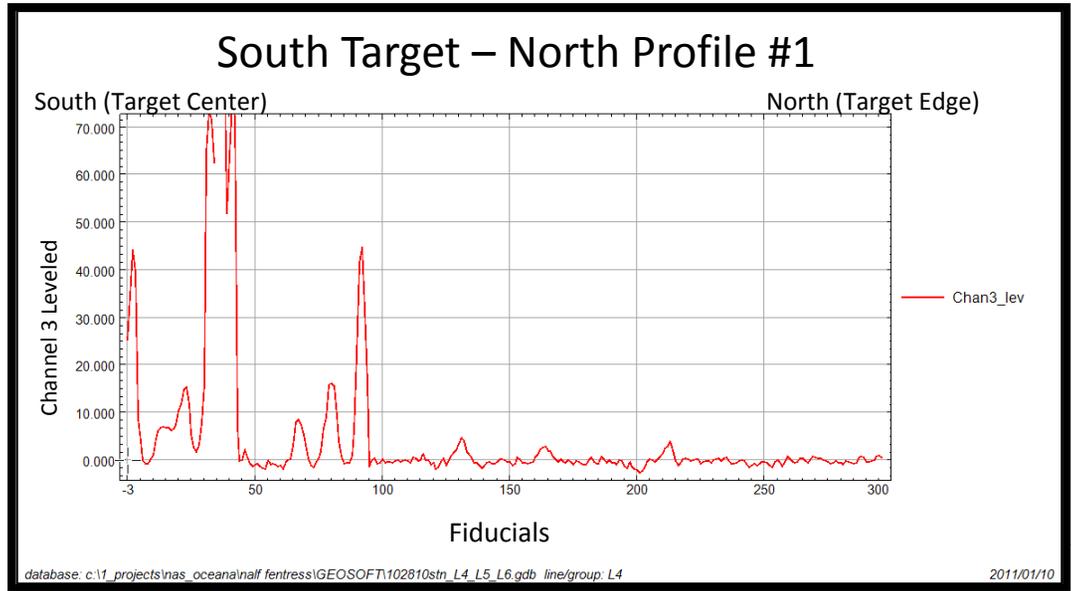
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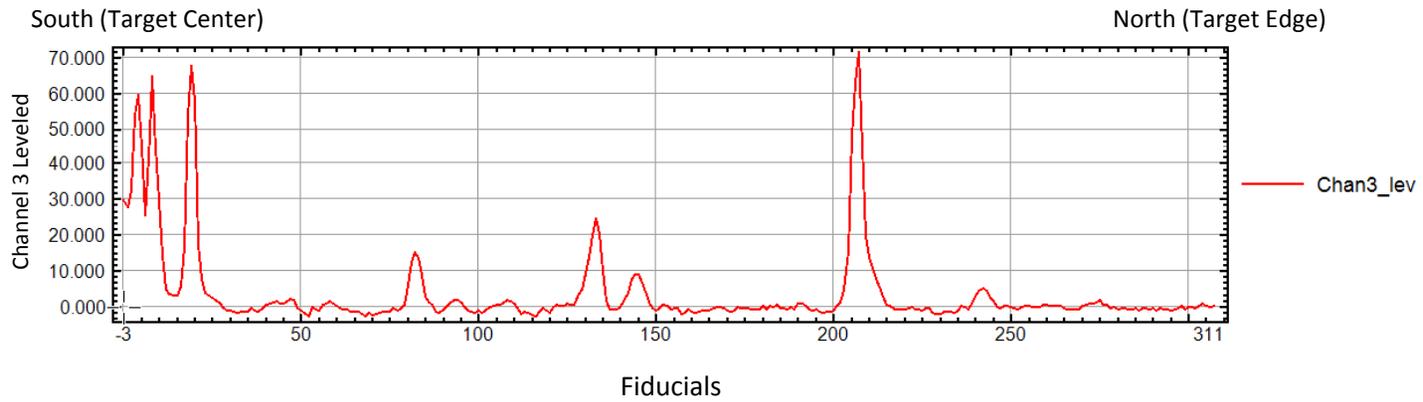


