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FINAL SITE INSPECTION REPORT AT UXO 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31 AND 33

NSWC INDIAN HEAD MD
9/10/2010
CH2MHILL

Final

Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33

Naval Support Facility Indian Head
Indian Head, Maryland

Contract Task Order 0012

September 2010

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Prepared by

Chantilly, Virginia

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Executive Summary

A Site Inspection (SI) was conducted for 12 unexploded ordnance (UXO) land and water sites under the Munitions Response Program at Naval Support Facility Indian Head, in Indian Head, Maryland. The work was performed under the U.S. Department of the Navy, Naval Facilities Engineering Command Washington Comprehensive Long-term Environmental Action, Navy; Contract Number N62470-08-D-1000, Contract Task Order 0012. The 12 UXO sites are:

Land Sites
UXO 6 – Nitroglycerin Slums Burning Ground
UXO 9 – Single Base Propellant Grains Spill Area
UXO 11 – The Valley
UXO 13 - FDR Skeet Range
UXO 20 – Safety Thermal Treatment Point
UXO 29 – Southwestern Pistol Range
UXO 30 – Gate 3 Burning Ground

Water Sites
UXO 18 – Battle Range Firing Area
UXO 19 – Igniter Area
UXO 27 – Sonar Training Area
UXO 31 – Pope's Creek
UXO 33 – Water Impact Area

Field investigation activities were performed from October 2009 through April 2010 to present site-specific information for use by members of the Navy, U.S. Environmental Protection Agency Region III, Maryland Department of the Environment, and Naval Support Facility Indian Head. The objective of the SI for the 12 UXO sites is to assess whether munitions and explosives of concern or munitions constituents are present at the sites and to determine whether additional investigations are warranted. This decision will be based on discussions with the Indian Head Installation Restoration Team on the appropriate management decision for each site. This report presents the investigation methods, findings, and recommendations for each site and provides the basis for making management decisions for each site following the Comprehensive Environmental Response, Compensation, and Liabilities Act process.

Following the completion of the SI investigations, all information, including field observations, field measurements, geophysical results, and analytical data, were reviewed and interpreted. Analytical results were evaluated and compared against the U.S. Environmental Protection Agency's regional screening levels and installation-specific background concentrations, where applicable. On the basis of this process, recommendations are provided as to whether there would be further investigation or no further action for each site. Table ES-1 summarizes the scope of work completed for each site and recommendations. In summary, one site (UXO 29) is recommended for no further action, four sites (UXOs 18, 27, 31, and 33) for institutional controls, and seven sites (6, 9, 11,

13, 19, 20, and 30) for remedial investigations and/or interim removal actions to reduce the near-term risk to human health and the environment.

Table ES-1
Summary of SI Investigation Activities and Recommended Actions
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Site	Aerial Photographic Analysis	Digital Geophysical Mapping	Munitions and Explosives of Concern Inventory (MEC)	Expanded Preliminary Assessment	Munitions Constituents (MC) Sampling					Recommended Actions
					Surface Soil Samples	Subsurface Soil Samples	*In Situ* Groundwater Samples	Sediment	Laboratory Analyses	
UXO 6 - Nitroglycerine Slums Burning Ground	x				x	x	x		Perchlorate, explosives (including nitroglycerin, nitrocellulose, and nitroguanidine), and PAHs	**MEC** • No further investigation **MC** • No further investigation for surface soil and subsurface soil • RI for groundwater
UXO 9 - Single Base Propellant Grains Spill Area	x		x							**MEC** • Non-time critical removal action **MC** • RI for soil and groundwater
UXO 11 - The Valley	x	x			x	x	x		TAL metals, perchlorate, and explosives (including nitroglycerin, nitrocellulose, and nitroguanidine)	**MEC and MC** • RI for MEC and MC (in soil and groundwater)
UXO 13 - FDR Skeet Range	x				x				TAL metals and PAHs	**MEC** • No further action **MC** • RI for surface soil around the trap house
UXO 18 - Battle Range Firing Area				x						**MEC and MC** • No further investigation • Implement institutional controls • Update Danger Zone on NOAA maps and regulations
UXO 19 - Igniter Area	x		x					x	TAL metals, perchlorate, and explosives (including nitroglycerin, nitrocellulose, and nitroguanidine)	**MEC** • Non-time critical removal action **MC** • No further investigation for sediment
UXO 20 - Safty Thermal Treatment Point	x									**MEC and MC** • RI for MEC and MC (soil and groundwater)
UXO 27 - Sonar Training Area		x								**MEC and MC** • No further investigation • Implement institutional controls • Update Danger Zone on NOAA maps and regulations
UXO 29 - Southwestern Pistol Range	x									No further action
UXO 30 - Gate 3 Burning Ground	x	x			x	x	x		TAL metals, perchlorate, explosives (including nitroglycerin, nitrocellulose, and nitroguanidine), and PAHs	**MEC and MC** • RI for MEC and MC (soil and groundwater)
UXO 31 - Pope's Creek				x						**MEC and MC** • No further investigation • Implement institutional controls • Update Danger Zone on NOAA maps and regulations
UXO 33-Water Impact Area				x						**MEC and MC** • No further investigation • Implement institutional controls • Update Danger Zone on NOAA maps and regulations

Notes:
RI = Remedial investigation
TAL = Target Analyte List
PAHs - polycyclic aromatic hydrocarbons
NOAA - National Oceanic and Atmospheric Administration

Abbreviations and Acronyms

µg/kg	microgram(s) per kilogram
ARM	ARM Geophysics
bgs	below ground surface
CSM	conceptual site model
DGM	digital geophysical mapping
DPT	direct-push technology
DQO	data quality objective
DTE	desktop evaluation
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
ESS	Explosives Safety Submission
IAS	Initial Assessment Study
IDW	investigation-derived waste
IHIRT	Indian Head Installation Restoration Team
IRA	interim removal action
IVS	instrument verification strip
GPS	global positioning system
GSV	geophysical system verification
m	meter(s)
MC	munitions constituents
MDE	Maryland Department of the Environment
MEC	munitions and explosives of concern
mg/kg	milligram(s) per kilogram
msl	mean sea level
Navy	U.S. Department of the Navy
NFA	no further action
NG	nitroglycerin
NOAA	National Oceanic and Atmospheric Administration
NOSSA	Naval Ordnance Safety and Security Activity
NSF-IH	Naval Support Facility Indian Head
OB	open burning
OB/OD	open burning/open detonation
OER	Ordnance & Explosives Remediation, Inc.
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PVC	polyvinyl chloride

QC	quality control
RDX	Royal Demolition eXplosive (also known as cyclonite or hexogen)
RI	Remedial Investigation
RSL	regional screening level
RTK	real-time kinematic
SI	Site Inspection
STTP	Safety Thermal Treatment Point
TVG	transverse gradiometer
UFP-SAP	Uniform Federal Policy-Sampling and Analysis Plan
UTL	upper tolerance limit
UXO	unexploded ordnance
WAMS	Water Area Munitions Study

SECTION 1

Introduction

This report presents the Site Inspection (SI) results for 12 sites at Naval Support Facility Indian Head (NSF-IH), in Indian Head, Maryland (Figures 1-1 and 1-2). This document was prepared under the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command Washington Comprehensive Long-term Environmental Action, Navy; Contract Number N62470-08-D-1000, Contract Task Order 0012. CH2M HILL has prepared this report for use by the Indian Head Installation Restoration Team (IHIRT), which comprises the Navy, U.S. Environmental Protection Agency (EPA) Region III, Maryland Department of the Environment (MDE), and NSF-IH.

The SI was performed from October 2009 through April 2010 in accordance with the following work plans:

- CH2M HILL, 2009. *Site Inspection Work Plan for Igniter Area - UXO 19* (hereinafter referred to as the Igniter Area Work Plan)
- CH2M HILL, 2010a. *Munitions Investigation Work Plan for Land Sites UXO 6, UXO 9, UXO 11, UXO 20, and UXO 30; and Water Site UXO 27* (hereinafter referred to as the MEC Work Plan)
- CH2M HILL, 2010b. *Uniform Federal Policy-Sampling and Analysis Plan for Munitions Constituents Site Inspection at Land Sites UXO 6, 11, 13, and 30* (hereinafter referred to as the UFP-SAP)

This report summarizes SI activities and recommended site management decisions for the following unexploded ordnance (UXO) land and water sites:

<u>Land Sites (Figure 1-1)</u>
UXO 6 – Nitroglycerin (NG) Slums Burning Ground
UXO 9 – Single Base Propellant Grains Spill Area
UXO 11 – The Valley
UXO 13 - FDR Skeet Range
UXO 20 – Safety Thermal Treatment Point (STTP)
UXO 29 – Southwestern Pistol Range
UXO 30 – Gate 3 Burning Ground

<u>Water Sites (Figure 1-2)</u>
UXO 18 – Battle Range Firing Area
UXO 19 – Igniter Area
UXO 27 – Sonar Training Area
UXO 31 – Pope's Creek
UXO 33 – Water Impact Area

Site descriptions and background information used in this report are contained in the following reports:

Land Sites: Final Preliminary Assessment, Main Installation, Naval District Washington, Indian Head, Maryland (Malcolm Pirnie, 2005a) (hereinafter referred to as the PA)

Water Sites: Final Water Area Munitions Study, Naval District Washington, Indian Head, Maryland (Malcolm Pirnie, 2005b) (hereinafter referred to as the WAMS)

1.1 Overview of SI Process

The Navy is in the process of investigating closed ranges following the investigation process required by the Comprehensive Environmental Response, Compensation and Liability Act. As part of this process, a Preliminary Assessment (PA) was completed for the land sites (Malcolm Pirnie, 2005a) and a Water Area Munitions Study (WAMS) was completed for the water sites (Malcolm Pirnie, 2005b). The next step in the investigation process was to conduct an SI, based on the recommendations in the PA. The 12 sites discussed in this SI report were identified in the PA.

In accordance with an SI, the investigations conducted were not intended to characterize the nature and extent of munitions and explosives of concern (MEC) and/or munition constituents (MC) contamination at each site, but rather to provide data sufficient to determine their presence or absence.

The 12 sites discussed in this report required various types of investigations, ranging from aerial photographic analysis to digital geophysical mapping (DGM), MEC inventory, and environmental sampling for MC. The site-specific sections in this report described the types of investigations conducted for each site and the findings from the investigations.

This report also provides the basis for making one of the following management decisions for each site, following the Comprehensive Environmental Response, Compensation and Liability Act process:

1. Perform a time-critical removal action or non-time-critical removal action, based on the types of MEC or MC present, to remove the contamination from the site
2. Perform a remedial investigation and/or other investigation as warranted, based on the presence of MEC and MC
3. Remove the site from further study and recommend no further action (NFA), based on the absence of geophysical anomalies or MC

The results of the SI investigation are presented in this report for use by the IHIRT in making a management decision about the path forward for each site.

1.2 Project Objectives

The overall objective of the SI was to determine the presence or absence of MEC and/or MC at each site. To accomplish this objective, one or more of the following investigations were conducted: environmental sampling for MC, DGM, and MEC inventory activities. The information obtained from these investigations will be used to move the 12 UXO land and

water sites through the SI and gain endorsement from the IHIRT on the appropriate management decision for each site.

1.3 Base Setting

NSF-IH is located in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, DC. NSF-IH is a Navy facility consisting of the Main Installation on Cornwallis Neck Peninsula and the Stump Neck Annex on Stump Neck Peninsula (Figure 1-1). The Main Installation contains approximately 2,500 acres and is bounded by the Potomac River to the northwest, west, and south; Mattawoman Creek to the south and east; and the town of Indian Head to the northeast. Included as part of the main area are Marsh Island and Thoroughfare Island, which are located in Mattawoman Creek. Elevations range from sea level to approximately 125 feet above mean sea level (msl). The Stump Neck Annex contains approximately 1,084 acres and is bounded by Mattawoman Creek to the northeast, the Potomac River to the northwest, and Chicamuxen Creek to the south-southwest. Elevations range from sea level to approximately 10 feet above msl.

Both the Main Installation (Cornwallis Neck Peninsula) and the Stump Neck Annex are on the National Priorities List. The Main Installation and Stump Neck Annex are separated by Mattawoman Creek (noncontiguous), have separate EPA identification numbers, and perform dissimilar operations.

NSF-IH was established in 1890 and is the Navy's oldest continuously operating ordnance station. At various times during its operation, NSF-IH has served as a gun and armor proving ground, a powder factory, a propellant plant, and a research facility. Stump Neck Annex, which was acquired in 1901, provided a safety buffer for testing larger naval guns that were tested by firing into the Potomac River and at Stump Neck. The production of gunpowder and development of new explosives during the onset of World War II resulted in the construction of several new facilities at Indian Head, as well as the construction of Route 210 as a Defense Access Road in 1943. Development and improvements at Indian Head continued throughout the 1950s and 1960s, and in 1966, NSF-IH was renamed the Naval Ordnance Station.

After the Vietnam conflict, the mission of NSF-IH shifted from primarily a production facility to a highly technical engineering support operation. In 1987, the facility was established as a Center for Excellence to promote technological excellence in the following specialized fields: energetic chemicals; guns, rockets and missile propulsion; ordnance devices; explosives; safety and environmental protection; and simulators and training (Parsons, 2000). Current military land uses are operations and training; production; maintenance and utilities; research, development, testing, and evaluation; explosive storage; supply and non-explosive storage; administration; community facilities and services; housing; and open space.

Information on the topography, geology, hydrology, and hydrogeology are presented in the PA and WAMS reports. To reduce duplication of information, the information will not be repeated in this report.

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 1-1 - FACILITY & LAND SITE LOCATIONS.MXD BHATHAWA 8/6/2010 10:23:25

Legend

Approximate Site Boundary

Installation Boundary

N

0 2,300 4,600 Feet

1 inch = 4,600 feet

Imagery Source: Google Earth Pro

Figure 1-1
Facility and Land Site Locations
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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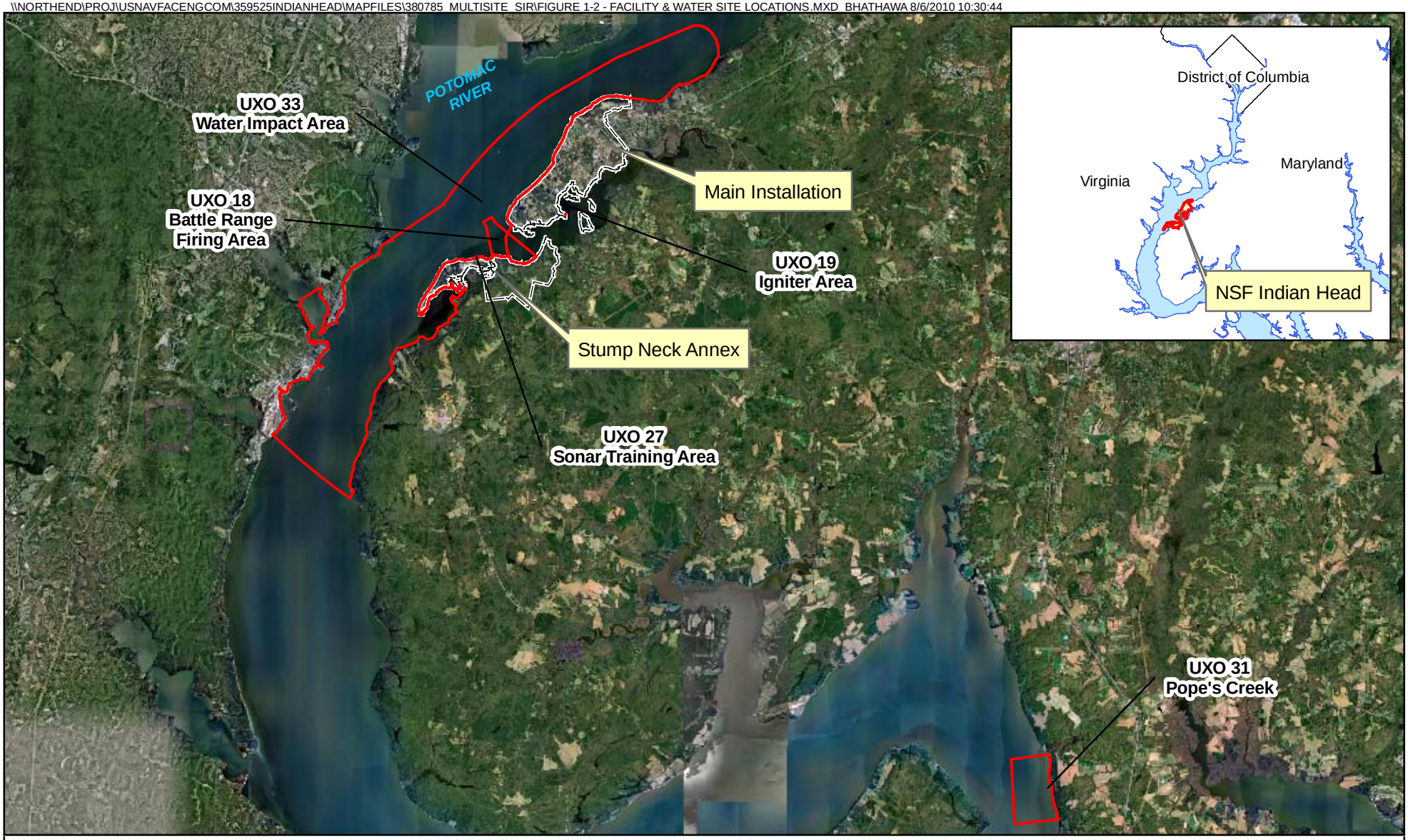
\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 1-2 - FACILITY & WATER SITE LOCATIONS.MXD BHATHAWA 8/6/2010 10:30:44



Legend

Approximate Site Boundary

Installation Boundary

N

0 8,000 16,000 Feet

1 inch = 16,000 feet

Imagery Source: Google Earth Pro

Figure 1-2
Facility and Water Site Locations
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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SECTION 2

Investigation Methods and Data Management

2.1 Aerial Photographic Analysis

Aerial photographic analysis was performed for UXOs 6, 9, 11, 13, 19, 20, 27, and 30. A similar analysis was not performed for UXOs 18, 29, 31, and 33 because the IHIRT had agreed to NFA for UXO 29, and the other three sites (UXOs 18, 31, and 33) are large (more than 300 acres) water sites. The analysis was conducted by Environmental Research, Inc. of Linden, Virginia. The firm's report is provided in Appendix A, and the results are summarized in the specific section of this report for each site.

2.2 Geophysical Survey

DGM was performed at land sites UXO 11 and UXO 30, and at shallow water site UXO 27 to identify anomalies that could represent subsurface (or underwater) MEC. ARM Geophysics (ARM), of Hershey, Pennsylvania, performed the DGM. Quality control (QC) review of the data was performed by both ARM and CH2M HILL geophysicists. In preparation for the geophysical survey at the land sites, a land survey was conducted to establish site boundaries and a grid system, followed by land clearing to remove vegetation that would impede the geophysical surveys. Appendix B provides the DGM report from ARM (hereinafter referred to as the Geophysical Report), and a summary of the work performed is provided below.

2.2.1 Land Survey

Positioning control for the geophysical survey at the land sites was conducted in accordance with the MEC Work Plan (CH2M HILL, 2010a). Thoth Land Surveying Professionals, Inc., a Maryland-licensed surveyor, conducted the site surveying activities to delineate the site boundaries and establish control points and a 30-meter (m) x 30m grid system within UXO 11 and UXO 30. All survey results were provided to CH2M HILL for incorporation into the project geographic information system.

2.2.2 Land Clearing

Ordnance & Explosives Remediation, Inc. (OER) was subcontracted to clear vegetation within sites UXO 11 and UXO 30 where necessary to perform the DGM surveys. Subgrowth and trees smaller than 6 inches in diameter were cut to within 6 inches of the ground surface using gas-powered chain saws and brush trimmers. Cut vegetation was mulched and left in place. Land clearing activities were conducted in conjunction with a visual UXO surface clearance by OER's UXO technicians to protect personnel and equipment. Because heavy rains occurring immediately before the start of field operations caused significant safety concerns along some of the steeper sloped terrain within UXO 11, a small percentage of the site could not be cleared of vegetation.

In addition, severe weather conditions were experienced during February/March 2010, resulting in two blizzards and accumulations of more than 30 inches of snow, followed by

ice and wind storms. These storms dropped limbs and trees within UXO11. The amount of tree fall was beyond the capabilities of manual brush clearing and would have required tracked vehicles to move large-trunked trees, resulting in intrusive actions to the soil and subsurface. To collect data, downed trees remained in place and were avoided by DGM crews, resulting in several data gaps for DGM coverage of the site. The impact of data gaps were found to be minimal and did not affect the overall analysis.

2.2.3 Land DGM

The DGM survey of the land sites was performed using the Geonics EM61-MK2 time domain electromagnetic (EM) sensor. This type of metal detectors is designed to detect shallow ferrous and non-ferrous metallic objects with very good spatial resolution and with minimal interference from adjacent metallic features and is therefore well suited for work close to man-made structures and in areas of dense subsurface metallic debris.

The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. The decay of the eddy currents produces a secondary magnetic field that is measured as a voltage in millivolts by the receiver coil of the instrument. The EM61-MK2 offers the ability to measure secondary eddy currents at four distinct time intervals. By taking measurements at relatively long times after the start of the decay, the current induced in the ground has fully dissipated, and only the current in the metal is producing a secondary field. Assuming accurate data positioning, target resolution of approximately 0.5 m can be expected.

Positioning for the DGM surveys was provided by a real-time kinematic (RTK) global positioning system (GPS) when possible and by wheel fiducial positioning techniques where remaining tree canopies or other tall obstacles limited the use of GPS methods.

A geophysical system verification (GSV) was performed as part of the process for validating the DGM system used during the geophysical mapping. The GSV is a physics-based, presumptively selected technology process in which signal strength and sensor performance are compared to known response curves of Industry Standard Objects to verify DGM systems before and during site surveys. The GSV process is designed to provide initial verification of the proposed DGM system using an instrument verification strip (IVS), followed by a blind seeding program for continued verification throughout the field operations.

Based on observation of the IVS activities and an independent analysis of the IVS results, the CH2M HILL QC geophysicist concluded that the system met project data quality objectives (DQOs) and was considered validated and appropriate for use at the land sites at NSF-IH. Details concerning the GSV are provided in the *Geophysical System Verification Work Plan for Land Sites UXO 11, UXO 20 and UXO 30, NSF-IH, Indian Head, Maryland* (Attachment to Appendix B in the MEC Work Plan) and a summary of the GSV activities is included in the Geophysical Report.

ARM used the established 30m x 30m grid system to manage the collection of geophysical data. Approximately 30 percent of the grid areas were digitally mapped using the EM61-MK2 coupled with the RTK-GPS. Grids were collected by laying measuring tapes along the two edges perpendicular to the survey direction. Non-metallic marker items were used to denote lines every 0.76m (2.5 feet), which were travelled in alternating directions during the

survey. The GPS rover unit received base station corrections in real time via a radio modem from the base station located over a known point near the IVS, which was located on the golf course south of UXO-11.

The remaining 70 percent of the grids were digitally mapped using the EM61-MK2 coupled with a Geonics wheel fiducial positioning system. The fiducial method is accomplished using a specialized odometer counter wheel on the EM61-MK2 that triggers the instrument to record once for every 0.1 m of ground covered. Lines were collected in a similar method to the GPS surveys. To assist in positioning the data, additional tape measures were laid out perpendicular to the survey direction at 7.6m (25-foot) intervals within the grid. A fiducial mark was recorded in the data each time the center of the EM61-MK2 trigger wheel crossed a fiducial line.

ARM processed the geophysical data in accordance with a systematic procedure, which is detailed in the Geophysical Report.

2.2.4 Water DGM

The general approach for the collecting data from shallow marine sites was to conduct bathymetry and side-scan sonar and DGM, consisting of boat-towed, underwater magnetometer surveys, within UXO 27 and an area adjacent to the Dive Locker Pier. Marine data acquisition for UXO 27 was conducted in two phases: the first phase consisted of bathymetry and side-scan sonar surveys to characterize the seabed site conditions, and the second phase consisted of a magnetometer survey to look for the presence of ferrous anomalies that could represent potential MEC.

The bathymetric survey provided detailed information regarding the seafloor, which was used for planning the magnetometer survey. The side-scan sonar data identified the presence of debris on the seafloor that could affect magnetometer data collection and was therefore avoided. Survey lines for the bathymetric/side-scan survey were spaced at 20m intervals, and data were processed and analyzed in the field. Review of bathymetric/ side-scan sonar data allowed the magnetometer survey plan to be fine-tuned to follow specific elevation contours, thereby increasing the survey team's ability to maintain the instrument at the intended height of less than 1.5 m (5 feet) above the seafloor, maximizing magnetometer survey efficiency and allowing safe data acquisition within survey specifications.

Phase two of the survey consisted of a magnetometer survey to determine the presence of ferrous metallic anomalies that could represent potential MEC. Data were collected with two Geometrics G-882 cesium vapor magnetometers configured as a transverse gradiometer (TVG) so the instruments maintained a constant 1.5m separation from each other for the duration of data collection. Survey lines for this phase of data acquisition were collected at a nominal spacing of 1.0m with a 1.5m cross-track tolerance, with the sensors sampling at 20 hertz. All reasonable efforts were made to maintain a constant instrument height above the seafloor of less than 1.5 m (5 feet). This was accomplished at the Dive Locker Pier site by varying the amount of cable and making small adjustments to the tow vessel speed. At the shallower UXO 27 site, the TVG was floated throughout the survey.

The shallow marine DGM surveys were conducted using RTK-GPS for positioning. All geophysical data were processed offsite at ARM's processing center in Hershey. The

processing followed a systematic procedure, which is detailed in the Geophysical Report. Industry standard QC tests were performed at the start of the DGM work at UXO 27 and daily, as required. QC tests were designed to assess equipment functionality and accuracy. Additionally, project DQOs were monitored throughout DGM activities to ensure a high-quality survey. The QC and DQO results are detailed in the Geophysical Report.

2.3 Munitions Constituents

2.3.1 Sampling

On April 12, 2010, CH2M HILL, with the assistance of the Navy and MDE, staked out the sample locations at UXOs 6, 11, and 30. Sampling had been completed at UXO 19 in October 2009. UXO 13 could not be accessed because mission activities were ongoing. On April 13, 2010, utility clearance was conducted at the sites under the supervision of a CH2M HILL engineer and a CH2M HILL UXO technician. MC sampling consisted of the collection of surface soil, subsurface soil, sediment, and grab *in situ* groundwater samples. Anomaly avoidance was conducted by a CH2M HILL UXO technician during all field activities because of the potential presence of MEC and MC. Table 2-1 summarizes the sampling and analytical program; the information provided includes site name, station identification, sample identification, sampling depth interval, parameters analyzed, and methodologies followed.

Sampling was conducted at UXOs 6, 11, 13, 19, and 30. Because subsurface soil and grab *in situ* groundwater sampling was performed with direct-push technology (DPT) at UXOs 6, 11, and 30, utility clearance was completed by Accumark. No utilities were present at UXOs 6 and 30. Appendix C provides a list utilities present at UXO 11.

Only surface soil samples were collected at UXO 13 and only sediment samples at UXO 19. Soil borings for collecting subsurface soil and grab *in situ* groundwater were completed using a Geoprobe® 6620 track-mounted DPT rig. Vironex provided all drilling services during field activities under the supervision of CH2M HILL personnel.

Continuous soil core samples were collected from each soil boring for lithologic description using a 2-inch-inner-diameter, 5-foot-long stainless steel Macro-Core® soil sampling device with a removable acetate liner. Soil boring logs are provided in Appendix D. Subsurface soil samples for laboratory analysis were collected as follows: one from the 6-inch to 2-foot below ground surface (bgs) interval and one from the 1.5-foot interval above the water table. The shallow subsurface soil interval sample was intended to capture residual constituents that may have vertically migrated through the soil column from the ground surface via infiltration. The deep subsurface soil interval sample directly above the water table was intended to capture residual constituents that have potential to accumulate (i.e., float) and migrate horizontally on the water table surface, leaving residual constituents within the capillary fringe.

Groundwater samples were collected from select soil boring locations at UXO 6, 11, and 30 using the DPT rig. The groundwater samples collected from UXO 11 and UXO 30 were collected using a direct-push stainless steel screen driven to depth within a sealed, steel sheath using an expendable drive point. Once desired depth was achieved, approximately 3.5 feet of screen was exposed to the subsurface by retracting the outer casing, thereby

allowing representative groundwater samples to be collected. Groundwater samples were collected using a peristaltic pump with dedicated tubing. Following sample collection, the stainless steel screen assembly was removed from the borehole and decontaminated.

Because of the slow recharge of groundwater at UXO 6, a disposable 1-inch-inner-diameter polyvinyl chloride (PVC) screen assembly was used for groundwater sample collection instead of the Geoprobe® stainless steel screen assembly. The disposable PVC screen assembly consisted of 1-inch-inner-diameter casing and a 1-inch–inner- diameter 0.010 slot 10-foot-long screen. The disposable screen was inserted into the borehole following soil sample collection and allowed to sit overnight to maximize groundwater withdrawal volume. Following collection of the groundwater samples, the PVC screen assembly was removed from the borehole and disposed.

Boreholes were advanced into the water table whenever possible. At several locations, the borings were terminated within a thick dry clay sequence without encountering the water table. MEC avoidance was performed at each boring location through the use of metal detection avoidance equipment by a UXO technician at 1-foot intervals until the groundwater table was encountered or 10 feet bgs was reached. None of the boreholes were converted into permanent monitoring wells and were therefore abandoned in accordance with Code of Maryland Regulations 26.04.04.11, Abandonment Standards. Boreholes were backfilled with a bentonite clay mixture consisting of at least 2 pounds of bentonite clay per 1 gallon of water. Soil, sediment, and DPT locations were surveyed with a portable GPS unit; the coordinates are presented in Table 2-2.

All soil and groundwater samples were placed in coolers and stored on ice for shipment to Empirical Laboratories, LLC in Nashville, Tennessee and Microbac Laboratories, Inc. in Marietta, Ohio. Microbac Laboratories, Inc. is a subcontractor of Empirical Laboratories and supported them in the analyses of groundwater samples.

Investigation-derived waste (IDW) produced during MC sampling consisted of soil cuttings from soil borings, decontamination water, spent acetate liners, and personal protective equipment. IDW was accumulated in five 55-gallon drums and staged in the parking lot at Building 286. Solid and liquid samples were collected for waste characterization and disposal. The samples were analyzed for Toxicity Characteristic Leaching Procedure analysis of volatile organic compounds, semivolatile organic compounds, pesticides, herbicides, metals, wet chemistry, and reactivity. Based on the results, the samples were characterized as non-hazardous. Appendix E provides the analytical results of the solid and liquid IDW and Form 1s.

2.3.2 Data Management and Evaluation

This section presents information on the analytical data collected during the SI and the documentation process used to ensure data quality. Data tracking and management procedures, from the collection of the data in the field through data validation, are presented in the UFP-SAP and UXO 19 Work Plan.

Data collected as part of the MC sampling for UXOs 6, 11, 13, 19, and 30 were screened against the project action limits in accordance with the UFP-SAP. Soil and sediment data were screened against EPA Region III 2010 adjusted residential regional screening levels (RSLs), and groundwater data were screened against EPA Region III 2010 adjusted tap

water RSLs. Chemical concentrations in soil and groundwater that exceeded risk-based screening levels were further evaluated by comparing the maximum detected concentrations to site background concentrations, where applicable, provided in the *Background Soil Investigation Report for Indian Head and Stump Neck Annex Naval Surface Warfare Center, Indian Head, Maryland* (hereinafter referred to as the Background Report; Tetra Tech NUS, Inc., 2002).

Surface soil concentrations were compared against the 95 percent upper tolerance limit (95 percent UTL) background concentrations identified in Table 4-2 in the Background Report. Subsurface soil concentrations were compared against the 95 percent UTLs provided in Table 4-3 (clay-like subsurface soils) of the Background Report. For chemical concentrations in groundwater and sediment, the maximum detected concentration for each chemical was compared against the 95 percent UTL background concentration identified in Table A-8 and Table A-12, respectively, in Appendix A of the Background Report. Copies of Tables 4-2, 4-3, A-8, and A-12 from the Background Report are provided in Appendix F. This evaluation process was used to support the recommendations for further investigation or no further investigation at the site.

2.4 Subcontractors

The following subcontractors provided services in support of the SI:

Environmental Research, Inc. of Linden, VA – Performed aerial photographic analysis.

Thoth Land Surveying Professional, Inc. (Thoth) of Washington, DC. – Licensed surveyor who surveyed DGM boundaries and recorded QC seeds for DGM QC validation.

OER of Cohasset, MA – Cleared access road, brush and small trees, and non-MEC metal items.

ARM of Hershey, PA - Performed DGM.

Accumark, Inc. (Accumark) of Bowie, MD – Performed utility clearing.

Vironex of Ashland, VA – Performed DPT for MC sampling.

Empirical Laboratories, LLC of Nashville, TN and Microbac Laboratories, Inc. in Marietta, OH – provided analytical services for soil and groundwater. Microbac Laboratories, Inc. is a subcontractor of Empirical Laboratories and supported the analyses of groundwater samples

DataQual Environmental Services, LLC of St. Louis, MO – Performed data validation services.

2.5 Conceptual Site Model

The conceptual site model (CSM) integrates information regarding the physical characteristics of the site, potentially exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify exposure routes and receptors. The PA and WAMs present the CSMs for the sites. The CSMs for all sites have been updated to reflect data gathered from the SI.

A key element of the CSM is the exposure pathway analysis. For MEC, a complete or potentially complete exposure pathway must include the following components: 1) a source (e.g., locations where MEC are expected to be found); 2) access (e.g., controlled or uncontrolled access, items on the surface or within the subsurface); 3) an activity (e.g., non-intrusive grounds maintenance or intrusive construction); and 4) receptors (e.g., Navy personnel (military and civilian), construction workers, recreational users or authorized visitors), and future resident. It is important to recognize that environmental mechanisms (e.g., erosion) and/or human intervention may result in the repositioning of MEC.

For MC, a complete or potentially complete exposure pathway must include the following components: 1) a source (e.g., locations where MC are expected to be found); 2) an exposure medium (e.g., surface soil); 3) an exposure route (e.g., dermal contact); and 4) receptors (e.g., Navy personnel (military and civilian), construction workers, recreational users or authorized visitors), and future residents. If the point of exposure is not at the same location as the source, the pathway may also include a release mechanism (e.g., volatilization) and a transport medium (e.g., air).

The potential interactions between the source and receptors are assessed differently between MEC and MC. For MEC, interaction between the potential receptors and an MEC source has two components. The receptor must have access to the source and must engage in some activity that results in contact with individual MEC items within the source area. For MC, interaction between the source and receptors involves a release mechanism for the MC, an exposure medium that contains the MC, and an exposure route that places the receptor into contact with the affected medium.

TABLE 2-1
Surface Soil, Subsurface Soil, Sediment, and In Situ Groundwater Sampling and Analysis Summary
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

UXO No.	Media	Station ID	Sample ID	Date	Number of Samples	Sample Depth (ft bgs)	Deviation(s) from Workplan	SVOCs	Nitroaromatics, Nitroamines, PETN	Nitroguanidine	Nitrocellulose	Nitroglycerin	Perchlorate	Metals/Hg/CN	6020 Metals	Filtered Metals/Hg	Filtered 6020 Metals	Cyanide
6	Surface Soil	ISUXO6-DP01	ISUXO6-SS01-0001	4/28/2010	1	0-0.5	Workplan states 3 surface soil, 6 subsirface soil, and 3 *in situ* groundwater samples will be collected at UXO 6. No deviations to the workplan at UXO 6. Other Notes: 1) Duplicate samples taken at DP01 (SB01P and GP01P)	x	x	x	x	x	x					
		ISUXO6-DP02	ISUXO6-SS02-0001	4/29/2010	1	0-0.5		x	x	x	x	x	x					
		ISUXO6-DP03	ISUXO6-SS03-0001	4/29/2010	1	0-0.5		x	x	x	x	x	x					
	Subsurface Soil	ISUXO6-DP01	ISUXO6-SB01-0102	4/28/2010	1	1.0-2.0		x	x	x	x	x	x					
		ISUXO6-DP01	ISUXO6-SB01-1617	4/28/2010	1	16.0-17.0		x	x	x	x	x	x					
		ISUXO6-DP02	ISUXO6-SB02-0102	4/29/2010	1	1.0-2.0		x	x	x	x	x	x					
		ISUXO6-DP02	ISUXO6-SB02-1718	4/29/2010	1	17.0-18.0		x	x	x	x	x	x					
		ISUXO6-DP03	ISUXO6-SB03-0102	4/29/2010	1	1.0-2.0		x	x	x	x	x	x					
		ISUXO6-DP03	ISUXO6-SB03-1920	4/29/2010	1	19.0-20.0		x	x	x	x	x	x					
	In Situ Groundwater	ISUXO6-DP01	ISUXO6-GP01-0410	4/29/2010	1	15.0-25.0		x	x	x	x	x	x					
		ISUXO6-DP02	ISUXO6-GP02-0410	4/29/2010	1	15.0-25.0		x	x	x	x	x	x					
		ISUXO6-DP03	ISUXO6-GP03-0410	4/29/2010	1	15.0-25.0		x	x	x	x	x	x					
11	Surface Soil	ISUXO11-DP01	ISUXO11-SS01-0001	4/20/2010	1	0-0.5	Workplan states 30 susurface soil, 50 subsurface soil, and 5 *in situ* groundwater samples will be collected at Uxo 11. Devitions from workplan: Areas B and D were not fully staked out because some areas were submerged. 30 surface soil, 45 subsurface soil, and 2 *in situ* groundwater sampels were collected. Other Notes: 1) DP01, DP02, and DP25 were offset from proposed locations 5 feet north due to metal plate under dirt, hand auger 2) DP04 was offset from proposed location 5 feet south due to potential underground utility 3) Duplicate samples were taken at DP05 (SB05P), DP06 (SS06P, SB06P), DP09 (SB09P), DP12 (SB12P), DP14 (SB14P), DP22 (SB22P), and DP28 (SS28P) 4) MS/MSD samples were taken at DP07 (SB07), DP15 (SS15), and DP18 (SB18) 5) Deep subsurface soil was not collected at DP05, DP20, DP23, and DP24 because a shallow water table was encountered. 6) Deep subsurface soil was not collected at DP08 because there was no soil recovery. 7) Groundwater samples were not collected at DP03, DP14, and DP22 because there was no water encountered at these locations. Groundwater was collected at DP05 instead. 8) Groundwater not collected at DP11 due to equipment refusal.		x	x	x	x	x	x				
		ISUXO11-DP02	ISUXO11-SS02-0001	4/21/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP03	ISUXO11-SS03-0001	4/22/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP04	ISUXO11-SS04-0001	4/20/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP05	ISUXO11-SS05-0001	4/22/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP06	ISUXO11-SS06-0001	4/21/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP07	ISUXO11-SS07-0001	4/22/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP08	ISUXO11-SS08-0001	4/20/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP09	ISUXO11-SS09-0001	4/28/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP10	ISUXO11-SS10-0001	4/28/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP11	ISUXO11-SS11-0001	4/28/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP12	ISUXO11-SS12-0001	4/28/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP13	ISUXO11-SS13-0001	4/28/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP14	ISUXO11-SS14-0001	4/27/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP15	ISUXO11-SS15-0001	4/27/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP16	ISUXO11-SS16-0001	4/27/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP17	ISUXO11-SS17-0001	4/26/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP18	ISUXO11-SS18-0001	4/23/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP19	ISUXO11-SS19-0001	4/27/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP20	ISUXO11-SS20-0001	4/27/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP21	ISUXO11-SS21-0001	4/23/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP22	ISUXO11-SS22-0001	4/27/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP23	ISUXO11-SS23-0001	4/27/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP24	ISUXO11-SS24-0001	4/22/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-DP25	ISUXO11-SS25-0001	4/20/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-SO26	ISUXO11-SS26-0001	4/26/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-SO27	ISUXO11-SS27-0001	4/26/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-SO28	ISUXO11-SS28-0001	4/26/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-SO29	ISUXO11-SS29-0001	4/26/2010	1	0-0.5			x	x	x	x	x	x				
		ISUXO11-SO30	ISUXO11-SS30-0001	4/26/2010	1	0-0.5			x	x	x	x	x	x				

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	Subsurface Soil	ISUXO11-DP01	ISUXO11-SB01-0102	4/20/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP01	ISUXO11-SB01-0607	4/20/2010	1	6.0-7.0			x	x	x	x	x	x				
		ISUXO11-DP02	ISUXO11-SB02-0102	4/21/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP02	ISUXO11-SB02-2415	4/21/2010	1	24.0-25.0			x	x	x	x	x	x				
		ISUXO11-DP03	ISUXO11-SB03-0102	4/22/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP03	ISUXO11-SB03-0708	4/22/2010	1	7.0-8.0			x	x	x	x	x	x				
		ISUXO11-DP04	ISUXO11-SB04-0102	4/20/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP04	ISUXO11-SB04-0607	4/20/2010	1	6.0-7.0			x	x	x	x	x	x				
		ISUXO11-DP05	ISUXO11-SB05-0102	4/22/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP05	ISUXO11-SB05-TDBD	N/A	1	13.5-15			x	x	x	x	x	x				
		ISUXO11-DP06	ISUXO11-SB06-0102	4/21/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP06	ISUXO11-SB06-2425	4/21/2010	1	24.0-25.0			x	x	x	x	x	x				
		ISUXO11-DP07	ISUXO11-SB07-0102	4/22/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP07	ISUXO11-SB07-1920	4/22/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP08	ISUXO11-SB08-0102	4/20/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP08	ISUXO11-SB08-TDBD	N/A	1	13.5-15			x	x	x	x	x	x				
		ISUXO11-DP09	ISUXO11-SB09-0102	4/28/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP09	ISUXO11-SB09-1920	4/28/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP10	ISUXO11-SB10-0102	4/28/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP10	ISUXO11-SB10-1920	4/28/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP11	ISUXO11-SB11-0102	4/28/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP11	ISUXO11-SB11-0708	4/28/2010	1	7.0-8.0			x	x	x	x	x	x				
		ISUXO11-DP12	ISUXO11-SB12-0102	4/28/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP12	ISUXO11-SB12-1920	4/28/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP13	ISUXO11-SB13-0102	4/28/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP13	ISUXO11-SB13-1920	4/28/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP14	ISUXO11-SB14-0102	4/27/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP14	ISUXO11-SB14-1920	4/27/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP15	ISUXO11-SB15-0102	4/27/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP15	ISUXO11-SB15-1920	4/27/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP16	ISUXO11-SB16-0102	4/27/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP16	ISUXO11-SB16-1920	4/27/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP17	ISUXO11-SB17-0102	4/26/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP17	ISUXO11-SB17-2829	4/26/2010	1	28.0-29.0			x	x	x	x	x	x				
		ISUXO11-DP18	ISUXO11-SB18-0102	4/23/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP18	ISUXO11-SB18-0405	4/23/2010	1	4.0-5.0			x	x	x	x	x	x				
		ISUXO11-DP19	ISUXO11-SB19-0102	4/27/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP19	ISUXO11-SB19-1920	4/27/2010	1	19.0-20.0			x	x	x	x	x	x				
		ISUXO11-DP20	ISUXO11-SB20-0102	4/27/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP20	ISUXO11-SB20-TDBD	N/A	1	13.5-15			x	x	x	x	x	x				
		ISUXO11-DP21	ISUXO11-SB21-0102	4/23/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP21	ISUXO11-SB21-0607	4/23/2010	1	6.0-7.0			x	x	x	x	x	x				
		ISUXO11-DP22	ISUXO11-SB22-0102	4/27/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP22	ISUXO11-SB22-2425	4/27/2010	1	24.0-25.0			x	x	x	x	x	x				
		ISUXO11-DP23	ISUXO11-SB23-0102	4/27/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP23	ISUXO11-SB23-TDBD	N/A	1	13.5-15			x	x	x	x	x	x				
		ISUXO11-DP24	ISUXO11-SB24-0102	4/22/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP24	ISUXO11-SB24-TDBD	N/A	1	13.5-15			x	x	x	x	x	x				
		ISUXO11-DP25	ISUXO11-SB25-0102	4/22/2010	1	1.0-2.0			x	x	x	x	x	x				
		ISUXO11-DP25	ISUXO11-SB25-0506	4/22/2010	1	5.0-6.0			x	x	x	x	x	x				

TABLE 2-1
Surface Soil, Subsurface Soil, Sediment, and In Situ Groundwater Sampling and Analysis Summary
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

UXO No.	Media	Station ID	Sample ID	Date	Number of Samples	Sample Depth (ft bgs)	Deviation(s) from Workplan	SVOCs	Nitroaromatics, Nitroamines, PETN	Nitroguanidine	Nitrocellulose	Nitroglycerin	Perchlorate	Metals/Hg/CN	6020 Metals	Filtered Metals/Hg	Filtered 6020 Metals	Cyanide
	In Situ Groundwater	ISUXO11-DP05	ISUXO11-GP05-0410	4/22/2010	1	6.0-10.0			x	x	x	x	x	x	x	x	x	x
		ISUXO11-DP11	ISUXO11-GP11-MMYY	N.A	1	15			x	x	x	x	x	x	x	x	x	x
		ISUXO11-DP14	ISUXO11-GP14-MMYY	N/A	1	15			x	x	x	x	x	x	x	x	x	x
		ISUXO11-DP18	ISUXO11-GP18-0410	4/23/2010	1	5.0-10.0			x	x	x	x	x	x	x	x	x	x
		ISUXO11-DP22	ISUXO11-GP22-MMYY	N/A	1	15			x	x	x	x	x	x	x	x	x	x
13	Surface Soil	ISUXO13-DP01	ISUXO13-SS01-0001	4/30/2010	1	0-0.5	Workplan states 10 surface soil samples will be collected at UXO 13. No deviations to the workplan at UXO 13.	x						x				
		ISUXO13-DP02	ISUXO13-SS02-0001	4/30/2010	1	0-0.5		x						x				
		ISUXO13-DP03	ISUXO13-SS03-0001	4/30/2010	1	0-0.5		x						x				
		ISUXO13-DP04	ISUXO13-SS04-0001	4/30/2010	1	0-0.5	Other Notes:	x						x				
		ISUXO13-DP05	ISUXO13-SS05-0001	4/30/2010	1	0-0.5	1) Duplicate sample taken at DP07 (SS07P)	x						x				
		ISUXO13-DP06	ISUXO13-SS06-0001	4/30/2010	1	0-0.5		x						x				
		ISUXO13-DP07	ISUXO13-SS07-0001	4/30/2010	1	0-0.5		x						x				
		ISUXO13-DP08	ISUXO13-SS08-0001	4/30/2010	1	0-0.5		x						x				
		ISUXO13-DP09	ISUXO13-SS09-0001	4/30/2010	1	0-0.5		x						x				
		ISUXO13-DP10	ISUXO13-SS10-0001	4/30/2010	1	0-0.5		x						x				
19	Sediment	ISUXO19-SD01	ISUXO19-SD01-0001	10/27/2009	1	0-0.5	Workplan states 4 sediment samples will be collected at UXO		x	x	x	x	x	x				
		ISUXO19-SD02	ISUXO19-SD02-0001	10/27/2009	1	0-0.5	19. No deviations to the workplan at UXO 19.		x	x	x	x	x	x				
		ISUXO19-SD03	ISUXO19-SD03-0001	10/27/2009	1	0-0.5	Other Notes:		x	x	x	x	x	x				
		ISUXO19-SD04	ISUXO19-SD04-0001	10/27/2009	1	0-0.5	1) Duplicate sample taken at SD02 (SD02P)		x	x	x	x	x	x				
30	Surface Soil	ISUXO30-DP01	ISUXO30-SS01-0001	4/16/2010	1	0-0.5	Workplan states 12 surface soil, 24 subsurface soil, and 3 *in*	x	x	x	x	x	x	x				
		ISUXO30-DP02	ISUXO30-SS02-0001	4/16/2010	1	0-0.5	*situ* groundwater samples will be collected at UXO 30.	x	x	x	x	x	x	x				
		ISUXO30-DP03	ISUXO30-SS03-0001	4/16/2010	1	0-0.5	Devitions from workplan: 12 surface soil, 11 subsurface soil,	x	x	x	x	x	x	x				
		ISUXO30-DP04	ISUXO30-SS04-0001	4/16/2010	1	0-0.5	and 3 *in situ* groundwater sampels were collected.	x	x	x	x	x	x	x				
		ISUXO30-DP05	ISUXO30-SS05-0001	4/16/2010	1	0-0.5		x	x	x	x	x	x	x				
		ISUXO30-DP06	ISUXO30-SS06-0001	4/14/2010	1	0-0.5	Other Notes:	x	x	x	x	x	x	x				
		ISUXO30-DP07	ISUXO30-SS07-0001	4/15/2010	1	0-0.5	1) Duplicate samples taken at DP02 (SS02P and SB02P),	x	x	x	x	x	x	x				
		ISUXO30-DP08	ISUXO30-SS08-0001	4/15/2010	1	0-0.5	DP03 (SB03P), DP05 (SB05P)	x	x	x	x	x	x	x				
		ISUXO30-DP09	ISUXO30-SS09-0001	4/15/2010	1	0-0.5	2) MS/MSD sample taken at DP01 and DP09	x	x	x	x	x	x	x				
		ISUXO30-DP10	ISUXO30-SS10-0001	4/15/2010	1	0-0.5	3) Shallow subsurface soil samples were unable to be collected	x	x	x	x	x	x	x				
		ISUXO30-DP11	ISUXO30-SS11-0001	4/16/2010	1	0-0.5	at DP04, DP10, and DP11 because a shallow water table was	x	x	x	x	x	x	x				
		ISUXO30-DP12	ISUXO30-SS12-0001	4/16/2010	1	0-0.5	encountered.	x	x	x	x	x	x	x				

TABLE 2-1
Surface Soil, Subsurface Soil, Sediment, and In Situ Groundwater Sampling and Analysis Summary
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

UXO No.	Media	Station ID	Sample ID	Date	Number of Samples	Sample Depth (ft bgs)	Deviation(s) from Workplan	SVOCs	Nitroaromatics, Nitroamines, PETN	Nitroguanidine	Nitrocellulose	Nitroglycerin	Perchlorate	Metals/Hg/CN	6020 Metals	Filtered Metals/Hg	Filtered 6020 Metals	Cyanide
	Subsurface Soil	ISUXO30-DP01	ISUXO30-SB01-0102	4/16/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP01	ISUXO30-SB01-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP02	ISUXO30-SB02-0102	4/16/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP02	ISUXO30-SB02-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP03	ISUXO30-SB03-0102	4/16/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP03	ISUXO30-SB03-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP04	ISUXO30-SB04-TDBD	N/A	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP04	ISUXO30-SB04-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP05	ISUXO30-SB05-0102	4/16/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP05	ISUXO30-SB05-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP06	ISUXO30-SB06-0102	4/14/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP06	ISUXO30-SB06-1516	4/16/2010	1	15.0-16.0		x	x	x	x	x	x	x				
		ISUXO30-DP07	ISUXO30-SB07-0102	4/15/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP07	ISUXO30-SB07-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP08	ISUXO30-SB08-0102	4/15/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP08	ISUXO30-SB08-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP09	ISUXO30-SB09-0102	4/15/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP09	ISUXO30-SB09-1415	4/15/2010	1	14.0-15.0		x	x	x	x	x	x	x				
		ISUXO30-DP10	ISUXO30-SB10-TDBD	N/A	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP10	ISUXO30-SB10-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP11	ISUXO30-SB11-TDBD	N/A	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP11	ISUXO30-SB11-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
		ISUXO30-DP12	ISUXO30-SB12-0102	4/16/2010	1	1.0-2.0		x	x	x	x	x	x	x				
		ISUXO30-DP12	ISUXO30-SB12-TDBD	N/A	1	18.5-20		x	x	x	x	x	x	x				
	In Situ Groundwater	ISUXO30-DP05	ISUXO30-GP05-0410	4/16/2010	1	4.0-8.0		x	x	x	x	x	x	x	x	x	x	x
		ISUXO30-DP09	ISUXO30-GP09-0410	4/15/2010	1	15.0-20.0		x	x	x	x	x	x	x	x	x	x	x
		ISUXO30-DP12	ISUXO30-GP12-0410	4/16/2010	1	20		x	x	x	x	x	x	x	x	x	x	x

DP = direct push
SB = subsurface soil
SS = surface soil
ft bgs = feet below ground surface
PETN = pentaerythritol tetranitrate
SVOCs = semi-volatile organic compounds
N/A = not applicable

UXO = unexploded ordnance
Hg = Mercury
CN - cyanide
MS/MSD = matrix spike/matris spike duplicate
GP = *in situ* groundwater
TDBD = top depth bottom depth

TABLE 2-2
GPS Coordinates for Sample Locations
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Indian Head Sample Location Coordinates			
Site	**Station ID**	**Easting**	**Northing**
UXO 6	ISUXO6-DP01	1258432.17154000000	328807.02940800000
	ISUXO6-DP02	1258518.28680000000	328773.21146000000
	ISUXO6-DP03	1258612.52594000000	328719.66446000000
UXO 11	ISUXO11-DP01	1260034.73166000000	340093.59278900000
	ISUXO11-DP02	1260129.06138000000	339850.03071300000
	ISUXO11-DP03	1260004.21336000000	339888.46233000000
	ISUXO11-DP04	1260095.23188000000	339974.61102100000
	ISUXO11-DP05	1260059.86539000000	339958.08124500000
	ISUXO11-DP06	1260167.94948000000	339854.71126700000
	ISUXO11-DP07	1260079.36116000000	339890.80069400000
	ISUXO11-DP08	1260244.07932000000	339894.12173900000
	ISUXO11-DP09	1260440.08690000000	340225.71381700000
	ISUXO11-DP10	1260464.80947000000	340176.86290500000
	ISUXO11-DP11	1260521.79999000000	340098.20820000000
	ISUXO11-DP12	1260558.24948000000	340024.84530000000
	ISUXO11-DP13	1260736.96347000000	339968.58905500000
	ISUXO11-DP14	1260795.63855000000	339989.01725000000
	ISUXO11-DP15	1260882.07824000000	340016.94603800000
	ISUXO11-DP16	1260944.09419000000	340044.98775200000
	ISUXO11-DP17	1260853.37778000000	339895.73264100000
	ISUXO11-DP18	1260843.92544000000	339822.00401700000
	ISUXO11-DP19	1260968.12736000000	339854.15545100000
	ISUXO11-DP20	1260978.83004000000	339779.36651700000
	ISUXO11-DP21	1260957.10197000000	339671.29974800000
	ISUXO11-DP22	1261077.29895000000	339826.67109400000
	ISUXO11-DP23	1261037.17863000000	339753.07634200000
	ISUXO11-DP24	1261057.20078000000	339658.86687500000
	ISUXO11-DP25	1260481.48739000000	340369.45843800000
	ISUXO11-SO26	1260181.20476000000	339930.76255600000
	ISUXO11-SO27	1260173.34129000000	339920.55448600000
	ISUXO11-SO28	1260180.65462000000	339905.25843400000
	ISUXO11-SO29	1260196.62991000000	339895.52569100000
	ISUXO11-SO30	1260205.89546000000	339916.94360400000
UXO 13	ISUXO13-DP01	1258139.69404000000	331584.51785800000
	ISUXO13-DP02	1258174.79108000000	331623.11161300000
	ISUXO13-DP03	1258246.81325000000	331579.54772300000
	ISUXO13-DP04	1258183.51974000000	331526.98680500000
	ISUXO13-DP05	1257761.30142000000	331815.59285500000
	ISUXO13-DP06	1257880.36680000000	331979.83465300000
	ISUXO13-DP07	1258174.57291000000	332023.87951200000
	ISUXO13-DP08	1258349.87964000000	331996.18009200000
	ISUXO13-DP09	1258512.48266000000	331912.33052200000
	ISUXO13-DP10	1258631.26294000000	331712.68361200000
UXO 19	ISUXO19-SD01	1258765.33583000000	328675.30582900000
	ISUXO19-SD02	1258825.60769000000	328637.89776700000
	ISUXO19-SD03	1258877.55181000000	328591.12030100000
	ISUXO19-SD04	1258910.31094000000	328531.78479000000
UXO 30	ISUXO30-DP01	1257611.26782000000	335355.61223600000
	ISUXO30-DP02	1257605.45539000000	335331.16972900000
	ISUXO30-DP03	1257559.69777000000	335074.96631300000
	ISUXO30-DP04	1257529.39013000000	335058.63604100000
	ISUXO30-DP05	1257587.26269000000	335287.28253800000
	ISUXO30-DP06	1257586.81387000000	335228.50532900000
	ISUXO30-DP07	1257575.92631000000	335182.50579700000
	ISUXO30-DP08	1257593.64338000000	335183.95641100000
	ISUXO30-DP09	1257579.43927000000	335153.59931800000
	ISUXO30-DP10	1257553.14942000000	334988.80635700000
	ISUXO30-DP11	1257510.75340000000	334925.15350300000
	ISUXO30-DP-12	1257570.78865000000	334988.51885100000

SECTION 3

UXO 6 – NG Slums Burning Ground

3.1 Site Background

UXO 6 is a 0.3-acre site along the shoreline of the Potomac River (Figure 1-1 and Photo 3-1). UXO 6 was initially known as Site 22 under the Installation Restoration Program. However, the site was moved to the Munitions Response Program and is now referred to as UXO 6. The site is on the southeastern shore of the Main Installation adjacent to Mattawoman Creek. Building 1216 is adjacent to the site. The general topography is relatively flat, with an elevation of 5 feet above msl. The site is reported to have been used as an open burning (OB) ground for NG slums (a production disposal byproduct, created when excess NG from the NG production facility was mixed with sawdust for stabilization before disposal, making the NG easier and safer to handle and transport). UXO 6 was operated from the late 1940s to approximately 1953. The types and quantities of accelerants used to burn the NG slums, if any, are unknown.

On November 25, 2008, the Navy and CH2M HILL conducted a site visit, but could not determine the exact location of the site. No bare areas, charred areas, or stressed vegetation were observed at the top of the road. The same observation was made during a CH2M HILL site visit on April 22, 2009 with the Navy, EPA, and MDE. Appendix G provides photographs of site conditions taken as part of this SI.

3.2 Rationale and Objective

The PA noted that if NG was used at the site, there was a potential for material potentially presenting an explosive hazard, including MC, to be present. With the historical practice of burning NG slums, any contaminant released would likely have been released at the surface. It is possible that NG, a miscible liquid, may have migrated through the soil column to the shallow groundwater through infiltration. If NG were present, it may have adhered to soil particles in the soil column (surface soil and subsurface soil) as well as reached the surficial groundwater table. Human and ecological receptors may be exposed to NG in surface soil.

Because of historical burning activities and burning of NG slum, the constituents of potential concern at UXO 6 consist of explosives and polycyclic aromatic hydrocarbons (PAHs) in surface soil, subsurface soil, and groundwater. The specific objective of the SI at UXO 6 is to determine if explosives (including nitroguanidine, nitrocellulose, and NG) and PAHs are present in surface soil, subsurface soil, and groundwater.

This objective was accomplished through by collecting surface soil, subsurface soil, and grab *in situ* groundwater samples from three locations. Because the exact location of the OB ground was unknown, an aerial photographic analysis was performed to identify any area or areas where burning could have occurred to bias the collection of samples from these areas.

3.3 Aerial Photographic Analysis

Historic aerial photographs from 1937 through 1962 were reviewed (Appendix A). Up until 1943, no environmentally significant findings were noted, although an access road led to the site. In a 1950 photograph, a structure was present east of the site, and in a 1952 photograph a stained or burned area is visible at the end of the access road; an additional structure is shown west of the stained or burned area. This area was present at least through 1957, but in a 1962 photo it and the rest of the site were observed to be revegetated. A loop road with a structure or object at its end was present on the site in photos from 1954 onwards.

3.4 Field Activities

3.4.1 Soil and *In Situ* Groundwater Sampling

The sample locations proposed in the work plan were moved to fall within the stained or burned area shown on the 1952 aerial photograph in Appendix A. Field activities were conducted from April 28 to April 29, 2010. A total of three surface soil, six subsurface soil, and three *in situ* groundwater samples were collected from three locations - ISUXO6-DP01, ISUXO6-DP02, and ISUXO6-DP03 - using DPT (Figure 3-1). The depth intervals for all media are shown on Table 2-1. The samples were placed in the appropriate sample jars, stored in coolers at 4°C, and shipped to Empirical Labs, LLC. The samples were analyzed for explosives (including nitroguanidine, nitrocellulose, and nitroglycerine) and PAHs (Table 2-1).

Utility clearance was conducted before fieldwork began because of subsurface intrusive activities. At each location, continuous soil Macro-Cores® were collected from ground surface until groundwater was encountered for subsurface lithologic description. The soil boring logs are provided in Appendix D. Although MEC were not anticipated, anomaly avoidance was performed by CH2M HILL before and during soil boring advancement at 1-foot intervals until either the water table was encountered or 10 feet bgs was reached. To verify that explosive hazard conditions were low, field screening for NG was conducted with an explosive detection/identification field test kit. The field kit used was Expray-2 from Medimpex United, Inc., which is used to test for various explosives, including NG. To use, a soil sample was wiped with a test paper and sprayed with Expray. The results indicated that NG was not present in the soil because there was no color change.

3.4.2 Deviation from the Work Plan

The only deviation from the work plan was moving one location, ISUXO06-DP03, to the stained or burned area identified on the 1952 aerial photograph.

3.5 Geology and Hydrogeology

Based on the findings of the soil boring program, the site is underlain mostly by clay down to approximately 30 feet bgs. Because the site is close to the Mattawoman Creek, it is assumed that groundwater flow follows the land topography and groundwater flow direction is towards the creek.

3.6 Munitions Constituents

3.6.1 Analytical Results

Tables 3-1 through 3-3 present the raw data; detected constituents as shaded cells; exceedances of the RSLs in bold underlined font; the frequency of detection; and frequency of exceedance for surface soil, subsurface soil, and in situ groundwater, respectively. Samples were collected from three locations - ISUXO6-DP1, ISUXO6-DP2, and ISUXO6-DP3 (Figure 3-1).

The data were evaluated according to the process described in Section 2.4. Soil data were screened against the adjusted residential soil RSL, and groundwater was screened against the adjusted tap water RSL. Chemical concentrations in soil and groundwater that exceeded the RSLs were further evaluated by comparing the maximum detected concentrations to site background concentrations, where applicable. The nature and extent of constituents for soil and groundwater were evaluated based on exceedance of the RSLs and background concentrations.

Surface Soil

Table 3-1 presents the PAHs and explosives results for surface soil. Surface soil sample locations are shown on Figure 3-1.

PAHs

Five PAHs (1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, anthracene, and fluorine) were detected in ISUXO6-DP1, and one PAH (1-methylnaphthalene) in ISUXO6-DP3. No PAHs were detected in ISUXO6-DP2. None of the detected PAHs exceeded their RSLs.

Explosives

Three explosives compounds were detected at each of the three sampled locations. Nitroguanidine and royal demolition explosives (RDX) were detected at all locations; 1,3-dinitrobenzene at ISUXO6-DP1, 2-amino-4,6-dinitrotoluene at ISUXO6-DP2, and 1,3,5-trinitrobenzene at ISUXO6-DP3. None of the detected explosive compounds exceeded their RSLs.

Subsurface Soil

Table 3-2 presents the PAHs and explosives results for subsurface soil. Subsurface soil sample locations are shown on Figure 3-1.

PAHs

No PAHs were detected in any of the subsurface soil samples. As a result, there are no exceedances of RSLs.

Explosives

One or more explosive compounds were detected at each location. At ISUXO6-DP1, RDX was the only constituent detected at the first depth interval (0.5 foot to 2 feet bgs); 1,3,5-trinitrobenzene, NG, nitroguanidine, and perchlorate were detected at the second depth interval (approximately 1.5 feet above the water table). At ISUXO6-DP2, RDX was the only constituent detected at both depth intervals. The concentration was higher in the first depth interval (65.3K micrograms per kilogram [µg/kg]) than the second depth interval

(58.7J µg/kg). At ISUXO6-DP3, 2-nitrotoluene, RDX, and tetryl were detected at the first depth interval; nitroguanidine and RDX were detected at the second depth interval. The concentration of RDX was higher in the first depth interval (77.3J µg/kg) than the second depth interval (61.9J µg/kg). None of the detected explosive compounds exceeded their RSLs.

In Situ Groundwater

Table 3-3 presents the PAHs and explosives results for groundwater. Groundwater sample locations are shown on Figure 3-1. Figure 3-2 shows the concentrations of compounds that exceeded the RSLs and 95 percent UTLs.

PAHs

One PAH (pyrene) was detected in ISUXO6-DP1, but it did not exceed the adjusted tap water RSL. No PAHs were detected at ISUXO6-DP2 and ISUXO6-DP3.

Explosives

As shown on Table 3-3, several explosives were detected at each location. One or more of five explosives—2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, nitrobenzene, and NG—exceeded the RSLs at each location. None of the RSL-exceeded constituents could be compared to the 95 percent UTL background concentration because there are no background levels for these compounds.

3.6.2 Summary of Investigation Findings

Soil and groundwater samples were collected and analyzed for the purpose of making a site management decision. The following bullets summarize the results of constituents that exceeded the RSLs:

- Surface soil
  - No exceedances of detected PAHs (1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, anthracene, and fluorine) and explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2-amino-4,6-dinitrotoluene, nitroguanidine, and RDX)
- Subsurface soil
  - No detections of PAHs
  - No exceedances of detected explosives (1,3,5-trinitrobenzene, 2-nitrotoluene, NG, nitroguanidine, perchlorate, RDX, and tetryl)
- *In situ* Groundwater
  - One PAH (pyrene) was detected at one location (ISUXO6-DP1) in the duplicate sample, but it did not exceed the RSL
  - Several explosives (2,4,6-trinitrotoluene, 2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, HMX, nitrobenzene, nitrocellulose, NG, nitroguanidine, and tetryl) were detected at each location. Location ISUXO-DP1 had the most detected compounds and the overall highest concentrations of detected compounds
  - There are exceedances of five detected explosives (2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, nitrobenzene, and NG) at ISUXO6-DP1, two explosives (nitrobenzene and NG) at ISUXO6-DP2, and one explosive (nitrobenzene) at ISUXO6-DP3

- There are no background values for the RSL-exceeded explosive compounds, so a comparison to background concentrations was not possible

3.7 Conceptual Site Model

The CSM for UXO 6 was presented in Section 5.3.11 of the PA, and is summarized here and updated if necessary. CSMs for MEC and MC are shown as Figures 3-3 and 3-4, respectively. Figure 3-5 presents a graphical illustration of the CSM. The nature of the activity that presumably occurred at the site suggests that MEC may be present; however, the density of the MEC (NG) is not known. Therefore, potentially complete pathways exist for human and ecological receptors for MEC in the surface soil. This includes receptors for hand/tread underfoot contact as well as surface intrusive work that may be conducted at the site. MEC is not expected to be present in the subsurface.

Soil affected by MC represents a primary source medium. The burning grounds are currently not used; however, Hussey Circle Road, located south of the range, is used occasionally, so vegetation is kept at a minimum. The site is located within an upland hunting area. Based on current site use, potential current human receptors include Navy personnel (military and civil servants), trespassers, visitors, maintenance workers, contractors, and recreational users (hunters). Future site use is not expected to change significantly from current site use; therefore, potential future receptors include current receptors and construction/utility workers who may perform any future construction projects at the site. Additionally, although unlikely, future residents are considered a worst-case future scenario when considering unrestricted future site use. Human and ecological receptors have potentially complete exposure pathways for direct contact with MC in surface soil, which includes dermal contact, ingestion, and inhalation (dust). Runoff and/or erosion may transport the MC from surface soil to surface water/ sediments, so a potentially complete pathway also exists for all human and ecological receptors of surface water/sediments. Given that the site is located within an upland hunting area, human and ecological receptors have a potentially complete pathway by ingesting game/prey that have previously consumed contaminated vegetation or prey. Precipitation infiltration may provide for contaminant mobility into the subsurface soil and into the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies.

Potentially complete exposure pathways exist for MC in subsurface soils (direct contact, ingestion and inhalation) during intrusive work activities. Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors and for ecological receptors at the point of groundwater discharge to Mattawoman Creek. Potential receptors for the groundwater include construction/utility workers during excavation activities, and in the unlikely event the groundwater is used as a potable water supply, future residents and/or site workers.

3.8 Conclusions and Recommendations

The PA recommended an SI for both MEC and MC. The site was investigated to determine the presence or absence of PAHs and explosives in surface soil, subsurface soil, and groundwater. The results from this investigation are adequate to meet the objective of the SI.

Based on the results of the screening, residual NG or byproducts from historical burning activities at the site apparently have migrated through the soil column into the underlying shallow groundwater. Although these compounds were detected in soil, they were detected at low levels that do not exceed their RSLs. Therefore, surface soil and subsurface soil are recommended for no further investigation. The presence of explosives in groundwater, specifically NG, suggests that these compounds are related to site activities, burning of NG slums. Therefore, an RI is recommended for groundwater. No further investigation is recommended for MEC.

TABLE 3-1
UXO 6 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO6-DP01	ISUXO6-DP02	ISUXO6-DP03
Sample ID					ISUXO6-SS01-0001	ISUXO6-SS02-0001	ISUXO6-SS03-0001
Sample Date					4/28/10	4/29/10	4/29/10
Chemical Name							
Semivolatile Organic Compounds (UG/KG)							
1-Methylnaphthalene	22000	2 / 3	0 / 3	NA	8.44	7.6 U	3.93 J
2-Methylnaphthalene	31000	1 / 3	0 / 3	73	8.93	7.6 U	1.79 B
Acenaphthene	340000	0 / 3	0 / 3	140	10.8 B	7.6 U	8.21 U
Acenaphthylene	340000	1 / 3	0 / 3	NA	9.65 J	7.6 U	8.21 U
Anthracene	1700000	1 / 3	0 / 3	260	11.5	7.6 U	8.21 U
Benzo(a)anthracene	150	0 / 3	0 / 3	480	8.21 U	7.6 U	8.21 U
Benzo(a)pyrene	15	0 / 3	0 / 3	390	8.21 U	7.6 U	8.21 U
Benzo(b)fluoranthene	150	0 / 3	0 / 3	420	2.93 B	7.6 U	8.21 U
Benzo(g,h,i)perylene	170000	0 / 3	0 / 3	130	8.21 U	7.6 U	2.34 B
Benzo(k)fluoranthene	1500	0 / 3	0 / 3	360	2.07 B	7.6 U	8.21 U
Chrysene	15000	0 / 3	0 / 3	440	8.21 U	7.6 U	8.21 U
Dibenz(a,h)anthracene	15	0 / 3	0 / 3	NA	8.21 U	7.6 U	8.21 U
Fluoranthene	230000	0 / 3	0 / 3	1,100	5.92 B	7.6 U	8.67 B
Fluorene	230000	1 / 3	0 / 3	150	14	7.6 U	8.21 U
Indeno(1,2,3-cd)pyrene	150	0 / 3	0 / 3	100	8.21 U	7.6 U	8.21 U
Naphthalene	3600	0 / 3	0 / 3	110	6.9 B	7.6 U	8.21 U
Phenanthrene	1700000	0 / 3	0 / 3	1,100	12.4 B	3.46 B	6.09 B
Pyrene	170000	0 / 3	0 / 3	880	5.31 B	7.6 U	3.12 B
Explosives (UG/KG)							
1,3,5-Trinitrobenzene	220000	1 / 3	0 / 3	NA	60 U	60 U	27.9 J
1,3-Dinitrobenzene	610	1 / 3	0 / 3	NA	27.6 J	60 U	60 U
2,4,6-Trinitrotoluene	3600	0 / 3	0 / 3	NA	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	0 / 3	0 / 3	NA	60 U	60 U	60 U
2,6-Dinitrotoluene	6100	0 / 3	0 / 3	NA	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	1 / 3	0 / 3	NA	60 U	21.8 K	60 U
2-Nitrotoluene	2900	0 / 3	0 / 3	150	60 U	60 U	60 U
3-Nitrotoluene	610	0 / 3	0 / 3	NA	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	0 / 3	0 / 3	NA	60 U	60 U	60 U
4-Nitrotoluene	24000	0 / 3	0 / 3	210	60 U	60 U	60 U
HMX	380000	0 / 3	0 / 3	NA	60 U	60 U	60 U
Nitrobenzene	4800	0 / 3	0 / 3	NA	60 U	60 U	60 U
Nitrocellulose	100000000	0 / 3	0 / 3	NA	3000 U	3000 U	3000 U
Nitroglycerin	610	0 / 3	0 / 3	NA	150 U	150 U	150 U
Nitroguanidine	610000	3 / 3	0 / 3	NA	308	1,320	51 J
Perchlorate	5500	0 / 3	0 / 3	NA	2.46 U	2.28 U	2.46 U
PETN	NSL	0 /3	0 / 3	NA	150 U	150 U	150 U
RDX	5500	3 / 3	0 / 3	NA	24.5 J	37.2 K	51.1 J
Tetryl	24000	0 / 3	0 / 3	NA	60 U	60 U	60 U

Notes:

Shading indicates detections.

Bolded underlined shading indicates detected regional screening level (RSL) exceedances.

RSLs are current as of May, 2010.

NSL: No screening level

UG/KG - Micrograms per kilogram

NA - Not available

U - The material was analyzed for, but not detected

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine

PETN - pentaerythritol tetranitrate

RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen

associated blank.

or precise

may be lower

95 percent upper tolerance limits (UTLs) are taken from Table 4-2 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code. Example: ISUXO6-SS01-0001; where I is for Indian Head; S is for site; UXO6 is the site number; SS01 is surface soil sample from station 1; and 0001 is the sample depth interval (0-0.5 foot bgs). If a "P" is at the end of "SS01" then it is a duplicate sample from that station.

TABLE 3-2
UXO 6 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO6-DP01			ISUXO6-DP02		ISUXO6-DP03	
Sample ID					ISUXO6-SB01-0102	ISUXO6-SB01-1617	ISUXO6-SB01P-0102	ISUXO6-SB02-0102	ISUXO6-SB02-1718	ISUXO6-SB03-0102	ISUXO6-SB03-1920
Sample Date					4/28/10	4/28/10	4/28/10	4/29/10	4/29/10	4/29/10	4/29/10
Chemical Name											
Semivolatile Organic Compounds (UG/KG)											
1-Methylnaphthalene	22000	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	2.23 B	8.11 U
2-Methylnaphthalene	31000	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	2.59 B	8.11 U
Acenaphthene	340000	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	2.2 B	8.11 U
Acenaphthylene	340000	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	8.7 U	8.11 U
Anthracene	1700000	0 / 6	0 / 6	NA	7.97 U	8.13 U	1.76 B	2.69 B	8.05 U	8.7 U	8.11 U
Benzo(a)anthracene	150	0 / 6	0 / 6	NA	7.97 U	8.13 U	2.22 B	3.69 B	8.05 U	8.7 U	8.11 U
Benzo(a)pyrene	15	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	8.7 U	8.11 U
Benzo(b)fluoranthene	150	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	8.7 U	8.11 U
Benzo(g,h,i)perylene	170000	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	8.7 U	8.11 U
Benzo(k)fluoranthene	1500	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	8.7 U	8.11 U
Chrysene	15000	0 / 6	0 / 6	NA	7.97 U	8.13 U	2.62 B	4.65 B	8.05 U	8.7 U	8.11 U
Dibenz(a,h)anthracene	15	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	8.7 U	8.11 U
Fluoranthene	230000	0 / 6	0 / 6	NA	2.41 B	8.13 U	6.03 B	13.8 B	8.06 B	8.7 U	8.11 U
Fluorene	230000	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	2.39 B	8.11 U
Indeno(1,2,3-cd)pyrene	150	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	8.7 U	8.11 U
Naphthalene	3600	0 / 6	0 / 6	NA	7.97 U	8.13 U	8.28 U	7.81 U	8.05 U	8.7 U	8.11 U
Phenanthrene	1700000	0 / 6	0 / 6	NA	2.87 B	3.77 B	6.72 B	15.3 B	3.62 B	2.83 B	3.39 B
Pyrene	170000	0 / 6	0 / 6	NA	2.29 B	8.13 U	5.22 B	8.11 B	3.18 B	8.7 U	8.11 U
Explosives (UG/KG)											
1,3,5-Trinitrobenzene	220000	1 / 6	0 / 6	NA	60 U	22.2 J	60 U	60 U	60 U	60 U	60 U
1,3-Dinitrobenzene	610	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,4,6-Trinitrotoluene	3600	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,6-Dinitrotoluene	6100	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2-Nitrotoluene	2900	1 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	87.6	60 U
3-Nitrotoluene	610	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
HMX	380000	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Nitrobenzene	4800	0 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Nitrocellulose	100000000	0 / 6	0 / 6	NA	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U
Nitroglycerin	610	1 / 6	0 / 6	NA	150 U	128 J	150 U	150 U	150 U	150 U	150 U
Nitroguanidine	610000	2 / 6	0 / 6	NA	100 U	40.2 J	100 U	100 U	100 U	100 U	316
Perchlorate	5500	1 / 6	0 / 6	NA	2.39 U	7.82	2.48 U	2.34 U	2.41 U	2.61 UL	2.43 U
PETN	NSL	0 / 6	0 / 6	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	6 / 6	0 / 6	NA	38.6 J	60 U	28.5 J	65.3 K	58.7 J	77.3 J	61.9 J
Tetryl	24000	1 / 6	0 / 6	NA	60 U	60 U	60 U	60 U	60 U	22.9 J	60 U

Notes:

Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010
NSL: NO screening level
B - Not detected at significantly greater than that in an associated blank.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
NS - Not sampled

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
UL - Analyte not detected, quantitation limit is probably higher
UG/KG - Micrograms per kilogram
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 3-3
UXO 6 - Raw, Detected, and Exceed Constituents in In Situ Groundwater
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Tapwater Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO6-DP01		ISUXO6-DP02	ISUXO6-DP03
Sample ID					ISUXO6-GP01-0410	ISUXO6-GP01P-0410	ISUXO6-GP02-0410	ISUXO6-GP03-0410
Sample Date					4/29/10	4/29/10	4/29/10	4/29/10
Chemical Name								
Semivolatile Organic Compounds (UG/L)								
1-Methylnaphthalene	2.3	0 / 3	0 / 3	NA	0.2 UJ	0.425 B	0.19 UJ	0.213 UJ
2-Methylnaphthalene	15	0 / 3	0 / 3	NA	0.2 UJ	0.52 B	0.076 B	0.213 UJ
Acenaphthene	220	0 / 3	0 / 3	NA	0.2 UJ	0.344 B	0.33 B	0.213 UJ
Acenaphthylene	220	0 / 3	0 / 3	NA	0.2 UJ	0.325 B	0.19 UJ	0.213 UJ
Anthracene	1100	0 / 3	0 / 3	NA	0.2 UJ	0.235 B	0.305 B	0.213 UJ
Benzo(a)anthracene	0.029	0 / 3	0 / 3	NA	0.2 UJ	0.19 UJ	0.748 B	0.213 UJ
Benzo(a)pyrene	0.0029	0 / 3	0 / 3	NA	0.2 UJ	0.19 UJ	0.453 B	0.213 UJ
Benzo(b)fluoranthene	0.029	0 / 3	0 / 3	NA	0.2 UJ	0.19 UJ	0.521 B	0.213 UJ
Benzo(g,h,i)perylene	110	0 / 3	0 / 3	NA	0.2 UJ	0.19 UJ	0.196 B	0.213 UJ
Benzo(k)fluoranthene	0.29	0 / 3	0 / 3	NA	0.2 UJ	0.19 UJ	0.244 B	0.213 UJ
Chrysene	2.9	0 / 3	0 / 3	NA	0.2 UJ	0.19 UJ	0.854 B	0.213 UJ
Dibenz(a,h)anthracene	0.0029	0 / 3	0 / 3	NA	0.2 UJ	0.19 UJ	0.0896 B	0.213 UJ
Fluoranthene	150	0 / 3	0 / 3	NA	0.2 UJ	0.0873 B	1.58 B	0.213 UJ
Fluorene	150	0 / 3	0 / 3	NA	0.2 UJ	0.351 B	0.139 B	0.213 UJ
Indeno(1,2,3-cd)pyrene	0.029	0 / 3	0 / 3	NA	0.2 UJ	0.19 UJ	0.287 B	0.213 UJ
Naphthalene	0.14	0 / 3	0 / 3	NA	0.2 UJ	0.537 B	0.279 B	0.213 UJ
Phenanthrene	1100	0 / 3	0 / 3	NA	0.2 UJ	0.249 B	1.27 B	0.213 UJ
Pyrene	110	1 / 3	0 / 3	NA	0.2 UJ	0.0881 J	1.38 B	0.213 UJ
Explosives (UG/L)								
1,3,5-Trinitrobenzene	110	0 / 3	0 / 3	NA	0.147 B	0.231 UJ	0.394 B	0.17 B
1,3-Dinitrobenzene	0.37	0 / 3	0 / 3	NA	0.791 B	0.231 UJ	0.3 UJ	0.253 UJ
2,4,6-Trinitrotoluene	1.8	3 / 3	0 / 3	NA	0.378 J	0.231 UJ	0.205 J	0.111 J
2,4-Dinitrotoluene	0.22	0 / 3	0 / 3	NA	0.253 UJ	0.231 UJ	0.3 UJ	0.253 UJ
2,6-Dinitrotoluene	3.7	1 / 3	0 / 3	NA	0.0863 J	0.202 J	0.3 UJ	0.253 UJ
2-Amino-4,6-dinitrotoluene	7.3	1 / 3	0 / 3	NA	0.376 J	0.231 UJ	0.373 B	0.135 B
2-Nitrotoluene	0.31	1 / 3	1 / 3	NA	**24.9 J**	0.0986 J	5.25 B	3.85 B
3-Nitrotoluene	0.37	2 / 3	1 / 3	NA	**2.65 J**	0.231 UJ	0.125 J	0.253 UJ
4-Amino-2,6-dinitrotoluene	7.3	0 / 3	0 / 3	NA	0.253 UJ	0.231 UJ	0.3 UJ	0.253 UJ
4-Nitrotoluene	4.2	1 / 3	1 / 3	NA	**13.3 J**	0.231 UJ	0.3 UJ	0.253 UJ
HMX	180	1 / 3	0 / 3	NA	0.231 J	0.231 UJ	0.3 UJ	0.253 UJ
Nitrobenzene	0.12	3 / 3	3 / 3	NA	**0.493 J**	0.231 UJ	**0.366 J**	**0.269 J**
Nitrocellulose	11000000	1 / 3	0 / 3	NA	300 U	125 J	300 U	300 U
Nitroglycerin	0.37	3 / 3	2 / 3	NA	**0.828 J**	0.577 UJ	**0.574 J**	0.317 J
Nitroguanidine	370	3 / 3	0 / 3	NA	17 J	17.3 J	20.6 J	45.5 J
Perchlorate	2.6	0 / 3	0 / 3	NA	2 U	2 U	1 U	5 U
PETN	NSL	0 / 3	0 / 3	NA	0.632 UJ	0.577 UJ	0.75 UJ	0.632 UJ
RDX	0.61	0 / 3	0 / 3	1.2	0.38 B	0.231 UJ	0.254 B	0.336 B
Tetryl	15	1 / 3	0 / 3	NA	0.323 J	0.231 UJ	0.3 UJ	0.253 UJ

Notes:

Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010
NSL: No screening level. There is no RSL for PETN. Thallium was removed from the RSLs in December, 2009.
B - Not detected at significantly greater than that in an associated blank.
J - Analyte present. Value may or may not be accurate or precise
NS - Not sampled

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UG/L - Micrograms per liter
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table A-8 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-GP01-MMYY; where I is for Indian Head; S is for site; UXO6 is the site number; GP01 is groundwater sample from station 1; and MMYY is the month and year of collection. If a “P” is at the end of “GP01” then it is a duplicate sample from that station.

Legend

- Surface Soil, Subsurface Soil, and *in situ* Groundwater Sample Locations
- Approximate Site Boundary

Notes:
1. Location ISUXO6-DP02 was located within the stained or burned area shown on a 1952 aerial photograph.

N

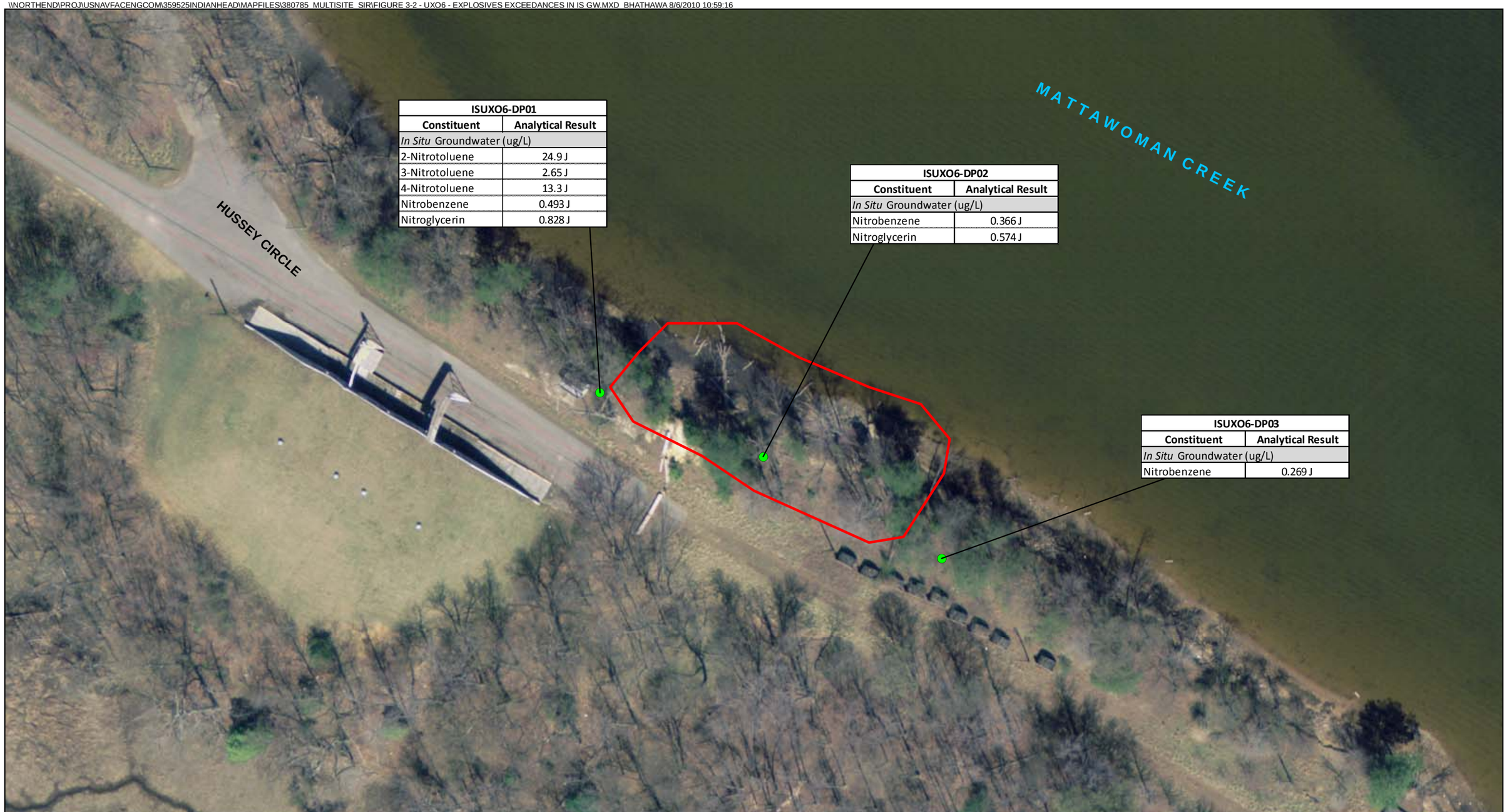
0 25 50 Feet

1 inch = 50 feet

Figure 3-1
UXO 6 - Site and MC Sampling Locations
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Imagery Source: USGS

CH2MHILL



ISUXO6-DP01	
Constituent	**Analytical Result**
In Situ Groundwater (ug/L)	
2-Nitrotoluene	24.9 J
3-Nitrotoluene	2.65 J
4-Nitrotoluene	13.3 J
Nitrobenzene	0.493 J
Nitroglycerin	0.828 J

ISUXO6-DP02	
Constituent	**Analytical Result**
In Situ Groundwater (ug/L)	
Nitrobenzene	0.366 J
Nitroglycerin	0.574 J

ISUXO6-DP03	
Constituent	**Analytical Result**
In Situ Groundwater (ug/L)	
Nitrobenzene	0.269 J

Legend

- Surface Soil, Subsurface Soil, and *in situ* Groundwater Sample Locations
- Approximate Site Boundary

Imagery Source: USGS

Notes:
1. Location ISUXO6-DP02 was located within the stained or burned area shown on a 1952 aerial photograph.
2. Constituents noted in the data boxes at each location indicate that they exceeded their respective RSLs.
3. Bold font indicates that the constituent exceeded both the RSL and background (if available).
4. Background values are presented in *Background Soil Investigation Report for Indian Head and Stump Neck Annex* (Tetra Tech, 2002).
5. There are no RSL exceedances in surface or subsurface soil; only in *in situ* groundwater.
6. J – Analyte present. Value may or may not be accurate or precise.

N

0 25 50 Feet

1 inch = 50 feet

Figure 3-2
UXO 6 - Explosives Exceedances in *In Situ* Groundwater
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

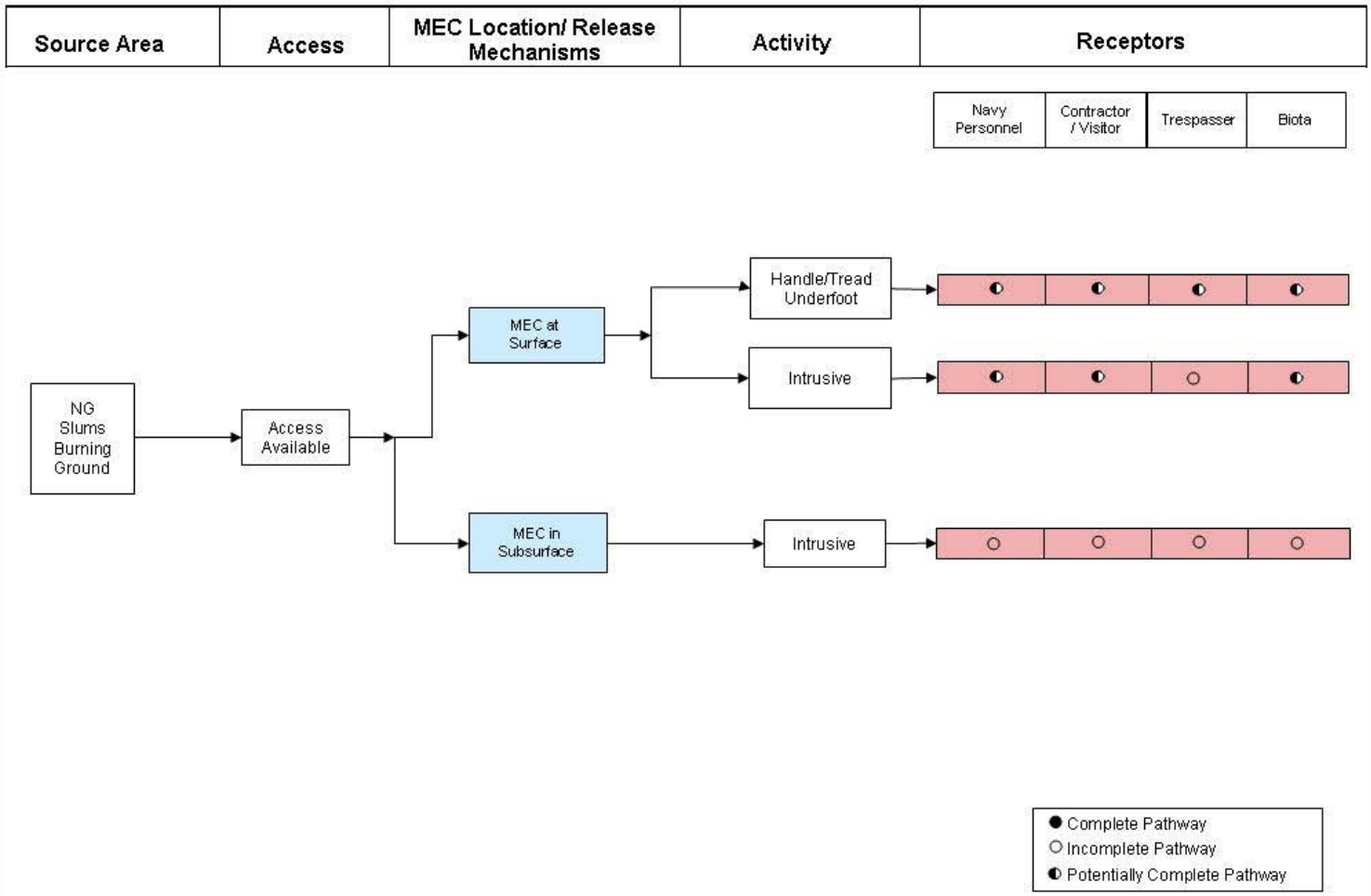


FIGURE 3-3
UXO 6 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.3-3 in the Preliminary Assessment (Malcolm Pirnie 2005)

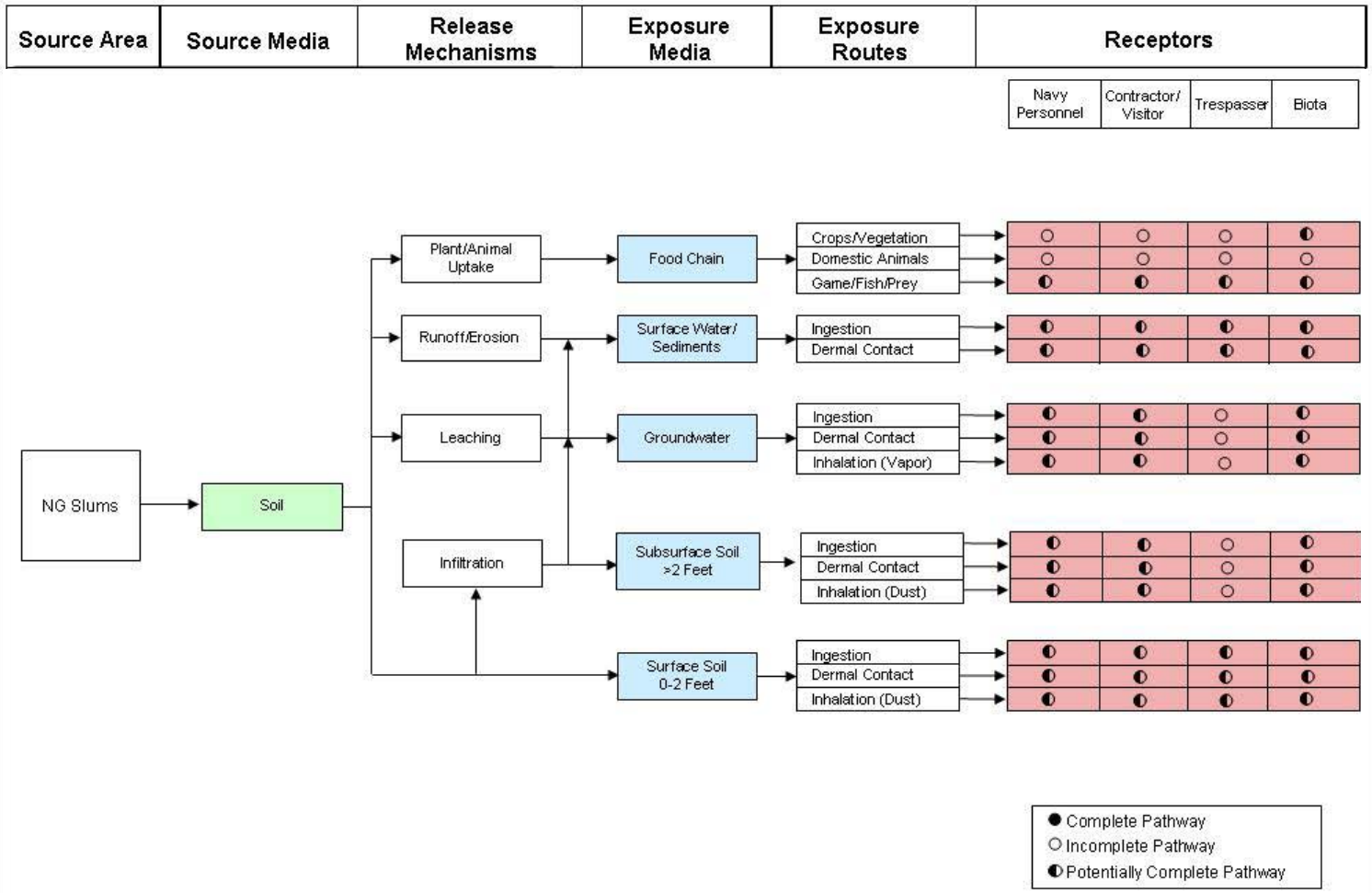


FIGURE 3-4
UXO 6 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.3-4 in the Preliminary Assessment (Malcolm Pirnie 2005)

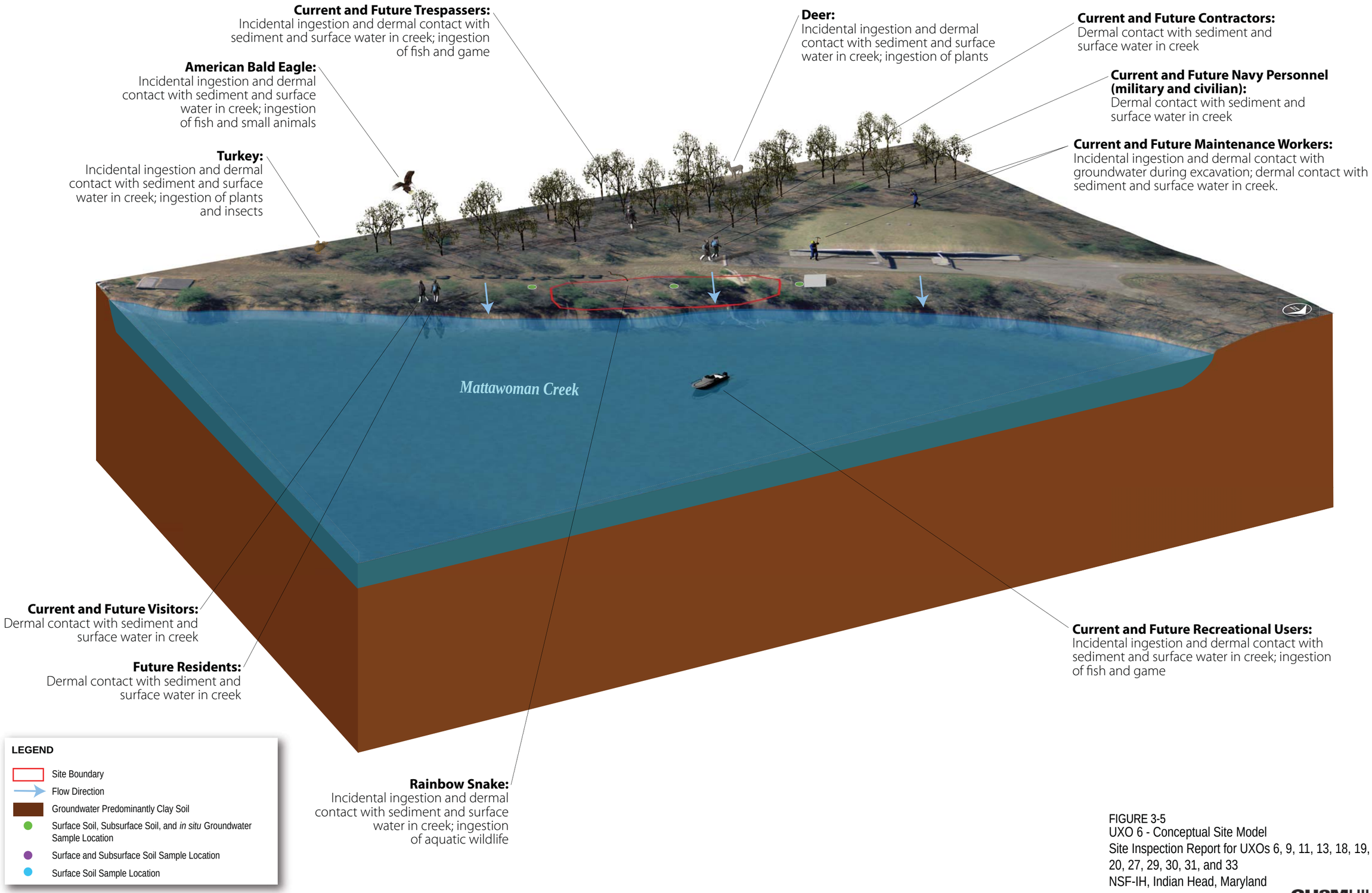


FIGURE 3-5
UXO 6 - Conceptual Site Model
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

ES080210002745WDC IH_Site_6_CSM_v6.ai 8-06-10 mlb

CH2MHILL

Photo 3-1: UXO 6 – General view of the site. View is to the northeast from Hussey Road. Mattawoman Creek is in the background. Photo was taken on 11/25/08.