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EM61-MK2 Reconnaissance Data



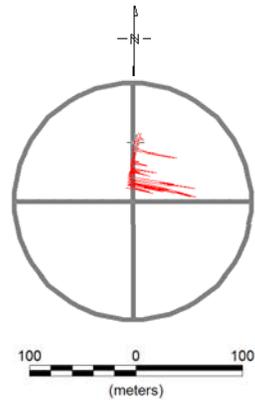


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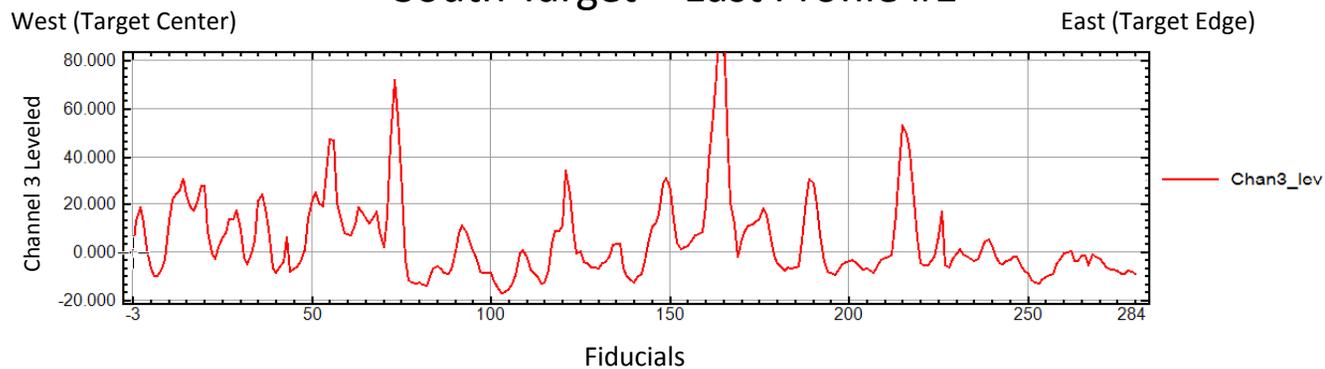
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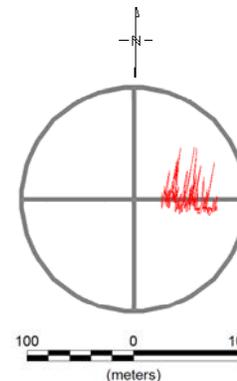
Naval Auxiliary Landing Field Fentress -
EM61-MK2 Reconnaissance Data