SECTION 4

UXO 9 – Single Base Propellant Grains Spill Area

4.1 Site Background

UXO 9 is a 52-acre site in the northeastern portion of the Indian Head peninsula at the Main Installation (Figure 1-1).The site was investigated in a 1983 IAS (Fred C. Hart Associates Inc., 1983) under the Installation Restoration Program as Site 10. The report recommended NFA because of a low risk to human health and the environment from nitrocellulose. The Navy has moved the site to the Munitions Response Program because MC is known to be present at the site.

As reported in the PA, the site consists of an area where single base propellant grains were spilled during transportation of the propellant by rail at the installation. Transportation of the grains started between 1927 and 1942 and ended in the late 1980s; the railroad line was abandoned in the late 1980s. Single base propellant grains were observed on the ground surface outside Building 188 during the PA.

Single base propellant grains consist mostly of nitrocellulose (formed from the reaction between cellulose and nitric acid). These grains are not soluble and, based on their size, are not considered transportable through the soil column; however, grains could be transported by overland flow during periods of high precipitation and released in surface water. Direct contact at the ground surface is considered the most likely exposure scenario. MC, which includes nitrates and diphenylamine, could infiltrate to subsurface soil. Precipitation infiltration may also provide contaminant mobility through the subsurface to the shallow or surficial groundwater aquifer, which is assumed to be connected to nearby surface water bodies. Shallow groundwater is considered a potential exposure medium.

Currently, the site is an open, grassy area along the abandoned railroad tracks formerly used to transport propellants to numerous buildings (Photo 4-1). Human and ecological receptors may be exposed to propellant grains in surface soil (primarily from handling and treading underfoot). Contact with the propellant grains in subsurface soil is an incomplete pathway (from intrusive activities). During the April 22, 2009 site visit by the Navy and CH2M HILL, a propellant grain was observed on the ground near the northwest corner of Building 188, and a metal canister was observed near the north corner of the building. The Navy historian, Mr. James Dolph, pointed out that the propellant grains could have been packed in this type of canister for transportation; the canisters are typically zinc-plated to prevent sparks.

Based on subsequent e-mail correspondence with Mr. Thomas Wright of NSF-IH after the April 22, 2009 site visit, CH2M HILL was informed that the buildings along the railroad tracks were, in general, used as dry powder houses. The term “dry powder house” was used to identify buildings to "dry" the powder (or grains) that were produced in varying sizes, depending on the guns for which they were manufactured. The grains (or green powder)

were transported by rail to the dry powder houses, were they were left to dry for 5 to 6 weeks. They were then treated with graphite and mixed in a blending tower. The powder was then placed in metal cans and stored in magazines before being shipped from the installation.

4.2 Rationale and Objective

This site was used to load and transport single base propellant grains from the former production area. This resulted in the release of grains around buildings where the grains were handled and loaded, and along the tracks. As a result, facility operations may have resulted in MEC and MC being released into the environment. The PA recommended an SI for MEC and a Remedial Investigation (RI) for MC.

The objective of the SI was to assess the spatial distribution of propellant grains through visual inspection (MEC inventory) along the railroad tracks and around the buildings along the tracks. One propellant grain was observed during the PA and the April 22, 2009 site visit, so the presence of the grains has been confirmed. The objective was accomplished through a site walkthrough, which was conducted to identify areas where grains are present. Figure 4-1 shows the locations of the buildings and the railroads tracks where the visual inspection occurred. An aerial photographic analysis also was also performed to identify past activities (such as loading of trains) around buildings.

4.3 Aerial Photographic Analysis

Historical aerial photographs from 1937 through 1981 were reviewed (Appendix A). Open rail boxcars filled with light-colored material were observed in a photograph of an area of disturbed ground west of the site in 1937 as well as in 1944. The 1944 photograph also showed stacked materials (crates, containers) located south of the site. The 1950 photograph showed boxcars in the northwestern portion of the site and stacked materials (crates, containers) south of the site. By 1954, open storage bins were present in the south central portion of the rail yard; boxcars were located in the eastern and western portions of the site; and stacked materials (crates, containers) were present south of the site.

The 1956, 1957, 1961, 1962, 1964, and 1972 photographs showed rail boxcars and/or rail tank cars in various areas of the site, open storage bins, and stacked material (crates and containers) onsite. In the 1962 photograph, the open rail boxcars contained light- and medium-toned material. In 1972, open storage bins were inactive and the area was vegetated. In 1980 and 1981, a large graded area was present in the western portion of the site. Rail boxcars were present in the western and eastern portions of the site in the 1980 photograph, but the stacked materials seen in photos from years south of the site were no longer present. The 1981 photograph also showed rail boxcars in the western and eastern portions of the site.

4.4 Field Activities

A MEC inventory was conducted at UXO 9 from April 29, 2010 to April 31, 2010, consisting of a visual inspection of the site to locate potential MEC or MC. The inspection was performed by CH2M HILL personnel, which included two UXO technicians. For the

inventory, the site was divided into two areas: 1) the former railroad tracks, and 2) the former dry houses (Buildings 174, 175, 176, 177, 181, 182, 183, 188, 204, 206, 207, and 210).

The visual inspection of the former railroad tracks was conducted by four team members, spread across the width of the former railroad, with approximately 2 feet between each person. The width of the former rail line was defined as the area between the two rails plus an additional 5 feet on the outside of the rails. The team began on the northwestern end of the westernmost rail line and proceeded southeast to the site boundary, using the partially exposed rails as a guide. Once the inspection of the western rail had been completed, the team inspected the easternmost rail line using the same method, but proceeded from southeast to northwest. MEC items discovered during the inspection were marked with a pin flag and photographed.

The inspection of the former dry houses consisted of a visual survey of the area within a 15-foot perimeter about each building and associated structures, such as walkways and loading docks. Crawlspaces and areas beneath the loadings docks were also thoroughly inspected. As at the former railroad tracks area, MEC items discovered during the inspection were marked with a pin flag and photographed. Table 4-1 summarizes information on the propellant inventory. Figure 4-2 shows the distribution of the propellant grains at the site.

4.5 Results

Appendix G provides photographs of site conditions taken during the MEC inventory. Following the visual inspection of the former railroad tracks, only one propellant grain, approximately 1.25 inches in length, was discovered. The grain was located on the ground surface approximately 36 feet east of Building 210, along the westernmost rail line. During the inspection, it was observed that the former rail lines, including the area on both sides of the rails, had been filled with sand and gravel to allow for conventional vehicle traffic. This suggests that the ground surface was approximately 5 inches lower during the period when the rail lines were in use.

During the visual inspection of the former dry houses, propellant grains and propellant canister lids were observed. Although MEC was discovered at multiple locations within the 15-foot perimeter of each building, the items were observed to be concentrated in areas where propellants were likely handled. These consisted of areas near building entrances, as well as beneath walkways and loading docks. Additionally, propellant grains were observed near building downspouts and downstream of the associated runoff route. This suggested that the force of water during intense rain events could carry propellant grains beyond the 15-foot building perimeter. Owing to the density of propellant grains at some locations, groupings, as opposed to individual grains, were marked, as shown in the photographic log for UXO 9 (Appendix G).

4.6 Conceptual Site Model

The CSM for the UXO 9 was presented in Section 5.5.11 of the PA, and is summarized here and updated as necessary. CSMs for MEC and MC are shown as Figures 4-3 and 4-4, respectively. At UXO 9, historical and visual evidence indicate that MEC are present; therefore, a complete exposure pathway exists for MEC. As illustrated on Figure 4-3, surface soil containing MEC represents a source medium. A complete exposure pathway exists for

surface soil through direct contact for both human and ecological receptors. The presence of single-base propellant grains on the ground surface has the potential to present a flammable and/or explosive risk from direct contact. Single-base propellant grains are not expected to be in the subsurface.

As illustrated in Figure 4-4, soil affected by MC represents a primary source medium. Single grains were released directly to the ground surface in documented spills in this area. The site is currently not used, except for several storage buildings. Currently, the site is an open grassy area crossed by abandoned railroad tracks formerly used to transport propellants to numerous buildings, which are now either vacant or used for general equipment storage. This area is reported to include two designated wildlife grazing areas and is located within an upland hunting area. Based on current site use, potential current human receptors include Navy personnel (military and civil servants), trespassers, visitors, maintenance workers, contractors, and recreational users (hunters). Future site use is not expected to change significantly from current site use; therefore, potential future receptors include current receptors and construction/utility workers who may perform any future construction projects at the site. Additionally, although unlikely, future residents are considered a worst-case future scenario when considering unrestricted future site use.

A potentially complete pathway exists for surface soil for all human and ecological receptors for ingestion, dermal contact, and inhalation (dusts). Although single grains are not soluble in water and therefore cannot be transported by infiltration, the associated MC (nitrates and diphenylamine) may be transported to the subsurface soil and surficial groundwater by infiltration. Potentially complete pathways exist at the site for subsurface soil for all receptors expected to perform surface intrusive activities. Because the site is located within an upland hunting area, the food chain also represents an exposure medium through plant/animal uptake for biota (including game such as deer and wild turkey).

Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors and for ecological receptors at the point of groundwater discharge to Mattawoman Creek or the unnamed tributary to the creek in the eastern portion of the site.. Potential receptors for the groundwater include construction/utility workers during excavation activities, and in the unlikely event the groundwater is used as a potable water supply, future residents and/or site workers. Through surface runoff and erosion, MC may have been transported from surface soils to the unnamed tributary to Mattawoman Creek, and ultimately to the creek. Therefore, ecological receptors may also be exposed to MC through direct contact and ingestion of sediment and surface water.

4.7 Conclusions and Recommendations

The PA recommended an SI for MEC and an RI for MC. In support of the SI, the site was investigated to determine the spatial distribution of single based propellant grains along the railroad tracks and dry houses at UXO 9. The results from the investigation are adequate to meet the objective of the SI.

The spatial distribution of propellant grains around Buildings 174, 175, 176, 177, 181, 182, 183, 188, 204, 206, 207, and 210 indicated that propellant grains are widely distributed throughout building entranceways, walkways, loading docks, crawl spaces, and down

spouts. A non-time critical removal action is recommended to remove the propellant grains from around the buildings and the tracks.

In accordance with the PA, an RI is recommended for MC to investigate soil and groundwater.

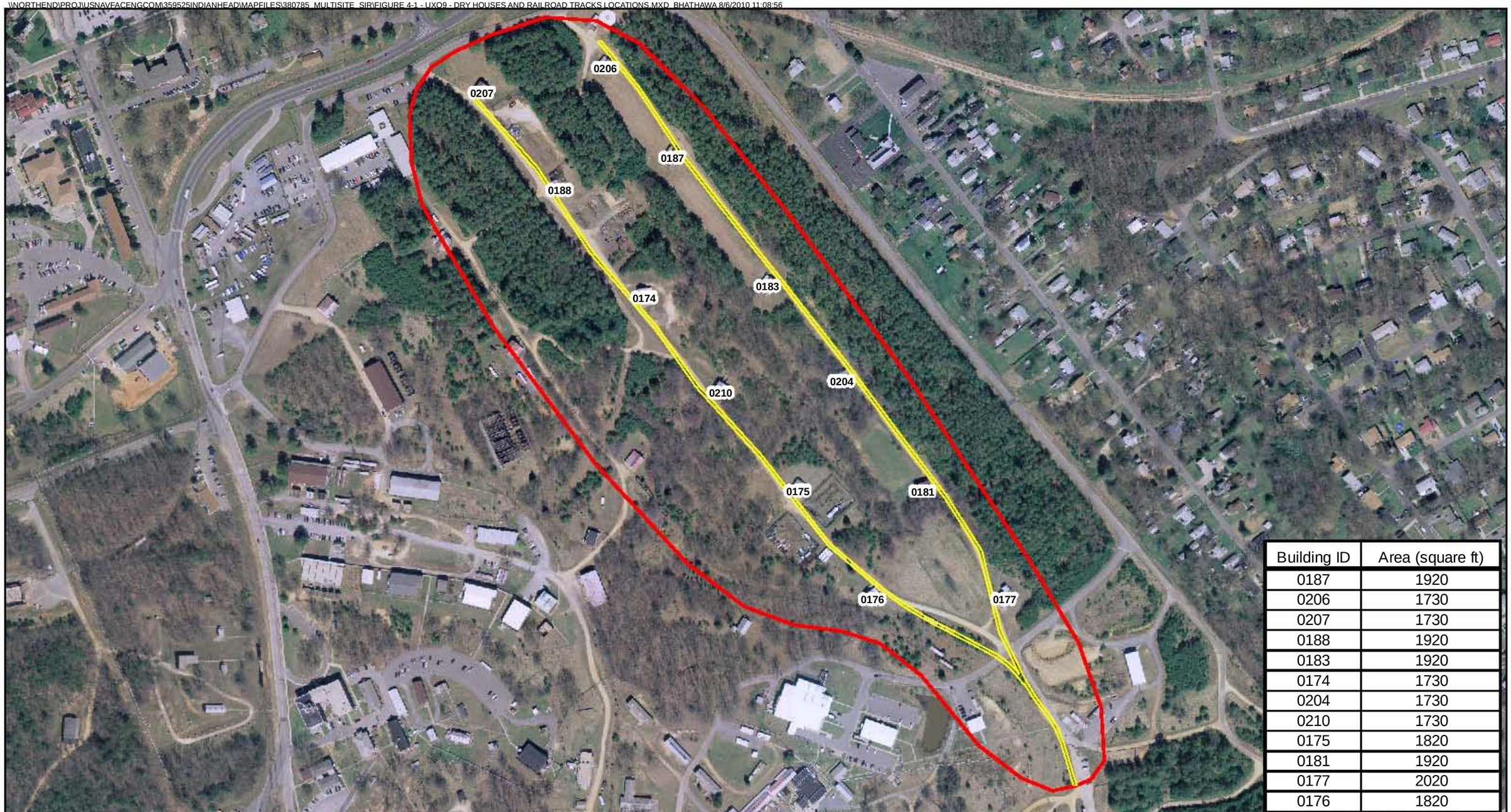
TABLE 4-1
UXO 9 - Summary of Observed Single Base Propellant Grains
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Item ID	Grid Cell	Team	Date Found	Time	Item Group	Quantity	Weight	Comments
UXO 09-10059	UXO 09	UXO1	31-Mar-10	13:58:05	Propellant Grains	4	0.1	#3-1; 4 red-brown sm grains. Flag to rt of stairwell, while facing.
UXO 09-10005	UXO 09	UXO1	30-Mar-10	16:09:02	Propellant Grains	1	0.1	#8-7; med lt br grain. Under load dock. No fix. MEC debris - probable illumination round, external shell split open, burster tube deteriorated with holes and observed empty. Open cavity filled with dirt debris.
UXO 09-10075	UXO 09	UXO1	31-Mar-10	10:25:44	Propellant Grains	3	0.1	#7-18, all sm bl, same fix 7-10. Btwn stump & cement.
UXO 09-10047	UXO 09	UXO1	30-Mar-10	11:30:01	Propellant Grains	1	0.1	Under N platform; #13-2; Brown
UXO 09-10062	UXO 09	UXO1	31-Mar-10	11:28:39	Propellant Grains	100	2	#5-1, Bldg ; N corner, rear of bldg under W ramp, near bldg foundation. Cluster of 9 flags. ~100 bl, br, sm grains.
UXO 09-10017	UXO 09	UXO1	30-Mar-10	15:00:44	Propellant Grains	1	0.1	#9-2; sm black; under middle ramp; 3' from bldg wall.
UXO 09-10078	UXO 09	UXO1	31-Mar-10	10:22:05	Propellant Grains	7	0.2	#7-15; br-or, 5 sm, 2lg. Same fix 7-10.
UXO 09-10077	UXO 09	UXO1	31-Mar-10	10:23:33	Propellant Grains	5	0.2	#7-16; Same fix 7-10. All mmed, br-or.
UXO 09-10086	UXO 09	UXO1	31-Mar-10	9:52:04	Other (see comments)	1	0.3	#7-7;container lid. See 7-5 fix.
UXO 09-10076	UXO 09	UXO1	31-Mar-10	10:24:42	Propellant Grains	3	0.1	#7-17; all sm, bl; same fix 7-10.
UXO 09-10074	UXO 09	UXO1	31-Mar-10	10:29:23	Propellant Grains	3	0.1	#7-19; sm, br-or, along stairwell. Btwn RR track& stairs.
UXO 09-10055	UXO 09	UXO1	31-Mar-10	14:23:20	Propellant Grains	2	0.1	#3-5; dark gray, sm. Adj to staircase.
UXO 09-10071	UXO 09	UXO1	31-Mar-10	10:44:58	Propellant Grains	7	0.3	#6-1; all sm, bl. Under platform.
UXO 09-10011	UXO 09	UXO1	30-Mar-10	15:41:32	Propellant Grains	2	0.1	#8-1; 2 ea single hole, black color, no fix, NW rear bldg corner; 1' from cinder bllock ramp support, btwn ramp and wood pallet.
UXO 09-10080	UXO 09	UXO1	31-Mar-10	10:18:40	Propellant Grains	6	0.2	#7-13; same fix 7-10; All sm, black.
UXO 09-10034	UXO 09	UXO1	30-Mar-10	13:59:55	Propellant Grains	3	0.3	#11-2; 1/4"dia X 1/2"L; under N load ramp.
UXO 09-10079	UXO 09	UXO1	31-Mar-10	10:20:08	Propellant Grains	18	0.3	#7-14; same fix 7-10; All br-or; 17 sm, 1 med.
UXO 09-10007	UXO 09	UXO1	30-Mar-10	16:04:15	Other (see comments)	1	0.3	#8-5; container top only; near #8-4 behind brick support.
UXO 09-10015	UXO 09	UXO1	30-Mar-10	15:10:26	Propellant Grains	1	0.1	#11-5;off-white small; under E ramp 2' from bldg corner.
UXO 09-10018	UXO 09	UXO1	30-Mar-10	14:56:28	Propellant Grains	1	0.1	#9-1; med lt brown.
UXO 09-10032	UXO 09	UXO1	30-Mar-10	14:05:51	Propellant Grains	7	0.3	#1-4; 1 bl; 6 br-or; 1/4" dX 1/2" lL
UXO 09-10061	UXO 09	UXO1	31-Mar-10	11:39:16	Propellant Grains	3	0.1	#5-2; sm, br-or. Btwn ramps. See 5-1 fix
UXO 09-10040	UXO 09	UXO1	30-Mar-10	12:20:20	Propellant Grains	4	0.2	#12-5; all 3/8" dia X1". Brown-orange
UXO 09-10033	UXO 09	UXO1	30-Mar-10	14:01:32	Propellant Grains	11	0.7	11-3; 1 item black; 10 br-or; under N laod dock.
UXO 09-10065	UXO 09	UXO1	31-Mar-10	11:12:19	Propellant Grains	7	0.3	#6-7; 2 lg, 5 sm br, ~1' from NW bldg corner
UXO 09-10083	UXO 09	UXO1	31-Mar-10	10:03:30	Propellant Grains	6	0.3	#7-10; 4 sm, 2 med, all br. ~ 8' under platform from fix
UXO 09-10045	UXO 09	UXO1	30-Mar-10	11:54:41	Propellant Grains	1	0.1	#13-1; south side bldg 13; color brown or.
UXO 09-10039	UXO 09	UXO1	30-Mar-10	12:22:26	Propellant Grains	2	0.1	#12-6; 2 black; 1/4" dia X 1/2" L and 3/8" dia X ~1"L.
UXO 09-10044	UXO 09	UXO1	30-Mar-10	12:01:44	Other (see comments)	1	0.4	Top (only) of grey container.;#12-1
UXO 09-10016	UXO 09	UXO1	30-Mar-10	15:05:17	Propellant Grains	1	0.2	#9-3; lg br-or. Middle ramp btwn pillars.
UXO 09-10010	UXO 09	UXO1	30-Mar-10	15:46:40	Propellant Grains	2	0.1	#8-2; med size lt br; under stair well W side of bldg.
UXO 09-10029	UXO 09	UXO1	30-Mar-10	14:16:58	Propellant Grains	8	0.3	#11-7; all br-or; 1/4" d X 1/2"L. No fix.
UXO 09-10051	UXO 09	UXO1	31-Mar-10	15:14:54	Propellant Grains	5	0.2	#2-3; 5 med black grains; flag 10' back from bldg edge btwn support columns. GPS pt ~15' E of bldg side.
UXO 09-10037	UXO 09	UXO1	30-Mar-10	12:32:16	Propellant Grains	1	0.1	#12-8; brown-orange. S side.
UXO 09-10003	UXO 09	UXO1	30-Mar-10	16:16:59	Propellant Grains	1	0.1	#8-9; sm, yellow brown;3' diag from rear E corner of bldg. No fix
UXO 09-10063	UXO 09	UXO1	31-Mar-10	11:18:49	Propellant Grains	4	0.2	#6-9; 3 med, 1 sm br.
UXO 09-10023	UXO 09	UXO1	30-Mar-10	14:38:07	Propellant Grains	3	0.1	#10-1; 3ea (1 split in 2 sections;) 1 bl; rest br; no fix; 1' off E wall; 4th pillar from rear.
UXO 09-10020	UXO 09	UXO1	30-Mar-10	14:47:15	Propellant Grains	3	0.2	#11-5; 1 lg, 2 smal; inside 3rd pillar from road.l
UXO 09-10046	UXO 09	UXO1	30-Mar-10	11:39:50	Propellant Grains	1	0.2	#13-3; 2 ea (1 broken), 6' W of 13-2. Brown-orange.
UXO 09-10053	UXO 09	UXO1	31-Mar-10	14:44:10	Propellant Grains	400	10	#2-1; Under RR load pltform, 15 flagged groupings. Sizes, colors various. Bldg #207.
UXO 09-10085	UXO 09	UXO1	31-Mar-10	9:57:05	Propellant Grains	9	0.4	#7-8; all sm grains, br, bl, &grey. Along side platform.
UXO 09-10070	UXO 09	UXO1	31-Mar-10	10:50:52	Propellant Grains	2	0.1	#6-2; both sm, br-or. East side of eastern stairwell, rear of bldg 175.
UXO 09-10048	UXO 09	UXO1	30-Mar-10	11:14:10	Propellant Grains	1	0.1	Brown-orange
UXO 09-10041	UXO 09	UXO1	30-Mar-10	12:17:37	Propellant Grains	4	0.2	1 grain 3/8" dia X ~ 1" L; 3ea smaller; all brown-orange.

TABLE 4-1
UXO 9 - Summary of Observed Single Base Propellant Grains
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Item ID	Grid Cell	Team	Date Found	Time	Item Group	Quantity	Weight	Comments
UXO 09-10031	UXO 09	UXO1	30-Mar-10	14:08:39	Propellant Grains	1	0.1	#11-5; br-or; 1/4" X 1/2"; no fix due to trees.
UXO 09-10064	UXO 09	UXO1	31-Mar-10	11:16:50	Propellant Grains	1	0.2	#6-8; lg, white. See 6-7 fix.
UXO 09-10042	UXO 09	UXO1	30-Mar-10	12:14:34	Propellant Grains	6	0.3	#12-3; 5 grains ~1"L X 3/8" dia. Brown/orange; 1 grain smaller, green color.
UXO 09-10008	UXO 09	UXO1	30-Mar-10	15:50:16	Propellant Grains	2	0.2	#8-4; med lt br; under loading dock. No fix; middle of loading dockadj RR tracks
UXO 09-10021	UXO 09	UXO1	30-Mar-10	14:45:28	Other (see comments)	2	0.8	#11-4; 2 tops of containers.; btwn 2nd pair of pillars from road.
UXO 09-10022	UXO 09	UXO1	30-Mar-10	14:43:34	Propellant Grains	2	0.2	#10-2; lg grain; lt br; under E side of bldg; no fix.
UXO 09-10027	UXO 09	UXO1	30-Mar-10	14:22:37	Propellant Grains	11	0.3	#11-9; under wood ramp; br-or. No fix
UXO 09-10001	UXO 09	UXO1	30-Mar-10	16:22:05	Propellant Grains	2	0.2	#8-11; med & sm lt br. N side of middle ramp rear of bldg
UXO 09-10067	UXO 09	UXO1	31-Mar-10	11:05:46	Propellant Grains	5	0.1	#6-5; sm, br, ~5' from middle stairwell. No fix.
UXO 09-10066	UXO 09	UXO1	31-Mar-10	11:08:14	Propellant Grains	2	0.1	#6-6; 1 bl, 1br sm. Below 1st step of W stairwell, bldg 175. No fix.
UXO 09-10052	UXO 09	UXO1	31-Mar-10	15:00:07	Propellant Grains	200	5	#2-2; NW end of bldg 207 loading platform. Various colors &sizes in groupings under platform marked by 15 flags. Opposite (SE) end under platform marked by 10 flags.
UXO 09-10035	UXO 09	UXO1	30-Mar-10	13:55:43	Propellant Grains	1	0.29	#11-1; brown-orange; 3/4"d X 2";under N load ramp.
UXO 09-10084	UXO 09	UXO1	31-Mar-10	10:00:58	Propellant Grains	2	0.1	#7-9; 1 bl, 1 br grain. See 7-8 fix. Under platform ~ 1'.
UXO 09-10090	UXO 09	UXO1	31-Mar-10	9:38:57	Propellant Grains	2	0.2	#7-3; brown med & black sm grain. See 7-1 fix; under side loading platform
UXO 09-10068	UXO 09	UXO1	31-Mar-10	11:02:39	Propellant Grains	7	0.2	#6-4; 2 lg & white; 5 br, sm. At W corner middle stairs bldg 175.
UXO 09-10091	UXO 09	UXO1	31-Mar-10	9:35:42	Propellant Grains	3	0.3	#7-2 ; grey, med grains. NW stairs. No fix, see 7-1.
UXO 09-10014	UXO 09	UXO1	30-Mar-10	15:16:23	Propellant Grains	1	0.1	#9-6; off-white; no fix.
UXO 09-10002	UXO 09	UXO1	30-Mar-10	16:19:36	Propellant Grains	2	0.2	#8-10; med and sm reddish & lt brown. 4' S of ramp end.
UXO 09-10060	UXO 09	UXO1	31-Mar-10	11:41:22	Propellant Grains	50	1	#5-3; ~ 50 sm grains, most br-or, few bl. 7 flag grouping under E ramp. See 5-1 fix.
UXO 09-10054	UXO 09	UXO1	31-Mar-10	14:26:37	Propellant Grains	3	0.1	#3-6; 2 bl, 1 gray sm grains. Front of stair case. No fix. See 3-5.
UXO 09-10036	UXO 09	UXO1	30-Mar-10	12:34:37	Propellant Grains	1	0.1	#12-9; 1 item; brown-orange; 1/4" dia X 1/2"L
UXO 09-10030	UXO 09	UXO1	30-Mar-10	14:14:13	Propellant Grains	4	0.2	#11-6; 1 dark brown; 3 br-or; 1 partially disintegrated; various sizes.; no fix
UXO 09-10050	UXO 09	UXO1	31-Mar-10	15:23:08	Propellant Grains	1	0.1	#2-4; black small grain east side of east ramp next to brick ramp support, rear of bldg.. No fix due to bldg blocking sat signal.
UXO 09-10092	UXO 09	UXO1	31-Mar-10	9:32:35	Propellant Grains	1	0.1	#7-1; black, med grain under NW staairwell.
UXO 09-10024	UXO 09	UXO1	30-Mar-10	14:29:33	Propellant Grains	8	0.3	#11-12; br-or; 1/4" d X 1/2" L; no fix; located 2' from bldg corner.
UXO 09-10073	UXO 09	UXO1	31-Mar-10	10:34:48	Propellant Grains	2	0.1	#7-20; sm, br-or.
UXO 09-10012	UXO 09	UXO1	30-Mar-10	15:22:00	Propellant Grains	15	0.5	21 ea,#9-8 thru 15; flag cluster no fix; E front corner btwn steps and corner of bldg; all out from under; loading dock; various size/color.
UXO 09-10072	UXO 09	UXO1	31-Mar-10	10:37:29	Propellant Grains	1	0.3	#7-21; sm, bl grain witg container lid. See 7-20 fix. Direct under bldg number sign (176).
UXO 09-10069	UXO 09	UXO1	31-Mar-10	10:57:59	Propellant Grains	9	0.3	#6-3; sm/v sm bl, br & off- white. 3' from E corner of middle stairwell, rear of bldg 175.
UXO 09-10087	UXO 09	UXO1	31-Mar-10	9:50:02	Propellant Grains	3	0.3	#7-6; 2sm, 1 med; all br-or. See 7-5 fix, ~5' from platform edge. See 7-5 fix.
UXO 09-10026	UXO 09	UXO1	30-Mar-10	14:24:51	Propellant Grains	6	0.2	#11-10; br-or; no fix; side of ramp.
UXO 09-10057	UXO 09	UXO1	31-Mar-10	14:11:06	Propellant Grains	2	0.1	3-3; 2 sm, off-white.
UXO 09-10025	UXO 09	UXO1	30-Mar-10	14:28:05	Propellant Grains	4	0.1	#11-11; br-or. No fix.
UXO 09-10006	UXO 09	UXO1	30-Mar-10	16:06:30	Propellant Grains	8	0.3	#8-6; 4 ea lg lr br; 4 ea medium size.
UXO 09-10004	UXO 09	UXO1	30-Mar-10	16:12:09	Propellant Grains	6	0.3	#8-8 ; 4 ea med lt br; 2 ea sm. No fix; under E end loading dock next to container top.
UXO 09-10058	UXO 09	UXO1	31-Mar-10	14:06:16	Propellant Grains	3	0.1	#3-2; red and brown sm grain.No fix. Near 3-1 fix.
UXO 09-10028	UXO 09	UXO1	30-Mar-10	14:18:49	Propellant Grains	7	0.3	#11-;8; br-or to gray; 1/4"dX 1/2" L. No fix.
UXO 09-10088	UXO 09	UXO1	31-Mar-10	9:45:55	Propellant Grains	1	0.1	#7-5; sm,br-or grain. Under load platform, ~10' from RR edge.
UXO 09-10043	UXO 09	UXO1	30-Mar-10	12:11:22	Propellant Grains	2	0.2	#12-2; 2 ea (1 lg - ~3/4 dia X 2" L. UnderN load platform.
UXO 09-10081	UXO 09	UXO1	31-Mar-10	10:12:55	Propellant Grains	47	0.6	#7-12; all or-bt, all sml behind supports under NW stairwell. Same fix as 7-1.
UXO 09-10019	UXO 09	UXO1	30-Mar-10	14:48:57	Propellant Grains	1	0.1	#10-6; 1 black med grain.
UXO 09-10013	UXO 09	UXO1	30-Mar-10	15:17:30	Propellant Grains	1	0.1	#9-7; br-or; sm; no fix
UXO 09-10049	UXO 09	UXO1	29-Mar-10	15:16:11	Propellant Grains	1	0.1	Yellow flag #1A; 36ft east of bldg #210 load platform; 40" N. Of track
UXO 09-10089	UXO 09	UXO1	31-Mar-10	9:43:27	Propellant Grains	11	0.4	#7-4; all br-or, sm. See7-1 fix. Under front loading platform.
UXO 09-10056	UXO 09	UXO1	31-Mar-10	14:14:07	Propellant Grains	3	0.1	#3-4; br, red, white small grains; adj. to stair case.
UXO 09-10082	UXO 09	UXO1	31-Mar-10	10:07:35	Propellant Grains	23	0.3	#7-11; various sizes/colors; (sm & very sm)See 7-10 fix.
UXO 09-10009	UXO 09	UXO1	30-Mar-10	15:48:16	Other (see comments)	2	1	#8-3; 2 ea container tops. Near #8-2.
UXO 09-10038	UXO 09	UXO1	30-Mar-10	12:25:54	Propellant Grains	5	0.2	4 1/4"dia X 1/2" and 1 3/8" dia X ~1" L, 1 of the 4 is black.#12-7; all under N platform.

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 4-1 - UXO9 - DRY HOUSES AND RAILROAD TRACKS LOCATIONS.MXD BHATHAWA 8/6/2010 11:08:56



Building ID	Area (square ft)
0187	1920
0206	1730
0207	1730
0188	1920
0183	1920
0174	1730
0204	1730
0210	1730
0175	1820
0181	1920
0177	2020
0176	1820

Legend

Approximate Site Boundary

Visual Inspection Area for Propellant Grains

Note:

1. According to Information from the Navy, the buildings were developed as powder dry houses.
2. A "Powder dry house" was a building in which the powder (or grains) that were produced at different sites were dried. The grains (or freeze powder) were transported by rail to the dry houses where they were left to dry for 5-6 weeks.

N

0 150 300 Feet

1 inch = 300 feet

Figure 4-1

UXO 9 - Dry Houses and Railroad Tracks Locations

Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33

NSF-IH, Indian Head, Maryland

Imagery Source: USGS

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 4-2 - UXO9 - DISTRIBUTION OF SINGLE BASE PROPELLANT GRAINS.MXD BHATHAWA 8/6/2010 11:11:37

Legend
- Locations of Observed Propellant Grains
- Area Investigated for Propellant Grains
- Approximate Site Boundary

Notes:
1. Single base propellant grains survey was conducted by CH2M HILL in April 2010.
2. Investigative areas and propellant grains locations were surveyed with a GPS unit

N

0 75 150 Feet

1 inch = 150 feet

Imagery Source: USGS

Figure 4-2
UXO 9 - Distribution of Single Base Propellant Grains
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

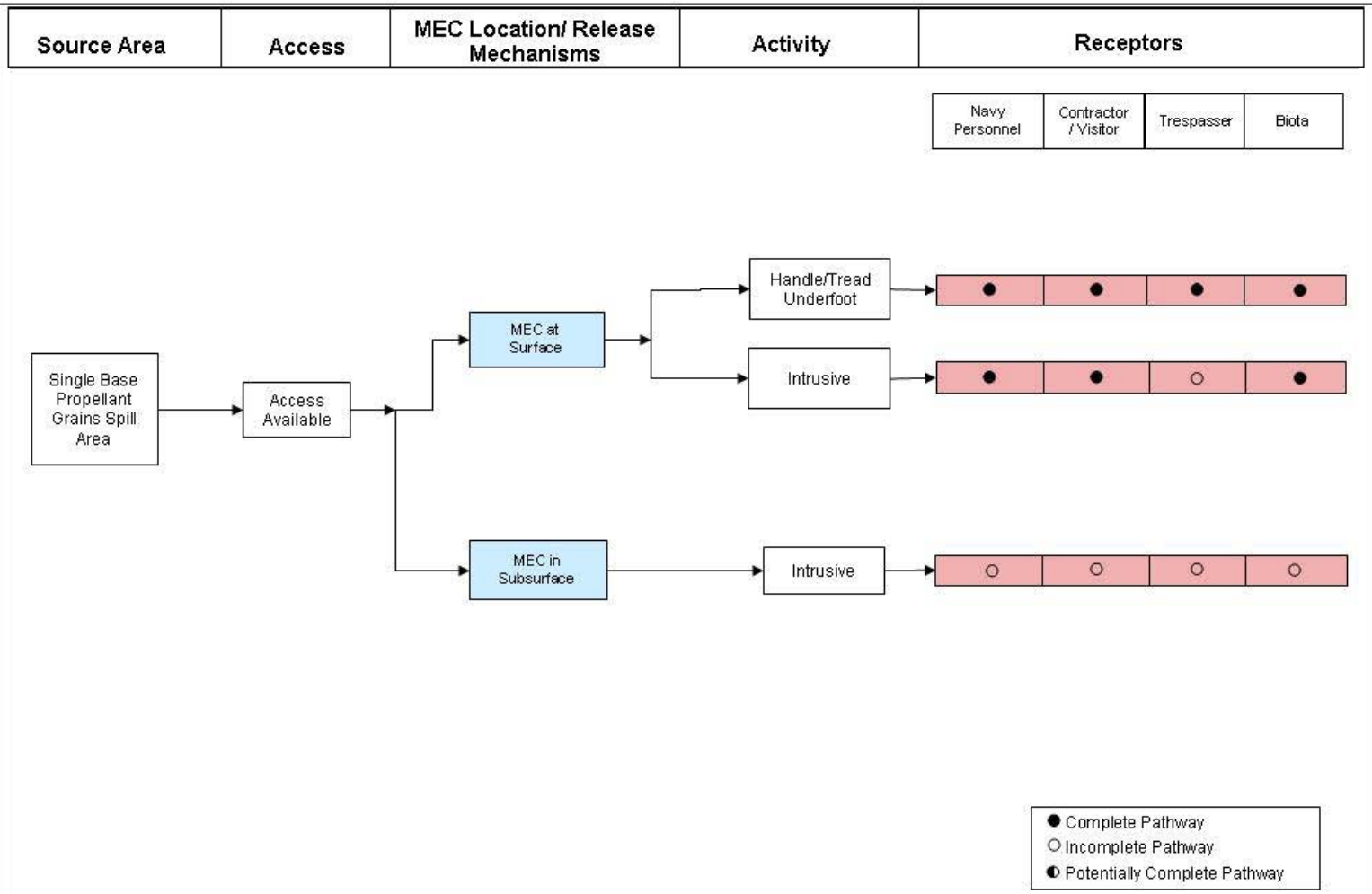


FIGURE 4-3
UXO 9 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.5-4 in the Preliminary Assessment (Malcolm Pirnie 2005)

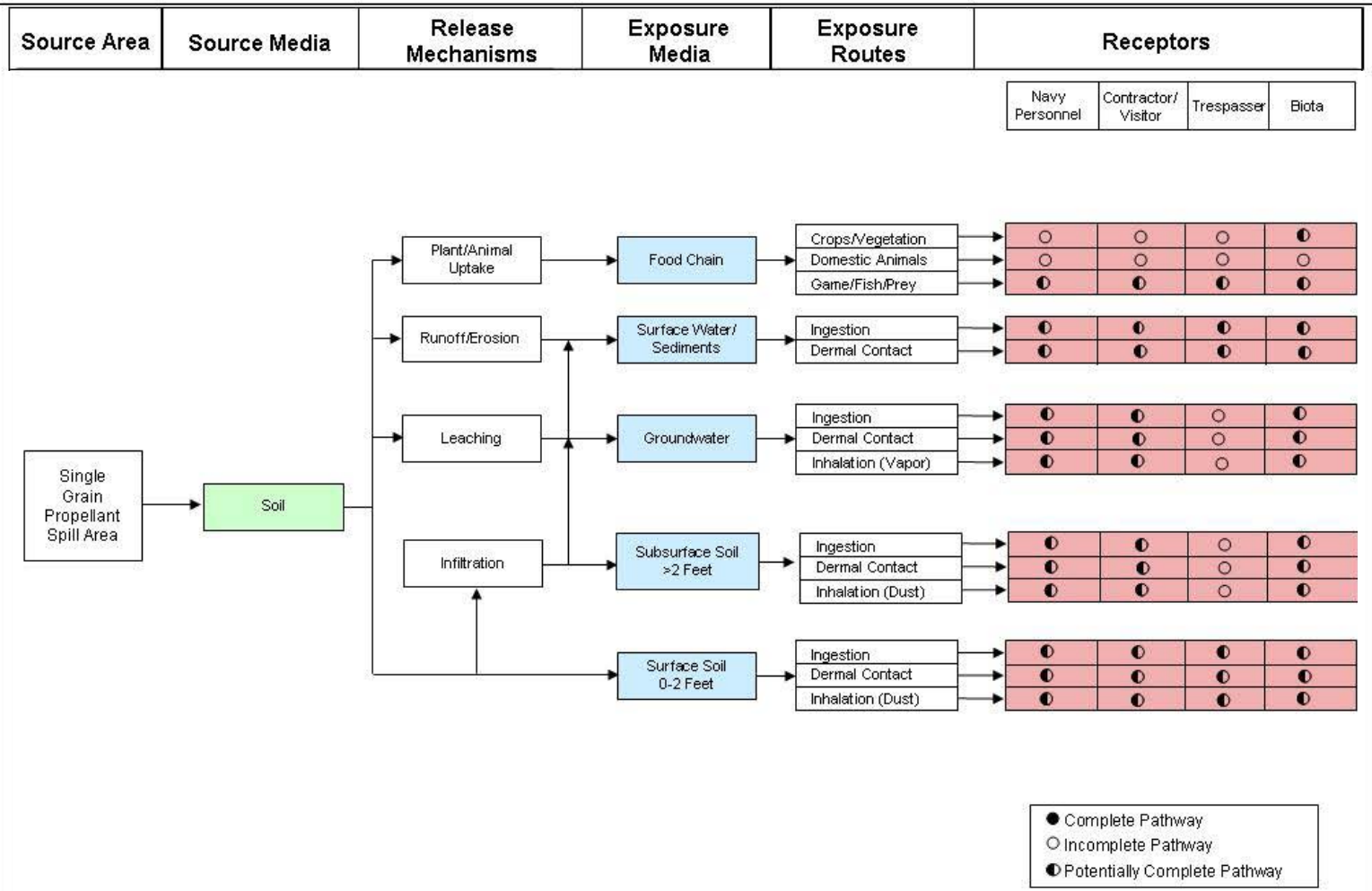


FIGURE 4-4
UXO 9 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.5-5 in the Preliminary Assessment (Malcolm Pirnie 2005)

Photo 4-1: UXO 9 – General view of the site. View is to the northwest along the railroad tracks. Building 204 is on the left. Photo was taken on 11/25/08.

SECTION 5

UXO 11 – The Valley

5.1 Site Background

UXO 11 is a 21-acre site adjacent to the Potomac River on the northwest portion of the Main Installation (Figure 1-1). UXO 11 was previously listed as Installation Restoration Site 29 in the IAS. As reported in the PA, the site was a tidal marshland prior to the 1890s. In the 1890s, it was identified by the Bureau of Ordnance as ideal for testing guns and armor because the hills on both sides would absorb shots and potential explosions of new types of gun barrels.

The site was used for developing and testing numerous ordnance items between 1891 and 1921. It also was used for jet propulsion research from 1940 through 1944. Various calibers of guns (1-inch through 16-inch) were proved at UXO 11, with various projectiles, including armor-piercing shells. Tested projectiles contained a variety of explosive fillers, including black powder, smokeless powder, brown prismatic powder, emmensite, joveite, wet gun cotton, randite, and other high explosives, such as thorite. Testing of cartridge cases, fuzes, primers, firing devices, gum implements, and powders also was conducted. In addition, UXO 11 was used to test steel armor plates for shipboard use; sections of armor plates (8 feet by 10 feet and weighing up to 25 tons) were offloaded at the dock and moved by crane to the appropriate testing location. The projectiles tested ranged from 4 to 10 inches in diameter. UXO 11 also was used to test experimental guns, which led to modifications and improvements of the weapons. In addition, powder testing was performed to assess explosive force, deterioration in storage, and other characteristics.

The PA reported the presence of two firing points at UXO 11 (Figure 5-1). The North Battery firing point was used for firing long-range guns across UXO 11 south toward primary impact areas at Stump Neck Annex and the Potomac River; because of increasing gun distance and experimental firing, impacts also occurred as far away as Quantico, Virginia. The South Battery firing point was used for firing short-range guns into the North Butt along the northeast hillside. The width of UXO 11 was approximately 400 feet, which enabled precision and accuracy testing of short-range guns. The primary impact areas of the short-range gun were sand butts with armor plates positioned against hillsides of UXO 11. The PA estimated the penetration depths for munitions tested and/or developed to range from 4 to 12 feet; these depths are likely overly conservative given that test firing occurred into prepared butts. The depth to which munitions can penetrate the ground surface depends on many factors, such as the type of soil, the angle of impact, the size of the munitions, the velocity of the impact, and site-specific environmental conditions.

The PA noted two examples of specific explosions that had occurred in UXO 11; the information was taken from the 1987 annual report. The first example was that a 10-inch armor-piercing projectile exploded on impact with a steel armor plate; fragmentation from the plate and projectile were spread over ¼ mile. The second example was that a gun with loaded Gathmaun projectile exploded on the battery as a result of excessive pressure

buildup in the gun. The projectile contained 307 pounds of gun cotton, and debris was spread more than 1 mile away. According to the PA, munitions and related debris (such as base plates, inert mortar, and fins) may be located within this documented fragmentation zone of 1-mile radius.

Since 1944, part of UXO 11 has been redeveloped as the Dashielle Marina and is used for recreational boat access to the Potomac River. There is also a Navy conference center at the site. The remainder of the site has been used for a variety of installation activities. As part of the PA, a site visit was conducted and it is reported that the data collection team was able to visually observe approximately 90 percent of the range. No munitions, MC, or evidence of munitions used were observed during that visual survey.

On April 22, 2009, Mr. James Dolph, the Navy historian, informed the IHIRT that shots were also fired to the south-southeast at UXO 11 (investigative Area D for the SI). A discussion ensued during this visit on the bomb proof areas at UXO 11; one area specifically was formerly assumed to be a chemical warfare area used for testing lachrymatory agents. According to Mr. Dolph, there were three bomb proofs at this site, but he could not definitely say which bomb proof was used for testing lachrymatory agents. One bomb proof, Building 44, was visited at the time (Appendix G provides photographs). Another bomb proof is in the hillside next to Building 62; entry was not possible because the door was locked. It was assumed that the third bomb proof area was on the other side of the hillside behind Building 62, but this was not confirmed.

5.2 Rationale and Objective

Because of the historic use of the site, the objective of the SI was to determine the presence or absence of MEC and MC at UXO 11. The objective for MEC was accomplished through DGM of Areas A, B, C, and D (covering approximately 7.5 acres). The objective for MC was accomplished through the collection of surface soil, subsurface soil, and *in situ* grab groundwater in Areas A through D to determine if perchlorate, explosives (including nitroguanidine, nitrocellulose, and NG) and metals were present at concentrations that exceed the adjusted residential soil RSL for soil and adjusted tap water RSL for groundwater.

5.3 Aerial Photographic Analysis

One historic aerial photograph from 1937 was reviewed (Appendix A). The photograph showed that excavations and probable pits were present in an area of disturbed ground in the north central portion of the valley. Two areas of disturbed ground were visible in the southern portion of the site.

5.4 Field Activities

Although UXO 11 covers about 21 acres, approximately 7.5 acres were investigated as part of the SI. Based on a review of the PA and the site visit conducted on April 22, 2009, four areas (Areas A through D) were identified for MC and MEC investigations. Figure 5-2 shows the boundaries of the four investigation areas.

Area A (west hillside) (approximately 1.75 acres) covered the barrel area and hillside where shots would have fired from the North Battery firing point. Area B (approximately 4 acres) covered the North Butt hillside where shots would have been fired from the South Battery firing point. Area C (approximately 1.4 acres) covered the hill slope where shots would have been fired from the south. Area D (approximately 0.4 acre) was selected based on field observation during the April 2009 site visit. Photo 5-1 shows a general view of the site. Appendix G provides photographs of site conditions taken as part of the SI.

Field activities at this site consisted of the following, in chronological order:

Site boundary survey for DGM by Thoth from March 8 to 9, 2010.

Land clearing – Performed by OER and initiated on March 9, 2010. The site was cleared of brush and small trees, and non-MEC metal items were removed. Expended munitions (projectiles) were visually identified on the surface with large case fragments (Appendix G provides photographs of these items).

Survey of buried seeds and grid stakes for DGM – CH2M HILL buried the seeds; Thoth surveyed the buried seeds and grid stakes. Work was performed on March 18 and 19, 2010, and March 29, 2010

DGM - Performed by ARM. Work was initiated on March 30, 2010. All work was completed by April 22, 2010.

Stakeout of MC sampling locations - Performed by the Navy, MDE, and CH2M HILL on April 12, 2010.

Utility clearing - Performed by Accumark on April 13, 2010.

DPT and MC sampling – Drilling services were provided by Vironex and sampling was conducted by CH2M HILL from April 20 to April 28, 2010.

All field activities were conducted under the supervision of CH2M HILL's UXO technician and/or engineer. Anomaly avoidance was implemented throughout field activities by the UXO technician.

5.4.1 DGM Survey

A DGM survey of Areas A, B, C, and D began on March 30, 2010 and was completed on April 21, 2010. The coverage map for UXO 11 is provided in Figure 5-3. Some areas were not cleared of vegetation or surveyed because of steep slopes. These areas are shown as white space on Figure 5-2; they include C3A4A9, C3A4B9, C3A4C9, C3A4D9, C3A4E9, C3A4B10, C3A4C10, C3A4D10, and C3A4D11. Photographs were taken of areas that could not be surveyed and are included in the Geophysical Report.

An extensive QC program was applied to the DGM operations at UXO-11. The geophysical system was field-tested, as specified in the MEC Work Plan. The CH2M HILL QC geophysicist confirmed that all DQOs outlined in the MEC Work Plan were met during the DGM survey. All tests outlined in the MEC Work Plan were performed on the DGM instruments at the appropriate intervals (e.g., daily, at start of project), and the results were checked by ARM's QC geophysicist prior to delivery to CH2M HILL and subsequently checked by CH2M HILL QC geophysicists.

Eighteen blind QC items were seeded within the investigation area. The QC items were used to validate the DGM subcontractor's ability to meet the project DQOs. The seed locations were checked by a UXO technician using a hand-held analog geophysical instrument to confirm that no existing geophysical anomalies were present at the seed location, and CH2M HILL personnel performed seeding using hand tools. Once placed, the locations of all seeded items were surveyed using an RTK-GPS. All QC items were detected during the DGM either as point-source anomalies or inside saturated polygon anomalies.

5.4.2 MC Survey

Figure 5-1 shows the sample locations (ISUXO11-DP01 through ISUXO11-DP30) in Areas A through D. Locations ISUXO11-DP26 through ISUXO11-DP30 are around Building 44, one of the bomb proof areas identified at this site. The sample locations proposed in the UFP-SAP were adjusted based on site conditions. All locations were surveyed with a GPS unit.

Field activities were conducted from April 20 to April 28, 2010. A total of 30 surface soil samples, 45 subsurface soil samples (25 samples from the first depth interval and 20 samples from the second depth interval), and 2 *in situ* groundwater samples were collected. The depth intervals for all media are shown on Table 2-1. The samples were placed in the appropriate sample jars, stored in coolers at 4°C, and shipped to Empirical Labs, LLC. The samples were analyzed for perchlorate, explosives (including nitroguanidine, nitrocellulose, and NG), and metals, including mercury and cyanide (total for soil and groundwater, and dissolved for groundwater) (Table 2-1).

Utility clearance was conducted before the start of fieldwork. At each location, continuous soil Macro-Cores® were collected with a DPT rig from the ground surface until groundwater was encountered (or until several feet of dry clay was penetrated and the boring terminated) for subsurface lithologic description. The soil boring logs are provided in Appendix D. Although MEC were not anticipated, anomaly avoidance was performed by CH2M HILL's UXO technician before and during soil boring advancement at 1-foot intervals until either the water table was reached or 10 feet bgs, whichever was encountered first.

5.4.3 Deviation from the UFP-SAP

The following deviations from the UFP-SAP occurred:

Section 5.4.1 provides a discussion of areas that could not be geophysically mapped

Several of the proposed environmental sampling locations were adjusted in the field because of site conditions, such as steep slopes, utilities, and the presence of a metal plate and concrete pad in Area D.

Fifty subsurface soil samples were proposed for collection from 25 locations – ISUXO11-DP01 through ISUXO11-DP25, but a total of only 45 samples were collected. A breakdown of the deviation by depth interval is provided below:

- Twenty-five samples were proposed from the first depth interval, which was from 0.5 foot to 2 feet bgs. All locations were sampled.
- Twenty-five samples were proposed from the second depth interval, which was proposed to be collected 1.5 feet above the water table. Only 21 samples were collected (Table 2-1). Four samples were not collected from locations ISUXO11-DP08, ISUXO11-

DP20, ISUXO11-DP23, and ISUXO11-DP24 because of a shallow water table of 5 feet bgs or less.

Five *in situ* groundwater samples were proposed for collection from five locations, but a total of two samples were collected from two locations, ISUXO11-DP03 and ISUXO11-DP18. A groundwater sample was not collected from the proposed location at ISUXO11-DP11 because of refusal of the sampling equipment at approximately 8 feet bgs. Several attempts were made to offset and penetrate the subsurface below 8 feet bgs, but they did not meet with success. The obstruction appeared to be made of wood, based on the wood fragments that were recovered in the DPT drive shoe. Groundwater samples were not collected from locations ISUXO11-DP14 and ISUXO11-DP22 as planned because of the presence of a dry clay layer that was not penetrated at either boring location. At location ISUXO11-DP14, the boring was terminated at 20 feet bgs, approximately 10 to 15 feet into the clay layer. At location ISUXO11-DP22, the boring was terminated at 25 feet bgs, approximately 20 feet into the clay layer. At both locations, the water table was not encountered before termination of the boring.

5.5 Geology and Hydrogeology

Based on the results of the soil boring program, the site is underlain mostly by clay intermixed with clayey sand and silty sand down to approximately 29 feet bgs. Because the site is close to the Potomac River, it is assumed that groundwater flow follows the land topography and groundwater flow direction is towards the creek.

5.6 Results

5.6.1 Digital Geophysical Mapping

The DGM identified linear subsurface anomaly features that appear to be underground utilities (Figure 5-4). These linear features are most apparent in Area A, but can also be seen in the southern and western portions of Area B, and the northern portion of Area C. These features were not selected as anomalies, but they have the potential of masking lower amplitude anomaly responses in their immediate vicinity. Other cultural features within the DGM areas, such as walls, buildings, signs and power-line interference, may have an impact on the data in the immediate vicinity of these features. Many of these cultural features can be seen in the aerial photographs as well as having been marked in the grid data sheets by the field crew.

In addition to high amplitude linear features, much of the UXO 11 site contains a high density of DGM responses where individual anomalies are indistinguishable because of their proximity to neighboring anomalies. In these areas, polygon anomalies were created around the extent of the high EM response and are identified as “class 3” anomalies. Class 3 anomalies generally require additional analog “mag and dig” investigation remove the clusters of anomalies such that individual discrete anomalies can be mapped. Where possible, prominent individual peaks were identified within the polygon anomalies and identified as “class 2” anomalies. This allows the potential for a more-directed future investigation within the “class 3”polygons. Standard individual anomalies are identified as “class 1” anomalies and are easily distinguishable as point-source targets.

A total of 4,748 individual ("class 1" and "class 2") geophysical anomalies were identified in UXO-11, with an additional 134 polygon anomalies. Table 5-1 presents the breakdown by class of anomalies in each area. Attachment F in Appendix B provides figures that show the locations of the anomalies. Although the DGM identified the locations of subsurface anomalies indicative of metallic material, the survey did not differentiate whether these anomalies are MEC or non-munitions related debris.

TABLE 5-1
UXO 11 - Anomaly Classes by Area

Anomaly Class	Area A	Areas B/D	Area C	Total
1	275	2212	369	**2856**
2	737	649	506	**1892**
3	65	45	24	**134**

5.6.2 Munitions Constituents

Analytical Results

Tables 5-2 through 5-4 present the raw data, including detected constituents as shaded cells; exceedances of the RSLs in bold underlined font; the frequency of detection; and frequency of exceedance for surface soil, subsurface soil, and *in situ* groundwater, respectively. Samples were collected from 30 locations – ISUXO11-DP01 through ISUXO11-DP30 (Figure 5-1).

The data were evaluated according to the process described in Section 2.4. Soil data were screened against the adjusted residential soil RSL and groundwater was screened against the adjusted tap water RSL. Chemical concentrations in soil and groundwater that exceeded the RSLs were further evaluated by comparing the maximum detected concentrations to site background concentrations, where applicable. The nature and extent of constituents for soil and groundwater were evaluated based on exceedance of the RSLs and background concentrations.

Surface Soil

Table 5-2 presents the explosives and metals results for surface soil. Surface soil sample locations (ISUXO11-DP01 through ISUXO11-DP30) are shown on Figure 5-1. The spatial distribution of the compounds that exceeded the RSLs and background concentrations are shown on Figure 5-5.

Explosives

Several explosives were detected at each location. The concentrations of detected compounds at locations ISUXO11-DP26 through ISUXO11-DP30 around the bomb proof are consistent with the concentrations detected at other locations onsite. None of the detected explosive compounds exceeded their RSLs.

Metals

Several metals were detected at all locations. Four to eight of twelve detected metals (aluminum, antimony, arsenic, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, and vanadium) exceeded the RSLs at one or more locations. Arsenic does not have a

background value for comparison. Except for aluminum and vanadium, the other metals exceeded their respective background concentrations.

Subsurface Soil

Table 5-3 presents the explosives and metals results for subsurface soil. Subsurface soil sample locations (ISUXO11-DP01 through ISUXO11-DP25) are shown on Figure 5-1. The spatial distribution of the compounds that exceeded the RSLs and background concentrations are shown on Figure 5-5.

Explosives

One or more explosive compounds were detected at each location. However, two explosives exceeded the RSLs at two locations (ISUXO11-DP01 and ISUXO11-DP18). Location ISUXO11-DP01 had an exceedance of NG at a concentration of 755K µg/kg in the second depth interval (6 to 7 feet bgs); NG was not detected in either the surface soil sample or the first subsurface depth interval. Location ISUXO11-DP18 had exceedances of 3-nitrotoluene (1,370K µg/kg) and NG (1,380 µg/kg) in the second depth interval (4 to 6 feet bgs); neither compound was detected in either the surface soil sample or the first subsurface soil sample depth interval. The constituents 3-nitrotoluene and NG do not have background values for comparison. Although these constituents were not analyzed in background samples, they are not likely to be present in background. There were no RSL exceedances at the other 23 locations.

Metals

Several metals were detected at all locations. Two or more of eight metals (arsenic, chromium, cobalt, iron, lead, manganese, nickel, and vanadium) exceeded the RSLs at each location. In general, these compounds are similar to the ones that exceeded the RSLs in surface soil. The prevalent metals were arsenic, chromium, cobalt, and iron, with greater than 36 exceedances out of 46 samples. The frequency of exceedances for lead, manganese, nickel, and vanadium are 3, 7, 5, and 23 out of 46 samples. The three RSL exceedances for lead were at locations ISUXO11-DP07 (1,220 milligrams per kilogram [mg/kg] at first interval), ISUXO11-DP11 (635 mg/kg at second interval), and ISUXO11-DP25 (420 mg/kg at first interval). They all exceeded the background concentration of 40.5 mg/kg. The five RSL exceedances for nickel were at four locations - ISUXO11-DP01 (191 mg/kg at first interval and 317 mg/kg at second interval), ISUXO11-DP04 (434 mg/kg at first interval), ISUXO11-DP11 (251 mg/kg at second interval), and ISUXO11-DP12 (204 mg/kg at first interval). They all exceeded the background concentration of 18.2 mg/kg.

In Situ Groundwater

Table 5-4 presents the explosives and metals (total and dissolved) results for *in situ* groundwater samples collected from two locations, ISUXO11-DP03 and ISUXO11-DP18 (Figure 5-1). Figure 5-5 shows the concentrations of those compounds that exceeded the RSLs and 95 percent UTLs.

Explosives

As shown on Table 5-3, one or more explosives compounds were detected at each location. One compound (3-nitrotoluene) exceeded the RSL at ISUXO11-DP03 and seven compounds (1,3-dinitrobenzene, 2,4-dinitrotoluene, 3-nitroluene, nitrobenzene, NG, nitroguanidine, and RDX) exceeded the RSLs at ISUXO11-DP18. Except for RDX, none of the RSL-exceeded constituents could be compared to the 95 percent UTL background concentration because

there are no background levels for these compounds. RDX was detected only at ISUXO11-DP18 (2.28µg/L); it exceeded both the RSL (0.61 µg/L) and the background concentration (1.2 µg/L).

Total Metals

Several metals were detected at both locations. Seven or more of 11 metals (aluminum, antimony, arsenic, chromium, cobalt, copper, iron, lead, manganese, nickel, and vanadium) exceeded the RSLs at each location. Overall, location ISUXO11-DP18 had more detects and exceedances than location ISUXO11-DP03.

Aluminum, chromium, cobalt, copper, iron, manganese, and vanadium have 95 percent UTL background concentrations, but antimony, arsenic, lead, and nickel do not have background concentrations. For those compounds that have background concentrations, except for aluminum and manganese, the maximum concentrations of the other RSL-exceeded compounds exceeded the background concentrations.

Dissolved Metals

Several metals were detected at both locations. Four metals (arsenic, cobalt, iron, and manganese) exceeded the RSLs at each location. Cobalt, iron, and manganese have 95 percent UTL background concentrations, but arsenic does not have a background concentration. For those compounds that have background concentrations, the maximum concentrations of cobalt and manganese did not exceed the background concentrations, but iron exceeded the background concentration at ISUXO11-DP03.

5.6.3 Summary of Investigation Findings

Soil and groundwater samples were collected and analyzed for the purpose of making a site management decision. The following bullets summarize the results of constituents that exceeded the RSLs and/or background concentrations:

- Surface soil
  - Several explosives were detected at each location. None of the detected explosive compounds exceeded their RSLs.
  - Several metals were detected at all locations. Four to 8 of 12 detected metals (aluminum, antimony, arsenic, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, and vanadium) exceeded the RSLs at one or more locations. Antimony, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, exceeded their respective background concentrations.
- Subsurface soil
  - One or more explosive compounds were detected at each location. Two explosives (3-nitrotoluene and NG) exceeded the RSLs; NG at ISUXO11-DP01, and 3-nitrolenene and NG at ISUXO11-DP18. 3-nitrotoluene and NG do not have background values for comparison. There were no RSL exceedances at the other 23 locations.
  - Several metals were detected at all locations. Two or more of eight metals (arsenic, chromium, cobalt, iron, lead, manganese, nickel, and vanadium) exceeded the RSLs at each location.

- *In situ* Groundwater
  - One or more explosives were detected at each location. One compound (3-nitrotoluene) exceeded the RSL at ISUXO11-DP03, and seven compounds (1,3-dinitrobenzene, 2,4-dinitrotoluene, 3-nitroluene, nitrobenzene, NG, nitroguanidine, and RDX) exceeded the RSLs at ISUXO11-DP18. RDX was detected only at ISUXO11-DP18 (2.28µg/L); it exceeded both the RSL (0.61 µg/L) and the background concentration (1.2 µg/L).
  - Total and dissolved metals detected and RSL exceeded compounds are similar. These compounds are also similar to those detected in surface soil and subsurface soil. The spatial distribution of compounds that exceeded the RSL and background concentrations is shown on Figure 5-3.

5.7 Conceptual Site Model

The CSM for UXO 11 was presented in Section 5.7.11 of the PA, and is summarized here. For UXO 11, historical evidence indicates that MEC and MC may be present; therefore, complete or potentially complete exposure pathways exist for MEC and MC. CSMs for MEC and MC are shown as Figures 5-6 and 5-7, respectively. Figure 5-8 presents a graphical illustration of the CSM.

Figure 5-6 illustrates several potentially complete exposure pathways for receptors. A potential for MEC to be present at the range and accessed by range receptors through surface and subsurface soils is possible. Human receptors (including Navy personnel (military and civil servants), trespassers, visitors, maintenance workers, contractors, and recreational users) may contact MEC at the surface during recreational activities at the range such as walking, hiking, and hunting. Contractors and Navy personnel have the potential to be exposed to MEC in the subsurface during intrusive activities. Ecological receptors (biota) at the range may disturb surface soils during foraging, nesting or other natural activities in which they may come in contact with MEC.

Currently, the site houses a monument, a boat launch ramp, a reporting shack, Dashiell Marina, Buildings 48, 54, 62, 100, 253, and 254 and a gravel road (Torrense Road). The area surrounding the boat launch and marina is gravel covered. The site is currently used as a boat launching area for access to the Potomac River, a marina, and for Navy conference meetings and storage. Current activities include frequent vegetation clearing, grass cutting, driving, and human activity related to recreational uses of the Potomac River. Based on current site use, potential current human receptors include Navy personnel (military and civil servants), trespassers, visitors, maintenance workers, contractors, and recreational users. Future site use is not expected to change significantly from current site use; therefore, potential future receptors include current receptors and construction/utility workers who may perform any future construction projects at the site. Additionally, although unlikely, future residents are considered a worst-case future scenario when considering unrestricted future site use. Therefore, in surface soils, potentially complete exposure pathways exist for MC for human and ecological receptors via ingestion, direct contact or inhalation. Plants may accumulate MC as well. Because hunting is permitted on a limited basis within the site, MC entering the food chain may provide migration pathways for human and ecological receptors. Precipitation infiltration may provide for MC mobility through the subsurface to

the shallow or surficial groundwater aquifer, which is assumed to be connected to nearby surface water bodies. Nearby surface water bodies are used for recreational purposes. Potentially complete exposure pathways exist for MC in subsurface soils (direct contact, ingestion and inhalation during intrusive work activities), as well as in surface water and sediments (direct contact and ingestion).

Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors and at the point of discharge to the river for ecological receptors. Potential receptors for the groundwater include construction/utility workers during excavation activities and, in the unlikely event the groundwater is used as a potable water supply, future residents and/or site workers.

5.8 Conclusions and Recommendations

The PA recommended an SI for MEC and MC. In support of the SI, the site was investigated to determine the presence or absence of MEC and of MC in surface soil, subsurface soil, and groundwater. The results from this investigation are adequate to meet the objectives of the SI.

Based on visual evidence of munition debris, further MEC investigation is warranted. Based on the soil and groundwater results, although explosives are detected in all media, RSL exceedances are sporadic throughout the site. Detections of metals are prevalent in all media; however, most of them are less than their RSLs and background concentrations, if the RSLs are exceeded. Based on historical use of the site and the presence of explosives and metals, further investigation is recommended for soil. The groundwater data indicates that explosives and metals are present; therefore further investigation is recommended.

UXO 11 is recommended to move to an RI for MEC and MC in soil and groundwater.

TABLE 5-2
UXO 11 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP01	ISUXO11-DP02	ISUXO11-DP03	ISUXO11-DP04	ISUXO11-DP05	ISUXO11-DP06		ISUXO11-DP07	ISUXO11-DP08
Sample ID					ISUXO11-SS01-0001	ISUXO11-SS02-0001	ISUXO11-SS03-0001	ISUXO11-SS04-0001	ISUXO11-SS05-0001	ISUXO11-SS06-0001	ISUXO11-SS06P-0001	ISUXO11-SS07-0001	ISUXO11-SS08-0001
Sample Date					4/20/10	4/21/10	4/22/10	4/20/10	4/22/10	4/21/10	4/21/10	4/22/10	4/20/10
Chemical Name													
Explosives (UG/KG)													
1,3,5-Trinitrobenzene	220000	18 / 30	0 / 30	NA	62.2	60 U	45.9 J	35.6 J	37.3 J	60 U	60 U	60 U	60 U
1,3-Dinitrobenzene	610	10 / 30	0 / 30	NA	60 U	60 U	87.9 J	25 J	60 U	60 U	60 U	59.7 J	58.9 J
2,4,6-Trinitrotoluene	3600	5 / 30	0 / 30	NA	60 U	60 U	60 U	56.9 J	60 U	60 U	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	4 / 30	0 / 30	NA	60 U	60 U	60 U	31.1 J	60 U	60 U	60 U	60 U	60 U
2,6-Dinitrotoluene	6100	4 / 30	0 / 30	NA	60 U	60 U	60 U	65.8	60 U	60 U	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	4 / 30	0 / 30	NA	60 U	60 U	60 U	67.6	60 U	60 U	60 U	60 U	60 U
2-Nitrotoluene	2900	3 / 30	0 / 30	150	24.4 J	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
3-Nitrotoluene	610	2 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	2 / 30	0 / 30	NA	60 U	60 U	60 U	63.2 J	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	2 / 30	0 / 30	210	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
HMX	380000	13 / 30	0 / 30	NA	60 U	21 J	25 J	60 U	60 U	38.4 J	60 U	23.2 J	60 U
Nitrobenzene	4800	4 / 30	0 / 30	NA	60 U	60 U	60 U	22.5 J	60 U	60 U	60 U	60 U	25.2 J
Nitrocellulose	100000000	11 / 30	0 / 30	NA	3000 UJ	3000 UJ	1,310 J	5,970 J	3000 UJ	3000 UJ	3000 UJ	3000 UJ	3000 UJ
Nitroglycerin	610	10 / 30	0 / 30	NA	150 U	150 U	150 U	179 J	150 U	150 U	150 U	150 U	83.3 J
Nitroguanidine	610000	28 / 30	0 / 30	NA	100	229 J	148 J	283	257 J	44.8 J	94.9 J	100 U	80.2
Perchlorate	5500	0 / 30	0 / 30	NA	2.27 U	2.38 U	2.44 U	2.79 U	2.54 U	2.34 U	2.73 U	2.38 U	2.66 U
PETN	NSL	0 / 30	0 / 30	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	27 / 30	0 / 30	NA	78.8 J	99.2 J	112 J	39.7 J	36.2 J	122 J	105 J	53.2 J	60 U
Tetryl	24000	4 / 30	0 / 30	NA	60 U	60 U	28.9 J	60 U	60 U	60 U	60 U	60 U	60 U
Total Metals (MG/KG)													
Aluminum	7700	30 / 30	18 / 30	19,700	**7,920**	**9,000**	**9,140**	5,970	**11,600**	6,940	**8,440**	5,870	5,560
Antimony	3.1	5 / 30	2 / 30	NA	0.762 L	0.891 R	0.888 R	0.575 L	0.968 R	0.883 R	1.03 R	**5.89 L**	0.979 R
Arsenic	0.39	30 / 30	29 / 30	14.9	**2.89**	**1.2**	**1.65**	**3.82**	**2.98**	**1.18**	**1.39**	**16.3**	**47.2**
Barium	1500	30 / 30	0 / 30	80.4	0.736 J	29.9	43.3	40.2	41.9	34.6	39.4	60.2	59.9
Beryllium	16	29 / 30	0 / 30	1.1	0.283 U	0.289 J	0.777	0.461	0.339	1.48	1.5	0.542	0.454
Cadmium	7	12 / 30	0 / 30	2.5	0.566 U	0.297 U	0.296 U	0.131 J	0.323 U	0.294 U	0.343 U	0.107 J	0.576
Calcium	NUT	30 / 30	0 / 30	2,060	7,110 J	934 J	1,580 J	845 J	140 J	1,130 J	1,200 J	620 J	1,650 J
Chromium	0.29	30 / 30	30 / 30	33.4	**240 J**	**11.6 J**	**15.6 J**	**25.5 J**	**14.1 J**	**43.3 J**	**13.3 J**	**44.9 J**	**17.8 J**
Cobalt	2.3	30 / 30	26 / 30	22.3	**28.6**	**2.31**	**3.67**	**3.84**	**3.17**	**6.51**	**6.57**	**5.77**	**6.7**
Copper	310	30 / 30	2 / 30	20.3	26.5 J	10.1 J	20.7 J	44.2 J	10.8 J	38.1 J	40.5 J	61 J	132 J
Cyanide	160	3 / 30	0 / 30	0.73	0.283 U	0.297 U	0.305 U	0.349 UL	0.318 U	0.293 U	0.342 U	0.166 J	0.333 UL
Iron	5500	30 / 30	30 / 30	38,500	**7,930 J**	**6,260 J**	**25,800 J**	**13,100 J**	**10,500 J**	**17,100 J**	**20,300 J**	**14,700 J**	**16,100 J**
Lead	400	30 / 30	2 / 30	62.5	0.284 J	7.96	25.7	200	39.6	9.46 J	13.7 J	**1,600**	68.6
Magnesium	NUT	30 / 30	0 / 30	1,620	35,900	462 L	738 L	721 L	631 L	642 L	703 L	474 L	486 L
Manganese	180	30 / 30	10 / 30	1,390	**226**	10.2	66.2	125	39.5	43.2	58.7	178	**402**
Mercury	2.3	28 / 30	1 / 30	0.16	0.0362 U	0.0233 J	0.0662	0.0365	0.0559	0.0363	0.0304 J	0.0887	0.0502
Nickel	150	30 / 30	3 / 30	15.4	**736**	4.64	6.7	80.3	22.4	9.45	9.03	79.3	53.7
Potassium	NUT	22 / 30	0 / 30	1,470	1130 U	586 K	597 K	326 K	389 K	2350 U	2750 U	6100 U	389 K
Selenium	39	18 / 30	0 / 30	1.2	0.512	0.342 J	0.193 J	0.212 J	0.314 J	0.353 U	0.412 U	0.366 U	0.325 J
Silver	39	1 / 30	0 / 30	0.84	1.13 U	1.19 U	1.18 U	1.36 U	1.29 U	1.18 U	1.37 U	1.22 U	1.3 U
Sodium	NUT	4 / 30	0 / 30	120	108 K	297 U	296 U	340 U	323 U	294 U	180 K	305 U	326 U
Thallium	NSL	0 / 30	0 / 30	2.3	0.453 U	0.475 U	0.474 U	0.544 U	0.516 U	0.942 U	1.1 U	0.488 U	0.522 U
Vanadium	39	30 / 30	13 / 30	53.3	7.31	31.9	**51.1**	25.8	23.2	31.2	**40.1**	23.5	27.7
Zinc	2300	30 / 30	0 / 0	37.5	5.22	13.2	26.2	29	20.9	24	23.9	26.7	55.5

Notes:

Shading indicates detections.

Bolded underlined shading indicates detected regional screening level (RSL) exceedances.

RSLs are current as of May, 2010.

NUT: There is no screening level for Ca, Mg, K, and Na because they are nutrients.

NSL: No screening level. There is no RSL for PETN. Thallium was removed from the RSLs in December, 2009.

J - Analyte present. Value may or may not be accurate or precise

K - Analyte present. Value may be biased high. Value may be lower

L - Analyte present. Value may be biased low. Value may be higher

R - Unreliable Result

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine

PETN - pentaerythritol tetranitrate

RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

MG/KG - Milligrams per kilogram

UG/KG - Micrograms per kilogram

NA - Not available

U - The material was analyzed for, but not detected

95 percent upper tolerance limits (UTLs) are the background values taken from Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code. Example: ISUXO6-SS01-0001; where I is for Indian Head; S is for site; UXO6 is the site number; SS01 is surface soil sample from station 1; and 0001 is the sample depth interval (0-0.5 foot bgs). If a "P" is at the end of "SS01" then it is a duplicate sample from that station.

TABLE 5-2
UXO 11 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP09	ISUXO11-DP10	ISUXO11-DP11	ISUXO11-DP12	ISUXO11-DP13	ISUXO11-DP14	ISUXO11-DP15	ISUXO11-DP16	ISUXO11-DP17
Sample ID					ISUXO11-SS09-0001	ISUXO11-SS10-0001	ISUXO11-SS11-0001	ISUXO11-SS12-0001	ISUXO11-SS13-0001	ISUXO11-SS14-0001	ISUXO11-SS15-0001	ISUXO11-SS16-0001	ISUXO11-SS17-0001
Sample Date					4/28/10	4/28/10	4/28/10	4/28/10	4/28/10	4/27/10	4/27/10	4/27/10	4/26/10
Chemical Name													
Explosives (UG/KG)													
1,3,5-Trinitrobenzene	220000	18 / 30	0 / 30	NA	60 U	60 U	34.3 J	60 U	46.3 J	60 U	29.4 J	60 U	32.7 J
1,3-Dinitrobenzene	610	10 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,4,6-Trinitrotoluene	3600	5 / 30	0 / 30	NA	60 U	60 U	25.6 J	60 U	60 U	60 U	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	4 / 30	0 / 30	NA	60 U	60 U	60 U	78	60 U	60 U	60 U	60 U	60 U
2,6-Dinitrotoluene	6100	4 / 30	0 / 30	NA	60 U	60 U	60 U	52.9 J	60 U	60 U	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	4 / 30	0 / 30	NA	60 U	60 U	60 U	28.4 J	60 U	60 U	60 U	60 U	60 U
2-Nitrotoluene	2900	3 / 30	0 / 30	150	60 U	60 U	30.9 J	60 U	60 U	60 U	30.8 J	60 U	60 U
3-Nitrotoluene	610	2 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	2 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	2 / 30	0 / 30	210	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
HMX	380000	13 / 30	0 / 30	NA	25.8 J	60 U	60 U	105	60 U	60 U	60 U	28.5 J	60 U
Nitrobenzene	4800	4 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Nitrocellulose	100000000	11 / 30	0 / 30	NA	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U
Nitroglycerin	610	10 / 30	0 / 30	NA	150 U	150 U	86.5 J	150 U	150 U	150 U	52.1 J	150 U	150 U
Nitroguanidine	610000	28 / 30	0 / 30	NA	88.7 J	196	63.3 J	270	100 U	878	63.3 J	67.3 J	205 J
Perchlorate	5500	0 / 30	0 / 30	NA	2.33 U	2.69 U	2.81 U	2.42 U	2.68 U	2.68 U	2.42 U	2.45 U	2.71 U
PETN	NSL	0 / 30	0 / 30	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	27 / 30	0 / 30	NA	36.2 J	29.2 J	21.4 J	60 U	27 J	28 J	71	56.2 J	54.6 J
Tetryl	24000	4 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	26.8 J
Total Metals (MG/KG)													
Aluminum	7700	30 / 30	18 / 30	19,700	**8,660**	**9,880**	**11,600**	5,100	**13,400**	**13,500**	**14,900**	**14,400**	**11,700**
Antimony	3.1	5 / 30	2 / 30	NA	0.84 U	0.99 U	2.11 U	**3.24 J**	1.98 U	1.97 U	1.84 U	1.81 U	1.99 U
Arsenic	0.39	30 / 30	29 / 30	14.9	**2.1**	0.36	**0.907**	**5.28**	**1.23**	**0.863**	**2.4**	**3.46**	**1.13**
Barium	1500	30 / 30	0 / 30	80.4	84	31.1	43	67.4	38.3	35.5	48.1	42.5	41.7
Beryllium	16	29 / 30	0 / 30	1.1	0.52	0.694	1.14	0.639 J	1.28	0.84	0.951	0.937	0.972
Cadmium	7	12 / 30	0 / 30	2.5	0.28 U	0.33 U	0.702 UL	1.55 U	0.66 UL	0.657 UL	0.612 UL	0.604 UL	0.664 U
Calcium	NUT	30 / 30	0 / 30	2,060	1,240	5,330	2,330	1,910	938	682	516 J	264 J	544
Chromium	0.29	30 / 30	30 / 30	33.4	**13.6**	**17.9**	**26.9**	**359**	**26.5**	**22.5**	**23**	**25.5**	**25.8**
Cobalt	2.3	30 / 30	26 / 30	22.3	**4.71**	2.12	1.88	**11.9**	**2.49**	1.13 J	**4.6**	**3.85**	**2.79**
Copper	310	30 / 30	2 / 30	20.3	16.1	15.7	29.6	**389**	30.4	24.3	18.2	17.8	60.3
Cyanide	160	3 / 30	0 / 30	0.73	0.291 U	0.337 U	0.351 U	0.303 U	0.335 U	0.335 U	0.303 U	0.307 U	0.339 U
Iron	5500	30 / 30	30 / 30	38,500	**19,400**	**24,900**	**49,400**	**64,300**	**45,000**	**43,000**	**41,100**	**36,300**	**45,900**
Lead	400	30 / 30	2 / 30	62.5	13.9	4.71	19.9	**531**	147	6.43	14	11.1	93.7
Magnesium	NUT	30 / 30	0 / 30	1,620	870	1,440	1,340	703 J	1,070	789	783	601 J	1,010
Manganese	180	30 / 30	10 / 30	1,390	**225**	50.5	33.1	**433**	45.8	30.7	132	65	49.2
Mercury	2.3	28 / 30	1 / 30	0.16	0.0176 J	0.036 U	0.0183 J	0.311	0.0486	0.0268 J	0.0388	0.0226 J	0.0293 J
Nickel	150	30 / 30	3 / 30	15.4	15.1	4.12	8.83	**550**	7.41	3.95	6.57	5.79	21.9
Potassium	NUT	22 / 30	0 / 30	1,470	550 J	1320 U	2810 U	6210 U	671 J	2630 U	511 J	641 J	691 J
Selenium	39	18 / 30	0 / 30	1.2	0.26 J	0.396 U	0.843 U	1.86 U	0.793 U	0.43 J	0.734 U	0.725 U	0.797 U
Silver	39	1 / 30	0 / 30	0.84	1.12 U	1.32 U	2.81 UL	6.21 U	2.64 UL	2.63 UL	2.45 UL	2.42 UL	2.66 U
Sodium	NUT	4 / 30	0 / 30	120	280 U	330 U	702 U	1550 U	660 U	657 U	612 U	604 U	332 U
Thallium	NSL	0 / 30	0 / 30	2.3	0.448 U	0.528 U	1.12 U	2.48 U	1.06 UL	1.05 UL	0.979 UL	0.966 UL	1.06 U
Vanadium	39	30 / 30	13 / 30	53.3	32.1	**50.6**	**76**	28.4	**75.7**	**89.8**	**67.9**	**54.1**	**70.5**
Zinc	2300	30 / 30	0 / 0	37.5	19.1	9.48	18.4	176	30.9	13.9	23.1	22.7	23.1

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. There is no RSL for PETN. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA - Not available
U - The material was analyzed for, but not detected

95 percent upper tolerance limits (UTLs) are the background values taken from Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code. Example: ISUXO6-SS01-0001; where I is for Indian Head; S is for site; UXO6 is the site number; SS01 is surface soil sample from station 1; and 0001 is the sample depth interval (0-0.5 foot bgs). If a "P" is at the end of "SS01" then it is a duplicate sample from that station.

TABLE 5-2
UXO 11 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP18	ISUXO11-DP19	ISUXO11-DP20	ISUXO11-DP21	ISUXO11-DP22	ISUXO11-DP23	ISUXO11-DP24	ISUXO11-DP25	ISUXO11-SO26
Sample ID					ISUXO11-SS18-0001	ISUXO11-SS19-0001	ISUXO11-SS20-0001	ISUXO11-SS21-0001	ISUXO11-SS22-0001	ISUXO11-SS23-0001	ISUXO11-SS24-0001	ISUXO11-SS25-0001	ISUXO11-SS26-0001
Sample Date					4/23/10	4/27/10	4/27/10	4/23/10	4/27/10	4/27/10	4/22/10	4/20/10	4/26/10
Chemical Name													
Explosives (UG/KG)													
1,3,5-Trinitrobenzene	220000	18 / 30	0 / 30	NA	48.3 J	27.4 J	46.1 J	34.1 J	24.8 J	70.4 J	66.5 J	60 U	32.8 J
1,3-Dinitrobenzene	610	10 / 30	0 / 30	NA	60 U	60 U	78.3 J	25.1 J	33.4 J	60 U	60 U	22.3 J	57.3 J
2,4,6-Trinitrotoluene	3600	5 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	77.2 J
2,4-Dinitrotoluene	1600	4 / 30	0 / 30	NA	21.9 J	60 U	60 U	60 U	60 U	60 U	60 U	60 U	201 J
2,6-Dinitrotoluene	6100	4 / 30	0 / 30	NA	60 U	60 U	25 J	60 U	60 U	60 U	60 U	60 U	21.9 J
2-Amino-4,6-dinitrotoluene	15000	4 / 30	0 / 30	NA	63.8 J	60 U	60 U	60 U	60 U	60 U	60 U	60 U	129 J
2-Nitrotoluene	2900	3 / 30	0 / 30	150	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
3-Nitrotoluene	610	2 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	26.9 J	22.5 J	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	2 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	129 J
4-Nitrotoluene	24000	2 / 30	0 / 30	210	60 U	60 U	60 U	60 U	60 U	37 J	60 U	60 U	23.2 J
HMX	380000	13 / 30	0 / 30	NA	60 U	60 U	25.6 J	25.9 J	30.4 J	60 U	52.5 J	60 U	60 U
Nitrobenzene	4800	4 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	32.8 J
Nitrocellulose	100000000	11 / 30	0 / 30	NA	1,600 J	3000 U	2,510 J	3,320 J	3000 U	2,010 J	1,040 J	3000 UJ	15,400
Nitroglycerin	610	10 / 30	0 / 30	NA	150 U	150 U	56.9 J	150 U	150 U	150 U	150 U	74.8 J	119 J
Nitroguanidine	610000	28 / 30	0 / 30	NA	617 J	98 J	109 J	433 J	102 J	175 J	316 J	61.1	717 J
Perchlorate	5500	0 / 30	0 / 30	NA	2.72 U	2.52 U	2.62 U	2.43 U	2.66 U	2.81 U	2.53 U	2.52 U	2.4 U
PETN	NSL	0 / 30	0 / 30	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	27 / 30	0 / 30	NA	62.3 J	90.2 J	34.6 J	66.5 J	53.5 J	42.5 J	43.7 J	60 U	75.2 J
Tetryl	24000	4 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U	60 U	29.5 J	60 U	40.5 J
Total Metals (MG/KG)													
Aluminum	7700	30 / 30	18 / 30	19,700	**8,950**	**10,500**	**7,720** K	4,650	**13,500**	7,290 K	**8,740**	1,910	4,670
Antimony	3.1	5 / 30	2 / 30	NA	1.01 R	1.93 U	0.939 U	0.894 R	2.02 U	1.04 U	0.939 R	0.946 R	0.897 U
Arsenic	0.39	30 / 30	29 / 30	14.9	**4.91**	**1.48**	**5.33**	**2.66**	**1.03**	**4.11**	**4.55**	**2.45**	**5.96**
Barium	1500	30 / 30	0 / 30	80.4	53.8	43.5	53.3	32.5	49.5	47	51	14.2	42.4
Beryllium	16	29 / 30	0 / 30	1.1	0.684	0.903	0.691	0.423	1.09	0.671	0.669	0.23 J	0.35
Cadmium	7	12 / 30	0 / 30	2.5	0.303 J	0.643 UL	0.348	0.298 U	0.674 U	0.204 J	0.113 J	0.112 J	0.442
Calcium	NUT	30 / 30	0 / 30	2,060	1,670 J	337 J	1,940	1,640 J	852	1,810	2,160 J	606 J	2,830
Chromium	0.29	30 / 30	30 / 30	33.4	**15.2 J**	**16.9**	**12.9**	**16.8 J**	**57.4**	**12.3**	**16.4 J**	**7.58 J**	**27.2**
Cobalt	2.3	30 / 30	26 / 30	22.3	**13.1**	**2.81**	**13.6**	**6.4**	2.27	**13.3**	**5.82**	**4.77**	**5.46**
Copper	310	30 / 30	2 / 30	20.3	24.1 J	14.4	21.3	50 J	47.2	18.5	21.5 J	4.37 J	83.4
Cyanide	160	3 / 30	0 / 30	0.73	0.34 U	0.315 U	0.327 U	0.304 U	0.332 U	0.351 U	0.175 J	0.315 U	0.3 U
Iron	5500	30 / 30	30 / 30	38,500	**17,800 J**	**33,800**	**15,800 L**	**12,400 J**	**49,400**	**15,400 L**	**18,700 J**	**6,200 J**	**12,400 L**
Lead	400	30 / 30	2 / 30	62.5	62.2	9.02	63.7	55.2	92.2	43.4	44.5	156	346
Magnesium	NUT	30 / 30	0 / 30	1,620	847 L	737	760 L	785 L	1,050	732 L	1,110 L	234 L	1,350 L
Manganese	180	30 / 30	10 / 30	1,390	**208**	31.2	**229**	108	36.3	**206**	107	**219**	156
Mercury	2.3	28 / 30	1 / 30	0.16	0.107	0.0159 J	0.135	0.0958	0.0323 J	0.0889	0.125	0.0659	**2.95**
Nickel	150	30 / 30	3 / 30	15.4	21.6	40.3	14.8	35	69.7	13.2	16	4.71	64.7
Potassium	NUT	22 / 30	0 / 30	1,470	589 K	547 J	570 J	512 K	622 J	472 J	556 K	1260 U	405 J
Selenium	39	18 / 30	0 / 30	1.2	0.23 J	0.772 U	0.313 J	0.242 J	0.809 U	0.348 J	0.204 J	0.378 U	0.477
Silver	39	1 / 30	0 / 30	0.84	1.35 U	2.57 UL	0.106 J	1.19 U	2.7 U	1.38 U	1.25 U	1.26 U	1.2 U
Sodium	NUT	4 / 30	0 / 30	120	80.3 K	643 U	313 U	298 U	337 U	346 U	158 K	315 U	299 U
Thallium	NSL	0 / 30	0 / 30	2.3	0.541 U	1.03 UL	0.501 U	0.477 U	1.08 U	0.553 U	0.501 U	0.505 U	0.478 U
Vanadium	39	30 / 30	13 / 30	53.3	**39.7**	**51.4**	38.1	26.4	**73.8**	37.3	**40.1**	18.7	23.2
Zinc	2300	30 / 30	0 / 0	37.5	99	20.3	97 L	33.1	25.9	79.9 L	63.6	63.2	157

Notes:

Shading indicates detections.

Bolded underlined shading indicates detected regional screening level (RSL) exceedances.

RSLs are current as of May, 2010.

NUT: There is no screening level for Ca, Mg, K, and Na because they are nutrients.

NSL: No screening level. There is no RSL for PETN. Thallium was removed from the RSLs in December, 2009.

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K - Analyte present. Value may be biased high. Value may be lower

L - Analyte present. Value may be biased low. Value may be higher

R - Unreliable Result

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine

PETN - pentaerythritol tetranitrate

RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen

UJ - Analyte not detected, quantitation limit may be inaccurate

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MG/KG - Milligrams per kilogram

UG/KG - Micrograms per kilogram

NA - Not available

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95 percent upper tolerance limits (UTLs) are the background values taken from Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code. Example: ISUXO6-SS01-0001; where I is for Indian Head; S is for site; UXO6 is the site number; SS01 is surface soil sample from station 1; and 0001 is the sample depth interval (0-0.5 foot bgs). If a "P" is at the end of "SS01" then it is a duplicate sample from that station.

TABLE 5-2
UXO 11 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-SO27	ISUXO11-SO28		ISUXO11-SO29	ISUXO11-SO30
Sample ID					ISUXO11-SS27-0001	ISUXO11-SS28-0001	ISUXO11-SS28P-0001	ISUXO11-SS29-0001	ISUXO11-SS30-0001
Sample Date					4/26/10	4/26/10	4/26/10	4/26/10	4/26/10
Chemical Name									
Explosives (UG/KG)									
1,3,5-Trinitrobenzene	220000	18 / 30	0 / 30	NA	58.7 J	60 U	60 U	60 U	38.6 J
1,3-Dinitrobenzene	610	10 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	70.8
2,4,6-Trinitrotoluene	3600	5 / 30	0 / 30	NA	30.5 J	20.2 J	21.5 J	60 U	60 U
2,4-Dinitrotoluene	1600	4 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U
2,6-Dinitrotoluene	6100	4 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	4 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U
2-Nitrotoluene	2900	3 / 30	0 / 30	150	60 U	60 U	60 U	60 U	60 U
3-Nitrotoluene	610	2 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	2 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	2 / 30	0 / 30	210	60 U	60 U	60 U	60 U	60 U
HMX	380000	13 / 30	0 / 30	NA	60 U	67.2 J	38.4 J	60 U	40 J
Nitrobenzene	4800	4 / 30	0 / 30	NA	60 U	77.9 J	60 U	60 U	60 U
Nitrocellulose	100000000	11 / 30	0 / 30	NA	7,470	18,900 J	9,810 J	3000 U	1,730 J
Nitroglycerin	610	10 / 30	0 / 30	NA	88 J	150 UJ	115 J	150 U	249 J
Nitroguanidine	610000	28 / 30	0 / 30	NA	424 J	4,300 J	302 J	293 J	331 J
Perchlorate	5500	0 / 30	0 / 30	NA	2.3 U	2.28 U	2.3 U	2.37 U	2.22 U
PETN	NSL	0 / 30	0 / 30	NA	150 U	150 U	150 U	150 U	150 U
RDX	5500	27 / 30	0 / 30	NA	29 J	54.3 J	34.1 J	28.4 J	34.3 J
Tetryl	24000	4 / 30	0 / 30	NA	60 U	60 U	60 U	60 U	60 U
Total Metals (MG/KG)									
Aluminum	7700	30 / 30	18 / 30	19,700	4,850	5,240	5,430	5,380 K	3,600 K
Antimony	3.1	5 / 30	2 / 30	NA	0.872 U	0.943	0.51 J	0.879 U	0.851 U
Arsenic	0.39	30 / 30	29 / 30	14.9	**5.57**	**4.69**	**4.18**	**0.839**	**6.04**
Barium	1500	30 / 30	0 / 30	80.4	67.8	57.9	57	12	28
Beryllium	16	29 / 30	0 / 30	1.1	0.343	0.403	0.532	0.141 J	0.317
Cadmium	7	12 / 30	0 / 30	2.5	0.2 J	0.39	0.389	0.293 U	0.213 J
Calcium	NUT	30 / 30	0 / 30	2,060	860	1,270	1,200	328	968
Chromium	0.29	30 / 30	30 / 30	33.4	**10.8**	**225 J**	**24 J**	**7.33**	**26.3**
Cobalt	2.3	30 / 30	26 / 30	22.3	**5.03**	**6.66**	**6.16**	**0.769**	**4.03**
Copper	310	30 / 30	2 / 30	20.3	16	**399**	**392**	14.8	30.4
Cyanide	160	3 / 30	0 / 30	0.73	0.288 U	0.285 U	0.288 U	0.296 U	0.287
Iron	5500	30 / 30	30 / 30	38,500	**7,170 L**	**19,100 L**	**19,300 L**	**6,780 L**	**9,400 L**
Lead	400	30 / 30	2 / 30	62.5	185	181	210	11.2	65.6
Magnesium	NUT	30 / 30	0 / 30	1,620	461 L	565 L	429 L	140 L	717 L
Manganese	180	30 / 30	10 / 30	1,390	**295**	**206**	**223**	10.1	128
Mercury	2.3	28 / 30	1 / 30	0.16	0.0624	1.3	1.14	0.0175 J	0.164
Nickel	150	30 / 30	3 / 30	15.4	9.72	**358 J**	69.6 J	4.46	38.9
Potassium	NUT	22 / 30	0 / 30	1,470	411 J	666 J	586 J	329 J	366 J
Selenium	39	18 / 30	0 / 30	1.2	0.292 J	0.5	0.645	0.244 J	0.317 J
Silver	39	1 / 30	0 / 30	0.84	1.16 U	1.11 U	1.17 U	1.17 U	1.13 U
Sodium	NUT	4 / 30	0 / 30	120	291 U	278 U	292 U	293 U	284 U
Thallium	NSL	0 / 30	0 / 30	2.3	0.465 U	0.446 U	0.468 U	0.469 U	0.454 U
Vanadium	39	30 / 30	13 / 30	53.3	17.1	23.2	25.7	21.8	18.5
Zinc	2300	30 / 30	0 / 0	37.5	75.5	118	132	8.66 L	48.4 L

Notes:

Shading indicates detections.

Bolded underlined shading indicates detected regional screening level (RSL) exceedances.

RSLs are current as of May, 2010.

NUT: There is no screening level for Ca, Mg, K, and Na because they are nutrients.

NSL: No screening level. There is no RSL for PETN. Thallium was removed from the RSLs in December, 2009.

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L - Analyte present. Value may be biased low. Value may be higher

R - Unreliable Result

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine

PETN - pentaerythritol tetranitrate

RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

MG/KG - Milligrams per kilogram

UG/KG - Micrograms per kilogram

NA - Not available

U - The material was analyzed for, but not detected

95 percent upper tolerance limits (UTLs) are the background values taken from Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code. Example: ISUXO6-SS01-0001; where I is for Indian Head; S is for site; UXO6 is the site number; SS01 is surface soil sample from station 1; and 0001 is the sample depth interval (0-0.5 foot bgs). If a "P" is at the end of "SS01" then it is a duplicate sample from that station.