South Target – East Profile #1

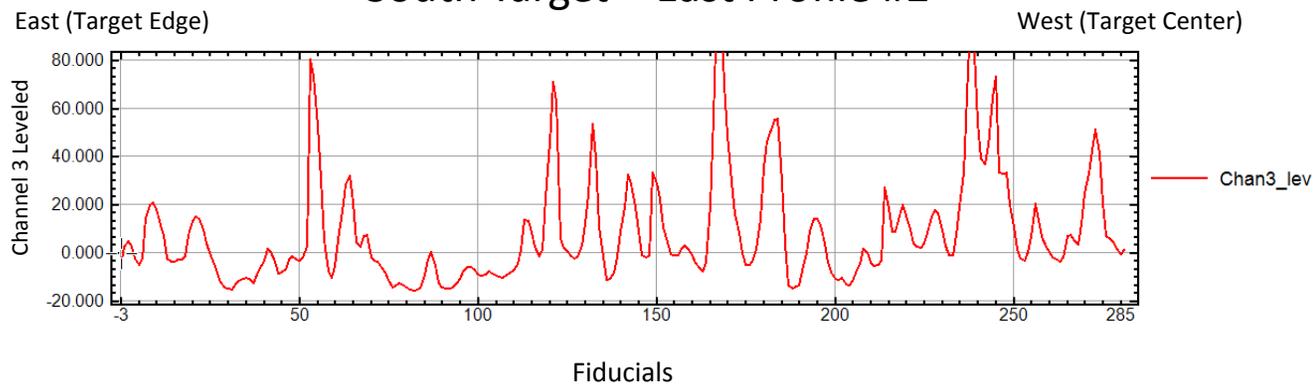


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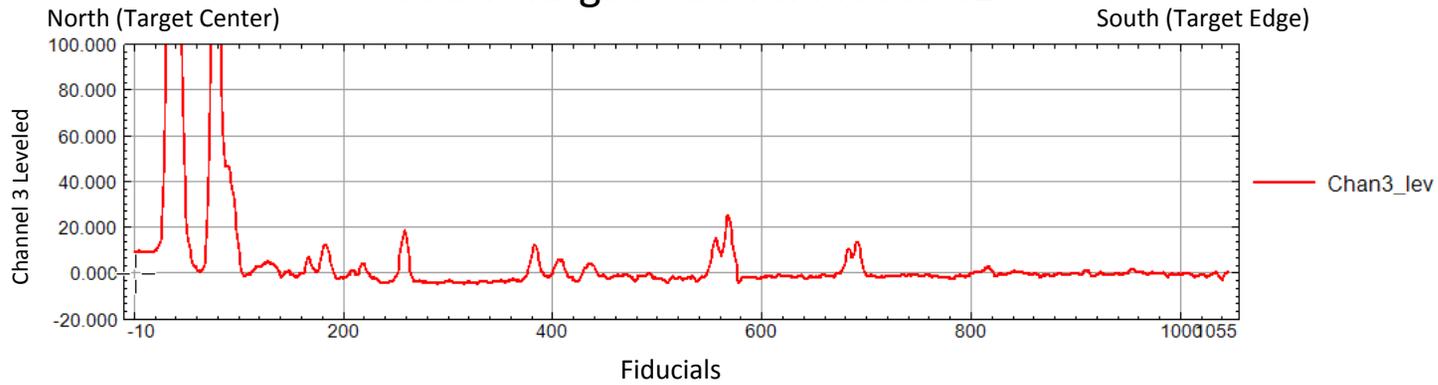
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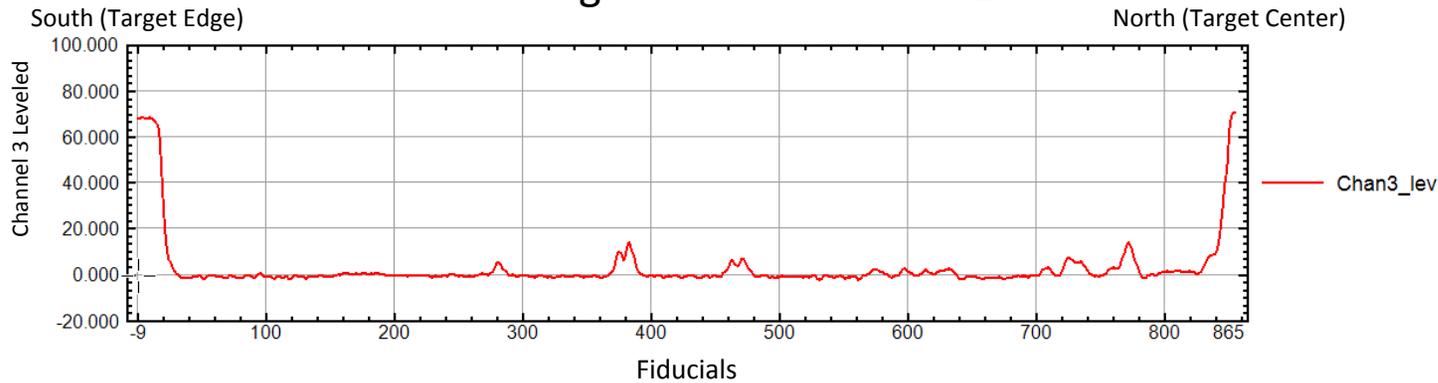
South Target – South Profile #1