TABLE 5-3
UXO 11 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP01		ISUXO11-DP02		ISUXO11-DP03		ISUXO11-DP04	
Sample ID					ISUXO11-SB01-0102	ISUXO11-SB01-0607	ISUXO11-SB02-0102	ISUXO11-SB02-2425	ISUXO11-SB03-0102	ISUXO11-SB03-0708	ISUXO11-SB04-0102	ISUXO11-SB04-0607
Sample Date					4/20/10	4/20/10	4/21/10	4/21/10	4/22/10	4/22/10	4/20/10	4/20/10
Chemical Name												
Explosives (UG/KG)												
1,3,5-Trinitrobenzene	220000	17 / 45	0 / 45	NA	59.3 J	430 K	60 U	60 U	60 U	53.9 J	33.7 J	60 U
1,3-Dinitrobenzene	610	13 / 45	0 / 45	NA	60 U	64 K	24.5 J	60 U	54.7 J	36.8 J	60 U	60 U
2,4,6-Trinitrotoluene	3600	8 / 45	0 / 45	NA	60 U	719 K	60 U	60 U	60 U	85.7 J	20.7 J	60 U
2,4-Dinitrotoluene	1600	8 / 45	0 / 45	NA	60 U	1,140 K	60 U	60 U	60 U	24 J	60 U	60 U
2,6-Dinitrotoluene	6100	7 / 45	0 / 45	NA	60 U	1,800 K	60 U	60 U	60 U	102 J	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	278 K	60 U	60 U	60 U	60 U	60 U	60 U
2-Nitrotoluene	2900	6 / 45	0 / 45	NA	60 U	1,290 K	60 U	60 U	60 U	60 U	60 U	60 U
3-Nitrotoluene	610	4 / 45	1 / 45	NA	60 U	113 K	60 U	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	21.4 J	40.2 K	60 U	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	7 / 45	0 / 45	NA	60 U	2,750 K	60 U	60 U	60 U	86.6 J	60 U	60 U
HMX	380000	18 / 45	0 / 45	NA	22.7 J	22.9 K	60 U	60 U	23.5 J	60 U	60 U	60 U
Nitrobenzene	4800	6 / 45	0 / 45	NA	60 U	80 K	60 U	60 U	60 U	60 U	20.1 J	60 U
Nitrocellulose	100000000	10 / 45	0 / 45	NA	3000 UJ	3000 UJ	3000 UJ	3000 UJ	3000 UJ	1,850 J	11,500 J	3000 UJ
Nitroglycerin	610	6 / 10	2 / 45	NA	150 U	**755 K**	150 U	150 U	150 U	150 U	73.4 J	150 U
Nitroguanidine	610000	33 / 45	0 / 45	NA	255	549	68.6 J	86.7 J	100 U	433 J	100 U	100 U
Perchlorate	5500	1 / 45	0 / 45	NA	2.45 U	2.56 U	2.55 U	2.54 U	2.56 U	3.13 U	2.58 U	2.85 U
PETN	NSL	3 / 45	0 / 45	NA	150 U	173 K	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	37 / 45	0 / 45	NA	114 J	298 K	30.7 J	60 U	91.9 J	90.3 J	60 U	60 U
Tetryl	24000	4 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Total Metals (MG/KG)												
Aluminum	7700	45 / 45	0 / 45	35,400	5,890	3,830	**9,790**	3,360	**8,140**	6,390	5,700	5,390
Antimony	3.1	7 / 45	0 / 45	1.8	0.386 L	1.16 L	0.952 R	0.92 R	0.984 R	1.18 R	1.21 L	1.06 R
Arsenic	0.39	42 / 45	41 / 45	134	**10.6**	**6.26**	**1.33**	**0.995**	**1.1**	**5.7**	**7.81**	**0.693**
Barium	1500	45 / 45	0 / 45	134	35.4	101	36.4	34.8	30.6	78.2	122	25.8
Beryllium	16	45 / 45	0 / 45	3.3	0.341	0.427	0.42	2.42	0.664	2.75	0.456	1.17
Cadmium	7	9 / 45	0 / 45	0.61	0.189 J	0.279 J	0.317 U	0.307 U	0.328 U	0.442	0.566	0.353 U
Calcium	NUT	45 / 45	0 / 45	2,590	2,660 J	2,350 J	545 J	1,860 J	1,050 J	3,230 J	506 J	944 J
Chromium	0.29	45 / 45	45 / 45	60.1	**80.9 J**	**223 J**	**17.4 J**	**3.05 J**	**13.9 J**	**12 J**	**159 J**	**9.97 J**
Cobalt	2.3	45 / 45	36 / 45	133	**10.3**	**9.87**	**3.28**	**23.2**	**2.32**	**10.4**	**9.72**	**12.9**
Copper	310	45 / 45	0 / 45	48.6	56.9 J	68.7 J	13.4 J	25.7 J	17 J	99.4 J	128 J	15 J
Cyanide	160	1 / 45	0 / 45	16.1	0.307 U	0.32 UL	0.319 U	0.317 U	0.32 U	0.392 U	0.323 UL	0.356 UL
Iron	5500	45 / 45	43 / 45	83,100	**18,100 J**	**23,300 J**	**12,200 J**	**8,950 J**	**24,200 J**	**15,300 J**	**23,600 J**	**27,600 J**
Lead	400	45 / 45	3 / 45	40.5	86	139	7.72	4.47	12.6	207	234	9.21
Magnesium	NUT	45 / 45	0 / 45	2,640	7,980	4,920	540 L	885 L	597 L	388 L	411	663 L
Manganese	180	45 / 45	7 / 45	4,130	160	153	12.4	**203**	26.7	130	**235**	34.5
Mercury	2.3	25 / 45	0 / 45	0.18	0.129	0.365	0.0361 U	0.0433 U	0.022 J	0.166	0.0667	0.0373 J
Nickel	150	45 / 45	5 / 45	18.2	**191**	**317**	3.53	11.3	3.86	34.5	**434**	17.8
Potassium	NUT	25 / 45	0 / 45	2,610	467 K	307 K	684 K	2450 U	512 K	3130 U	380 K	303 K
Selenium	39	16 / 45	0 / 45	13.3	0.212 J	0.258 J	0.278 J	0.368 U	0.21 J	0.286 J	0.25 J	0.423 U
Silver	39	0 / 45	0 / 45	11.4	1.19 U	1.23 U	1.27 U	1.23 U	1.31 U	1.57 U	1.32 U	1.41 U
Sodium	NUT	14 / 45	0 / 45	258	107 K	308 U	317 U	307 U	328 U	133 K	331 U	353 U
Thallium	NSL	0 / 45	0 / 45	21.8	0.474 U	0.493 U	0.508 U	2.45 U	0.525 U	1.25 U	0.53 U	0.564 U
Vanadium	39	45 / 45	23 / 45	194	19.5	21.9	**52.9**	12.2	**49.7**	30	22.1	21.6
Zinc	2300	45 / 45	0 / 45	70.4	66.2	72.2	15.4	21.1	15.8	110	46	17.1

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 5-3
UXO 11 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP05		ISUXO11-DP06			ISUXO11-DP07		ISUXO11-DP08
Sample ID					ISUXO11-SB05-0102	ISUXO11-SB05P-0102	ISUXO11-SB06-0102	ISUXO11-SB06-2425	ISUXO11-SB06P-0102	ISUXO11-SB07-0102	ISUXO11-SB07-1920	ISUXO11-SB08-0102
Sample Date					4/22/10	4/22/10	4/21/10	4/21/10	4/21/10	4/22/10	4/22/10	4/20/10
Chemical Name												
Explosives (UG/KG)												
1,3,5-Trinitrobenzene	220000	17 / 45	0 / 45	NA	60 U	60 U	28.3 J	60 U	60 U	60 U	60 U	37 J
1,3-Dinitrobenzene	610	13 / 45	0 / 45	NA	60 U	26.9 J	60 U	60 U	60 U	58.6 J	60 U	38.3 J
2,4,6-Trinitrotoluene	3600	8 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	8 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,6-Dinitrotoluene	6100	7 / 45	0 / 45	NA	60 U	60 U	26.3 J	60 U	60 U	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2-Nitrotoluene	2900	6 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
3-Nitrotoluene	610	4 / 45	1 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	7 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
HMX	380000	18 / 45	0 / 45	NA	28 J	70.1 J	28.3 J	60 U	29.5 J	28.8 J	23.7 J	21.4 J
Nitrobenzene	4800	6 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Nitrocellulose	100000000	10 / 45	0 / 45	NA	3000 UJ	3000 UJ	3000 UJ	3000 UJ	3000 UJ	3000 UJ	3000 UJ	2,530 J
Nitroglycerin	610	6 / 10	2 / 45	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	241 J
Nitroguanidine	610000	33 / 45	0 / 45	NA	60 J	66.4 J	52.4 J	97.4 J	40.6 J	100 U	49.6 J	59.6
Perchlorate	5500	1 / 45	0 / 45	NA	2.58 U	2.47 U	2.58 U	2.75 U	2.36 U	2.39 U	2.61 U	2.62 U
PETN	NSL	3 / 45	0 / 45	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	37 / 45	0 / 45	NA	60 U	60 U	87.6 J	60 U	86.3	31 J	32.1 J	33.1 J
Tetryl	24000	4 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	33.4 J	25.3 J	60 U	60 U
Total Metals (MG/KG)												
Aluminum	7700	45 / 45	0 / 45	35,400	**10,600**	**8,890**	**8,510**	3,880	7,580	5,550	3,700	5,740
Antimony	3.1	7 / 45	0 / 45	1.8	0.921 R	0.321 L	0.957 R	1.06 R	0.855 R	1.24 L	4.75 R	0.979 R
Arsenic	0.39	42 / 45	41 / 45	134	**3.46**	**3.19**	**2.36 J**	**0.43**	**1.28 J**	**4.64**	**6.24**	**2.71**
Barium	1500	45 / 45	0 / 45	134	83.8	89.7	31.1	36	25.7	36.5	138	71.2
Beryllium	16	45 / 45	0 / 45	3.3	0.397	0.357	0.393	1.87	0.318	0.524	2.95	0.973
Cadmium	7	9 / 45	0 / 45	0.61	0.307 U	0.316 U	0.319 U	0.352 U	0.285 U	0.292 U	0.316 U	0.326 U
Calcium	NUT	45 / 45	0 / 45	2,590	144 J	164 J	579 J	2,260 J	520 J	551 J	1,240 J	2,190 J
Chromium	0.29	45 / 45	45 / 45	60.1	**36.8 J**	**56 J**	**9.3 J**	**4.34 J**	**8.43 J**	**13 J**	**4.04 J**	**10.6 J**
Cobalt	2.3	45 / 45	36 / 45	133	**4.91**	**5.62**	**3.27**	**69**	**2.31**	**3.42**	**11.2**	**16.2**
Copper	310	45 / 45	0 / 45	48.6	36.4 J	45.5 J	9.42 J	127 J	7.79 J	43.1 J	23 J	264 J
Cyanide	160	1 / 45	0 / 45	16.1	0.322 U	0.308 U	0.322 U	0.343 U	0.295 U	0.299 U	0.326 U	0.328 UL
Iron	5500	45 / 45	43 / 45	83,100	**13,700 J**	**13,200 J**	**9,680 J**	**12,500 J**	**6,880 J**	**11,600 J**	1,360 J	**8,350 J**
Lead	400	45 / 45	3 / 45	40.5	70.5	95.5	6.29	3.26	5.99	**1,220**	7.35	36.4
Magnesium	NUT	45 / 45	0 / 45	2,640	546 L	470 L	482 L	1,200 L	382 L	340 L	624 L	618 L
Manganese	180	45 / 45	7 / 45	4,130	92.4	121	38.6 J	84.1	17.7 J	48.2	29.2	89.3
Mercury	2.3	25 / 45	0 / 45	0.18	0.0659	0.0588	0.0456 U	0.0438 U	0.0222 J	0.0436	0.0445 U	0.0492
Nickel	150	45 / 45	5 / 45	18.2	83.3	103	5 J	29.8	3.08 J	26.1	4.81	28.9
Potassium	NUT	25 / 45	0 / 45	2,610	418 K	368 K	531 K	502 K	395 K	5830 U	6330 U	6530 U
Selenium	39	16 / 45	0 / 45	13.3	0.245 J	0.379 J	0.2 J	0.422 U	0.342 U	0.35 U	3.8 U	0.392 U
Silver	39	0 / 45	0 / 45	11.4	1.23 U	1.27 U	1.28 U	1.41 U	1.14 U	1.17 U	6.33 U	1.31 U
Sodium	NUT	14 / 45	0 / 45	258	307 U	316 U	319 U	352 U	285 U	292 U	316 U	326 U
Thallium	NSL	0 / 45	0 / 45	21.8	0.491 U	0.506 U	0.51 U	0.563 U	0.456 U	0.467 U	10.1 U	2.61 U
Vanadium	39	45 / 45	23 / 45	194	24.9	22	24.5	14.8	19.1	32	18.3	22.6
Zinc	2300	45 / 45	0 / 45	70.4	22.9	21.9	14.5	76.5	10.6	15.8	16.2	25.2

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. Thallium was removed from the RSLs in December, 2009.
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L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 5-3
UXO 11 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP09			ISUXO11-DP10		ISUXO11-DP11	
Sample ID					ISUXO11-SB09-0102	ISUXO11-SB09-1920	ISUXO11-SB09P-0102	ISUXO11-SB10-0102	ISUXO11-SB10-1920	ISUXO11-SB11-0102	ISUXO11-SB11-0708
Sample Date					4/28/10	4/28/10	4/28/10	4/28/10	4/28/10	4/28/10	4/28/10
Chemical Name											
Explosives (UG/KG)											
1,3,5-Trinitrobenzene	220000	17 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
1,3-Dinitrobenzene	610	13 / 45	0 / 45	NA	45.3 J	60 U	60 U	60 U	60 U	60 U	34 J
2,4,6-Trinitrotoluene	3600	8 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	8 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,6-Dinitrotoluene	6100	7 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2-Nitrotoluene	2900	6 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
3-Nitrotoluene	610	4 / 45	1 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	7 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
HMX	380000	18 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Nitrobenzene	4800	6 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	25.5 J
Nitrocellulose	100000000	10 / 45	0 / 45	NA	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	5,160
Nitroglycerin	610	6 / 10	2 / 45	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U
Nitroguanidine	610000	33 / 45	0 / 45	NA	77.6 J	100 U	3,650 J	100 U	57.7 J	1,540	1,420
Perchlorate	5500	1 / 45	0 / 45	NA	2.37 U	2.5 U	2.61 U	2.49 U	2.65 U	2.73 U	2.85 U
PETN	NSL	3 / 45	0 / 45	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	37 / 45	0 / 45	NA	53.1 J	60 U	66.3 J	21.5 J	31.5 J	22.1 J	64.5
Tetryl	24000	4 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Total Metals (MG/KG)											
Aluminum	7700	45 / 45	0 / 45	35,400	**9,760**	7,270	**10,500**	**11,700**	7,390	**11,600**	**8,640**
Antimony	3.1	7 / 45	0 / 45	1.8	1.77 U	0.958 U	0.999 U	1.92 U	1.98 U	2.03 U	1.71 J
Arsenic	0.39	42 / 45	41 / 45	134	0.383 J	0.264 J	**1.01**	**0.403 J**	0.658 U	**0.987**	**0.727**
Barium	1500	45 / 45	0 / 45	134	49.3 J	9.04	72.3 J	17.6	26.2	46.5	45.2
Beryllium	16	45 / 45	0 / 45	3.3	1.04 J	0.683	0.697 J	0.698	2.4	1.02	1.3
Cadmium	7	9 / 45	0 / 45	0.61	0.591 UL	0.319 U	0.333 U	0.639 UL	0.658 U	0.678 U	0.723 U
Calcium	NUT	45 / 45	0 / 45	2,590	2,890	2,760	3,010	2,730	2,320	1,900	2,870
Chromium	0.29	45 / 45	45 / 45	60.1	**18.9**	**6.48**	**15.5**	**19.8**	**31.8**	**24.5**	**50.5**
Cobalt	2.3	45 / 45	36 / 45	133	1.62 J	0.865	**2.53 J**	**2.49**	0.996 J	1.73	**10.7**
Copper	310	45 / 45	0 / 45	48.6	14.2	6.81	11.9	12.7	25.7	32.6	178
Cyanide	160	1 / 45	0 / 45	16.1	0.297 U	0.313 U	0.326 U	0.311 U	0.331 U	0.341 U	0.356 U
Iron	5500	45 / 45	43 / 45	83,100	**38,700**	**5,900**	**29,500**	**32,200**	**61,700**	**45,400**	**55,500**
Lead	400	45 / 45	3 / 45	40.5	4.38	1.83	5.99	5.71	2.17	14	**635**
Magnesium	NUT	45 / 45	0 / 45	2,640	1,350	1,590	1,370	1,160	1,410	1,330	1,230
Manganese	180	45 / 45	7 / 45	4,130	34.9 J	17.9	84.2 J	64.9	33.2	27.1	**557**
Mercury	2.3	25 / 45	0 / 45	0.18	0.0405 U	0.04 U	0.0369 U	0.0411 U	0.0468 U	0.145	0.334
Nickel	150	45 / 45	5 / 45	18.2	3.83	1.78	4.96	4.75	3.49	12	**251**
Potassium	NUT	25 / 45	0 / 45	2,610	603 J	1280 U	607 J	2560 U	2630 U	2710 U	2890 U
Selenium	39	16 / 45	0 / 45	13.3	0.709 U	0.383 U	0.4 U	0.767 U	0.79 U	0.814 U	0.867 U
Silver	39	0 / 45	0 / 45	11.4	2.36 UL	1.28 U	1.33 U	2.56 U	2.63 UL	2.71 UL	2.89 UL
Sodium	NUT	14 / 45	0 / 45	258	182 J	142 J	202 J	200 J	658 U	678 U	723 U
Thallium	NSL	0 / 45	0 / 45	21.8	0.945 U	0.511 U	0.533 U	1.02 U	1.05 UL	1.08 UL	1.16 U
Vanadium	39	45 / 45	23 / 45	194	**43.6**	4.32	35.2	**44.2**	**106**	**67.8**	**69.1**
Zinc	2300	45 / 45	0 / 45	70.4	10.9	5.22	12.6	10.5	11.6	15.2	108

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
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MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 5-3
UXO 11 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP12			ISUXO11-DP13		ISUXO11-DP14		
Sample ID					ISUXO11-SB12-0102	ISUXO11-SB12-1920	ISUXO11-SB12P-0102	ISUXO11-SB13-0102	ISUXO11-SB13-1920	ISUXO11-SB14-0102	ISUXO11-SB14-1920	ISUXO11-SB14P-0102
Sample Date					4/28/10	4/28/10	4/28/10	4/28/10	4/28/10	4/27/10	4/27/10	4/27/10
Chemical Name												
Explosives (UG/KG)												
1,3,5-Trinitrobenzene	220000	17 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
1,3-Dinitrobenzene	610	13 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,4,6-Trinitrotoluene	3600	8 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	8 / 45	0 / 45	NA	26.4 J	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2,6-Dinitrotoluene	6100	7 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	22.7 J	60 U	60 U	60 U	60 U	60 U	60 U	60 U
2-Nitrotoluene	2900	6 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
3-Nitrotoluene	610	4 / 45	1 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	24.6 J	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	7 / 45	0 / 45	NA	60 U	60 U	52.4 J	60 U	60 U	60 U	60 U	60 U
HMX	380000	18 / 45	0 / 45	NA	60 U	60 U	49.2 J	60 U	60 U	31.2 J	42.6 J	60 U
Nitrobenzene	4800	6 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Nitrocellulose	100000000	10 / 45	0 / 45	NA	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U
Nitroglycerin	610	6 / 10	2 / 45	NA	150 UJ	150 U	288 J	150 U	150 U	150 U	150 U	150 U
Nitroguanidine	610000	33 / 45	0 / 45	NA	43.2 J	100 U	100 U	200	100 U	188 J	100 U	100 UJ
Perchlorate	5500	1 / 45	0 / 45	NA	2.52 U	2.39 U	2.4 U	2.65 U	2.43 U	2.74 U	2.52 U	2.72 U
PETN	NSL	3 / 45	0 / 45	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	37 / 45	0 / 45	NA	27 J	33.6 J	60 U	39.6 J	39.6 J	54 J	29.8 J	60 U
Tetryl	24000	4 / 45	0 / 45	NA	60 U	60 U	35 J	60 U	60 U	60 U	60 U	60 U
Total Metals (MG/KG)												
Aluminum	7700	45 / 45	0 / 45	35,400	6,110	6,170	5,530	**11,300**	6,440	**12,300**	7,560	**10,600**
Antimony	3.1	7 / 45	0 / 45	1.8	0.723 J	1.73 U	1.82 U	1.98 U	0.916 U	2.05 U	0.925 U	2.06 U
Arsenic	0.39	42 / 45	41 / 45	134	**2.08**	**0.704**	**1.96**	**1.59**	**0.556**	**0.9 J**	**0.899**	**1.31 J**
Barium	1500	45 / 45	0 / 45	134	47.6	20.1	41.4	53.1	24.4	39	15.1	49.6
Beryllium	16	45 / 45	0 / 45	3.3	0.759	1.04	0.793	1.29	4.95	0.736	10.9	0.799
Cadmium	7	9 / 45	0 / 45	0.61	0.623 U	0.578 U	0.607 U	0.66 U	0.305 U	0.685 UL	0.308 U	0.688 U
Calcium	NUT	45 / 45	0 / 45	2,590	2,100	809	1,800	689	1,910	313 J	3,740 K	355 K
Chromium	0.29	45 / 45	45 / 45	60.1	**86.2 J**	**16.6**	**49.4 J**	**23.4**	**11.2**	**20.5**	**12.2**	**21.6**
Cobalt	2.3	45 / 45	36 / 45	133	**5.46**	**14.8**	**6.7**	**4.01**	**2.9**	1.13 J	**9.8**	0.796 J
Copper	310	45 / 45	0 / 45	48.6	133 J	14.1	87.3 J	33	10.4	20.7	12.6	16.3
Cyanide	160	1 / 45	0 / 45	16.1	0.315 U	0.299 U	0.3 U	0.332 U	0.304 U	0.342 U	0.315 U	0.341 U
Iron	5500	45 / 45	43 / 45	83,100	**36,500**	**31,400**	**32,400**	**39,200**	**13,700**	**35,200**	**14,200**	**37,700**
Lead	400	45 / 45	3 / 45	40.5	205 J	3.72	385 J	36	2.34	3.3	2.03	2.63
Magnesium	NUT	45 / 45	0 / 45	2,640	727	781	668	1,130	1,520	760	2,350	786
Manganese	180	45 / 45	7 / 45	4,130	156 J	23.5	**284 J**	95.1	58.5	15.4	147	13.1
Mercury	2.3	25 / 45	0 / 45	0.18	0.218	0.0348 U	0.166	0.257	0.0388 U	0.0467 U	0.043 U	0.0421 U
Nickel	150	45 / 45	5 / 45	18.2	**204**	7.59	**171**	22.8	4.55	3.51	4.59	2.65 L
Potassium	NUT	25 / 45	0 / 45	2,610	2490 U	2310 U	2430 U	546 J	1220 U	2740 U	1230 U	2750 U
Selenium	39	16 / 45	0 / 45	13.3	0.748 U	0.693 U	0.728 U	0.792 U	0.367 U	0.822 U	0.37 U	0.826 UL
Silver	39	0 / 45	0 / 45	11.4	2.49 U	2.31 UL	2.43 U	2.64 UL	1.22 U	2.74 UL	1.23 U	2.75 UL
Sodium	NUT	14 / 45	0 / 45	258	623 U	188 J	607 U	660 U	160 J	685 U	236 J	688 U
Thallium	NSL	0 / 45	0 / 45	21.8	0.998 U	0.924 UL	0.971 U	1.06 UL	0.489 U	1.1 UL	0.493 UL	1.1 U
Vanadium	39	45 / 45	23 / 45	194	34.1	**55.6**	**39.3**	**62.3**	32.6	**74.3**	26	**68.6**
Zinc	2300	45 / 45	0 / 45	70.4	71.4	14.7	89.1	20	6.48	11.9	9.16	12.3

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 5-3
UXO 11 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP15		ISUXO11-DP16		ISUXO11-DP17		ISUXO11-DP18	
Sample ID					ISUXO11-SB15-0102	ISUXO11-SB15-1920	ISUXO11-SB16-0102	ISUXO11-SB16-1920	ISUXO11-SB17-0102	ISUXO11-SB17-2829	ISUXO11-SB18-0102	ISUXO11-SB18-0405
Sample Date					4/27/10	4/27/10	4/27/10	4/27/10	4/26/10	4/26/10	4/23/10	4/23/10
Chemical Name												
Explosives (UG/KG)												
1,3,5-Trinitrobenzene	220000	17 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	26 J	60 U	72.5	80 K
1,3-Dinitrobenzene	610	13 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	25.5 J	206 K
2,4,6-Trinitrotoluene	3600	8 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	375 K
2,4-Dinitrotoluene	1600	8 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	55.4 J	391 K
2,6-Dinitrotoluene	6100	7 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	74.4	573 K
2-Amino-4,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	268 K
2-Nitrotoluene	2900	6 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	43.9 J	56.7 K
3-Nitrotoluene	610	4 / 45	1 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	**1,370 K**
4-Amino-2,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	412 K
4-Nitrotoluene	24000	7 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	592 K
HMX	380000	18 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	24.2 J	281 K
Nitrobenzene	4800	6 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	3,440 K
Nitrocellulose	100000000	10 / 45	0 / 45	NA	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	2,110 J	1,170 J
Nitroglycerin	610	6 / 10	2 / 45	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	**1,380 K**
Nitroguanidine	610000	33 / 45	0 / 45	NA	100 U	100 U	73.3 J	251	59.9 J	385 J	148 J	1,210 J
Perchlorate	5500	1 / 45	0 / 45	NA	2.57 U	2.52 U	2.7 U	2.48 U	2.6 U	2.5 U	2.67 U	2.82 U
PETN	NSL	3 / 45	0 / 45	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	369 K
RDX	5500	37 / 45	0 / 45	NA	50.8 J	53.5 J	66.6	77	44.6 J	36.6 J	43.9 J	732 K
Tetryl	24000	4 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	564 K
Total Metals (MG/KG)												
Aluminum	7700	45 / 45	0 / 45	35,400	**13,500**	**9,080**	**19,600**	**8,910**	**11,600**	3,370 K	6,950	**14,200**
Antimony	3.1	7 / 45	0 / 45	1.8	1.89 U	0.91 U	5.11 U	0.926 U	1.94 U	0.939 U	0.957 R	1.04 R
Arsenic	0.39	42 / 45	41 / 45	134	**0.932**	**0.76**	**2.85**	**0.811**	**0.647**	**2.22**	**10.5**	**5.64**
Barium	1500	45 / 45	0 / 45	134	52.7	54	56.2	42.4	41.6	18.8	56.4	77.2
Beryllium	16	45 / 45	0 / 45	3.3	0.974	1.19	1.21 J	1.15	1.03	0.822	0.766	0.582
Cadmium	7	9 / 45	0 / 45	0.61	0.63 UL	0.303 U	1.7 U	0.309 U	0.647 U	0.313 U	0.291 J	0.291 J
Calcium	NUT	45 / 45	0 / 45	2,590	564 J	1,990	372 J	1,520	501	990	1,650 J	711 J
Chromium	0.29	45 / 45	45 / 45	60.1	**31.9**	**14.1**	**37.1**	**12.8**	**23.1**	**4.41**	**12.6 J**	**17.4 J**
Cobalt	2.3	45 / 45	36 / 45	133	1.97	1.83	**2.98 J**	**2.56**	2.08	**6.9**	**13**	**7.17**
Copper	310	45 / 45	0 / 45	48.6	20	14.2	30.2	25.1	26	9.37	24.8 J	41 J
Cyanide	160	1 / 45	0 / 45	16.1	0.321 U	0.316 U	0.337 U	0.31 U	0.325 U	0.313 U	0.334 U	0.352 U
Iron	5500	45 / 45	43 / 45	83,100	**57,300**	**20,300**	**69,500**	**23,300**	**46,100**	2,560 L	**19,400 J**	**18,900 J**
Lead	400	45 / 45	3 / 45	40.5	6.29	2.33	9.56	2.43	8.08	5.74	78.7	78.6
Magnesium	NUT	45 / 45	0 / 45	2,640	941	1,410	1,030 J	1,170	961	714 L	566 L	708 L
Manganese	180	45 / 45	7 / 45	4,130	19.1	25.7	28.2	17.6	29.9	43.1	**221**	110
Mercury	2.3	25 / 45	0 / 45	0.18	0.0254 J	0.0338 U	0.03 J	0.0384 U	0.0357 U	0.0413 U	0.12	0.261
Nickel	150	45 / 45	5 / 45	18.2	4.04	3.02	6.38	4.9	9.39	3.35	14.2	24.8
Potassium	NUT	25 / 45	0 / 45	2,610	2520 U	548 J	6810 U	560 J	900 J	641 J	450 K	783 K
Selenium	39	16 / 45	0 / 45	13.3	0.756 U	0.364 U	2.04 U	0.371 U	0.776 U	1.88 U	0.281 J	0.58
Silver	39	0 / 45	0 / 45	11.4	2.52 UL	1.21 U	6.81 U	2.47 U	2.59 U	1.25 U	1.28 U	1.38 U
Sodium	NUT	14 / 45	0 / 45	258	630 U	192 J	1700 U	194 J	323 U	134 J	319 U	75.1 K
Thallium	NSL	0 / 45	0 / 45	21.8	1.01 UL	2.43 U	2.72 U	0.988 UL	1.03 U	2.5 U	0.511 U	0.553 U
Vanadium	39	45 / 45	23 / 45	194	**87.8**	29.6	**102**	**42.6**	**83.3**	20.8	38.7	**40.3**
Zinc	2300	45 / 45	0 / 45	70.4	16.6	9.2	26.4	11.6	20.9	6.73 L	105	317

Notes:
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Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
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UL - Analyte not detected, quantitation limit is probably higher
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

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SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP19		ISUXO11-DP20	ISUXO11-DP21		ISUXO11-DP22			ISUXO11-DP23
Sample ID					ISUXO11-SB19-0102	ISUXO11-SB19-1920	ISUXO11-SB20-0102	ISUXO11-SB21-0102	ISUXO11-SB21-0607	ISUXO11-SB22-0102	ISUXO11-SB22-2425	ISUXO11-SB22P-0102	ISUXO11-SB23-0102
Sample Date					4/27/10	4/27/10	4/27/10	4/23/10	4/23/10	4/27/10	4/27/10	4/27/10	4/27/10
Chemical Name													
Explosives (UG/KG)													
1,3,5-Trinitrobenzene	220000	17 / 45	0 / 45	NA	60 U	60 U	60.9	53.6 J	49.3 J	22.1 J	60 U	60 U	101 J
1,3-Dinitrobenzene	610	13 / 45	0 / 45	NA	60 U	60 U	120	50.5 J	60 U	60 U	60 U	60 U	60 U
2,4,6-Trinitrotoluene	3600	8 / 45	0 / 45	NA	60 U	60 U	60 U	21.4 J	22.6 J	60 U	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	8 / 45	0 / 45	NA	60 U	60 U	34.6 J	60 U	60 U	60 U	60 U	60 U	74 J
2,6-Dinitrotoluene	6100	7 / 45	0 / 45	NA	60 U	60 U	66	60 U	60 U	60 U	60 U	60 U	60 U
2-Amino-4,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	113
2-Nitrotoluene	2900	6 / 45	0 / 45	NA	60 U	60 U	28.1 J	60 U	60 U	60 U	60 U	60 U	69.9
3-Nitrotoluene	610	4 / 45	1 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	128 J
4-Amino-2,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	42 J
4-Nitrotoluene	24000	7 / 45	0 / 45	NA	60 U	60 U	49.1 J	60 U	60 U	60 U	60 U	60 U	79 J
HMX	380000	18 / 45	0 / 45	NA	60 U	60 U	27.2 J	27.3 J	29.8 J	60 U	60 U	60 U	60 U
Nitrobenzene	4800	6 / 45	0 / 45	NA	60 U	60 U	23.6 J	60 U	60 U	60 U	60 U	60 U	39.9 J
Nitrocellulose	100000000	10 / 45	0 / 45	NA	3000 U	3000 U	2,170 J	3000 UJ	3000 UJ	3000 U	3000 U	3000 U	2,740 J
Nitroglycerin	610	6 / 10	2 / 45	NA	150 U	150 U	150 U	52.2 J	150 U	150 U	150 U	150 U	150 U
Nitroguanidine	610000	33 / 45	0 / 45	NA	88 J	192	66.8 J	458 J	706 J	88.9 J	182	79 J	110 J
Perchlorate	5500	1 / 45	0 / 45	NA	2.48 U	2.5 U	2.66 U	2.2 U	2.58 U	2.84 U	1.14 J	2.68 U	2.64 U
PETN	NSL	3 / 45	0 / 45	NA	150 U	150 U	195 J	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	37 / 45	0 / 45	NA	69.7	47.1 J	43.1 J	60 U	60 U	50.5 J	36.9 J	46 J	42.8 J
Tetryl	24000	4 / 45	0 / 45	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
Total Metals (MG/KG)													
Aluminum	7700	45 / 45	0 / 45	35,400	**8,360**	**10,600**	7,170 K	7,000	**8,120**	**10,700**	6,910	**12,200**	6,950 K
Antimony	3.1	7 / 45	0 / 45	1.8	0.952 U	4.73 U	0.969 U	0.825 R	0.947 R	5.45 U	1.93 U	1.95 U	0.974 U
Arsenic	0.39	42 / 45	41 / 45	134	**0.995**	1.58 U	**8.66**	**2.43**	**3.76**	1.82 U	0.644 U	**0.73**	**8.42**
Barium	1500	45 / 45	0 / 45	134	30.6	80	54	33.3	50.5	40.9	23.1	50.1	48.2
Beryllium	16	45 / 45	0 / 45	3.3	0.498	7.13	0.751	0.535	0.762	1.09	2.33	0.95	0.74
Cadmium	7	9 / 45	0 / 45	0.61	0.317 U	1.58 UL	0.147 J	0.275 U	0.316 U	1.82 U	0.644 UL	0.65 UL	0.179 J
Calcium	NUT	45 / 45	0 / 45	2,590	382	3,680	1,530	1,480 J	1,070 J	1,320	2,360	1,250	1,520
Chromium	0.29	45 / 45	45 / 45	60.1	**10.9**	**26.1**	**13.5**	**11.6 J**	**15.1 J**	**36.4 J**	**28.5**	**23.7 J**	**12**
Cobalt	2.3	45 / 45	36 / 45	133	2	**3.11 J**	**11**	**4.38**	**5.7**	4.55 U	**3.25**	1.19 J	**11.6**
Copper	310	45 / 45	0 / 45	48.6	11.2	15.7	21.6	14.7 J	31.2 J	25.4	33.1	24.5	21
Cyanide	160	1 / 45	0 / 45	16.1	0.309 U	0.312 U	0.333 U	0.275 U	0.322 U	0.355 U	0.32 U	0.335 U	0.329 U
Iron	5500	45 / 45	43 / 45	83,100	**17,000**	**97,300**	**19,400 L**	**13,300 J**	**23,500 J**	**76,900 J**	**53,700**	**49,600 J**	**16,700 L**
Lead	400	45 / 45	3 / 45	40.5	5.08	4.19	53.3	24.8	42.7	4.46	2.79	5.21	60.8
Magnesium	NUT	45 / 45	0 / 45	2,640	886	2,330	560 L	690 L	596 L	1,360 J	1,440	1,180	555 L
Manganese	180	45 / 45	7 / 45	4,130	26.8	107	**218**	106	86	18.7	142	14.4	177
Mercury	2.3	25 / 45	0 / 45	0.18	0.035 U	0.0426 U	0.16	0.0677	0.0432	0.0484 U	0.0373 U	0.0428 U	0.129
Nickel	150	45 / 45	5 / 45	18.2	12.3	7.78	11.2	11.2	8.6	5.46 J	3.44	8.06 J	13.5
Potassium	NUT	25 / 45	0 / 45	2,610	869 J	6300 U	465 J	463 K	644 K	2910 U	2580 U	2600 U	413 J
Selenium	39	16 / 45	0 / 45	13.3	0.325 J	1.89 U	0.406	0.272 J	0.379 U	2.18 U	0.773 U	0.78 U	0.286 J
Silver	39	0 / 45	0 / 45	11.4	1.27 U	6.3 UL	1.29 U	1.1 U	1.26 U	7.27 U	2.58 UL	2.6 UL	1.3 U
Sodium	NUT	14 / 45	0 / 45	258	317 U	1580 U	323 U	275 U	72.4 K	364 U	644 U	650 U	325 U
Thallium	NSL	0 / 45	0 / 45	21.8	0.508 U	2.52 UL	0.517 U	0.44 U	0.505 U	2.91 U	1.03 UL	1.04 UL	0.519 U
Vanadium	39	45 / 45	23 / 45	194	**39.7**	**120**	**42.1**	30.3	**51.3**	**117 J**	**123**	**67.9 J**	38.3
Zinc	2300	45 / 45	0 / 45	70.4	15.3	18.1	91.1 L	27	127	10.3	14.9	13.1	86.8 L

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 5-3
UXO 11 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO11-DP24	ISUXO11-DP25	
Sample ID					ISUXO11-SB24-0102	ISUXO11-SB25-0102	ISUXO11-SB25-0506
Sample Date					4/22/10	4/20/10	4/20/10
Chemical Name							
Explosives (UG/KG)							
1,3,5-Trinitrobenzene	220000	17 / 45	0 / 45	NA	37 J	111 J	46.1 J
1,3-Dinitrobenzene	610	13 / 45	0 / 45	NA	60 U	60 U	60 U
2,4,6-Trinitrotoluene	3600	8 / 45	0 / 45	NA	23.3 J	60 U	20.3 J
2,4-Dinitrotoluene	1600	8 / 45	0 / 45	NA	60 U	65.3	60 U
2,6-Dinitrotoluene	6100	7 / 45	0 / 45	NA	60 U	115 J	60 U
2-Amino-4,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	228 J	60 U
2-Nitrotoluene	2900	6 / 45	0 / 45	NA	60 U	80.8	60 U
3-Nitrotoluene	610	4 / 45	1 / 45	NA	60 U	49.8 J	60 U
4-Amino-2,6-dinitrotoluene	15000	5 / 45	0 / 45	NA	60 U	60 U	60 U
4-Nitrotoluene	24000	7 / 45	0 / 45	NA	60 U	219	60 U
HMX	380000	18 / 45	0 / 45	NA	22.8 J	23.8 J	60 U
Nitrobenzene	4800	6 / 45	0 / 45	NA	60 U	60 U	60 U
Nitrocellulose	100000000	10 / 45	0 / 45	NA	3000 UJ	2,160 J	417,000 J
Nitroglycerin	610	6 / 10	2 / 45	NA	150 U	150 U	150 U
Nitroguanidine	610000	33 / 45	0 / 45	NA	233 J	105	100 U
Perchlorate	5500	1 / 45	0 / 45	NA	2.91 U	2.56 U	2.66 U
PETN	NSL	3 / 45	0 / 45	NA	150 U	150 U	150 U
RDX	5500	37 / 45	0 / 45	NA	41 J	99.8 J	29.8 J
Tetryl	24000	4 / 45	0 / 45	NA	60 U	60 U	60 U
Total Metals (MG/KG)							
Aluminum	7700	45 / 45	0 / 45	35,400	7,570	6,200	**8,990**
Antimony	3.1	7 / 45	0 / 45	1.8	1.07 R	0.936 R	1.02 R
Arsenic	0.39	42 / 45	41 / 45	134	**8.88**	**4.35**	**1.99**
Barium	1500	45 / 45	0 / 45	134	58	37.2	48
Beryllium	16	45 / 45	0 / 45	3.3	0.802	0.85	0.916
Cadmium	7	9 / 45	0 / 45	0.61	0.358 U	1.16	0.339 U
Calcium	NUT	45 / 45	0 / 45	2,590	2,510 J	2,860 J	3,940 J
Chromium	0.29	45 / 45	45 / 45	60.1	**15.8 J**	**14.8 J**	**13.6 J**
Cobalt	2.3	45 / 45	36 / 45	133	**5.45**	**6.11**	**5.25**
Copper	310	45 / 45	0 / 45	48.6	25.6 J	139 J	47.7 J
Cyanide	160	1 / 45	0 / 45	16.1	0.191 J	0.32 U	0.332 U
Iron	5500	45 / 45	43 / 45	83,100	**27,700 J**	**16,500 J**	**15,600 J**
Lead	400	45 / 45	3 / 45	40.5	75.5	**420**	19.6
Magnesium	NUT	45 / 45	0 / 45	2,640	930 L	554 L	515
Manganese	180	45 / 45	7 / 45	4,130	108	**220**	30.3
Mercury	2.3	25 / 45	0 / 45	0.18	0.105	0.0765	0.104
Nickel	150	45 / 45	5 / 45	18.2	13.7	18.9	9.01
Potassium	NUT	25 / 45	0 / 45	2,610	577 K	398 K	632 K
Selenium	39	16 / 45	0 / 45	13.3	0.449	0.339 J	0.407 U
Silver	39	0 / 45	0 / 45	11.4	1.43 U	1.25 U	1.36 U
Sodium	NUT	14 / 45	0 / 45	258	205 K	312 U	339 U
Thallium	NSL	0 / 45	0 / 45	21.8	0.573 U	0.499 U	0.543 U
Vanadium	39	45 / 45	23 / 45	194	**45.8**	37.3	38.7
Zinc	2300	45 / 45	0 / 45	70.4	66.2	463	37.7

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 5-4
UXO 11 - Raw, Detected, and Exceeded Constituents in In Situ Groundwater
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Tapwater Adjusted	Frequency of Detection	Frequency of Detection	95 Percent UTL	ISUXO11-DP03	ISUXO11-DP18
Sample ID					ISUXO11-GP03-0410	ISUXO11-GP18-0410
Sample Date					4/22/10	4/23/10
Chemical Name						
Explosives (UG/L)						
1,3,5-Trinitrobenzene	110	1 / 2	0 / 2	NA	0.267 U	0.489 J
1,3-Dinitrobenzene	0.37	1 / 2	1 / 2	NA	0.157 B	**1.95 J**
2,4,6-Trinitrotoluene	1.8	1 / 2	0 / 2	NA	0.211 J	0.3 U
2,4-Dinitrotoluene	0.22	2 / 2	1 / 2	NA	0.137 J	**0.538 J**
2,6-Dinitrotoluene	3.7	2 / 2	0 / 2	NA	0.191 J	2.02
2-Amino-4,6-dinitrotoluene	7.3	0 / 2	0 / 2	NA	0.181 B	0.3 U
2-Nitrotoluene	0.31	0 / 2	0 / 2	NA	0.267 U	0.388 B
3-Nitrotoluene	0.37	2 / 2	2 / 2	NA	**0.628**	**2.2 J**
4-Amino-2,6-dinitrotoluene	7.3	1 / 2	0 / 2	NA	0.267 U	0.227 J
4-Nitrotoluene	4.2	1 / 2	0 / 2	NA	0.267 U	1.23 J
HMX	180	1 / 2	0 / 2	NA	0.267 U	0.597 J
Nitrobenzene	0.12	1 / 2	1 / 2	NA	0.267 U	**0.953 J**
Nitrocellulose	11000000	0 / 2	0 / 2	NA	300 U	300 U
Nitroglycerin	0.37	1 / 2	1 / 2	NA	0.667 U	**2.88 J**
Nitroguanidine	370	2 / 2	1 / 2	NA	185 J	**398 J**
Perchlorate	2.6	0 / 2	0 / 2	NA	1 U	0.2 U
PETN	NSL	1 / 2	0 / 2	NA	0.667 U	7 J
RDX	0.61	1 / 2	1 / 2	1.2	0.267 U	**2.28 J**
Tetryl	15	1 / 2	0 / 2	NA	0.267 U	1.79 J
Total Metals (UG/L)						
Aluminum	3700	2 / 2	1 / 2	286,545,198	3,610	**67,300**
Antimony	1.5	2 / 2	2 / 2	NA	**3.88 L**	**4.67 L**
Arsenic	0.045	2 / 2	2 / 2	NA	**70.2 J**	**82.3 J**
Barium	730	2 / 2	0 / 2	254	161	650
Beryllium	7.3	1 / 2	0 / 2	NA	5 U	4.82 J
Cadmium	1.8	0 / 2	0 / 2	2.8	0.6 U	0.6 U
Calcium	NUT	2 / 2	0 / 2	599,450	107,000	47,800
Chromium	0.043	2 / 2	2 / 2	20.9	**27.5**	**993**
Cobalt	1.1	2 / 2	2 / 2	39.6	**4.73**	**43.5**
Copper	150	2 / 2	1 / 2	22.4	93.4	**352**
Cyanide	73	0 / 2	0 / 2	NA	10 UL	10 UL
Iron	2600	2 / 2	2 / 2	57,199	**29,000**	**310,000**
Lead	15	2 / 2	2 / 2	NA	**85.6**	**146**
Magnesium	NUT	2 / 2	0 / 2	31,254	13,100	19,900
Manganese	88	2 / 2	2 / 2	28,160	**1,430**	**2,950**
Mercury	1.1	1 / 2	0 / 2	0.13	0.2 U	0.259
Nickel	73	2 / 2	1 / 2	39.0	25.2	**518**
Potassium	NUT	2 / 2	0 / 2	83058	10,800	10,900
Selenium	18	1 / 2	0 / 2	NA	5 U	8.23
Silver	18	0 / 2	0 / 2	NA	3 U	3 U
Sodium	NUT	2 / 2	0 / 2	NA	27,900	21,000
Thallium	NSL	1 / 2	0 / 2	NA	0.2 U	0.519
Vanadium	18	2 / 2	1 / 2	24.1	15.2	**271**
Zinc	1100	2 / 2	0 / 2	45.2	188	391
Dissolved Metals (UG/L)						
Aluminum	3700	2 / 2	0 / 2	286,545,198	109 J	74.4 J
Antimony	1.5	0 / 2	0 / 2	NA	1 U	1 U
Arsenic	0.045	2 / 2	2 / 2	NA	**0.907 J**	**4.68**
Barium	730	2 / 2	0 / 2	254	130	259
Beryllium	7.3	0 / 2	0 / 2	NA	5 U	5 U
Cadmium	1.8	0 / 2	0 / 2	2.8	0.6 U	0.6 U
Calcium	NUT	2 / 2	0 / 2	599,450	91,400	35,100
Chromium	0.043	0 / 2	0 / 2	20.9	10 U	10 U
Cobalt	1.1	2 / 2	2 / 2	39.6	**6.58**	**12.1**
Copper	150	0 / 2	0 / 2	22.4	10 U	10 U
Iron	2600	2 / 2	2 / 2	57,199	**14,200**	**90,500**
Lead	15	0 / 2	0 / 2	NA	3 U	3 U
Magnesium	NUT	2 / 2	0 / 2	31,254	11,600	13,400
Manganese	88	2 / 2	2 / 2	28,160	**1,260**	**1,050**
Mercury	1.1	0 / 2	0 / 2	0.13	0.2 U	0.2 U
Nickel	73	2 / 2	0 / 2	39.0	8.31 J	24.8
Potassium	NUT	2 / 2	0 / 2	83058	9,870	6,950
Selenium	18	0 / 2	0 / 2	NA	5 U	5 U
Silver	18	0 / 2	0 / 2	NA	3 U	3 U
Sodium	NUT	2 / 2	0 / 2	NA	25,700	20,000
Thallium	NSL	0 / 2	0 / 2	NA	0.2 U	0.2 U
Vanadium	18	0 / 2	0 / 2	24.1	12.5 U	12.5 U
Zinc	1100	2 / 2	0 / 2	45.2	13.7 J	14.8 J

Notes:

Shading indicates detections.

Bolded underlined shading indicates detected regional screening level (RSL) exceedances.

RSLs are current as of May, 2010.

NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.

NSL: No screening level. There is no RSL for PETN. Thallium was removed from the RSLs in December, 2009.

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine

PETN - pentaerythritol tetranitrate

RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen

B - Analyte not detected at significantly greater than that in an associated blank.

J - Analyte present. Value may or may not be accurate or precise

L - Analyte present. Value may be biased low. Value may be higher

U - The material was analyzed for, but not detected

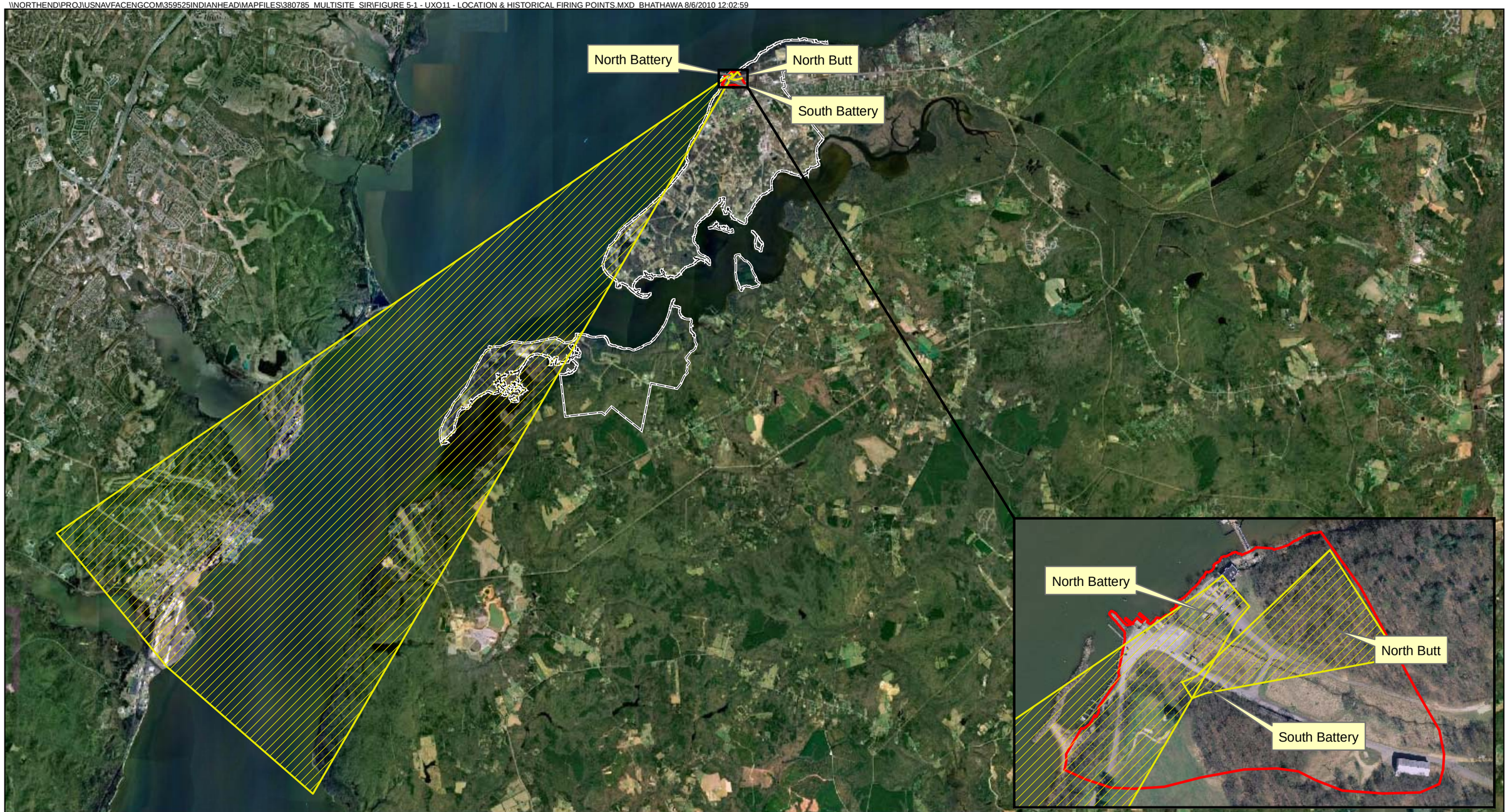
UL - Analyte not detected, quantitation limit is probably higher

UG/L - Micrograms per liter

NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table A-8 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-GP01-MMYY; where I is for Indian Head; S is for site; UXO6 is the site number; GP01 is groundwater sample from station 1; and MMYY is the month and year of collection. If a "P" is at the end of "GP01" then it is a duplicate sample from that station.



Legend

- Approximate Site Boundary
- Firing Fans
- Installation Boundary

Note:
1. This figure was created using Map 5.7-4 and Map 5.7-7 from the PA (Malcom Pirnie, 2005)

N

0 3,000 6,000 Feet

1 inch = 6,000 feet

Figure 5-1
UXO 11 - Location and Historical Firing Points
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Imagery Source: Google Earth Pro and USGS

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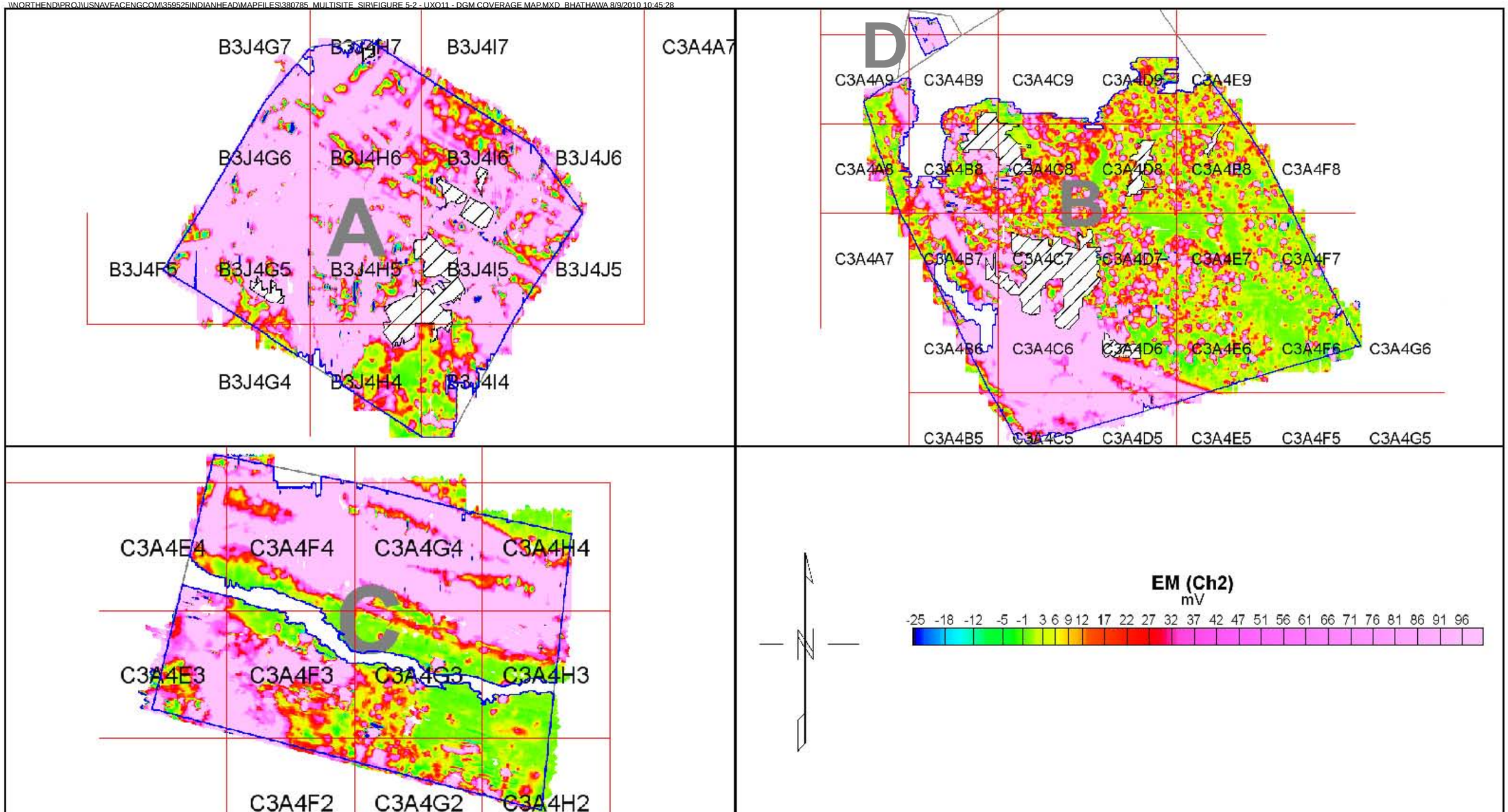

Note:
Figure is taken from Geophysical Survey Report (ARM 2010), which is provided as Appendix B.

Figure 5-2
UXO 11 - DGM Coverage Map
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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Legend

- Surface Soil, Subsurface Soil, and *in situ* Groundwater Sample Locations
- Surface and Subsurface Soil Sample Locations
- Surface Soil Sample Locations
- Investigation Areas for MEC and MC
- Approximate Site Boundary

Imagery Source: USGS

Notes:
1. Sample locations were based on historic aerial photographs, site visits conducted on November 25, 2008 and April 22, 2009, and locations stakeout with the Navy and MDE on April 12, 2010.
2. Areas A through D were based on historical information presented in the PA and provided by Mr. James Dolph (Navy historian).
3. Area E contains Building 44, one of three bomb proof areas identified by Mr. Dolph.

N

0 75 150 Feet

1 inch = 150 feet

Figure 5-3
UXO 11 - MC Sampling Locations
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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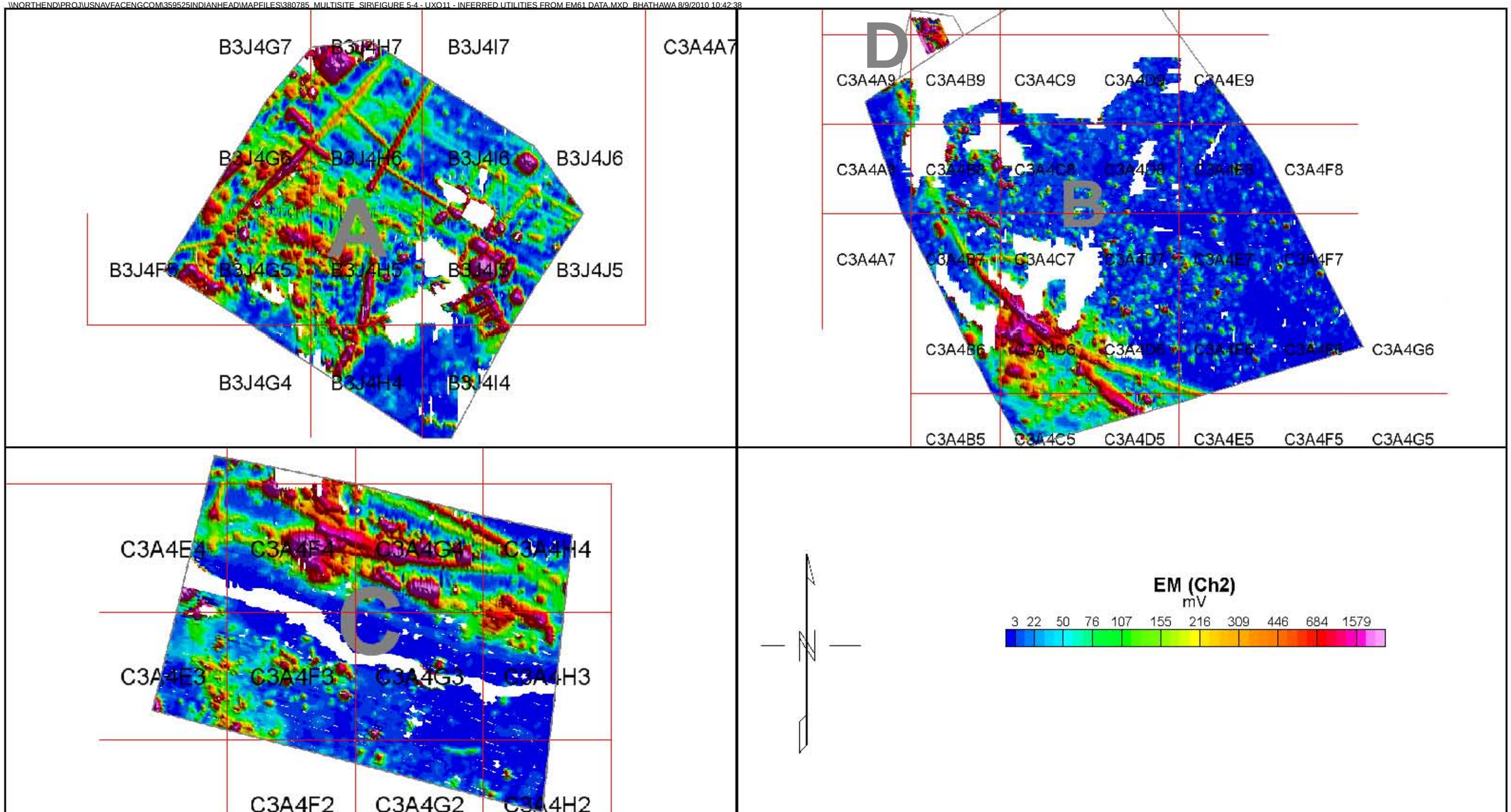
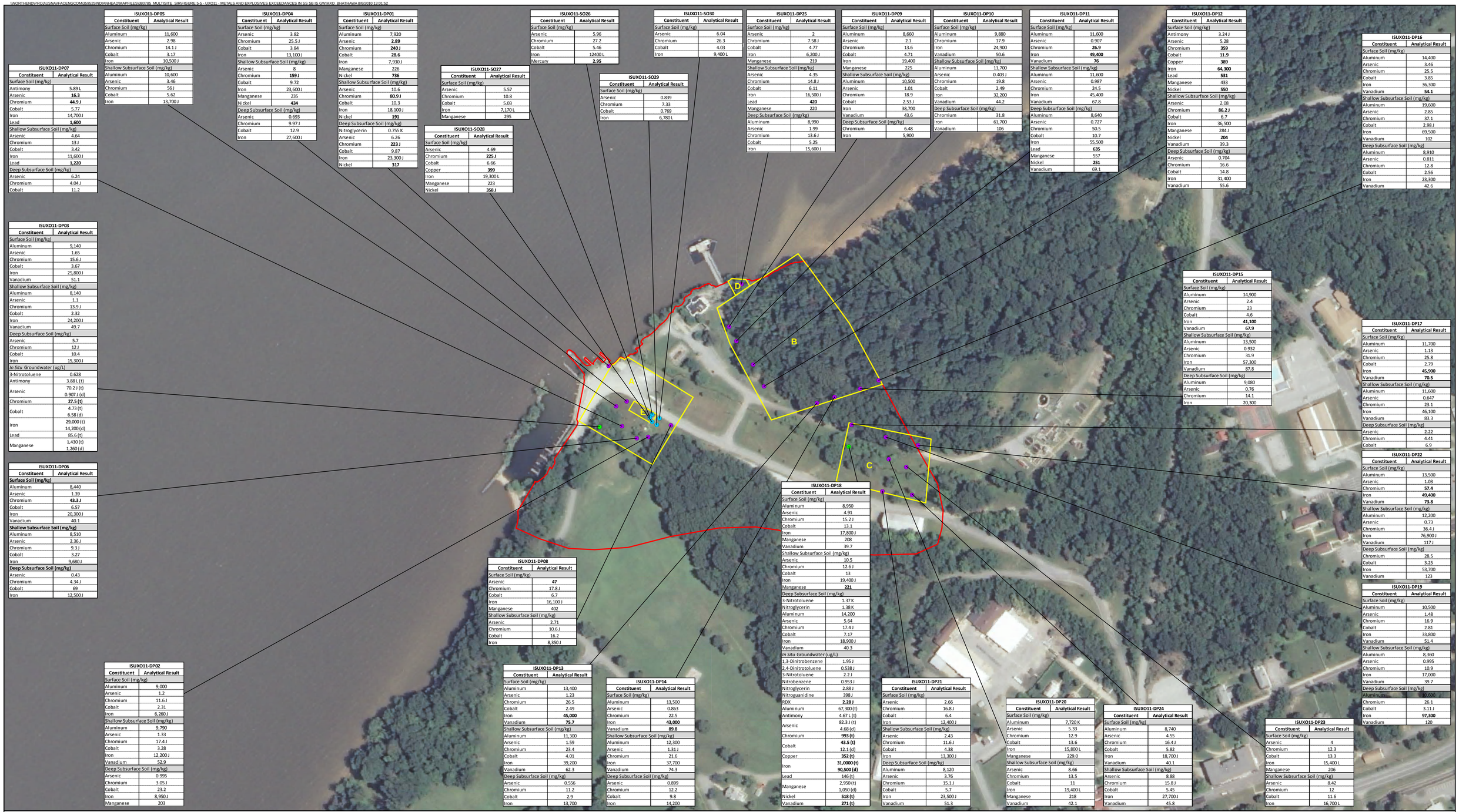


Note:
Figure is taken from Geophysical Survey Report (ARM 2010), which is provided as Appendix B.

Figure 5-4
UXO 11 - Inferred Utilities from EM61 Data
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

\\NORTHENDPROJUSNAVFACENGCOM35625\INDIANHEADMAPFILES\380785_MULTISITE_SIR\FIGURE 5-5 - UXO11 - METALS AND EXPLOSIVES EXCEEDANCES IN SS SB IS GW.MXD BHATHAWA 8/6/2010 13:01:52



ISUXO11-DP07	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Antimony	5.89 L
Arsenic	**16.3**
Chromium	**44.9 J**
Cobalt	5.77
Iron	14,700 J
Lead	**1,600**
Shallow Subsurface Soil (mg/kg)	
Arsenic	4.64
Chromium	13 J
Cobalt	3.42
Iron	11,600 J
Lead	**1,220**
Deep Subsurface Soil (mg/kg)	
Arsenic	6.24
Chromium	4.04 J
Cobalt	11.2

ISUXO11-DP05	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	11,600
Arsenic	2.98
Chromium	14.1 J
Cobalt	3.17
Iron	10,500 J
Shallow Subsurface Soil (mg/kg)	
Aluminum	10,600
Arsenic	3.46
Chromium	56 J
Cobalt	5.62
Iron	13,700 J

ISUXO11-DP04	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	3.82
Chromium	25.5 J
Cobalt	3.84
Iron	13,100 J
Shallow Subsurface Soil (mg/kg)	
Arsenic	8
Chromium	**159 J**
Cobalt	9.72
Iron	23,600 J
Manganese	235
Nickel	**434**
Deep Subsurface Soil (mg/kg)	
Arsenic	0.693
Chromium	9.97 J
Cobalt	12.9
Iron	27,600 J

ISUXO11-DP01	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	7,920
Arsenic	**2.89**
Chromium	**240 J**
Cobalt	**28.6**
Iron	7,930 J
Manganese	226
Nickel	**736**
Shallow Subsurface Soil (mg/kg)	
Arsenic	10.6
Chromium	**80.9 J**
Cobalt	10.3
Iron	18,100 J
Nickel	**191**
Deep Subsurface Soil (mg/kg)	
Nitroglycerin	0.755 K
Arsenic	6.26
Chromium	**223 J**
Cobalt	9.87
Iron	23,300 J
Nickel	**317**

ISUXO11-SO26	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	5.96
Chromium	27.2
Cobalt	5.46
Iron	12400 L
Mercury	**2.95**

ISUXO11-SO30	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	6.04
Chromium	26.3
Cobalt	4.03
Iron	9,400 L

ISUXO11-SO27	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	5.57
Chromium	10.8
Cobalt	5.03
Iron	7,170 L
Manganese	295

ISUXO11-SO29	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	0.839
Chromium	7.33
Cobalt	0.769
Iron	6,780 L

ISUXO11-SO28	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	4.69
Chromium	**225 J**
Cobalt	6.66
Copper	**399**
Iron	19,300 L
Manganese	223
Nickel	**358 J**

ISUXO11-SO25	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	2
Chromium	7.58 J
Cobalt	4.77
Iron	6,200 J
Manganese	219
Shallow Subsurface Soil (mg/kg)	
Arsenic	4.35
Chromium	14.8 J
Cobalt	6.11
Iron	16,500 J
Lead	**420**
Manganese	220
Deep Subsurface Soil (mg/kg)	
Aluminum	8,990
Arsenic	1.99
Chromium	13.6 J
Cobalt	5.25
Iron	15,600 J

ISUXO11-SO09	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	8,660
Arsenic	2.1
Chromium	13.6
Cobalt	4.71
Iron	19,400
Manganese	225
Shallow Subsurface Soil (mg/kg)	
Aluminum	10,500
Arsenic	1.01
Chromium	18.9
Cobalt	2.53 J
Iron	38,700
Vanadium	43.6
Deep Subsurface Soil (mg/kg)	
Chromium	6.48
Iron	5,900

ISUXO11-DP10	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	9,880
Chromium	17.9
Iron	24,900
Vanadium	50.6
Shallow Subsurface Soil (mg/kg)	
Aluminum	11,700
Arsenic	0.403 J
Chromium	19.8
Cobalt	2.49
Iron	32,200
Vanadium	44.2
Deep Subsurface Soil (mg/kg)	
Chromium	31.8
Iron	61,700
Vanadium	106

ISUXO11-DP11	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	11,600
Arsenic	0.907
Chromium	**26.9**
Iron	**49,400**
Vanadium	**76**
Shallow Subsurface Soil (mg/kg)	
Aluminum	11,600
Arsenic	0.987
Chromium	24.5
Iron	45,400
Vanadium	67.8
Deep Subsurface Soil (mg/kg)	
Aluminum	8,640
Arsenic	0.727
Chromium	50.5
Cobalt	10.7
Iron	55,500
Lead	**635**
Manganese	557
Nickel	**251**
Vanadium	69.1

ISUXO11-DP12	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Antimony	3.24 J
Arsenic	5.28
Chromium	**359**
Cobalt	**11.9**
Copper	**389**
Iron	**64,300**
Lead	**531**
Manganese	433
Nickel	**550**
Shallow Subsurface Soil (mg/kg)	
Arsenic	2.08
Chromium	**86.2 J**
Cobalt	6.7
Iron	36,500
Manganese	284 J
Nickel	**204**
Vanadium	39.3
Deep Subsurface Soil (mg/kg)	
Arsenic	0.704
Chromium	16.6
Cobalt	14.8
Iron	31,400
Vanadium	55.6

ISUXO11-DP16	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	14,400
Arsenic	3.46
Chromium	25.5
Cobalt	3.85
Iron	36,300
Vanadium	**54.1**
Shallow Subsurface Soil (mg/kg)	
Aluminum	19,600
Arsenic	2.85
Chromium	37.1
Cobalt	2.98 J
Iron	69,500
Vanadium	102
Deep Subsurface Soil (mg/kg)	
Aluminum	8,910
Arsenic	0.811
Chromium	12.8
Cobalt	2.56
Iron	23,300
Vanadium	42.6

ISUXO11-DP03	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	9,140
Arsenic	1.65
Chromium	15.6 J
Cobalt	3.67
Iron	25,800 J
Vanadium	51.1
Shallow Subsurface Soil (mg/kg)	
Aluminum	8,140
Arsenic	1.1
Chromium	13.9 J
Cobalt	2.32
Iron	24,200 J
Vanadium	49.7
Deep Subsurface Soil (mg/kg)	
Arsenic	5.7
Chromium	12 J
Cobalt	10.4
Iron	15,300 J
In Situ Groundwater (ug/L)	
3-Nitrotoluene	0.628
Antimony	3.88 L (t)
Arsenic	70.2 J (t) 0.907 J (d)
Chromium	**27.5 (t)**
Cobalt	4.73 (t) 6.58 (d)
Iron	29,000 (t) 14,200 (d)
Lead	85.6 (t)
Manganese	1,430 (t) 1,260 (d)

ISUXO11-DP15	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	14,900
Arsenic	2.4
Chromium	23
Cobalt	4.6
Iron	**41,100**
Vanadium	**67.9**
Shallow Subsurface Soil (mg/kg)	
Aluminum	13,500
Arsenic	0.932
Chromium	31.9
Iron	57,300
Vanadium	87.8
Deep Subsurface Soil (mg/kg)	
Aluminum	9,080
Arsenic	0.76
Chromium	14.1
Iron	20,300

ISUXO11-DP17	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	11,700
Arsenic	1.13
Chromium	25.8
Cobalt	2.79
Iron	**45,900**
Vanadium	**70.5**
Shallow Subsurface Soil (mg/kg)	
Aluminum	11,600
Arsenic	0.647
Chromium	23.1
Iron	46,100
Vanadium	83.3
Deep Subsurface Soil (mg/kg)	
Arsenic	2.22
Chromium	4.41
Cobalt	6.9

ISUXO11-DP22	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	13,500
Arsenic	1.03
Chromium	**57.4**
Iron	**49,400**
Vanadium	**73.8**
Shallow Subsurface Soil (mg/kg)	
Aluminum	12,200
Arsenic	0.73
Chromium	36.4 J
Iron	76,900 J
Vanadium	117 J
Deep Subsurface Soil (mg/kg)	
Chromium	28.5
Cobalt	3.25
Iron	53,700
Vanadium	123

ISUXO11-DP06	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	8,440
Arsenic	1.39
Chromium	**43.3 J**
Cobalt	6.57
Iron	20,300 J
Vanadium	40.1
Shallow Subsurface Soil (mg/kg)	
Aluminum	8,510
Arsenic	2.36 J
Chromium	9.3 J
Cobalt	3.27
Iron	9,680 J
Deep Subsurface Soil (mg/kg)	
Arsenic	0.43
Chromium	4.34 J
Cobalt	69
Iron	12,500 J

ISUXO11-DP18	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	8,950
Arsenic	4.91
Chromium	15.2 J
Cobalt	13.1
Iron	17,800 J
Manganese	208
Vanadium	39.7
Shallow Subsurface Soil (mg/kg)	
Arsenic	10.5
Chromium	12.6 J
Cobalt	13
Iron	19,400 J
Manganese	**221**
Deep Subsurface Soil (mg/kg)	
3-Nitrotoluene	1.37 K
Nitroglycerin	1.38 K
Aluminum	14,200
Arsenic	5.64
Chromium	17.4 J
Cobalt	7.17
Iron	18,900 J
Vanadium	40.3
In Situ Groundwater (ug/L)	
1,3-Dinitrobenzene	1.95 J
2,4-Dinitrotoluene	0.538 J
3-Nitrotoluene	2.2 J
Nitrobenzene	0.953 J
Nitroglycerin	2.88 J
Nitroguanidine	398 J
RDX	**2.28 J**
Aluminum	67,300 (t)
Antimony	4.67 L (t)
Arsenic	82.3 J (t) 4.68 (d)
Chromium	**993 (t)**
Cobalt	**43.5 (t)** 12.1 (d)
Copper	**352 (t)**
Iron	**31,0000 (t)** **90,500 (d)**
Lead	146 (t)
Manganese	2,950 (t) 1,050 (d)
Nickel	**518 (t)**
Vanadium	**271 (t)**

ISUXO11-DP08	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	**47**
Chromium	17.8 J
Cobalt	6.7
Iron	16,100 J
Manganese	402
Shallow Subsurface Soil (mg/kg)	
Arsenic	2.71
Chromium	10.6 J
Cobalt	16.2
Iron	8,350 J

ISUXO11-DP02	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	9,000
Arsenic	1.2
Chromium	11.6 J
Cobalt	2.31
Iron	6,260 J
Shallow Subsurface Soil (mg/kg)	
Aluminum	9,790
Arsenic	1.33
Chromium	17.4 J
Cobalt	3.28
Iron	12,200 J
Vanadium	52.9
Deep Subsurface Soil (mg/kg)	
Arsenic	0.995
Chromium	3.05 J
Cobalt	23.2
Iron	8,950 J
Manganese	203

ISUXO11-DP13	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	13,400
Arsenic	1.23
Chromium	26.5
Cobalt	2.49
Iron	**45,000**
Vanadium	**75.7**
Shallow Subsurface Soil (mg/kg)	
Aluminum	11,300
Arsenic	1.59
Chromium	23.4
Cobalt	4.01
Iron	39,200
Vanadium	62.3
Deep Subsurface Soil (mg/kg)	
Arsenic	0.556
Chromium	11.2
Cobalt	2.9
Iron	13,700

ISUXO11-DP14	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	13,500
Arsenic	0.863
Chromium	22.5
Iron	**43,000**
Vanadium	**89.8**
Shallow Subsurface Soil (mg/kg)	
Aluminum	12,300
Arsenic	1.31 J
Chromium	21.6
Iron	37,700
Vanadium	74.3
Deep Subsurface Soil (mg/kg)	
Arsenic	0.899
Chromium	12.2
Cobalt	9.8
Iron	14,200

ISUXO11-DP21	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	2.66
Chromium	16.8 J
Cobalt	6.4
Iron	12,400 J
Shallow Subsurface Soil (mg/kg)	
Arsenic	2.43
Chromium	11.6 J
Cobalt	4.38
Iron	13,300 J
Deep Subsurface Soil (mg/kg)	
Aluminum	8,120
Arsenic	3.76
Chromium	15.1 J
Cobalt	5.7
Iron	23,500 J
Vanadium	51.3

ISUXO11-DP20	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	7,720 K
Arsenic	5.33
Chromium	12.9
Cobalt	13.6
Iron	15,800 L
Manganese	229.0
Shallow Subsurface Soil (mg/kg)	
Arsenic	8.66
Chromium	13.5
Cobalt	11
Iron	19,400 L
Manganese	218
Vanadium	42.1

ISUXO11-DP24	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	8,740
Arsenic	4.55
Chromium	16.4 J
Cobalt	5.82
Iron	18,700 J
Vanadium	40.1
Shallow Subsurface Soil (mg/kg)	
Arsenic	8.88
Chromium	15.8 J
Cobalt	5.45
Iron	27,700 J
Vanadium	45.8

ISUXO11-DP23	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Arsenic	4
Chromium	12.3
Cobalt	13.3
Iron	15,400 L
Manganese	206
Shallow Subsurface Soil (mg/kg)	
Arsenic	8.42
Chromium	12
Cobalt	11.6
Iron	16,700 L

ISUXO11-DP19	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	10,500
Arsenic	1.48
Chromium	16.9
Cobalt	2.81
Iron	33,800
Vanadium	51.4
Shallow Subsurface Soil (mg/kg)	
Aluminum	8,360
Arsenic	0.995
Chromium	10.9
Iron	17,000
Vanadium	39.7
Deep Subsurface Soil (mg/kg)	
Aluminum	10,600
Chromium	26.1
Cobalt	3.11 J
Iron	**97,300**
Vanadium	120

Legend

- Surface Soil, Subsurface Soil, and *in situ* Groundwater Sample Locations
- Surface and Subsurface Soil Sample Locations
- Surface Soil Sample Locations
- Investigation Areas for MEC and MC
- Approximate Site Boundary

Notes:
1. Sample locations were based on historic aerial photographs, site visits conducted on November 25, 2008 and April 22, 2009, and locations stakeout with the Navy and MDE on April 12, 2010.
2. Constituents noted in the data boxes at each location indicate that they exceeded their respective RSLs
3. Bold font indicates that the constituent exceeded both the RSL and background (if available)
4. Background values are presented in *Background Soil Investigation Report for Indian Head and Stump Neck Annex* (Tetra Tech, 2002).
5. J – Analyte present. Value may or may not be accurate or precise.
6. L – Analyte present. Value may be biased low. Value may be higher
7. K – Analyte present. Value may be biased high. Value may be lower
8. (t) - Total Metals
9. (d) - Dissolved Metals

N

0 75 150 Feet

1 inch = 150 feet

Figure 5-5
UXO 11- Metals and Explosives Exceedances in Surface Soil, Subsurface Soil, and *In Situ* Groundwater
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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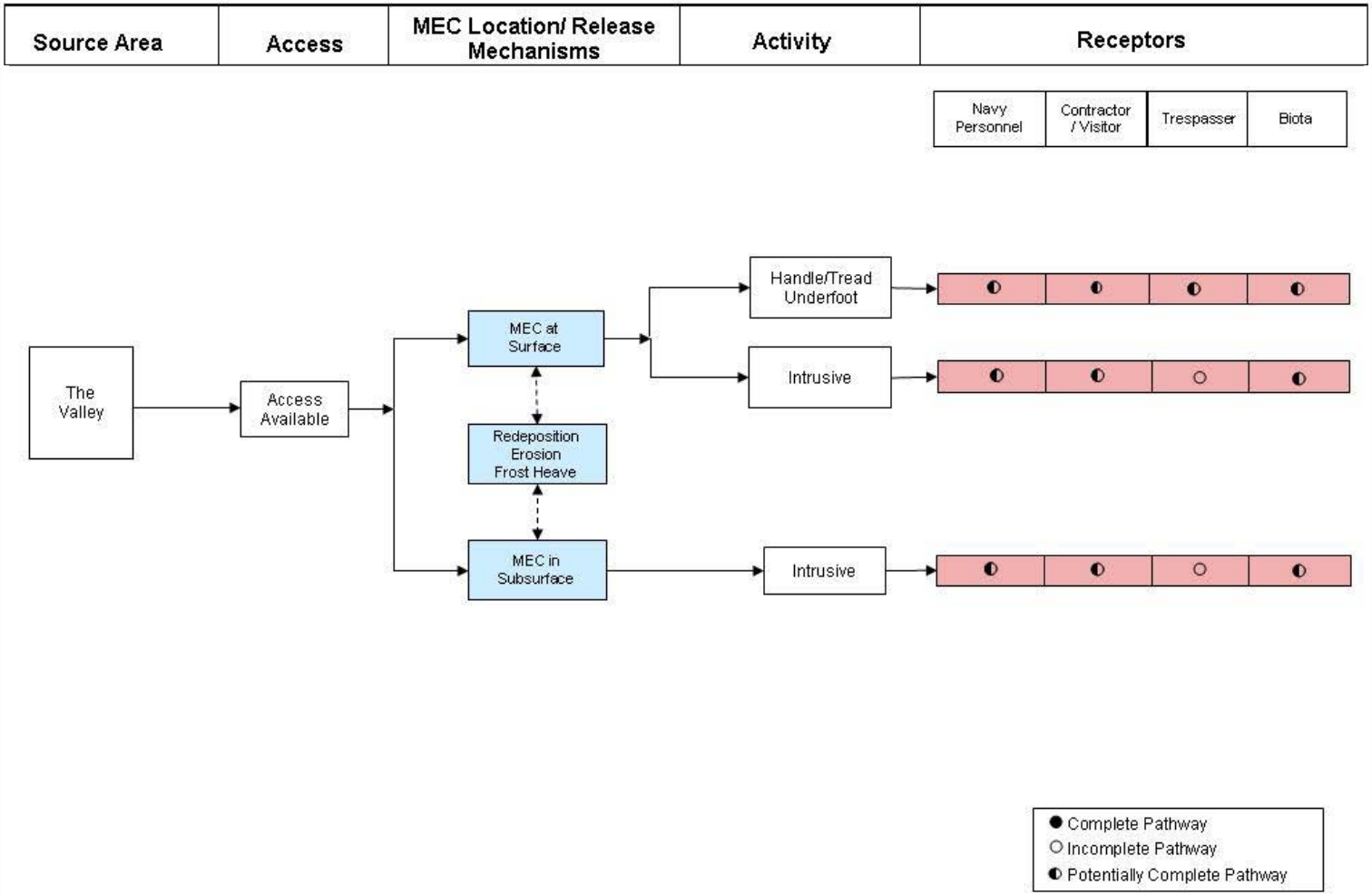

FIGURE 5-6
UXO 11 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.7-9 in the Preliminary Assessment (Malcolm Pirnie 2005)

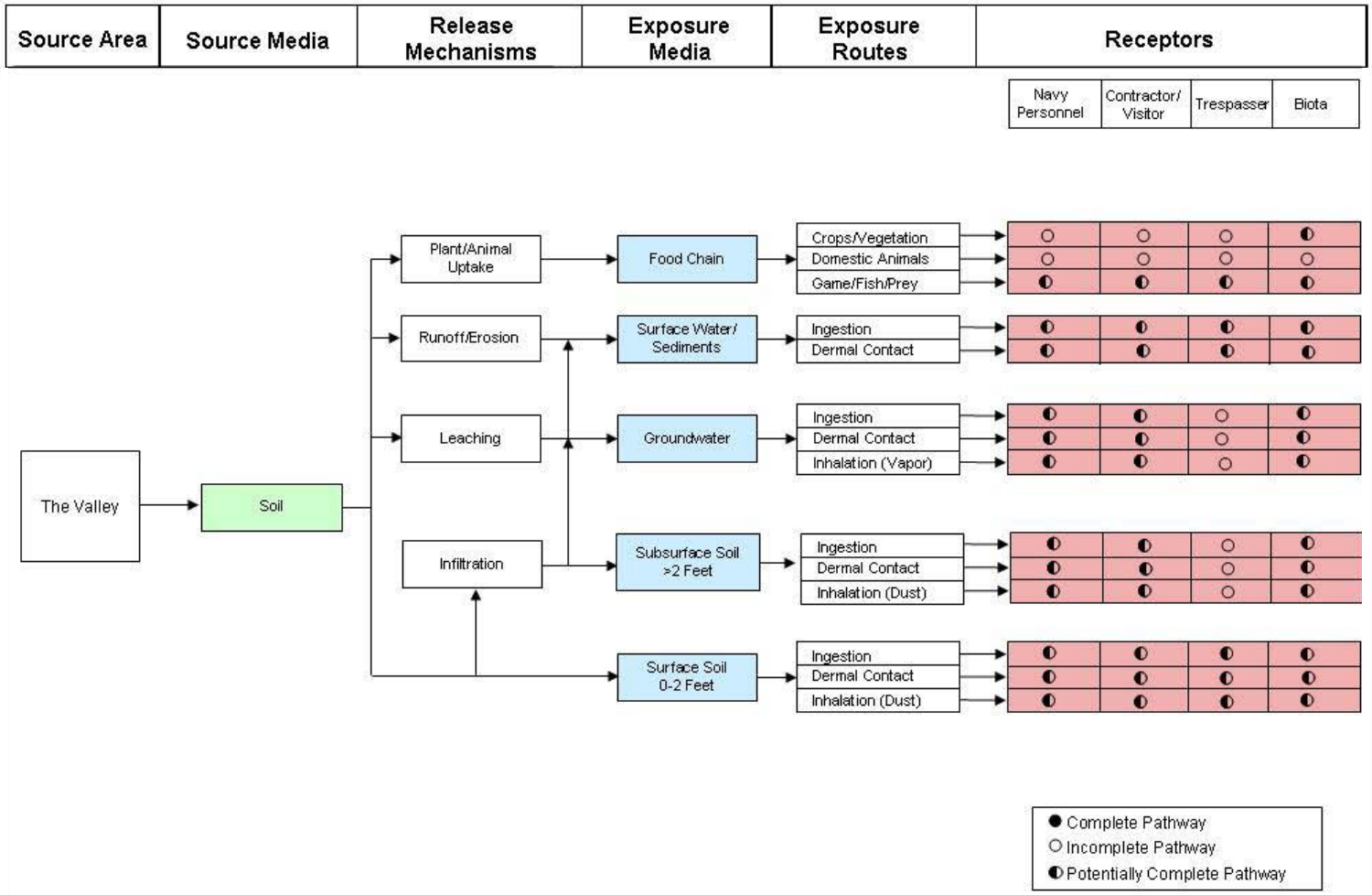

FIGURE 5-7
UXO 11 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.7-10 in the Preliminary Assessment (Malcolm Pirnie 2005)

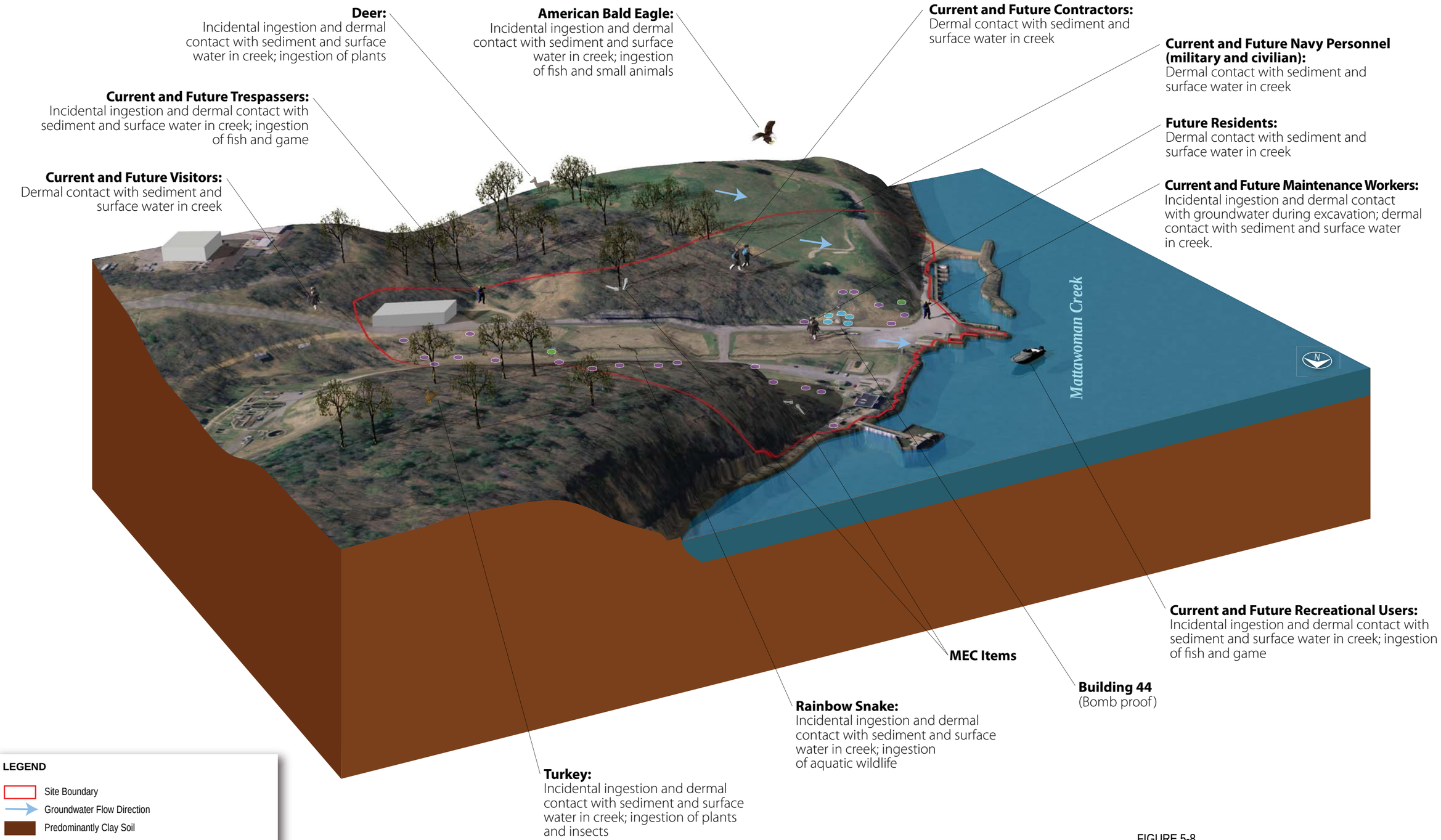

FIGURE 5-8
UXO 11 - Conceptual Site Model
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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ES080210002745WDC IH_Site_11_CSM_v7.ai 8-06-10 aeg/mlb

Photo 5-1: UXO 11 – General view of the site. View is to the east looking towards the valley. Photo was taken on 11/25/08.

SECTION 6

UXO 13 – FDR Skeet Range

6.1 Site Background

UXO 13 is a 34-acre site in the southwestern portion of NSF-IH adjacent to Mattawoman Creek (Figure 1-1). It was reportedly used as a recreational skeet range from the 1940s to the 1960s, but this use could not be confirmed during the PA. It is assumed that the area's use of munitions was limited to shotgun ammunition and clay targets. Based on interviews with employees, the PA reported that historic facility maps from the 1940s showed two small structures in the area of the site that were identified as possible trap houses. Based on the inferred orientations of the trap houses, firing would have been to the northeast.

A visual survey of a woodland area that is no longer used was conducted on June 23, 2003, as part of the PA. During the survey, remnants of a wooden building were observed on the northern portion of the site. Munitions used at the range were assumed to be limited to shotgun ammunition. The exact quantity of shotgun ammunition deployed or fired at the range is unknown. Firing records were not available during the PA, and there was no defensible method of determining the amount of ammunition potentially fired at the range.

CH2M HILL did not visit this site during the site visits conducted in November 2008 and April 2009 because the exact location of the skeet range was unknown.

6.2 Rationale and Objective

MEC is not associated with this site because it is a small arms range. The munitions constituents of concern for this site would be lead (and other metals such as antimony, arsenic, and nickel) from the shots and PAHs from pitch tar used in clay targets. The PA recommended soil sampling in the area that would have been the maximum shot fall zone, which would be 375 to 600 feet from the suspected trap houses, to verify the presence of MC in the suspected range area.

The specific objective of the SI at UXO 13 was to determine if PAHs and metals are present in surface soil at concentrations that exceed the adjusted residential soil RSL. The objective was accomplished through the collection of surface soil samples from 10 locations. An aerial photographic analysis was performed to assist in the observation of the trap houses, if they had existed, to focus the area of investigation.

6.3 Aerial Photographic Analysis

Historical aerial photographs from 1943 to 1962 were reviewed (Appendix A). The 1943 photograph showed a skeet range. In a 1950 photo, the range appeared inactive, and in a 1961 photo only two of the structures associated with the former skeet range are visible. These structures were completely surrounded by vegetation in photos from 1962.

6.4 Field Activities

6.4.1 Soil Sampling

The sample locations were selected based on the locations of the trap houses observed in the 1943 aerial photograph. This decreased the site for investigation to about 2 acres. On April 30, 2010, 10 surface soil samples were collected at 10 locations (ISUXO13-DP01 through ISUXO13-DP10) at a depth interval of 0 to 0.5 feet bgs (Table 2-1). At each location, a soil sample was collected with a disposable hand trowel. The samples were placed in the appropriate sample jars, stored in coolers at 4°C, and shipped to Empirical Labs, LLC. The samples were analyzed for PAHs and metals (Table 2-1).

Photo 6-1 shows a general view of the site. Appendix G provides photographs of site conditions taken as part of this SI. Figure 6-1 shows the soil sample locations, which were based on the trap houses in the 1943 aerial photograph and the most likely shot fall zone approximately 375 to 600 feet from the former trap houses. Locations ISUXO13-DP01 through ISUXO13-DP04 are around a trap house, possibly the high house. Locations ISUXO13-DP05 through ISUXO13-DP10 are within the 350- to 600-foot shot fall zone. Although this is not an MEC site, anomaly avoidance was performed at each location before soil sampling began. Utility clearance was not conducted because there were no subsurface intrusive activities.

6.4.2 Deviation from the Work Plan

There were no deviations from the work plan.

6.5 Munitions Constituents

6.5.1 Analytical Results

Table 6-1 presents the raw analytical results; detected constituents as shaded cells; exceedances of the RSL in bold underlined font; the frequency of detection; and frequency of exceedance for surface soil. Surface soil samples were collected from locations ISUXO13-DP01 through ISUXO13-DP10 (Figure 6-1).

The data were evaluated according to the process described in Section 2.4. Soil data were screened against the adjusted residential soil RSLs. Chemical concentrations in soil that exceeded the RSLs were further evaluated by comparing the maximum detected concentrations to site background concentrations, where applicable. The nature and extent of constituents for soil were evaluated based on exceedance of the RSLs and background concentrations.

PAHs

As shown on Table 6-1, several PAHs were detected at each location, except at locations ISUXO13-DP01 through ISUXO13-DP04, where all PAHs were detected. None of the detected compounds exceeded the RSLs at locations ISUXO13-DP06, ISUXO13-DP09, and ISUXO13-DP10. One or more of seven PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene – exceeded the RSLs at the other locations. Except for

dibenz(a,h)anthracene, which does not have a 95 percent UTL background concentration, the other compounds exceeded their respective 95 percent UTL background concentrations.

Metals

Several metals were detected at all 10 locations. Two or more of five metals exceeded their RSLs at each location. These metals are aluminum, arsenic, chromium, cobalt, iron, and manganese. Except for arsenic, which exceeded the 95 percent UTL background concentration, the other compounds did not exceed their respective 95 percent UTL background concentrations.

6.5.2 Summary of Investigation Findings

Surface soil samples were collected and analyzed for the purpose of making a site management decision. A number of PAHs and metals were detected in the samples and identified as constituents exceeding the RSLs. Concentrations of these compounds as well as those that exceeded the 95 percent UTL background concentrations are shown on Figure 6-2. As shown in the figure, the RSL-exceeded compounds (PAHs and metals) are prevalent at locations ISUXO13-DP01 through ISUXO13-DP04, around the trap house. Their concentrations are much higher than those at the other locations (ISUXO13-DP05 through ISUXO13-DP10).

The maximum concentrations of RSL-exceeded PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene) and metal (arsenic) were above the 95 percent UTL background concentrations. As shown on Figure 6-2, the PAHs and arsenic are at locations around the trap house. There is no exceedance of the background values in the shot fall zone.

6.6 Conceptual Site Model

The CSM for UXO 13 was presented in Section 5.1.11 of the PA, and is summarized here and updated if necessary. UXO 13 was used as a skeet range, so MEC is not present. Therefore, the exposure pathway for MEC is incomplete and a exposure pathway analysis and CSM was not completed. The analytical results indicate that PAHs and metals are present at the site at levels that exceed the RSLs. Figure 6-3 shows the CSM for potential receptors for exposure to MC.

Soil and surface water/sediments represent a primary source medium for MC. Lead shot and PAHs from clay targets may have been deposited on the ground surface. Based on the estimated fan for the skeet range, lead and PAHs could also have been directly released to surface water. The area identified by the Navy Range Inventory to be the former FDR Skeet Range is undeveloped and not used; however, the area within the firing arc is currently developed with numerous installation buildings. Additional portions of the area are currently wooded, with no active use. The area is part of an upland hunting area. Based on current site use, potential current human receptors include Navy personnel (military and civil servants), trespassers, visitors, maintenance workers, contractors, and recreational users (hunters). Future site use is not expected to change significantly from current site use; therefore, potential future receptors include current receptors and construction/utility workers who may perform any future construction projects at the site. Additionally,

although unlikely, future residents are considered a worst-case future scenario when considering unrestricted future site use.

Potentially complete exposure pathways in surface soils and surface water/sediments, exist for the ingestion, direct contact and inhalation of lead and PAHs for human and animal receptors. Plants may accumulate MC as well. Given that the site is located within an upland hunting area, MC entering the food chain may provide migration pathways for human and ecological receptors. Precipitation infiltration may provide for lead and PAH mobility into the subsurface soil and into the shallow or surficial groundwater aquifer, which is assumed to be connected to Mattawoman Creek, which is used recreationally. Potentially complete exposure pathways to surface water and sediments exist for human and ecological receptors through dermal contact and ingestion. Potentially complete exposure pathways also exist for MC in subsurface soils (direct contact, ingestion and inhalation during intrusive work activities) for all human and ecological receptors.

Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors and at the point of discharge in Mattawoman Creek for ecological receptors. Potential receptors for the groundwater include construction/utility workers during excavation activities and, in the unlikely event the groundwater is used as a potable water supply, future residents and/or site workers.

6.7 Conclusions and Recommendations

The PA recommended no further action for MEC and an SI for MC. The site was used as a skeet range, so it is not a MEC site. No further action is recommended for MEC. This site was investigated to determine the presence or absence of PAHs and metals in surface soil. The results from this investigation are adequate to meet the objective of the SI.

Several PAHs and metals exceeded their RSLs. The highest concentrations and exceedances were at locations ISUXO13-DP01 through ISUXO13-DP04, around the trap house. Surface soil around the trap house is recommended for further investigation to sufficiently delineate the area for a possible removal action. Therefore, an RI is recommended for surface soil around the trap house at UXO 13. No further investigation is recommended for the shot fall area.

TABLE 6-1
UXO 13 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO13-DP01	ISUXO13-DP02	ISUXO13-DP03	ISUXO13-DP04	ISUXO13-DP05	ISUXO13-DP06	ISUXO13-DP07		ISUXO13-DP08	ISUXO13-DP09	ISUXO13-DP10
Sample ID					ISUXO13-SS01-0001	ISUXO13-SS02-0001	ISUXO13-SS03-0001	ISUXO13-SS04-0001	ISUXO13-SS05-0001	ISUXO13-SS06-0001	ISUXO13-SS07-0001	ISUXO13-SS07P-0001	ISUXO13-SS08-0001	ISUXO13-SS09-0001	ISUXO13-SS10-0001
Sample Date					4/30/10	4/30/10	4/30/10	4/30/10	4/30/10	4/30/10	4/30/10	4/30/10	4/30/10	4/30/10	4/30/10
Chemical Name															
Semivolatile Organic Compounds (UG/KG)															
1-Methylnaphthalene	22000	10 / 10	0 / 10	NA	439	6.51 J	103	461	3.48 J	1.79 J	3.46 J	4.04 J	2.37 J	3.63 J	1.89 J
2-Methylnaphthalene	31000	9 / 10	0 / 10	73	633	8.17 J	120	512	3.59 J	7.94 U	2.64 J	3.81 J	1.95 J	2.13 J	2.37 J
Acenaphthene	340000	5 / 10	0 / 10	140	4,100	49	620	4,850	9.86 U	7.94 U	8.57 UJ	9.07 UJ	9.21 U	8.11 U	1.95 J
Acenaphthylene	340000	5 / 10	0 / 10	NA	55.1 J	2.38 J	18.8 J	61.1 J	9.86 U	7.94 U	8.57 UJ	9.07 UJ	9.21 U	3.06 J	7.99 U
Anthracene	1700000	9 / 10	0 / 10	260	39,200	242	3,590	32,600	4.79 J	7.94 U	3.62 J	9.07 UJ	2.68 J	4.83 J	4.82 J
Benzo(a)anthracene	150	9 / 10	4 / 10	480	**88,100**	**1,260**	**17,800**	**79,000**	20.8	7.94 U	8.69 J	7.34 J	6.88 J	6 J	6.85 J
Benzo(a)pyrene	15	10 / 10	7 / 10	390	**80,000**	**1,500**	**23,500**	**79,100**	**31.4**	7.38 J	**16.7 J**	9.07 UJ	**16.4**	13.7	13.7
Benzo(b)fluoranthene	150	10 / 10	4 / 10	420	**121,000**	**981**	**34,800**	**107,000**	37.7 J	8.63	24.9 J	22.2 J	17.5	21 J	16.4 J
Benzo(g,h,i)perylene	170000	7 / 10	0 / 10	130	36,200	884	13,600	37,700	14.7	7.94 U	8.57 UJ	9.07 UJ	8.01 J	8.11 U	6.38 J
Benzo(k)fluoranthene	1500	10 / 10	3 / 10	360	**38,400 J**	803 J	**12,900**	**43,800**	17 J	3.41 J	10.3 J	9.07 UJ	6.23 J	6.03 J	5.76 J
Chrysene	15000	9 / 10	3 / 10	440	**78,500**	1,470	**17,500**	**68,100**	26.3	7.94 U	12.9 J	12.5 J	12.9	12	8.66
Dibenz(a,h)anthracene	15	4 / 10	4 / 10	NA	**13,100**	**190**	**4,180**	**11,600**	9.86 U	7.94 U	8.57 UJ	9.07 UJ	9.21 U	8.11 U	7.99 U
Fluoranthene	230000	10 / 10	0 / 10	1,100	201,000	1,320	32,100	179,000	47	11	28.6 J	22 J	19.4	24	20
Fluorene	230000	5 / 10	0 / 10	150	6,280	40.2	546	5,390	9.86 U	7.94 U	8.57 UJ	9.07 UJ	9.21 U	8.11 U	3.51 J
Indeno(1,2,3-cd)pyrene	150	9 / 10	4 / 10	100	**45,400**	**916**	**14,300**	**38,700**	18.5	3.09 J	8.92 J	10.8 J	9.05 J	8.11 U	7.04 J
Naphthalene	3600	5 / 10	0 / 10	110	1,260 J	15.4 J	274	867 J	9.86 U	7.94 U	8.57 UJ	9.07 UJ	9.21 U	3.7 J	7.99 U
Phenanthrene	1700000	10 / 10	0 / 10	1,100	136,000	1,020	17,200	126,000	22.3	3.91 J	15.3 J	13.4 J	6.95 J	12.7	10.9
Pyrene	170000	10 / 10	0 / 10	880	147,000	1,640	25,200	150,000	34.8	5.66 J	17.4 J	13.7 J	14.7	15.9	14.6
Total Metals (MG/KG)															
Aluminum	7700	10 / 10	2 / 10	19,700	4,700	4,930	2,820	2,160	**9,190**	4,660	2,820	3,240	5,080	5,500	**7,720**
Antimony	3.1	4 / 10	0 / 10	NA	1.82 L	0.928 UL	1.03 L	1.4 L	1.14 UL	0.889 UL	0.422 L	0.497 L	1.05 UL	0.894 UL	0.877 UL
Arsenic	0.39	10 / 10	10 / 10	14.9	**23**	**3.13**	**25.3**	**58.8**	**5.76**	**2.22**	**1.79**	**1.92**	**2.59**	**2.37**	**3.13**
Barium	1500	10 / 10	0 / 10	80.4	143 L	90.5 L	85.2 L	37.7 L	28.2 L	24.8 L	13.4 L	17.8 L	23.9 L	25 L	38.9 L
Beryllium	16	10 / 10	0 / 10	1.1	0.408	0.27 J	0.755	0.515	0.448	0.316	0.124 J	0.154 J	0.299 J	0.347	0.434
Cadmium	7	3 / 10	0 / 10	2.5	0.933	0.309 U	0.383	0.254 J	0.379 U	0.296 U	0.31 U	0.337 U	0.35 U	0.298 U	0.292 U
Calcium	NUT	10 / 10	0 / 10	2060	5,310	1,510	633	439	160 J	248 J	96.2 J	188 J	158 J	139 J	298
Chromium	0.29	10 / 10	10 / 10	33.4	**12**	**8.04**	**8.2**	**13.7**	**20**	**11.6**	**5.75**	**7.16**	**10**	**11.3**	**12.7**
Cobalt	2.3	10 / 10	9 / 10	22.3	**3.52**	**2.64**	**4.13**	**2.65**	**5.17**	**7.35**	1.39	1.92	**4.11**	**2.71**	**7.73**
Copper	310	10 / 10	0 / 10	20.3	14.6	4.1	14.2	36.1	5.12	5.33	4.2	4.56	6.46	7.84	6.55
Cyanide	160	2 / 10	0 / 10	0.73	0.689	0.316 U	0.316 U	5.01	0.369 U	0.298 U	0.321 U	0.34 U	0.345 U	0.304 U	0.3 U
Iron	5500	10 / 10	9 / 10	38,500	**12,600**	**7,580**	5,190	**6,750**	**23,900**	**10,500**	4,700	**5,920**	**9,820**	**11,500**	**15,200**
Lead	400	10 / 10	0 / 10	62.5	298	125	149	198	19.4	6.45	150	124	88.8	66.1	22.9
Magnesium	NUT	10 / 10	0 / 10	1620	529 L	652 L	292 L	156 L	478 L	491 L	203 L	269 L	388 L	447 L	668 L
Manganese	180	10 / 10	4 / 10	1,390	**306 L**	65.7 L	**185 L**	74.5 L	151 L	**204 L**	17.9 L	29.2 L	**272 L**	47.4 L	114 L
Mercury	2.3	9 / 10	0 / 10	0.16	0.365	0.0708	0.33	0.224	0.0427 J	0.0347 U	0.0296 J	0.0365 J	0.0371 J	0.0209 J	0.0191 J
Nickel	150	10 / 10	0 / 10	15.4	9.73	4.23	8.82	8.95	4.95	5.4	2.73	3.42	4.38	4.75	6.36
Potassium	NUT	6 / 10	0 / 10	1470	373 J	339 J	1240 U	1220 U	356 J	272 J	1240 U	282 J	1400 U	361 J	462 J
Selenium	39	10 / 10	0 / 10	1.2	0.948	0.295 J	0.519	0.695	0.591	0.255 J	0.318 J	0.259 J	0.378 J	0.246 J	0.201 J
Silver	39	0 / 10	0 / 10	0.84	1.37 U	1.24 U	1.24 U	1.22 U	1.52 U	1.19 UL	1.24 U	1.35 U	1.4 UL	1.19 U	1.17 UL
Sodium	NUT	0 / 10	0 / 10	120	341 U	309 U	310 U	305 U	379 U	296 U	310 U	337 U	350 U	298 U	292 U
Thallium	NSL	0 / 10	0 / 10	2.3	0.546 U	0.495 U	0.495 U	0.489 U	0.606 U	0.474 U	0.496 U	0.539 U	0.561 U	0.477 UL	0.468 UL
Vanadium	39	10 / 10	0 / 10	53.3	30	19.4	15.6	20.8	33.6	16.7	14	14.2	20.3	22.5	22.2
Zinc	2300	10 / 10	0 / 10	37.5	233	19.4	62.7	33.3	18.9	15.6	9.21	12.7	17.7	18.1	23.9

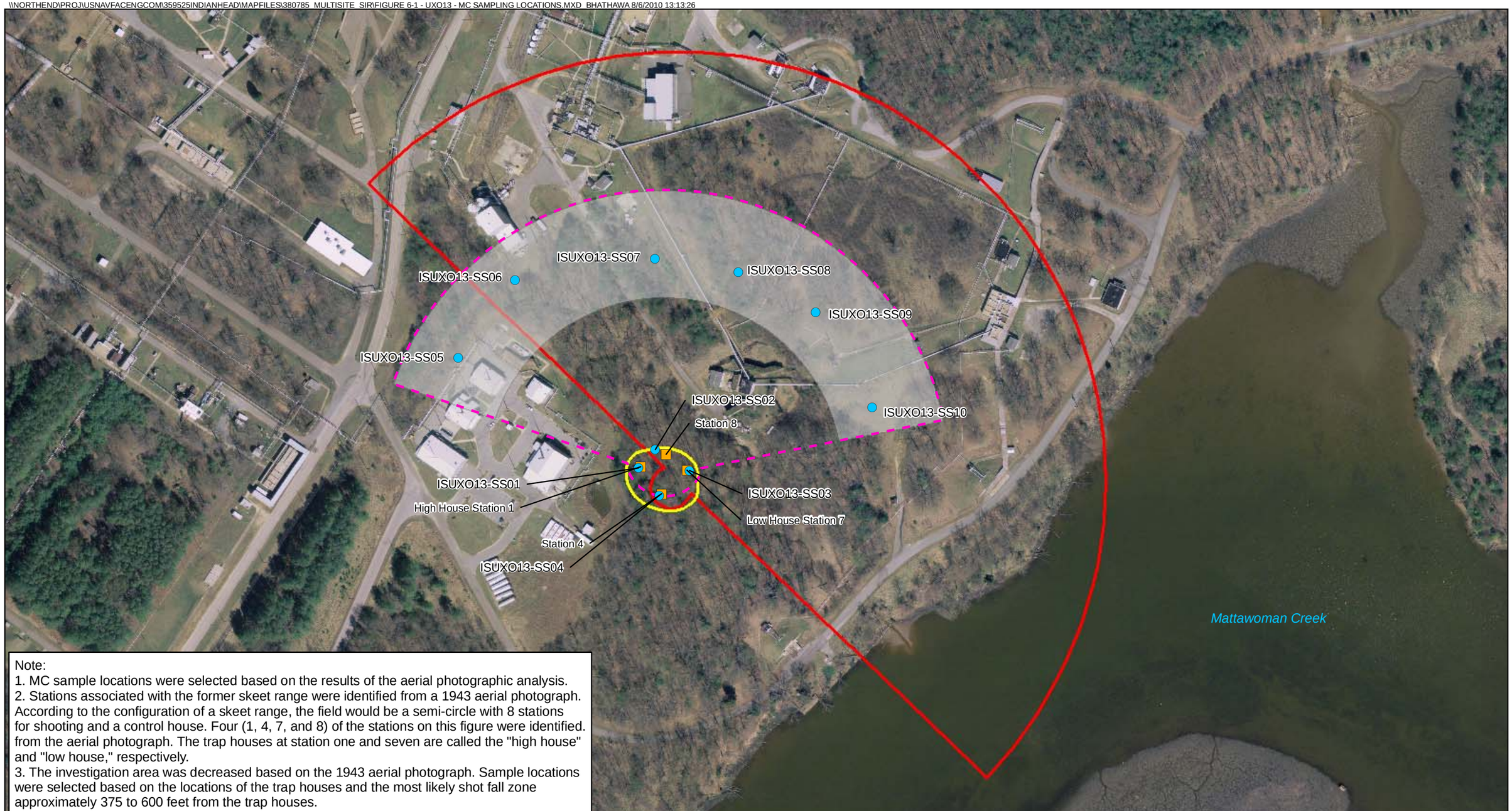
Notes:

Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrients. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
L - Analyte present. Value may be biased low. Value may be higher
U - The material was analyzed for, but not detected

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA - Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-2 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code. Example: ISUXO6-SS01-0001; where I is for Indian Head; S is for site; UXO6 is the site number; SS01 is surface soil sample from station 1; and 0001 is the sample depth interval (0-0.5 foot bgs). If a "P" is at the end of "SS01" then it is a duplicate sample from that station.



Note:
1. MC sample locations were selected based on the results of the aerial photographic analysis.
2. Stations associated with the former skeet range were identified from a 1943 aerial photograph. According to the configuration of a skeet range, the field would be a semi-circle with 8 stations for shooting and a control house. Four (1, 4, 7, and 8) of the stations on this figure were identified. from the aerial photograph. The trap houses at station one and seven are called the "high house" and "low house," respectively.
3. The investigation area was decreased based on the 1943 aerial photograph. Sample locations were selected based on the locations of the trap houses and the most likely shot fall zone approximately 375 to 600 feet from the trap houses.

Legend
- Surface Soil Sample Locations
- Locations of Stations 1, 4, 7, and 8
- Revised Investigation Area
- Potential Shotfall Zone (375' to 600')
- UXO 13 FDR Skeet Range Boundary (based on the 1950 Aerial Photograph)
- Approximate Site Boundary

N

0 100 200 Feet

1 inch = 200 feet

Figure 6-1
UXO 13 - MC Sampling Locations
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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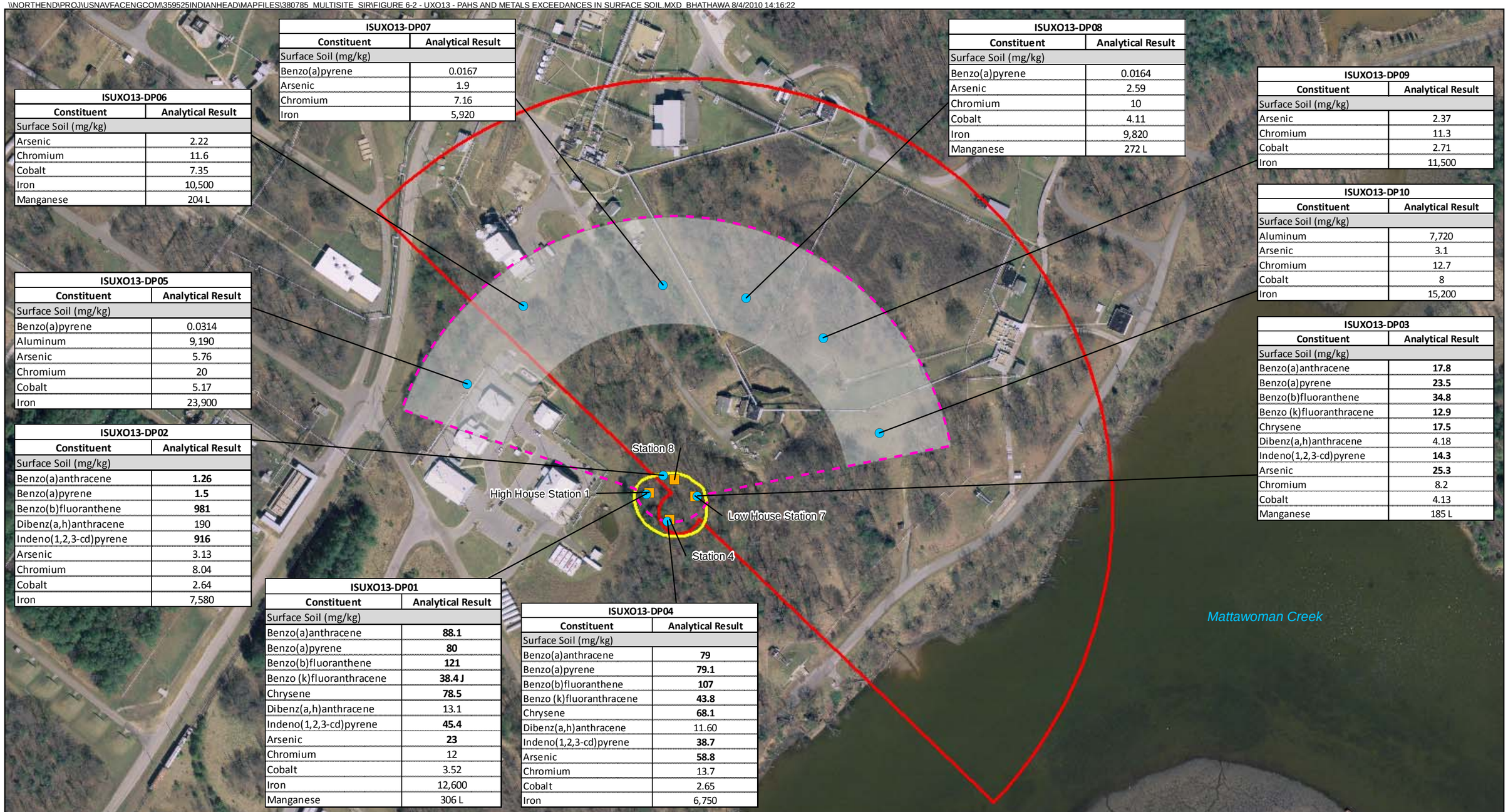

ISUXO13-DP07

Constituent	Analytical Result
Surface Soil (mg/kg)	
Benzo(a)pyrene	0.0167
Arsenic	1.9
Chromium	7.16
Iron	5,920

ISUXO13-DP08

Constituent	Analytical Result
Surface Soil (mg/kg)	
Benzo(a)pyrene	0.0164
Arsenic	2.59
Chromium	10
Cobalt	4.11
Iron	9,820
Manganese	272 L

ISUXO13-DP06

Constituent	Analytical Result
Surface Soil (mg/kg)	
Arsenic	2.22
Chromium	11.6
Cobalt	7.35
Iron	10,500
Manganese	204 L

ISUXO13-DP09

Constituent	Analytical Result
Surface Soil (mg/kg)	
Arsenic	2.37
Chromium	11.3
Cobalt	2.71
Iron	11,500

ISUXO13-DP10

Constituent	Analytical Result
Surface Soil (mg/kg)	
Aluminum	7,720
Arsenic	3.1
Chromium	12.7
Cobalt	8
Iron	15,200

ISUXO13-DP05

Constituent	Analytical Result
Surface Soil (mg/kg)	
Benzo(a)pyrene	0.0314
Aluminum	9,190
Arsenic	5.76
Chromium	20
Cobalt	5.17
Iron	23,900

ISUXO13-DP03

Constituent	Analytical Result
Surface Soil (mg/kg)	
Benzo(a)anthracene	**17.8**
Benzo(a)pyrene	**23.5**
Benzo(b)fluoranthene	**34.8**
Benzo (k)fluoranthracene	**12.9**
Chrysene	**17.5**
Dibenz(a,h)anthracene	4.18
Indeno(1,2,3-cd)pyrene	**14.3**
Arsenic	**25.3**
Chromium	8.2
Cobalt	4.13
Manganese	185 L

ISUXO13-DP02

Constituent	Analytical Result
Surface Soil (mg/kg)	
Benzo(a)anthracene	**1.26**
Benzo(a)pyrene	**1.5**
Benzo(b)fluoranthene	**981**
Dibenz(a,h)anthracene	190
Indeno(1,2,3-cd)pyrene	**916**
Arsenic	3.13
Chromium	8.04
Cobalt	2.64
Iron	7,580

ISUXO13-DP01

Constituent	Analytical Result
Surface Soil (mg/kg)	
Benzo(a)anthracene	**88.1**
Benzo(a)pyrene	**80**
Benzo(b)fluoranthene	**121**
Benzo (k)fluoranthracene	**38.4 J**
Chrysene	**78.5**
Dibenz(a,h)anthracene	13.1
Indeno(1,2,3-cd)pyrene	**45.4**
Arsenic	**23**
Chromium	12
Cobalt	3.52
Iron	12,600
Manganese	306 L

ISUXO13-DP04

Constituent	Analytical Result
Surface Soil (mg/kg)	
Benzo(a)anthracene	**79**
Benzo(a)pyrene	**79.1**
Benzo(b)fluoranthene	**107**
Benzo (k)fluoranthracene	**43.8**
Chrysene	**68.1**
Dibenz(a,h)anthracene	11.60
Indeno(1,2,3-cd)pyrene	**38.7**
Arsenic	**58.8**
Chromium	13.7
Cobalt	2.65
Iron	6,750

Legend

- Surface Soil Sample Locations
- Locations of Stations 1, 4, 7, and 8
- Revised Investigation Area
- Potential Shotfall Zone (375' to 600')
- UXO 13 FDR Skeet Range Boundary (based on the 1950 Aerial Photograph)
- Approximate Site Boundary

Note:
1. Sample locations were based on a 1943 aerial photograph, which showed the high and low houses of the former skeet range.
2. Constituents noted in the data boxes at each location indicate that they exceeded their respective RSLs
3. Bold font indicates that the constituent exceeded both the RSL and background (if available)
4. Background values are presented in *Background Soil Investigation Report for Indian Head and Stump Neck Annex* (Tetra Tech, 2002).
5. J – Analyte present. Value may or may not be accurate or precise.
6. L – Analyte present. Value may be biased low. Value may be higher.

N

0 100 200 Feet

1 inch = 200 feet

Figure 6-2
UXO 13 - PAHs and Metals Exceedances in Surface Soil
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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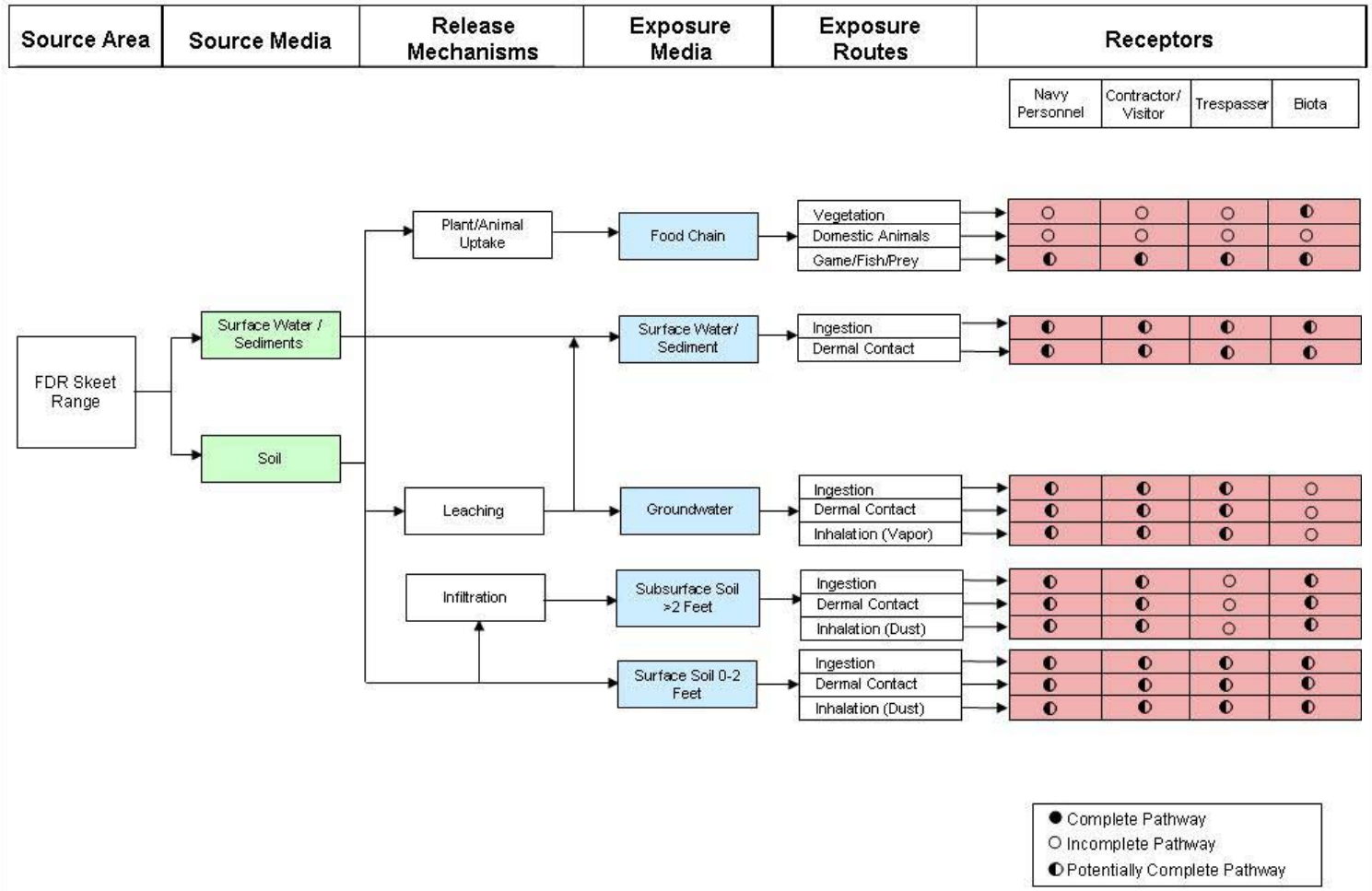


FIGURE 6-3
UXO 13 - CSM for Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.1-2 in the Preliminary Assessment (Malcolm Pirnie 2005)

Photo 6-1: UXO 13 – General view of the site. Possibly remnants of a trap house Photograph was taken in June 2010.

SECTION 7

UXO 18 – Battle Range Firing Area

7.1 Site Background

A PA of this site was completed and the findings documented in the WAMS. UXO 18 is a 340-acre water site in the north-central section of Stump Neck Annex (Figure 7-1 and Photo 7-1). It extends from the Potomac River to the north bluff along the shoreline of the Mattawoman Creek (Figure 1-2). Approximately 184 acres of the site is within UXO 33—Water Impact Area, which makes the overlapped area an MEC area and the remaining 156 acres a suspected MEC area. The site was potentially used in the 1900s for battle range firing, high-powered firing, and for studying underwater impacts. Projectiles tested may have consisted of 3-, 5-, 8-, 12-, and 14-inch armor-piercing shells, which were fired at the KATAHDIN target, an experimental Navy ram ship that was assumed to have been in the Potomac River close to its confluence with Mattawoman Creek. It is also documented that high-powered firing, using the same munition types as those used for the KATAHDIN target or pasteboard targets, would have been conducted into the north bluff. Other munitions types that could be present at this site would include those related to UXO 33 because of site overlap.

The WAMS could not confirm firing from the water to these targets or development of the pasteboard targets, nor find out the exact dates of usage. As part of the WAMS, a visual survey was performed, but it yielded no evidence of MC or MEC scraps or fragments. Neither the visual survey nor the historical information could definitively confirm that this site was used for battle range firing.

7.2 Rationale and Objectives for an Expanded PA

The WAMS recommended an SI for MEC and no further action for MC. The SI would consist of a geophysical investigation of 5 acres in the 340-acre site to determine if MEC is present and whether further action is necessary. The PA did not specify the 5-acre area for MEC investigation. The PA recommended NFA for MC because activities at the site are based on anecdotal evidence, and there was limited historical documentation to support the presence of MC.

Because UXO 18 is a large water site (more than 300 acres), and because of the uncertainty associated with the types of munitions that could have been used or the exact locations where activities or operations could have occurred, CH2M HILL recommended an expanded PA to augment, but not duplicate, the information in WAMS. As a result, information collected as part of the expanded PA would be used in conjunction with the WAMS information to provide a recommendation for the site.

The objectives of the expanded PA were accomplished through: (1) review of existing information in WAMS; (2) records search to obtain additional information on operations at the site; (3) review of information on sediment dynamics; and (4) risk analysis.

7.3 Results

Appendix G provides photographs of site conditions taken as part of this SI. Appendix H presents detailed discussion of the results of the expanded PA. The additional research conducted indicated 12-inch projectiles hitting the water at Stump Neck within 100 feet of the Navy-owned dock, and underwater experiments have been reported from the Explosives Investigation Lab at Stump Neck (Carlisle, 1990). These impact areas could well have been within the Battle Range Firing Area. CH2M HILL was unable to locate any historical copies of the Explosives Investigation Lab reports or Ordnance Investigation Memoranda from this testing. As a result, the specific locations of the impact areas could not be identified.

The Battle Range Firing Area is lat the mouth of Mattawoman Creek, which borders the town of Indian Head on the southeast. Mattawoman Creek is listed as impaired under Section 303 of the Clean Water Act for excess nutrients, sediment, and loss of living resources. It is also listed by the Maryland Department of State Planning as an Area of Critical State Concern.

The results of the sediment dynamics study noted that UXO 18 is at the mouth of Mattawoman Creek and the average depths in the region are 7 to 10 feet. The area is depositional in nature; sediment carried by Mattawoman Creek deposits near the mouth of the creek as the cross-sectional area increases and flow velocities decrease. Estimates of deposition in Mattawoman Creek were not available, but it was assumed that measured deposition rates at Indian Head are also representative of deposition rates at UXO 18. MEC items from the explosive fragments of gun firing may have been partially or fully buried by a combination of sediment deposition and sinking into soft bottom sediments.

The results of the risk analysis indicated that UXO 18 is a large area where MEC may or may not remain; bottom conditions have silted over, and swift currents with winter flooding may have moved potential sources down the river or creek. The likelihood of encountering MEC through recreational activities associated with water sports is remote. However, commercial activities such as channel dredging could actively disturb bottom sediment conditions to cause a potential MEC item to be vacuumed from the bottom into a marine vessel.

7.4 Conceptual Site Model

The CSM for UXO 18 was presented in Section 6.1.11 of the WAMS, and is summarized here and updated if necessary. No MEC was observed during the visual survey and historical documentation does not provide definitive evidence that this area was a target for battle range firing. Therefore, a CSM for MEC was not completed. Because this site overlaps UXO 33, Water Impact Area, refer to Figure 14-1 for MEC CSM. MEC is suspected at this range; therefore, the presence of MC is unlikely. As a result, a CSM was not completed. For MC exposure pathways related to the Water Impact Area, refer to Figure 14-2.

7.5 Conclusions and Recommendations

The water dynamics study showed that any munitions items that may be present have likely been buried by sediment deposition. This would result in an incomplete pathway to human receptors (recreational) from MEC items and MC. Based on the findings from the expanded

PA, no further investigation is recommended. However, because of the potential for MEC to be present, it is recommended that the existing Danger Zone on the National Oceanic and Atmospheric Administration (NOAA) maps should be expanded to include the potential impact area from UXO 18. In addition, the Danger Zone regulations should be updated to reflect the current site use and to restrict intrusive activities (such as anchoring and dredging) into the underlying sediments unless UXO avoidance procedures are performed.

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 7-1 - UXO 18 - SITE MAP.MXD BHATHAWA 9/1/2010 09:13:09

Legend

Approximate Site Boundary

Installation Boundary

N

0 500 1,000 Feet

1 inch = 1,000 feet

Imagery Source: Google Earth Pro

Figure 7-1
UXO 18 – Site Map
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

Photo 7-1: UXO 18 – General view of the site. View of the Potomac River is to the east. Photo was taken on 9/9/10.

SECTION 8

UXO 19 – Igniter Area

8.1 Site Background

According to the WAMS, UXO 19 is offshore of Mattawoman Creek along a wooded and marshy area in a small promontory referred to as "Thieves Point" on the Main Installation and cover approximately 0.01 acre (approximately 20 feet by 20 feet) (Figure 1-2). The promontory is a wetland and considered a species protection area. There was one structure nearby, Building 1451, which was formerly used for storage and was vacant at the time of the WAMS.

The history of MEC use at UXO 19 is documented in the WAMS. The WAMS reports that a small pile of igniters was found by Base personnel at the site during an extremely low tide in 1996 or 1997. Based on descriptions in the WAMS, the igniters were assumed to be electric primers or electrically primed rifle cartridges approximately 50 caliber in size. Furthermore, the igniters were suspected to be M2 and/or M60 time blasting fuse igniters. The WAMS further reported that in March 2004, additional ordnance items were observed by Base personnel along the shoreline during a low tide event. These items appeared to be MK 1 MOD 1 or MK 2 MOD 0 float signals, and a 250-, 500-, or 750-pound old-style bomb.

Several of the igniters were reportedly picked up and disposed of, but it is unknown if the disposal of the remaining igniters occurred. The origin of the igniters, dates of use, or date of disposal were unknown. Interviews with former employees indicated that the igniters might have come from the Cast Plant. As part of the WAMS, a site visit was conducted in June 2003. The WAMS noted that igniters were not observed and there were no indications of MEC because the site was covered with water.

On November 25, 2008, the Navy and CH2M HILL conducted a site visit. Building 1451 has been demolished since the WAMS was completed (Photo 8-1). Igniters were not observed; however, munitions-related items, dead wood, and other debris were scattered not only at UXO 19, but also along an approximately 400-foot stretch of the shoreline and shallow water. A 100-pound bomb was observed in the shallow water approximately 2 to 4 feet from the shoreline. The same observation was made during the CH2M HILL site visit on April 22, 2009 with the Navy, EPA, and MDE. On October 26, 2009 and January 12, 2010, CH2M HILL attempted to conduct a munitions inventory along the shoreline at UXO 19, but was not completed because of algae –covered water and frozen water conditions, respectively. CH2M HILL did observe the 100-pound bomb (An-M30A1 Old Style GP) with a large hole in the shallow water as well as rocket motors (features consistent with 5.0-inch A.R. motor). Precise MEC nomenclatures and quantities of rocket motors are unknown. Appendix G provides photographs of the site.

An IRA for MEC is planned for an area covering approximately 0.14 acre (approximately 400 feet along the shoreline by 130 feet into the shallow water of Mattawoman Creek) based on visual observations of items on November 25, 2008, and May 22, 2009. The objective of

the IRA is to remove MEC or material potentially presenting an explosive hazard and non-MEC metal items along the shoreline and visible MEC within the shallow water.

8.2 Rationale and Objective

MEC is associated with this site based on the items observed during several site visits. The WAMS documented that MC associated with the site include lead styphnate, the filler material used in M2 and M60 igniters, and smoke composition, the filler material used in MK 1 and MK 2 float signals.

The specific objective of the SI at UXO 19 was to determine if explosives compounds (including nitroguanidine, nitrocellulose, and NG) and metals are present in sediment at concentrations that exceed the adjusted residential soil RSL. The objective was accomplished through the collection of four sediment samples from four locations along the shoreline.

8.3 Aerial Photographic Analysis

Historical aerial photographs from 1937 to 1961 were reviewed (Appendix A). A 1937 photo showed an access road leading into the site area; probable debris was visible at the end of this road in a cleared area adjacent to the site in photos from 1943 to 1950. A 1952 photo showed this debris as no longer visible, and a large cleared area along the end of the access road. In a 1961 photo a freshly graded fill area was shown located at the end of the road, and light-toned material was visible along the shoreline within the fill area.

8.4 Field Activities

8.4.1 Sediment Sampling

On October 27, 2009, four sediment samples were collected at four locations (ISUXO19SD01 through ISUXO19SD04) at a depth interval of 0 to 0.5 feet below the sediment surface along the shoreline in Mattawoman Creek (Table 2-1). At each location, a sample was collected with a disposable hand trowel. The samples were placed in the appropriate sample jars, stored in coolers at 4°C, and shipped to Empirical Labs, LLC. The samples were analyzed for perchlorate, explosives (including nitroguanidine, nitrocellulose, and NG) and metals (including cyanide and mercury) (Table 2-1).

Appendix G provides photographs of site conditions taken as part of the SI. Figure 8-1 shows the sediment sample locations. Because of the presence of MEC at the site, anomaly avoidance was performed at each location by a UXO technician before sediment sampling was initiated. Utility clearance was not performed because there were no subsurface intrusive activities and the sampling locations were in the water.

8.4.2 Deviation from the Work Plan

There were no deviations from the work plan.

8.5 Munitions Constituents

8.5.1 Analytical Results

Table 8-1 presents the raw analytical results; detected constituents as shaded cells; exceedances of the RSL in bold underlined font; the frequency of detection; and frequency of exceedance for surface soil. Sediment samples were collected from locations ISUXO19SD01 through ISUXO19SD04 (Figure 8-1).

The data were evaluated according to the process described in Section 2.4. Sediment data were screened against the adjusted residential soil RSLs. Chemical concentrations in sediment that exceeded the RSLs were further evaluated by comparing the maximum detected concentrations to site background concentrations, where applicable. The nature and extent of constituents for soil were evaluated based on exceedance of the RSLs and background concentrations.

Explosives

Only one explosive compound (2-amino-4,6-dinitrotoluene) was detected at one location, ISUXO19SD02. The concentration was detected in the primary sample, but not the duplicate sample. The concentration (120J µg/kg) did not exceed the RSL.

Metals

Several metals were detected at all four locations. Only arsenic and chromium exceeded their RSLs at each location. Neither compound, however, exceeded their respective 95 percent UTL background concentration.

8.5.2 Discussion of Investigation Findings

Sediment samples were collected and analyzed for the purpose of making a site management decision. Only one explosive (2-amino-4,6-dinitrotoluene) was detected at a concentration of 120J µg/kg at one location (ISUXO19SD02). Explosives were not detected at the other three locations.

Metals were detected at all locations, but only arsenic and chromium exceeded their RSLs (Figure 8-2). The concentrations of arsenic ranged from 5.32J mg/kg (ISUXO19SD04) to 19.2J mg/kg (ISUXO19SD02). The concentrations of chromium ranged from 16.4 mg/kg (ISUXO19SD04) to 21.9 mg/kg (ISUXO19SD02). The maximum concentrations of these compounds did not exceed their respective 95 percent UTL concentrations of 63 mg/kg and 79.2 mg/kg, respectively. The frequency of detections at each location is similar, but location ISUXO19SD02 has the highest concentrations of the RSL-exceeded metals.

8.6 Conceptual Site Model

The CSM for UXO 19 was presented in Section 5.1.11 of the WAMS and is summarized here and updated if necessary. CSMs for MEC and MC are shown as Figures 8-3 and 8-4, respectively. Potential receptors include both human (Navy personnel (military and civilian), commercial/recreational user, and trespasser) and ecological receptors (biota) that may contact the source medium. Human and ecological receptors could potentially be affected by MEC at the sediment surface. Human receptors could disturb MEC through recreational activities such as wading and fishing. Activities, such as physical contact with

sediments, could also affect biota. The pathways for MEC in the subsurface are incomplete for all receptors because no intrusive activities, such as river dredging, are anticipated. MEC could, however, be transported to surface sediment by the tides, water currents, erosion/redeposition, and relocation during heavy rains and storm surges.

The site and adjacent land is currently not used. The promontory is a wetland and considered a species protection area. Mattawoman Creek, adjacent to the site is used recreationally for fishing and boating. Potential receptors include both human (Navy personnel (military and civilian), commercial/recreational user, and trespasser) and ecological receptors (biota) that may contact the source medium or other media at the site that may be affected. Potential receptors may potentially ingest or come into physical contact with surface water at the site. Biota can potentially ingest or come into physical contact with affected surface water. Human receptors have the potential for physical contact and ingestion of affected water through recreational activities such as wading or fishing.

A potentially complete pathway is indicated for biota exposed to MC via the food chain. MC may be taken up by plants and benthic organisms and transferred through the food chain to feeding biota. There are no domestic animals on or near the site, so the domestic animal exposure pathway is considered incomplete for all receptors. Fishing is known to occur on Mattawoman Creek; therefore, fish provide a potentially complete pathway for all receptors.

Human and ecological receptors could potentially be affected by MC at the sediment surface through ingestion or dermal contact. Human receptors could contact MC through recreational activities such as wading and fishing. Activities, such as physical contact with and ingestion of sediments, could also affect biota. The ingestion and dermal contact pathways for MC in the subsurface are incomplete for all receptors because no intrusive activities, such as river dredging, are anticipated in the Igniter Area. MC could, however, be transported to surface water by the tides, water currents, erosion/redeposition, and relocation during heavy rains and storm surges.

8.7 Conclusions and Recommendations

The PA recommended a removal action for MEC and an SI for MC. This site was investigated to determine the presence or absence of explosives and metals in sediment along the shoreline of Mattawoman Creek. The results from this investigation are adequate to meet the objective of the SI. The results show that explosives compounds are not of concern at this site. Although two metals (arsenic and chromium) exceeded their RSLs, their concentrations were below the background levels. Therefore, sediment is recommended for no further investigation.

TABLE 8-1
UXO 19 - Raw, Detected, and Exceeded Constituents in Sediment
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Res Soil X 10 for SD Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO19SD01	ISUXO19SD02		ISUXO19SD03	ISUXO19SD04
Sample ID					ISUXO19SD010001	ISUXO19SD020001	ISUXO19SD020001P	ISUXO19SD030001	ISUXO19SD040001
Sample Date					10/27/09	10/27/09	10/27/09	10/27/09	10/27/09
Chemical Name									
Explosives (µg/kg)									
1,3,5-Trinitrobenzene	2200000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
1,3-Dinitrobenzene	6100	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
2,4,6-Trinitrotoluene	36000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
2,4-Dinitrotoluene	16000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
2,6-Dinitrotoluene	61000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
2-Amino-4,6-dinitrotoluene	150000	1 / 4	0 / 4	NA	300 U	120 J	300 U	300 U	300 U
2-Nitrotoluene	29000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
3-Nitrotoluene	6100	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
4-Amino-2,6-dinitrotoluene	150000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
4-Nitrotoluene	240000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
HMX	3800000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
Nitrobenzene	48000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
Nitrocellulose	100000000	0 / 4	0 / 4	NA	3000 U	3000 U	3000 U	3000 U	3000 U
Nitroglycerin	6100	0 / 4	0 / 4	NA	1,500 U	1,500 U	1,500 U	1,500 U	1,500 U
Nitroguanidine	6100000	0 / 4	0 / 4	NA	100 U	100 U	100 U	100 U	100 U
Perchlorate	55000	0 / 4	0 / 4	NA	27.6 U	33 U	29.5 U	29.1 U	26.5 UJ
PETN	NSL	0 / 4	0 / 4	NA	1,500 U	1,500 U	1,500 U	1,500 U	1,500 U
RDX	55000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
Tetryl	240000	0 / 4	0 / 4	NA	300 U	300 U	300 U	300 U	300 U
Total Metals (mg/kg)									
Aluminum	77000	4 / 4	0 / 4	52,362	2,540	4,000	3,610	4,630	6,510
Antimony	31	0 / 4	0 / 4	NA	1.01 R	2.39 R	2.2 R	2.09 R	0.947 R
Arsenic	3.9	4 / 4	4 / 4	63	**9.17 J**	**19.2 J**	**16.3 J**	**15.9 J**	**5.32 J**
Barium	15000	4 / 4	0 / 4	577	18.7 K	35.4 K	26.8 K	37.4 K	52.7 K
Beryllium	160	4 / 4	0 / 4	10.9	0.74	1.09	1.18	1.22	0.812
Cadmium	70	0 / 4	0 / 4	1.85	0.376 B	0.192 B	0.733 U	0.696 U	0.163 B
Calcium	NUT	4 / 4	0 / 4	88,137	337 K	562 K	455 K	750 K	736 K
Chromium	2.9	4 / 4	4 / 4	79.2	**19.7**	**21.9**	**19.7**	**21.7**	**16.4**
Cobalt	23	4 / 4	0 / 4	118	6.12 K	4.76 K	4.58 K	5.38 K	5.79 K
Copper	3100	4 / 4	0 / 4	297	20.3 L	39.6 L	32.6 L	33.1 L	35.7 L
Cyanide	1600	1 / 4	0 / 4	NA	0.345 U	0.413 U	0.368 U	1.07	0.331 U
Iron	55000	4 / 4	0 / 4	193,218	31,300 J	50,700 J	47,000 J	52,500 J	30,700 J
Lead	4000	4 / 4	0 / 4	476	15.2 L	47.9 L	17.6 L	21.5 L	24.8 L
Magnesium	NUT	4 / 4	0 / 4	19,043	291 J	525 J	449 J	650 J	975
Manganese	1800	4 / 4	0 / 4	2,561	159	317 J	212 J	398	139
Mercury	23	2 / 4	0 / 4	0.778	0.039 U	0.0266 J	0.0186 J	0.0234 J	0.0375 U
Nickel	1500	4 / 4	0 / 4	382	7.32	7.27	7.28	12.6	8.96
Potassium	NUT	4 / 4	0 / 4	5,061	229 K	413 K	360 K	452 K	524 K
Selenium	390	2 / 4	0 / 4	6.45	0.329 J	0.797 U	0.733 U	0.696 U	0.361
Silver	390	0 / 4	0 / 4	0.92	0.338 U	0.797 U	0.733 U	0.696 U	0.316 U
Sodium	NUT	4 / 4	0 / 4	472	98.5 K	141 K	128 K	149 K	142 K
Thallium	NSL	0 / 4	0 / 4	NA	0.541 U	1.28 U	1.17 U	1.11 U	0.505 U
Vanadium	390	4 / 4	0 / 4	196	19.4	51.6 J	31 J	39.5	17.5
Zinc	23000	4 / 4	0 / 4	1,660	42.5 K	74.9 K	63.5 K	63.8 K	50.9 K

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrient. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. There is no RSL for PETN. Thallium was removed from the RSLs in December, 2009.
B - Analyte not detected at significantly greater than that in an associated blank
J - Analyte present, value may or may not be accurate or precise
K - Analyte present, value may be biased high, actual value may be lower
L - Analyte present, value may be biased low, actual value may be higher
R - Unreliable Result
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
95 percent upper tolerance limits (UTLs) are taken from Table A-12 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
NA - Not available
mg/kg - Milligrams per kilogram
µg/kg - Micrograms per kilogram

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 8-1 - UXO19 - MC SAMPLING LOCATIONS.MXD BHATHAWA 8/6/2010 13:51:38

Note:
1. Sample locations were based on the November 25, 2008 site visit and MEC inventory in October 2009 at the time the samples were collected.
2. The investigation area was expanded from the site boundary in the PA based on observations made during the November 25, 2008 site visit; munitions-related items were observed scattered along an approximately 400-foot stretch of the shoreline, and shallow water.

Legend
- Sediment Sample Locations
- Igniter Area Boundary in the Preliminary Assessment
- Proposed Site Inspection Area

N

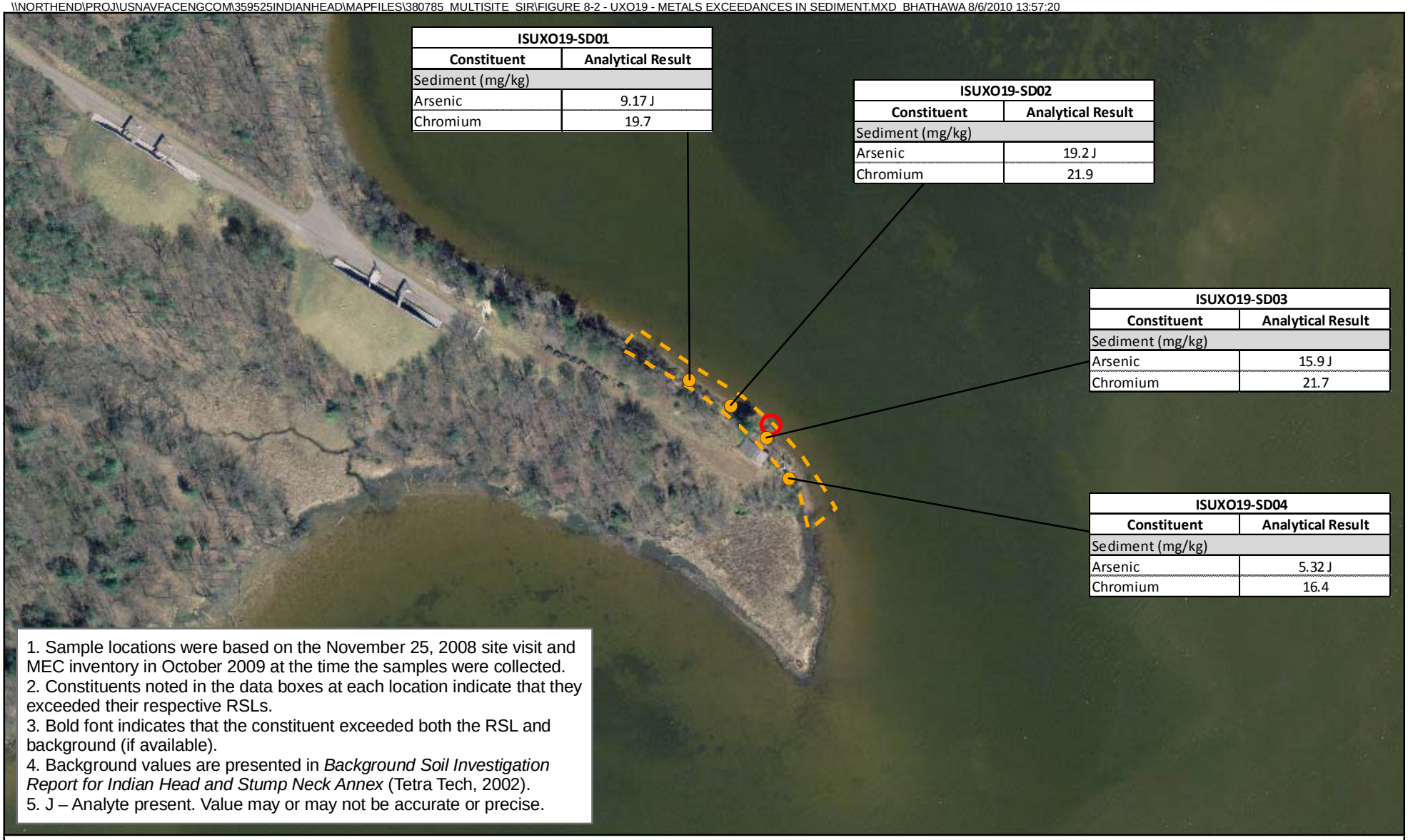
0 100 200 Feet

1 inch = 200 feet

Figure 8-1
UXO 19 - MC Sampling Locations
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 8-2 - UXO19 - METALS EXCEEDANCES IN SEDIMENT.MXD BHATHAWA 8/6/2010 13:57:20



ISUXO19-SD01	
Constituent	**Analytical Result**
Sediment (mg/kg)	
Arsenic	9.17 J
Chromium	19.7

ISUXO19-SD02	
Constituent	**Analytical Result**
Sediment (mg/kg)	
Arsenic	19.2 J
Chromium	21.9

ISUXO19-SD03	
Constituent	**Analytical Result**
Sediment (mg/kg)	
Arsenic	15.9 J
Chromium	21.7

ISUXO19-SD04	
Constituent	**Analytical Result**
Sediment (mg/kg)	
Arsenic	5.32 J
Chromium	16.4

1. Sample locations were based on the November 25, 2008 site visit and MEC inventory in October 2009 at the time the samples were collected.
2. Constituents noted in the data boxes at each location indicate that they exceeded their respective RSLs.
3. Bold font indicates that the constituent exceeded both the RSL and background (if available).
4. Background values are presented in *Background Soil Investigation Report for Indian Head and Stump Neck Annex* (Tetra Tech, 2002).
5. J – Analyte present. Value may or may not be accurate or precise.

Legend

- Sediment Sample Locations
- Igniter Area Boundary in the Preliminary Assessment
- Proposed Site Inspection Area

N

0 100 200 Feet

1 inch = 200 feet

Figure 8-2
UXO 19 - Metals Exceedances in Sediment
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

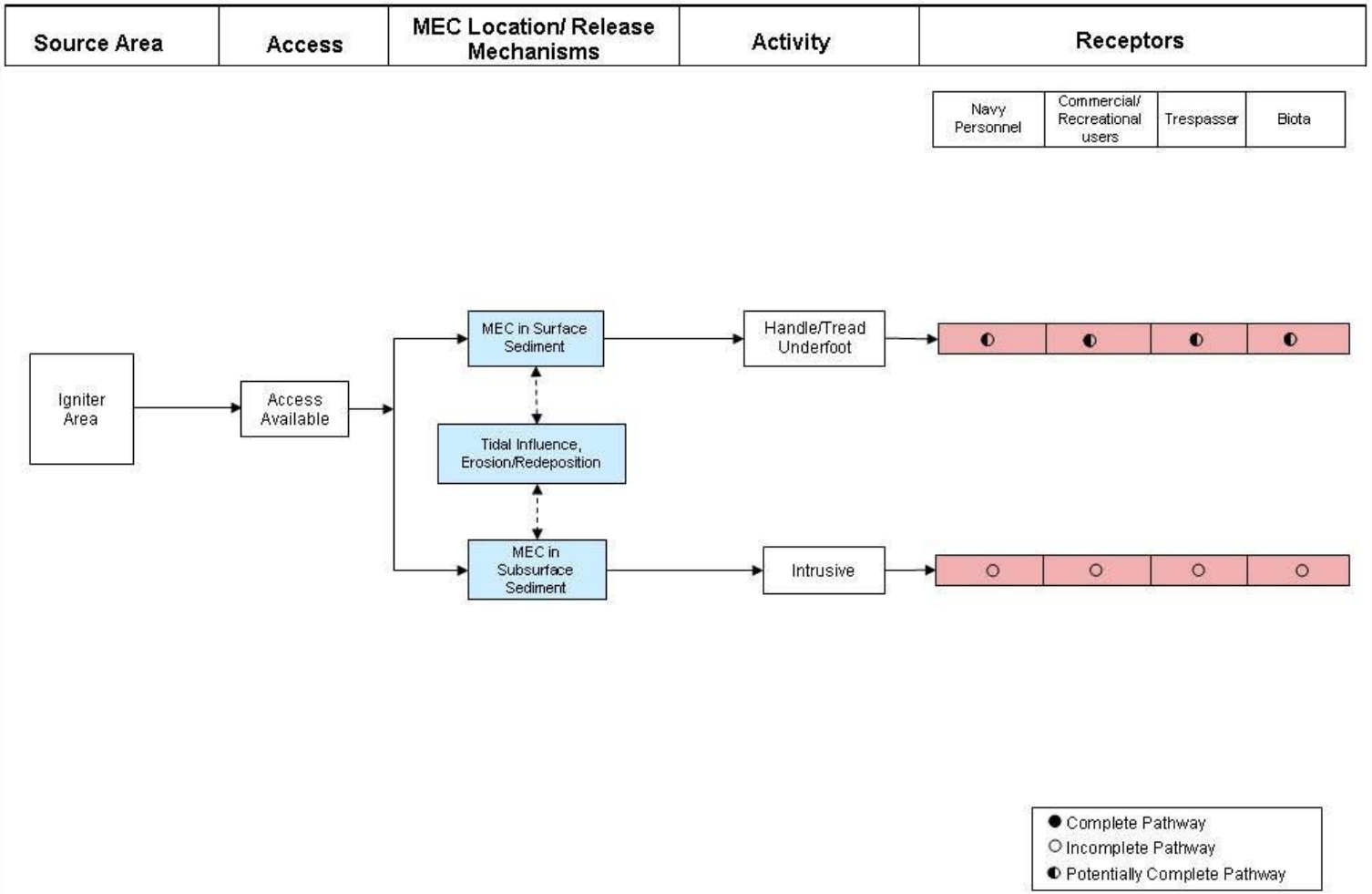


FIGURE 8-3
UXO 19 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.1-7 in the Water Area Munitions Study (Malcolm Pirnie 2005)

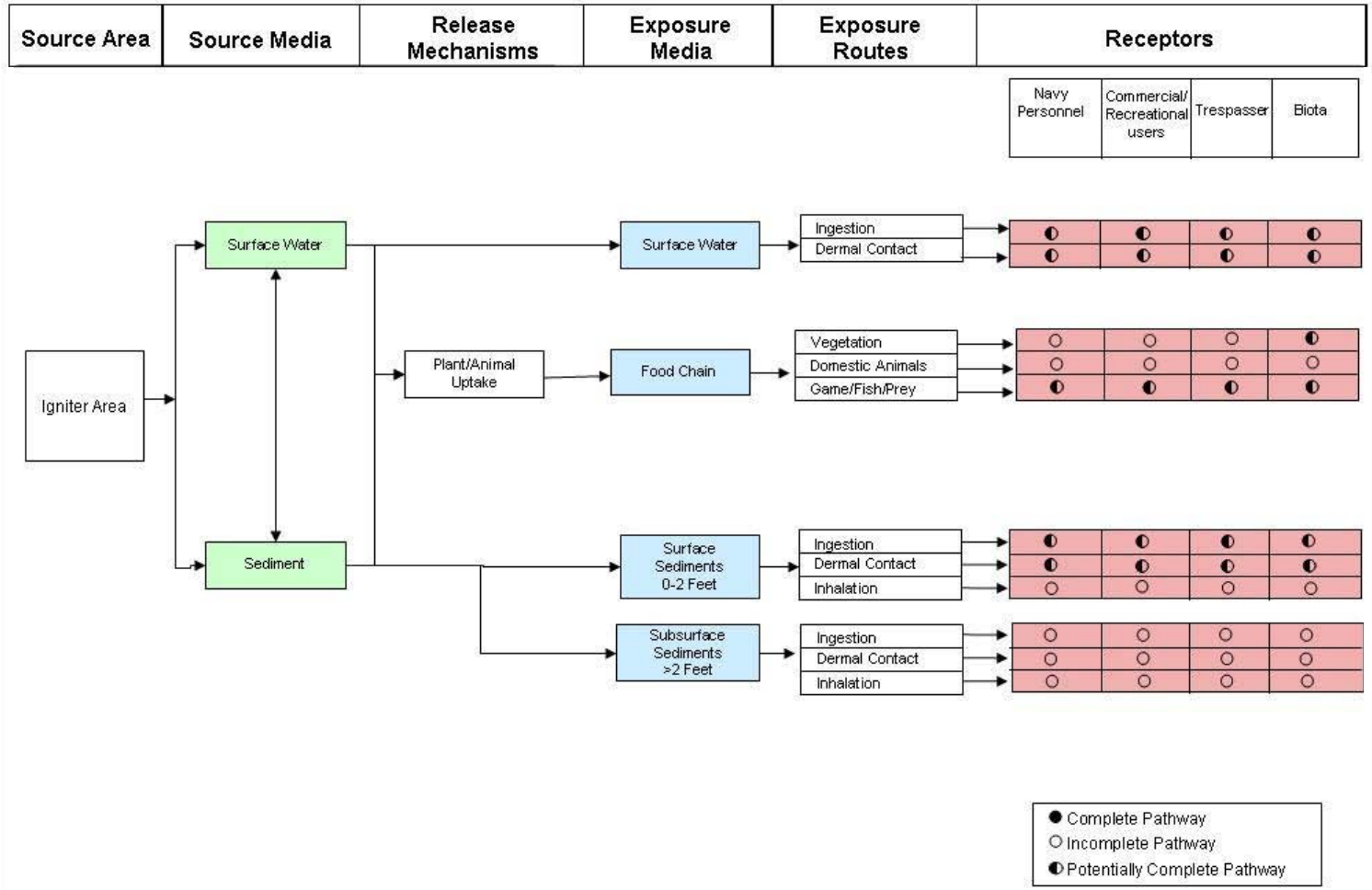


FIGURE 8-4
UXO 19 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.1-8 in the Water Area Munitions Study (Malcolm Pirnie 2005)

Photo 8-1: UXO 19 – General view of the site. View is to the east. Photo was taken from the top of demolished Building 1451 foundation. Mattawoman Creek is to the left and top. Photo was taken on 11/25/08.

SECTION 9

UXO 20 – Safety Thermal Treatment Point

9.1 Site Background

UXO 20 is a 1.6-acre site at the end of Old Burn Point Way on a peninsula that extends southwest from the Main Installation into the confluence of the Mattawoman Creek and the Potomac River (Figure 1-1). According to the IAS, the STTP is a man-made peninsula constructed of sand, fill material, rocket motor casings, empty cartridges, and coal fly ash. The PA reported an active test point that uses a maximum of 100 pounds of 1.1 explosive, which translates to a fragmentation distance of 5,362 feet, north of the STTP site on the same peninsula. This potential fragmentation zone fully encompasses the site. At the time of the PA, testing occurred within enclosed chambers, but explosives testing outside of the chamber was being proposed.

After abandoning the original burning ground in 1942, OB of waste pyrotechnics and single-base, double-base, and composite propellants was performed. Initially, the STTP was set up for two separate uses: (1) the primary burn area, located from the tip of the peninsula and the area 150 feet inland, used for OB of munitions; and (2) the secondary burn area, used for munitions testing, which included deflagration-to-detonation testing and pierce testing. From 1942 to 1988, OB occurred at the site on a weekly basis. Until the 1950s, several types of propellants, including water or solvent wet wastes, were burned at the STTP at a rate of 40 to 50 pounds per week. The burning of up to 25,000 pounds per year of less-sensitive explosives, other pyrotechnics, and difficult-to-burn ordnance materials continued through 1988. Additionally, the STTP was used for the open burning/ open detonation (OB/OD) of projectiles, cartridge-activated devices/ propellant-actuated devices, primers, less-sensitive explosives, high explosives, and other pyrotechnics using in-ground pits. Although ejected materials occasionally left the OB area, most ordnance items would not have penetrated the ground because no firing of munitions occurred.

According to Base personnel, all material was burned directly on the ground when the STTP was first constructed. Scrap propellants were put in pits in the ground and ignited. New soil would be brought in periodically as needed. Onsite burn pans were added in 1980. In a few instances, the steel deflection shield was not able to prevent ejected materials from leaving the area. These incidences were caused primarily by burning NG solvents or plastic- bonded explosives in bulk form.

The IAS (Fred Hart, 1982) reports that sometime in the late 1970s, 5 gallons of waste solvents were spilled on the STTP, reaching surface water. In addition, it was reported that during the same time period, metal items from the site were occasionally ejected into Mattawoman Creek and the Potomac River during OB.

The STTP was previously designated as Solid Waste Management Unit 20 under the installation's Resource Conservation and Recovery Act program. In 1993, a study was conducted at the STTP to evaluate whether a clean closure of the range was feasible under the Resource Conservation and Recovery Act. As part of this site characterization, soil and

groundwater samples were collected. The investigation concluded that the detected concentrations of explosives and metals within the soil and groundwater were at levels that would prohibit closure without further action. Soil and groundwater samples contained elevated levels of metals, explosives, volatiles, and semivolatiles when compared to background samples.

Several objects were observed during a June 2003 visual survey of the STTP as part of the PA. These objects included a large, cylindrical steel unit, which was identified as the former burn tank in the primary burn area, as well as a steel deflection screen and miscellaneous explosives testing equipment. On November 25, 2008, the Navy and CH2M HILL conducted a site visit and observed the same items documented in the PA as well as a free-standing metal frame and a steel deflection screen (Photo 9-1). The same observation was made during the April 22, 2009 site visit CH2M HILL made with the Navy, EPA, MDE, and Navy historian Jim Dolph. Appendix G provides photographs of site conditions taken as part of the SI.

9.2 Rationale and Objective

UXO 20 has been used for OB/OD of waste pyrotechnics, solvents, projectiles, cartridge-activated devices / propellant-actuated devices; primers, less-sensitive explosives, high explosives, and single-base, double-base, and composite propellants, according to historical evidence and site personnel interviews. Because facility activities may have resulted in munitions being released into the environment, an SI was recommended for MEC and an RI for MC in the PA.

The objective of the SI was to determine the presence or absence of MEC at UXO 20 through DGM in 2.59 acres of the site. This area was expanded based on visual observations of items at the site during the November 2008 and April 2009 visits. An aerial photographic analysis was performed to identify past activities at the site.

9.3 Aerial Photographic Analysis

Historical aerial photographs from 1943 to 1981 were reviewed (Appendix A). In a June 1943 photograph an access road led to a small peninsula along the shoreline, and this peninsula was expanded by October. In a 1950 photograph, four stained areas were visible on the peninsula. A 1951 photo shows a large rectangular stained area near the center of the peninsula, and what was likely an open vertical tank on the north end. In a 1952 photo, another stained area is visible on the south end of the peninsula, and in a 1954 photo a rectangular light-toned area was also in evidence there; multi-toned material appeared in photos dating from 1956 to 1964, and an evidence of an explosion was visible in a 1961 photo. In photographs from 1972 through 1981, dark-toned material was visible at the southern end of the peninsula. In a 1972 photo, an open tank and a vertical open tank are visible at the north end of the site; the vertical tank remained in photos through 1981.

9.4 Field Activities

Fieldwork in support of DGM would have consisted of vegetation clearing in about 1 acre of the 2.59 acres, surface metal removal for staging within 100 yards of the site for disposal as scrap metal, and DGM over 2.59 acres of the site. Before field activities started, an Explosive

Safety Determination Request (ESSDR) was submitted to NOSSA for approval. An ESSDR was deemed appropriate for this fieldwork because there would be no intrusive activities. NOSSA's response was that because the items may be contaminated with explosives, equipment that would come in contact with these items would present explosive conditions; so an ESS was warranted. Appendix G provides photographs of site conditions taken as part of this SI.

Deviation from the MEC Work Plan

Field activities in support of a DGM were not performed because NOSSA would only allow work to be done under an ESS.

9.5 Conceptual Site Model

The CSM for UXO 20 was presented in Section 5.4.11 of the PA, and is summarized here. Historical use indicates that MEC may be present in the surface soil at the site. CSMs for MEC and MC are shown as Figures 9-1 and 9-2, respectively. As shown on Figure 9-1, a potentially complete exposure pathway exists for MEC in the subsurface and surface soil. Potential receptors include both human and ecological receptors. Exposure routes include direct contact through handle/tread underfoot as well as intrusive activities such as excavation.

As shown on Figure 9-2, soil and surface water/sediments affected by MC represent a primary source medium. The site is currently vacant; however, an active test point in located on the northern portion of the peninsula, and the potential fragmentation zone may extend over the site. Current activities at the site include light ground maintenance. Based on the current site use, potential current human receptors include Navy personnel (military and civil servants), trespassers, visitors, maintenance workers, contractors, and recreational users. Future site use is not expected to change significantly from current site use; therefore, potential future receptors include current receptors and construction/utility workers who may perform any future construction projects at the site. Additionally, although unlikely, future residents are considered a worst-case future scenario when considering unrestricted future site use.

Potentially complete exposure pathways exist for surface soil, surface water and sediments for all human and ecological receptors. Exposure routes include direct contact, ingestion, and inhalation. Direct human or biota contact with subsurface soil is possible if the soil is disturbed through excavation or drilling activities, creating possible migration routes/ mechanisms for constituent-affected soils. Direct human or biota contact with surface soil may also be possible. The food chain also represents an exposure medium through plant/animal uptake for biota (including game such as deer and wild turkey). Hunting is permitted near to the range during certain periods of the year and by permit only. Because Since the area is partially located on a wetland area there are also potential pathways for ecological ingestion by biota on range, and dermal contact with surface water/sediments for both human and ecological receptors.

Precipitation infiltration may provide for contaminant mobility into the subsurface soil and into the shallow or surficial groundwater aquifer, which is assumed to be connected to Mattawoman Creek. Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in

shallow groundwater for human receptors and for ecological receptors after discharge to Mattawoman Creek.. Potential receptors for the groundwater include construction/utility workers during excavation activities, and in the unlikely event the groundwater is used as a potable water supply, future residents and/or site workers.

9.6 Recommendations

The PA recommended an SI for MEC and an RI for MC. An RI is recommended for MEC and MC (in soil and groundwater) at UXO 20.

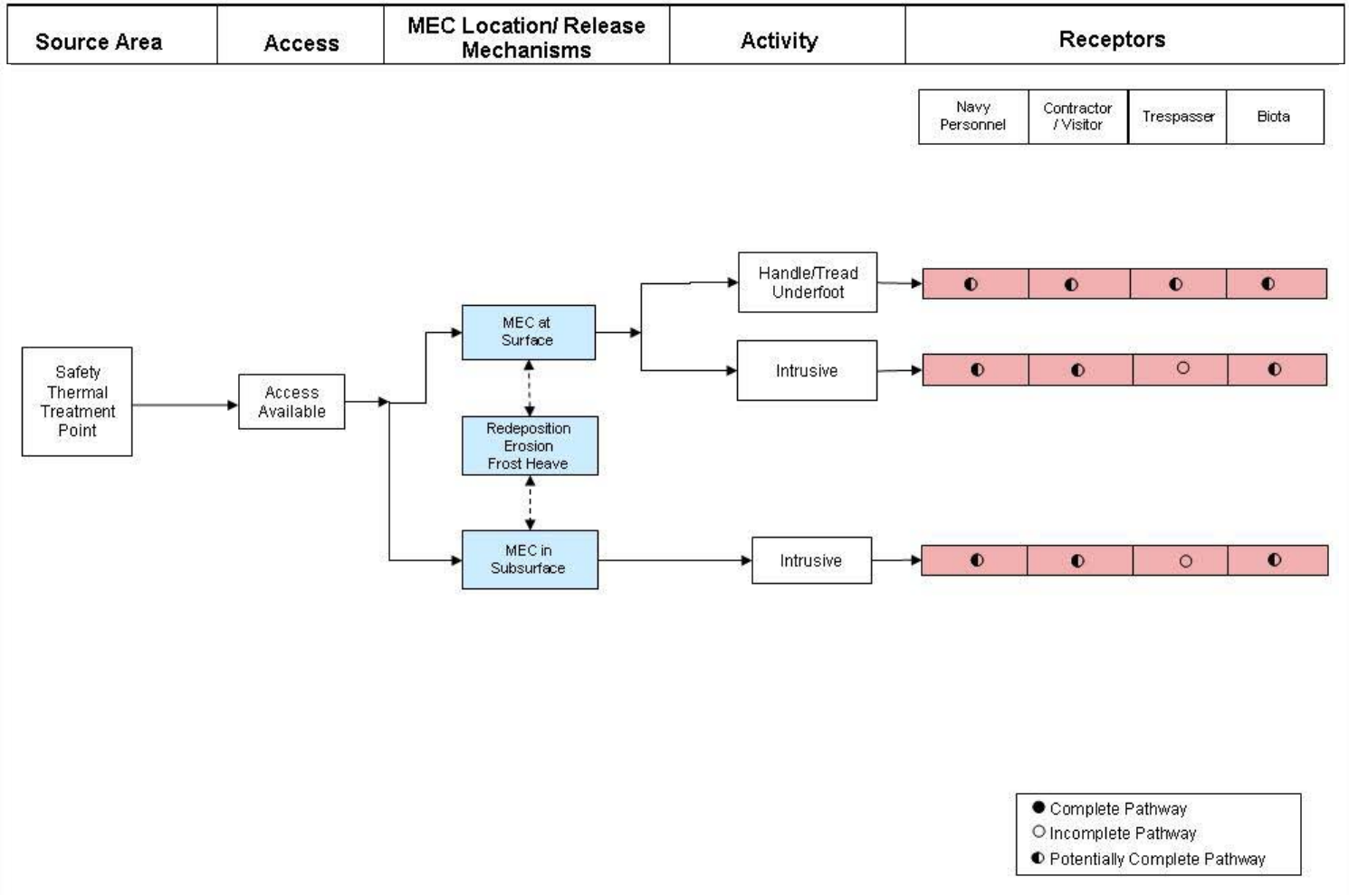


FIGURE 9-1
UXO 20 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.4-6 in the Preliminary Assessment (Malcolm Pirnie 2005)

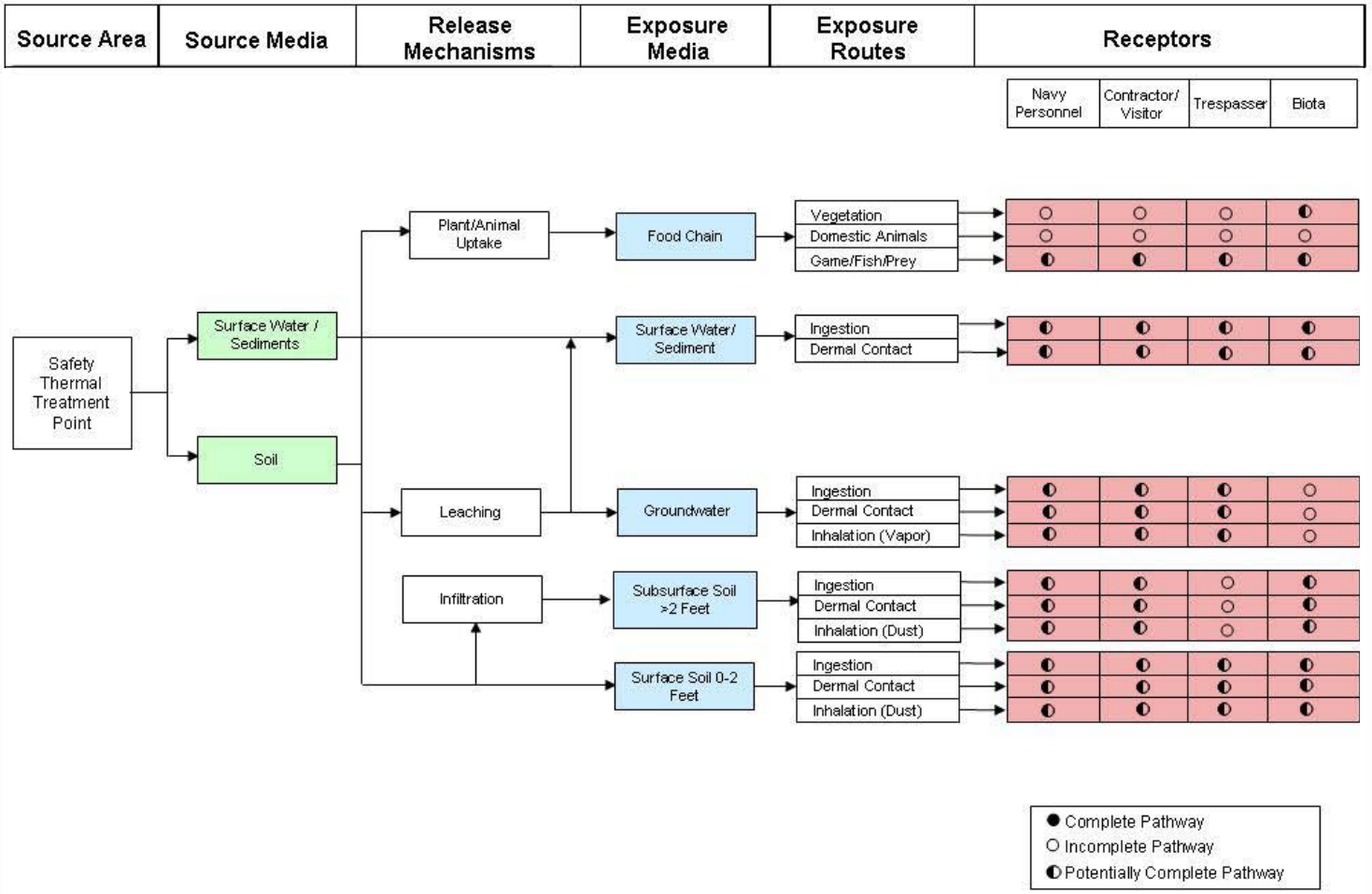


FIGURE 9-2
UXO 20 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.4-7 in the Preliminary Assessment (Malcolm Pirnie 2005)

Photo 9-1: UXO 20 - General view of the site. View is to the north. It shows a grassy foreground (bare in some areas) with MEC items in the background. Photo was taken on 11/25/08.

SECTION 10

UXO 27 – Sonar Training Area

10.1 Site Background

UXO 27 is a 2.1-acre site, of which approximately 1.5 acres lies within the Potomac River and 0.6 acre is on the adjacent shoreline of the Stump Neck Annex (Figure 1-2 and Photo 10-1). It is encompassed within the boundaries of UXO 33 - Water Impact Area. The WAMS reported that this site was used for sonar training by Navy divers during the 1980s to mid 1990s. During the training, inert munitions items were submerged just offshore so divers could train in underwater ordnance identification. One torpedo casing, one underwater mine casing, and one bomb casing were visible at low tide approximately 75 feet from the water's edge, and it is not known if the items were inert ordnance associated with sonar training. The water portion of the site is currently a recreational waterway, and the land portion is undeveloped. Because potentially non-inert ordnance items have been observed at the site, munitions may be present. As part of the WAMS, a visual survey of UXO 27 was conducted on June 2, 2004. Only a minimal portion of UXO 27 was visible from the shoreline. The visual survey revealed no evidence of munitions at the site.

On November 25, 2008, the Navy and CH2M HILL conducted a site visit. The exact location of the site could not be determined. Based on conversations between CH2M HILL's senior munitions consultant with a former EOD person, and input from the Navy historian, it was speculated that the site may be off the Dive Locker Pier, less than a mile to the west of UXO 27.

10.2 Rationale and Objective

Because of the historical use of the site, the WAMS recommended an SI for MEC and no further action for MC. The objective of the SI was to determine the presence or absence of MEC at UXO 27. The exact location, however, was not identified during the WAMS, so two locations were investigated during this SI using water DGM. The first location is the 1.5 acres of the original location in the WAMS that lies within the Potomac River (herein referred to as UXO 27), and the second location is the area referred as the Dive Locker Pier. Figure 10-1 shows the locations of both areas. An aerial photographic analysis was performed to identify past activities at the site.

10.3 Aerial Photographic Analysis

Historical aerial photographs from 1943 to 1981 were reviewed (Appendix A). Photos from 1943 to 1957 show a boat house and building present at the pier; the boat house was expanded between 1956 and 1957. A boat house was also shown east of the pier in a 1961 photo, along with a boat, and two dark-toned objects were visible in the river west of the pier in photos through 1964. A rectangular structure was located along the shoreline east of the pier, which featured a ship and other vessels in a 1964 photo. A photo from 1972 showed

that the boat house near the pier was no longer in evidence, and an access road leading to a cleared area along the shoreline east of the pier was shown in photos up through 1981.

10.4 Field Activities

Field activities for water DGM at both areas started on April 15, 2010 and were completed on April 18, 2010. Shallow marine bathymetry and side-scan sonar surveys were conducted over approximately 8 acres (5.1 acres at UXO 27 and 2.98 acres at the Dive Locker Pier) by an ARM field team consisting of two field geophysicists along with a marine scientist from Aqua Survey, Inc. (subcontracted to ARM). From April 15 to April 18, 2010, the shallow marine DGM survey was conducted using a TVG marine magnetometer system with RTK-GPS positioning. The coverage maps for UXO 27 and the Dive Locker Pier are provided in Figure 10-2 and Figure 10-3, respectively. A detailed description of the work performed is provided in the Geophysical Report (Appendix B).

Data acquisition was conducted in two phases: the first phase consisted of a bathymetry and side-scan sonar survey to characterize the site conditions of the river bed, and the second phase consisted of a magnetometer survey to determine the presence of ferrous anomalies. At the Dive Locker Pier, approximately 2.98 acres of data were collected adjacent to the northern end of the pier. Data were not collected on the western or eastern sides of the pier because of a number of factors, including: Access restrictions associated with Department of Defense operations on the western side of the pier; limited maneuverability of the tow vessel and tow-fish between the eastern side of the pier and pilings/breakwater; and equipment safety of operating the tow-fish close to the existing pier, pilings, and other structures.

Following collection of the data, an extensive QC program was applied to the DGM operations at both areas. The geophysical system was field-tested as indicated in the MEC Work Plan. Both ARM and CH2M HILL performed QC of geophysical data and data deliverables. The CH2M HILL QC geophysicist confirmed that all DQOs outlined in the work plan were met during the DGM survey. All tests outlined in the MEC Work Plan were performed on the DGM instruments at the appropriate intervals (e.g., daily, at start of project), and results were checked by ARM's QC geophysicist prior to delivery to CH2M HILL and subsequently checked by CH2M HILL geophysicists.

10.5 Results

Following data processing as described in the Geophysical Report, UXO 27 has a total of 277 individual anomalies over the 5.1-acre area. Of these, 143 individual anomalies were identified in the approximately 1.7 acres of the designated grid boundary and 134 anomalies were identified outside of the grid boundary. This resulted in a target density of approximately 51 and 87 anomalies per acre in the 5.1-acre area (overall surveyed area) and 1.7-acre area (designated grid boundary), respectively. Attachment F in Appendix B provides figures that show the locations of the anomalies.

The Dive Locker Pier had a total of 245 individual anomalies, of which 75 anomalies were located within 4 anomaly polygons, in the approximately 3-acre area where data were collected. This resulted in a target density of approximately 84 anomalies per acre. Attachment F in Appendix B provides figures that show the locations of the anomalies.

10.6 Conceptual Site Model

The CSM for the UXO 27 was presented in Section 6.2.11 of the WAMS, and is summarized here and updated if necessary. CSMs for MEC and MC are shown as Figures 10-4 and 10-5, respectively. As shown on Figure 10-4, potential receptors include both human (Navy personnel (military and civilian), commercial/recreational user, and trespasser) and ecological receptors (biota) that may contact the source medium. Human receptors such as Navy personnel (military and civilian), commercial/recreational user or trespassers could disturb MEC at the sediment surface through recreational activities such as wading and fishing. Activities, such as physical contact with sediments, could also affect biota.

The pathways for MEC in the subsurface are incomplete for all receptors because no intrusive activities, such as river dredging, are anticipated in the site. MEC could, however, be transported to surface sediment by the tides, water currents, erosion/redeposition, and relocation during heavy rains and storm surges.

As shown on Figure 10-5, the site is currently used for recreational activities, including fishing and boating. Potential receptors include both human (Navy personnel (military and civilian), commercial/recreational user, and trespasser) and ecological receptors (biota) that may contact the source medium or other media at the site that may be affected. Potential receptors may potentially ingest or come into physical contact with surface water at the site. Biota can potentially ingest or come into physical contact with affected surface water. Human receptors have the potential for physical contact and ingestion of affected water through recreational activities such as wading or fishing.

A potentially complete pathway is indicated for biota exposed to MC at the site via the food chain. MC may be taken up by plants and benthic organisms and transferred through the food chain to feeding biota. There are no domestic animals on or near the former range, so the domestic animal exposure pathway is considered incomplete for all receptors. Fishing is known to occur on Potomac River; therefore, fish provide a potentially complete pathway for all receptors.

Human and ecological receptors could potentially be affected by MC at the sediment surface through ingestion or dermal contact. Human receptors such as Navy personnel (military and civilian), commercial/recreational user or trespassers could contact MC through recreational activities such as wading and fishing. Activities, such as physical contact with and ingestion of sediments, could also affect biota. The ingestion and dermal contact pathways for MC in the subsurface are incomplete for all receptors because no intrusive activities, such as river dredging, are anticipated in the Sonar Training Area. MC could, however, be transported to surface water by the tides, water currents, erosion/redeposition, and relocation during heavy rains and storm surges.

10.7 Conclusions and Recommendation

The WAMS recommended an SI for MEC and no further action for MC. The marine DGM results for UXO 27 and the Dive Locker Pier identified 277 and 245 anomalies, respectively. This indicates that ferrous metals are present in these areas in the Potomac River.

Because of the potential for MEC to be present, it is recommended that institutional controls should be implemented; existing Danger Zone on NOAA maps should be expanded to include the potential areas from UXO 27 and the Dive Locker Pier. In addition, the Danger Zone regulations should be updated to reflect the current site use and to restrict intrusive activities (such as anchoring or dredging) into the underlying sediments unless UXO avoidance procedures are performed first.

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 10-1 - UXO27 AND DIVE LOCKER PIER LOCATIONS.MXD BHATHAWA 8/6/2010 14:08:04

Legend
Approximate Site Boundary

N

0 150 300 Feet

1 inch = 300 feet

Figure 10-1
UXO 27 and Dive Locker Pier Locations
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

Grid Boundary

Grid Corner

25 Anomaly Number

Obstacle / Man-Made Feature

Polygon Anomaly

Interpreted Anomaly - Class 1

Interpreted Anomaly - Class 2

N

Analytic Signal (TMI)

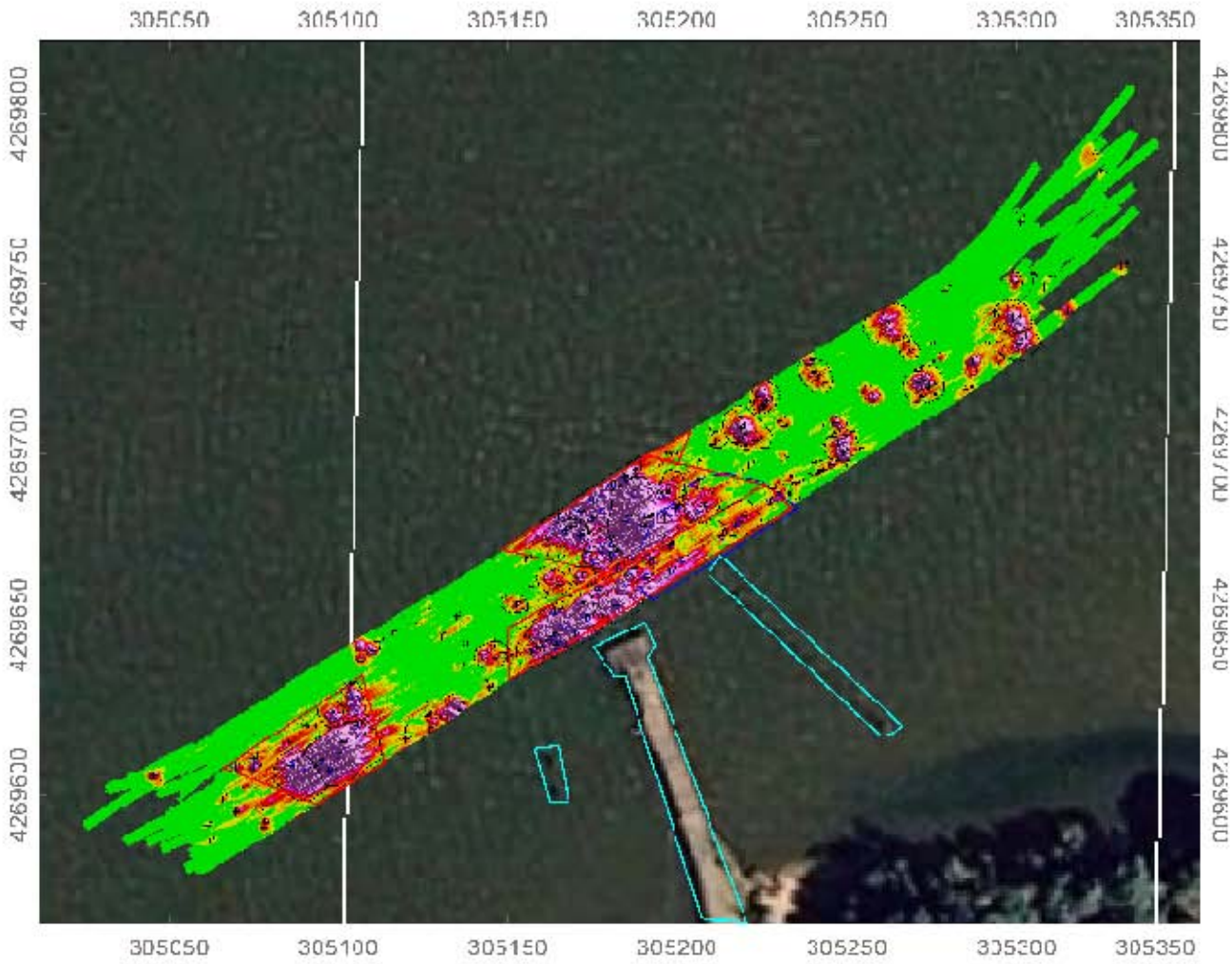
nT/m

-70 -37 -26 -19 -12 -6 -2 1 4 6 9 12 16 21 26 33 42 58

Figure 10-2
UXO 27 - DGM Coverage Map
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Note:
Figure is taken from the Geophysical Survey Report (ARM 2010), which is provided as Appendix B.

CH2MHILL



Anomaly Outline (Approx.)
Influence of Metal Bollards (Approx.)
25 Anomaly Number
Obstacle / Man-Made Feature
Polygon Anomaly
Interpreted Anomaly - Class 1 (From TFAS)
Interpreted Anomaly - Class 3 (From TFAS)

Analytic Signal (TMI)
nT/m
-70 -37 -26 -19 -12 -6 -2 1 4 5 8 12 15 21 26 33 42 58

Figure 10-3
Dive Locker Pier - DGM Coverage Map
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Note:
Figure is taken from the Geophysical Survey Report (ARM 2010), which is provided as Appendix B.

CH2MHILL

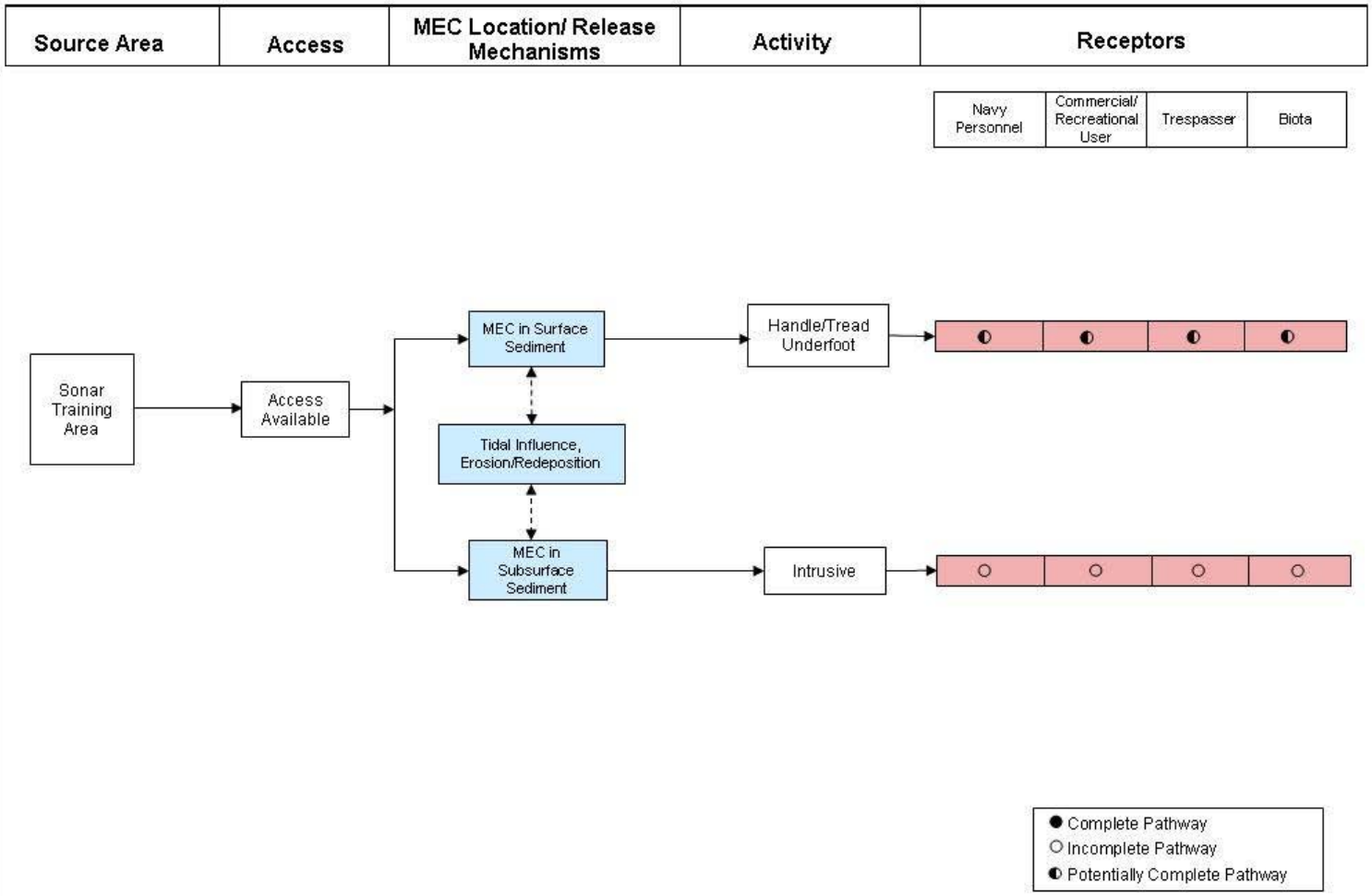


FIGURE 10-4
UXO 27 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 6.2-2 in the Water Area Munitions Study (Malcolm Pirnie 2005)

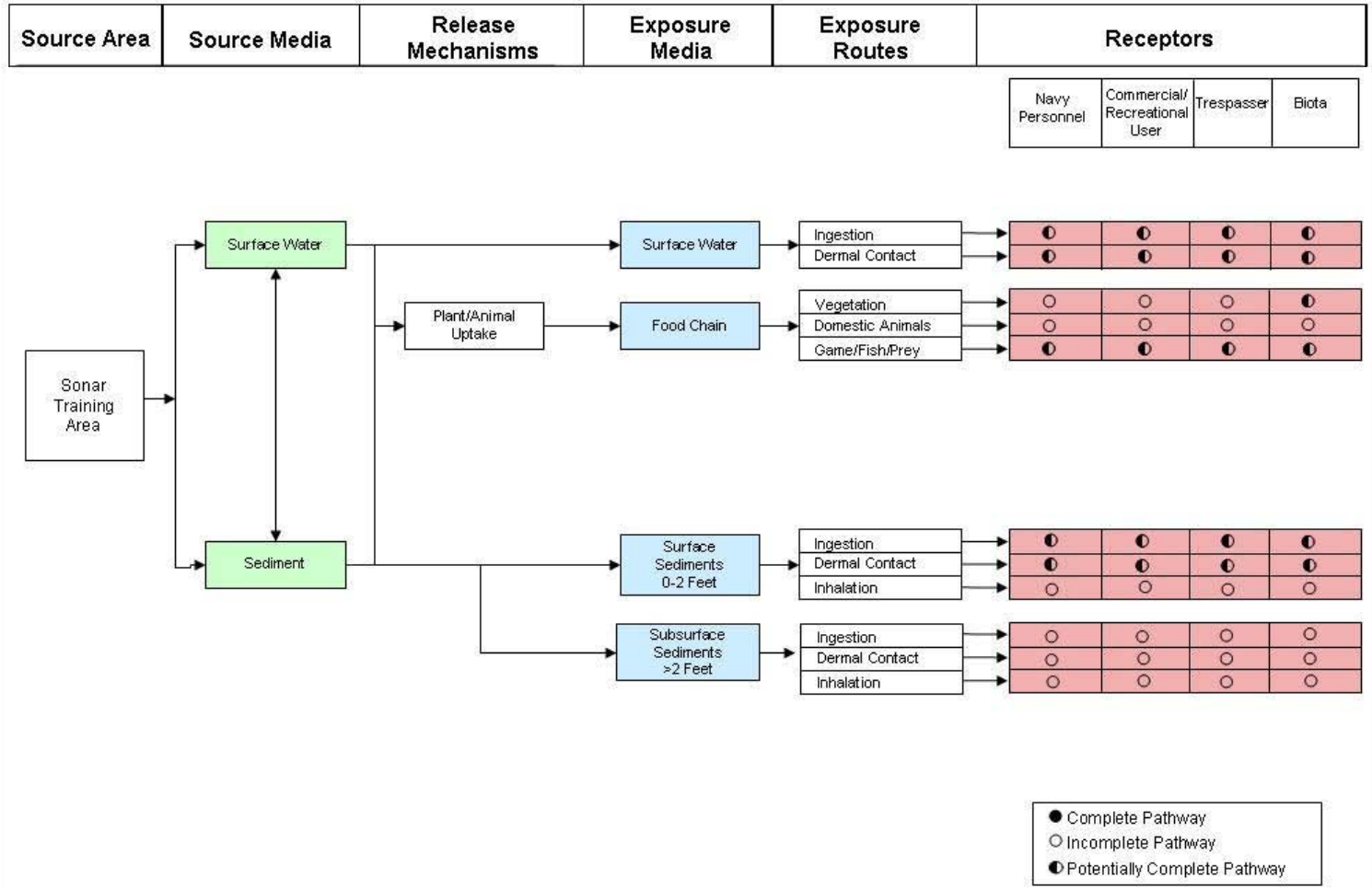


FIGURE 10-5
UXO 27 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 6.2-3 in the Water Area Munitions Study (Malcolm Pirnie 2005)

Photo 10-1: UXO 27 – General view of the site. View is to the southeast from the Potomac River. Photo was taken on 4/18/10.

SECTION 11

UXO 29 – Southwestern Pistol Range

11.1 Site Background

UXO 29 is a 1.26-acre site at the western end of the Main Installation (Figure 1-1). It lies within the estimated boundary of the firing fan from UXO 11 (The Valley) site. It was reportedly used for small arms training. The dates of use are unknown. It was identified on a 1942 installation map as a "target area" (Figure 11-1). A hill is located along the northeastern portion of the range, and the PA noted that shooting may have occurred into the hill. No information was found regarding the layout and orientation of the range. Detailed records of the types and quantities of small arms ammunition used at this range were not available during the PA. Based on the reported use of the site for small arms, the following small arms ammunitions were likely used: .22-cal, 9-mm, .45-cal, and .50-cal. A visual survey was conducted on June 2, 2004 as part of the PA. The area consists of a cleared grassy field surrounded by hardwood forest. It was noted in the PA that according to installation personnel, an osprey nest was seen adjacent to this site. The area is currently designated as a wildlife field.

On November 25, 2008, the Navy and CH2M HILL conducted a site visit. The exact location of the target area could not be determined. It is currently a large open grassy area with a hummocky terrain (Photo 11-1). The same observation was made during the April 22, 2009 site visit CH2M HILL made with the Navy, EPA, MDE, and Navy historian Jim Dolph. Appendix G provides photographs of site conditions taken as part of the SI.

11.2 Rationale and Objective

Based on the reported use of small arms for the site, the PA recommended NFA for MEC and an SI for MC. The specific objective of the SI at UXO 29 was to determine if metals and cyanide are present in surface soil. The objective would have been accomplished through the collection of surface soil from 10 locations.

During the April 22, 2009 site visit with by Navy, EPA, MDE, Navy historian Dolph), and CH2M HILL, Mr. Dolph presented information he had obtained from the National Archives. The information was presented in a desktop evaluation (DTE) technical memorandum (CH2M HILL, 2010c) with a proposed recommendation for the site. The information provided in the subsequent sections is taken from the DTE technical memorandum.

11.3 Desktop Evaluation and Results

According to Mr. Dolph, the target line at this site would have been parallel to the shoreline, indicating that the Navy would have been shooting towards the water rather than into the hillside in the opposite direction. It was initially assumed that the firing line would have been perpendicular to the shoreline and the target area would have been in front of the hillside. However, the map provided by Mr. Dolph showed the reverse (Figure 11-2). The

map shown on this figure is dated June 30, 1949. It is assumed that the firing range is shown on this map at a later date as a carry-over of features shown on previous maps. Mr. Dolph speculated that during the war, a target area would have been set up quickly for practice, which could have been used for about 3 years. Based on the aerial photograph that Mr. Dolph obtained, the land looked as though it had been severely graded, with no evidence of the pistol range (Figure 11-3). In that regard, it is unknown how much clean soil was placed on the surface. As a result, sampling is not considered to be necessary because the soil presently at the site will not be representative of past conditions. It is assumed that any soil sample that will be collected will be clean soil. The DTE recommended no further investigation for this site.

11.4 Conceptual Site Model

The CSM for UXO 29 was presented in Section 5.6.11 of the PA, and is summarized here and updated if necessary. Historical and visual evidence indicated that MEC are not present. Therefore, no complete exposure pathways exist for MEC. As a result, a CSM was not completed for MEC. The PA documented that MC may be present; therefore, potential MC exposure pathways do exist (Figure 11-4). Based on the results of this SI, the site has been regraded and as a result, exposure pathways no longer exist.

11.5 Recommendation

Based on IHIRT discussions on April 22, 2009, and the recommendation in the DTE, the IHIRT agreed to NFA for this site.