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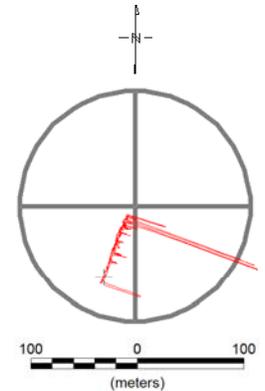
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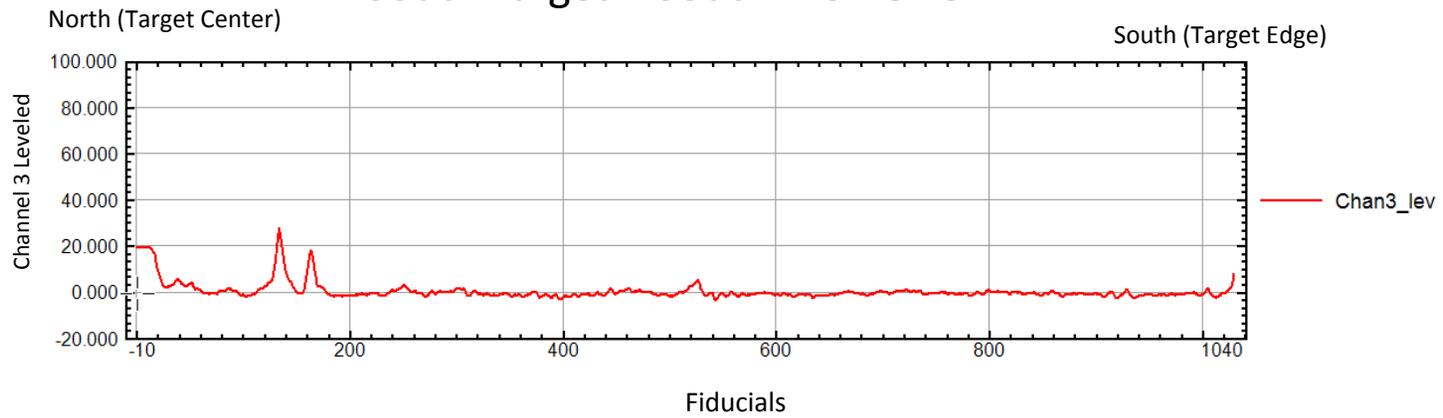