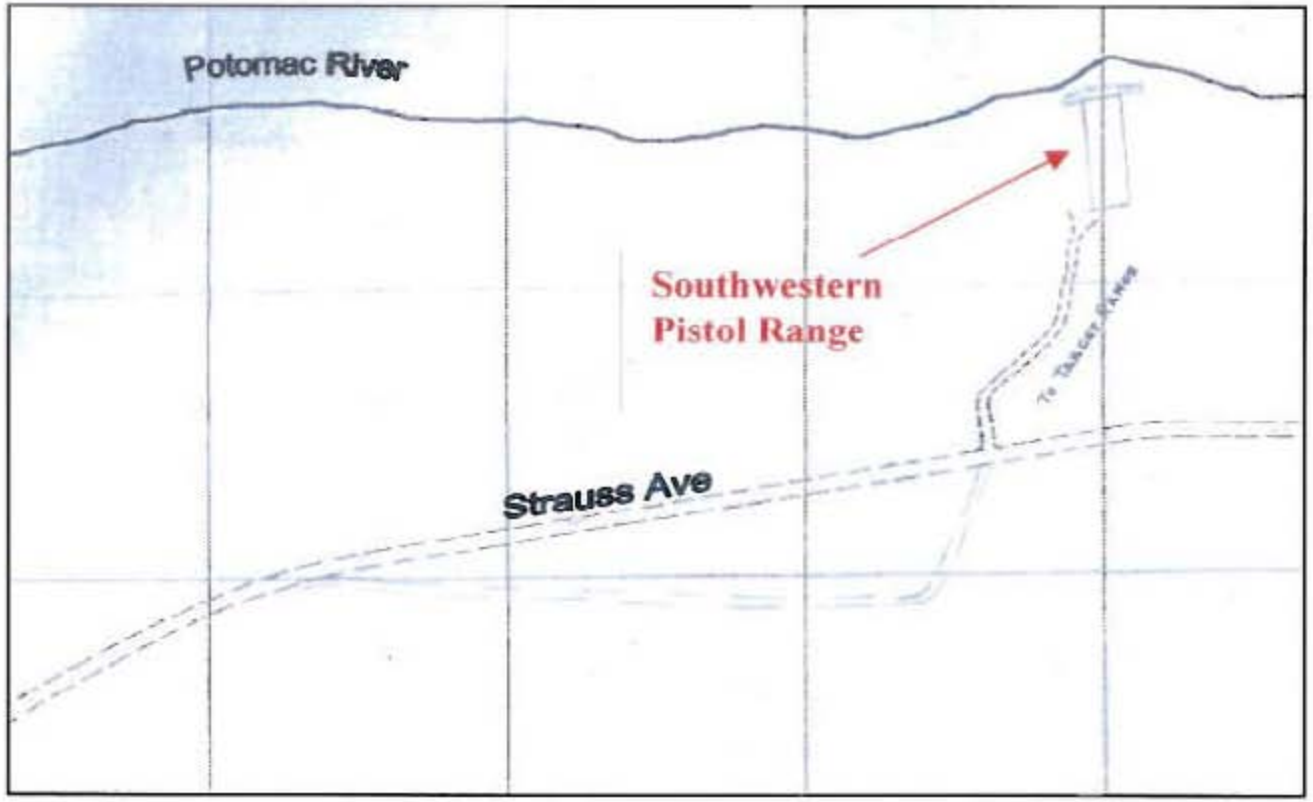


Figure 11-1
1942 Installation Map with Location of UXO 29
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 30, and 33
NSF-IH, Indian Head, Maryland

Note:
1) Figure is shown as Figure 5.6-1 in the Preliminary Assessment Report (Malcom Pirnie, 2005)

CH2MHILL

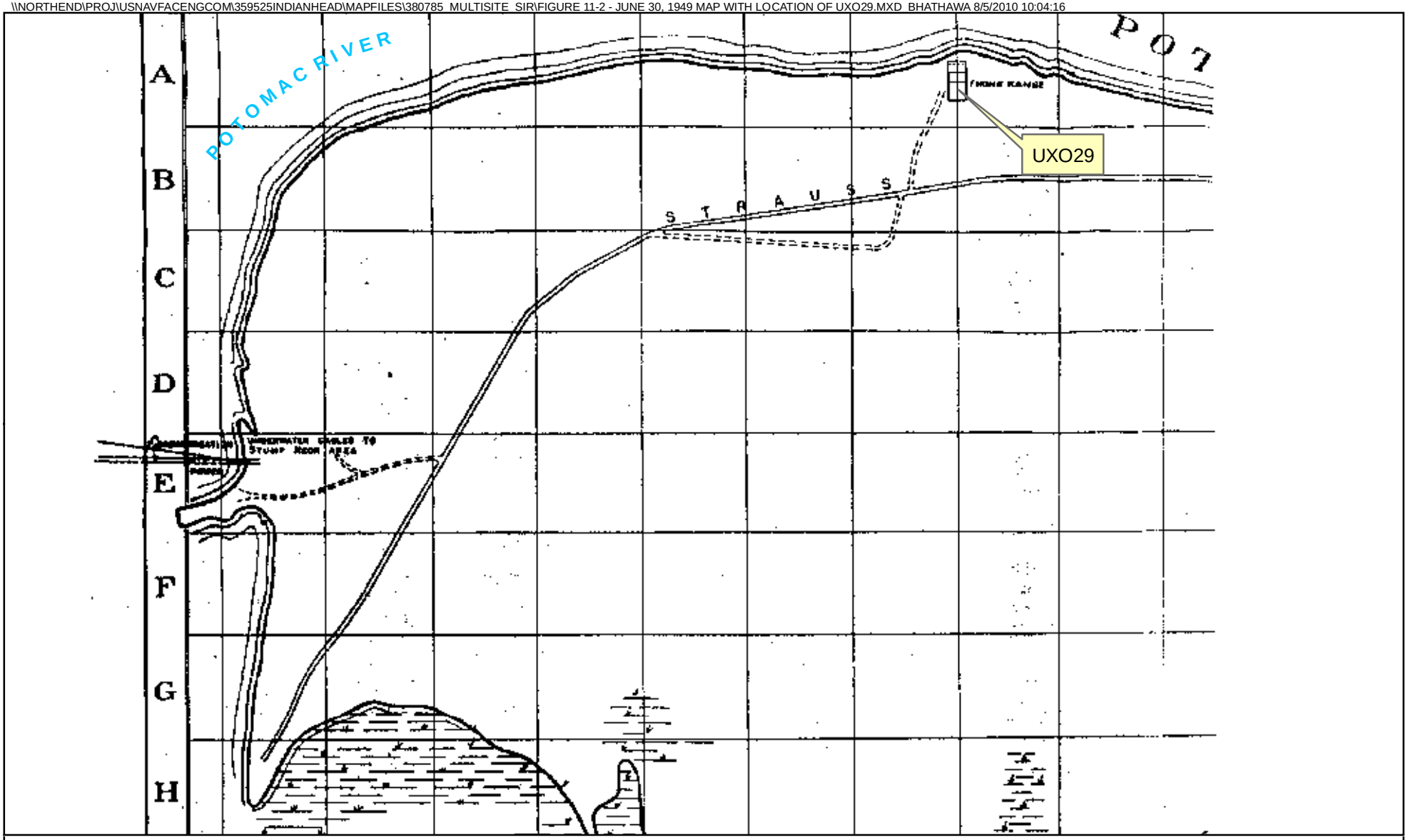
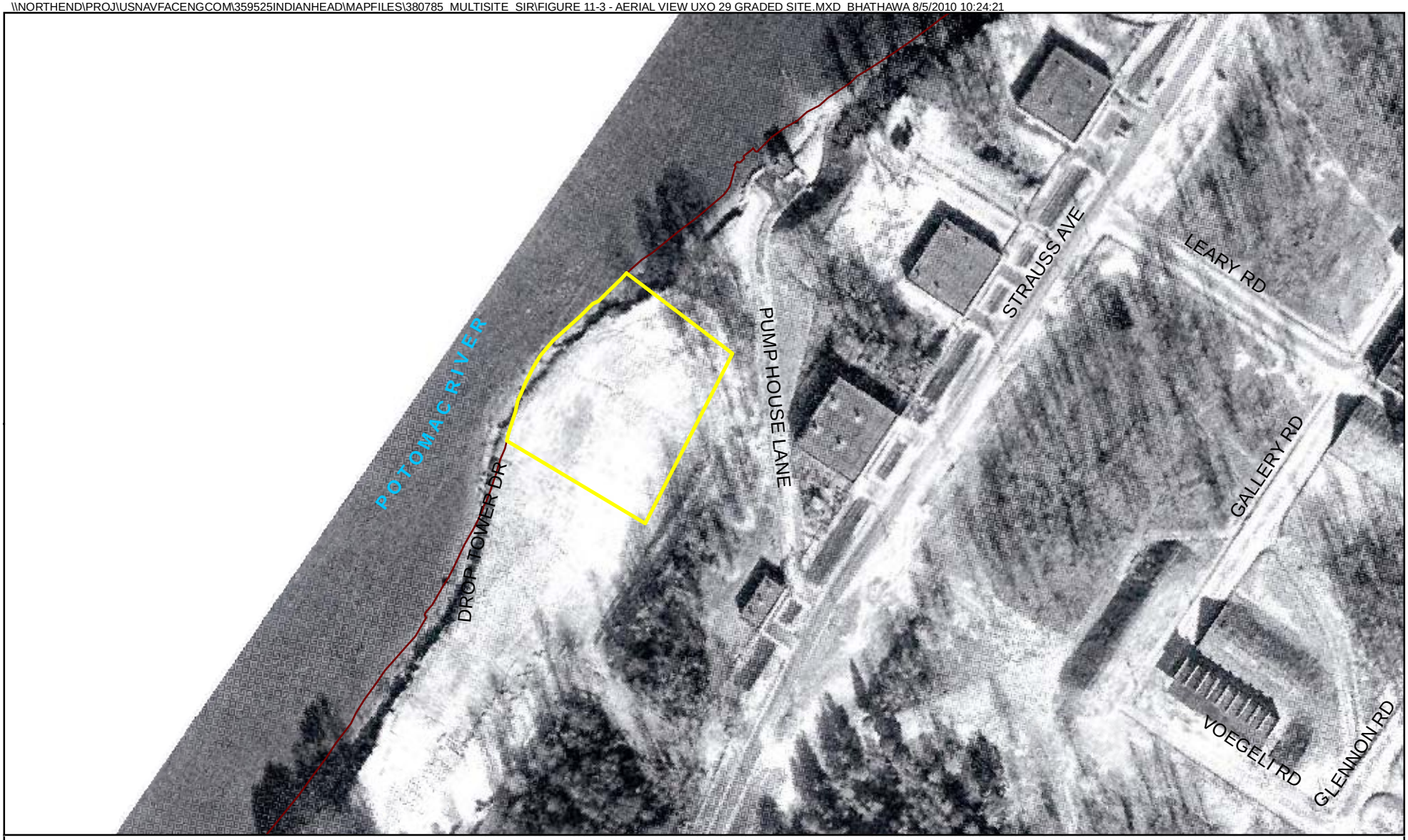


Figure 11-2
June 30, 1949 Map with Location of UXO 29
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 30, and 33
NSF-IH, Indian Head, Maryland

Note:
1) Figure is based on PRNC. Dwg. No. 26169, which is a map of Naval Powder Factory, Indian Head, MD. The map shows conditions on June 30, 1949.

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 11-3 - AERIAL VIEW UXO 29 GRADED SITE.MXD BHATHAWA 8/5/2010 10:24:21



Legend

Southwestern Pistol Range

Installation Boundary

Note:

1) Aerial photograph was provided to CH2M HILL by Mr. James Dolph with the Navy. The Date of the photograph is unkown.

2) Site boundary is from the Preliminary Assessment Report (Malcolm Pirnie, 2006)

N

0 100 200 Feet

1 inch = 200 feet

Figure 11-3
Aerial View UXO 29 Graded Site
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 30, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

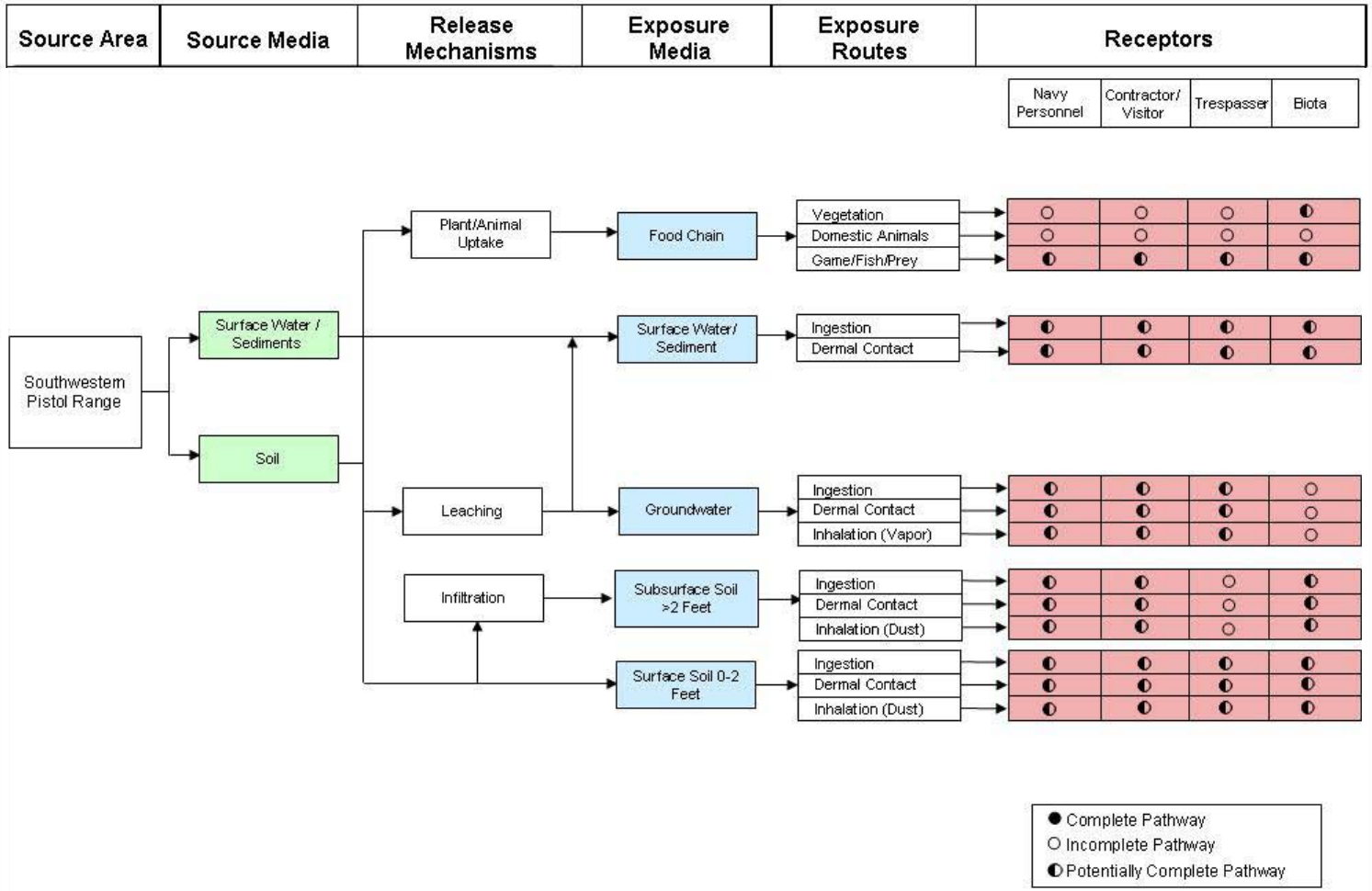


FIGURE 11-4
UXO 29 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.6-5 in the Preliminary Assessment (Malcolm Pirnie 2005)

Photo 11-1: UXO 29 – General view of the site. View is to the southwest. Terrain is grassy and hummocky. Potomac River is to the right and the hillside is to the left. Photo was taken on 11/25/08.

SECTION 12

UXO 30 – Gate 3 Burning Ground

12.1 Site Background

UXO 30 is on the western shoreline of the Main Installation along the shoreline of the Potomac River (Figure 1-1). The site covers approximately 0.23 acre (100 feet by 450 feet) and lies within the estimated firing fan from UXO 11 (The Valley), making it a suspected munitions area. It is reported in the PA that the site was a potential burning ground operating from 1955 to 1961. Explosives may have been brought to the site for burning; however, the types and quantities of explosives are unknown. Based on interviews conducted during the PA, burned munitions could have included flares, pyrotechnics, solid fuse boosters, bulk explosives, propellants, and small arms ammunition. A visual survey of the site was conducted on June 2, 2004 as part of the PA. Pieces of an old stove were observed, as well as evidence of burnt ground surface. However, the visual survey revealed no evidence of munitions at the site.

On November 25, 2008, the Navy and CH2M HILL conducted a site visit (Photo 12-1). The exact location of the site could not be determined. However, plastic bottles, empty drums, metal pipes and pieces, charred ground, and two structures that appear to have been associated with a gas line were observed. The same observation was made during the April 22, 2009 site visit CH2M HILL made with the Navy, EPA, MDE, and Navy historian Jim Dolph. Mr. Dolph presented aerial photographs of the site showing a barge that was moored in the water to the south of the site. It was mentioned that the location and tracking of the gas lines would likely lead to the shoreline because burning may have occurred on the barge. Based on the items observed at the site, Mr. Dolph and MDE observed that this could be the original landfill for NSF-IH.

12.2 Rationale and Objective

MEC burned at UXO 30 could have included flares, pyrotechnics, solid fuse boosters, bulk explosives, propellants, and small arms ammunition. UXO 30 is overlapped by the firing fan from UXO 11, so there is a potential for munitions associated with UXO 11 to be present at the UXO 30.

The objective of the SI is to determine the presence or absence of MEC and MC at UXO 30. The objective for MEC was accomplished through DGM of the entire site. The objective for MC was accomplished through the collection of surface soil, subsurface soil, and *in situ* grab groundwater to determine if PAHs, perchlorate, explosives (including nitroguanidine, nitrocellulose, and NG) and metals are present at concentrations that exceed the adjusted residential soil RSL for soil and adjusted tap water RSL for groundwater.

12.3 Aerial Photographic Analysis

Historical aerial photographs from 1937 to 1964 were reviewed (Appendix A). In a 1937 photo an access road is shown leading to a rectangular structure in the water, which

remained in place throughout the study period. Another access road leads to a ground-scarred and disturbed area to the north, which was revegetated by 1943 according to photos. A linear feature was visible in the disturbed area beginning in a 1943 photo, and remained until at least 1952, according to photos. A footpath visible in a 1944 photo was revegetated in a 1950 photo, and a guard house had been built by that time as well. A light-toned structure was present in a 1952 photo near the linear feature, and remained until 1957. Medium- and dark-toned materials were present at the end of the access road in a 1962 photo, and by 1964 the access road had revegetated.

12.4 Field Activities

Field activities at this site consisted of the following, in chronological order:

Stakeout of site boundary using GPS for DGM – Performed by CH2M HILL. Several of the points to the west of the site boundary were in the Potomac River; therefore, the shoreline was used as the west boundary line for the site.

Site boundary survey for DGM by licensed surveyor - Performed by Thoth on March 8, 2010.

Access road and land clearing – Performed by OER from March 9, 2010 through March 12, 2010. The site was cleared of brush and small trees, and non-MEC metal items were removed

Survey of buried seeds for DGM QC check – CH2M HILL buried the seeds at UXOs 11 and 30; Thoth surveyed the seeds from March 18 to 19, 2010.

DGM - Performed by ARM from March 30, 2010 to April 9, 2010.

Stakeout of MC sampling locations - Performed the Navy, MDE, and CH2M HILL on April 12, 2010.

Utility clearing - Performed by Accumark, Inc. on April 13, 2010.

DPT and MC sampling – Drilling services provided by Vironex and sampling conducted by CH2M HILL from April 14 to April 16, 2010.

All field activities were conducted under the supervision of CH2M HILL's UXO technician and/or engineer. Anomaly avoidance was implemented throughout field activities by the UXO technician. Appendix G provides photographs of site conditions taken as part of the SI.

12.4.1 DGM Survey

On April 6, 2010, a DGM survey was conducted in all accessible areas across the site. The coverage map for UXO 30 is provided in Figure 12-1. An extensive QC program was applied to the DGM operations at the site. The geophysical system was field-tested as described in the MEC Work Plan. Both ARM and CH2M HILL performed QC of geophysical data and data deliverables. The CH2M HILL QC geophysicist confirmed that all DQOs outlined in the MEC Work Plan were met during the DGM survey.

All tests outlined in the work plan were performed on the DGM instruments at the appropriate intervals (e.g., daily, at start of project) and results were checked by ARM's QC

geophysicist prior to delivery to CH2M HILL and subsequently checked by CH2M HILL geophysicists.

Two blind QC items were seeded within the investigation area. The QC items were used to validate the DGM subcontractor's ability to meet the project DQOs. The seed locations were checked by a UXO technician using a hand-held analog geophysical instrument to confirm that no existing geophysical anomalies were present at the seed location, and CH2M HILL personnel performed seeding using hand tools. Once placed, the locations of the seeded items were surveyed using an RTK GPS. Both QC items were detected and selected as point source anomalies during the DGM. A detailed description of the work performed is provided in the Geophysical Report.

12.4.2 Munitions Constituents

Figure 12-1 shows the sample locations. During the stakeout of the sample locations proposed in the UFP-SAP, some of the locations were adjusted based on site conditions. Five locations were marked outside and to the south of the site boundary along the pipe on the shoreline and in the pits. Two locations were placed outside and to the north of the site boundary because the site boundary is approximate and it was deemed reasonable to take sample outside of this approximated boundary. Five locations are within the approximate site boundary. All locations were surveyed at the time of stakeout with a GPS unit.

Field activities were conducted from April 14 to April 16, 2010. A total of 12 surface soil samples, 11 subsurface soil samples, and 3 *in situ* groundwater samples were collected. Samples were collected from 12 locations - ISUXO30-DP01 through ISUXO30-DP12 (Figure 12-2). The depth intervals for all media are shown on Table 2-1. The samples were placed in the appropriate sample jars, stored in coolers at 4°C, and shipped to Empirical Labs, LLC. The samples were analyzed for PAHs, perchlorate, explosives (including nitroguanidine, nitrocellulose, and NG), and metals, including mercury and cyanide (total for soil and groundwater, and dissolved for groundwater) (Table 2-1).

Utility clearance was conducted before fieldwork began. At each location, continuous soil Macro-Cores® were collected from ground surface until groundwater was encountered for subsurface lithologic description. The soil boring logs are provided in Appendix D. Though MEC were not anticipated, anomaly avoidance was performed by CH2M HILL's UXO technician before and during soil boring advancement at 1-foot intervals to the water table or until 10 feet bgs, whichever was encountered first.

Deviation from UFP-SAP

The following deviations occurred:

Several of the proposed sampling locations were adjusted in the field because of site conditions, such as tracking of gas lines, locations of pits, and identified charred/ denuded ground.

Twenty-four subsurface soil samples were proposed for collection from 12 locations - ISUXO30-DP01 through ISUXO30-DP12. No soil samples were collected from locations ISUXO30-DP04, ISUXO30-DP10, and ISUXO30-DP11 because of the shallow depth of the water table at these locations (approximately 1.5 feet bgs or less). A breakdown of the deviation by depth interval is provided below:

- Twelve samples were proposed from the first depth interval, which was from 0.5 foot to 2 feet bgs. Nine samples were collected, as shown on Table 2-1. Samples could not be collected from locations ISUXO30-DP04, ISUXO30-DP10, and ISUXO30-DP11 because of the shallow depth of the water table at these locations (approximately 1.5 feet bgs or less).
- Twelve samples were proposed from the second depth interval, which was proposed to be collected 1.5 feet above the water table. Two samples were collected from ISUXO30-DP06 and ISUXO30-DP09 (Table 2-1). Samples could not be collected from the other locations because of the shallow depth of the water table at these locations (approximately 5 feet bgs or less).

12.5 Geology and Hydrogeology

Based on the findings of the soil boring program, the site is underlain mostly by clay intermixed with clayey sand and silty sand down to approximately 20 feet bgs. Because the site is close to the Potomac River, it is assumed that groundwater flow follows the land topography and groundwater flow direction is towards the creek.

12.6 Results

12.6.1 Digital Geophysical Mapping

As described in for UXO 11, cultural features within the UXO 30 DGM area, such as walls, buildings, signs and power-line interference, may affect the data in the immediate vicinity of these features. Many of these cultural features can be seen in aerial photographs, as well as having been marked in the grid data sheets by the field crew.

UXO 30 contains high densities of subsurface anomalies, where individual anomalies are indistinguishable because of their proximity to neighboring anomalies. In these areas, polygon anomalies were created around the extent of the high EM response and are identified as “class 3” anomalies. Class 3 anomalies generally require additional analog “mag and dig” investigation to remove the high-density areas and then map discrete individual anomalies. Where possible, prominent individual peaks were identified within the polygon anomalies and identified as “class 2” anomalies. This allows the potential of a more directed future investigation within the “class 3”polygons. Standard individual anomalies are identified as “class 1” anomalies and are easily distinguishable as point-source targets.

A total of 122 individual (“class 1” and “class 2”) geophysical anomalies were identified in UXO-30, with an additional 4 polygon anomalies. Attachment F in Appendix B provides figures that show the locations of the anomalies. Although the DGM identified the locations of subsurface anomalies indicative of metallic material, the survey did not differentiate as to whether these anomalies are MEC or non-munitions-related metal debris.

12.6.2 Munitions Constituents

Analytical Results

Tables 12-1 through 12-3 present the raw data; detected constituents as shaded cells; exceedances of the RSLs in bold underlined font; the frequency of detection; and frequency

of exceedance for surface soil, subsurface soil, and *in situ* groundwater, respectively. Samples were collected from 12 locations - ISUXO30-DP01 through ISUXO30-DP12 (Figure12-1).

The data were evaluated according to the process described in Section 2.4. Soil data were screened against the adjusted residential soil RSL and groundwater was screened against the adjusted tap water RSL. Chemical concentrations in soil and groundwater that exceeded the RSLs were further evaluated by comparing the maximum detected concentrations to site background concentrations, where applicable. The nature and extent of constituents for soil and groundwater were evaluated based on exceedance of the RSLs and background concentrations.

Surface Soil

Table 12-1 presents the PAHs, explosives, and metals results for surface soil. Surface soil sample locations are shown on Figure 12-1. The spatial distribution of the compounds that exceeded the RSLs and background concentrations are shown on Figure 12-3.

PAHs

Several PAHs were detected at each sample location. Several of eight PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene) exceeded their RSLs at all locations except at ISUXO30-DP01. Except for dibenz(a,h)anthracene, which does not have a 95 percent UTL background concentration, the other compounds exceeded their respective 95 percent UTL background concentrations.

Explosives

Several explosives were detected at each location. Only 1,3-dinitrobenzene exceeded the RSL at three locations (ISUXO30-DP03, ISUXO30-DP05, and ISUXO30-DP07). This compound does not have a 95 percent UTL background concentration, so a comparison of the maximum detected concentration could not be made.

Metals

Several metals were detected at all locations. Three or more of seven metals (aluminum, arsenic, chromium, cobalt, iron, manganese, and vanadium) exceeded the RSLs at each location. Only iron and vanadium exceeded their respective 95 percent UTL background concentration.

Subsurface Soil

Table 12-2 presents the PAHs, explosives, and metals results for subsurface soil. Subsurface soil sample locations are shown on Figure 12-1. The spatial distribution of the compounds that exceeded the RSLs and background concentrations are shown on Figure 12 -3.

PAHs

Several PAHs were detected in all subsurface soil samples. One or more of six PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) exceeded their RSLs at each location except at ISUXO30-DP01 and ISUXO30-DP02. These RSL-exceeded compounds are the same as those detected in the surface soil samples, but at lower concentrations. There are no background values to compare the RSL-exceeded compounds. The two locations (ISUXO30-

DP06 and ISUXO30-DP09) where a second subsurface soil sample was collected showed a decrease in concentration from the first depth interval to the second depth interval.

Explosives

One or more explosive compounds were detected at each location. None of the detected explosive compounds exceeded their RSLs.

Metals

Several metals were detected at all locations. Three or more of seven metals (aluminum, arsenic, chromium, cobalt, iron, manganese, and vanadium) exceeded the RSLs at each location. These are the same compounds that exceeded the RSLs in surface soil. In the surface soil, iron and vanadium exceeded their respective 95 percent UTL background, but in the subsurface soil, none exceeded the background concentrations.

In Situ Groundwater

Table 12-3 presents the PAHs, explosives, and metals (total and dissolved) results for *in situ* groundwater samples collected from three locations (Figure 12-1). Figure 12-3 shows the concentrations of those compounds that exceeded the RSLs and 95 percent UTLs.

PAHs

Several PAHs were detected at ISUXO30-DP05 and ISUXO30-DP12, but none at ISUXO30-DP09. Five PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, and naphthalene) exceeded their RSLs. These compounds are similar to those that exceeded the RSLs in surface soil and subsurface soil (first depth interval; second depth interval was not collected because of shallow water depths). None of the RSL-exceeded constituents could be compared to the 95 percent UTL background concentration because there are no background levels for these compounds.

Explosives

As shown on Table 12-3, one or more explosives were detected at each location. One or more of four explosives – 2-nitrotoluene, nitrobenzene, NG, and RDX – exceeded the RSLs at two locations (ISUXO30-DP05 and ISUXO30-DP12); there are no exceedances at ISUXO30-DP09. At ISUXO30-DP12, only nitrobenzene (0.141J µg/L) exceeded the RSL (0.12 µg/L). Except for RDX, none of the RSL-exceeded constituents could be compared to the 95 percent UTL background concentration because there are no background levels for these compounds. RDX was detected only at ISUXO30-DP05 (2.3 µg/L); it exceeded both the RSL (0.61 µg/L) and the background concentration (1.2 µg/L).

Total Metals

Several metals were detected at all locations. Most of nine metals (aluminum, antimony, arsenic, chromium, cobalt, iron, lead, manganese, and nickel) exceeded the RSLs at each location. Locations ISUXO30-DP05 and ISUXO30-DP12 have more exceedances than location ISUXO30-DP09. For the most part, these compounds are similar to those detected in the soil samples.

Aluminum, chromium, cobalt, iron, and manganese have 95 percent UTL background concentrations, and antimony, arsenic, lead, and nickel do not have background concentrations. For compounds that have background concentrations, none of their maximum concentrations exceeded the background concentrations except cobalt at location ISUXO30-DP12.

Dissolved Metals

Several metals were detected at all locations. Four or more of 10 metals (aluminum, antimony, arsenic, chromium, cobalt, iron, lead, manganese, nickel, and vanadium) exceeded the RSLs at each location. Location ISUXO30-DP05 had more exceedances than locations ISUXO30-DP09 and ISUXO30-DP12. Again, these compounds are similar to those detected in the soil samples and total metals.

Aluminum, chromium, cobalt, iron, manganese, and vanadium have 95 percent UTL background concentrations, and antimony, arsenic, lead, and nickel do not. For those compounds with background concentrations, none of their maximum concentrations exceeded the background concentrations except cobalt at ISUXO30-DP12 and vanadium at ISUXO30-DP05.

Summary of Investigation Findings

Soil and groundwater samples were collected and analyzed for the purpose of making a site management decision. The following bullets summarize the results of constituents that exceeded the RSLs and/or background concentrations:

- Surface soil
  - A number of PAHs and metals were detected and identified as constituents exceeding the RSLs. Concentrations of these compounds as well as those that exceeded the 95 percent UTL background concentrations, where applicable, are shown on Figure 12-3. The highest concentrations and exceedances are at locations ISUXO30-DP05, ISUXO30-DP07, and ISUXO30-DP08, which are within the site boundary.
  - One explosive (1,3-dinitrobenzene) exceeded the RSL at three locations (ISUXO30-DP03, ISUXO30-DP05, and ISUXO30-DP07).
  - Of the seven metals (aluminum, arsenic, chromium, cobalt, iron, manganese, and vanadium) that exceeded the RSLs, only iron and vanadium exceeded their respective 95 percent UTL background concentration. Iron exceeded both the RSL and background at all 12 locations. Vanadium was detected at all locations, but exceeded both the RSL and background at only one location (ISUXO30-DP01).
- Subsurface soil
  - Several PAHs were detected and exceeded their RSLs and background concentrations. Figure 12-3 shows the distribution of the exceeded compounds. The two locations (ISUXO30-DP06 and ISUXO30-DP09) where a second subsurface soil sample was collected showed a decrease in the concentration of compounds from the first depth interval to the second depth interval.
  - Several explosives were detected, but none exceeded their RSLs.
  - Three or more of seven detected metals (aluminum, arsenic, chromium, cobalt, iron, manganese, and vanadium) exceeded the RSLs at each location, but none exceeded the background concentrations
- *In situ* Groundwater
  - Five PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, and naphthalene) exceeded their RSLs at ISUXO30-DP05

and ISUXO30-DP12. No PAHs were detected at ISUXO30-DP09. There are no background concentrations for comparison.

- Several explosives were detected at ISUXO30-DP05 and ISUXO30-DP12, but only one at ISUXO30-DP09. There were four RSL exceedances at ISUXO30-DP05 (2-nitrotoluene, nitrobenzene, NG, and RDX) and only one RSL exceedance at ISUXO30-DP12 (nitrobenzene). RDX, the only compound that has a 95 percent UTL background concentration, was detected only at ISUXO30-DP05 (2.3 µg/L); it exceeded both the RSL (0.61 µg/L) and the background concentration (1.2 µg/L).
- Total and dissolved metals detected and RSL-exceeded compounds are similar. These compounds are also similar to those detected in surface soil and subsurface soil. The spatial distribution of compounds that exceeded the RSL and background concentrations is shown on Figure 12-3.

12.7 Conceptual Site Model

The CSM for UXO 30 was presented in Section 5.23.11 of the PA, and is summarized here and updated if necessary. UXO 30 is overlapped by the firing fan from UXO 11 (The Valley). Therefore, there is a potential for munitions associated with UXO 11 to be present at UXO 30. However, for the purposes of the PA, only MEC and/or MC associated with the UXO 30 was considered in the CSM exposure pathway analysis. CSMs for MEC and MC are shown as Figures 12-4 and 12-5, respectively. Figure 12-6 presents a graphical illustration of the CSM.

The nature of the activity that presumably occurred at UXO 30 suggested that MEC may be present. Therefore, potentially complete pathways exist for human and ecological receptors for MEC in the surface soil. This includes receptors for hand/tread underfoot contact as well as surface intrusive work that may be conducted at the Gate 3 Burning Ground. MEC is not expected in the subsurface.

Soil affected by MC represents the primary source medium. The burning grounds are currently not used; however, hunting is possible in the area. Based on current site use, potential current human receptors include Navy personnel (military and civil servants), trespassers, visitors, maintenance workers, contractors, and recreational users (hunters). Future site use is not expected to change significantly from current site use; therefore, potential future receptors include current receptors and construction/utility workers who may perform any future construction projects at the site. Additionally, although unlikely, future residents are considered a worst-case future scenario when considering unrestricted future site use.

All human and ecological receptors have potentially complete exposure pathways for direct contact with MC in surface soil, which includes dermal contact, ingestion, and inhalation (dust). Runoff and/or erosion may transport the MC from surface soil to surface water/ sediments (Potomac River), so a potentially complete pathway also exists for all human and ecological receptors of surface water/sediments through ingestion and dermal contact. Potentially complete exposure pathways exist for MC in subsurface soils (direct contact, ingestion and inhalation during intrusive work activities) for all receptors with the exception of trespassers. It is not anticipated that trespassers would come in contact with subsurface soils. Plants may accumulate MC from soil as well. Given that hunting is

permitted close to the site, MC entering the food chain may provide migration pathways for human and ecological receptors.

Precipitation infiltration may provide for contaminant mobility into the subsurface soil and into the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies. Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors. Potential receptors for the groundwater include construction/utility workers during excavation activities and, in the unlikely event the groundwater is used as a potable water supply, future residents and/or site workers. The site's proximity to the Potomac River provides possible migration routes for MC in groundwater to reach the river, where receptors could be exposed to MC in surface water or sediments.

12.8 Conclusions and Recommendation

The PA recommended an SI for MEC and MC. The site was investigated to determine the presence or absence of MEC and of MC in surface soil, subsurface soil, and groundwater.

Based on the DGM results, further investigation is warranted to determine whether MEC is present at the site. It is recommended that an intrusive investigation of a statistically representative sample of the anomalies identified within the site be performed to assess if MEC is present.

Based on the results of MC, PAHs apparently have migrated from the surface soil to the groundwater; the concentrations, in general, have decreased from the surface soil to the subsurface soil. The concentrations in the groundwater that exceeded the RSLs are slightly higher than the RSLs. There is no spatial trend in the distribution of these compounds. Explosives are detected in all media, but RSL exceedances are sporadic throughout the site. Detections of metals are prevalent in all media; however, most of them are less than their RSLs and background concentrations.

The prominent presence of PAHs and metals compared to explosives in all media, suggest that these compounds are related to site activities (burning). Based on historical information, explosives may have been burned, but they are present at low levels at the site. Soil and groundwater are recommended for further investigation through an RI mainly because of the presence of PAHs and metals.

TABLE 12-1
UXO 30 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOS 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO30-DP01	ISUXO30-DP02		ISUXO30-DP03	ISUXO30-DP04	ISUXO30-DP05
Sample ID					ISUXO30-SS01-0001	ISUXO30-SS02-0001	ISUXO30-SS02P-0001	ISUXO30-SS03-0001	ISUXO30-SS04-0001	ISUXO30-SS05-0001
Sample Date					4/16/10	4/16/10	4/16/10	4/16/10	4/16/10	4/16/10
Chemical Name										
Semivolatile Organic Compounds (UG/KG)										
1-Methylnaphthalene	22000	11 / 12	0 / 12	NA	11.2 U	8.84 UJ	2.35 J	34.7	923	567
2-Methylnaphthalene	31000	11 / 12	0 / 12	73	11.2 U	8.84 UJ	3.89 J	55.3	867	932
Acenaphthene	340000	11 / 12	0 / 12	140	11.2 U	8.84 UJ	2.4 J	40.6	822	359
Acenaphthylene	340000	11 / 12	0 / 12	NA	11.2 U	1.92 J	23.9 J	461 J	2,640	4,530 J
Anthracene	1700000	11 / 12	0 / 12	260	11.2 U	1.8 J	31.1 J	679	6,840	8,910
Benzo(a)anthracene	150	12 / 12	11 / 12	480	5.93 J	11.5 J	**362 J**	**2,840**	**10,700**	**44,400**
Benzo(a)pyrene	15	12 / 12	11 / 12	390	6.53 J	11 J	**377 J**	**2,680**	**5,940**	**32,300**
Benzo(b)fluoranthene	150	12 / 12	11 / 12	420	9.01 J	15 J	**467 J**	**3,720 J**	**7,660 J**	**37,700**
Benzo(g,h,i)perylene	170000	11 / 12	0 / 12	130	11.2 U	8.35 J	293 J	1,260	1,760	15,700 J
Benzo(k)fluoranthene	1500	12 / 12	6 / 12	360	3.94 J	8.84 UJ	169 J	**1,500**	**3,440 J**	**14,100**
Chrysene	15000	12 / 12	3 / 12	440	7.43 J	12.5 J	345 J	2,770	9,020	**37,900**
Dibenz(a,h)anthracene	15	11 / 12	11 / 12	NA	11.2 U	8.84 UJ	**63.7 J**	**462**	**696 J**	**6,330 J**
Fluoranthene	230000	12 / 12	0 / 12	1,100	9.96 J	18.9 J	495 J	5,210	19,200	68,400
Fluorene	230000	10 / 12	0 / 12	150	11.2 U	8.84 UJ	5.38 J	170	4,430	1,860
Indeno(1,2,3-cd)pyrene	150	11 / 12	11 / 12	100	11.2 U	9.22 J	**305 J**	**1,520**	**2,200**	**22,400 J**
Naphthalene	3600	11 / 12	2 / 12	110	11.2 U	2.27 J	14.4 J	203	339 J	**3,980**
Phenanthrene	1700000	12 / 12	0 / 12	1,100	5.97 J	7.89 J	52.2 J	2,370	21,800	28,100
Pyrene	170000	12 / 12	0 / 12	880	9.15 J	17.9 J	527 J	4,700 J	14,400	52,600
Explosives (UG/KG)										
1,3,5-Trinitrobenzene	220000	11/ /12	0 / 12	NA	23.3 J	60 U	59.3 J	6,030 J	43.4 J	134 J
1,3-Dinitrobenzene	610	9 / 12	3 / 12	NA	54.5 J	60 U	60 U	**842 J**	60 U	**851 J**
2,4,6-Trinitrotoluene	3600	4 / 12	0 / 12	NA	60 U	60 U	60 U	158 J	60 U	38.3 J
2,4-Dinitrotoluene	1600	6 / 12	0 / 12	NA	37.9 J	60 U	60 U	60 U	60 U	543 J
2,6-Dinitrotoluene	6100	5 / 12	0 / 12	NA	60 UJ	60 U	60 U	293 J	60 U	792 J
2-Amino-4,6-dinitrotoluene	15000	7 / 12	0 / 12	NA	60 UJ	60 U	60 U	60 U	60 U	57.9 J
2-Nitrotoluene	2900	5 / 12	0 / 12	150	60 UJ	60 U	24.5 J	135 J	60 U	332 J
3-Nitrotoluene	610	4 / 12	0 / 12	NA	60 UJ	60 U	60 U	42.3 J	60 U	129 J
4-Amino-2,6-dinitrotoluene	15000	5 / 12	0 / 12	NA	29.2 J	60 U	60 U	315 J	60 U	20.2 J
4-Nitrotoluene	24000	7 / 12	0 / 12	210	60 UJ	60 U	60 U	89.1 J	60 U	184 J
HMX	380000	3 / 12	0 / 12	NA	60 U	60 U	60 U	183 J	60 U	171
Nitrobenzene	4800	7 / 12	0 / 12	NA	60 UJ	60 U	60 U	113 J	60 U	135
Nitrocellulose	100000000	4 / 12	0 / 12	NA	3000 U	3000 U	3000 U	1,730 J	3000 U	1,500 J
Nitroglycerin	610	9 / 12	0 / 12	NA	133 J	75.3 J	70.5 J	211 J	69.6 J	91 J
Nitroguanidine	610000	2 / 12	0 / 12	NA	100 U	100 U	100 U	1,200 J	100 U	100 U
Perchlorate	5500	0 / 12	0 / 12	NA	3.35 U	2.65 U	2.59 U	3.49 U	2.12 U	3.17 U
PETN	NSL	4 / 12	0 / 12	NA	150 U	150 U	150 U	227 J	150 U	1,560 J
RDX	5500	7 / 12	0 / 12	NA	96.3 J	60 U	60 U	60 U	31.4 J	107 J
Tetryl	24000	7 / 12	0 / 12	NA	34.1 J	60 U	60 U	81.4 J	60 U	64.1 J
Total Metals (MG/KG)										
Aluminum	7700	12 / 12	3 / 12	19,700	**10,600**	**9,730**	**9,460**	**9,320**	509	4,900
Antimony	3.1	1 / 12	0 / 12	NA	2.43 R	0.96 R	0.942 R	1.31 R	0.808 R	5.98 R
Arsenic	0.39	12 / 12	12 / 12	14.9	**3.74**	**2.69**	**2.4**	**4.89**	**1.09**	**4.91**
Barium	1500	12 / 12	0 / 12	80.4	75.3	39.5	42.9	80.8	7.24	320
Beryllium	16	12 / 12	0 / 12	1.1	2.55	0.71	0.657	0.706	0.188 J	0.577 J
Cadmium	7	10 / 12	0 / 12	2.5	0.245 J	0.108 J	0.0648 J	0.312 J	0.269 U	3.05
Calcium	NUT	12 / 12	0 / 12	2,060	3,530 J	665 J	759 J	4,750 J	296 J	13,500 J
Chromium	0.29	12 / 12	12 / 12	33.4	**21.9**	**14.3**	**13.8**	**17.6**	**6.59**	**9.6**
Cobalt	2.3	12 / 12	10 / 12	22.3	**18.6**	**5.76**	**5.66**	**13.8**	2.07	**8.65**
Copper	310	12 / 12	0 / 12	20.3	22.9	11.1	12.3	21.4	2.74	27.7
Cyanide	160	0 / 12	0 / 12	0.73	0.419 U	0.331 U	0.323 U	0.436 U	0.265 U	0.396 U
Iron	5500	12 / 12	12 / 12	38,500	**41,700**	**26,200**	**25,700**	**17,900**	**7,270**	**16,500**
Lead	400	12 / 12	0 / 12	62.5	17	30.9	26.9	95.6	2.17	**466**
Magnesium	NUT	11 / 12	0 / 12	1620	1,450 L	879	881	1,440	269 U	1,190 J
Manganese	180	12 / 12	10 / 12	1,390	**648**	**330**	**338**	**850**	77.1	**1,160**
Mercury	2.3	10 / 12	0 / 12	0.16	0.0706	0.0589 J	0.0408 J	0.145	0.033 U	0.219
Nickel	150	12 / 12	0 / 12	15.4	13.7	5.98	5.81	12.8	3.22	11.2
Potassium	NUT	12 / 12	0 / 12	1,470	774 K	698 K	739 K	916 K	57.2 K	537 K
Selenium	39	4 / 12	0 / 12	1.2	0.972 U	0.207 J	0.377 U	0.576	0.323 U	2.39 U
Silver	39	0 / 12	0 / 12	0.84	3.24 U	1.28 U	1.26 U	1.74 U	1.08 U	7.97 U

TABLE 12-1
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SI Report for UXOS 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	**RSLs Residential Soil Adjusted**	**Frequency of Detection**	**Frequency of Exceedance**	**95 Percent UTL**	**ISUXO30-DP01**	**ISUXO30-DP02**		**ISUXO30-DP03**	**ISUXO30-DP04**	**ISUXO30-DP05**
Sample ID					**ISUXO30-SS01-0001**	**ISUXO30-SS02-0001**	**ISUXO30-SS02P-0001**	**ISUXO30-SS03-0001**	**ISUXO30-SS04-0001**	**ISUXO30-SS05-0001**
Sample Date					**4/16/10**	**4/16/10**	**4/16/10**	**4/16/10**	**4/16/10**	**4/16/10**
Chemical Name										
Sodium	NUT	1 / 12	0 / 12	120	405 U	320 U	314 U	90.3 J	269 U	1990 U
Thallium	NSL	0 / 12	0 / 12	2.3	3.24 U	0.512 U	0.502 U	0.698 U	0.431 U	3.19 U
Vanadium	39	12 / 12	1 / 12	53.3	**87.6**	38.5	38.8	36.6	7.68	25.3
Zinc	2300	12 / 12	0 / 12	37.5	40.2 J	34.5 J	33.8 J	84.1 J	9.59 J	887 J

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrient. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. There is no screening level for PETN. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA - Not available
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher

95 percent upper tolerance limits (UTLs) are taken from Table 4-2 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)
Each sample is designated by an alphanumeric code. Example: ISUXO6-SS01-0001; where I is for Indian Head; S is for site; UXO6 is the site number; SS01 is surface soil sample from station 1; and 0001 is the sample depth interval (0-0.5 foot bgs). If a "P" is at the end of "SS01" then it is a duplicate sample from that station.

TABLE 12-1
UXO 30 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOS 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO30-DP06	ISUXO30-DP07	ISUXO30-DP08	ISUXO30-DP09	ISUXO30-DP10	ISUXO30-DP11	ISUXO30-DP12
Sample ID					ISUXO30-SS06-0001	ISUXO30-SS07-0001	ISUXO30-SS08-0001	ISUXO30-SS09-0001	ISUXO30-SS10-0001	ISUXO30-SS11-0001	ISUXO30-SS12-0001
Sample Date					4/14/10	4/15/10	4/15/10	4/15/10	4/15/10	4/16/10	4/16/10
Chemical Name											
Semivolatile Organic Compounds (UG/KG)											
1-Methylnaphthalene	22000	11 / 12	0 / 12	NA	3.05 J	841	5,810	4.29 J	33.7	1,020	30.4
2-Methylnaphthalene	31000	11 / 12	0 / 12	73	5.46 J	1,040	5,920	6.3 J	45.8	610	42.1
Acenaphthene	340000	11 / 12	0 / 12	140	2.72 J	553	3,300	5.45 J	101	720	30.1
Acenaphthylene	340000	11 / 12	0 / 12	NA	43.2	4,690 J	12,300 J	70.7	144	3,060	845 J
Anthracene	1700000	11 / 12	0 / 12	260	54.6	10,400	24,400	97.9	327	5,830	532
Benzo(a)anthracene	150	12 / 12	11 / 12	480	**477**	**43,800**	**37,600**	**578**	**976**	**13,800**	**1,610**
Benzo(a)pyrene	15	12 / 12	11 / 12	390	**373**	**33,500**	**23,300**	**491**	**666**	**8,340**	**1,460**
Benzo(b)fluoranthene	150	12 / 12	11 / 12	420	**467**	**42,200**	**26,800**	**607**	**867**	**10,900 J**	**1,830**
Benzo(g,h,i)perylene	170000	11 / 12	0 / 12	130	182	12,900 J	9,600 J	327	364	2,990	725
Benzo(k)fluoranthene	1500	12 / 12	6 / 12	360	211	**16,100**	**10,900**	227	343	**5,330 J**	701
Chrysene	15000	12 / 12	3 / 12	440	466	**38,900**	**30,600**	572	901	12,700	1,720
Dibenz(a,h)anthracene	15	11 / 12	11 / 12	NA	**67.1**	**5,840 J**	**4,150 J**	**77.7**	**126**	**1,140 J**	**177**
Fluoranthene	230000	12 / 12	0 / 12	1,100	694	87,500	75,800	1,080	1,650	23,200	2,980
Fluorene	230000	10 / 12	0 / 12	150	11.2	3,460	16,600	25.7	104	3,600	10.2 U
Indeno(1,2,3-cd)pyrene	150	11 / 12	11 / 12	100	**235**	**19,400 J**	**14,300 J**	**373**	**437**	**3,660**	**822**
Naphthalene	3600	11 / 12	2 / 12	110	25.5	2,540	**5,160**	28.1	134	663 J	110
Phenanthrene	1700000	12 / 12	0 / 12	1,100	217	36,400	86,300	389	1,060	23,000	1,510
Pyrene	170000	12 / 12	0 / 12	880	625	72,800	58,600	1,040	1,440	19,300	3,430 J
Explosives (UG/KG)											
1,3,5-Trinitrobenzene	220000	11/ /12	0 / 12	NA	67 J	1,480	60 U	54.7 J	271 J	61.2	54.6 J
1,3-Dinitrobenzene	610	9 / 12	3 / 12	NA	97.2 J	**808 J**	92.3 J	60 U	311 J	31.5 J	232 J
2,4,6-Trinitrotoluene	3600	4 / 12	0 / 12	NA	36.9 J	60 U	60 U	60 U	60 U	60 U	28.6 J
2,4-Dinitrotoluene	1600	6 / 12	0 / 12	NA	60 U	560 J	60 U	69.9	33.5 J	60 U	61.7 J
2,6-Dinitrotoluene	6100	5 / 12	0 / 12	NA	60 U	659	60 U	60 U	36.8 J	60 U	34 J
2-Amino-4,6-dinitrotoluene	15000	7 / 12	0 / 12	NA	63.4 J	192 J	35 J	25.8 J	42.5 J	60 U	45 J
2-Nitrotoluene	2900	5 / 12	0 / 12	150	60 U	253 J	60 U	60 U	60 U	60 U	44.1 J
3-Nitrotoluene	610	4 / 12	0 / 12	NA	60 U	60 U	60 U	82.5	48.1 J	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	5 / 12	0 / 12	NA	60 U	60 U	60 U	133 J	60 U	60 U	27.4 J
4-Nitrotoluene	24000	7 / 12	0 / 12	210	49.7 J	664 J	60 U	55.4 J	21.2 J	60 U	58.8 J
HMX	380000	3 / 12	0 / 12	NA	60 U	212 J	60 U	60 U	60 U	60 U	60 U
Nitrobenzene	4800	7 / 12	0 / 12	NA	133 J	145 J	60 U	62.8 J	29.2 J	60 U	86.3
Nitrocellulose	100000000	4 / 12	0 / 12	NA	3000 U	3000 U	3000 U	3000 U	6,990	3000 U	2,500 J
Nitroglycerin	610	9 / 12	0 / 12	NA	268 J	300 J	146 J	150 U	150 U	150 U	104 J
Nitroguanidine	610000	2 / 12	0 / 12	NA	100 U	100 U	100 U	100 U	100 U	100 U	2,300 J
Perchlorate	5500	0 / 12	0 / 12	NA	2.46 U	2.65 UL	2.28 U	2.53 U	2.3 U	2.11 U	3.06 U
PETN	NSL	4 / 12	0 / 12	NA	150 U	903 J	150 U	101 J	150 U	150 U	150 U
RDX	5500	7 / 12	0 / 12	NA	60 U	96.9 J	60 U	60 U	72.6	20.4 J	52.4 J
Tetryl	24000	7 / 12	0 / 12	NA	90.1 J	54.6 J	60 U	60 U	47.3 J	60 U	137
Total Metals (MG/KG)											
Aluminum	7700	12 / 12	3 / 12	19,700	6,310	7,100	5,260	4,150	2,030	725	6,220
Antimony	3.1	1 / 12	0 / 12	NA	0.887 R	0.964 R	0.823 R	0.918 R	0.388 L	0.811 R	1.1 R
Arsenic	0.39	12 / 12	12 / 12	14.9	**3.65**	**3.97**	**3.08**	**2.32**	**2.5**	**0.835**	**5.22**
Barium	1500	12 / 12	0 / 12	80.4	32.6	64.4	31.7	30.6	24.3	8.05	60.9
Beryllium	16	12 / 12	0 / 12	1.1	0.484	0.492	0.404	0.342	0.447	0.264 J	0.581
Cadmium	7	10 / 12	0 / 12	2.5	0.0836 J	0.194 J	0.0675 J	0.0734 J	0.245 J	0.27 U	0.544
Calcium	NUT	12 / 12	0 / 12	2,060	385 J	864 J	363 J	441 J	708 J	293 J	2,380 J
Chromium	0.29	12 / 12	12 / 12	33.4	**22.8**	**14.9**	**13**	**9.37**	**11.7**	**5.34**	**13.7**
Cobalt	2.3	12 / 12	10 / 12	22.3	**7.06**	**7.59**	**8.1**	**7.39**	**7.26**	1.98	**7.43**
Copper	310	12 / 12	0 / 12	20.3	7.01	9.47	7.37	5.2	12	2.79	15.4
Cyanide	160	0 / 12	0 / 12	0.73	0.308 U	0.331 U	0.285 U	0.317 U	0.287 U	0.264 U	0.383 U
Iron	5500	12 / 12	12 / 12	38,500	**17,400**	**14,600**	**13,100**	**10,800**	**11,800**	**8,500**	**16,300**
Lead	400	12 / 12	0 / 12	62.5	134	50.6	24.6	91.9	156	2.74	85.8
Magnesium	NUT	11 / 12	0 / 12	1620	593	767	580	501	284 J	90.1 J	1,070
Manganese	180	12 / 12	10 / 12	1,390	**336**	**440**	**420**	**401**	**242**	80.3	**901**
Mercury	2.3	10 / 12	0 / 12	0.16	0.0429	0.13	0.0395	0.0353	0.0356	0.0337 U	0.0999
Nickel	150	12 / 12	0 / 12	15.4	7.32	6.97	4.95	4.72	9.2	1.97	12.4
Potassium	NUT	12 / 12	0 / 12	1,470	602 K	615 K	501 K	423 K	215 K	97.9 K	934 K
Selenium	39	4 / 12	0 / 12	1.2	0.355 U	0.196 J	0.329 U	0.367 U	0.348 U	0.324 U	0.394 J
Silver	39	0 / 12	0 / 12	0.84	1.18 U	1.29 U	1.1 U	1.22 U	1.16 U	1.08 U	1.47 U

TABLE 12-1
UXO 30 - Raw, Detected, and Exceeded Constituents in Surface Soil
SI Report for UXOS 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	**RSLs Residential Soil Adjusted**	**Frequency of Detection**	**Frequency of Exceedance**	**95 Percent UTL**	**ISUXO30-DP06**	**ISUXO30-DP07**	**ISUXO30-DP08**	**ISUXO30-DP09**	**ISUXO30-DP10**	**ISUXO30-DP11**	**ISUXO30-DP12**
Sample ID					**ISUXO30-SS06-0001**	**ISUXO30-SS07-0001**	**ISUXO30-SS08-0001**	**ISUXO30-SS09-0001**	**ISUXO30-SS10-0001**	**ISUXO30-SS11-0001**	**ISUXO30-SS12-0001**
Sample Date					**4/14/10**	**4/15/10**	**4/15/10**	**4/15/10**	**4/15/10**	**4/16/10**	**4/16/10**
Chemical Name											
Sodium	NUT	1 / 12	0 / 12	120	296 U	321 U	274 U	306 U	290 U	270 U	368 U
Thallium	NSL	0 / 12	0 / 12	2.3	0.473 U	0.514 U	0.439 U	0.489 U	0.465 U	0.433 U	0.589 U
Vanadium	39	12 / 12	1 / 12	53.3	29.6	27.8	22.2	18.1	13.8	12.3	35.4
Zinc	2300	12 / 12	0 / 12	37.5	24.3 J	64.7 J	27.5 J	23.3 J	57.9 J	12.9 J	108 J

Notes:
Shading indicates detections.
Bolded underlined shading indicates detected regional screening level (RSL) exceedances.
RSLs are current as of May, 2010.
NUT: Nutrient. There is no screening level for Ca, Mg, K, and Na because they are nutrients.
NSL: No screening level. There is no screening level for PETN. Thallium was removed from the RSLs in December, 2009.
J - Analyte present. Value may or may not be accurate or precise
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
R - Unreliable Result
HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
NA - Not available
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher

95 percent upper tolerance limits (UTLs) are taken from Table 4-2 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)
Each sample is designated by an alphanumeric code. Example: ISUXO6-SS01-0001; where I is for Indian Head; S is for site; UXO6 is the site number; SS01 is surface soil sample from station 1; and 0001 is the sample depth interval (0-0.5 foot bgs). If a “P” is at the end of “SS01” then it is a duplicate sample from that station.

TABLE 12-2

UXO 30 - Raw, Detected, and Exceeded Constituents in Subsurface Soil

SI Report for UXOs 6, 9, 11, 12, 18, 19, 20, 27, 29, 30, 31, and 33

NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO30-DP01	ISUXO30-DP02		ISUXO30-DP03		ISUXO30-DP05	ISUXO30-DP06		ISUXO30-DP07
Sample ID					ISUXO30-SB01-0102	ISUXO30-SB02-0102	ISUXO30-SB02P-0102	ISUXO30-SB03-0102	ISUXO30-SB03P-0102	ISUXO30-SB05-0102	ISUXO30-SB06-0102	ISUXO30-SB06-1516	ISUXO30-SB07-0102
Sample Date					4/16/10	4/16/10	4/16/10	4/16/10	4/16/10	4/16/10	4/14/10	4/16/10	4/15/10
Chemical Name													
Semivolatile Organic Compounds (UG/KG)													
1-Methylnaphthalene	22000	5 / 11	0 / 11	NA	9.6 U	9.02 UJ	8.95 U	9.05 U	8.7 U	3.29 J	9.09 U	8.12 U	24.5
2-Methylnaphthalene	31000	5 / 11	0 / 11	NA	9.6 U	9.02 UJ	8.95 U	9.05 U	8.7 U	5.73 J	9.09 U	8.12 U	30
Acenaphthene	340000	5 / 11	0 / 11	NA	9.6 U	9.02 UJ	8.95 U	9.05 U	8.7 U	3.26 J	9.09 U	8.12 U	18.9
Acenaphthylene	340000	7 / 11	0 / 11	NA	9.6 U	9.02 UJ	8.95 U	11.2 J	4.25 J	51.5	9.09 U	8.12 U	213
Anthracene	1700000	8 / 11	0 / 11	NA	9.6 U	2.76 J	8.95 U	8.11 J	4.22 J	75.4	9.09 U	8.12 U	361
Benzo(a)anthracene	150	10 / 11	4 / 11	NA	2.69 J	8.05 J	8.95 U	23	14.5	**478**	13.7	8.12 U	**2,350**
Benzo(a)pyrene	15	9 / 11	7 / 11	NA	9.6 U	7.7 J	8.95 U	**25.6**	**19.4**	**405**	**13.4**	8.12 U	**1,510**
Benzo(b)fluoranthene	150	10 / 11	5 / 11	NA	2.45 J	8.4 J	8.95 U	27.2	22.9	**529**	15.6	8.12 U	**2,000**
Benzo(g,h,i)perylene	170000	9 / 11	0 / 11	NA	9.6 U	9.19 J	8.95 UJ	13.4	8.33 J	240	6.57 J	8.12 U	600
Benzo(k)fluoranthene	1500	9 / 11	1 / 11	NA	9.6 U	7.99 J	8.95 U	11.2	7.84 J	208	5.98 J	8.12 U	746
Chrysene	15000	10 / 11	0 / 11	NA	2.42 J	8.26 J	8.95 U	31.6	17.1	474	14.8	8.12 U	2,150
Dibenz(a,h)anthracene	15	7 / 11	5 / 11	NA	9.6 U	8.34 J	8.95 U	9.05 U	8.7 U	**80.9**	9.09 U	8.12 U	**220**
Fluoranthene	230000	11 / 11	0 / 11	NA	3.05 J	6.9 J	8.95 U	53	34	784	22.4	8.81	3,450
Fluorene	230000	7 / 11	0 / 11	NA	9.6 U	9.02 UJ	8.95 U	9.05 U	1.78 J	15.3	9.09 U	8.12 U	98.9
Indeno(1,2,3-cd)pyrene	150	9 / 11	5 / 11	NA	9.6 U	9.73 J	8.95 UJ	13.2	9.99	**280**	8.7 J	8.12 U	**835**
Naphthalene	3600	6 / 11	0 / 11	NA	9.6 U	9.02 UJ	8.95 U	9.05 U	8.7 U	27	9.09 U	8.12 U	98.6
Phenanthrene	1700000	11 / 11	0 / 11	NA	2.22 J	3.17 J	8.95 U	31.1	13.7	248	8.17 J	2.8 J	1,430
Pyrene	170000	11 / 11	0 / 11	NA	2.97 J	7.29 J	8.95 U	54.7	28.4	696	20	3.13 J	3,040
Explosives (UG/KG)													
1,3,5-Trinitrobenzene	220000	7 / 11	0 / 11	NA	60 U	30.8 J	25.7 J	60 U	60 U	25.9 J	60 U	60 U	105 J
1,3-Dinitrobenzene	610	4 / 11	0 / 11	NA	60 U	60 U	33.8 J	60 U	46 J	64.8 J	60 U	60 U	60 U
2,4,6-Trinitrotoluene	3600	2 / 11	0 / 11	NA	60 U	60 U	60 U	60 U	60 U	21.5 J	60 U	60 U	60 U
2,4-Dinitrotoluene	1600	4 / 11	0 / 11	NA	60 U	60 U	60 U	60 U	60 U	35.4 J	60 U	60 U	81.5 J
2,6-Dinitrotoluene	6100	3 / 11	0 / 11	NA	60 U	60 U	60 U	60 U	60 U	56.3 J	60 U	60 U	53.6 J
2-Amino-4,6-dinitrotoluene	15000	4 / 11	0 / 11	NA	60 U	26.9 J	60 U	60 U	60 U	22.2 J	60 U	60 U	60 U
2-Nitrotoluene	2900	4 / 11	0 / 11	NA	60 U	60 U	60 U	60 U	60 U	29.3 J	60 U	60 U	45.9 J
3-Nitrotoluene	610	2 / 11	0 / 11	NA	23.8 J	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Amino-2,6-dinitrotoluene	15000	0 / 11	0 / 11	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	3 / 11	0 / 11	NA	60 U	60 U	60 U	60 U	60 U	60 U	20.3 J	60 U	60 U
HMX	380000	8 / 11	0 / 11	NA	60 U	27.5 J	26.6 J	46.2 J	54.2 J	60 U	31.6 J	27.6 J	60 U
Nitrobenzene	4800	2 / 11	0 / 11	NA	60 U	60 U	60 U	60 U	60 U	60 U	60 U	60 U	25.9 J
Nitrocellulose	100000000	0 / 11	0 / 11	NA	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U	3000 U
Nitroglycerin	610	5 / 11	0 / 11	NA	322 J	56.5 J	150 U	56.5 J	150 U	150 U	150 U	150 U	109 J
Nitroguanidine	610000	4 / 11	0 / 11	NA	100 U	100 U	100 U	1,280 J	2,700 J	100 U	100 U	67.8 J	100 U
Perchlorate	5500	0 / 11	0 / 11	NA	2.88 U	2.7 U	2.68 U	2.71 U	2.61 U	2.6 U	2.73 U	2.44 U	2.37 UL
PETN	NSL	1 / 11	0 / 11	NA	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U	150 U
RDX	5500	8 / 11	0 / 11	NA	91.7	40.6 J	101 J	102 J	30.1 J	60 U	52 J	39.9 J	113
Tetryl	24000	4 / 11	0 / 11	NA	60 U	60 U	23.8 J	37.4 J	28.8 J	60 U	60 U	25.4 J	60 U

TABLE 12-2

UXO 30 - Raw, Detected, and Exceeded Constituents in Subsurface Soil

SI Report for UXOs 6, 9, 11, 12, 18, 19, 20, 27, 29, 30, 31, and 33

NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO30-DP01	ISUXO30-DP02		ISUXO30-DP03		ISUXO30-DP05	ISUXO30-DP06		ISUXO30-DP07
Sample ID					ISUXO30-SB01-0102	ISUXO30-SB02-0102	ISUXO30-SB02P-0102	ISUXO30-SB03-0102	ISUXO30-SB03P-0102	ISUXO30-SB05-0102	ISUXO30-SB06-0102	ISUXO30-SB06-1516	ISUXO30-SB07-0102
Sample Date					4/16/10	4/16/10	4/16/10	4/16/10	4/16/10	4/16/10	4/14/10	4/16/10	4/15/10
Total Metals (MG/KG)													
Aluminum	7700	11 / 11	7 / 11	35,400	**10,800**	**14,400**	**12,900**	**9,970**	**9,290**	**8,680**	**10,800**	**11,100**	**10,300**
Antimony	3.1	0 / 11	0 / 11	1.8	2.08 R	1.03 R	0.997 R	0.992 R	0.988 R	1.94 R	5.06 R	1.81 R	0.879 R
Arsenic	0.39	11 / 11	11 / 11	18.9	**0.927**	**3.96**	**3.99**	**1.56**	**2.04**	**1.85**	**7.21**	**1.27**	**3.71**
Barium	1500	11 / 11	0 / 11	134	65.7	51	51.3	73.3	65.4	45.3	83.4	56.2	66.5
Beryllium	16	11 / 11	0 / 11	3.3	3	0.791	0.838	0.503	0.483	1.19	1.1	1.54	0.569
Cadmium	7	3 / 11	0 / 11	0.61	0.695 U	0.345 U	0.332 U	0.331 U	0.0758 J	0.647 U	1.69 U	0.603 U	0.293 U
Calcium	NUT	11 / 11	0 / 11	2,590	2,640 J	544 J	486 J	798 J	706 J	2,810 J	1,510 J	2,920 J	586 J
Chromium	0.29	11 / 11	11 / 11	60.1	**23.6**	**17.4**	**18.7**	**14.9**	**14.9**	**18.8**	**20.7**	**25.5**	**17.1**
Cobalt	2.3	11 / 11	11 / 11	133	**11.4**	**5.88**	**6.82**	**3.77**	**3.23**	**5.8**	**13**	**6.16**	**7.8**
Copper	310	11 / 11	0 / 11	48.6	22.4	12.8	14.1	10	9.47	23	49.2	22	6.86
Cyanide	160	1 / 11	0 / 11	16.1	0.36 U	0.338 U	0.336 U	3.11	0.326 U	0.325 U	0.341 U	0.304 U	0.296 U
Iron	5500	11 / 11	11 / 11	83,100	**54,700**	**34,300**	**32,200**	**11,100**	**12,300**	**37,400**	**23,200**	**33,800**	**14,600**
Lead	400	11 / 11	0 / 11	40.5	6.28	10.2	10.4	18.4	20	17.6	13.9	3.24	15.8
Magnesium	NUT	11 / 11	0 / 11	2,640	1,580 L	981	866	821	773	841 L	1,290	1,710 L	843
Manganese	180	11 / 11	6 / 11	4,130	106	167	**200**	26.7	27.6	**221**	82.8	57	**376**
Mercury	2.3	8 / 11	0 / 11	0.18	0.0491 U	0.0339 J	0.024 J	0.0444	0.0424	0.0348 U	0.0322 J	0.0377 U	0.0442
Nickel	150	11 / 11	0 / 11	18.2	9.85	7.81	7.62	6.35	5.76	5.13	12.3	5.25	6.83
Potassium	NUT	11 / 11	0 / 11	2,610	640 K	1,030 K	790 K	679 K	642 K	385 K	718 K	427 K	614 K
Selenium	39	3 / 11	0 / 11	13.3	0.834 U	0.414 U	0.204 J	0.22 J	0.395 U	0.776 U	2.02 U	0.724 U	0.251 J
Silver	39	0 / 11	0 / 11	11.4	2.78 U	1.38 U	1.33 U	1.32 U	1.32 U	2.59 U	6.75 U	2.41 U	1.17 U
Sodium	NUT	2 / 11	0 / 11	258	347 U	345 U	332 U	131 J	119 J	323 U	337 U	152 J	293 U
Thallium	NSL	0 / 11	0 / 11	21.8	1.11 U	0.552 U	0.532 U	0.529 U	0.527 U	1.03 U	2.7 U	0.965 U	0.469 U
Vanadium	39	11 / 11	5 / 11	194	**93.4**	**47.2**	**46.9**	23.7	24.7	**75.2**	**66.9**	**81.9**	28.4
Zinc	2300	11 / 11	0 / 11	70.4	25.1 J	34.6 J	30.3 J	24.4 J	21.7 J	58.3 J	28.1 J	15.3 J	40.6 J

Notes:

Shading indicates detections.

Bolded underlined shading indicates detected regional screening level (RSL) exceedances.

RSLs are current as of May, 2010.

NUT: Nutrient. There is no screening level for Ca, Mg, K, and Na because they are nutrients.

NSL: No screening level. There is no screening level for PETN. Thallium was removed from the RSLs in December, 2009.

J - Analyte present. Value may or may not be accurate or precise

K - Analyte present. Value may be biased high. Value may be lower

L - Analyte present. Value may be biased low. Value may be higher

R - Unreliable Result

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine

PETN - pentaerythritol tetranitrate

RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

U - The material was analyzed for, but not detected

MG/KG - Milligrams per kilogram

UG/KG - Micrograms per kilogram

NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 12-2
UXO 30 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 12, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO30-DP08	ISUXO30-DP09		ISUXO30-DP12
Sample ID					ISUXO30-SB08-0102	ISUXO30-SB09-0102	ISUXO30-SB09-1415	ISUXO30-SB12-0102
Sample Date					4/15/10	4/15/10	4/15/10	4/16/10
Chemical Name								
Semivolatile Organic Compounds (UG/KG)								
1-Methylnaphthalene	22000	5 / 11	0 / 11	NA	7.29 U	9.23	5.24 J	343
2-Methylnaphthalene	31000	5 / 11	0 / 11	NA	7.29 U	13.2	7.9 J	386
Acenaphthene	340000	5 / 11	0 / 11	NA	7.29 U	10.3	9.22	291
Acenaphthylene	340000	7 / 11	0 / 11	NA	8.81	127	91.8	1,470 J
Anthracene	1700000	8 / 11	0 / 11	NA	13.7	160	142	2,700
Benzo(a)anthracene	150	10 / 11	4 / 11	NA	92.6	**1,070**	**569**	**4,360**
Benzo(a)pyrene	15	9 / 11	7 / 11	NA	**71.7**	**764**	**431**	**4,170**
Benzo(b)fluoranthene	150	10 / 11	5 / 11	NA	93.1	**968**	**533**	**5,020 J**
Benzo(g,h,i)perylene	170000	9 / 11	0 / 11	NA	38.9	399	219	1,800
Benzo(k)fluoranthene	1500	9 / 11	1 / 11	NA	36.2	336	192	**1,840**
Chrysene	15000	10 / 11	0 / 11	NA	92.9	1,040	528	4,020
Dibenz(a,h)anthracene	15	7 / 11	5 / 11	NA	14.2	**124**	**67.3**	**520**
Fluoranthene	230000	11 / 11	0 / 11	NA	149	1,780	1,060	9,980
Fluorene	230000	7 / 11	0 / 11	NA	3.39 J	46.9	39.6	1,460
Indeno(1,2,3-cd)pyrene	150	9 / 11	5 / 11	NA	46.9	**470**	**267**	**2,200**
Naphthalene	3600	6 / 11	0 / 11	NA	5.24 J	54.1	34.6	444
Phenanthrene	1700000	11 / 11	0 / 11	NA	53.5	740	526	10,900
Pyrene	170000	11 / 11	0 / 11	NA	133	1,710	934	8,740 J
Explosives (UG/KG)								
1,3,5-Trinitrobenzene	220000	7 / 11	0 / 11	NA	30 J	174 J	96.6 J	51 J
1,3-Dinitrobenzene	610	4 / 11	0 / 11	NA	60 U	60 U	60 U	138 J
2,4,6-Trinitrotoluene	3600	2 / 11	0 / 11	NA	60 U	60 U	60 U	93.5 J
2,4-Dinitrotoluene	1600	4 / 11	0 / 11	NA	60 U	22.2 J	60 U	67.6 J
2,6-Dinitrotoluene	6100	3 / 11	0 / 11	NA	60 U	60 U	60 U	23.3 J
2-Amino-4,6-dinitrotoluene	15000	4 / 11	0 / 11	NA	60 U	60 U	42.1 J	52.2 J
2-Nitrotoluene	2900	4 / 11	0 / 11	NA	60 U	60 U	22.3 J	81.1
3-Nitrotoluene	610	2 / 11	0 / 11	NA	60 U	60 U	60 U	20.6 J
4-Amino-2,6-dinitrotoluene	15000	0 / 11	0 / 11	NA	60 U	60 U	60 U	60 U
4-Nitrotoluene	24000	3 / 11	0 / 11	NA	60 U	40.4 J	60 U	92.6 J
HMX	380000	8 / 11	0 / 11	NA	60 U	28.6 J	60 U	52 J
Nitrobenzene	4800	2 / 11	0 / 11	NA	60 U	60 U	60 U	36.8 J
Nitrocellulose	100000000	0 / 11	0 / 11	NA	3000 U	3000 U	3000 U	3000 U
Nitroglycerin	610	5 / 11	0 / 11	NA	150 U	150 U	150 U	107 J
Nitroguanidine	610000	4 / 11	0 / 11	NA	100 U	100 U	100 U	4,000 J
Perchlorate	5500	0 / 11	0 / 11	NA	2.19 U	2.44 U	2.45 UL	2.64 U
PETN	NSL	1 / 11	0 / 11	NA	150 U	150 U	150 U	171
RDX	5500	8 / 11	0 / 11	NA	60 U	60 U	32 J	116
Tetryl	24000	4 / 11	0 / 11	NA	60 U	60 U	60 U	182 J

TABLE 12-2
UXO 30 - Raw, Detected, and Exceeded Constituents in Subsurface Soil
SI Report for UXOs 6, 9, 11, 12, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Residential Soil Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO30-DP08	ISUXO30-DP09		ISUXO30-DP12
Sample ID					ISUXO30-SB08-0102	ISUXO30-SB09-0102	ISUXO30-SB09-1415	ISUXO30-SB12-0102
Sample Date					4/15/10	4/15/10	4/15/10	4/16/10
Total Metals (MG/KG)								
Aluminum	7700	11 / 11	7 / 11	35,400	4,760	3,760	4,860	4,790
Antimony	3.1	0 / 11	0 / 11	1.8	0.808 R	0.893 R	0.909 R	0.949 R
Arsenic	0.39	11 / 11	11 / 11	18.9	**2.32**	**2.11**	**2.68**	**3.83**
Barium	1500	11 / 11	0 / 11	134	28.4	24.4	31.6	28.5
Beryllium	16	11 / 11	0 / 11	3.3	0.414	0.353	0.44	0.496
Cadmium	7	3 / 11	0 / 11	0.61	0.0662 J	0.298 U	0.303 U	0.0884 J
Calcium	NUT	11 / 11	0 / 11	2,590	145 J	147 J	252 J	285 J
Chromium	0.29	11 / 11	11 / 11	60.1	**12.1**	**10.4**	**15.4**	**13**
Cobalt	2.3	11 / 11	11 / 11	133	**5.71**	**5.44**	**10.5**	**4.27**
Copper	310	11 / 11	0 / 11	48.6	5.49	5	5.87	9.75
Cyanide	160	1 / 11	0 / 11	16.1	0.273 U	0.305 U	0.306 U	0.33 U
Iron	5500	11 / 11	11 / 11	83,100	**12,100**	**9,430**	**15,200**	**18,500**
Lead	400	11 / 11	0 / 11	40.5	12.6	11.7	12.2	28.2
Magnesium	NUT	11 / 11	0 / 11	2,640	477	434	531	630
Manganese	180	11 / 11	6 / 11	4,130	**354**	**286**	**453**	91
Mercury	2.3	8 / 11	0 / 11	0.18	0.0231 J	0.0351	0.0168 J	0.0698
Nickel	150	11 / 11	0 / 11	18.2	4.51	3.94	5.43	5.6
Potassium	NUT	11 / 11	0 / 11	2,610	417 K	364 K	465 K	520 K
Selenium	39	3 / 11	0 / 11	13.3	0.323 U	0.357 U	0.364 U	0.379 U
Silver	39	0 / 11	0 / 11	11.4	1.08 U	1.19 U	1.21 U	1.26 U
Sodium	NUT	2 / 11	0 / 11	258	269 U	298 U	303 U	316 U
Thallium	NSL	0 / 11	0 / 11	21.8	0.431 U	0.476 U	0.485 U	0.506 U
Vanadium	39	11 / 11	5 / 11	194	18.7	15.3	21.4	20.6
Zinc	2300	11 / 11	0 / 11	70.4	21.7 J	16.1 J	18.5 J	35.4 J

Notes:

Shading indicates detections.

Bolded underlined shading indicates detected regional screening level (RSL) exceedances.

RSLs are current as of May, 2010.

NUT: Nutrient. There is no screening level for Ca, Mg, K, and Na because they are nutrients.

NSL: No screening level. There is no screening level for PETN. Thallium was removed from the RSLs in December, 2009.

J - Analyte present. Value may or may not be accurate or precise

K - Analyte present. Value may be biased high. Value may be lower

L - Analyte present. Value may be biased low. Value may be higher

R - Unreliable Result

HMX - High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine

PETN - pentaerythritol tetranitrate

RDX - Royal Demolition eXplosive. It is also known as cyclonite or hexogen

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

U - The material was analyzed for, but not detected

MG/KG - Milligrams per kilogram

UG/KG - Micrograms per kilogram

NA – Not available

95 percent upper tolerance limits (UTLs) are taken from Table 4-3 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-SB01-NNNN; where I is for Indian Head; S is for site; UXO6 is the site number; SB01 is subsurface soil sample from station 1; and NNNN is the sample depth interval. If a "P" is at the end of "SB01" then it is a duplicate sample from that station.

TABLE 12-3
UXO 30 - Raw, Detected, and Exceeded Constituents in In Situ Groundwater
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Tapwater Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO30-DP05		ISUXO30-DP09	ISUXO30-DP12
Sample ID					ISUXO30-GP05-0410	ISUXO30-GP05P-0410	ISUXO30-GP09-0410	ISUXO30-GP12-0410
Sample Date					4/16/10	4/16/10	4/15/10	4/16/10
Chemical Name								
Semivolatile Organic Compounds (UG/L)								
1-Methylnaphthalene	2.3	1 / 3	0 / 3	NA	0.192 U	0.187 U	0.192 U	1.9
2-Methylnaphthalene	15	1 / 3	0 / 3	NA	0.192 U	0.187 U	0.192 U	1.87
Acenaphthene	220	1 / 3	0 / 3	NA	0.192 U	0.187 U	0.192 U	0.933
Acenaphthylene	220	1 / 3	0 / 3	NA	0.192 U	0.187 U	0.192 U	0.81
Anthracene	1100	1 / 3	0 / 3	NA	0.192 U	0.187 U	0.192 U	0.783
Benzo(a)anthracene	0.029	2 / 3	2 / 3	NA	**0.124 J**	0.187 U	0.192 U	**0.202**
Benzo(a)pyrene	0.0029	2 / 3	2 / 3	NA	**0.13 J**	0.187 U	0.192 U	**0.141 J**
Benzo(b)fluoranthene	0.029	2 / 3	2 / 3	NA	**0.151 J**	0.187 U	0.192 U	**0.167 J**
Benzo(g,h,i)perylene	110	2 / 3	0 / 3	NA	0.0765 J	0.187 U	0.192 U	0.0979 J
Benzo(k)fluoranthene	0.29	0 / 3	0 / 3	NA	0.192 U	0.187 U	0.192 U	0.189 U
Chrysene	2.9	2 / 3	0 / 3	NA	0.139 J	0.187 U	0.192 U	0.23
Dibenz(a,h)anthracene	0.0029	0 / 3	0 / 3	NA	0.192 U	0.187 U	0.192 U	0.189 U
Fluoranthene	150	2 / 3	0 / 3	NA	0.197	0.0965 J	0.192 U	1.17
Fluorene	150	1 / 3	0 / 3	NA	0.192 U	0.187 U	0.192 U	1.56
Indeno(1,2,3-cd)pyrene	0.029	2 / 3	2 / 3	NA	**0.0931 J**	0.187 U	0.192 U	**0.103 J**
Naphthalene	0.14	1 / 3	1 / 3	NA	0.192 U	0.187 U	0.192 U	**3.07**
Phenanthrene	1100	2 / 3	0 / 3	NA	0.0913 J	0.187 U	0.192 U	4.45
Pyrene	110	2 / 3	0 / 3	NA	0.195	0.095 J	0.192 U	0.909
Explosives (UG/L)								
1,3,5-Trinitrobenzene	110	0 / 3	0 / 3	NA	0.826 B	0.224 U	0.235 U	0.224 U
1,3-Dinitrobenzene	0.37	1 / 3	0 / 3	NA	0.224 U	0.224 U	0.112 J	0.224 U
2,4,6-Trinitrotoluene	1.8	1 / 3	0 / 3	NA	0.182 J	0.224 U	0.235 U	0.224 U
2,4-Dinitrotoluene	0.22	0 / 3	0 / 3	NA	0.224 U	0.224 U	0.235 U	0.224 U
2,6-Dinitrotoluene	3.7	1 / 3	0 / 3	NA	0.224 U	0.224 U	0.235 U	0.116 J
2-Amino-4,6-dinitrotoluene	7.3	1 / 3	0 / 3	NA	0.32	0.224 U	0.235 U	0.224 U
2-Nitrotoluene	0.31	1 / 3	1 / 3	NA	0.384 B	**4.82 J**	0.235 U	0.224 U
3-Nitrotoluene	0.37	0 / 3	0 / 3	NA	0.224 U	0.224 U	0.235 U	0.224 U
4-Amino-2,6-dinitrotoluene	7.3	1 / 3	0 / 3	NA	0.132 J	0.149 J	0.235 U	0.224 U
4-Nitrotoluene	4.2	0 / 3	0 / 3	NA	0.224 U	0.224 U	0.235 U	0.224 U
HMX	180	1 / 3	0 / 3	NA	0.224 UJ	0.294 J	0.235 U	0.224 U
Nitrobenzene	0.12	2 / 3	2 / 3	NA	**0.279 J**	**0.534 J**	0.235 U	**0.141 J**
Nitrocellulose	11000000	0 / 3	0 / 3	NA	300 U	300 U	300 U	300 U
Nitroglycerin	0.37	1 / 3	1 / 3	NA	**0.446 J**	0.561 U	0.588 U	0.561 U
Nitroguanidine	370	2 / 3	0 / 3	NA	11.2 J	9.78 J	10 UJ	102 J
Perchlorate	2.6	1 / 3	0 / 3	NA	0.2 U	0.2 U	0.2 U	0.162 J
PETN	NSL	0 / 3	0 / 3	NA	0.561 U	0.561 U	0.588 U	0.561 U
RDX	0.61	1 / 3	1 / 3	1.2	**2.3**	1.03 B	0.349 B	0.224 U
Tetryl	15	2 / 3	0 / 3	NA	0.178 J	0.224 U	0.235 U	0.374 J

TABLE 12-3
UXO 30 - Raw, Detected, and Exceeded Constituents in In Situ Groundwater
SI Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

Station ID	RSLs Tapwater Adjusted	Frequency of Detection	Frequency of Exceedance	95 Percent UTL	ISUXO30-DP05		ISUXO30-DP09	ISUXO30-DP12
Sample ID					ISUXO30-GP05-0410	ISUXO30-GP05P-0410	ISUXO30-GP09-0410	ISUXO30-GP12-0410
Sample Date					4/16/10	4/16/10	4/15/10	4/16/10
Total Metals (UG/L)								
Aluminum	3700	3 / 3	1 / 3	286,545,198	**4,480 K**	2,070 K	527 K	2,380 K
Antimony	1.5	3 / 3	3 / 3	NA	**2.44 L**	**4.13 L**	**3.58 L**	**4.88 L**
Arsenic	0.045	3 / 3	3 / 3	NA	**42.3 J**	**77.6 J**	**62.7 J**	**90.7 J**
Barium	730	3 / 3	0 / 3	254	61.6	35.6 J	42	53.5 K
Beryllium	7.3	1 / 3	0 / 3	NA	5 U	5 U	5 U	4.92 J
Cadmium	1.8	1 / 3	0 / 3	2.8	0.6 U	0.6 U	0.6 U	1.53
Calcium	NUT	3 / 3	0 / 3	599,450	10,700	8,450	4,030 J	12,500
Chromium	0.043	2 / 3	2 / 3	20.9	**7.86 J**	**2.92 J**	10 U	**3.86 J**
Cobalt	1.1	3 / 3	3 / 3	39.6	**5.77**	**6.01**	**2.78**	**134**
Copper	150	2 / 3	0 / 3	22.4	9.61 J	4.34 J	10 U	17.5
Cyanide	73	0 / 3	0 / 3	NA	10 U	10 U	10 U	10 U
Iron	2600	3 / 3	3 / 3	57,199	**10,900 J**	**2,820 J**	**25,600**	**2,720**
Lead	15	2 / 3	2 / 3	NA	**17.2**	2.92 J	3 U	**33.7**
Magnesium	NUT	3 / 3	0 / 3	31,254	5,610 J	4,420 J	2,060 J	11,000
Manganese	88	3 / 3	3 / 3	28,160	**221**	**107**	**227**	**1,080**
Mercury	1.1	0 / 3	0 / 3	0.13	0.2 U	0.2 U	0.2 U	0.2 U
Nickel	73	2 / 3	1 / 3	39.0	7.06 J	4.32 J	10 U	**105**
Potassium	NUT	2 / 3	0 / 3	83,058	1,310 J	5000 U	1,330 J	5000 U
Selenium	18	0 / 3	0 / 3	NA	5 U	5 U	5 U	5 U
Silver	18	0 / 3	0 / 3	NA	3 U	3 U	3 U	3 U
Sodium	NUT	3 / 3	0 / 3	79,585	17,300	14,800	7,830	11,100
Thallium	NSL	0 / 3	0 / 3	NA	0.2 U	0.2 U	0.2 U	0.2 U
Vanadium	18	1 / 3	0 / 3	24.1	16.5	12.5 U	12.5 U	12.5 U
Zinc	1100	2 / 3	0 / 3	45.2	58.9 J	33.9 J	20 U	230
Dissolved Metals (UG/L)								
Aluminum	3700	3 / 3	1 / 3	286,545,198	**13,500 J**	901 J	309	233
Antimony	1.5	1 / 3	1 / 3	NA	**4.37**	1 U	1 U	1 U
Arsenic	0.045	3 / 3	3 / 3	NA	**74.6**	1 U	**2.32**	**0.706 J**
Barium	730	3 / 3	0 / 3	254	96.9	31.9 J	44	86.5 K
Beryllium	7.3	2 / 3	0 / 3	NA	1.16 J	5 U	5 U	1.62 J
Cadmium	1.8	1 / 3	0 / 3	2.8	0.6 U	0.6 U	0.6 U	0.831
Calcium	NUT	3 / 3	0 / 3	599,450	9,700	8,130	3,530 J	13,800
Chromium	0.043	1 / 3	1 / 3	20.9	**19.8**	10 U	10 U	10 U
Cobalt	1.1	3 / 3	3 / 3	39.6	**7.15**	**5.9**	**1.93**	**385**
Copper	150	2 / 3	0 / 3	22.4	19.8	10 U	10 U	6.7 J
Iron	2600	3 / 3	2 / 3	57,199	**22,900 J**	1,430 J	**22,300**	442
Lead	15	2 / 3	1 / 3	NA	**19.4**	3 U	3 U	3.15
Magnesium	NUT	3 / 3	0 / 3	31,254	5,380 J	4,130 J	1,730 J	10,400
Manganese	88	3 / 3	3 / 3	28,160	**272**	**95.9**	**181**	**3,780**
Mercury	1.1	0 / 3	0 / 3	0.13	0.2 U	0.2 U	0.2 U	0.2 U
Nickel	73	2 / 3	1 / 3	39.0	13.6	4.71 J	10 U	**78.3**
Potassium	NUT	2 / 3	0 / 3	83,058	1,920 J	5000 U	1,160 J	5000 U
Selenium	18	0 / 3	0 / 3	NA	5 U	5 U	5 U	5 U
Silver	18	0 / 3	0 / 3	NA	3 U	3 U	3 U	3 U
Sodium	NUT	3 / 3	0 / 3	79,585	16,100	13,900	7,250	12,300
Thallium	NSL	0 / 3	0 / 3	NA	0.2 U	0.2 U	0.2 U	0.2 U
Vanadium	18	1 / 3	1 / 3	24.1	**34.2**	12.5 U	12.5 U	12.5 U
Zinc	1100	2 / 3	0 / 3	45.2	92.6 J	36.2 J	20 U	216

Notes:

Shading indicates detections.

Bolded underlined shading indicates detected regional screening level (RSL) exceedances.

RSLs are current as of May, 2010

NUT: Nutrient. There is no screening level for Ca, Mg, K, and Na because they are nutrients.

NSL: No screening level. There is no RSL for PETN. Thallium was removed from the RSLs in December, 2009.

B - Analyte not detected at significantly greater than that in an associated blank.

NA – Not available

K - Analyte present. Value may be biased high. Value may be lower

L - Analyte present. Value may be biased low. Value may be higher

U - The material was analyzed for, but not detected

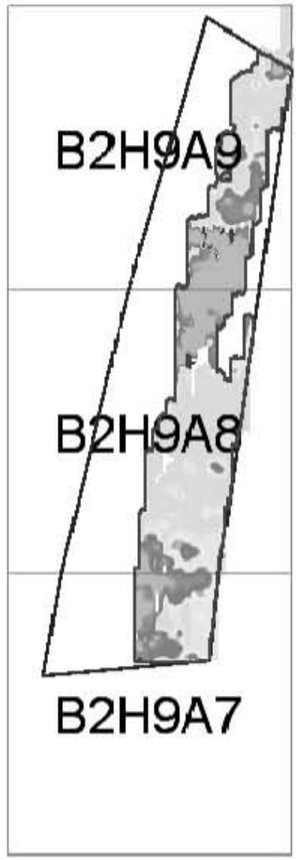
UG/L - Micrograms per liter

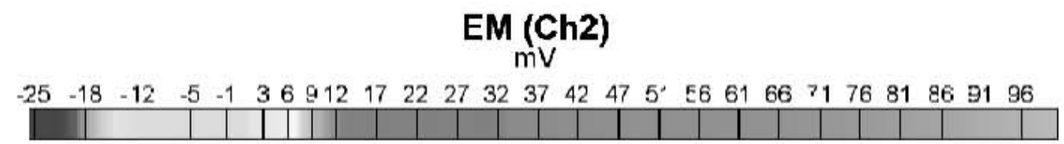
UJ - Analyte not detected, quantitation limit may be inaccurate

J - Analyte present. Value may or may not be accurate or precise

95 percent upper tolerance limits (UTLs) are taken from Table A-8 from the Background Soil Investigation Report for Indian Head and Stump Neck Annex (Tetra Tech, 2002)

Each sample is designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Example: ISUXO6-GP01-MMYY; where I is for Indian Head; S is for site; UXO6 is the site number; GP01 is groundwater sample from station 1; and MMYY is the month and year of collection. If a "P" is at the end of "GP01" then it is a duplicate sample from that station.



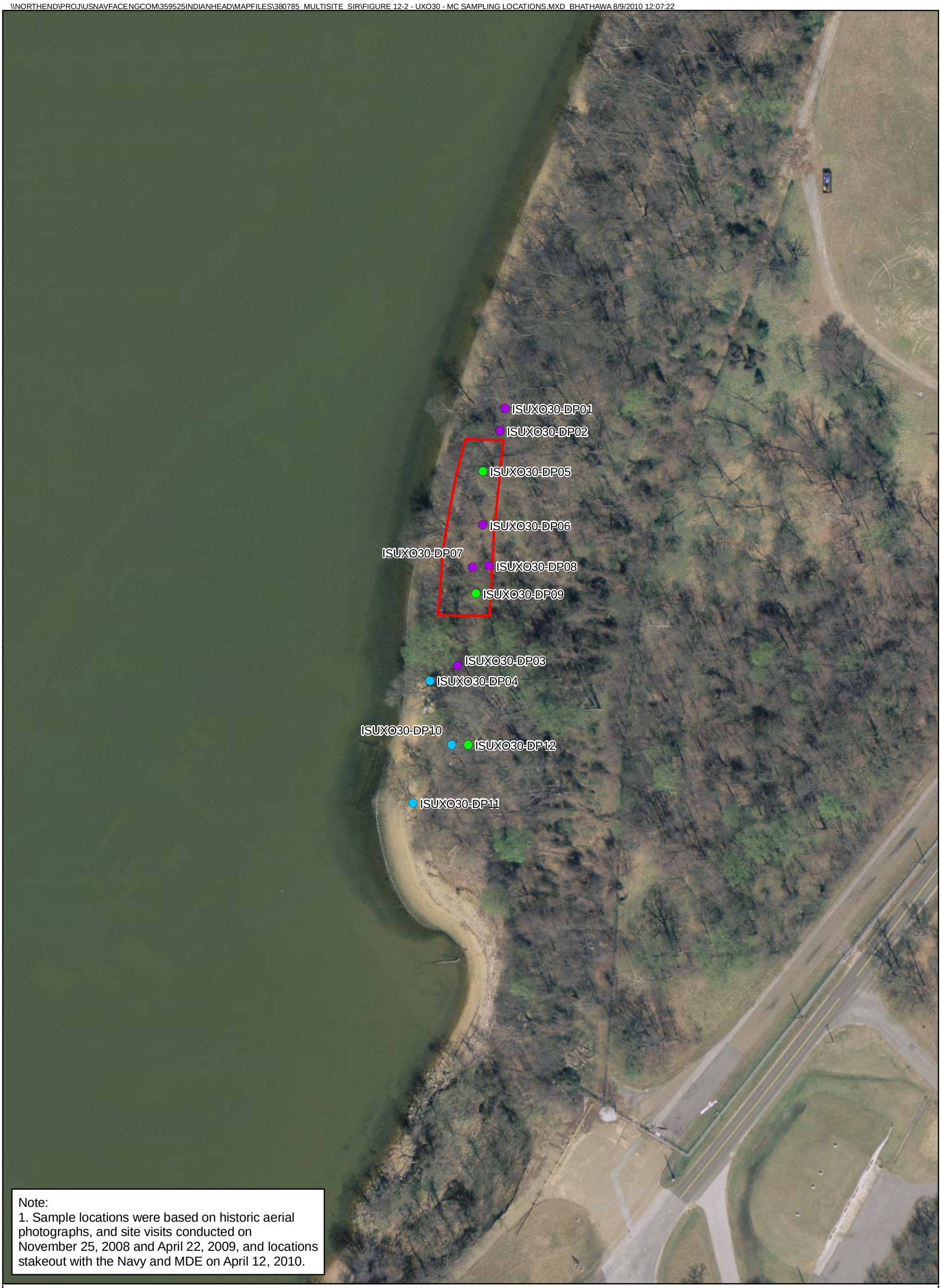


Note:
Figure is taken from Geophysical Survey Report (ARM 2010), which is provided as Appendix B.

Figure 12-1
UXO 30 - DGM Coverage Map
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 12-2 - UXO30 - MC SAMPLING LOCATIONS.MXD BHATHAWA 8/9/2010 12:07:22



Note:
1. Sample locations were based on historic aerial photographs, and site visits conducted on November 25, 2008 and April 22, 2009, and locations stakeout with the Navy and MDE on April 12, 2010.