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2011/01/10

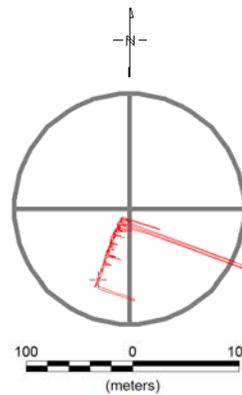


South Target – South Profile #3

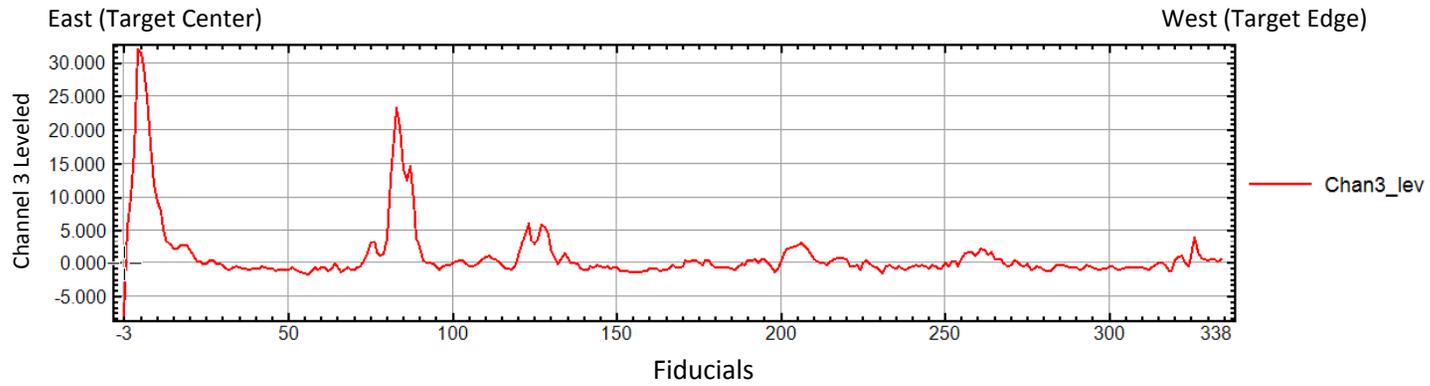


database: c:\1_projects\nas_oceana\nalf_fentress\GEOSOFIT\102810sts.gdb line/group: L2

2011/01/10

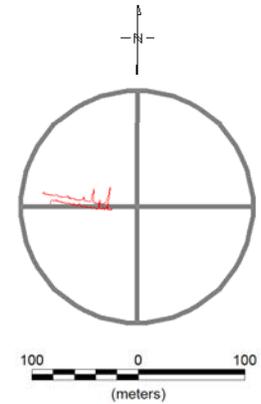


South Target – West Profile #1

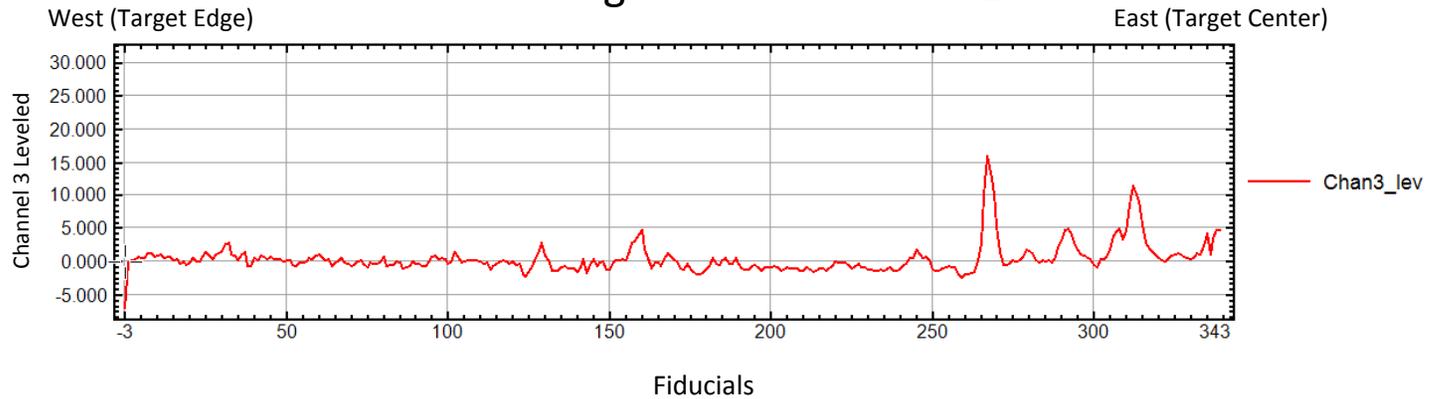


database: c:\1_projects\nas_oceana\nalf_fentress\GEOSOFT\102810stw_L5_L8.gdb line/group: L5

2011/01/11



South Target – West Profile #2



database: c:\1_projects\nas_oceana\nalf_fentress\GEOSOFT\102810stw_L5_L8.gdb line/group: L8

2011/01/11