Legend

- Surface Soil, Subsurface Soil, and *in situ* Groundwater Sample Locations
- Surface and Subsurface Soil Sample Locations
- Surface Soil Sample Locations
- Site Boundary

N

0 50 100 Feet

1 inch = 100 feet

Figure 12-2
UXO 30 - MC Sampling Locations
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

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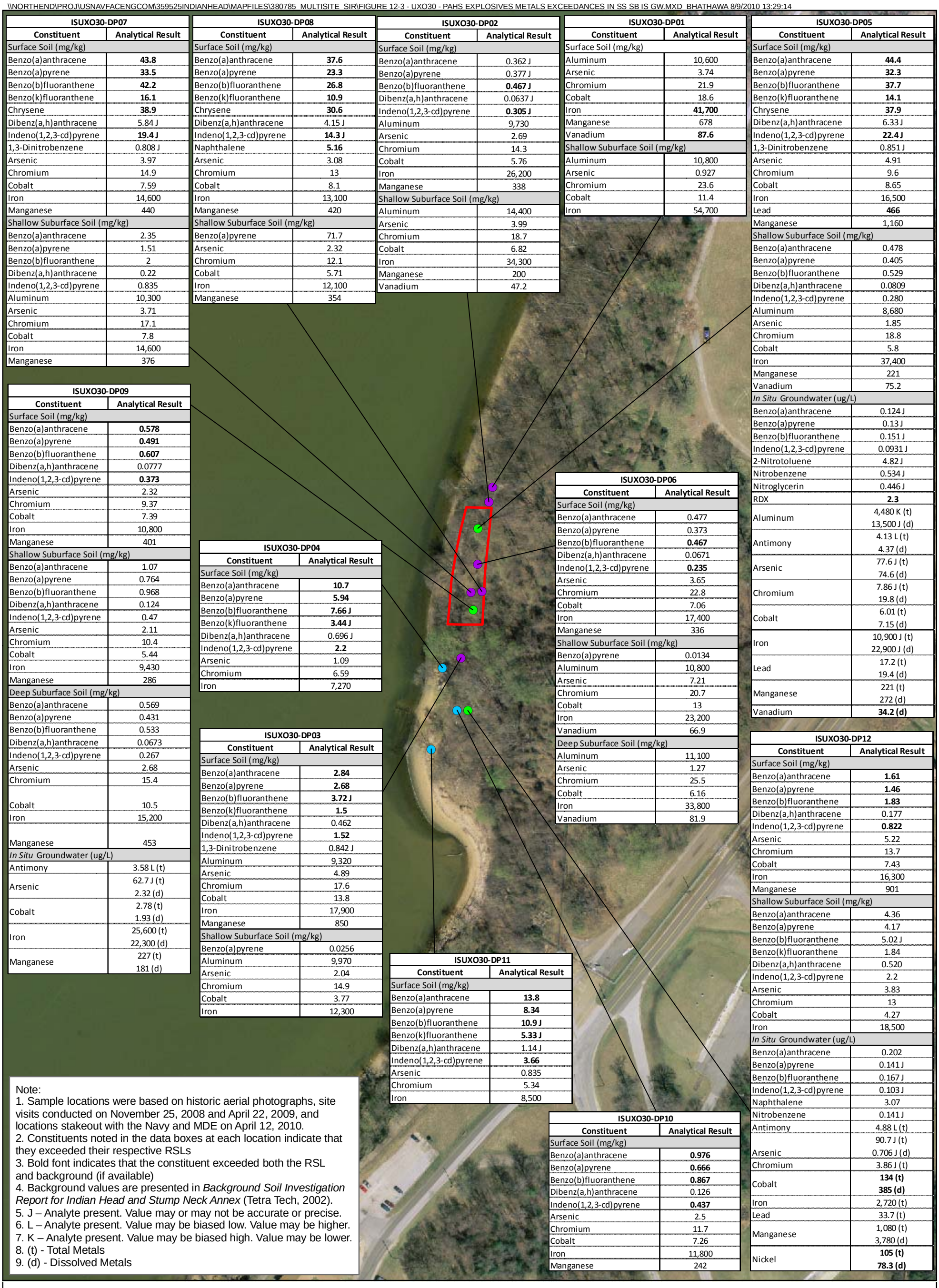


ISUXO30-DP07	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**43.8**
Benzo(a)pyrene	**33.5**
Benzo(b)fluoranthene	**42.2**
Benzo(k)fluoranthene	**16.1**
Chrysene	**38.9**
Dibenz(a,h)anthracene	5.84 J
Indeno(1,2,3-cd)pyrene	**19.4 J**
1,3-Dinitrobenzene	0.808 J
Arsenic	3.97
Chromium	14.9
Cobalt	7.59
Iron	14,600
Manganese	440
Shallow Suburface Soil (mg/kg)	
Benzo(a)anthracene	2.35
Benzo(a)pyrene	1.51
Benzo(b)fluoranthene	2
Dibenz(a,h)anthracene	0.22
Indeno(1,2,3-cd)pyrene	0.835
Aluminum	10,300
Arsenic	3.71
Chromium	17.1
Cobalt	7.8
Iron	14,600
Manganese	376

ISUXO30-DP08	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**37.6**
Benzo(a)pyrene	**23.3**
Benzo(b)fluoranthene	**26.8**
Benzo(k)fluoranthene	**10.9**
Chrysene	**30.6**
Dibenz(a,h)anthracene	4.15 J
Indeno(1,2,3-cd)pyrene	**14.3 J**
Naphthalene	**5.16**
Arsenic	3.08
Chromium	13
Cobalt	8.1
Iron	13,100
Manganese	420
Shallow Suburface Soil (mg/kg)	
Benzo(a)pyrene	71.7
Arsenic	2.32
Chromium	12.1
Cobalt	5.71
Iron	12,100
Manganese	354

ISUXO30-DP02	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	0.362 J
Benzo(a)pyrene	0.377 J
Benzo(b)fluoranthene	**0.467 J**
Dibenz(a,h)anthracene	0.0637 J
Indeno(1,2,3-cd)pyrene	**0.305 J**
Aluminum	9,730
Arsenic	2.69
Chromium	14.3
Cobalt	5.76
Iron	26,200
Manganese	338
Shallow Suburface Soil (mg/kg)	
Aluminum	14,400
Arsenic	3.99
Chromium	18.7
Cobalt	6.82
Iron	34,300
Manganese	200
Vanadium	47.2

ISUXO30-DP01	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Aluminum	10,600
Arsenic	3.74
Chromium	21.9
Cobalt	18.6
Iron	**41,700**
Manganese	678
Vanadium	**87.6**
Shallow Suburface Soil (mg/kg)	
Aluminum	10,800
Arsenic	0.927
Chromium	23.6
Cobalt	11.4
Iron	54,700

ISUXO30-DP05	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**44.4**
Benzo(a)pyrene	**32.3**
Benzo(b)fluoranthene	**37.7**
Benzo(k)fluoranthene	**14.1**
Chrysene	**37.9**
Dibenz(a,h)anthracene	6.33 J
Indeno(1,2,3-cd)pyrene	**22.4 J**
1,3-Dinitrobenzene	0.851 J
Arsenic	4.91
Chromium	9.6
Cobalt	8.65
Iron	16,500
Lead	**466**
Manganese	1,160
Shallow Suburface Soil (mg/kg)	
Benzo(a)anthracene	0.478
Benzo(a)pyrene	0.405
Benzo(b)fluoranthene	0.529
Dibenz(a,h)anthracene	0.0809
Indeno(1,2,3-cd)pyrene	0.280
Aluminum	8,680
Arsenic	1.85
Chromium	18.8
Cobalt	5.8
Iron	37,400
Manganese	221
Vanadium	75.2
In Situ Groundwater (ug/L)	
Benzo(a)anthracene	0.124 J
Benzo(a)pyrene	0.13 J
Benzo(b)fluoranthene	0.151 J
Indeno(1,2,3-cd)pyrene	0.0931 J
2-Nitrotoluene	4.82 J
Nitrobenzene	0.534 J
Nitroglycerin	0.446 J
RDX	**2.3**
Aluminum	4,480 K (t) 13,500 J (d)
Antimony	4.13 L (t) 4.37 (d)
Arsenic	77.6 J (t) 74.6 (d)
Chromium	7.86 J (t) 19.8 (d)
Cobalt	6.01 (t) 7.15 (d)
Iron	10,900 J (t) 22,900 J (d)
Lead	17.2 (t) 19.4 (d)
Manganese	221 (t) 272 (d)
Vanadium	**34.2 (d)**

ISUXO30-DP09	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**0.578**
Benzo(a)pyrene	**0.491**
Benzo(b)fluoranthene	**0.607**
Dibenz(a,h)anthracene	0.0777
Indeno(1,2,3-cd)pyrene	**0.373**
Arsenic	2.32
Chromium	9.37
Cobalt	7.39
Iron	10,800
Manganese	401
Shallow Suburface Soil (mg/kg)	
Benzo(a)anthracene	1.07
Benzo(a)pyrene	0.764
Benzo(b)fluoranthene	0.968
Dibenz(a,h)anthracene	0.124
Indeno(1,2,3-cd)pyrene	0.47
Arsenic	2.11
Chromium	10.4
Cobalt	5.44
Iron	9,430
Manganese	286
Deep Suburface Soil (mg/kg)	
Benzo(a)anthracene	0.569
Benzo(a)pyrene	0.431
Benzo(b)fluoranthene	0.533
Dibenz(a,h)anthracene	0.0673
Indeno(1,2,3-cd)pyrene	0.267
Arsenic	2.68
Chromium	15.4
Cobalt	10.5
Iron	15,200
Manganese	453
In Situ Groundwater (ug/L)	
Antimony	3.58 L (t)
Arsenic	62.7 J (t) 2.32 (d)
Cobalt	2.78 (t) 1.93 (d)
Iron	25,600 (t) 22,300 (d)
Manganese	227 (t) 181 (d)

ISUXO30-DP04	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**10.7**
Benzo(a)pyrene	**5.94**
Benzo(b)fluoranthene	**7.66 J**
Benzo(k)fluoranthene	**3.44 J**
Dibenz(a,h)anthracene	0.696 J
Indeno(1,2,3-cd)pyrene	**2.2**
Arsenic	1.09
Chromium	6.59
Iron	7,270

ISUXO30-DP06	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	0.477
Benzo(a)pyrene	0.373
Benzo(b)fluoranthene	**0.467**
Dibenz(a,h)anthracene	0.0671
Indeno(1,2,3-cd)pyrene	**0.235**
Arsenic	3.65
Chromium	22.8
Cobalt	7.06
Iron	17,400
Manganese	336
Shallow Suburface Soil (mg/kg)	
Benzo(a)pyrene	0.0134
Aluminum	10,800
Arsenic	7.21
Chromium	20.7
Cobalt	13
Iron	23,200
Vanadium	66.9
Deep Suburface Soil (mg/kg)	
Aluminum	11,100
Arsenic	1.27
Chromium	25.5
Cobalt	6.16
Iron	33,800
Vanadium	81.9

ISUXO30-DP12	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**1.61**
Benzo(a)pyrene	**1.46**
Benzo(b)fluoranthene	**1.83**
Dibenz(a,h)anthracene	0.177
Indeno(1,2,3-cd)pyrene	**0.822**
Arsenic	5.22
Chromium	13.7
Cobalt	7.43
Iron	16,300
Manganese	901
Shallow Suburface Soil (mg/kg)	
Benzo(a)anthracene	4.36
Benzo(a)pyrene	4.17
Benzo(b)fluoranthene	5.02 J
Benzo(k)fluoranthene	1.84
Dibenz(a,h)anthracene	0.520
Indeno(1,2,3-cd)pyrene	2.2
Arsenic	3.83
Chromium	13
Cobalt	4.27
Iron	18,500
In Situ Groundwater (ug/L)	
Benzo(a)anthracene	0.202
Benzo(a)pyrene	0.141 J
Benzo(b)fluoranthene	0.167 J
Indeno(1,2,3-cd)pyrene	0.103 J
Naphthalene	3.07
Nitrobenzene	0.141 J
Antimony	4.88 L (t)
Arsenic	90.7 J (t) 0.706 J (d)
Chromium	3.86 J (t)
Cobalt	**134 (t)** **385 (d)**
Iron	2,720 (t)
Lead	33.7 (t)
Manganese	1,080 (t) 3,780 (d)
Nickel	**105 (t)** **78.3 (d)**

ISUXO30-DP03	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**2.84**
Benzo(a)pyrene	**2.68**
Benzo(b)fluoranthene	**3.72 J**
Benzo(k)fluoranthene	**1.5**
Dibenz(a,h)anthracene	0.462
Indeno(1,2,3-cd)pyrene	**1.52**
1,3-Dinitrobenzene	0.842 J
Aluminum	9,320
Arsenic	4.89
Chromium	17.6
Cobalt	13.8
Iron	17,900
Manganese	850
Shallow Suburface Soil (mg/kg)	
Benzo(a)pyrene	0.0256
Aluminum	9,970
Arsenic	2.04
Chromium	14.9
Cobalt	3.77
Iron	12,300

ISUXO30-DP11	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**13.8**
Benzo(a)pyrene	**8.34**
Benzo(b)fluoranthene	**10.9 J**
Benzo(k)fluoranthene	**5.33 J**
Dibenz(a,h)anthracene	1.14 J
Indeno(1,2,3-cd)pyrene	**3.66**
Arsenic	0.835
Chromium	5.34
Iron	8,500

ISUXO30-DP10	
Constituent	**Analytical Result**
Surface Soil (mg/kg)	
Benzo(a)anthracene	**0.976**
Benzo(a)pyrene	**0.666**
Benzo(b)fluoranthene	**0.867**
Dibenz(a,h)anthracene	0.126
Indeno(1,2,3-cd)pyrene	**0.437**
Arsenic	2.5
Chromium	11.7
Cobalt	7.26
Iron	11,800
Manganese	242

Note:
1. Sample locations were based on historic aerial photographs, site visits conducted on November 25, 2008 and April 22, 2009, and locations stakeout with the Navy and MDE on April 12, 2010.
2. Constituents noted in the data boxes at each location indicate that they exceeded their respective RSLs
3. Bold font indicates that the constituent exceeded both the RSL and background (if available)
4. Background values are presented in *Background Soil Investigation Report for Indian Head and Stump Neck Annex* (Tetra Tech, 2002).
5. J – Analyte present. Value may or may not be accurate or precise.
6. L – Analyte present. Value may be biased low. Value may be higher.
7. K – Analyte present. Value may be biased high. Value may be lower.
8. (t) - Total Metals
9. (d) - Dissolved Metals

Legend
- Surface Soil, Subsurface Soil, and *in situ* Groundwater Sample Locations
- Surface and Subsurface Soil Sample Locations
- Surface Soil Sample Locations
- Site Boundary

N

0 75 150 Feet

1 inch = 150 feet

Figure 12-3
UXO 30 - PAHs, Explosives, and Metals Exceedances
in Surface Soil, Subsurface Soil, and *In Situ* Groundwater
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

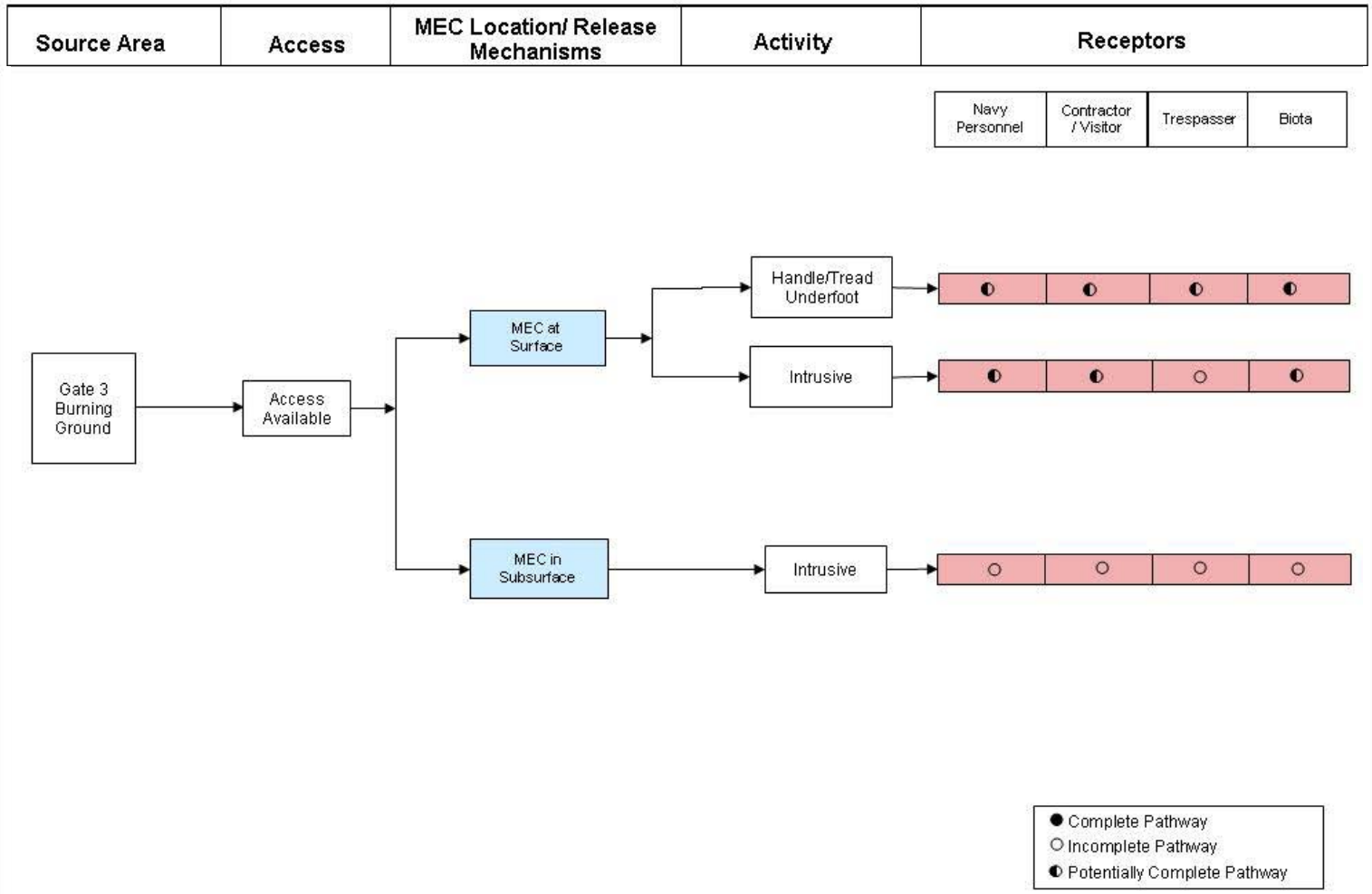


FIGURE 12-4
UXO 30 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.2-3 in the Preliminary Assessment (Malcolm Pirnie 2005)

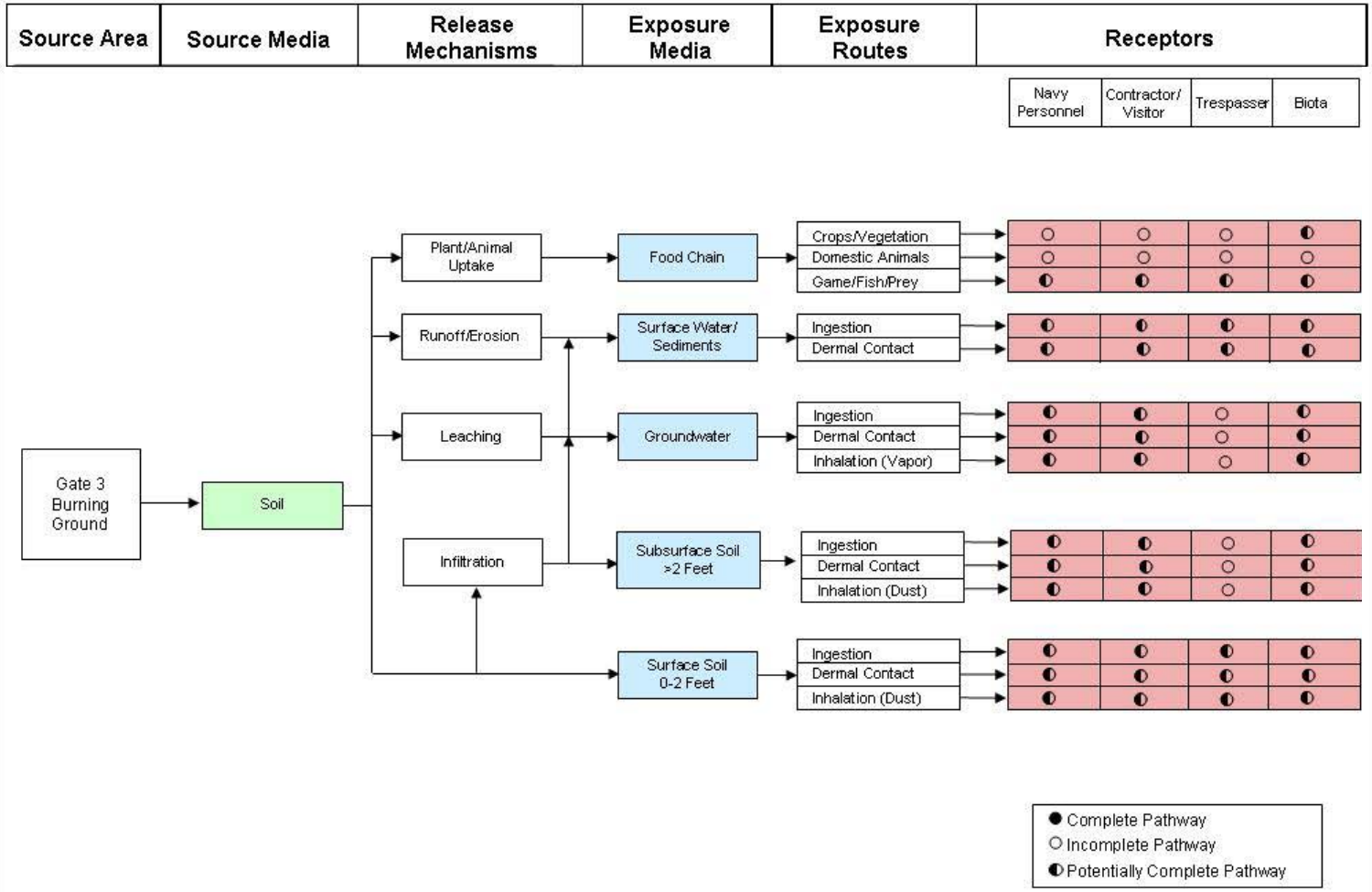


FIGURE 12-5
UXO 30 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.2-4 in the Preliminary Assessment (Malcolm Pirnie 2005)

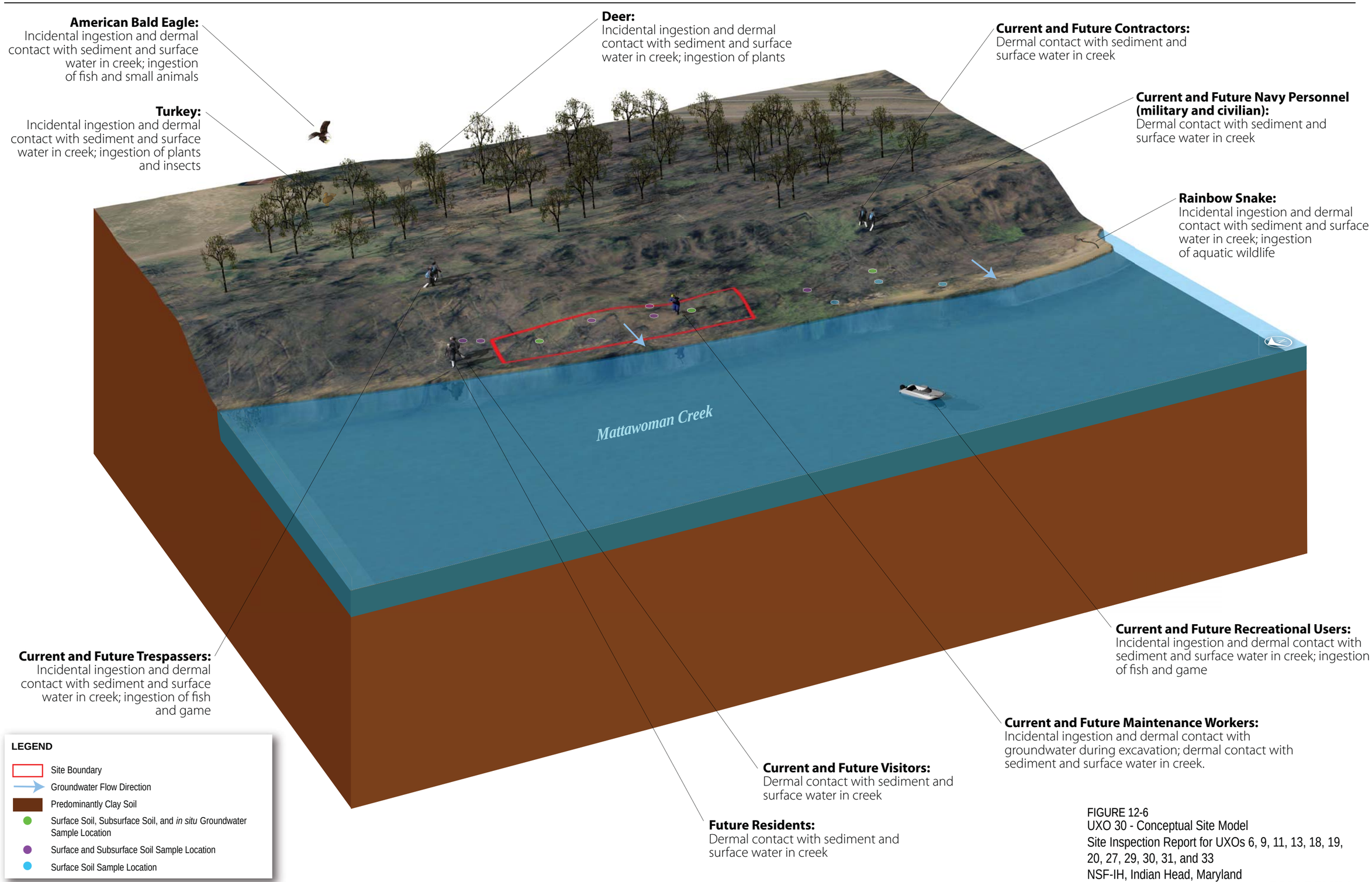


FIGURE 12-6
UXO 30 - Conceptual Site Model
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

ES080210002745WDC IH_Site_30_CSM_v5.ai 8-06-10 mlb

Photo 12-1: UXO 30 – General view of site. View is to the northwest with the Potomac River in the background. Photo was taken on 11/25/08.

SECTION 13

UXO 31 – Pope's Creek

13.1 Site Background

A PA of this site was completed and the findings documented in the WAMS. UXO 31 is an off-Base water site approximately 30 miles downstream and southeast of NSF-IH within the Potomac River and south of Pope's Creek, near the town of Pope's Creek, Maryland (Figure 1-2 and Photo 13-1). On June 2, 1947, a public notice was issued to advise that underwater testing of demolition charges or explosive material would be conducted in the Potomac River in the area of Pope's Creek (War Department, 1947). According to the WAMS, the testing area covered approximately 44 acres, and the publicized safety zone was approximately 841 acres. Figure 13-1 shows the locations of the test area and safety zone, which are about 2 miles north of the Potomac River Bridge. The types of munitions used in activities associated with this area are unknown. Based on information collected for the WAMS, there are no known MEC areas at the site. However, the site is categorized as a suspected MEC area on the basis of its reported use for underwater testing of demolition charges or explosive material.

13.2 Rationale and Objectives for Expanded PA

The WAMS recommended an SI for MEC over the entire 44-acre testing area and NFA for MC. The SI for MEC would consist of a geophysical investigation of 44 acres to determine if MEC is present and whether further action would be necessary. NFA was proposed for MC because activities at the site are based on anecdotal evidence.

Because UXO 31 is a large water site (more than 300 acres), and because of the uncertainty associated with the types of munitions that could have been used or the exact locations where activities or operations could have occurred, CH2M HILL recommended an expanded PA to augment, but not duplicate, the information in WAMS. As a result, information collected as part of the expanded PA would be used in conjunction with the WAMS information to propose a recommendation for the site.

The objectives of the expanded PA were accomplished through: (1) review of existing information in WAMS; (2) records search to obtain additional information on operations at the site; (3) review of information on sediment dynamics; and (4) risk analysis.

13.3 Results

Appendix H presents a detailed discussion of the results of the expanded PA. The additional research conducted indicated that the area used for explosives testing near Pope's Creek was on the eastern shore of the Potomac River. Testing was conducted in the deepest portion of the navigation channel (War Department, 1947). While references to underwater explosions at Pope's Creek were identified by Carlisle (1990), no specific information on locations and types of explosives used during testing were reviewed. A 1947 memorandum (Exhibit A in Appendix xx) refers to the firing of charges of 80 pounds or less for

underwater explosives research if the location were satisfactory. It further notes that large charges could be fired in the area near Pope's Creek, but that explosives testing should be suspended during spring months. The memorandum notes that precautions should be taken in the summer months to prevent possible injury to bathers in the Potomac River. No other information regarding activities at Pope's Creek was available during the records search.

The results of the sediment dynamics study noted the area used for explosives testing near Pope's Creek was on the eastern shore of the Potomac River. Testing was conducted in the deepest portion of the navigation channel, which had a depth of 78 feet (War Department, 1947). The channel appears to be migrating eastward; the eastern bank of the navigation channel shallows from more than 70 feet to under 10 feet over a short distance (Figure 5 in Appendix H). As the channel migrates to the east, the western portion of the channel is filled by sediment. MEC items may have been partially or fully buried by a combination of sediment deposition and sinking into soft bottom sediments.

The results of the risk analysis indicated that UXO 31 is a large area where MEC may or may not remain; bottom conditions have silted over, and swift currents with winter flooding may have moved potential sources down the river or creek. The likelihood of encountering MEC through recreational activities associated with water sports is remote. However, commercial activities such as channel dredging could actively disturb bottom sediment conditions to cause a potential MEC item to be vacuumed from the bottom into a marine vessel.

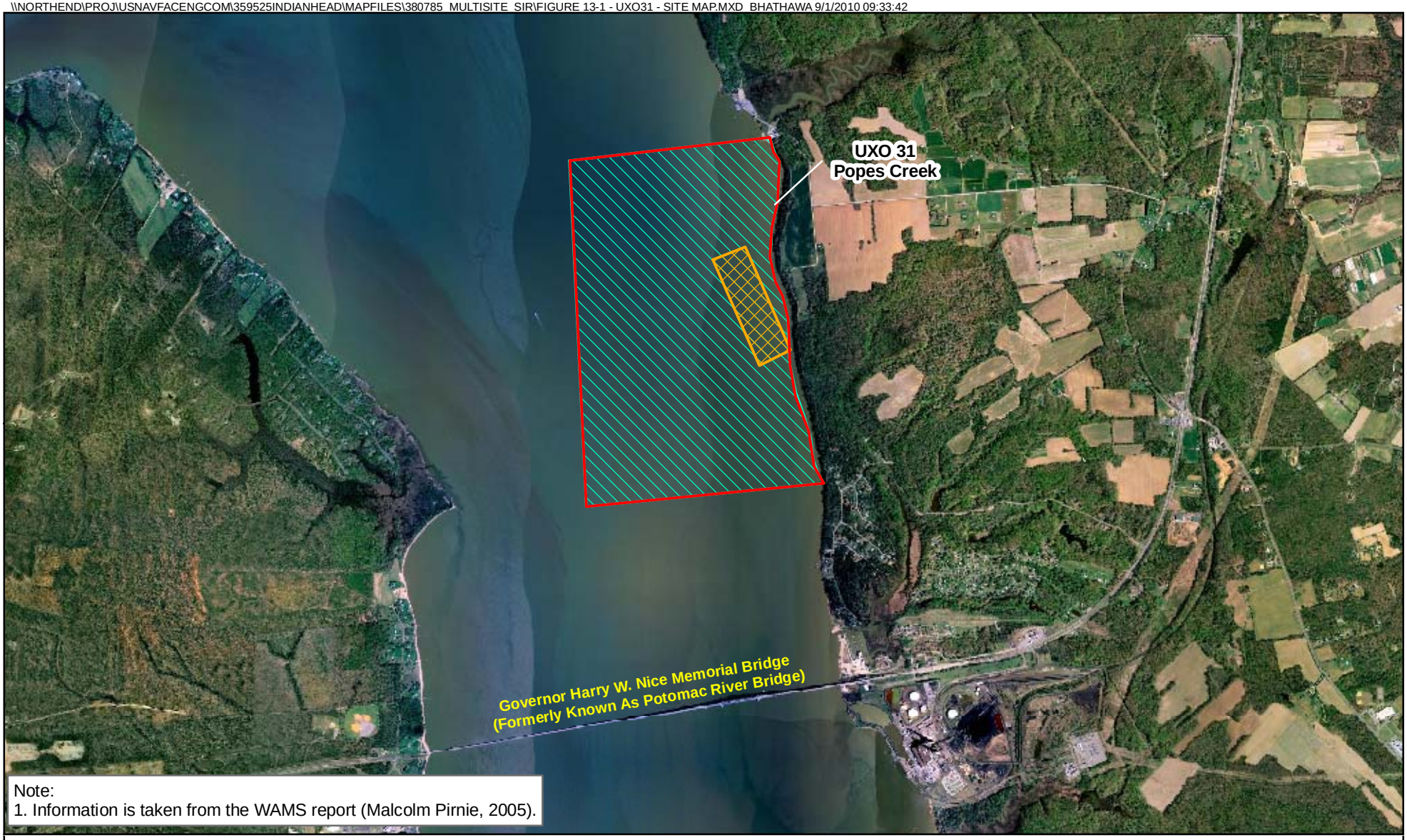
13.4 Conceptual Site Model

The CSM for UXO 31 was presented in Section 7.1.11 of the WAMS, and is summarized here and updated if necessary. CSMs from the PA for MEC and MC are shown as Figures 13-2 and 13-3, respectively. Following the expanded PA, it was concluded that there are incomplete pathways to human and ecological receptors because sediment deposition over time would have covered MEC and MC at the site. The only potential pathway is intrusive activities, such as river dredging, which could disturb the river sediment.

13.5 Recommendations

Figure 10 in Appendix H shows the explosive area where underwater testing was done. Given the time since munitions were last used at this site (1947), MEC and associated fragments would likely have been buried by sediment deposition over time. As a result, there is an incomplete pathway to human receptors (recreational) from MEC items and MC. Channel dredging will disturb the sediment bottom, which could create a condition in which MEC items could be encountered. Because of the low explosive safety risk and the absence of documented releases of MEC or MC at the site, no further MEC and MC investigations are recommended. However, because of the potential for MEC to be present, it is recommended that the existing Danger Zone on the NOAA maps should be expanded to include the potential impact area from UXO 31. In addition, the Danger Zone regulations should be updated to reflect the current site use and to restrict intrusive activities (such as anchoring or dredging) into the underlying sediments unless UXO avoidance procedures are performed first.

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 13-1 - UXO31 - SITE MAP.MXD BHATHAWA 9/1/2010 09:33:42



Note:
1. Information is taken from the WAMS report (Malcolm Pirnie, 2005).

Legend
- Danger Zone
- Explosive Area
- Approximate Site Boundary

N

0 1,500 3,000 Feet

Image Source: Google Earth Pro

Figure 13-1
UXO 31 - Site Map
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

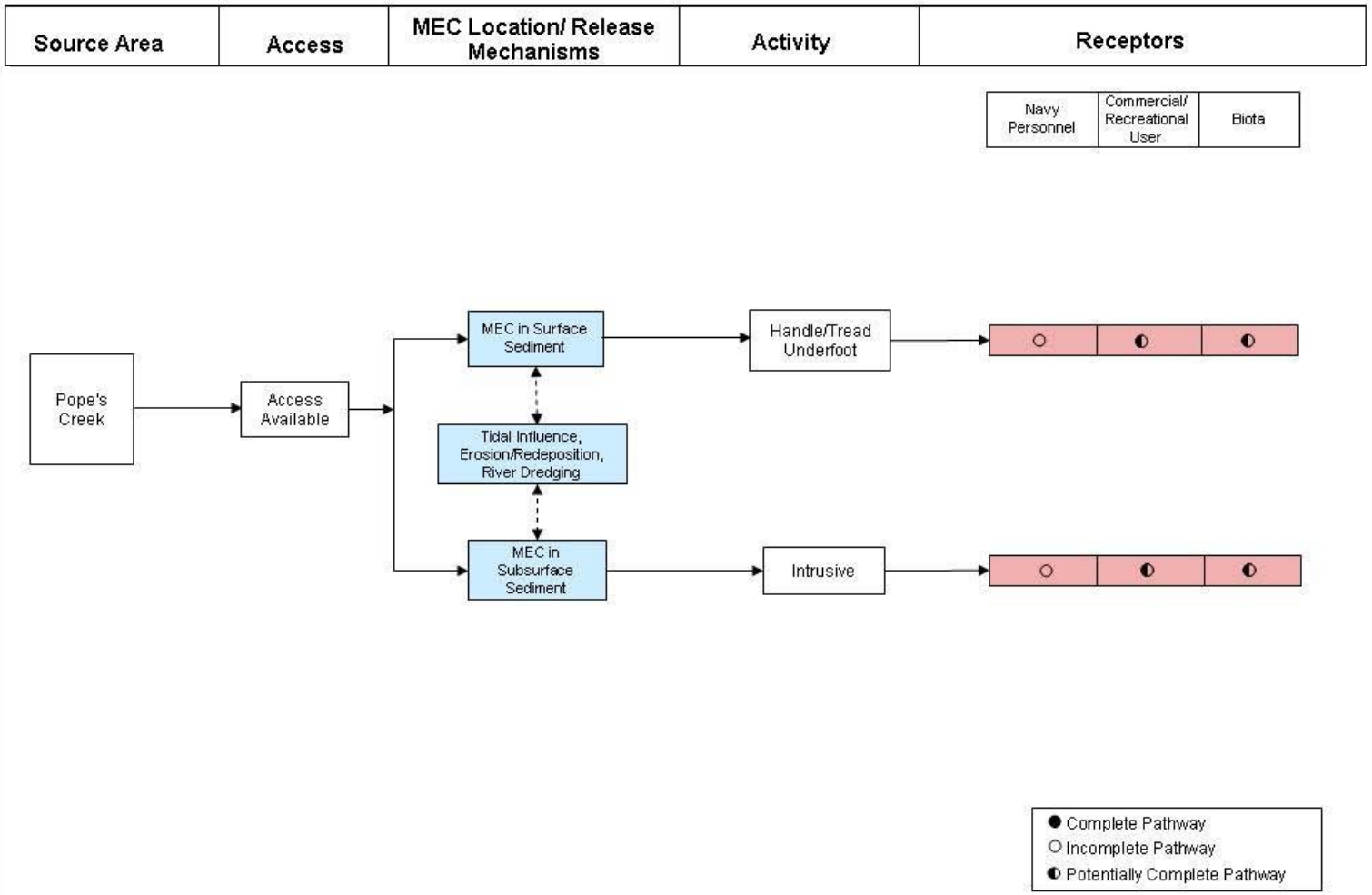


FIGURE 13-2
UXO 31 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 7.1-3 in the Water Area Munitions Study (Malcolm Pirnie 2005)

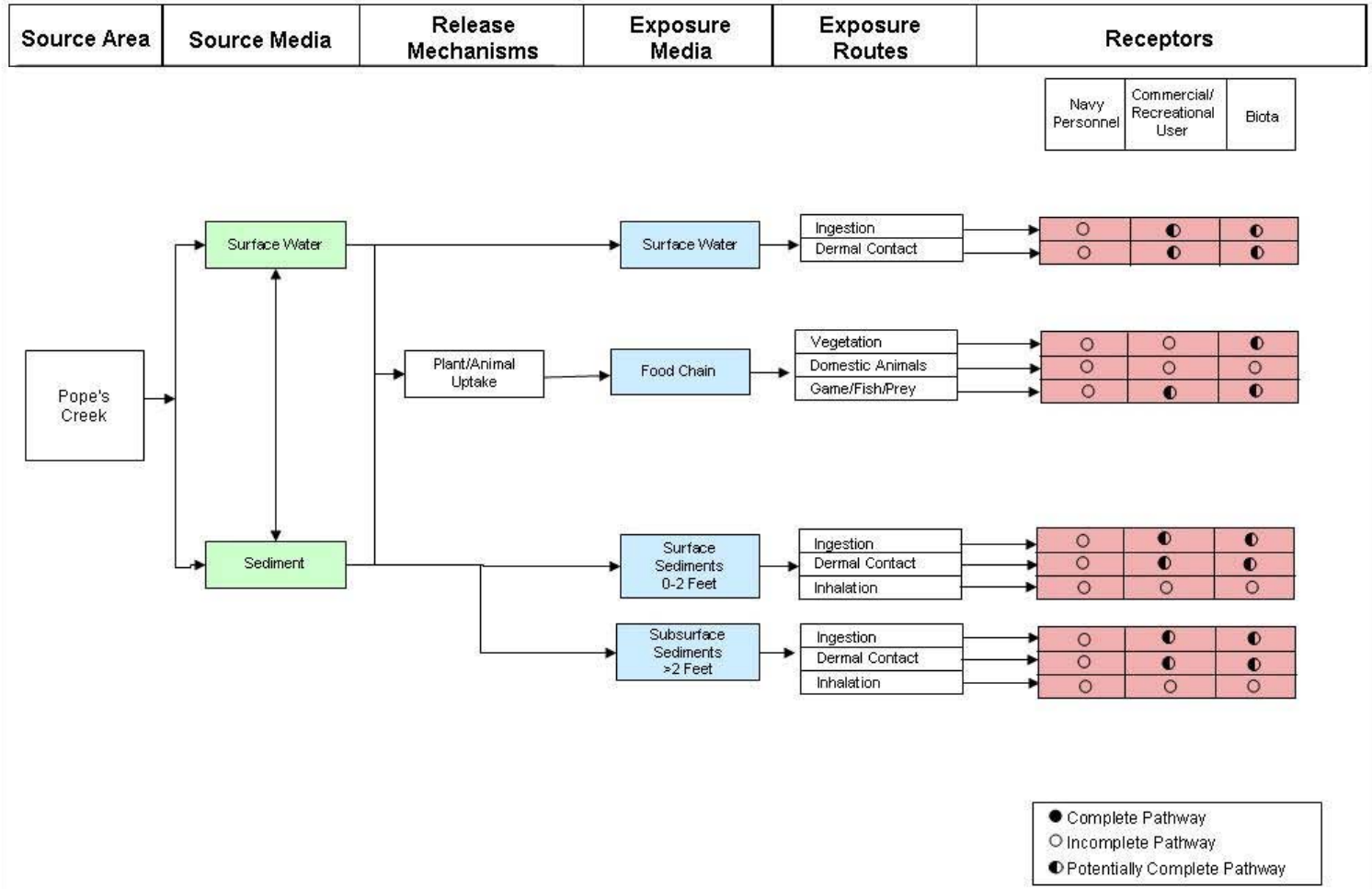


FIGURE 13-3
UXO 31 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 7.1-4 in the Water Area Munitions Study (Malcolm Pirnie 2005)

Photo 13-1: UXO 31 – General view of the site. View of the Potomac River is to the south; the Governor Harry W. Nice Memorial Bridge is in the background. Photo was taken on 9/9/10.

SECTION 14

UXO 33 – Water Impact Area

14.1 Site Background

A PA was completed for this site and the findings documented in the WAMS. UXO 33 is a 12,296-acre water site located between Chapman's Point, Maryland, and the mouth of Chopawamsic Creek (Figure 14-1 and Photo 14-1). Part of UXO 18 (Battle Range Firing Area) and all of UXO 27 (Sonar Training Area) are within this site. In the WAMS, the entire site is classified as a suspected MEC area because of historical operations, which included the following:

1. Strayed ordnance from battleship gun testing from January 24, 1891, until July 21, 1921, from UXO 11 (The Valley). Rockets were also fired from a dock firing station at UXO 11 until 1946 or 1947. Guns and rockets fired from UXO 11 may have missed intended targets and landed in UXO 33.
2. Underwater explosions in the Potomac River, which may have occurred in 1961. On December 23, 1960, a public notice was issued by the U.S. Army Corps of Engineers that underwater explosions in the Potomac River would occur between Chapman's Point and the mouth of Chicamuxen Creek between January 2, 1961, and March 15, 1961. The types of munitions used for the explosions are unknown. In a memorandum dated October 12, 1979, from the Chief of Naval Material, underwater explosions in the Potomac River were documented. Figure 5.2-1 in the WAMS shows the locations of the test sites described in the 1979 memorandum. Naval Facilities Engineering Command Washington personnel informed Malcolm Pirnie that this area was dredged in 1952 to recover munitions scrap for metal recycling.
3. Accidental releases of ordnance remnants and bulk propellant from the large motor test facility.

14.2 Rationale and Objectives for Expanded PA

The WAMS recommended an SI/RI for MEC and an RI for MC. The SI for MEC would focus on determining if MEC is present in 85 acres of the site; a geophysical investigation and remote underwater vehicle inspection were also proposed. The RI would be based on the SI results for MEC and MC. The SI for MC would consist of collecting sediment samples in the Potomac River for explosives and metals using remote underwater inspection to select sample locations.

Because UXO 33 is a large water site (more than 300 acres), and because of the uncertainty associated with the types of munitions that could have been used or the exact locations where activities or operations could have occurred, CH2M HILL recommended an expanded PA to augment, but not duplicate, the information in WAMS. As a result, information collected as part of the expanded PA would be used in conjunction with the WAMS information to propose a recommendation for the site.

The objectives of the expanded PA were accomplished through: (1) review of existing information in WAMS; (2) records search to obtain additional information on operations at the site; (3) review of information on sediment dynamics; and (4) risk analysis.

14.3 Results

Appendix H presents a detailed discussion of the results of the expanded PA. The bullets below summarize key findings from the additional research:

A Danger Zone was established in the Potomac River near the town of Indian Head; most of the shell fragments that fell into the Danger Zone were attributed to (1) proofing the fuses from 3- and 4-inch guns, (2) detonator tests, (3) shell fragments that disintegrated in flight or broke up within a gun, and (4) testing of time fuses. In November 1922, the Danger Zone was cancelled

Test to determine the effects of rope charges on 3/16-, 5/16-, 3/8-, ½-, and 1½-inch steel plates

Documentation of proposed underwater explosion testing in the Potomac River (Exhibits G and H in Appendix H), objectives of the testing, and that the best location will be in the deepest part of the channel

Documentation of testing in the Potomac River (Exhibits I and J, and Figure 4 in Appendix H)

Documentation of Explosive Ordnance Disposal personnel conducting tests on underwater ordnance (such as mines, torpedoes, and depth charges) and conducting underwater explosive training in mine neutralization (Exhibit L in Appendix H).

References to weapons testing, gunshots fired, underwater explosions tests in various documents

The results of the sediment dynamics study noted that UXO 33 encompasses more than 12,000 acres and covers the full range of bathymetric features in the lower Potomac River, from shallow flats to deep portions of the main river channel. This area also contains the dredged navigation channel off NSF-IH. MEC items from the explosive fragments of gun firing and underwater explosion testing may have been partially or fully buried by a combination of sediment deposition and sinking into soft bottom sediments.

The risk analysis indicated that UXO 33 spans both shallow and fairly deep waters of the Potomac River, with most of the area in fast-moving currents, the main channel, or in the intersections of tributaries with the confluence of creek and river waters. Annual spring and winter flooding, combined with occasional hurricane conditions, has made the river bottom over the past 100 years a changing and evolving one. The likelihood for MEC to remain where fired is “occasional,” with a greater probability for downriver movement from the initial intended impact area. This suspicion is the case for most of UXO 33, except for the two test sites shown on Figure 3 in Appendix H. Both test areas were at some time fixed for either surface firing or underwater testing. As a result, both areas have the potential for underwater remains of targets or test facilities that may still contain MEC.

14.4 Conceptual Site Model

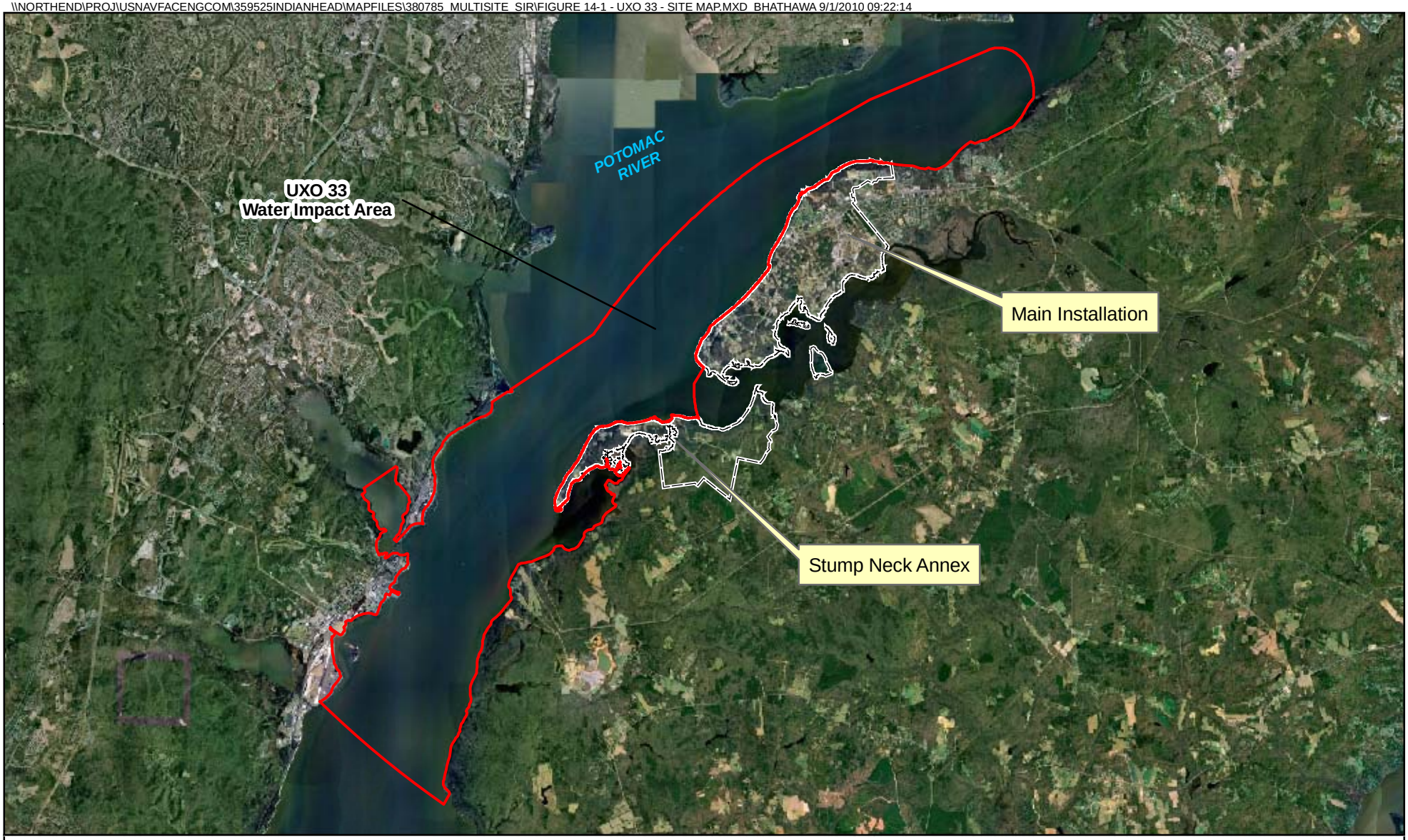
The CSM for UXO 33 was presented in Section 5.2.11 of the WAMS, and is summarized here and updated if necessary. CSMs from the PA for MEC and MC are shown as Figures 14-2 and 14-3, respectively. Following the expanded PA, it was concluded that there are incomplete pathways to human and ecological receptors because sediment deposition over time would have covered MEC and MC at the site. The only potential pathway is intrusive activities, such as river dredging, which could disturb the river sediment.

14.5 Recommendations

Figure 4 in Appendix H shows two test areas (Test Area A and Test Area B) within the site that were used for explosives testing with a limit not to exceed 80 pounds. It is reported that UXO 33 may have been affected by munitions since 1891 (strayed ordnance from testing at UXO 11—The Valley). Any munitions items that were fired into the site would likely be partially or fully buried over time by sediment deposition in the deep navigation channel. As a result, there is an incomplete pathway to human receptors (recreational) from MEC items and MC. No further MEC or MC investigations are recommended for UXO 33.

However, because of the potential for MEC to be present, it is recommended that the existing Danger Zone on the NOAA maps should be expanded to include the potential impact area from UXO 33. In addition, the Danger Zone regulations should be updated to reflect the current site use and to restrict intrusive activities (such as anchoring or dredging) into the underlying sediments unless UXO avoidance procedures are performed first.

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_SIR\FIGURE 14-1 - UXO 33 - SITE MAP.MXD BHATHAWA 9/1/2010 09:22:14



Legend

Approximate Site Boundary

Installation Boundary

N

0 5,000 10,000 Feet

1 inch = 10,000 feet

Imagery Source: Google Earth Pro

Figure 14-1
UXO 33 - Site Map
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

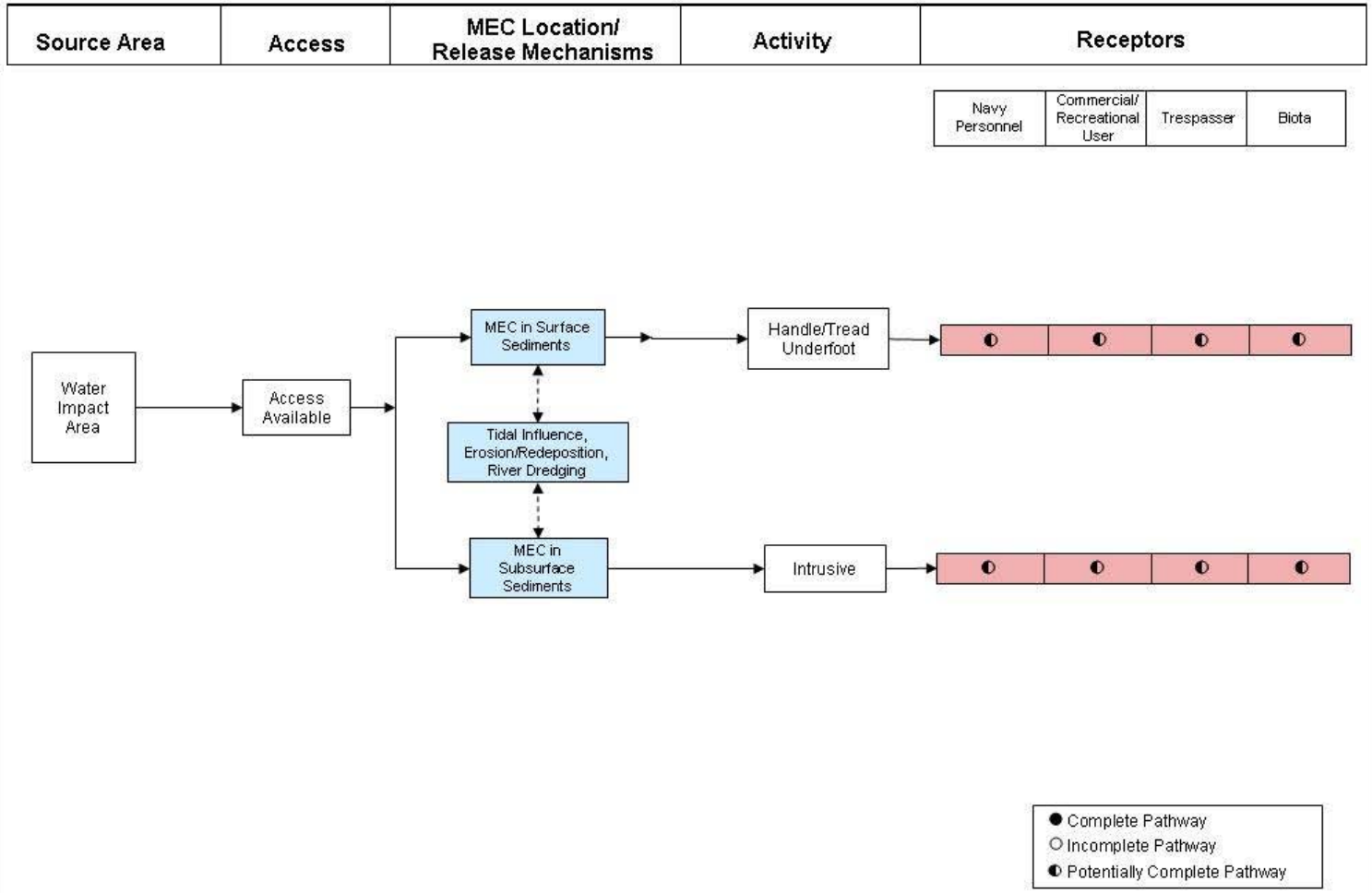


FIGURE 14-2
UXO 33 - CSM for MEC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.2-2 in the Water Area Munitions Study (Malcolm Pirnie 2005)

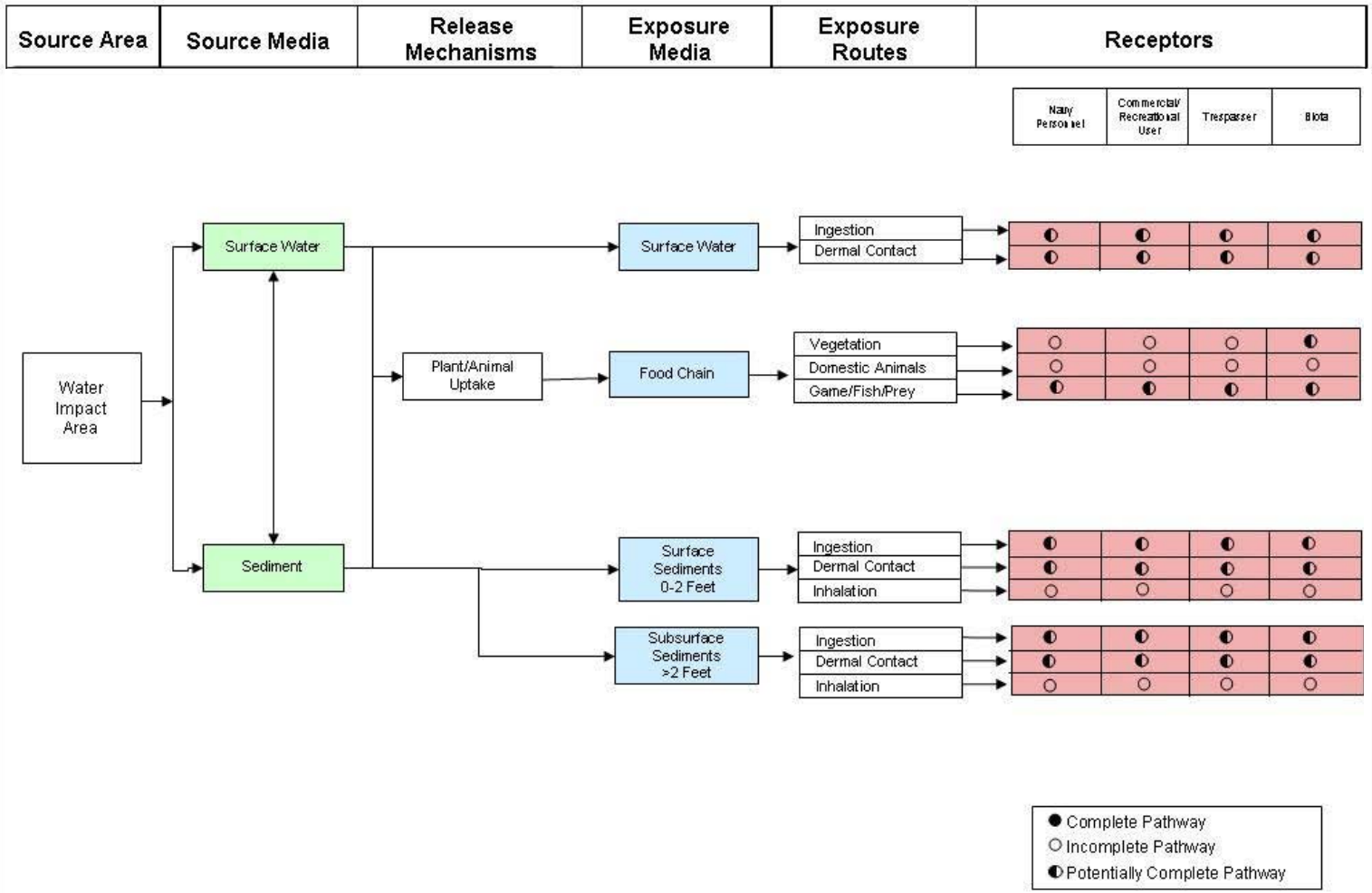


FIGURE 14-3
UXO 33 - CSM for MC Exposure Pathway
Site Inspection Report for UXOs 6, 9, 11, 13, 18, 19, 20, 27, 29, 30, 31, and 33
NSF-IH, Indian Head, Maryland

NOTE
This figure is shown as Figure 5.2-3 in the Water Area Munitions Study (Malcolm Pirnie 2005)

Photo 14-1: UXO 33 – General view of the site. View of the Potomac River is to the northeast. Photo was taken on 9/9/10.

SECTION 15

References

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Appendix A
Aerial Photographic Analysis Report

ERI-72-006
March 2010

AERIAL PHOTOGRAPHIC ANALYSIS

NAVAL SUPPORT FACILITY INDIAN HEAD

INDIAN HEAD, MARYLAND

Prepared for:

CH2M Hill under Navy CLEAN 1000 Program
Prime Contract No: N62470-08-D-1000

P.O. No: 936816

Prepared by:

Environmental Research, Inc.
5267 John Marshall Hwy., Suite C
Linden, Virginia 22642

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1.0 INTRODUCTION

Environmental Research, Inc. (ERI) conducted an analysis of aerial photographs of the Naval Support Facility Indian Head located in Indian Head, Maryland to support CH2M Hill and the Navy with an ongoing site inspection. ERI acquired and stereoscopically analyzed aerial photographs spanning the period from 1937 to 2006 to document activity at the eight UXO Sites listed below and as shown on Figure 1. The sites are listed and discussed in the text from north to south.

- UXO 11 – The Valley
- UXO 9 – Grains Spill
- UXO 30 – Gate 3 Burning Ground
- UXO 13 – Former Skeet Range
- UXO 6 – NG Burning Ground
- UXO 19 – Igniter Area
- UXO 20 – Safety Thermal Treatment Point
- UXO 27 – Sonar Training

Section 4.0 provides a description of features and activity observed on aerial photographs for the dates when environmentally significant findings were noted. The accompanying aerial digital print enlargements and GIS shapefiles display findings from the analysis. The Reference Section (5.0) provides the list of aerial photographs, maps, and collateral data used to prepare this report. A Legend of Symbols (6.0) is provided at the end of the report to be used with the hard copy and/or digital report.

Two digital versatile discs (DVDs) are included with the hardcopy report. One contains the GIS shapefiles and orthorectified aerial photographic mosaics, and one contains a PDF binder with the annotated aerial photographs and the written report. The coordinate system for the digital files in this report is in NAD (North American Datum) 1983, Maryland State Plane, units in feet. The GIS was created in ArcMap 9.1 and can be used alone or in combination with the hardcopy report.

2.0 METHODOLOGY

ERI analysts conducted this aerial photographic analysis by viewing stereo frames of film transparencies through a zoom stereoscope, backlit on a light table. Stereoscopic viewing creates a three-dimensional effect that, when combined with viewing at various magnifications, enables an analyst to identify signatures associated with various features. The term "signature" refers to a combination of visible characteristics, such as tone, shadow, texture, size, shape, pattern, and association, which enable an analyst recognize a specific object or condition on aerial photographs. Identification of signatures and features included in this report is based upon experience of analysts who have viewed similar signatures and features numerous times, often on high-quality imagery, over many years. At least one other senior imagery analyst reviewed the analysis to ensure completeness and consistency of this report. This quality control step is standard practice in the field of photographic interpretation.

Aerial photographs of representative dates were selected, orthorectified, and used to construct photo mosaics of the Naval Support Facility Indian Head. The findings from the analysis were digitized and data layers were keyed to the mosaics. The findings can be viewed on the accompanying DVD’s and digital print enlargements.

3.0 QUALIFICATIONS

Mary Sitton of Environmental Research, Inc. (ERI), performed the aerial photographic analysis for this report. As President of ERI, Ms. Sitton conducts historical and current aerial photographic analysis and land use/land cover mapping projects. Prior her involvement with ERI, Ms. Sitton worked as an independent environmental consultant for the U.S. Department of Justice, Environmental and Natural Resources Division and as on-site imagery analyst/geologist contractor for the U.S. Environmental Protection Agency's Environmental Photographic Interpretation Center (EPIC). Through these various positions, she has accumulated over 25 years of experience in aerial photographic research, acquisition, interpretation, and analysis, focusing on military and industrial operations and environmental conditions. Ms. Sitton holds B.S. degrees in Geology and Business Management from Radford University.

Linley (Hank) Malcom, who conducted the quality control analysis for this report, has 39 years of experience as an imagery analyst dealing with military issues. Mr. Malcom served as a U.S. Army intelligence Officer (1969-1972) and as an imagery analyst with the Central Intelligence Agency (1973-2000); he retired after 30 years of service. During his CIA career, he developed analytical methodologies and conducted in-depth studies of foreign military forces; developed techniques for analysis of foreign internal security forces; produced current intelligence; and mentored numerous junior and mid-level imagery analysts. From 1985 to 2000 he served as a Senior Imagery Analyst, and in this position he conducted analysis of high-interest issues and guided analysis of military forces and related issues in his division. For the past nine years he has been involved with analysis of industrial and military-related topics at ERI. Mr. Malcom holds a B.B.A. degree in Economic Geography from the University of Georgia.

4.0 AERIAL PHOTOGRAPHIC ANALYSIS

The following provides a description of findings from the analysis of aerial photographs for those dates when environmentally significant features were identified. The eight UXO sites are listed below from north to south. Figure numbers correspond to the annotated aerial photographs provided in Appendix A.

UXO 11 The Valley

FIGURE 2 June 22, 1937: Excavations and probable pits were present in an area of disturbed ground in the north central portion of the valley. Two areas of disturbed ground were in the southern portion of the site.

UXO 9 Grains Spill

FIGURE 3 June 22, 1937: Open rail boxcars containing light-toned material were present in an area of disturbed ground (probable staging area) west of the site. Rail tank cars were also present west of the site. A topographically low excavated area was present along a rail line in the western portion of the site.

FIGURE 4 August 26, 1944: Open rail boxcars containing light-toned material were present in an area of disturbed ground (probable staging area) west of the site. Open rail boxcars, rail boxcars and a rail tank car were present in the eastern portion of the site. The excavated area remained along a rail line in the western portion of the site. Light-toned material was present along or adjacent to the tracks in three locations within the site. Stacked materials (crates, containers) were located south of the site.

March 12, 1950: Rail boxcars were present in the northwestern portion of the site. Stacked materials (crates, containers) were located south of the site.
April 18, 1954: Open storage bins were present in the south central portion of the rail yard. Rail boxcars were located in the eastern and western portions of the site. Stacked materials (crates, containers) were present south of the site.

FIGURE 5 May 29, 1956: Open storage bins remained in the south-central portion of the site. Rail boxcars were located in the northern and southern portions of the site and west of the site. An area of disturbed ground was located adjacent to a storage building in the northeastern portion of the site. Stacked materials (crates, containers) remained south of the site.

October 22, 1957: Open storage bins remained in the south central portion of the site. Stacked materials (crates, containers) remained south of the site. Rail boxcars were located in the eastern portion of the site.

UXO 9 Grains Spill - continued

August 29, 1961: Open storage bins remained in the south-central portion of the site. Rail boxcars were located in the eastern and western portions of the site. Stacked materials (crates, containers) remained south of the site.

FIGURE 6 February 7, 1962: Open rail boxcars containing light and medium-toned material were located west of the site. Open storage bins remained in the south-central portion of the site; however, they appeared to be unused. Rail boxcars were located in the southern portion of the site. Stacked materials (crates, containers) remained south of the site.

May 5, 1964: Open storage bins remained in the south central portion of the site; however, they appeared unused. Rail boxcars were located in the eastern portion of the site. Stacked materials (crates, containers) remained south of the site.

September 23, 1972: The open storage bins were inactive and the area was vegetated. Rail boxcars were located in the western portion of the site. Rail boxcars and a rail tank car were present in the eastern portion of the site. Stacked materials (crates, containers) remained south of the site.

May 6, 1980: A large graded area was present in the western portion of the site (see annotation on 1962 aerial photograph). Rail boxcars were present in the western and eastern portions of the site. The stacked materials seen in previous years south of the site were no longer present.

May 7, 1981: The large graded area remained in the western portion of the site and might have had fill material added since 1980. Rail boxcars were present in the western and eastern portions of the site.

UXO 30 Gate 3 Burning Ground

June 22, 1937: An access road led to a rectangular structure in the water. This structure remained throughout the study period, becoming dilapidated in the more recent years. A smaller access road led to a ground-scarred and disturbed area to the north.

FIGURE 7 June 3, 1943: A linear feature was visible in a scarred and disturbed area surrounded by woods. The scarred and disturbed area seen in 1937 was revegetating.

October 22, 1943: The linear feature seen in June 1943 remained.

August 26, 1944: The linear feature remained. A footpath led to the structure from the main access road.

March 12, 1950: The linear rectangular feature remains; however, the footpath that led to the area had revegetated. The Gate 3 Guard House had been constructed.

FIGURE 8 June 19, 1952: A light-toned structure had been added near the linear feature.

UXO 30 Gate 3 Burning Ground - continued
April 18, 1954: The light-toned structure remained.

May 29, 1956: The light-toned structure remained. Two taller structures are adjacent to the light-toned structure.
August 1, 1957: Remnants of the light-toned structure seen since 1952 were visible.

FIGURE 9 February 7, 1962: A partially bermed area containing medium-toned material was at the end of the access road. Dark-toned material was located at the end of the access road.

May 5, 1964: The access road leading to the shore had revegetated.

UXO 13 Skeet Range
June 3, 1943: A skeet range was present onsite.
October 22, 1943: A skeet range was present onsite.
August 26, 1944: A skeet range was present onsite.

FIGURE 10 March 12, 1950: A skeet range was present onsite; however, it appeared inactive.

June 19, 1952 to August 29, 1961: Two of the structures associated with the former skeet range remained.
February 7, 1962: By 1962, the two structures were completely surrounded by vegetation.

UXO 6 NG Burning Ground
June 22, 1937 and June 3, 1943: An access road led to the site; however, no environmentally significant findings were noted.

FIGURE 11 March 20, 1950: A structure was present east of the site.

FIGURE 12 June 19, 1952: A stained or burned area was located on the north side of the cleared area and at the end of the access road. A vehicle (not annotated) and a structure were located west of the stained/burned area.

April 18, 1954: A loop access road was present within the cleared area. A structure or object was presennt at the end of the loop road. The stained or burned area and the structure located on the north side of the cleared area remained.
May 29, 1956: The loop access road remained. A freshly graded area was present at the end of the road. The stained or burned area and the structure remained north of the access road.

UXO 6 NG Burning Ground - continued

August 1, 1957: The loop access road remained. Vehicle tracks led into the cleared area south of the main access road. The stained or burned area and the structure remained north of the access road.

FIGURE 13 August 29, 1961: The loop access road remained.

February 7, 1962: The site appeared inactive and revegetating. The structure north of the access road remained.

UXO 19 Igniter Area

June 22, 1937 and June 3, 1943: An access road led into the site area.
October 21, 1943: Probable debris was present at the end of the access road in a cleared area adjacent to the site.

FIGURE 11 March 12, 1950: Probable debris and dark-toned mounded material were visible at the end of the access road in a cleared and disturbed area adjacent to the site.

FIGURE 12 June 19, 1952: A large cleared area was present along and at the end of the access road. The probable debris was no longer visible.

FIGURE 13 August 29, 1961: A freshly graded and fill area is located at the end of the loop road. Light-toned mounded material is located along the shoreline within the fill area.

UXO 20 Treatment Point

FIGURE 14 June 4, 1943: An access road (not annotated) led to a small peninsula along the shoreline. A vehicle was actively grading and filling the south end of the peninsula.
October 21, 1943: The peninsula had been expanded by October 1943. Dark-toned material was present across the entire peninsula.

March 12, 1950: Four stained areas were present on the peninsula.

FIGURE 15 April 5, 1951: A large rectangular stained area was present near the center of the peninsula. A probable open vertical tank was present on the north end of the peninsula.

June 19, 1952: A stained area was present on the south end of the peninsula.
April 18, 1954: A roughly rectangular light-toned area was present on the south end of the peninsula.

UXO 20 Treatment Point – continued

May 29, 1956 and August 1, 1957: Multi-toned material was present at the south end of the peninsula.

FIGURE 16 August 29, 1961: An explosion was evident at the south end of the peninsula.

FIGURE 17 February 7, 1962: Multi-toned material, debris and staining were evident at the south end of the peninsula.

May 5, 1964: Multi-toned material and light-toned objects were evident at the south end of the peninsula.

FIGURE 18 September 23, 1972: Dark-toned material was evident at the south end of the peninsula. Medium-toned mounded material was present in the central portion of the site. A vertical tank and an open vertical tank were present at the north end of the peninsula.

May 6, 1980, July 7, 1980, and May 7, 1981: Dark-toned objects were present at the south end of the peninsula. The vertical tank remained on the north end of the peninsula.

UXO-27 Sonar Training

June 3, 1943, October 21, 1943, March 12, 1950, April 5, 1951, June 19, 1952, April 18, 1954 and May 29, 1956: A boat house and a building are present at the pier.
August 1, 1957: A boat house and a building are present at the pier. The boat house has been expanded since 1956.

FIGURE 19 August 29, 1961: A boat house and boat (not annotated) were present east of the pier. Two dark-toned objects were present in the river west of the pier. A boat (not annotated) was present along the west side of the pier.

FIGURE 20 May 5, 1964: A ship and several other vessels (not annotated) were at the pier. A rectangular structure was along the shoreline east of the pier. A dark-toned object was present in the water west of the pier.

FIGURE 21 September 23, 1972: The boat house was no longer present. The pilings (not annotated) that supported the boat house remained on the east side of the pier. A probable vessel was present at the end of the pier. An access road (not annotated) led to a cleared area along the shoreline east of the pier.

May 6, 1980: The access road to the cleared area along the shoreline remained east of the pier.
May 7, 1981: The access road to the cleared area along the shoreline remained east of the pier.

5.0 REFERENCES
NAVAL SUPPORT FACILITY INDIAN HEAD

AERIAL PHOTOGRAPHS

Date	Source[1]	Scale	Type[2]	Mission	Roll/Frame Numbers
03/04-2007	USGS	0.5 ft	C	HiRes	seamless
04-03-98	FSA	1:40K	BW	NAPP	10586/86-89, 138-141
03-17-94	FSA	1:40K	CIR	NAPP	7698/13-18, 34-38
04-20-88	FSA	1:40K	CIR	NAPP	11/51-55
04-05-88	FSA	1:40K	CIR	NAPP	4/171-174
05-07-81	NOS	1:40K	C	81ZC	4706-4708
07-07-80	FSA	1:40K	BW	24017	380/64-67, 82, 83
05-06-80	AERO	1:24K	BW	CH	35/113,114
05-06-80	AERO	1:24K	BW	CH	34/115-118
09-23-72	FSA	1:20K	BW	AHU	8MM/243-246, 254-258
09-23-72	FSA	1:20K	BW	AHU	9MM/14-16
12-02-71	USGS	1:24K	BW	VCVT	1/14-16, 40-43
05-05-64	FSA	1:20K	BW	AHU	1DD/22-25, 53-58, 14-16
04-04-64	USGS	1:24K	BW	VAQW	1/48-51
04-04-64	USGS	1:24K	BW	VAQW	5/4-8
02-07-62	AERO	1:6K	BW	1206	2/6,7
02-07-62	AERO	1:6K	BW	1206	4/1,2
02-07-62	AERO	1:6K	BW	1206	5/4,5,9-11
02-07-62	AERO	1:6K	BW	1206	6/3,4,6-12
08-29-61	NOS	1:31K	BW	61S	3453-3455, 3475-3478
10-22-57	FSA	1:20K	BW	AHU	6T/13-16
08-01-57	FSA	1:20K	BW	AHU	1T/27-29, 39-43
05-29-56	NOS	1:20K	BW	56W	1460-1462,1470-1474
04-18-54	NOS	1:20K	BW	54W	210-213, 229-232

[1]AERO Aero-Metric, Dulles, VA.
FSA Farm Service Agency, U.S. Department of Agriculture, Salt Lake City, Utah.
NARA National Archives and Records Administration, College Park, Maryland.
NOS National Geodetic Information Center, Silver Spring, MD.
USGS U.S. Geological Survey, U.S. Department of the Interior, Sioux Falls, South Dakota.

[2] Film types: B/W – Black & white; C – Conventional color; CIR – Color infrared; D - Digital

AERIAL PHOTOGRAPHS – continued

Date	Source	Scale	Type	Mission	Roll/Frame Numbers
06-19-52	NARA	1:20K	BW	AHU	1K/61-63,98-100,111-113
04-05-51	NOS	1:10K	BW	51J	756-759,766-769
03-12-50	NARA	1:20K	BW	SV1 M	71-74,88-92,115-117
08-26-44	NOS	1:10K	BW	VA3877	44C/3323-3325
10-21-43	NARA	1:20K	BW	3M481	5V/29,30,69-71,125-128
06-04-43	NARA	1:20K	BW	-	10A/89-92
06-03-43	NARA	1:20K	BW	-	9A/23-25,58-60,92-94
06-22-37	NARA	1:20K	BW	AHU	1/31,32,35-40

MAPS

1978. Indian Head, MD -VA USGS 1:24,000 Quadrangle.

2009. Figure 1-1 Facility Location, Munitions Investigation Work Plan for Land Sites, UXOs 6, 9, 11, 20 and 30; and Water Site UXO 27. CH2M Hill.

Figure 1-2 Site Map Site Inspection Work Plan for Igniter Area – UXO 19. CH2M Hill.

UXO-13: FDR Skeet Range. CH2M Hill.

6.0 LEGEND OF SYMBOLS

BA - Bermed Area

CA - Cleared Area

CR - Crates

CT - Containers

DB - Debris

DG - Disturbed Ground

DK - Dark-Toned

EX - Excavation

FA - Fill Area

GA - Graded Area

LF - Linear Feature

LT - Light-Toned

M - Material

ML - Multi-Toned

MM - Mounded Material

MT - Medium-Toned

OBJ - Object

PROB - Probable

RBC - Rail Boxcar

RS - Rectangular Structure

RTC - Rail Tank Car

S - Structure

SB - Storage Bins

ST - Stain

V - Vehicle(s)

VT - Vertical Tank

_ _ _ Access Road

Figure 1
Indian Head, MD

Location Map
Naval Facility Support Indian Head

Approximate Scale: 1:34,100

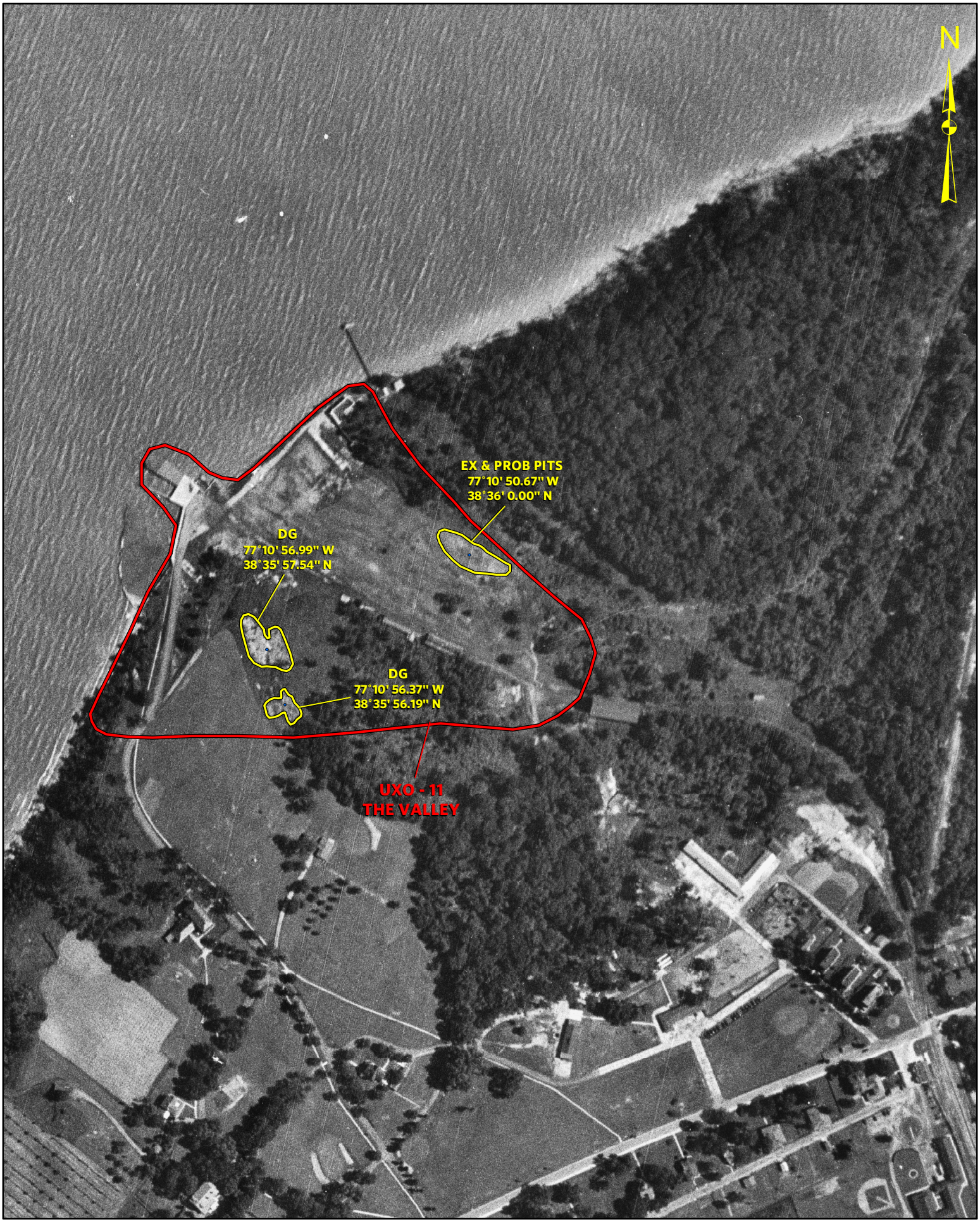

Figure 2
Indian Head, MD
UXO-11

June 22, 1937

Approximate Scale: 1:3,650

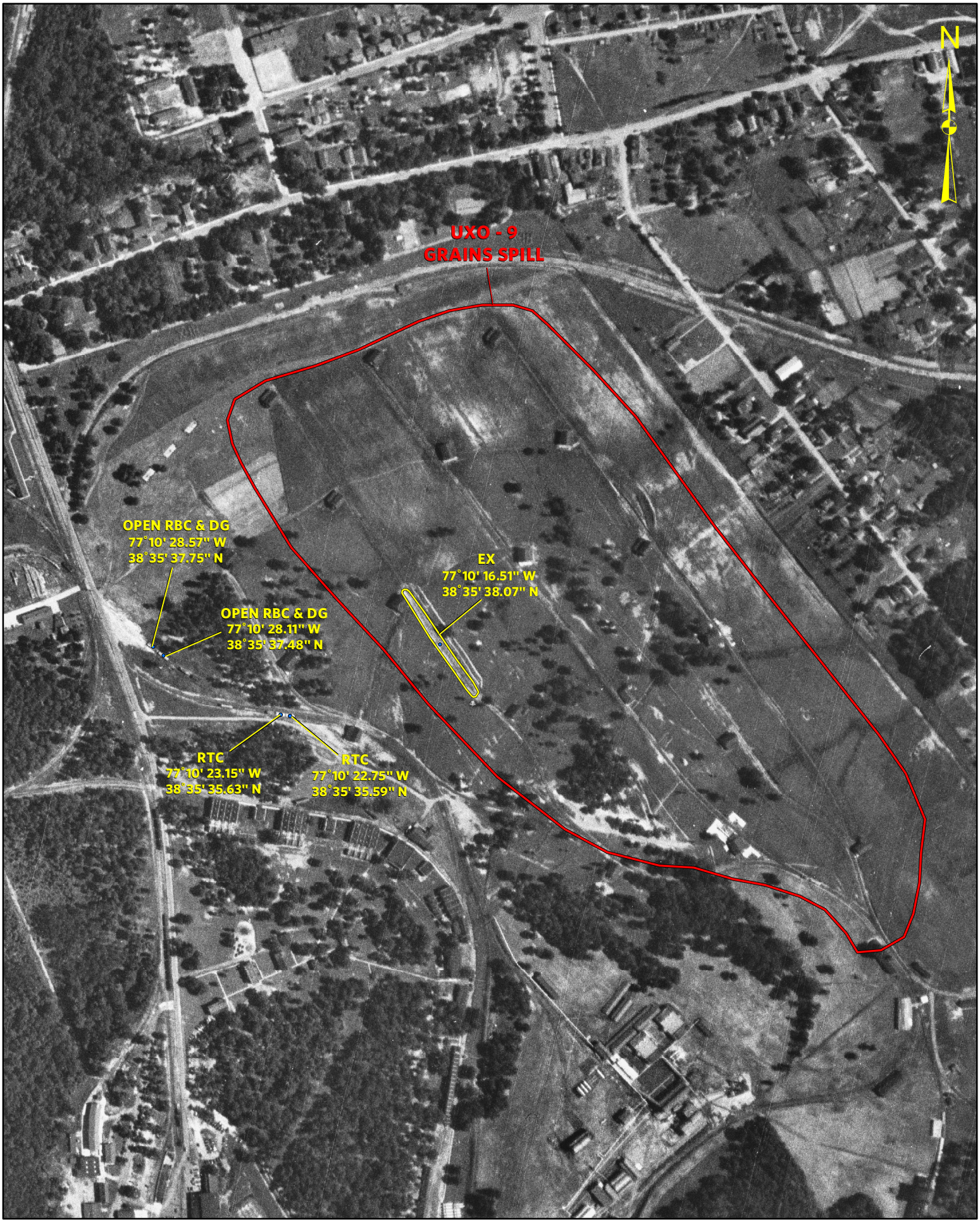

Figure 3
Indian Head, MD
UXO-9

June 22, 1937

Approximate Scale: 1:4,860

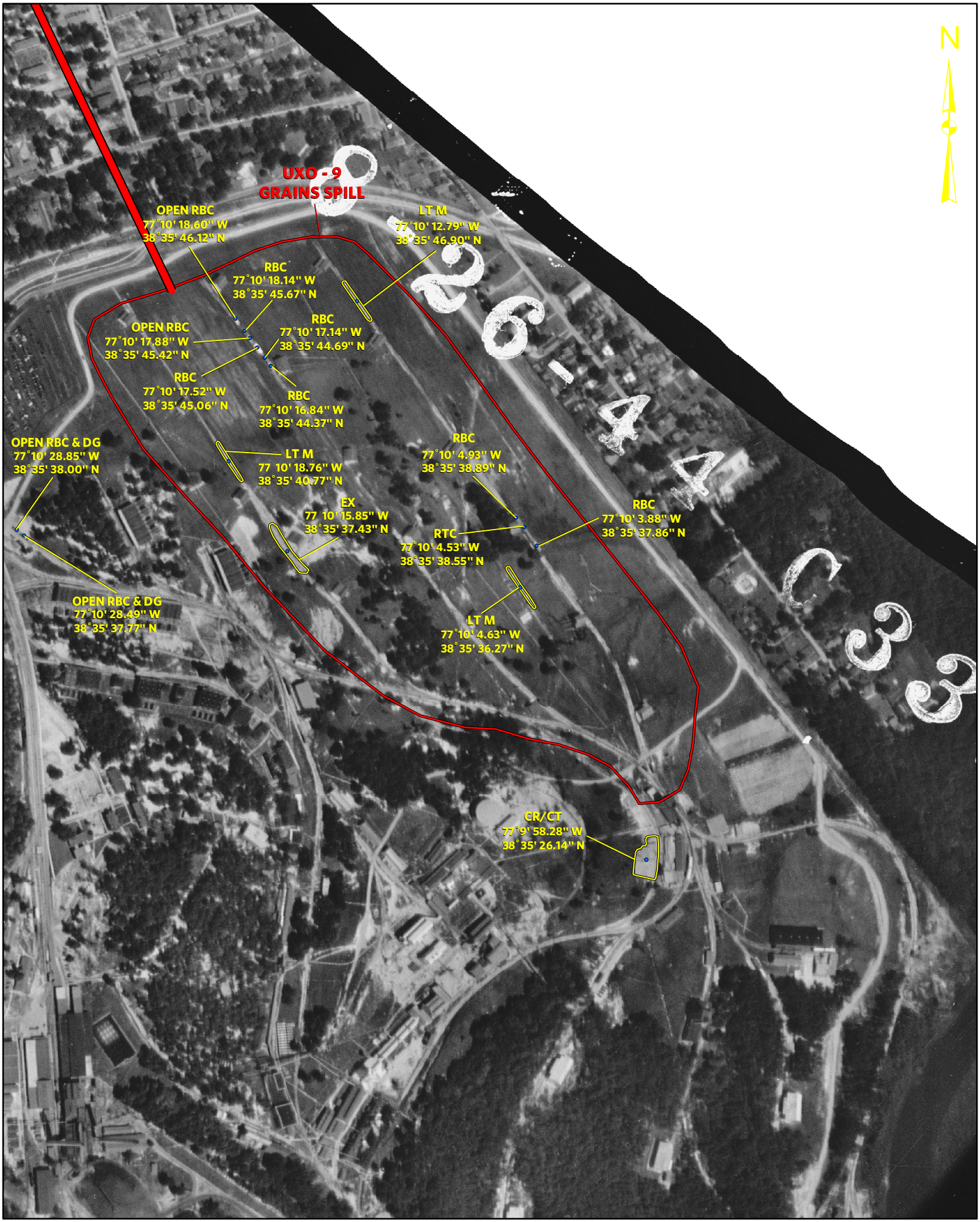

Figure 4
Indian Head, MD
UXO-9

August 26, 1944

Approximate Scale: 1:5,550

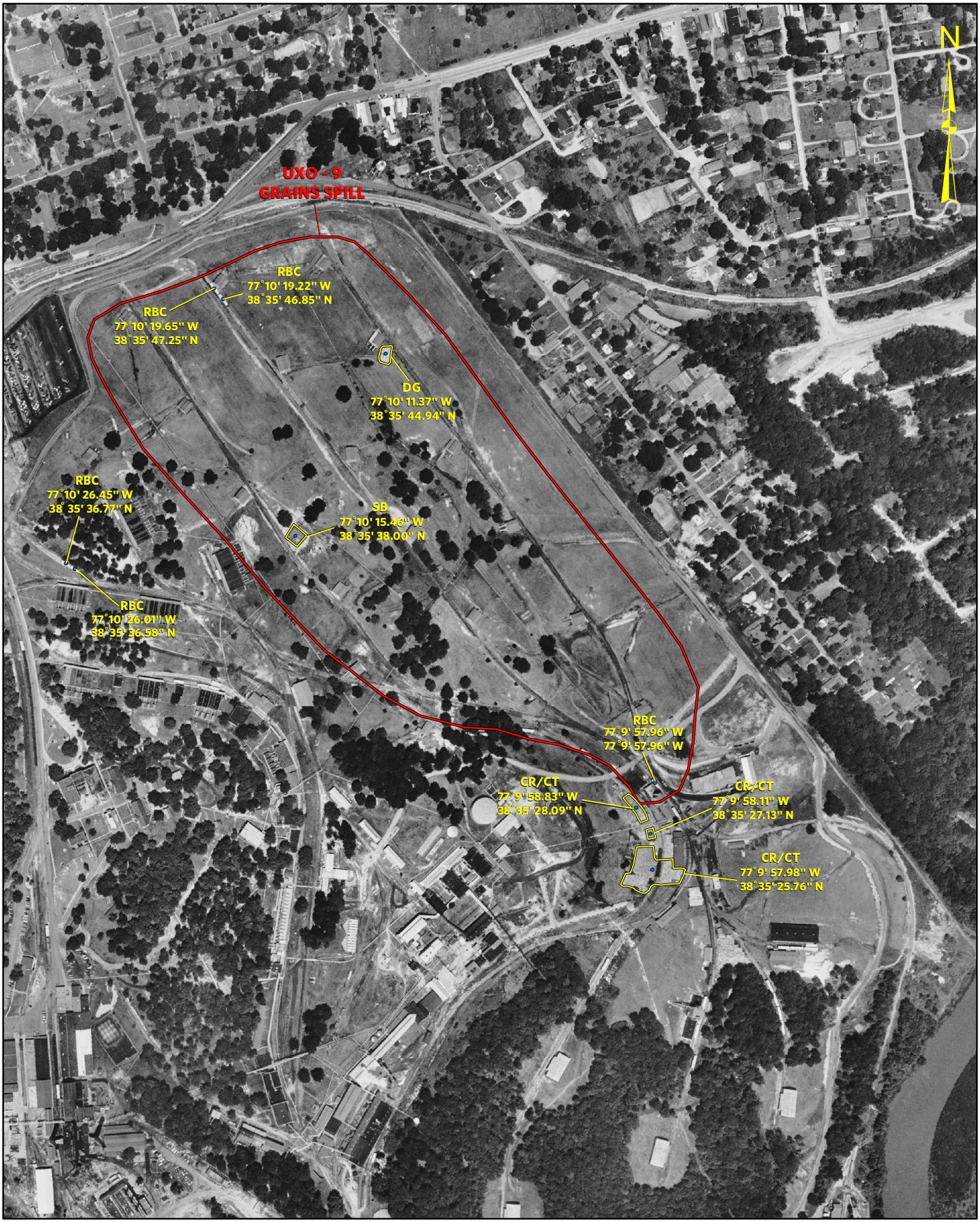

Figure 5
Indian Head, MD
UXO-9

May 29, 1956

Approximate Scale: 1:5,550

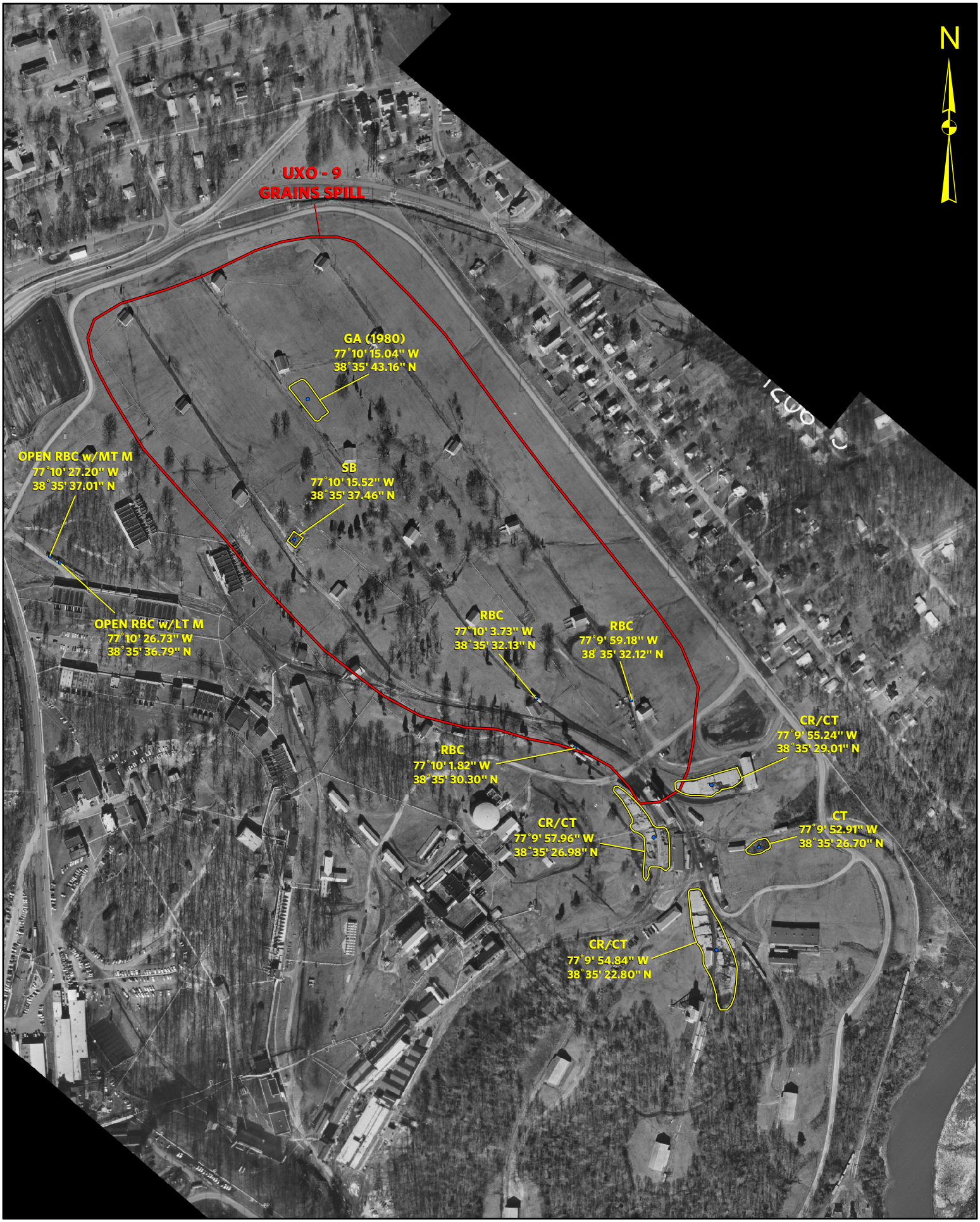

Figure 6
Indian Head, MD
UXO-9

February 7, 1962

Approximate Scale: 1:5,550

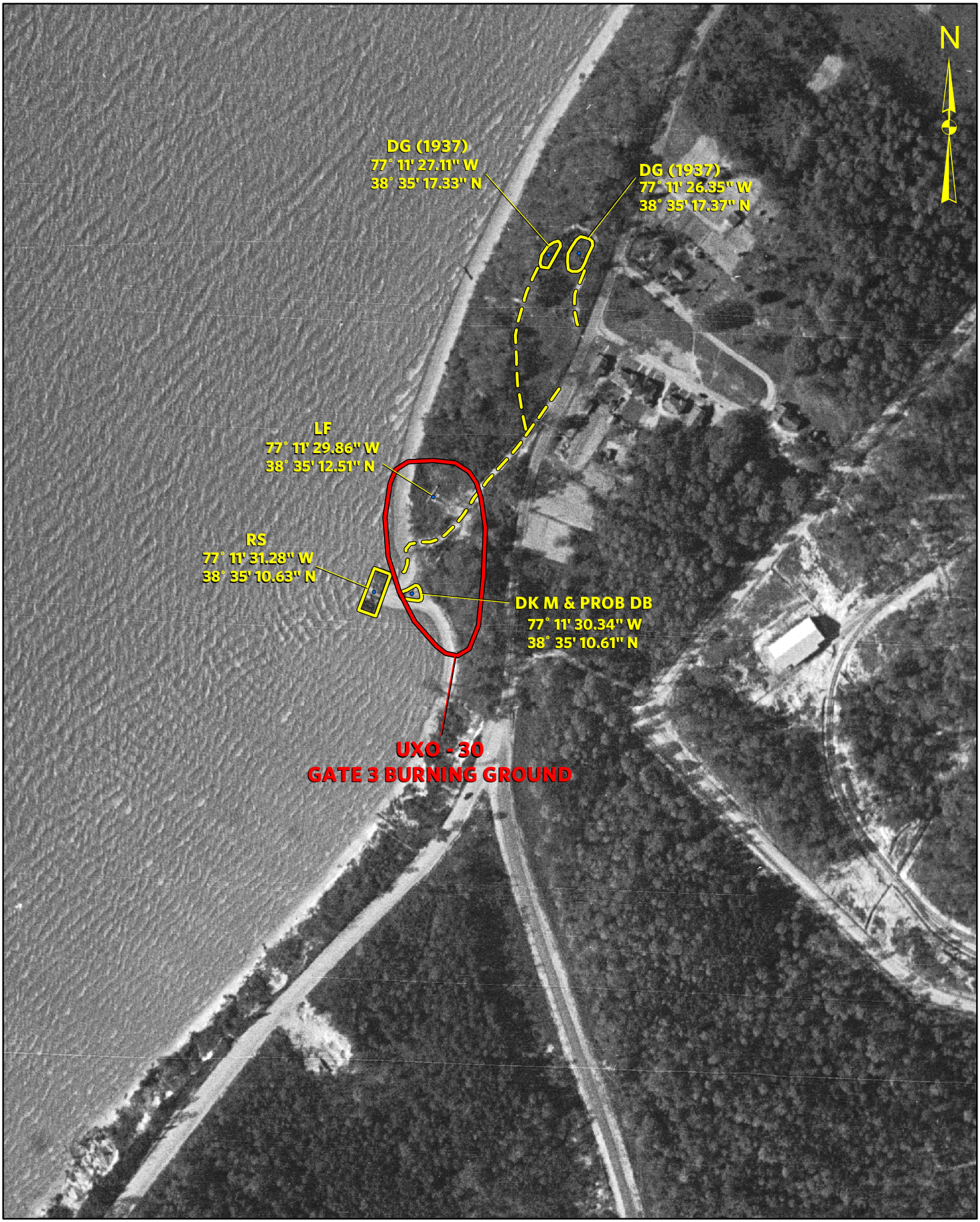

Figure 7
Indian Head, MD
UXO-30

June 4, 1943

Approximate Scale: 1:2,900

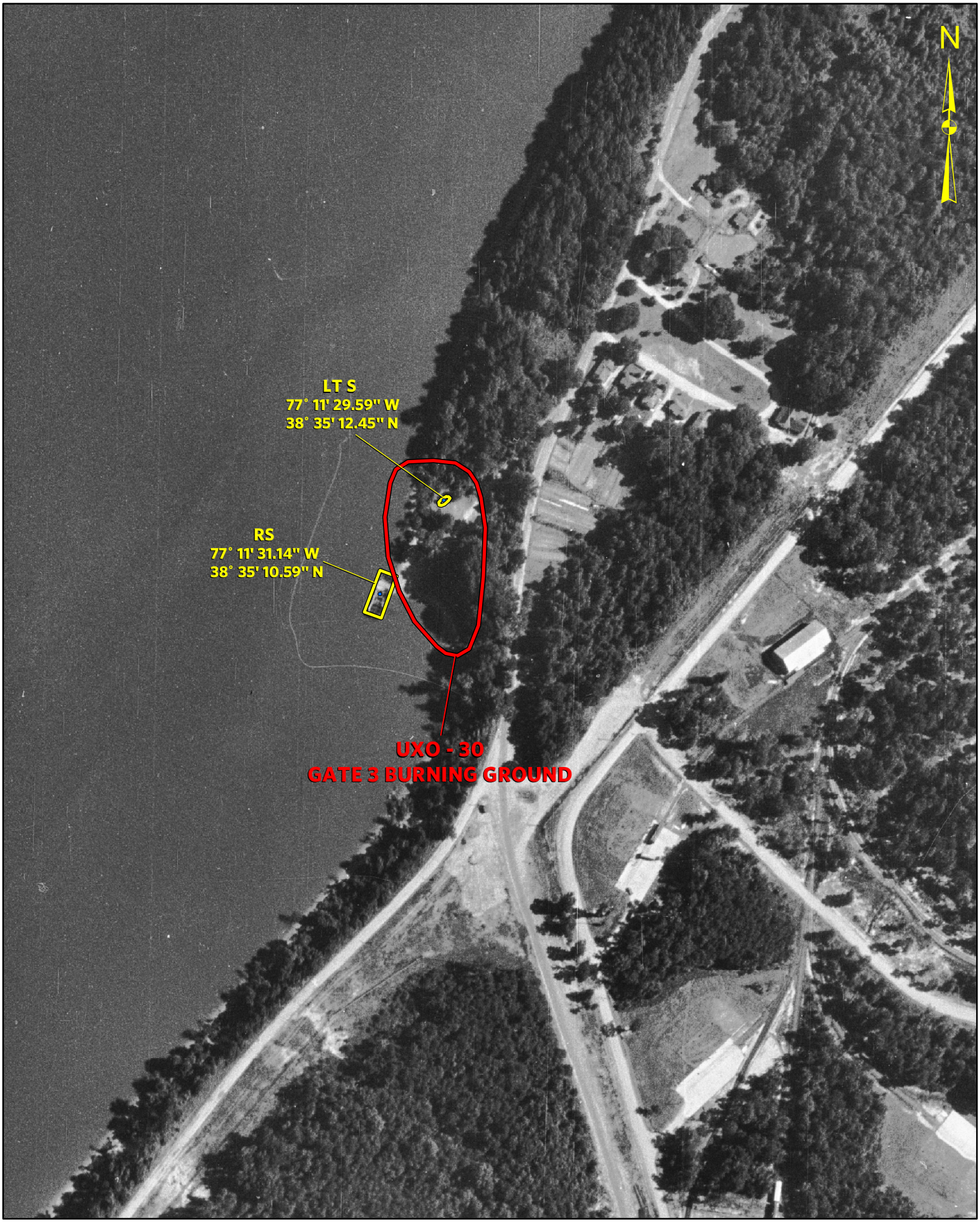

Figure 8
Indian Head, MD
UXO-30

June 19, 1952

Approximate Scale: 1:2,900

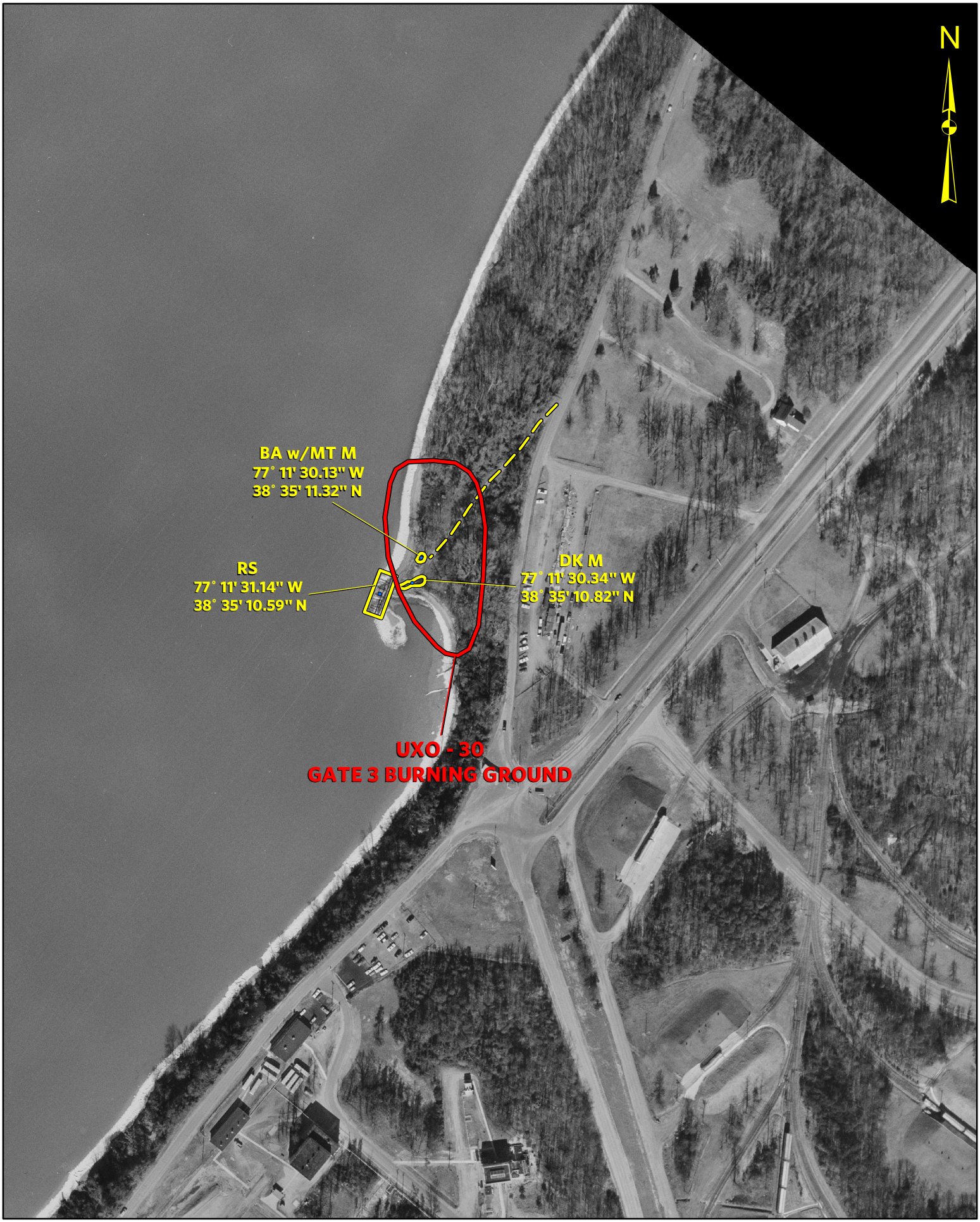

Figure 9
Indian Head, MD
UXO-30

February 7, 1962

Approximate Scale: 1:2,900

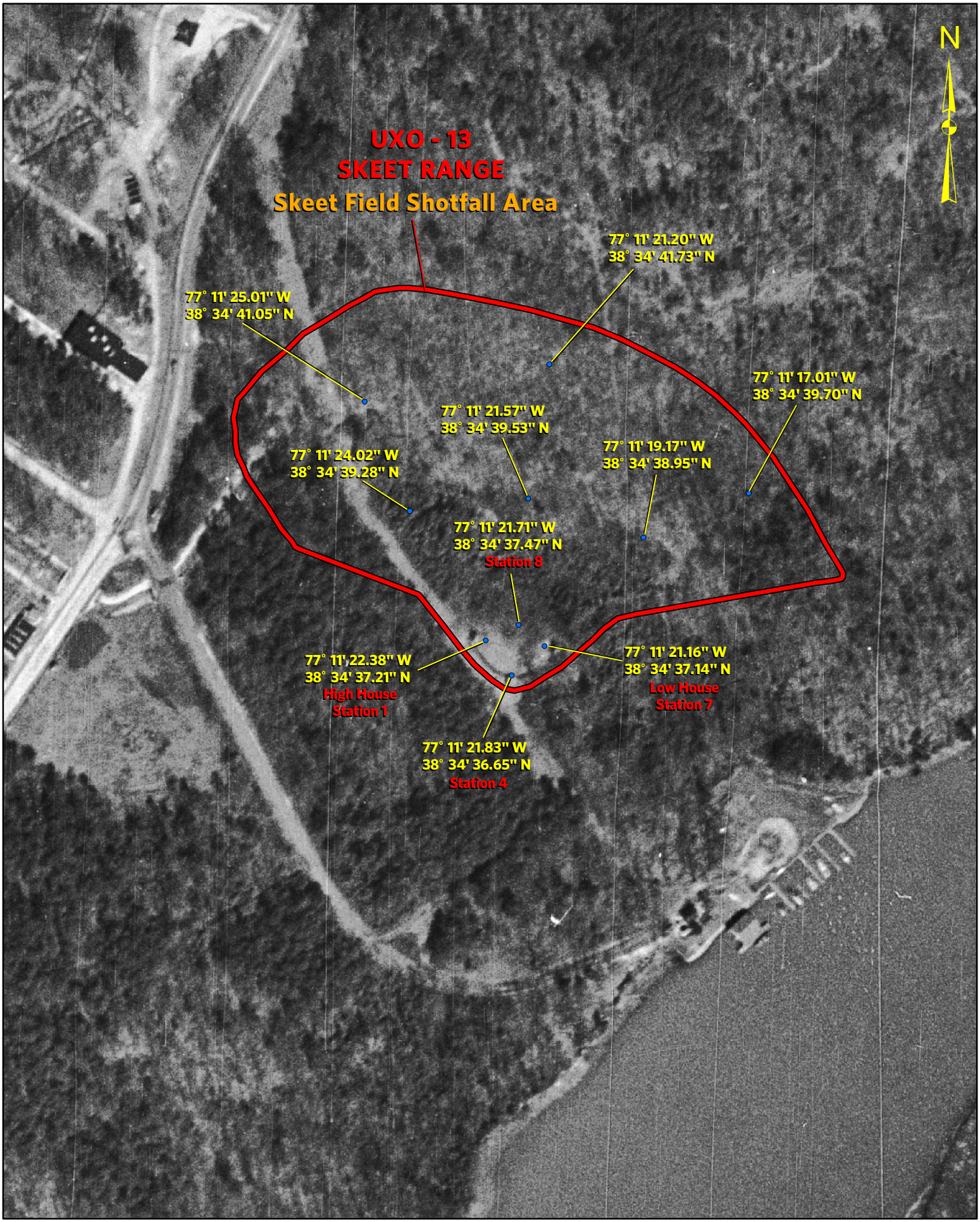

Figure 10
Indian Head, MD
UXO-13

March 12, 1950

Approximate Scale: 1:2,400

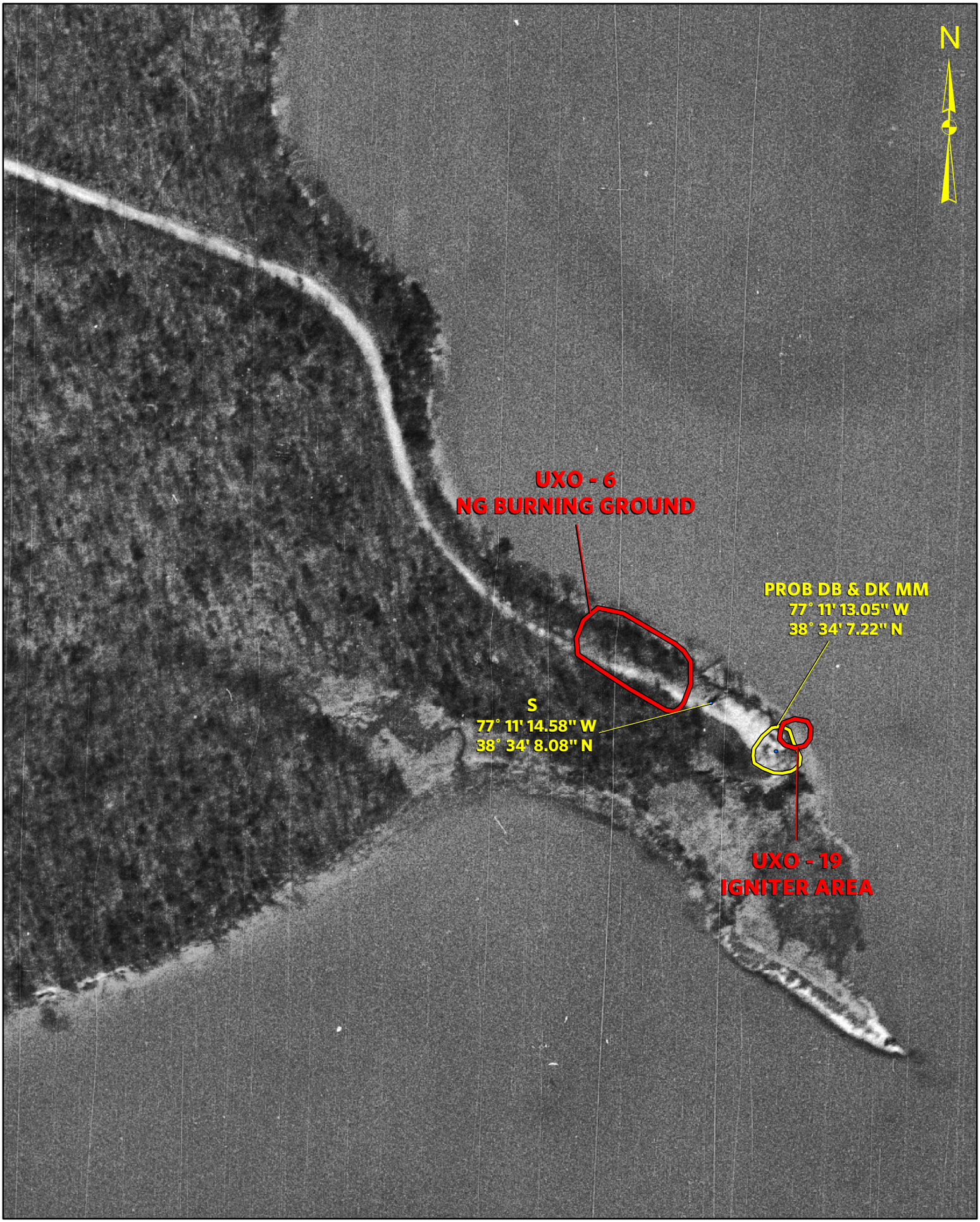

Figure 11
Indian Head, MD
UXO-6 & UXO-19

March 12, 1950

Approximate Scale: 1:2,700

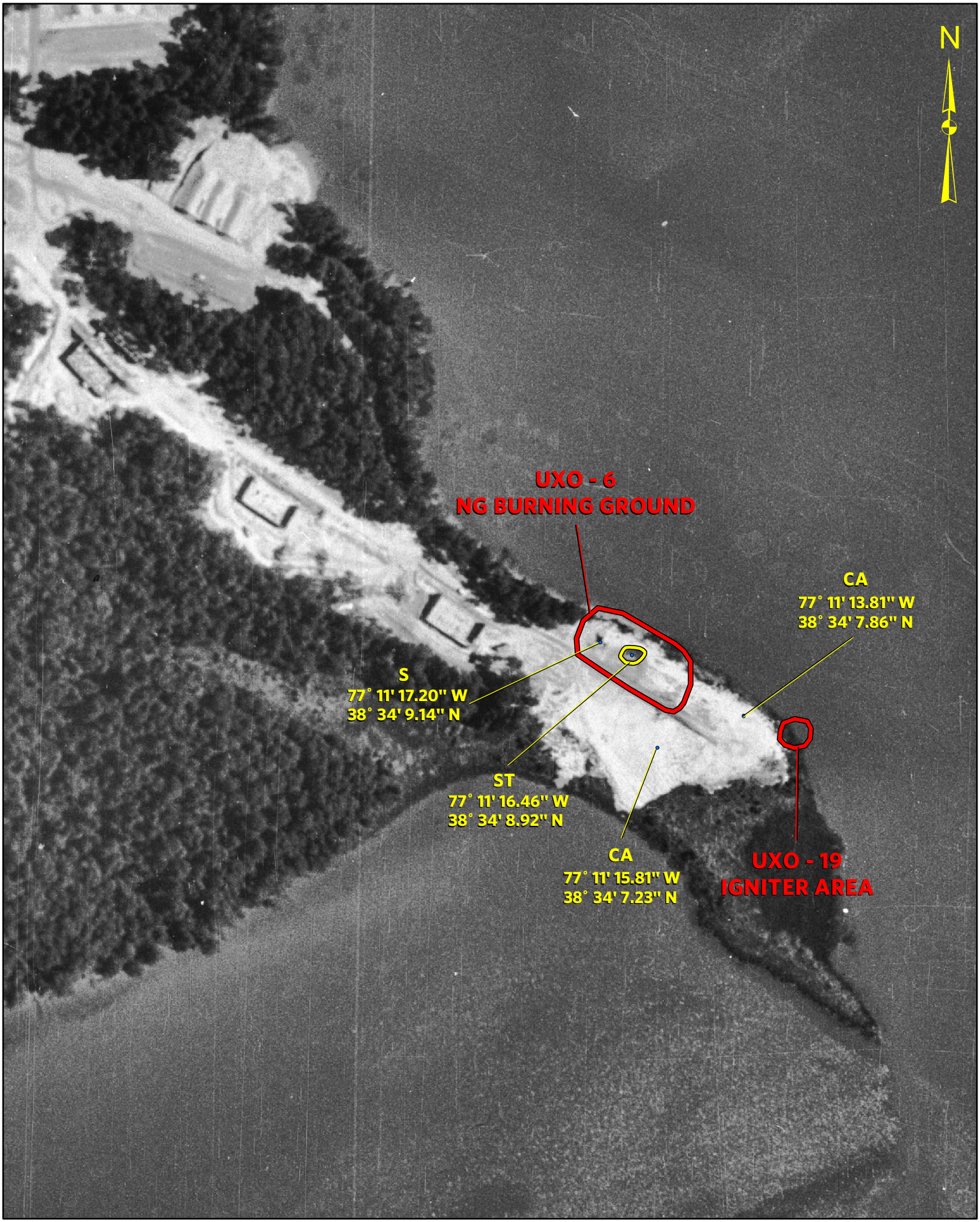

Figure 12
Indian Head, MD
UXO-6 & UXO-19

June 19, 1952

Approximate Scale: 1:2,700

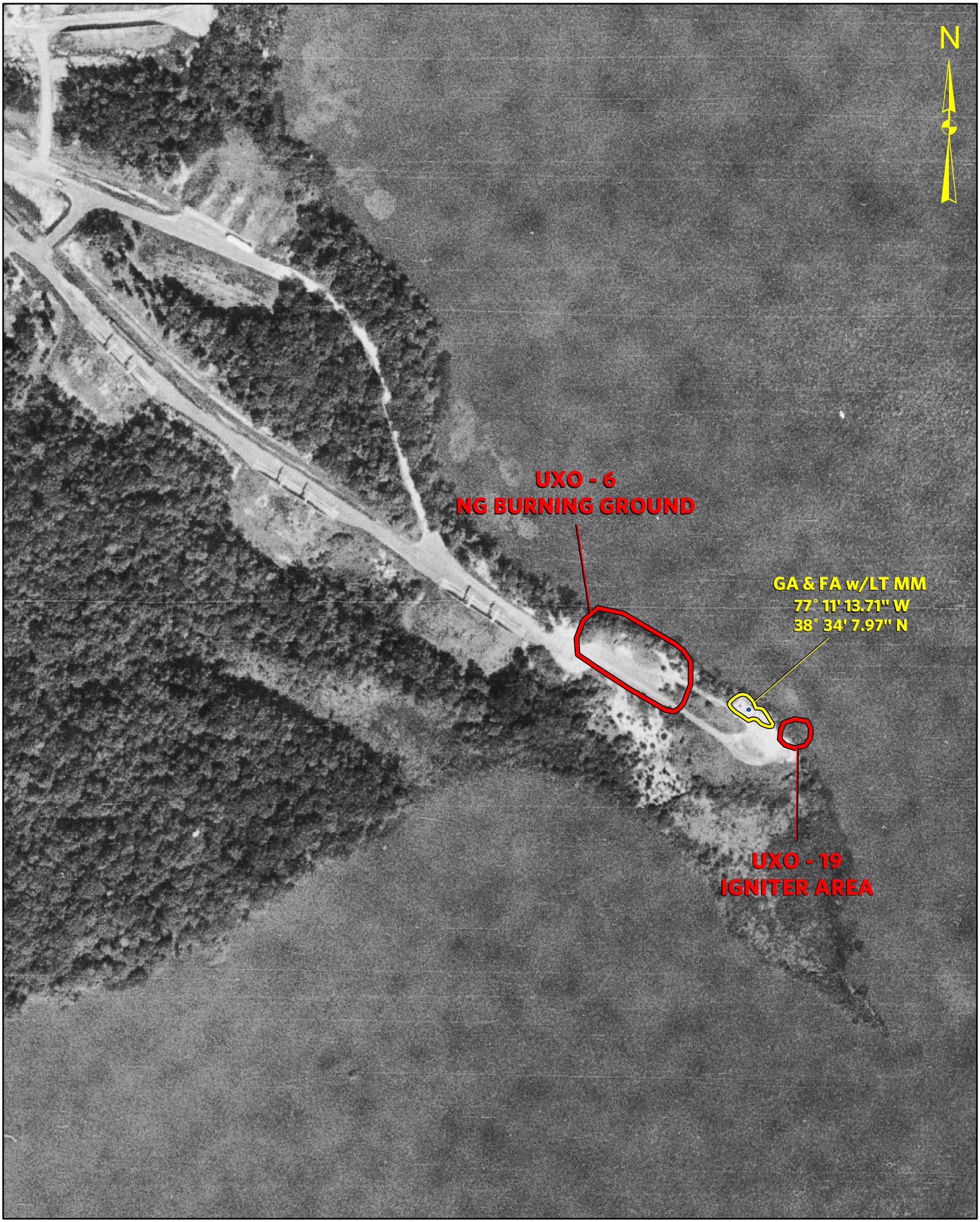

Figure 13
Indian Head, MD
UXO-6 & UXO-19

August 29, 1961

Approximate Scale: 1:2,700

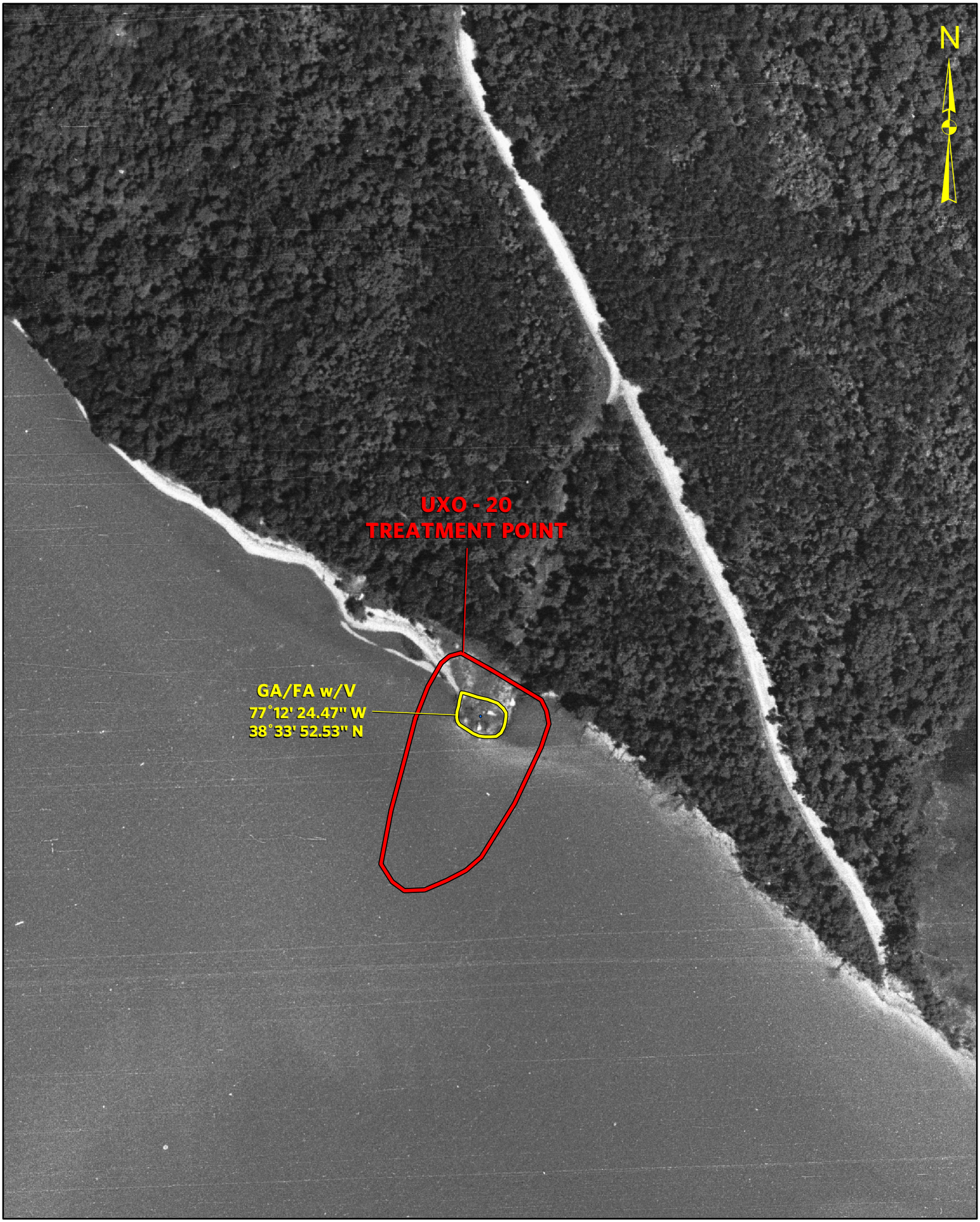

Figure 14
Indian Head, MD
UXO-20

June 4, 1943

Approximate Scale: 1:2,800

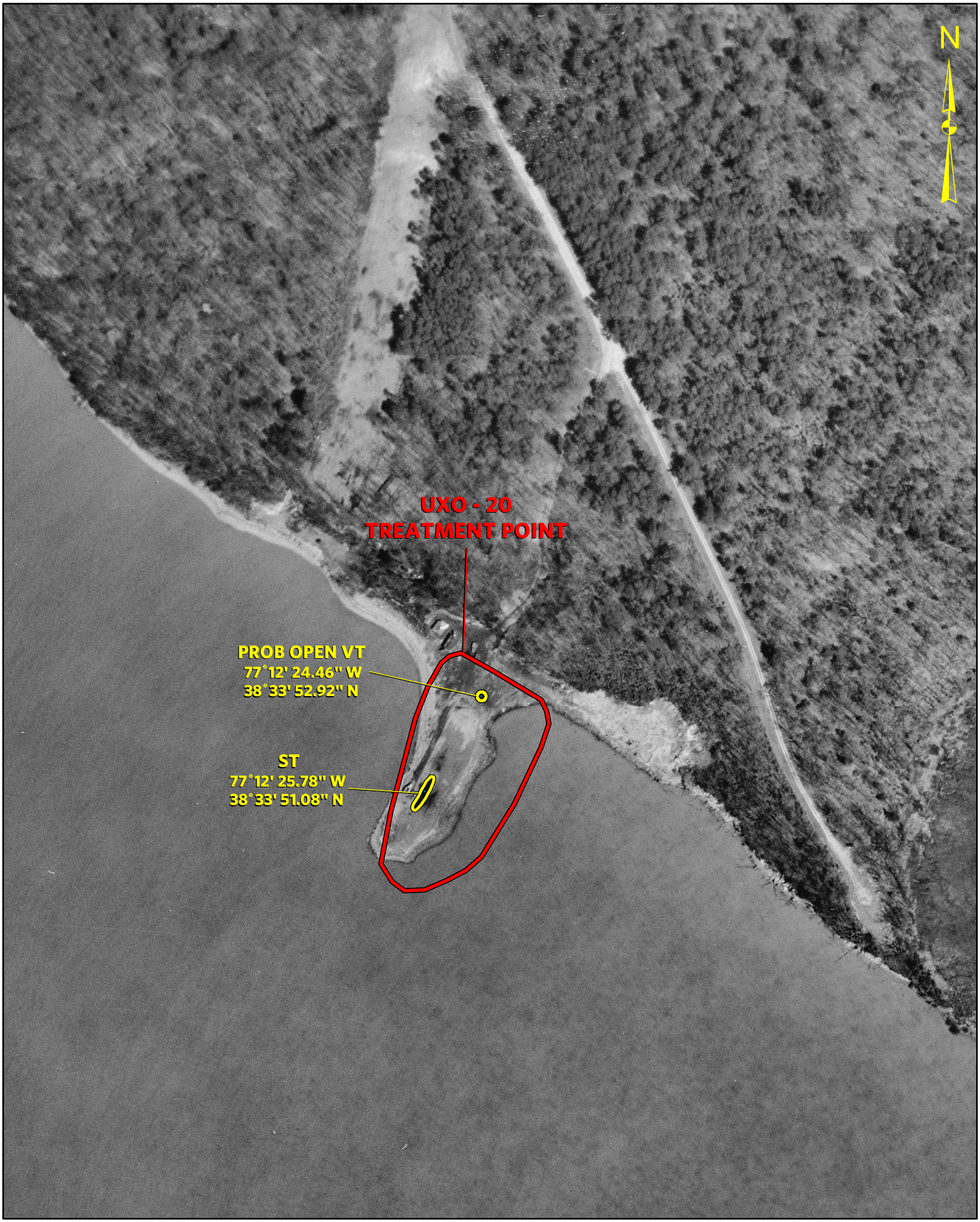

Figure 15
Indian Head, MD
UXO-20

April 5, 1951

Approximate Scale: 1:2,800

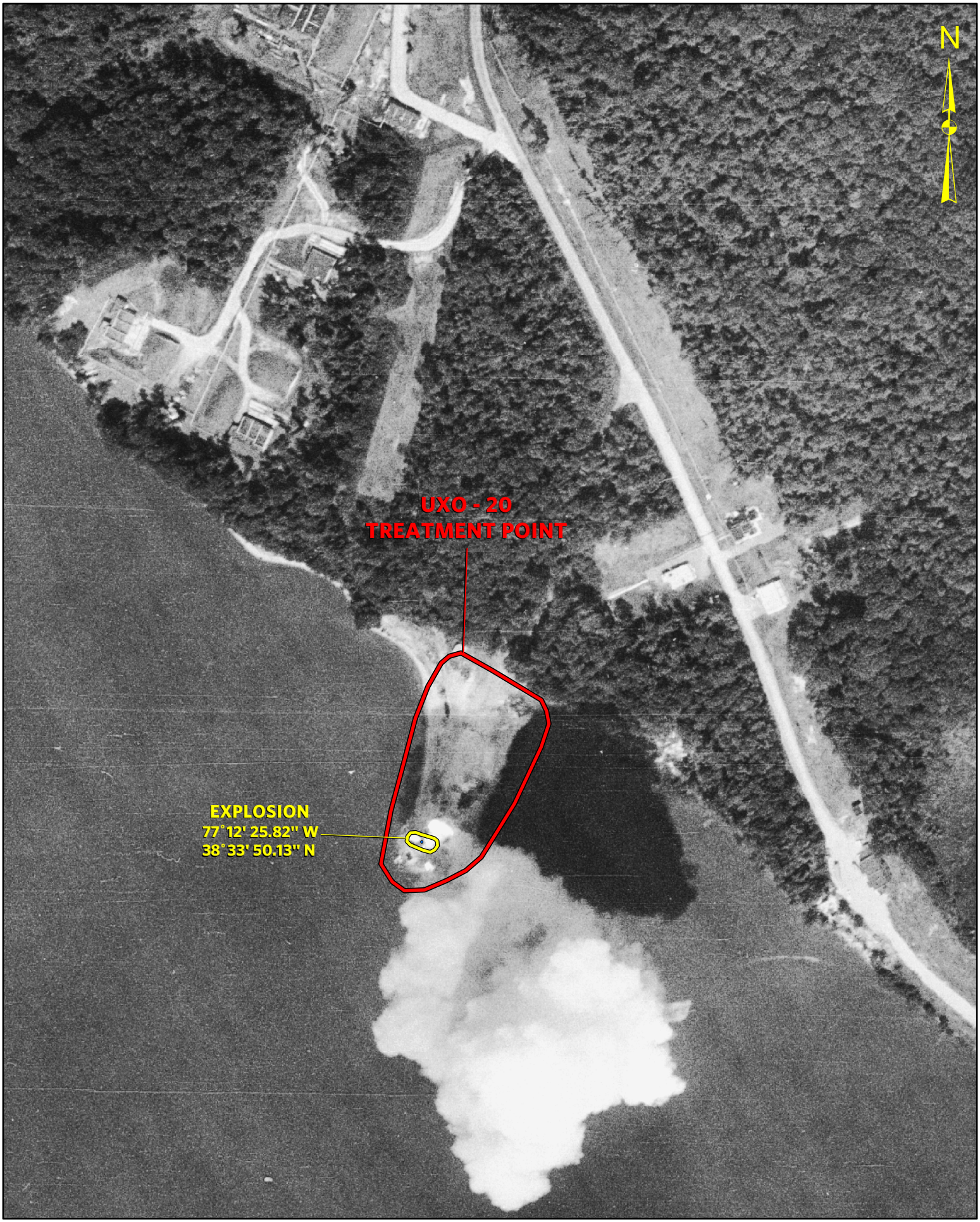

Figure 16
Indian Head, MD
UXO-20

August 29, 1961

Approximate Scale: 1:2,800

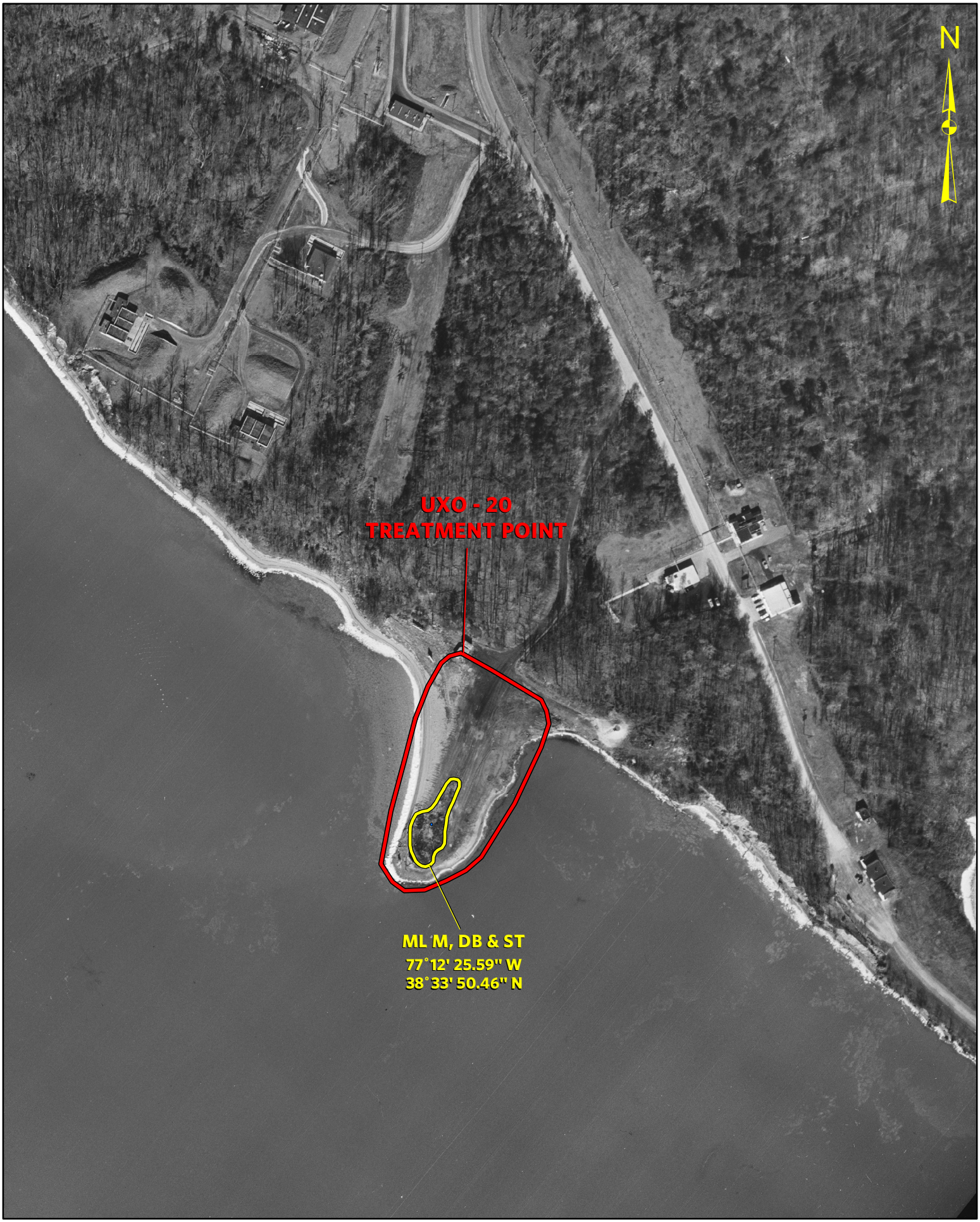

Figure 17
Indian Head, MD
UXO-20

February 7, 1962

Approximate Scale: 1:2,800

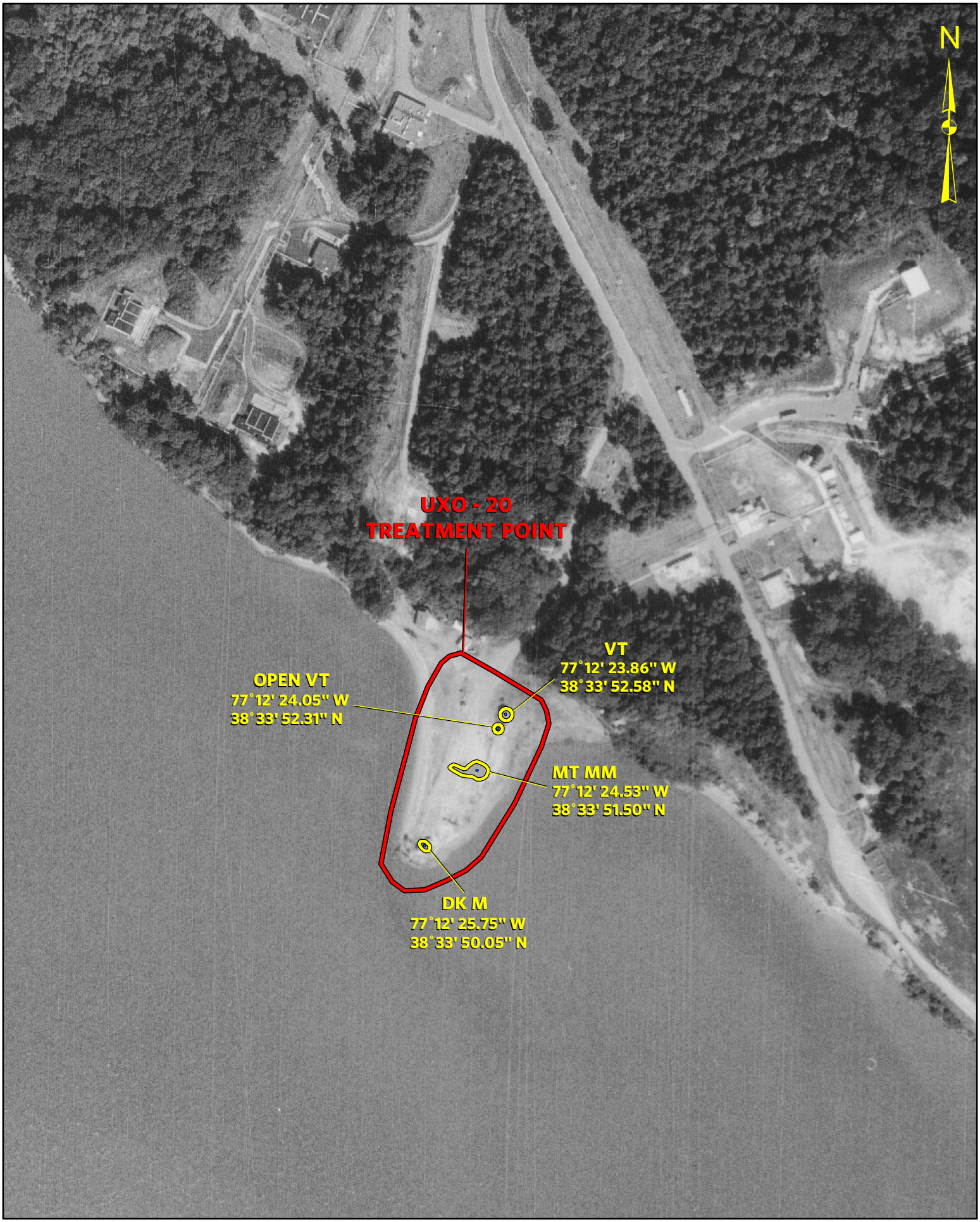

Figure 18
Indian Head, MD
UXO-20

September 23, 1972

Approximate Scale: 1:2,800

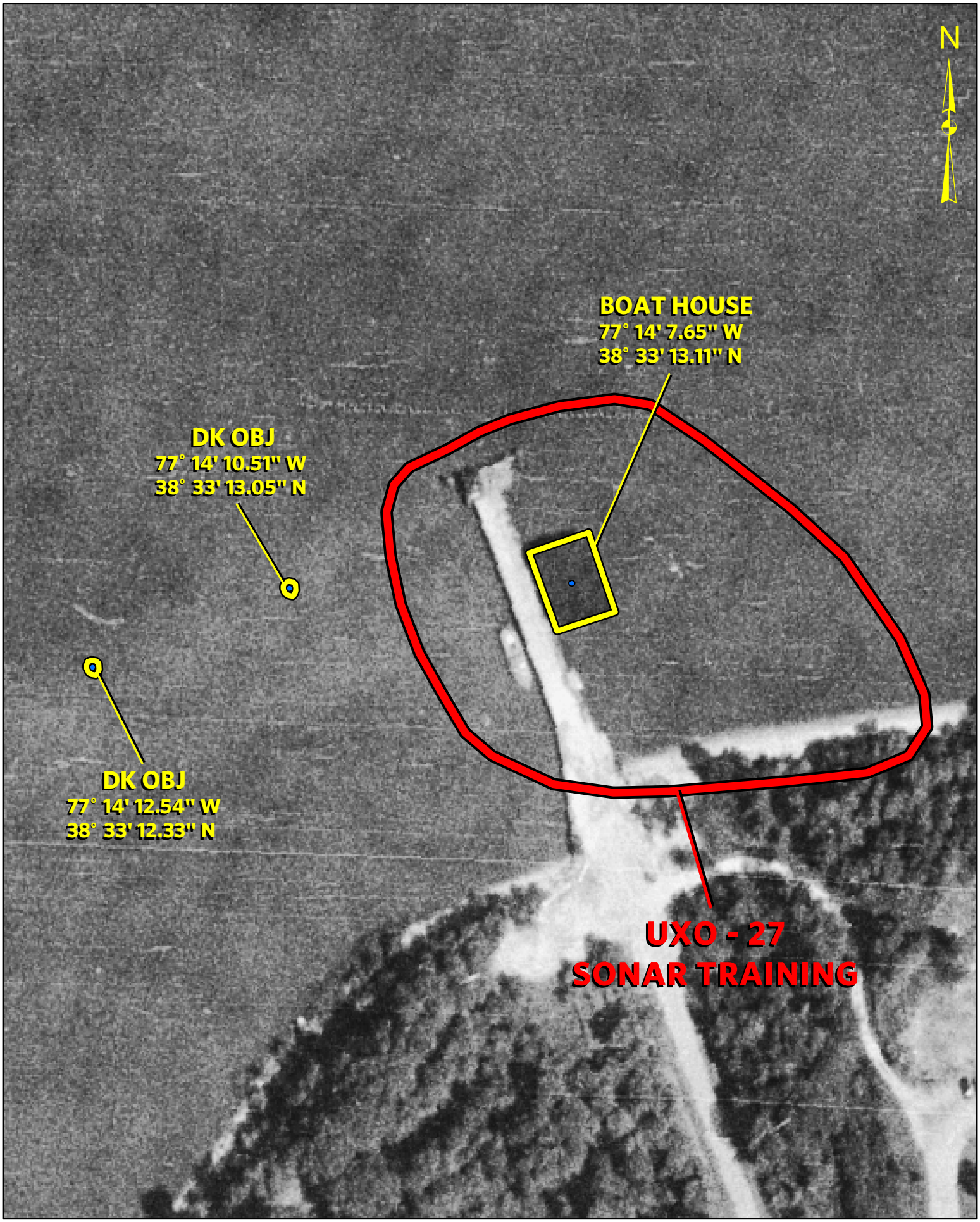

Figure 19
Indian Head, MD
UXO-27

August 29, 1961

Approximate Scale: 1:1,200

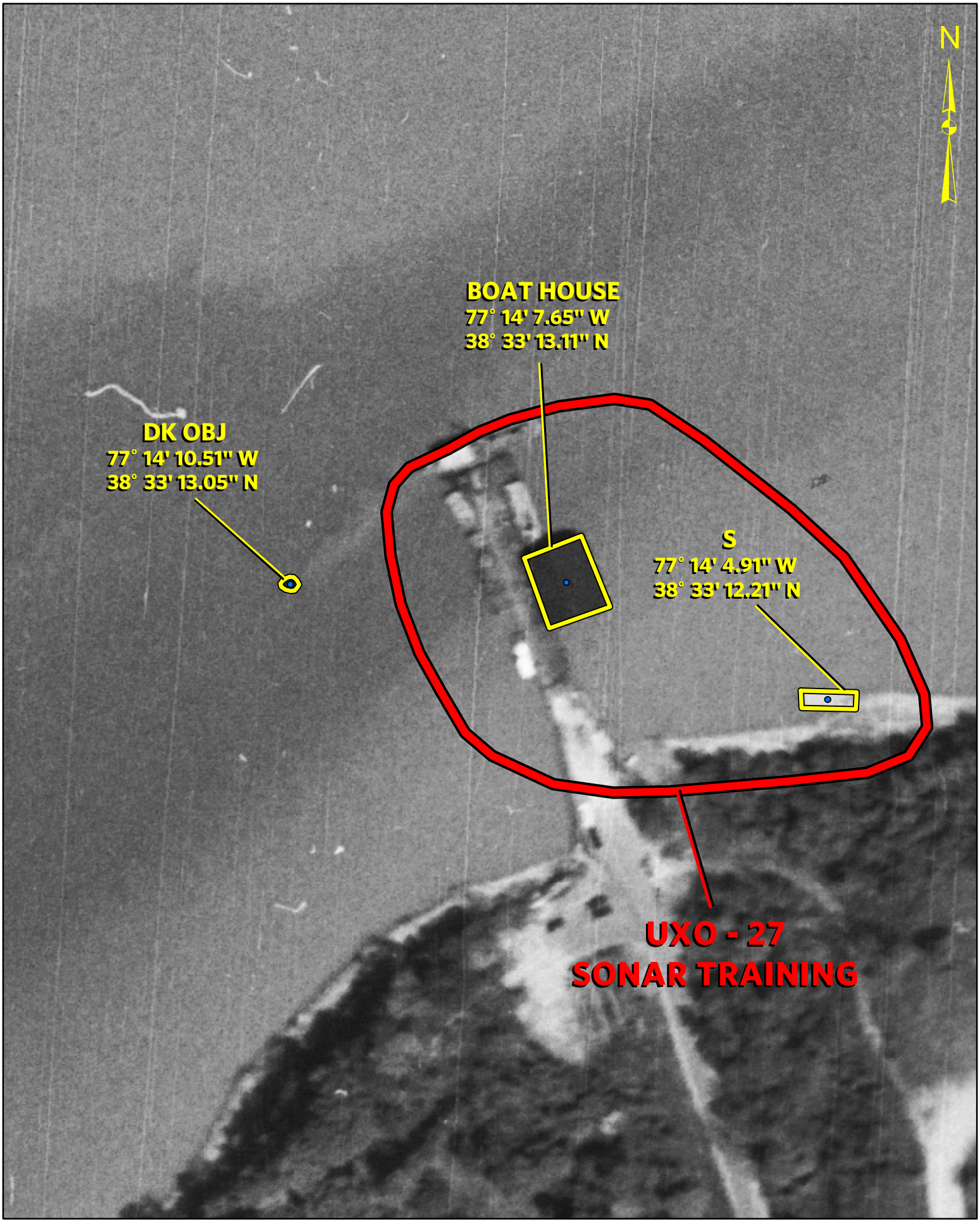

Figure 20
Indian Head, MD
UXO-27

May 5, 1964

Approximate Scale: 1:1,200

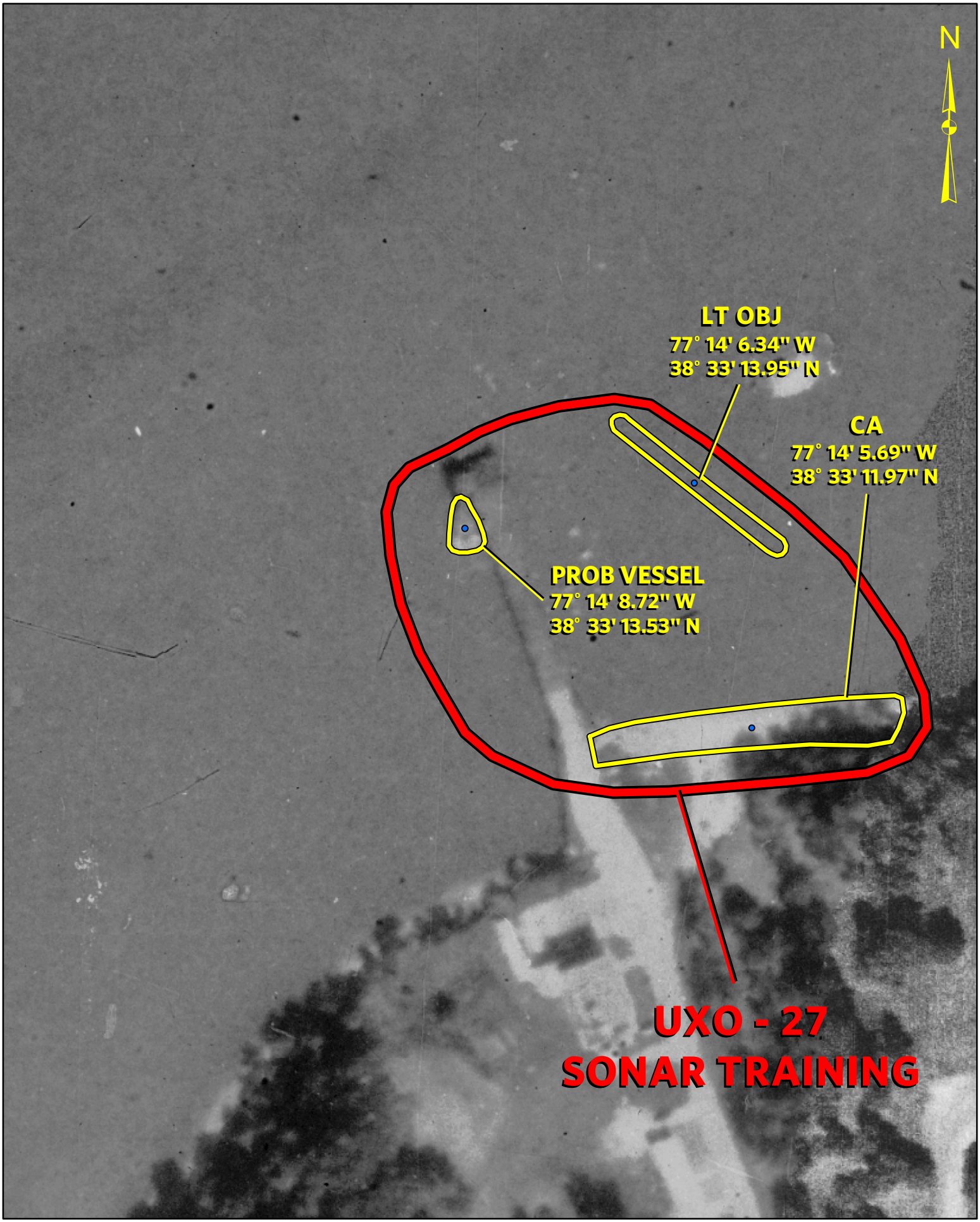

Figure 21
Indian Head, MD
UXO-27

September 23, 1972

Approximate Scale: 1:1,200

Appendix B
Digital Geophysical Mapping Report

Digital Geophysical Mapping for Land Sites UXO 11 and UXO 30, and Shallow Marine Sites UXO 27 and Dive Locker Pier
Naval Support Facility Indian Head
Indian Head, Maryland

Geophysical Report

Prepared for CH2M HILL

15010 Conference Center Drive, Suite 200
Chantilly, VA 20151

Prepared by ARM Geophysics

1129 West Governor Road
Hershey, PA 17033

June 2010

ARM Project 09359

June 2010

Ms. Margaret Kasim
Project Manager
CH2M HILL
15010 Conference Center Drive, Suite 200
Chantilly, VA 20151

RE: Geophysical Investigation Report
CH2M HILL
Digital Geophysical Mapping for
Land Sites UXO 11 and UXO 30, and
Water Sites UXO 27 and Dive Locker Pier
Naval Support Facility Indian Head
Indian Head, Maryland

Dear Ms. Kasim,

Following is a report detailing the investigation performed by ARM Geophysics at the Naval Support Facility Indian Head, Indian Head, Maryland.

If you have any questions or need additional information, please do not hesitate to contact the undersigned at 717-533-8600.

Respectfully Submitted
ARM Geophysics

Jeff Leberfinger
VP Geophysics

Ian Wilson
Project Geophysicist

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Attachments

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Attachment B: Root Cause Analyses and Corrective Actions Plans
Attachment C: Photographs of DGM Equipment
Attachment D: Photographs of Unsurveyable Areas
Attachment E: QC Summary
Attachment F: (DVD) Geophysical Data

Acronyms and Abbreviations

ARM	ARM Geophysics
CAP	Corrective Action Plan
CF	Compact Flash
cm	Centimeter
DGM	Digital Geophysical Mapping
DQO	Data Quality Objective
DVD	Digital Versatile Disc
EM	Electromagnetic
EM61	Geonics EM61-MK2
FTP	File Transfer Protocol
G-856	Geometrics G-856 Proton Precession Magnetometer
G-882	Geometrics G-882 Cesium Vapor Marine Magnetometer
GIS	Geographic Information System
GPS	Global Positioning System
H&S	Health and Safety
ISO	Industry Standard Object
IVS	Instrument Verification Strip
MILCON	Military Construction
m	Meter
MC	Munitions Constituents
MEC	Munitions and Explosives of Concern
MPC	Measurement Performance Criterion
MPPEH	Material Potentially Presenting an Explosive Hazard
MRP	Munitions Response Program
MR-SIMS	Munitions Response Site Information Management System
ms	Millisecond
NAD83	North American Datum, 1983

NMEA	National Marine Electronics Association
NSF-IH	Naval Support Facility, Indian Head
PA	Preliminary Assessment
QAPP	Quality Assurance Project Plan
QC	Quality Control
RTK	Real-time Kinematic
SOW	Scope of Work
SNR	Signal-to-Noise Ratio
TDEM	Time Domain Electromagnetic
TFAS	Total Field Analytic Signal
TMI	Total Magnetic Intensity
TVG	Transverse Gradiometer
USB	Universal Serial Bus
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
WGS84	World Geodetic System 1984

1 Introduction

1.1 Purpose of Investigation

ARM Geophysics (ARM) has prepared this report for CH2M HILL to present the results of a geophysical investigation performed at Naval Support Facility Indian Head (NSF-IH), Indian Head, Maryland during April 2010 (Figure 1-1). The purpose of the investigation was to perform digital geophysical mapping (DGM) across specified areas located both on land and in shallow marine areas in support of locating potential Munitions and Explosives of Concern (MEC) associated with previous activities at the site.

1.2 Scope of Work

The initial scope of work (SOW) included performing DGM surveys both on land (UXO 11 and UXO 30) and in shallow marine areas (UXO 27) (Figure 1-1). Based on discussions between CH2M HILL and the Navy and uncertainties associated with the exact area to be investigated for UXO 27, the SOW for the shallow marine survey was amended to include an additional area adjacent to the Dive Locker Pier located approximately 0.75 miles west of UXO 27 (Figure1-2).

Land site UXO 20, which was originally included as part of the Geophysical Investigation Plan, was removed from this phase of work and will be addressed at a future date.

1.2.1 Land Sites (UXO 11 and UXO 30)

The DGM survey on the land sites was performed using the Geonics EM61 electromagnetic (EM) sensor. The DGM surveys were conducted using both GPS and wheel fiducial positioning techniques.

1.2.2 Shallow Marine Sites (UXO 27 and the Dive Locker Pier)

The general scope of work for the shallow marine sites was to conduct side-scan sonar and digital geophysical mapping (DGM), consisting of boat-towed, underwater magnetometer surveys within UXO 27 and an area adjacent to the Dive Locker Pier. The survey area to be completed adjacent to the Dive Locker Pier was based on the amount of area that could be surveyed within a two day period as provided by the contract.

Surveys were conducted utilizing a single beam echo sounder for determining seabed morphology, an EdgeTech 4100 system for the side-scan sonar survey, two Geometrics G-882 Marine Magnetometers in transverse gradiometer (TVG) configuration for the DGM survey and real-time kinematic (RTK) global positioning system (GPS) for positioning.

1.3 Report Organization

The following sections of this report have been organized and separated into the following chapters:

- Chapter One – *Introduction*: The introduction includes background information about the site and the technology utilized.
- Chapter Two – *Equipment*: Provides an in depth explanation of the geophysical instruments utilized.

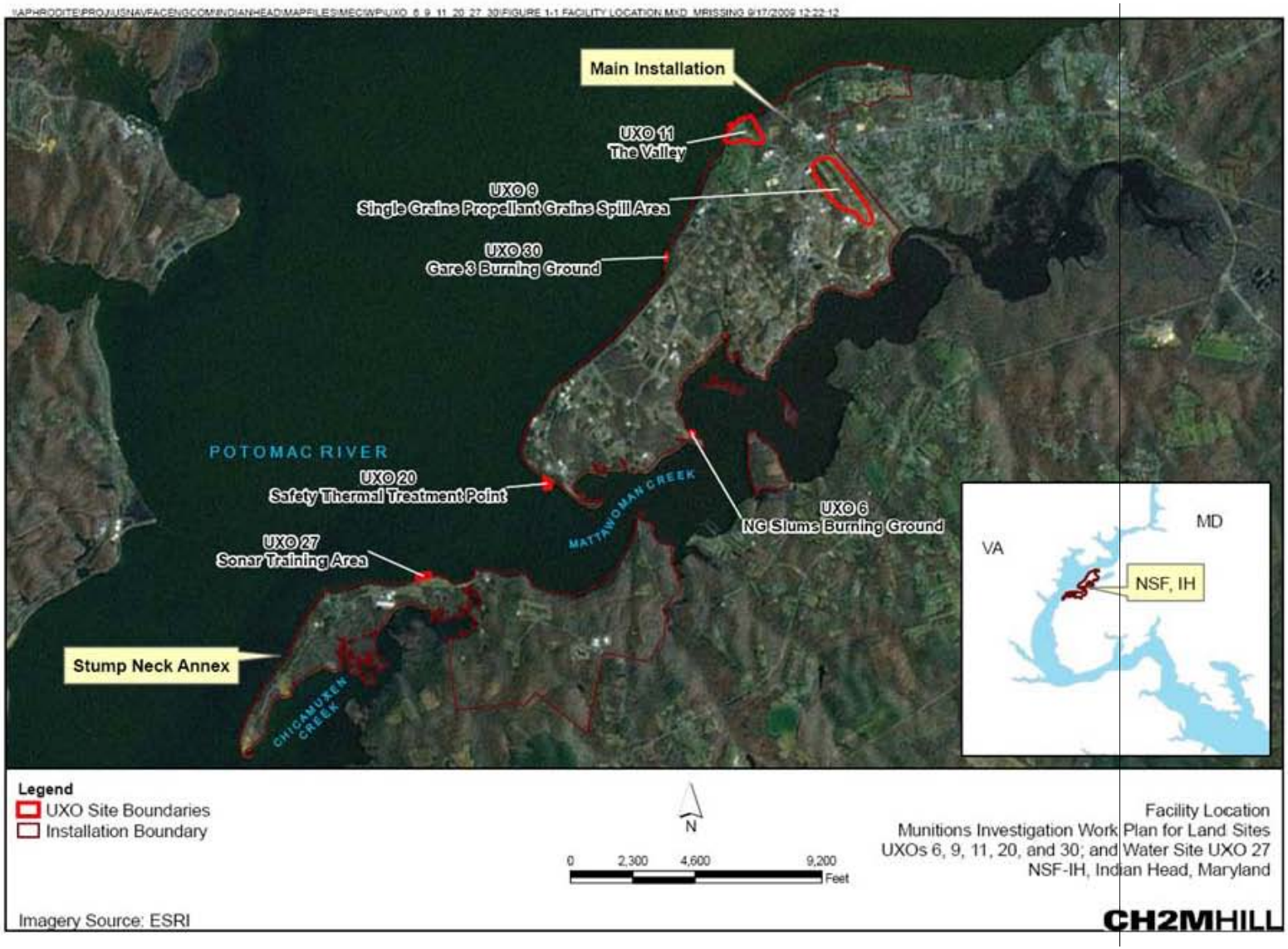


Figure 1-1: Naval Support Facility Indian Head Location (from CH2M HILL Work Plan)

Figure 1-2: Shallow Marine Sites UXO West (Dive Locker Pier) and UXO East (Beach)

- Chapter Three – *Methodology*: Details the methods and procedures used to collect and process the geophysical data.
- Chapter Four – *Geophysical Data Processing and Interpretation*: Details the processing and interpretation of the geophysical data.
- Chapter Five – *Results*: Provides the results of the DGM survey including area covered and targets selected.
- Chapter Six – *Quality Control*: Outlines the checks and procedures followed during the project to ensure quality data was collected and processed.
- Chapter Seven – *Summary and Conclusions*: Covers conclusions drawn from the geophysical investigation.

1.4 Site Location and Description

(From the CH2M HILL Project Instructions Document)

The NSF-IH is divided into two non-contiguous properties: the main NSF-IH installation and the Stump Neck Annex (Figure 1-1). The main NSF-IH installation is located on a peninsula between the Potomac River and Mattawoman Creek southwest of the town of Indian Head, Maryland. The Stump Neck Annex portion of the NSF-IH is located on a smaller peninsula approximately 1 mile southwest of the main installation between the Potomac River and Chicamuxen Creek. Land sites UXO 11 and UXO 30 are located within the main NSF-IH installation (Figure 1-1), while shallow marine sites UXO 27 (designated in this document as UXO 27 east) and the Dive Locker Pier (designated in this document as UXO 27 west) are located within the Stump Neck Annex.

1.4.1 UXO 11 – The Valley

UXO 11 is a 21-acre site adjacent to the Potomac River on the northwest portion of the Main Installation. The site was used for developing and testing numerous ordnance items between 1891 and 1921. It also was used for jet propulsion research from 1940 through 1944. Various calibers of guns (1-inch through 16-inch) were proved at UXO 11 using armor-piercing and various other projectiles. In addition, this area was used to test cartridge cases, fuzes, primers, firing devices, gun implements, steel armor plates, experimental guns and powders.

The Preliminary Assessment (PA) reported the presence of two firing points within UXO 11. The North Battery firing point was used for firing long-range guns across UXO 11 south toward primary impact areas at Stump Neck Annex and the Potomac River. The South Battery firing point was used for firing short-range guns into the North Butt along the northeast hillside. The Navy historian noted that shots were also fired to the south-southeast at UXO 11. Since 1944, part of UXO 11 has been redeveloped as the Dashielle Marina and is used for recreational boat access to the Potomac River. A Navy conference center is also located at the site. The remainder of the area has been used for a variety of installation activities.

1.4.2 UXO 30 - Gate 3 Burning Ground

UXO 30 is a 0.23-acre site along the shoreline of the Potomac River. The site is within the estimated firing fan from UXO 11 and is therefore a suspected munitions area (potential for munitions associated with UXO 11). Further, it is reported to have been a potential burning ground for explosives brought onto the site operating from 1955 to 1961, however, the types and quantities of explosives are unknown. Based on interviews conducted during the PA, burned munitions could have included flares, pyrotechnics, solid fuze boosters, bulk explosives, propellants and small arms ammunition. Evidence of burned ground surface and pieces of an old stove were observed during the PA.

On November 25, 2008, the Navy and CH2M HILL conducted a site visit. The exact location of the site could not be determined. The same observation was made during the April 22, 2009 site visit CH2M HILL made with the Navy, EPA and MDE.

1.4.3 UXO 27 East – Sonar Training Area

UXO 27 east is a 2.1-acre site of which approximately 1.5 acres is located within the Potomac River and 0.6 acres is located on the adjacent shoreline of the Stump Neck Annex (The land portion was not surveyed as part of this scope). The PA reported that the area was used for sonar training by Navy divers during the 1980s to mid 1990s. During the training, inert munitions items were submerged just offshore so divers could train in underwater ordnance identification. One torpedo casing, one underwater mine casing and one bomb casing were visible at low tide approximately 75 feet from the water's edge, and it is not known if the items were inert ordnance associated with sonar training. The water portion of the site is currently a recreational waterway, while the land portion is undeveloped.

A visual survey of the Sonar Training Area was conducted on June 2, 2004, by Malcolm Pirnie and Indian Head personnel. Only a minimal portion of the Sonar Training Area was visible from the shoreline. The visual survey revealed no evidence of MEC at the site. During the November 25, 2008, site visit, the Sonar Training Area could not be located.

(From: CH2M HILL Project Instructions, NSF-IH, dated February 25, 2010)

1.4.4 UXO 27 West Dive Locker Pier (Additional Area Associated with UXO 27)

The proposed location of the original SOW for UXO 27 was based on the PA Report. Based on conversations between CH2M HILL's senior munitions consultant with a former EOD person, and input from the navy historian, it is speculated that the training site may have been located off of the Dive Locker Pier to the west of the current proposed UXO 27 investigation area. Based on discussions with the Navy (received Navy's approval on 3/4/10) and the uncertainty associated with the exact area to be investigated for UXO 27, the SOW was amended to include an additional area adjacent to the Dive Locker Pier (Figure 1-2).

(From: CH2M HILL DGM SOW Amendment No. 1, PO 936897, NSF-IH, dated January 4, 2010)

2 Equipment

Two separate geophysical detectors were used for surveying the land and shallow marine sites at NSF-IH. The following sections provide a detailed description of the equipment used for each area.

2.1 Land Sites (UXO 11 and UXO 30)

2.1.1 Sensor

Geophysical data associated with land sites UXO 11 and UXO 30 were collected using Geonics EM61 electromagnetic detectors (EM61) set to record data in '4' channel mode. The EM61 is a Time Domain Electromagnetic (TDEM) system that generates 150 electromagnetic (EM) pulses per second and measures the response during the off time between pulses. After each pulse, the EM61 monitors the response of the induced EM fields at four discrete times (216µs, 366µs, 660µs and 1266µs). These four measurements are referred to as time gates or channels. The response of these four channels gives an indication of the conductivity of the subsurface, particularly highlighting areas of high conductivity usually indicative of metallic content present in the subsurface, with the response of the instrument measured in millivolts (mV). Examples of Data Deliverables are given in Attachment A.

2.1.2 Positioning Systems & Positioning Control

A *Leica* Model SR530 RTK-GPS was one of two positioning technologies used on site by the DGM team during DGM activities. The GPS rover unit received base station corrections in real time via a radio modem from the base station that was located over a known point near the Instrument Verification Strip (IVS) (discussed in 6.1), which was located on the golf course south of UXO 11.

The *Geonics* wheel-fiducials (FIDS) was the second positioning technology used on site by the DGM team for sampling areas which were covered by an overhanging canopy of trees or other tall obstacles which limited the use of GPS methods in meeting the project Data Quality Objectives (DQOs) for positioning. *Geonics* custom positioning wheels were utilized, with data values recorded for every 0.1m travelled (as opposed to the standard 0.2m) The RTK-GPS was used approximately 30% of the time, while the FIDS technology was used approximately 70% of the time.

Positioning control for both systems was provided by a CH2M HILL subcontracted Registered Land Surveyor (RLS). Prior to ARM arriving on site, the RLS subcontractor established control points (CP's) and a 30m x 30m grid system using wooden stakes within UXO 11 and UXO 30. The control points and stake locations were used to constrain the production DGM surveys and provide locations for quality control (QC) checks. The project utilized the North American Datum 1983 (NAD83), Universal Transverse Mercator (UTM) Zone 18 North meters.

2.1.3 Sensor Platform

The EM61 was deployed in a single coil platform configuration used by a team of up to three people to survey grid areas. The single coil system was mounted on *Geonics* standard wheels. The electronics module was mounted on a backpack and streamed data at a rate of 12 Hz to a *Juniper Systems* Allegro CX data logger running EM61 software. A GPS antenna was mounted above the center of the coil on a tripod and connected to the GPS rover streaming positional data at 1 Hz using the GGA and GSA National Marine Electronics Association (NMEA) strings to the *Juniper Systems*

Allegro CX data logger. The two streams of data were merged into one raw file, per file created, using Geonics data acquisition software, and the data were subsequently downloaded at the end of the day to a File Transfer Protocol (FTP) site using a Compact Flash (CF) card to be processed, as detailed later in this report.

2.1.4 Munitions Response Site Information Management System

All field notes, processing reports, dig sheets and other data for the land sites were handled within the CH2M HILL Munitions Response Site Information Management System (MRSIMS).

2.2 Shallow Marine Sites (UXO 27 East and West)

2.2.1 Pre-Survey

2.2.1.1 Single Beam Echo Sounder/Side-Scan Sonar

A survey-grade single beam echo sounder was used to determine water depths and morphology of the sea floor in the areas of interest while an EdgeTech 4100 side-scan sonar located any obstructions in the survey area. This survey allowed the field team to develop a detailed image of seafloor topography and determine the necessary parameters for the magnetometer/gradiometer survey to follow, for instance, the amount of cable required to keep the G-882 sensors within the target altitude of 0-5 feet above the seafloor.

2.2.2 Sensors

2.2.2.1 G-882/ G-856

Geophysical data were collected using a Geometrics G-882 TVG Marine Magnetometer system consisting of dual cesium vapor magnetometer sensors mounted side by side, 1.5 meters apart by a rigid hydrodynamic bracket (Figure 2-1). This instrument is equipped with an internal CM-221 mini-counter with a sensitivity of <0.004 nT/ pHz rms (typically 0.02 nT P-P at a 0.1 second sample rate or 0.002 nT at 1 second sample rate). The sampling rate for these surveys was 20 samples per second. The TVG setup provides multi-sensor data concatenation allowing side by side coverage which maximizes detection of small targets and reduces noise. In addition to doubling survey efficiency (compared to use of a single sensor), the dual sensor configuration allows for a more effective and accurate analysis and interpretation of total field as well as providing true magnetic gradient (horizontal) data.

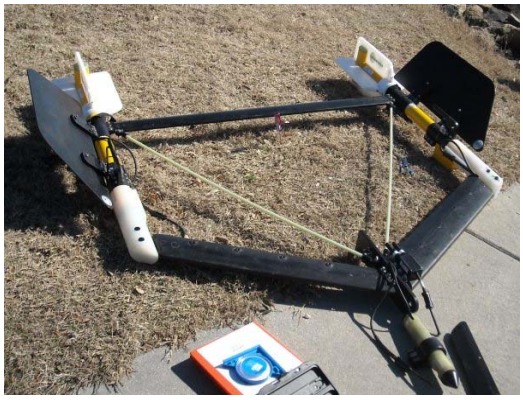


Figure 2-1: Geometrics G-882 TVG

As an additional control on data quality, the G-856 base station magnetometer was employed to measure and correct for the diurnal variation of the magnetic field. The G-856 base station was positioned away from any potential sources of magnetic interference. However, on April 16th, a magnetic item (compass) was inadvertently left on top of the sensor, rendering that day's base station data unusable. This incident is described in The Root Cause Analysis / Corrective Action

Plan contained in Attachment B. As described in Section 4.2.4.4, the data for this day was corrected by using non-linear filtering to remove the background response which included the diurnal effect. On April 17th, a vehicle approached and left the location of the base station, however, the anomaly introduced was short enough and the background stable enough that the anomaly could be satisfactorily removed by interpolation of the diurnal field (Figure 2-2).

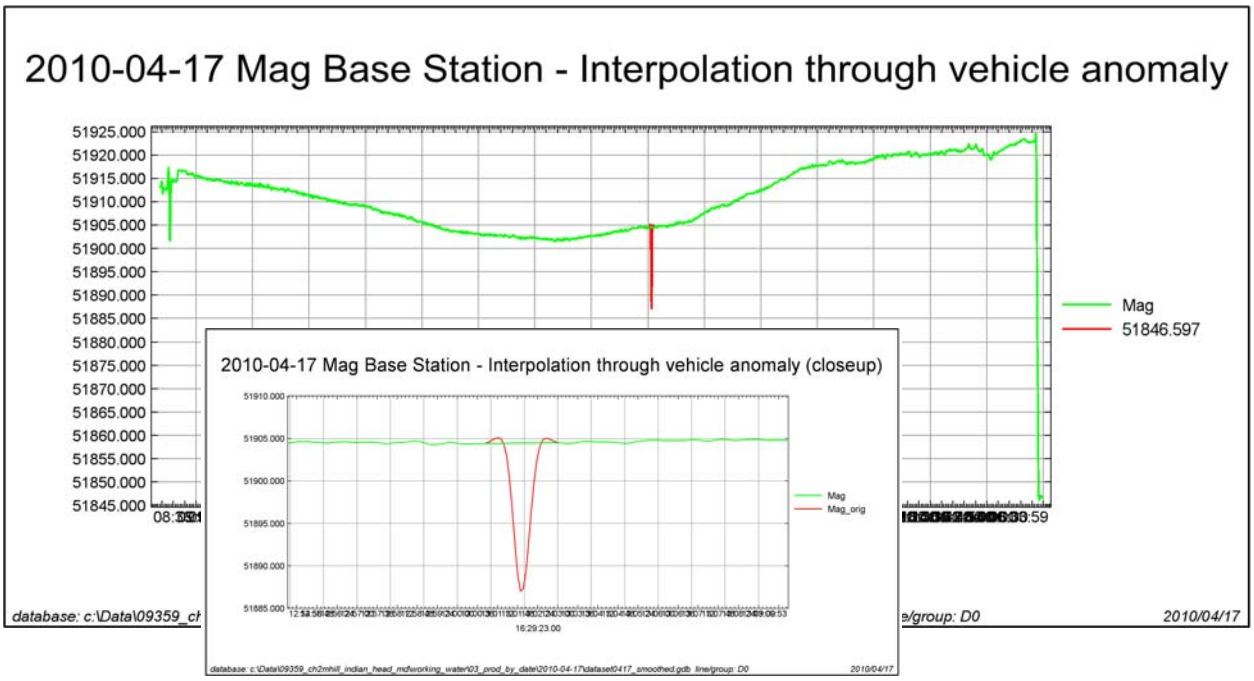


Figure 2-2: Interpolation of G-856 Data through Vehicle-Induced Anomaly

2.2.3 Survey Platform

Marine magnetometers are generally "tow-fish" instruments (so-called because of their streamlined appearance) and are towed at least two and a half 'boat-lengths' behind the vessel so that the vessel's magnetic signature does not interfere with the magnetic field measurements. The survey platform employed at NSF-IH consisted of the above detailed dual G-882 TVG marine magnetometer system (tow-fish) deployed behind a 22ft (6.7m) aluminum hull survey vessel. It was attached to the boat via a Kevlar soft tow cable and during DGM operations maintained a 20 – 30m distance from the vessel. The shipboard end of the tow cable was attached to a junction box for hookup to a laptop computer. The mechanical specifications for the sensor fish and tow cable are:

- **Sensor Fish:** Body 2.75 in. (7 cm) diameter, 4.5 ft (1.37 m) long with fin assembly (11 in. cross width), 40 lbs. (18 kg) Includes Sensor and Electronics and 1 main weight. Additional collar weights are 14lbs (6.4kg) each, total of 5 capable,
- **Tow Cable:** Kevlar Reinforced multi-conductor tow cable. Breaking strength 3,600 lbs, 0.48 in OD, 200 ft maximum. Weighs 17 lbs (7.7 kg) with terminations.

Photographs of the Sensor Platforms can be found in Attachment C

2.2.3.1 UXO 27 East

The towfish was deployed at UXO 27 east using a floatation device in order to keep it above the sea floor. The floatation device was constructed of closed-cell polyethylene foam 'swim noodles' and plastic webbing (Figure 2-3) which enabled the tow-fish to be towed while partially submerged at the surface. The stability of the floatation device also allowed for the GPS antenna to be mounted on a PVC frame directly above the tow-fish. The survey area within UXO 27 east had a depth of less than 1.5m (5 feet), necessitating the flotation device – see Figure 2-4,

Figure 2-3: G-882 TVG Tow-fish in Float Mode with GPS

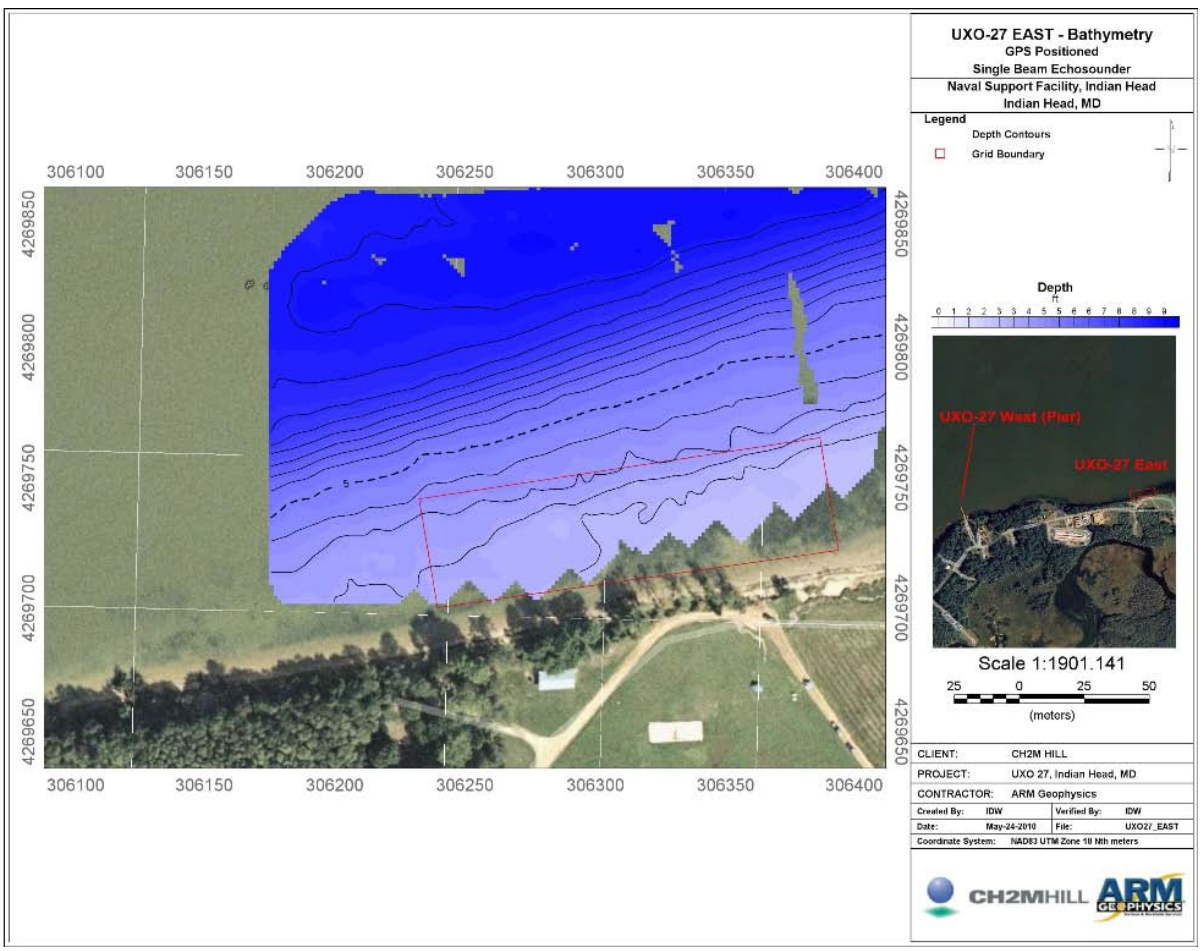


Figure 2-4: Bathymetric Survey – UXO 27 East (Beach); 0.5ft Contours

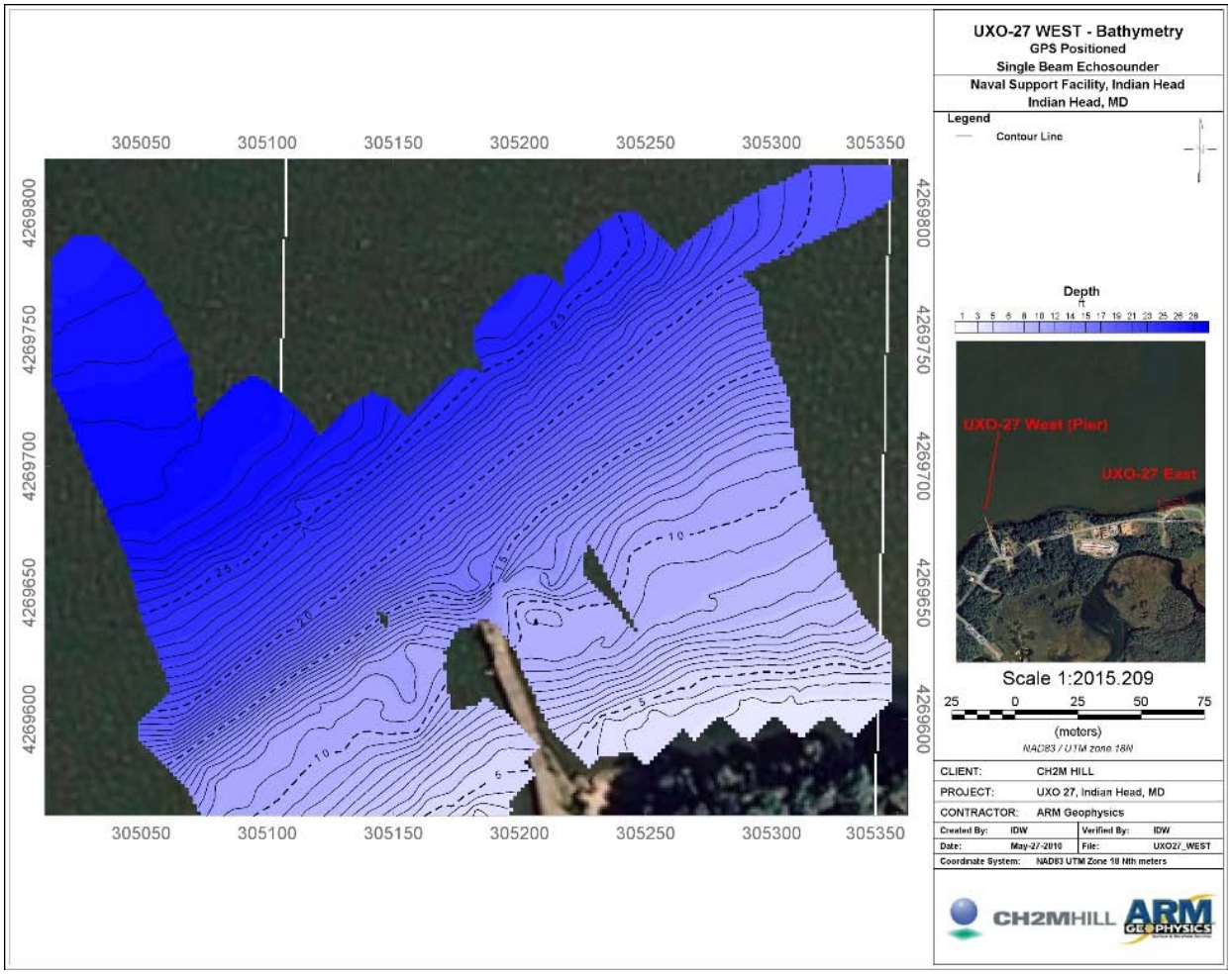


Figure 2-5: Bathymetric Survey – UXO 27 West (Pier); 0.5ft Contours

2.2.3.2 UXO 27 West (Dive Locker Pier)

The area surveyed north of the Dive Locker Pier had a depth range that varied between 3.8m and 6.9m (12.5ft and 22.5ft) – see Figure 2-5. Based on this depth range, the tow-fish was deployed in its standard mode without any floatation devices. The altitude of the tow-fish within the water column was adjusted according to sea floor depth in order to maintain an ideal sensor altitude of less than 1.5 m (5 feet) from the seafloor, however, survey conditions resulted in sections of data with altitudes between 5 and 10 feet (see section 3.2.1).

2.2.4 Positioning System

A Leica RTK-GPS was used on site by the field team. The GPS rover unit received base station corrections in real time via a radio modem from the base station that was located over a known survey point, located on shore adjacent to UXO 27.

Positioning control was provided by CH2M HILL based on NAD83, UTM Zone 18 North. Additional positioning control points were provided by the Navy for the UXO 27 area at Stump Neck Annex.

3 Methodology

3.1 Land Sites (UXO 11 and UXO 30)

3.1.1 Geophysical Data Acquisition

Land sites UXO 11 and UXO 30 were divided into 30m x 30m grids prior to ARM's arrival on site. ARM utilized this grid system to manage the collection of geophysical data.

ARM field personnel prepared grid maps – diagrams of the setup of each grid and the approximate locations of objects or obstacles such as trees, nearby cars, buildings and marked utilities that could affect the data or data coverage. These maps were included as a deliverable to CH2M HILL.

3.1.1.1 Single-Coil GPS DGM

Approximately 30% of the grid areas were digitally mapped using the *Geonics* EM61 coupled with the RTK-GPS. Grids were collected by laying measuring tapes along the two edges perpendicular to the survey direction. Non metallic marker items were used to denote lines every 0.76 meters (2.5 feet) which were travelled in alternating directions during the survey.

3.1.1.2 Single-Coil FIDS DGM

The majority of grids were digitally mapped using the *Geonics* EM61 coupled with a Geonics wheel fiducial positioning system. The fiducial method (FIDS) is accomplished using a specialized odometer counter wheel on the EM61 which triggers the EM61 to sample the data once for every 0.10 meters of ground covered, thus sampling the data at fixed distances as opposed to time-based fiducial sampling. This method was suitable for grids where GPS was hampered due to trees, buildings or other obstacles. Lines were collected in a similar method to the GPS surveys. To assist in positioning the data, additional tape measures were laid out perpendicular to the survey direction at 25 foot intervals within the grid. A fiducial mark was recorded in the data each time the center of the EM61 trigger wheel crossed a fiducial line.

3.2 Shallow Marine Sites (UXO 27 East and West)

3.2.1 Geophysical Data Acquisition

Marine data acquisition for the NSF-IH project was conducted in two phases: the first phase consisted of a bathymetry and side-scan sonar survey to characterize the seabed site conditions, and the second phase consisted of a magnetometer survey to determine the presence of ferrous anomalies in the area. Each of these phases is discussed in detail below.

Phase One included a thorough, single-beam hydrographic survey and, after a ship-board review of the bathymetry data, a side-scan sonar survey of the two marine survey sites. The bathymetric survey provided detailed information regarding the slope and morphology of the seafloor. This information was used for planning the magnetometer survey. The use of a single beam echo sounder increased safety, lowered the risk of damage to tow equipment, and served as an additional quality assurance to the accuracy of magnetometer vertical positioning and reference by allowing comparison of the pressure depth plus altimeter value to the absolute depth as measured

along the survey line by the vessel. The side-scan sonar survey was conducted utilizing an EdgeTech 4100 side-scan system operated at 25-50m range per channel at 500 kHz. The side-scan sonar data indicated to the boat crew the presence of any debris on the seafloor which could impact magnetometer data collection. Areas within the site that could potentially pose a risk to equipment or personnel safety due to seafloor debris identified by the side-scan survey were subsequently plotted for reference and avoidance using Hypack navigation software. Survey lines for the bathymetric/side-scan survey were spaced at 20m intervals, and data was processed and analyzed in the field. Review of bathymetric/side-scan sonar data allowed for the fine tuning of the magnetometer survey plan so that specific elevation contours could be followed, thereby increasing the survey team's ability to maintain the instrument at the goal height of less than 1.5 m (5 feet) above the seafloor, maximizing magnetometer survey efficiency and allowing safe data acquisition within survey specifications.

Phase Two of data acquisition consisted of a magnetometer survey to determine the presence of metallic anomalies in the NSF-IH areas of interest. Data was collected with two Geometrics G-882 cesium vapor magnetometers configured so that the instruments maintained a constant 1.5m separation from each other for the duration of data collection. The transverse gradiometer (TVG) is ideal for marine UXO and metallic object detection when high data density, high sensitivity, and tight line spacing are necessary. It improves survey efficiency by 100% while also significantly enhancing data quality as compared to single sensor systems. The TVG was equipped with two pressure depth sensors and a high resolution altimeter used to continually measure the tow-fish altitude above the seafloor. Survey lines for this phase of data acquisition were collected at a nominal spacing of 1.0m with a 1.5m cross-track tolerance with the sensors sampling at 20 Hz. All reasonable efforts were made to maintain a constant instrument height above the seafloor of less than 1.5 m (5 feet). This was facilitated at the UXO 27 west site by changing the amount of cable out and with small adjustments to the vessel speed. At the UXO 27 east site, the TVG was floated throughout the survey.

Of the 2.98 acres of data surveyed at UXO 27 west (pier) site, approximately 0.52 acres were collected at altitudes between 5.0 and 10.0 feet. These areas were mostly along the northwestern edge, corresponding to the deeper sea bed, and the areas immediately before and after turnarounds (see Figure 3-1)

All data within the UXO 27 east site grid boundary was collected with the TVG within 5 ft of the seafloor.

At the end of each survey day, all raw gradiometer data was placed on an FTP site for review and processing at ARM's office in Hershey, PA.

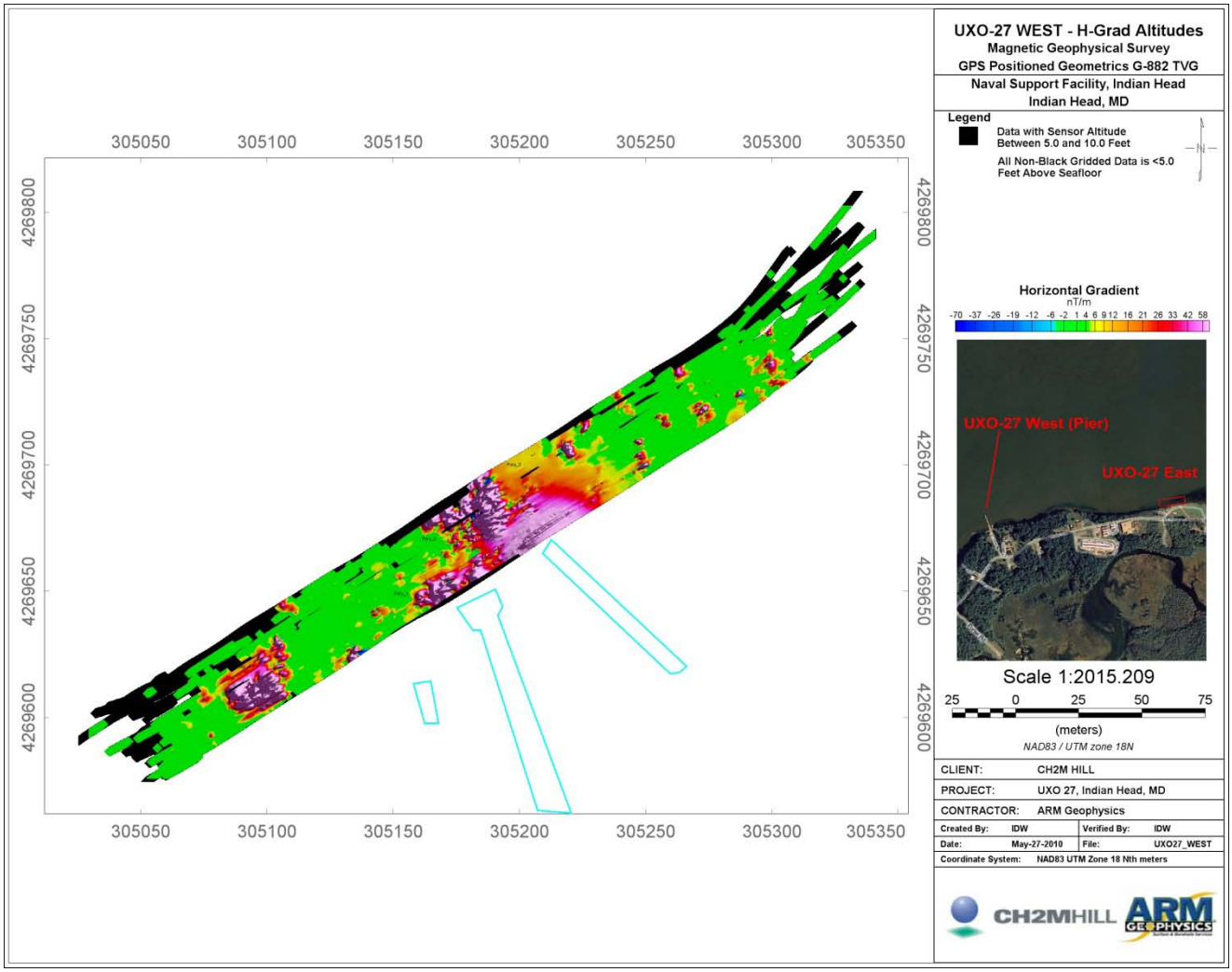


Figure 3-1: UXO 27 West (Pier) Altitudes between 5.0 and 10.0 feet

3.2.1.1 UXO 27 West (Dive Locker Pier Site)

Approximately 2.98 acres of data were collected adjacent to the northern end of the Dive Locker Pier. Data was not collected on the western or eastern sides of the pier because of a number of factors including: Access restrictions associated with Department of Defense (DOD) operations on the western side of the pier; limited maneuverability of tow vessel and tow-fish between eastern side of pier and pilings/breakwater; and the equipment safety factor of operating the tow-fish close to the existing pier, pilings and other structures. In addition, the survey area to be completed adjacent to the Dive Locker Pier was limited by the amount of survey area that could be completed within a two day period; technical issues during the first day hampered efforts to collect data, resulting in one full day of DGM only in this area.

3.2.1.2 UXO 27 East (Beach Site)

The UXO 27 east shallow marine survey site consisted of 1.65 acres. A total of 5.1 acres, including 1.62 acres of the 1.65 acre grid, of TVG data were collected (a small portion in the southeastern area of the grid did not have enough draft for the floated TVG). This area contained numerous boulders and was too shallow for collection as a boat-towed system. At low-mid tide, parts of this area were above the waterline with the deepest areas only a few inches in depth. The shallowest portion of the UXO 27 east survey near the shoreline was too shallow for the tow vessel and was towed manually pulling the floated TVG across the area (Figure 3-2).

Figure 3-2: G-882 TVG Manually Being Towed Across Shallow Water in UXO-27

4 Geophysical Data Processing and Interpretation

All geophysical data were processed off site at ARM's processing center in Hershey, PA. The processing followed a systematic procedure which is detailed below. Processing utilized a number of different applications including Geonics DAT61MK2, Geometrics MagMap2000, Geosoft Oasis Montaj, proprietary software and Geosoft Oasis Montaj scripts.

4.1 Land Sites (UXO 11 and UXO 30)

4.1.1 Data Download

Single-coil EM61 raw data (*.R61) were transferred daily from the Allegro field computer to a processing laptop via a CF card. Raw files were maintained on the Allegro for, at minimum, three days as an additional backup in case of damage or corruption during the download process. Following transfer, all raw data files were uploaded to a dedicated FTP site at the end of each work day.

4.1.2 Data Conversion

Data were converted from compressed binary (*.R61) format to ASCII (*.M61) format using Geonics DAT61MK2. GPS-positioned files were converted to ASCII XYZ format in DAT61, then imported into Geosoft for further processing. Fiducial-positioned M61 files were imported directly into Geosoft and positioned with reference to field notes of tape measurements and grid maps.

4.1.3 Data Import

Data were imported using ARM's proprietary Importer software which analyzed the data and performed the following steps automatically:

- Creation of a Oasis Montaj database
- Import of the XYZ data into the database
- Flagging of poor quality GPS for further inspection
- Conversion of GPS coordinates from WGS84 latitude and longitude to NAD83 UTM Zone 18N meter coordinates (GPS data only)
- Export of the raw data to XYZ file to provide to the client

The automatic nature of the steps facilitates the avoiding of errors in transforms and file naming.

Fiducial data were imported directly from the M61 files and the local X/Y coordinates positioned with respect to the field notes and then warped to real-world NAD83 UTM Zone 18 North meters.

4.1.4 Data Processing

Data processing involved multiple steps which are outlined below. These steps all occurred in Geosoft Oasis Montaj using a mix of manual and scripted methods.

4.1.4.1 Data Filtering

EM61 data were filtered to remove instrument drift using the UXFILT GX. This filter, utilizing appropriate parameters, acts to remove the gradual drift in EM61 data that occurs over time. This elevated or depressed background response is then brought back to 0mV. The filter allows the processor to specify the operational window and percentage of high and low values that are

ignored in determining the current background response. The parameters used for each dataset were documented in MRSIMS.

The results of the filtering were reviewed in Oasis Montaj profile mode to ensure that the data were not degraded by the process nor that the data levels were artificially raised or lowered. In some cases, the data required hand filtering, by manually applying DC-shifts, due to the high EM responses being encountered over large areas.

4.1.4.2 Data Lag/Latency Correction

Latency correction was required to correct for the delay of positioning information being streamed to the EM61. This correction was determined on a daily basis by performing a two line test as described in 6.2.1.7. Once a dataset had been corrected for this latency, the processor visually inspected the grid to determine if the correction was suitable. If anomalies appeared stretched, skewed or contained 'chevroning' effects, the correction was reviewed and reapplied as required.

The correction was applied using the LAG GX, and the parameters used were documented in MRSIMS.

4.1.4.3 Data Gridding

Gridding of the data was performed using the Minimum Curvature method. ARM utilized a cell size of 0.104 meters and a blanking distance of 0.52 meters to ensure full coverage of data without creating either artificial gaps, where data was not collected along a cardinal direction, nor artificially suppressing gaps. All four channels as well as two sum channels (response of channels 1-4, summed and response of channels 2-4, summed) were gridded for analysis. The resulting data were displayed in map form as grey-background color-shaded grids to assist interpretation.

4.1.5 Target Selection

Target selection was performed in several steps. Target picking occurred on a grid by grid basis, conducted once survey of the grid was complete.

4.1.5.1 Threshold Picking

The initial step involved running the UXPARSE GX. The GX utilized the Blakely Algorithm to pick peaks on a grid above a threshold value. As items of interest were not defined, picks were made at a threshold of 3mV on Ch3, with the subsequent anomalies stored in a target database. Targets were merged on a radius of 1.0m and manual adjustments made to re-position any anomalies that had shifted off-peak.

4.1.5.2 Decay Filter

The CH2M HILL decay filter was run to determine the validity of the EM response through analysis of the channels' response in relation to each other. In order to pass the filter, the response needed to be predictable and have a valid decay, e.g. CH1=20mV, CH2=12mV, CH3=7mV and CH4=3mV (i.e. CH1 > CH2 > CH3 > CH4).

4.1.5.3 Target Size, Strength and Signal-to-Noise Ratio

Further analyses were performed using the UCEANALYZETARGET GX. This GX analyzed the CH3 grid file and target database and calculated the Size, Strength and Signal-to-Noise Ratio (SNR) of each picked target.

4.1.5.4 Calculation of Apparent Time Constants and Tau

The UCEEMTAU GX was used to calculate the apparent time constant on the four time gates of the EM61 in order to normalize the time decay, represent it as a single number and as a result facilitate the interpretation of each picked target.

4.1.5.5 Target Classification

As the type of UXO of interest was not specified, classification of the picked targets was not made on threshold, anomaly attributes or tau values (beyond excluding targets that failed the filter). Instead the classifications used were related to the presence of a large number of (presumed) underground utilities and other high-amplitude anomalous areas across the site.

All gridded data were displayed as an overview map at a color scale where the linear features stood out relative to the background (as opposed to the regular scale where large areas of data appeared saturated). This overview was then referred to when picking anomalies in individual grids, and features that appeared linear over multiple grids were not picked (see Figure 4-1).

Areas of data where response from multiple anomalies had 'bled' into one another or where the response was 'saturated' relative to the displayed color scale were isolated as 'mag & dig' 4-sided polygons for analogue investigation. These polygons were listed as 'Class 3' in the digsheets.

Due to the large area contained within these polygon anomalies, prominent individual peaks in the gridded data were picked for intrusive investigation, as an alternative to wholesale mag & dig of the areas. These individual peaks were identified as 'Class 2' anomalies.

'Regular', individual picks outside of anomaly polygons were identified as 'Class 1'.

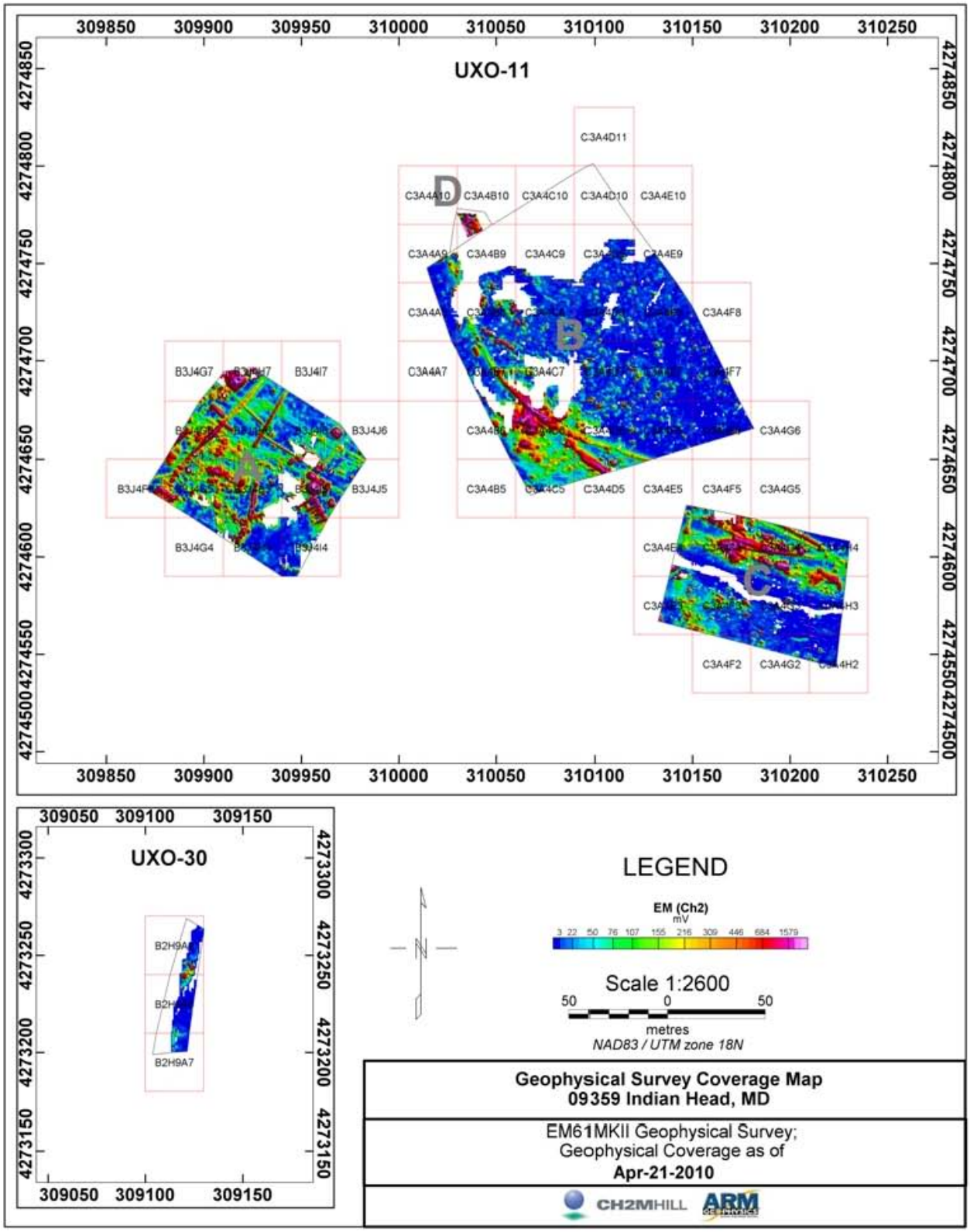


Figure 4-1: Inferred Utilities from EM61 Data

4.1.5.6 Digsheet Creation

The final target list was taken from Oasis Montaj and exported into Microsoft Excel. This Excel document was then formatted for MRSIMS import. The Excel file is included as part of the final deliverables package.

4.1.5.7 Map Creation

An Oasis Montaj map was created for each grid on site. Each map shows the gridded geophysical data, geophysical targets and class, grid location and survey information. Each map was packed and exported to JPEG for inclusion in the final deliverables package.

4.1.6 Deliverables Packages

Deliverable packages were uploaded to the project FTP site once a grid was deemed complete. The final deliverable package contains:

- Processed XYZ of Geophysical EM Data
- Grid files for Channels 1, 2, 3, 4 ,CHSUM 1-4 and CHSUM 2-4
- Map file in JPEG format
- Map file in Oasis Montaj Packed Map format
- Target list in XYZ format
- Target list in MR-SIMS format
- PDF deliverable report

Each package was compressed into a ZIP file to minimize bandwidth usage and disk storage requirements. Examples of data deliverables can be found in Attachment A.

4.1.7 Data Quality Objectives

DQOs are a set of standards that were required by CH2M HILL to be met during the collection and processing of the geophysical data at NSF-IH. The DQOs applicable to the land portion of the Indian Head project, as specified in the Geophysical Investigation Plan are those defined in Table 4-1, Table 4-2 and Table 4-3 below**:**

Table 4-1: Data Quality Objectives – As Defined In GSV Plan

Data Quality Objective	Measurement Performance Criteria	Test Method
DGM System Positioning. Accurate coordinates are being obtained from DGM positioning systems	Positional error at known monuments will not exceed 0.25m (9.8in)	IVS: QC Seeds to be located within specified distance Production: GPS Positional Test assessed for compliance
DGM System Munitions Detection. DGM system response is within industry standards for detection	Response to standardized item will not vary more than ±20% of expected value in static test	Results of the Static test quantitatively reviewed to ensure compliance

Table 4-2: Data Quality Objectives – General Survey DQOs

Data Quality Objective	Measurement Performance Criteria	Test Method
Down-line density is sufficient enough to detect MEC items	98% of samples within 0.2m (0.7 feet) of one another Velocity of survey sufficient to maintain sample separation at a sample rate of 12-15 Hz	DGM surveys monitored using the UX-Process sample separation tool. Results of sample separation provided on the final delivery report PDF
Coverage over survey area is sufficient to detect MEC items	95-98% of surveyable area covered by DGM at project lane spacing, taking into account allowable gaps	Line paths evaluated in Oasis Montaj and UX-Process Footprint Coverage tool used to assess % coverage at instrument swath
Positioning of detected items is accurate	Detection of QC seeds within specified distance	Evaluation of blind seeds by CH2M HILL

Table 4-3: Data Quality Objectives – Data Handling

All data must be delivered in a timely manner and in a useable format	Data packages completed and delivered within the schedule specified in the work plan	This DQO evaluated by examining the time of completion of a grid and the actual delivery date of the data

A discussion of the DQOs can be found in Section 6.3.

4.2 Shallow Marine Sites (UXO 27 East and West)

Geophysical data from the G-882 TVG surveys and G-856 base station were downloaded at the end of each day and transferred for processing to ARM's Hershey office. The processing followed a systematic method, detailed below. Processing utilized a number of software packages, including Geosoft Oasis Montaj (with UX-Detect), Geometrics MagMap2000 and proprietary software and Geosoft Oasis Montaj scripts.

4.2.1 Data Download

The gradiometer and base station data were transferred from the data collection laptop and G-856 unit to a separate computer for transfer to the Hershey office and for backup purposes. Files were retained on the computers for the entire project as an additional form of data backup.

The single-beam hydrographic and side-scan sonar data were downloaded to a processing computer via a CF card.

4.2.2 Data Conversion

Base station data were de-spiked and smoothed in Geometrics MagMap2000. This process also converted the time and date columns to a format able to be used as input into the Geosoft Oasis Montaj base station correction utility.

The raw *.INT ASCII gradiometer files were re-named *.XYZ and used as direct input into Geosoft.

4.2.3 Data Import

Gradiometer data were imported using ARM's proprietary MaglogImporter software. MaglogImporter performed the following steps automatically:

- Creation of a Oasis Montaj database
- Import of the XYZ data into the database, with data from each sensor imported to separate lines
- Conversion of the depth and altitude from meters to feet
- Flagging of poor quality GPS for further inspection
- Conversion of GPS coordinates from WGS84 latitude and longitude to the project coordinate system
- Export of the raw data to "_converted.XYZ" deliverable file

The automatic nature of this step was crucial to avoid errors in coordinate transforms and file naming.

Additionally, the same TVG data were also imported into a separate set of databases to take advantage of the horizontal gradiometer calculation from the two magnetometer sensors.

4.2.3.1 Conversion of Coordinates

Data was required to be converted from the native WGS84 latitude and longitude to NAD83 UTM Zone 18N meters. The position of each magnetometer sensor was calculated during collection, based on the position of the GPS antenna and the layback of the tow-fish, with these positions then used as the location of the data points.

For the calculation of the position of the horizontal gradient values, i.e. the center point of the line connecting the two sensors, Geosoft UX-Detect's Sensor Offset Corrections utility was used. This calculated the center position based on the location of the left sensor and the direction of travel.

4.2.4 Data Processing

Data processing involved multiple steps, outlined below. These steps were performed in Geosoft Oasis Montaj using a mix of manual and scripted methods.

4.2.4.1 Base Station Correction

The raw data from each sensor (TMIraw) was corrected in Geosoft by means of the recorded base station data in order to remove any long wavelength diurnal variation from the DGM data (UCEMAGBASE GX). This process resulted in a new, corrected channel, TMIcorr.

4.2.4.2 Data Lag/Latency Correction

Latency correction was required to correct for the delay of positioning information being streamed to the magnetometer/gradiometer array. The latency was tested daily by performing a two line test as described in 6.2.1.7. Once a dataset had been corrected for this latency, the processor visually inspected the grid to determine if the correction was suitable. If anomalies appeared

stretched, skewed or contained 'chevroning' effects, the correction was reviewed and reapplied as required. The correction was applied using the LAG GX function in Oasis Montaj.

4.2.4.3 Data Gridding

Gridding of the data was performed using the Minimum Curvature method. ARM used an initial cell size and blanking distance of 0.14 meters and 0.98 meters (0.14 and 1.96 for the horizontal gradient), respectively, to insure full coverage of the gridded data. The total field magnetic data (TMI) and horizontal gradient data were gridded for analysis. The data was displayed in map form as color-shaded grids to facilitate interpretation.

4.2.4.4 Residual TMI Calculation

Corrected TMI data from the western (pier) section was not available due to the failure of the base station. Additionally, there was a significant response in the raw data from the pier itself and a nearby line of bollards (see Figure 4-2). The long-wavelength background (containing the diurnal effect) and the high-amplitude, long wavelength anomaly associated with the pier were removed through calculation of the residual TMI field.

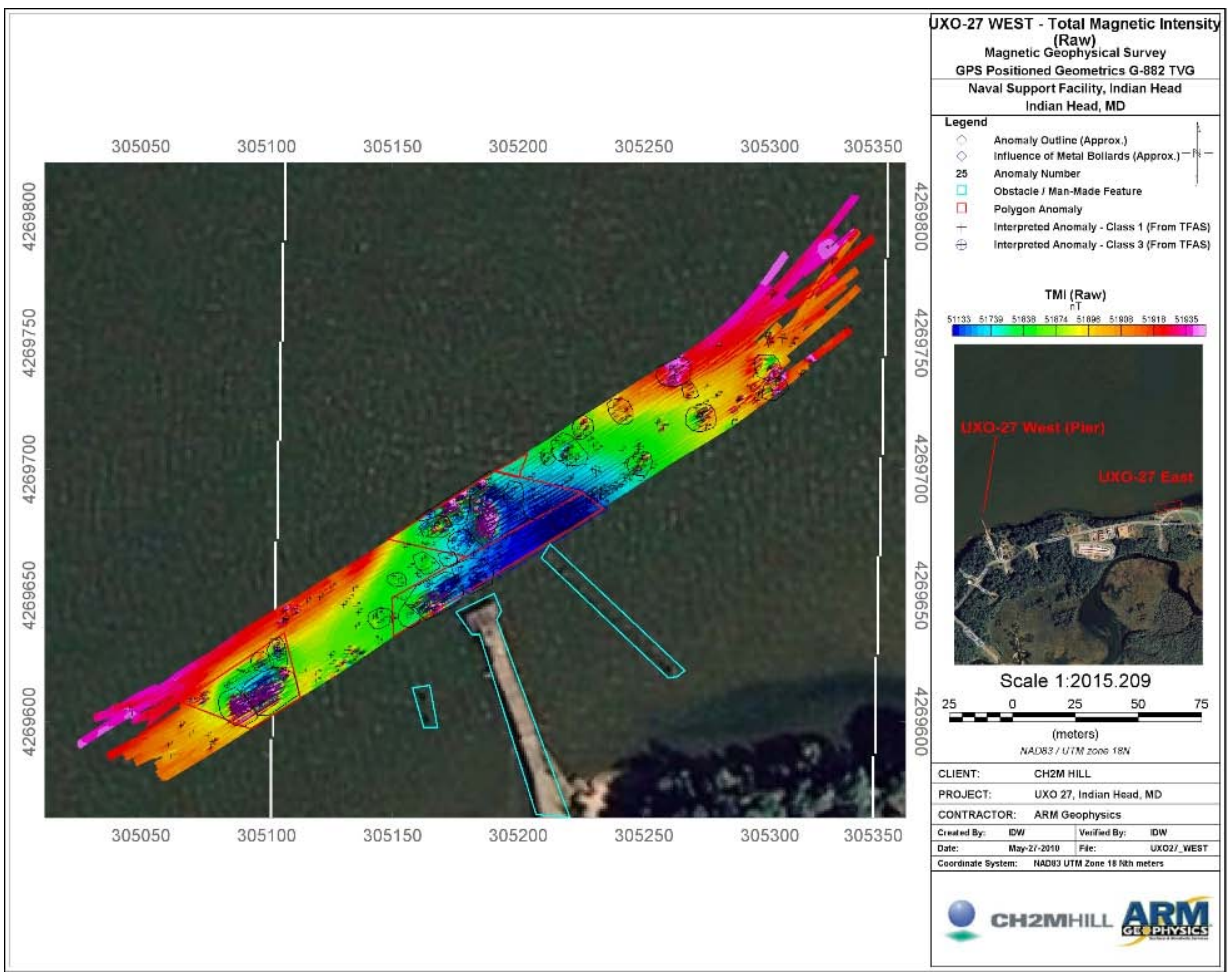


Figure 4-2: UXO 27 West (Pier): Grid of Raw TMI Data showing influence of pier

Removal of the background was achieved by means of a non-linear filter applied line by line to the raw TMI channel. This filter had a general window length of 75 but ranging to 200 in places to avoid artificially raising or lowering the signal. In cases where the filter would not accurately map the background without either attenuating features of interest or adding significant artifacts, the line would be split, the filter applied to each segment separately and the line then re-combined. Each line of data was assessed in profile mode to ensure that the filtered channel was a fair approximation of the long wavelength features but did not attenuate the medium to short wavelength anomalies. This filtered channel was then smoothed with a low-pass filter (window length 200) to remove the 'saw-tooth' effects introduced by the non-linear filter in parts of the data.

These resultant 'background' values were subtracted from the 'TMIRaw' channel to give the 'TMIRaw_Resid' channel. This channel was then gridded with the parameters specified above and used as input into the Analytic Signal calculation and as a reference during target selection.

One side effect, however, of the residual calculation process was the introduction of a certain amount of 'streaking' into the data as the filter could not, in places, map exactly the relatively long wavelength, high amplitude pier-induced anomaly without adding long 'lobes' to the surrounding data. ARM believes that the advantage gained from removing the long wavelength features – a clearer view of the data as a whole and the revelation of anomalies previously hidden in the high amplitude, long wave length response – outweighs the disadvantages of the artifacts introduced.

Once calculated, this residual TMI data was then treated as the TMIcorr channel, being corrected for lag, gridded and used as input into the total field analytic signal calculation.

4.2.4.4.1 Analytic Signal

Due to the dipolar response of anomalies in the TMI data, the total field analytic signal was calculated from the grid, and grid products, of the residual, corrected TMI data. This TFAS grid is mono-polar in nature and has the effect of centering the location of anomaly peaks over the item causing the response, as opposed to a dipolar anomaly, where the item is not necessarily located directly under the inflection point.

The grid of the western data set was somewhat 'streaky' in appearance, containing cross-line artifacts caused by a number of factors including differing tow-fish height (and therefore, instrument response) between adjacent sensor tracks, which was exaggerated by the high density of line paths required to achieve 100% coverage in addition to the streaking introduced in the residual field calculation process. Exaggeration of the streaking effect during calculation of the analytic signal was minimized through 3 passes of a Hanning (smoothing) filter and by setting a de-sampling factor of 4, based on the ratio of the default sensor path spacing and the grid cell size.

The eastern data set displayed very little streaking as the sensor height above bottom was more consistent than in the west. Additionally, there was no gradient imposed on the data by a large external ferrous source, requiring calculation of a residual.

4.2.5 Target Selection

Target selection was performed on each area (UXO 27 east and west), on completion of DGM, and consisted of the following:

4.2.5.1 Threshold Picking

The initial step involved running the UXPARSE GX on the grid of the analytic signal of the residual TMI data in the west and the analytic signal of the corrected TMI in the east. The GX utilized the Blakely Algorithm to pick peaks on the grids above a nominal threshold of 5.0 nT/m. These anomalies were then stored in a target database.

4.2.5.2 Data Comparison and Refinement

The picked targets from the TFAS grids were displayed on a map that contained the grids of TFAS, the horizontal gradient and the 'TMI' / 'TMI_resid' channels at an appropriate color scale. The grid of the raw TMI data was displayed for reference as well in the western area. These grids were then referred to in turn as additional targets were added, miss-positioned targets moved and extraneous targets removed. In cases where it was ambiguous whether or not an anomaly pick should remain, the profile data was referred to.

For small, well constrained anomalies, target positioning was clear. However, on larger anomalies, there were many 'peaks' that had been auto-selected. The number of picks on each of these large anomalies was reduced, in the case of medium sized anomalies (~5m across or less) to a single pick in the center of the anomaly and for larger anomalies (>5m across), several picks were left to ensure the target was well defined, particularly where it appeared the anomaly may have several sources. In the western area, where there were a large number of such anomalies, including some quite diffuse anomalies, polygons were drawn to define the rough outline of each.

Additionally, in the western area, the central portion of the data was characterized by a large area of higher amplitude response with individual targets not able to be distinguished from one another. This area was outlined with 4-sided 'anomaly polygons' and individual peaks picked where possible.

The western area contained a total of 245 target picks:

- 170 'Class 1' anomalies, representing individual target picks
- 75 'Class 3' anomalies, representing individual peaks contained within 4 polygon anomalies (designated Class 999 in the Excel digsheet deliverable)

The eastern area contained a total of 277 target picks:

- 143 'Class 1' anomalies, representing individual picks within the designated grid boundary
- 134 'Class 2' anomalies representing individual picks outside of the grid boundary; included as there appeared to be two rows of anomalies of similar size and shape, partly in and partly out of the grid boundary

4.2.6 Deliverables Packages

Oasis Montaj deliverables maps were created for each site for TFAS, horizontal gradient and TMI / residual TMI data. On each map were displayed the targets, picked and refined from the TFAS grid,

overlain on the relevant grid along with survey information. Each map was then packed and exported to JPEG for inclusion in the final deliverables package.

Deliverable packages were uploaded to the project FTP site once an area was deemed complete. The final deliverable package contains:

- Processed XYZ of Geophysical Data
- Grid files for corrected TMI, residual corrected TMI, total field analytic signal and horizontal gradient
- Map files in JPEG format
- Map files in Oasis Montaj Packed Map format
- Target list in XYZ format
- Target list in MRSIMS compatible Excel format

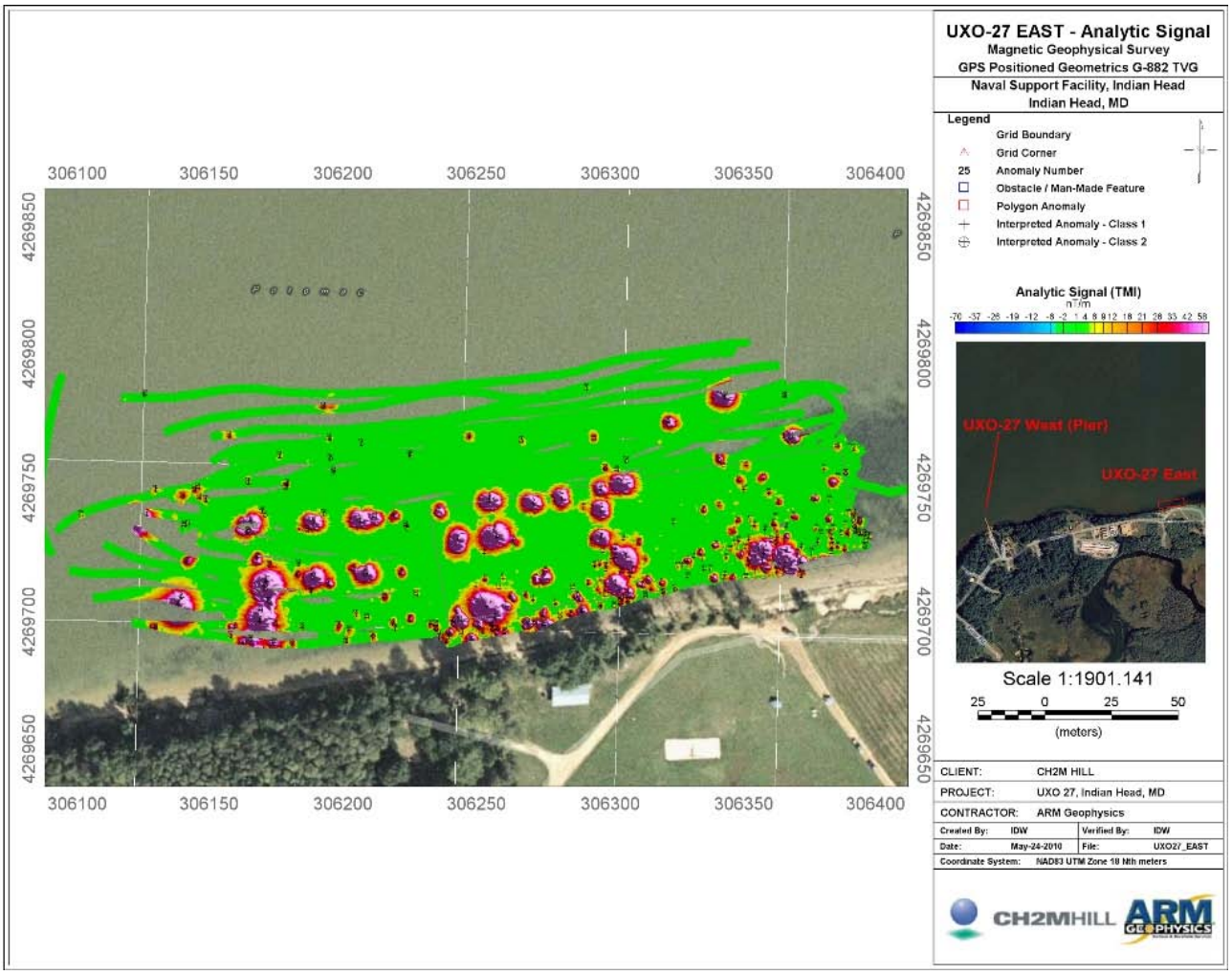


Figure 4-3: Example Deliverables Map: TFAS data from UXO 27 East

Each package was compressed into a ZIP file to minimize bandwidth usage and disk storage requirements and uploaded to the CH2M HILL FTP site. Data deliverables can also be found on the accompanying DVD.

4.2.7 Data Quality Objectives

DQOs are a set of standards that were required by CH2M HILL to be met during the collection and processing of the geophysical data at the Indian Head investigation area. The DQOs are outlined below in Table 4-4, Table 4-5 and Table 4-6.

Table 4-4: Data Quality Objectives – General DQOs

Data Quality Objective	Measurement Performance Criteria	Test Method
Magnetometer System Response. Each mag sensor responds in accordance with industry standards	Response to standard object will not vary more than ±20% from expected value	Results of Static Background sensor noise levels and Static Spike QC test were evaluated to ensure compliance
Magnetometer System Data Repeatability. Repeatable data are being obtained from each magnetometer	Response to standard object will not vary from previous measurements more than ±20% on a daily basis	Results of Static Background noise levels and Static Spike QC Test will be compared to previous days' measurements to ensure compliance
GPS-based System Positioning. Accurate coordinates are being obtained from magnetometer positioning system	Positional error at known ferrous metal object location will not exceed ±1m based upon underway system survey data and analyzed position fits	Results of derived positions from the Sensor QC Test will be evaluated to ensure compliance. RTK-GPS positioning will be verified by checking a known surface position each day before beginning work

Table 4-5: Data Quality Objectives – General Survey DQOs

Data Quality Objective	Measurement Performance Criteria	Test Method
Down-line density is sufficient enough to detect MEC items	98% of samples within 0.2m (0.7 feet) of one another Velocity of survey sufficient to maintain sample separation at a sample rate of 20 Hz	DGM surveys were monitored using the UX-Process sample separation and velocity tools
Coverage over survey area is sufficient to detect MEC items	95-98% coverage of area (taking into account inaccessible areas) at sensor swath (1.5m for TVG)	Line paths and sensor 'foot print' evaluated in Oasis Montaj
Instrument is maintained close enough to sea-floor for anomaly detection	Target altitude of tow-fish between 0.0 to 5.0 feet above seafloor 10 foot absolute maximum	Altitude channel monitored in Geosoft and data not meeting the 10 foot maximum ceiling removed from consideration. Data greater than 5-foot altitude tracked
Base Station collection rate sufficient to accurately sample the diurnal variation	Minimum Sample rate once per minute	Sample rate set to 0.2 Hz (once per 5 seconds)

Table 4-6: Data Quality Objectives – Data Handling

Data Quality Objective	Measurement Performance Criteria	Test Method
Data to be delivered in a timely manner and in a useable format	Data packages completed and delivered within the schedule specified in the work plan	examined the time of completion of an area and the actual delivery date of the data

Difficulty was encountered in meeting two of these DQOs, namely QC test repeatability and timely data delivery. A discussion of these can be found in section 6.4.

5 Results

5.1 Summary of Work Performed

ARM Geophysics performed land-based DGM over a total of 58 grids totaling 5.91 acres of the NSF-IH and shallow-water DGM of a total of 4.60 (8.08, if counting the additional acreage collected in UXO 27 east) acres in two separate sites. DGM activities associated with the land sites (UXO 11 and UXO 30) were performed using an EM61 metals detector using a combination of RTK-GPS and FIDS positioning. DGM activities associated with the shallow marine sites (UXO 27 east and west) were performed using a TVG Marine Magnetometer system with RTK-GPS positioning. ARM identified a total of 4870 individual land-based anomalies (inclusive of both Class 1 and Class 2 anomalies but excluding Class 3 'polygon anomalies' – see section 4.1.5.5) and 447 individual shallow water marine anomalies. The work took place between March 31 and April 22, 2010.

5.2 Mobilization

5.2.1 Land Sites (UXO 11 and UXO 30)

ARM mobilized a field team of two qualified field geophysicists for the land sites from their Hershey, PA office to Indian Head, MD on Tuesday, March 30, 2010. The field team received base access passes to NSF-IH on March 30 and completed a tour of the site. DGM surveying was conducted between March 31 and April 22, 2010.

5.2.2 Shallow Marine Sites (UXO 27 East and West)

ARM mobilized a field team of two qualified field geophysicists from their Hershey, PA office, along with a marine scientist from Aqua Survey, to Indian Head, MD on Wednesday, April 14, 2010. The field team received base access passes to NSF-IH, completed a tour of the site and performed bathymetry and side-scan sonar surveys. DGM surveying and associated QC testing was conducted at the UXO 27 east and west sites between April 15 and 18, 2010.

5.3 DGM Survey Activities

5.3.1 Area Covered

ARM surveyed a total of 5.91 acres within the land sites and 8.08 acres with the shallow marine sites at NSD-IH. The coverage maps for the land sites (UXO 11 and UXO 30) are provided in Figure 5.1. The coverage maps for the shallow marine sites (UXO 27 east and west) are provided in Figures 5-2 and 5-3, respectively.

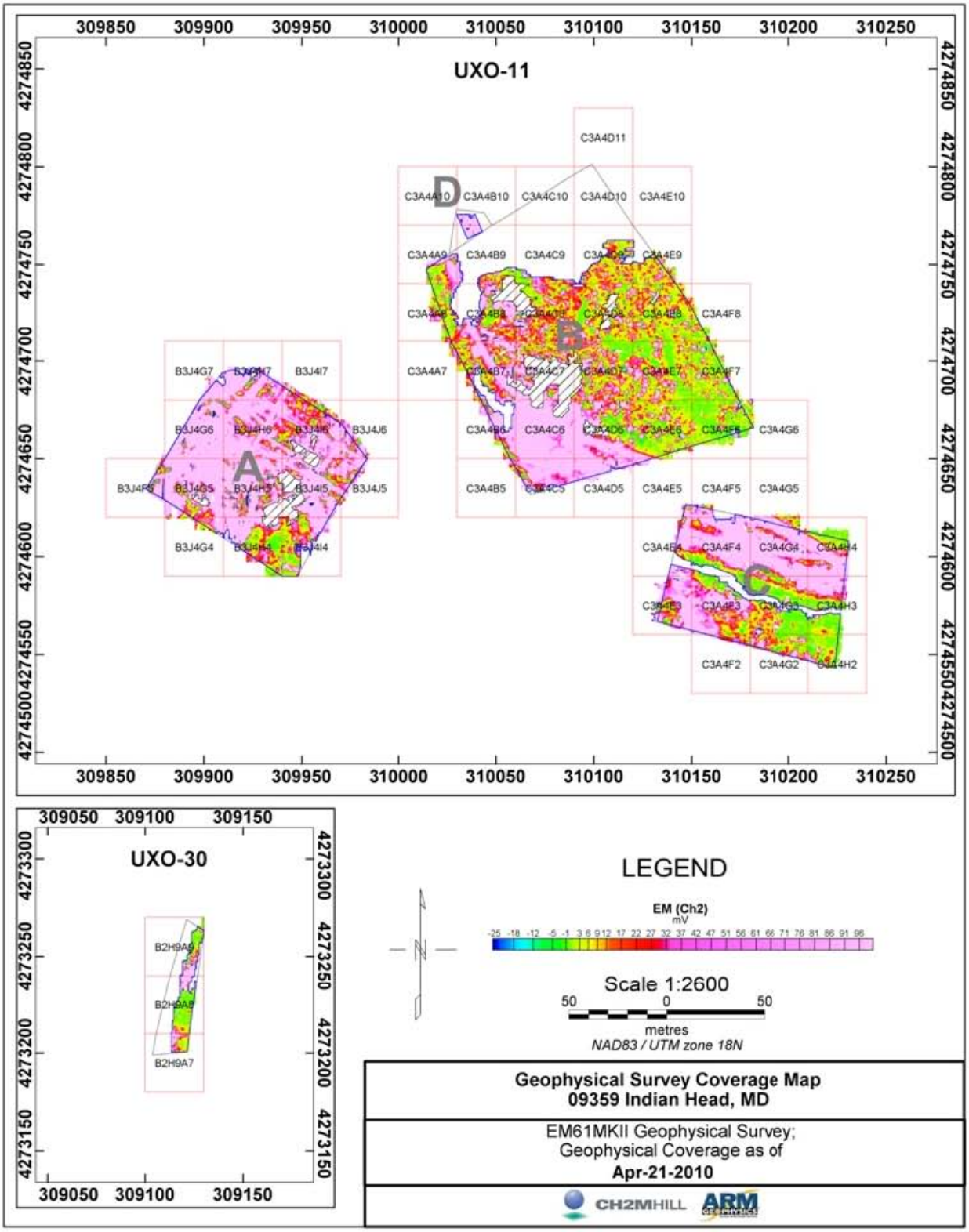


Figure 5-1: DGM Coverage Map – UXO 11, UXO 30

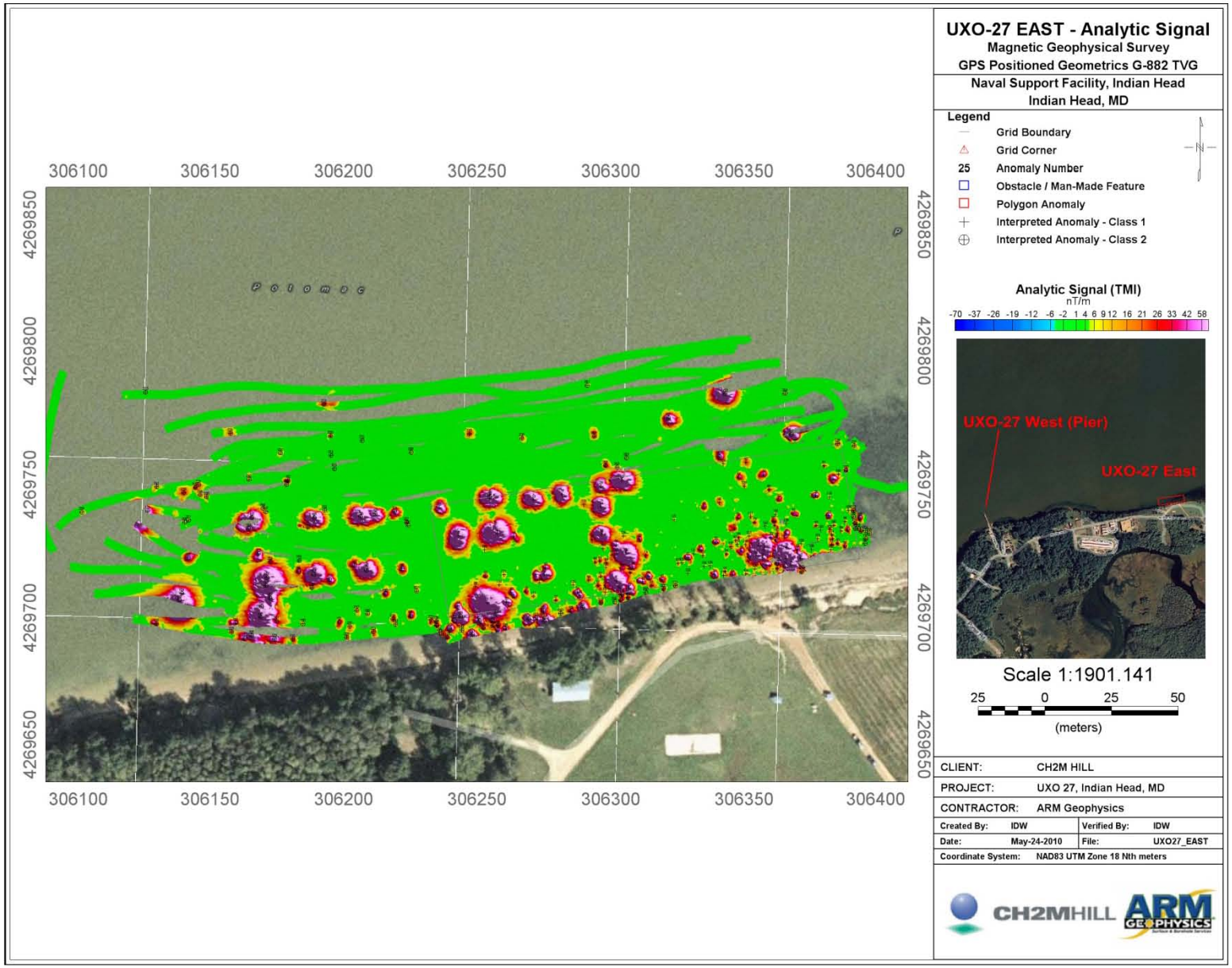


Figure 5-2: DGM Coverage Map – UXO 27 East (Beach)

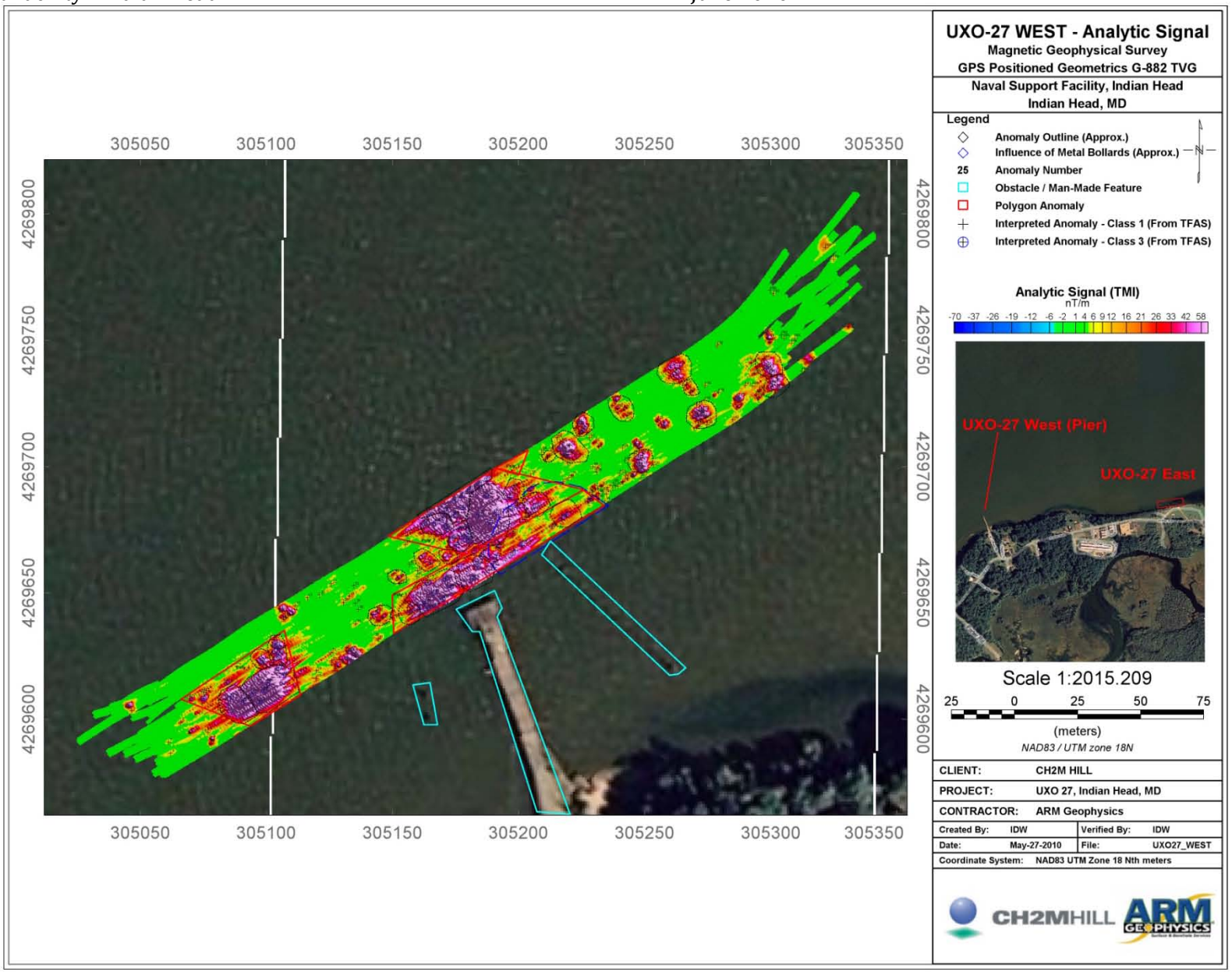


Figure 5-3: DGM Coverage Map – UXO 27 West (Pier)

5.3.2 Unsurveyable Areas

Some areas within the footprint of the land sites were unsurveyable. Figure 5-1 shows a number of large areas of white space, such as C3A4A9, C3A4B9, C3A4C9, C3A4D9, C3A4E9, C3A4B10, C3A4C10, C3A4D10, and C3A4D11. These areas contained either large areas of uncut/uncleared vegetation or slopes that were too steep for surveying; ARM collected all surveyable areas within the site boundaries. Photographs documenting these unsurveyable areas are located in Attachment D.

A small area (0.03 acres) within the footprint of the Marine site UXO 27 (east) was unsurveyable with the TVG Marine Magnetometer system. This area contained numerous boulders and was too shallow for collection with the TVG, even as a surface-floated system.

5.4 Targets /Anomalies

5.4.1 Land Sites (UXO 11 and UXO 30)

ARM identified 4870 individual anomalies and 138 polygon anomalies within the 5.91 acres of land DGM data collected over the NSF-IH. This gives an average density across the site of 824 individual anomalies per acre.

The breakdown of anomaly classes across the land area is presented below in Table 5-1 and Table 5-2:

Table 5-1: Breakdown of Anomaly Classes by Area

Anomaly Class	UXO 11 Area A	UXO 11 Area B	UXO 11 Area C	UXO 30
1	275	2212	369	61
2	737	649	506	61
3	65	45	24	4

Table 5-2: Total Anomaly Count by Class

Anomaly Class	Count of Anomalies	Percentage of Total Anomalies
1	2917	58.25%
2	1953	39.00%
3	138	2.76%
TOTAL	5008	100%

The target density across the land sites is not uniform, as illustrated by the first image in Attachment A (coverage map of gridded Ch3 data). As shown in this image and Figure 4-1, linear trends are apparent through many areas, with many of these being attributed to sub-surface utilities. However, other cultural features within the DGM areas such as walls, buildings, signs and

power-line interference can be seen to impact the data. Many of these cultural features can be seen in aerial photography as well as having been marked in the grid data sheets by the field crew.

5.4.2 Shallow Marine Sites (UXO 27 East and West)

245 individual anomalies, of which 75 were located within 4 anomaly polygons, were identified in the 2.98 acres of data collected over UXO 27 west (pier); resulting in a target density of 84.2 anomalies/acre.

143 individual anomalies were identified in the 1.65 acres of grid area in UXO 27 east (beach), 277 individual anomalies in the 5.1 acres overall, resulting in a target density of 86.7 and 51.3 anomalies per acre, respectively.

6 Quality Control

6.1 GSV: Land Sites UXO 11 and UXO 30 (EM61)

Details concerning the GSV for the land sites at NSF-IH are provided in the Geophysical System Verification Workplan for Land Sites UXO 11, UXO 20 and UXO 30, NSF-IH, Indian Head, Maryland.

6.1.1 System Validation

Before use, the EM61 was validated using an existing Instrument Verification Strip (IVS) located at the NSF-IH. Validation of the instrument involved collecting data over the IVS, processing and submitting the data to CH2M HILL for approval. The IVS is approximately 15m x 4m and is situated adjacent to the facility golf course south of UXO 11. The location of the IVS is shown on the grid map in Figure 6-1. The existing IVS survey coordinates are presented in Table 6-1.

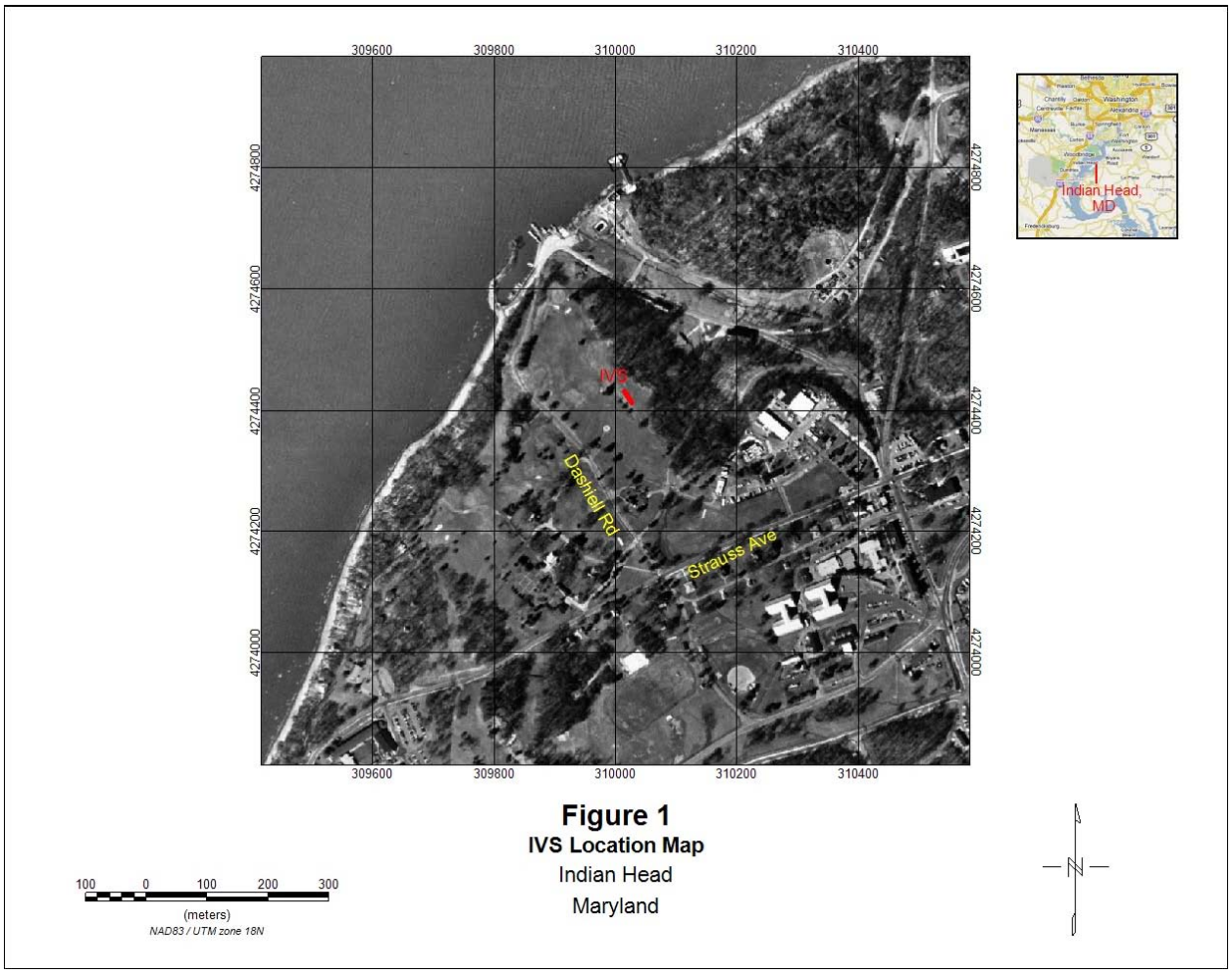


Figure 6-1: IVS Location – Figure 1 from GSV Plan

6.1.1.1 Seeded Items

The existing IVS was previously seeded by CH2M HILL using three industry standard objects (ISOs). The coordinates of the seed items, as specified in the GSV plan, and their orientation are shown in Table 6-1. The three ISOs (IVS-1, IVS-2, and IVS-3) consisted of 1-inch by 4-inch steel pipe nipples (McMaster-Carr part no. 44615K466).

Table 6-1: Location of IVS Seed Items, as per Work Plan

Existing IVS Survey Coordinates
Munitions Investigation Work Plan for Land Sites UXO 6, 9, 11, 20, and 30; and Water Site UXO 27 NSF-IH, Indian Head, Maryland

Point ID	Easting (m)	Northing (m)	Item Depth (cm)	Item Orientation	Description
IVS-south	310026.127	4274413.953	N/A	N/A	IVS south end point
IVS-1	310023.621	4274417.842	11.2	Horizontal, perpendicular to line direction	Seed Item
IVS-2	310021.226	4274421.671	17	Horizontal, perpendicular to line direction	Seed Item
IVS-3	310016.609	4274429.046	23.4	Horizontal, perpendicular to line direction	Seed Item
IVS-north	310015.528	4274430.801	N/A	N/A	IVS north end point

Coordinate system: North American Datum 1983 (NAD83) Universal Transverse Mercator (UTM) Zone 18 North (meters)

6.1.1.2 Seeded Surveys

Prior to use in the field, each geophysical system was required to perform a survey of the IVS. Table 6-2 shows the five lines that comprised each IVS pass; ARM completed one pass each for Fiducial and GPS positioned EM61.

Table 6-2: IVS Lines

Transect	Description	Purpose
A	offset by 0.75m	Demonstrate horizontal drop off of item response
B	directly over center of strip	Verify response vs. established response curves
C	offset by 0.37m (1/2 intended lane separation) from center of strip	Demonstrate horizontal drop off of item response
D	offset by 0.75m (on opposite side of strip from Transect A)	Demonstrate horizontal drop off of item response
E	offset by ~3m from strip	Measure background noise

An example of the seeded IVS survey with the EM61 (GPS-positioned) is shown in Figure 6-2

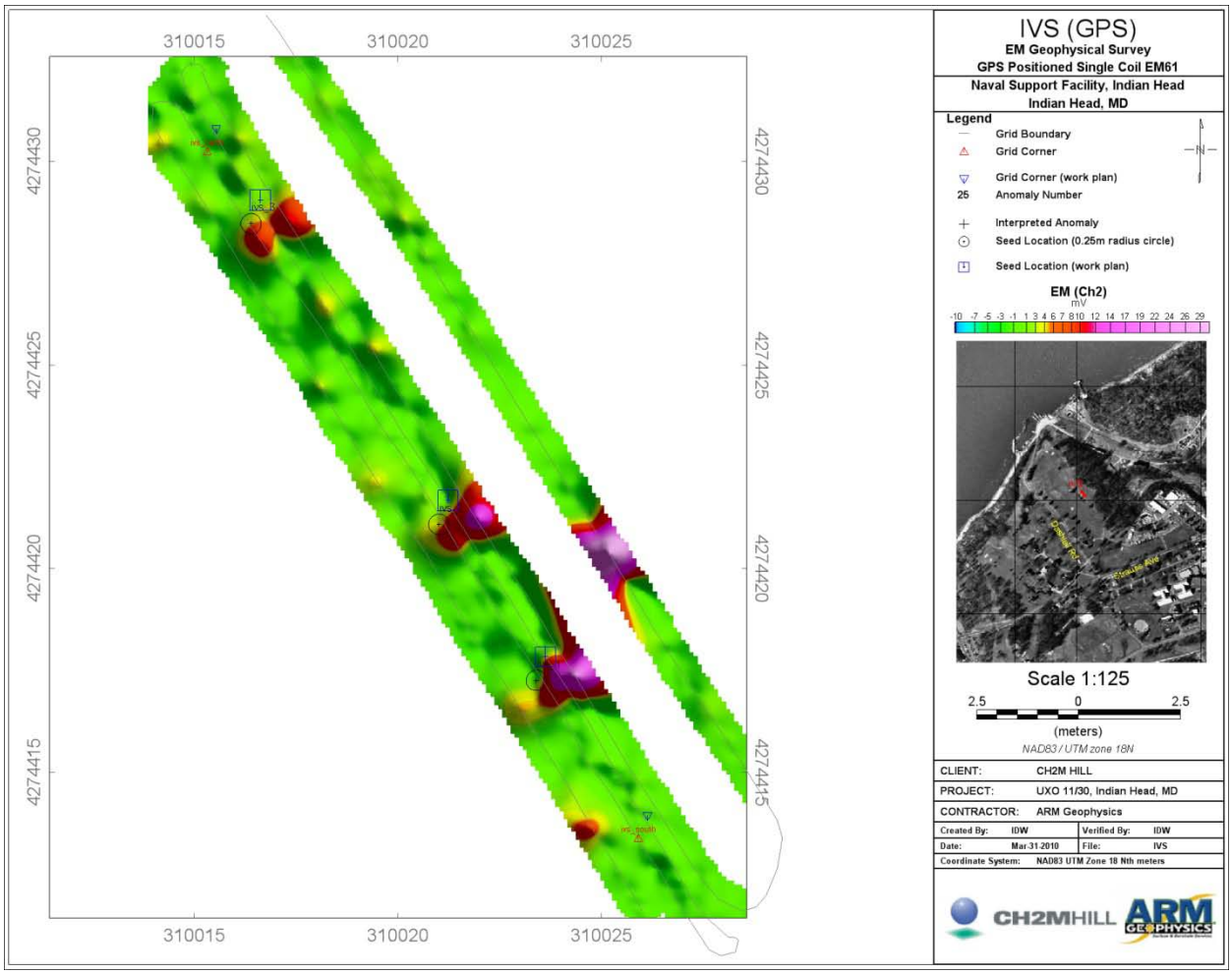


Figure 6-2: IVS Pass – GPS EM61, March 31st

As can be seen in Figure 6-2, the seed items were well detected by the EM61. However, there is a constant offset of the seeds from the two separate sets of seed coordinates provided. The GPS base station had been both set up and checked against points newly emplaced by the RLS contractor, whereas the IVS had been constructed for a previous project.

When the field crew setup on the IVS, they found that the stakes in the ground were offset from the positions in the GPS, and at least one of the stakes had the appearance of having been knocked over and replaced at some point. The IVS lines for collection with GPS and fiducials were laid out by the field crew according to the positions in the GPS, as it was assumed that the stakes had been moved.

6.1.2 Qualitative Assessment

The profiles of the EM61 data were qualitatively assessed against those of a pass performed over the same items by a previous contractor. This comparison can be seen in Figure 6-3 and Figure 6-4.

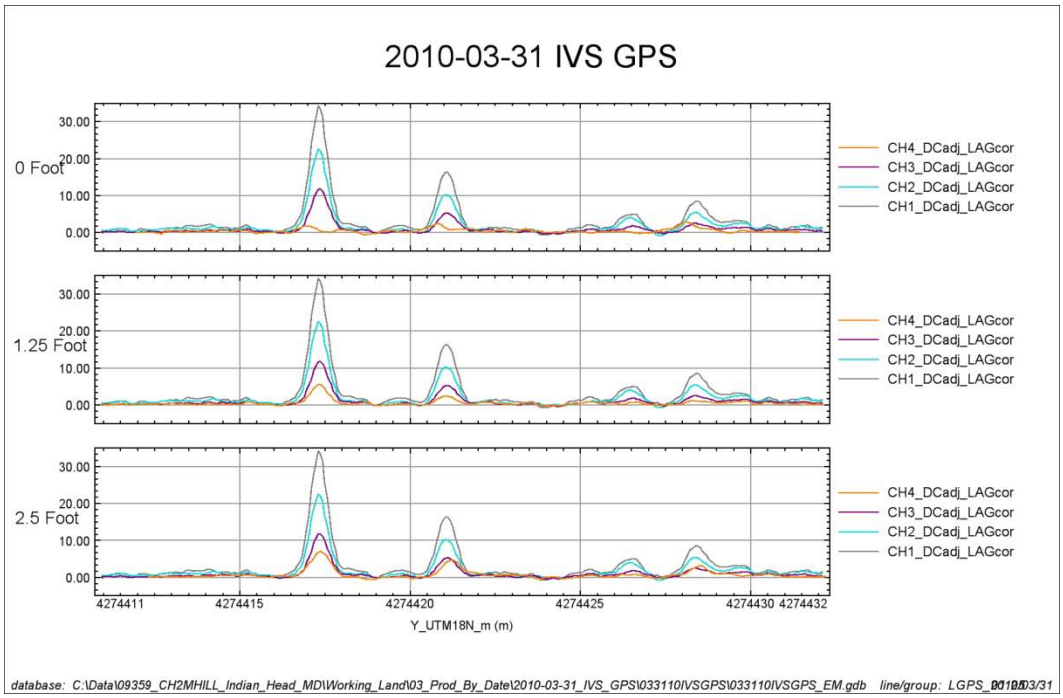


Figure 6-3: ARM IVS Pass Profile Data – March 31, 2010

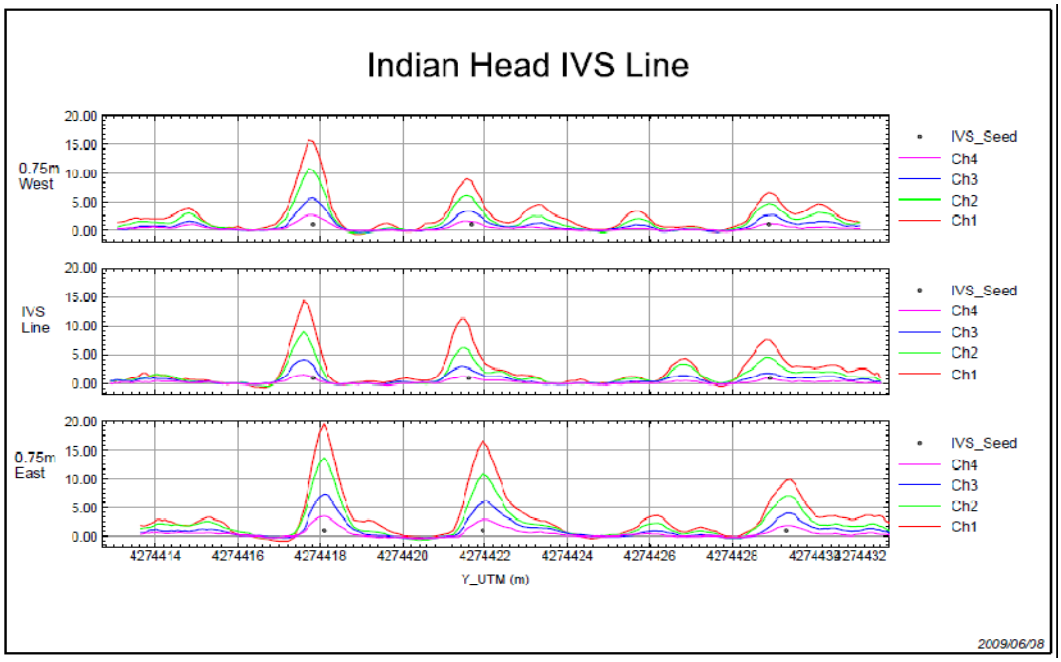


Figure 6-4: IVS Profile Data from Prior Pass – June 2009

Note that due to the offset of the March 31st IVS lines to the locations of the seeds, ARM line "2.5 Foot" corresponds most closely with the previous contractor's line "IVS". ARM detection of the seeds was stronger than that of the previous pass.

The constant offset and the fact that the GPS positional checks matched with the stakes of the newly emplaced grid system for the project led to the conclusion that there was a mis-match in the IVS coordinates, and the field crew were approved to commence DGM.

6.2 DGM Instruments and Positioning Quality Control

Industry standard QC tests were performed at the start of the project and daily as detailed in Table 6-3 below.

Table 6-3: Geophysical System QC Tests and Procedures

Test Description	Acceptance Criteria	Frequency
Equipment Warm-up	Run EM-61 for minimum 5 minutes before use, stability of response assessed in field.	Power on
Record Sensor Positions	Position within ±4 inches (10 cm) of known location	Beginning of Day
Personnel Test	<2.5mV spike on CH2, assessed in field	Beginning of Day
Vibration Test (Cable Shake)	<2.5mV spike on CH2, assessed in field	Beginning of Day
Static Background and Spike Test	±20% of standard item response	Beginning and End of Day
Repeat Data	Qualitative comparison of data	2% of Total Area Surveyed
Additional QC Tests		
Latency Test (6 Line)	Determine correction to be applied to production data to account for data lag / latency (per positioning system)	Start of Project
Latency Test (2 Line)	Determine correction to be applied to production data to account for data lag / latency (per positioning system)	Beginning of Day

6.2.1.1 Equipment Warm-up

Before use, the EM61 was turned on and allowed to run for a minimum of 5 minutes before use. This allows the instrument readings to stabilize before use.

6.2.1.2 Record Sensor Position

The positional test was performed daily when GPS positioning of data was to be employed and involved using the GPS to navigate to a known point and recording data. The accuracy was checked in the field and the recorded data plotted over the position of the known point. The results of this test are important to ensure the positioning system was operating correctly.

6.2.1.3 Personnel Test

Personnel tests were conducted each morning to ensure the operators did not exhibit an EM response. It is important to ensure the operator is response-free as carrying any metal may result in introducing false anomalies into the data or masking true anomalies. This test was assessed in the field by monitoring the data logger while the operator moved their body simulating data collection and the data recorded for evaluation.

6.2.1.4 Cable Shake Test

The cable shake test was performed daily to identify any potential loose connections, broken or shorting cables and other instrument faults. The test required the operator to shake all cables and components such as the electronics module and GPS cables while monitoring the data logger for any anomalous responses such as data spikes. The test was assessed in the field by monitoring the data logger and also in Oasis Montaj profile view as the test was logged as the first line in the static background and spike test file.

6.2.1.5 Static Background and Spike Test

Static/spike tests were conducted to quantify instrument background readings, electronic drift, locate potential interference, and determine response and repeatability of the instrument to a standard test item. Improper instrument function and the presence of local sources of ambient noise are potential causes of inconsistent, non-repeatable readings. A minimum of 1-minute static background data (after instrument warm-up) was collected, followed by 1-minute of standard (spike) data against a known object, followed by 1-minute of static background. The operators reviewed the readings to confirm their stability prior to continuing with the geophysical survey. Repeatability of the spike test was observed by means of a jig built to ensure the test item was in the same position relative to the instrument for all tests.

Background static and mean spike values of each test were tracked across the project to ensure consistency. Project DQOs required the response for each test to be within 20% of the standard instrument response.

It became evident, as the project progressed, that there was external interference being introduced into the AM static data from the vicinity of the QC test site (IVS site). This sporadic interference was noted in the field on occasions as being associated with what appeared to be ammunition firing activities and affected mainly channel 1 and 2 with only a few values being outside of the bounds of channel 1. The issue was brought to the attention of CH2M HILL and the location of the QC tests moved away from the assumed source of noise. The QC tests at the new site proved clean, demonstrating, along with a lack of similar noise apparent in the data, that the issue was not with the instrument. For reference, an example data set is shown in Figure 6-5 on the following page.

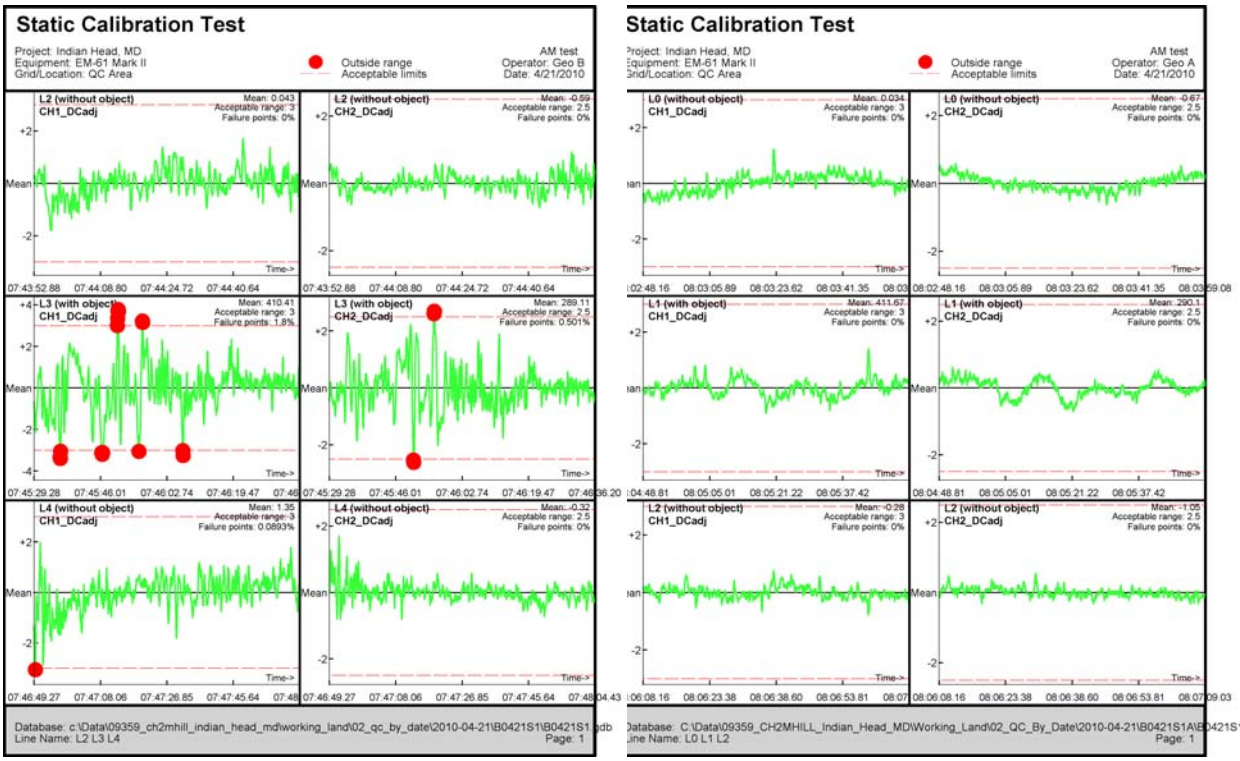


Figure 6-5: AM Static tests, April 21st – Left Ch1, Ch2 at IVS QC Site; Right Ch1, Ch2 at Alternate QC Site

6.2.1.6 Latency Test (6 Line)

The latency of the instrument was tested prior to any DGM being performed in order to document the lag/latency of the system, the accuracy of the positioning system and the repeatability of the response of the test item.

The test was performed using the following sequence:

- Line 1: Survey of the test line in one direction at normal pace with no test item present.
- Line 2: Survey of the test line in the opposite direction at normal pace with no test item present.
- Line 3: Survey of the test line in the first direction at normal pace with the test item present.
- Line 4: Survey of the test line in the second direction at normal pace with the test item present.
- Line 5: Survey of the test line in the first direction at fast pace with the test item present.
- Line 5: Survey of the test line in the second direction at slow pace with the test item present.

6.2.1.7 Latency Test (2 Line)

The 2 line latency test is an abbreviated variation of the 6 line test that was conducted every morning prior to conducting DGM. It involves one pass over the test item in opposite directions for each positioning method to be employed during data collection. This test was reviewed in Oasis Montaj using the profile view.

6.2.1.8 Repeat Data

At least 2% of the survey area was recollected as a QC repeat to document the system's ability to respond consistently and accurately over the repeated area. The color-shaded grid of the repeated data was overlain on the original DGM data and target picks to qualitatively assess repeatability.

6.2.2 Quality Control Seed Items

CH2M HILL implemented a QC seed program over the project site to assess the effectiveness of the process from data collection through target selection. At no time did ARM know the location of the QC seeds, and all blind seed assessments were performed by CH2M HILL. Items were seeded at a minimum of 0.75 seeds per acre in areas surveyed by the EM61.

6.3 DQO Performance

ARM paid attention to the DQO requirements presented throughout the project. For the purpose of reporting, the DQOs have been broken down into the categories as represented in Table 4-1**,** Table 4-2 and Table 4-3**.**

6.3.1.1 General DQOs

General DQOs required the system to produce accurate positioning and repeatable EM data. This DQO was successfully met as position tests were located within requirements and the responses from the standard response item from the spike test were within required parameters. See Attachment E for the QC Spike summary.

6.3.1.2 DGM Survey DQOs

DGM DQOs required the system to have adequate down-line sampling and across-line spacing to ensure complete coverage. These DQOs were assessed on a data-file basis through profile and line path assessment and on a grid-block basis by use of UX-Process / UX-Detect QC-QA velocity, sample separation and foot print coverage assessment tools. Maps of the DQO results can be found on the accompanying DVD and examples of deliverables in Attachment A.

6.3.1.3 Data Handling DQOs

Data handling DQOs required ARM to turn around data in a timely fashion with the work plan stating a 3 day turn around for raw (pre-processed) data and a 5 day turn around for (final) processed data. ARM did not meet this DQO at various stages of the project due to unforeseen issues including gap analysis, timing of grid block filling and staff resources.

6.4 Shallow Marine Sites UXO 27 East and West (Magnetometer)

6.4.1 DGM Instruments and Positioning Quality Control

Industry standard QC tests were performed at the start of the project and daily, as required. The tests have been designed to assess equipment functionality and accuracy and are detailed in **Table 6-4** below.

Table 6-4: Geophysical System (Magnetometer) QC Tests & Procedures

Test Description	Acceptance Criteria	Frequency
Equipment Warm-up	Run Magnetometer for 15 minutes before use, stability of response assessed in field.	Beginning of day
Record Sensor Positions	Position ±4 inches (10 cm) of known location	Beginning of Day
Vibration Test (Cable Shake)	Data profile does not exhibit data spikes	Beginning of day
Static Background and Spike Test	±20% of standard item response, after background correction	Beginning and end of day
Latency Test (2 Line)	Determine correction to be applied to production data to account for data lag / latency	Beginning of Day
Repeat Data	Qualitative repeatability of response amplitude	2% of total area surveyed

6.4.1.1 Equipment Warm-up

Before use, the G-882 magnetometers were turned on and allowed to run for a minimum of 15 minutes before use. This allowed the instrument readings to stabilize before data collection began.

6.4.1.2 Positional Check

The positional test was performed daily and involved using the GPS rover to navigate to a known point. The accuracy was checked in the field and the position recorded to confirm the accuracy during QC data processing. The results of this test are important to ensure the positioning system was operating correctly.

6.4.1.3 Cable Shake Test

The cable shake test was performed daily to help identify any potential loose connections, broken or shorting cables and other instrument faults. The test was conducted by monitoring the data as the TVG was being deployed, looking for any anomalous responses such as data spikes.

6.4.1.4 Static Background and Spike Test

Static/spike tests were conducted dockside daily to quantify instrument background readings, electronic drift, locate potential interference, and determine response and repeatability of the instrument to a standard test item. Improper instrument function and the presence of local sources of ambient noise are potential causes of inconsistent, non-repeatable readings. A minimum of 1-minute static background data (after instrument warm-up) was collected, followed by 1-minute of standard (spike) data against a known object, followed by 1-minute of static background. The operators reviewed the readings to confirm their stability prior to continuing with the geophysical survey. Repeatability of the spike test was observed by means of a jig built to support the industry test item (in this case a shot put) between the two magnetometer sensors to ensure that the test item was in the same position relative to the instrument for all tests.

Mean values of background and spike for each test were tracked across the project. Project DQOs required the response for each test to be within 20% of the standard instrument response. The

standard test item, as specified in the work plan, gave a very small response at the magnetometers. Following experience from a previous project, the test item had been placed in a fixed jig located directly between the two sensors to maximize the response at the sensors. Despite this, responses between the tests for the three survey days did not fall into the +/-20% envelope with percent difference values for the tests , as compared to the values for each sensor / test for the first day ranging from -6.98% to 45.67%. Percent differences between the AM and PM tests also fell outside of the +/-20% envelope, ranging between 4.67% and 57.40%. The reason for this is the extremely small response (2-5nT) of the 6lb iron shotput, even at an offset from the sensors of ~0.75m. Despite being in a fixed location relative to the sensors, the values between tests varied by up to 3nT; as this small variation represents a significant percentage of the original value.

As USACE spike test specifications allow for spike responses up to 500 instrument units (as opposed to the 5 instrument units recorded in this case), ARM will implement lessons learned from this project by, in future, employing either an alternative test item with a larger response or locating the current test item in a position relative to each sensor in turn whereby the recorded response is significantly greater than 5nT.

6.4.1.5 Latency Test (2 Line)

The 2-line test was conducted every morning prior to DGM data acquisition in order to document the lag/latency of the system and involved one pass over an area with a known anomalous response (pipeline crossing) in an east and west direction. The test was performed within the same area each day, approximately 900 meters northeast of UXO 27 east.

The results of the test were reviewed in Oasis Montaj using the profile and map views. A lag correction of 58 fids was required on April 16th as the tow-fish layback had not been applied; April 17th and 18th required 16 and 15 fiducials respectively.

6.4.1.6 Repeat Data

Two lines of data over the UXO 27 east (beach) area were recollected as a QC repeat to document the system's ability to respond consistently and accurately over the repeated area. The repeated data was overlain on the original DGM data in both map and profile view and compared qualitatively to assess repeatability.

6.4.2 DQO Performance

ARM paid attention to the DQO requirements throughout the project. For the purpose of reporting, the DQOs have been broken down into the categories as represented in Table 4-4 - Table 4-6

6.4.2.1 General DQOs

General DQOs required the system to produce accurate positioning and repeatable magnetometer data. Positioning metrics were tested by operating the GPS rover over a known point; additionally, the QC Repeat data and 2-Line test data were qualitatively assessed for positional repeatability.

Magnetometer response repeatability was assessed through the QC static-spike tests discussed in section 6.4.1.4 above.

6.4.2.2 General Survey DQOs

The down-line density of the magnetometer data was assessed using the UX-Process / UX-Detect QC sample separation tool to ensure less than 2% of values were greater than 0.2m apart. Additionally, the QC Velocity tool was used, however, at a sample rate of 20Hz, the system did not approach a velocity at which general sample separation would become a problem. In the south east corner of UXO 27 east, where the TVG required hand-towing due to water depth, there are a number of spurious separation distances >0.2m caused by "crop circles" in the data where the instrument was stationary.

Coverage was assessed using the UX-Process / UX-Detect foot print coverage tool. Of the two areas, only UXO 27 east had a defined boundary, however, the tool also allows calculation of area coverage as well as percent coverage. Over 99.8% of the grid area in UXO 27 was covered by the instrument at a sensor swath of 1.5m, taking into account the inaccessible portion of the grid and a number of boulders that the TVG had to negotiate. Outside of the grid box, the additional data collected has a number of 'holes', however, this portion of the DGM was out of scope.

Altitude of the tow-fish above sea-floor was assessed in profile and map view in Geosoft. No data within the grid area of UXO 27 east, outside of residual altimeter dropouts, were greater than the target height 5 feet above seafloor. Altimeter dropouts occur due to the close proximity of the sensor to the seafloor. More difficulty was encountered in maintaining an altitude of less than 5 feet in UXO west (pier), however. As discussed in Section 3.2.1, approximately 0.5 acres of data were collected at altitudes between 5.0 and 10.0 feet above seafloor, mainly by turn-arounds and along the deep water edge of the survey area. Data collected at altitudes greater than 10.0 feet above seafloor were minimal and were removed from consideration for this survey.

Magnetometer base station data were collected to correct for the diurnal magnetic variations encountered during a particular day. The G-856 magnetometer base station data for Friday, April 16, 2010, was, however, determined not to be usable. Discussions with the field crew determined that a compass was inadvertently left on top of the magnetometer throughout the day causing significant and unrepeatable fluctuations in the base station data rendering the data set useless for applying the typical base station correction. An RCA-CAP was prepared for the incident (Attachment B), and the magnetometer was carefully checked during future set-ups to ensure that miscellaneous items that could potentially affect the data quality were not left in proximity to the magnetometer base station.

6.4.2.3 Data Handling DQOs

Data handling DQOs required ARM to turn around data in a timely fashion with the work plan stating a 3 day turn around for raw (pre-processed) data and a 5 day turn around for (final) processed and interpreted data. ARM did not meet this DQO at various stages of the project due to unforeseen complexities with leveling and filtering the data while maintaining staff resources required for processing and QC assessment of the land data.

7 Summary and Conclusions

ARM completed the Digital Geophysical Mapping investigation of all accessible areas of land sites UXO 11 and UXO 30 at the Naval Support Facility Indian Head, Indian Head, Maryland and have completed shallow marine magnetometer surveys at UXO 27 east (beach) and UXO 27 west (Pier).

7.1 Land Sites (UXO11 and UXO 30)

Of the approximately 7.8 total acres of land survey initially scoped at UXO 11 and UXO 30, ARM collected 5.91 acres. The remaining acreage was not collected due to accessibility issues. DGM was performed using a Geonics EM61 electromagnetic (EM) sensor system. Processing and interpretation of the data identified 4870 individual anomalies of interest within the two sites, of which 1953 were encompassed within 138 polygon anomalies. The surveys, including GSV activities took place between March 31 and April 21, 2010. ARM geophysicists demobed from site on April 23rd.

Individual anomalies were classed into 2 different categories depending on their location with respect to the polygon anomalies that encompassed areas of anomalous response encountered across the site. Class 1 targets represent regular, individual above-threshold anomalies while Class 2 targets represent peaks in the gridded data that fall within the regions of otherwise anomalously high levels that are, themselves, bound by 4-sided polygons, categorized as Class 3 polygon-anomalies.

The DGM task proved challenging due to steep and deeply rutted terrain, marshy areas with standing water, obstructions within the survey areas (both natural and man-made) and the wooded nature of much of the land sites.

7.2 Shallow Marine Sites (UXO 27 East and West)

Shallow marine sites UXO 27 east and west (beach and pier, respectively) were surveyed using a twin-sensor G-882 TVG Marine Magnetometer.

Of the approximately 1.65 total acres of shallow marine survey scoped at UXO 27, ARM collected 1.63 acres due to shallow water. An additional 3.47 acres of data were collected surrounding the scoped grid. A total of 2.98 acres of data were surveyed at the western site. DGM was performed with Geometrics G-882 cesium vapor magnetometers and bathymetry and side-scan sonar survey with a EdgeTech 4100 sonar system. Processing and interpretation of the data was undertaken based on threshold picking of the total field analytic signal (TFAS) with reference to the horizontal gradient and residual total magnetic intensity (TMI) data and identified 227 individual anomalies of interest at the UXO 27 east site and 245 individual anomalies and 4 polygon anomalies at the western (pier) area. The work took place between the dates of March 15 – 18, 2010. Equipment, boat operator and one ARM geophysicist demobed on April 19th, with the other geophysicist remaining on-site to provide additional aid to the land survey team.

The marine DGM task proved successful, although challenging due to the nature of the site i.e., proximity to submerged and exposed hazards or obstructions, frequent vessel traffic, and windy conditions. Future marine field work performed by ARM will take into account the lessons learned from the NSF-IH site to improve efficiency and data quality.

8 References

CH2M HILL Final Geophysical Investigation Plan for Land Sites UXO 11, UXO 20, UXO 30 and Water Site UXO 27, Naval Support Facility Indian Head, Indian Head, Maryland (January 2010)

CH2M HILL Final Geophysical Systems Verification Work Plan for Land Sites UXO 11, UXO 20, and UXO 30, Naval Support Facility Indian Head, Indian Head, Maryland (January 2010)

CH2M HILL Project Instructions, Visual Inspection of Propellant Grains at UXO 9, Clearing and DGM at UXO 11, 20, and 30, and DGM Survey at UXO 27, Naval Support Facility Indian Head, Indian Head, Maryland (February 25, 2010)

Attachment A
Data Deliverable Examples

This attachment contains images showing examples of data deliverables

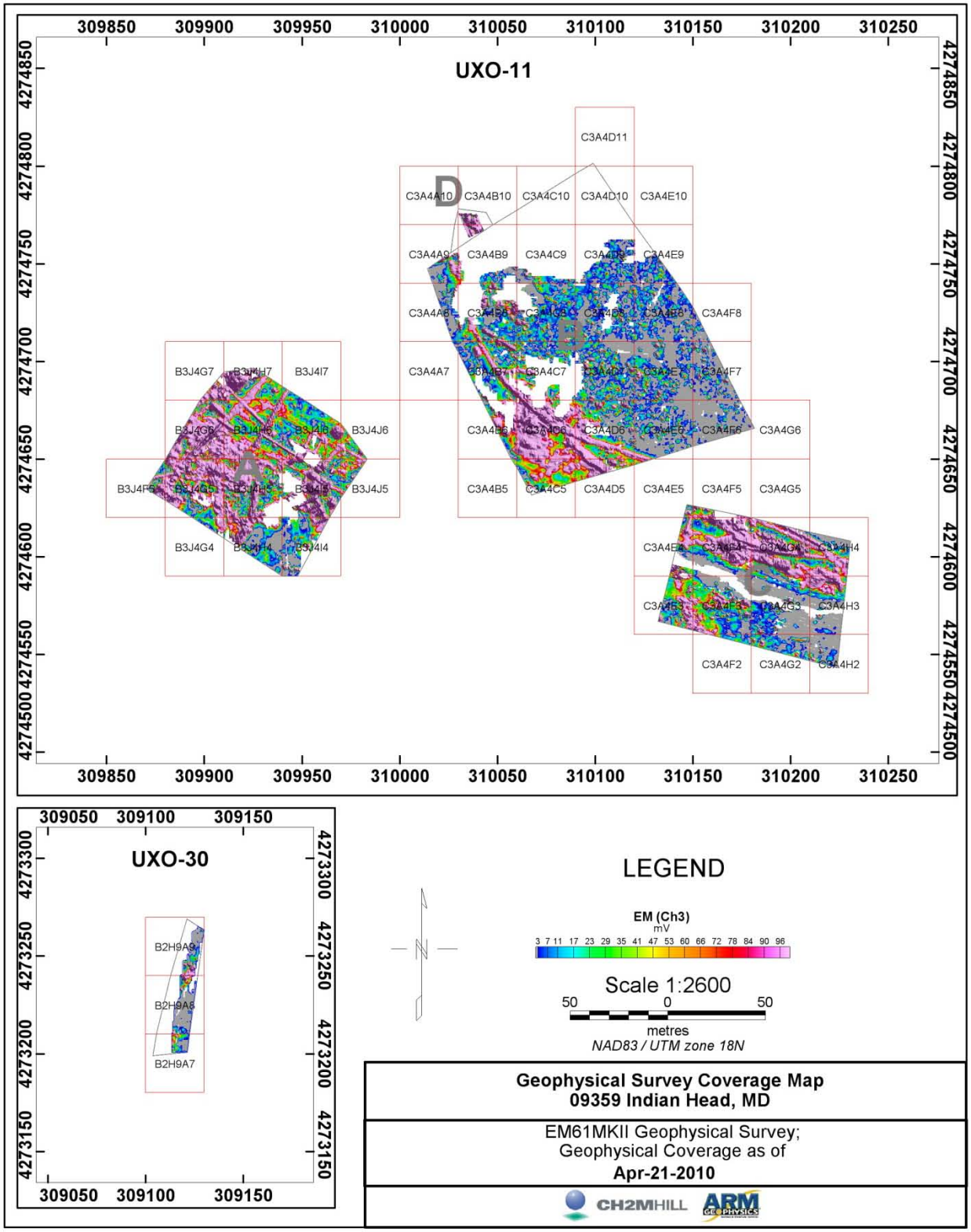


Image of All Color-Shaded Ch3 Grid Data for UXO-11 and UXO-30

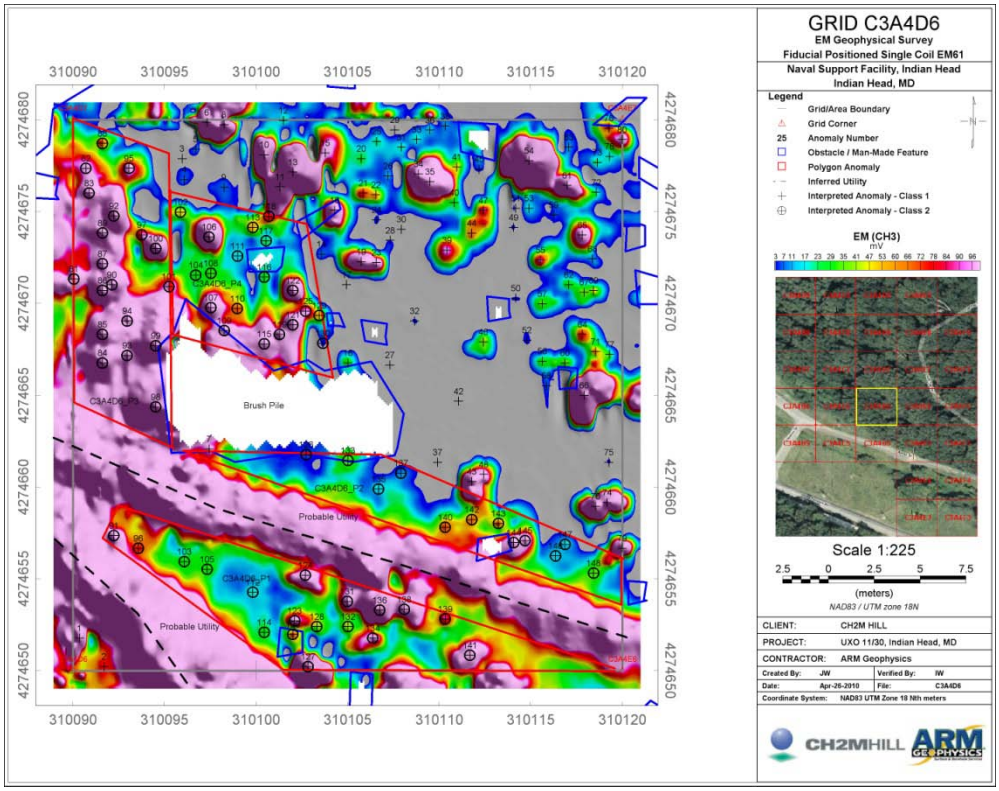


Image of Ch3 Color-Shaded Deliverable Map, C3A4D6

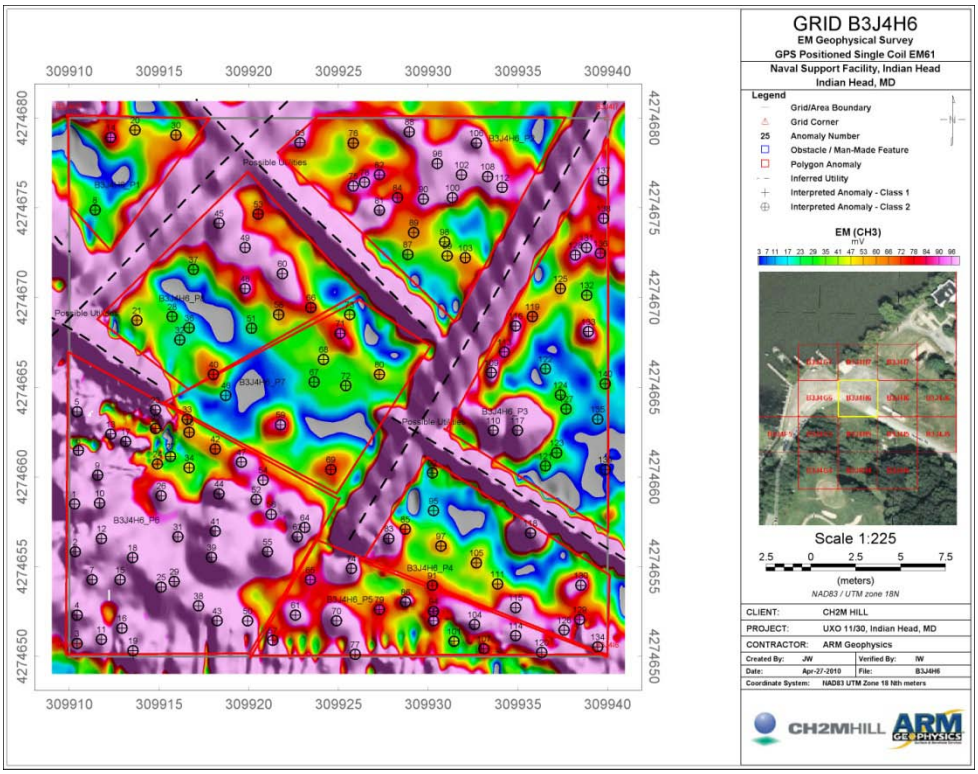


Image of Ch3 Color-Shaded Grid Map Deliverable, B3J4H6

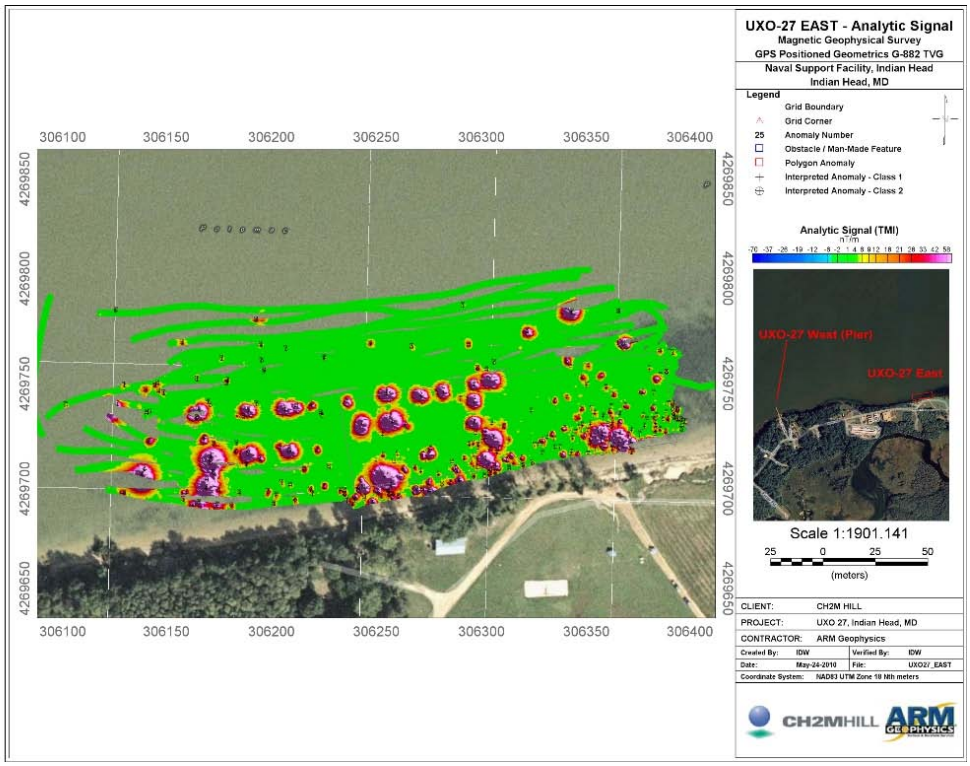


Image of UXO-27 East – Color-Shaded Grid Map Deliverable of TFAS

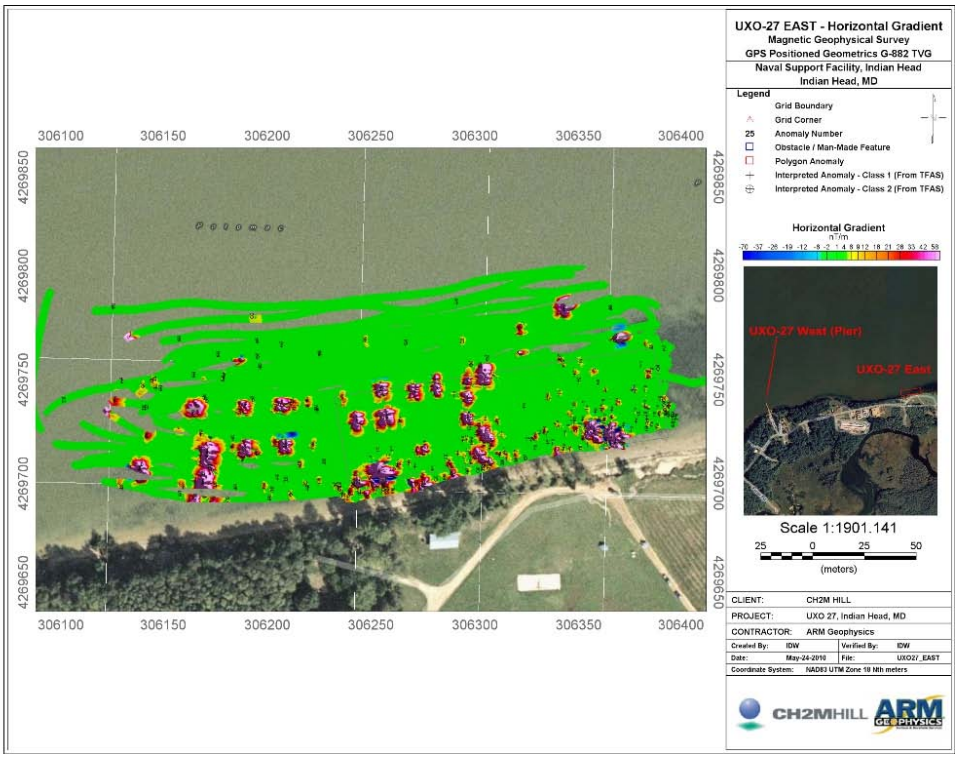


Image of UXO-27 East – Color-Shaded Grid Map Deliverable of Horizontal Gradient

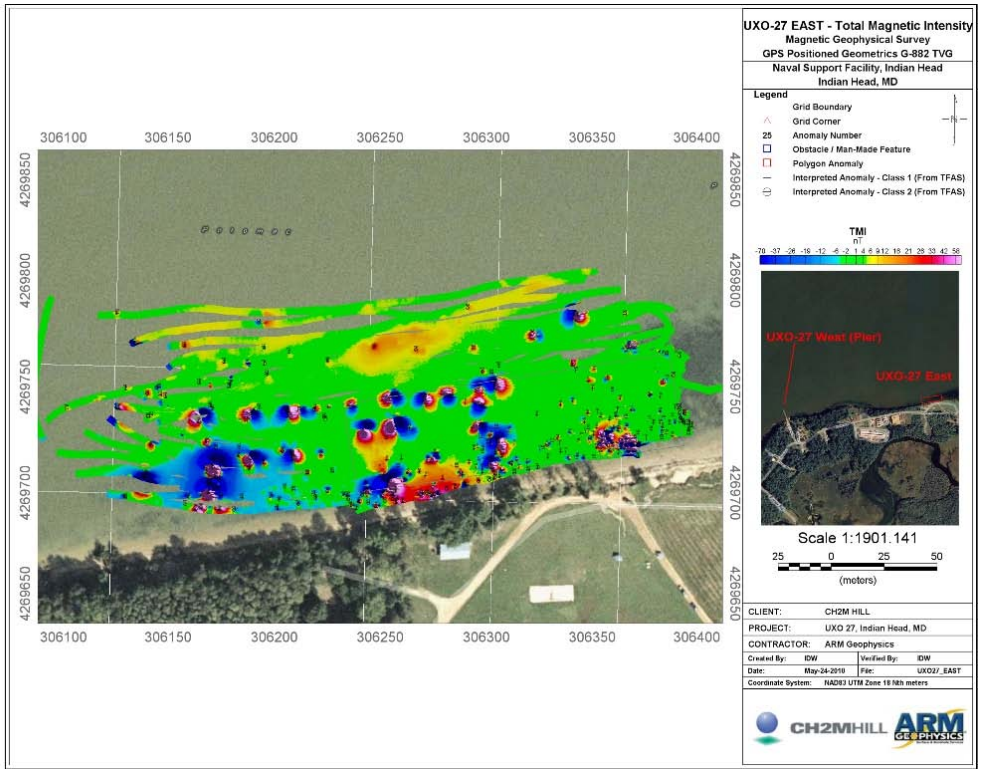


Image of UXO-27 East – Color-Shaded Grid Map Deliverable of Corrected TMI

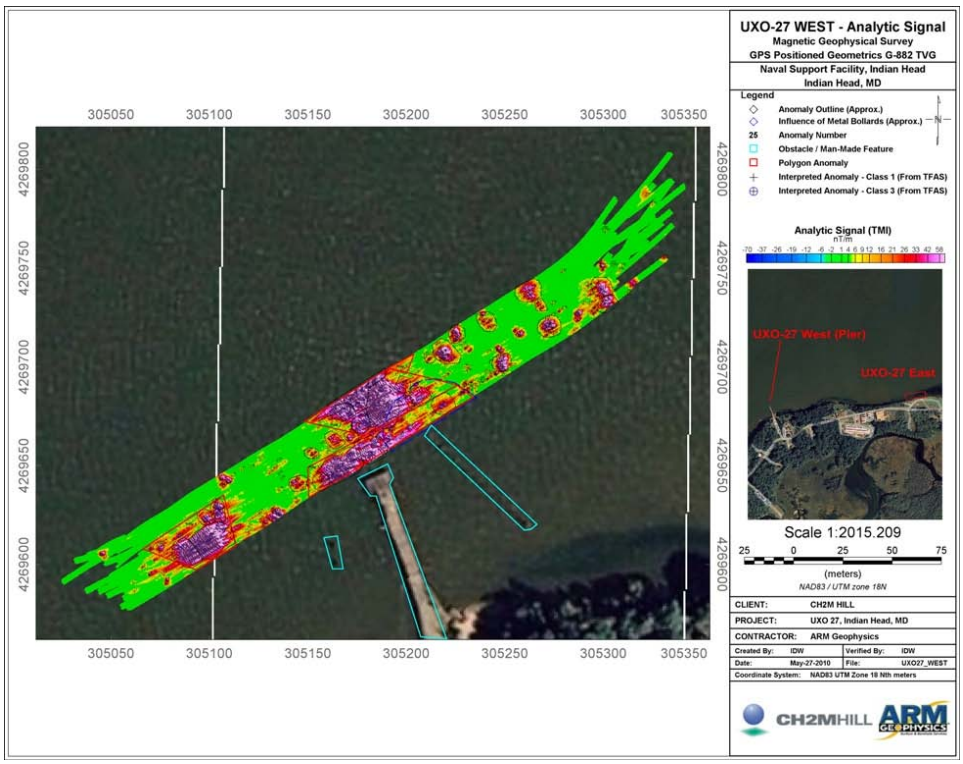


Image of UXO-27 West – Color-Shaded Grid Map Deliverable of TFAS

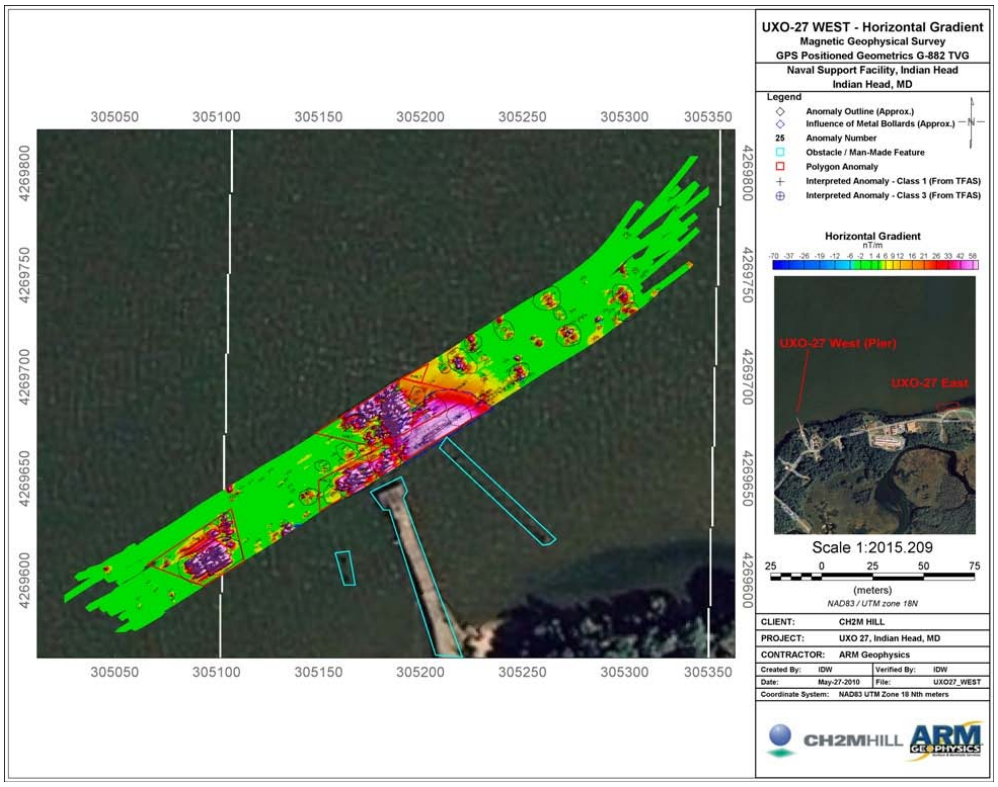


Image of UXO-27 West – Color-Shaded Grid Map Deliverable of Horizontal Gradient

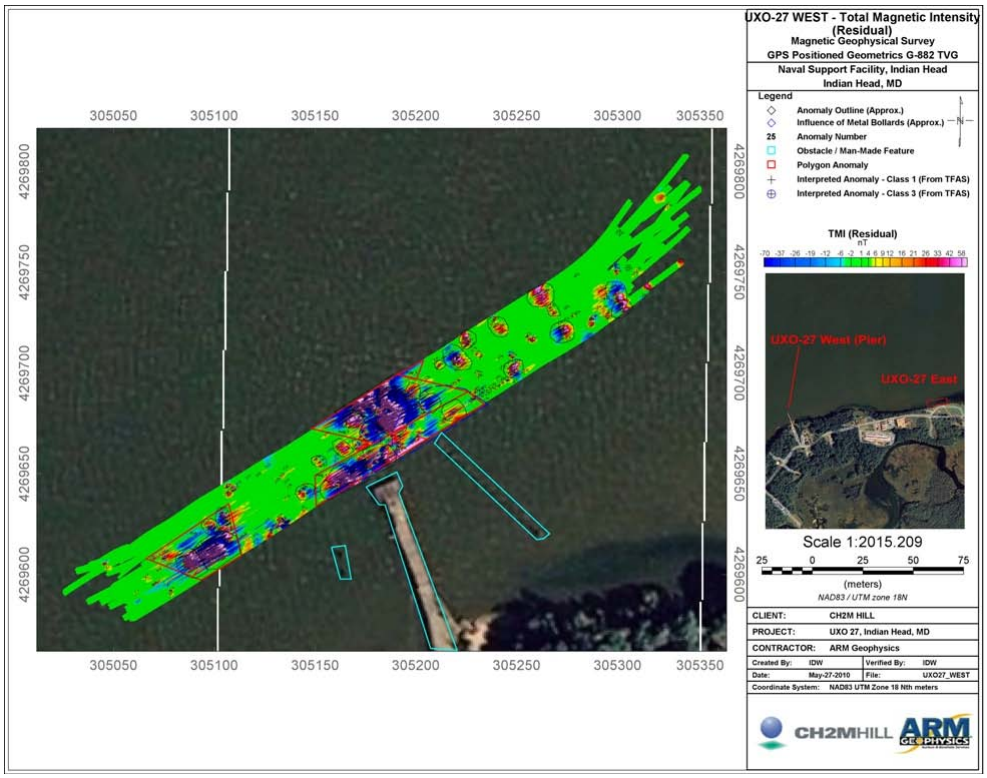


Image of UXO-27 West – Color-Shaded Grid Map Deliverable of Residual TMI

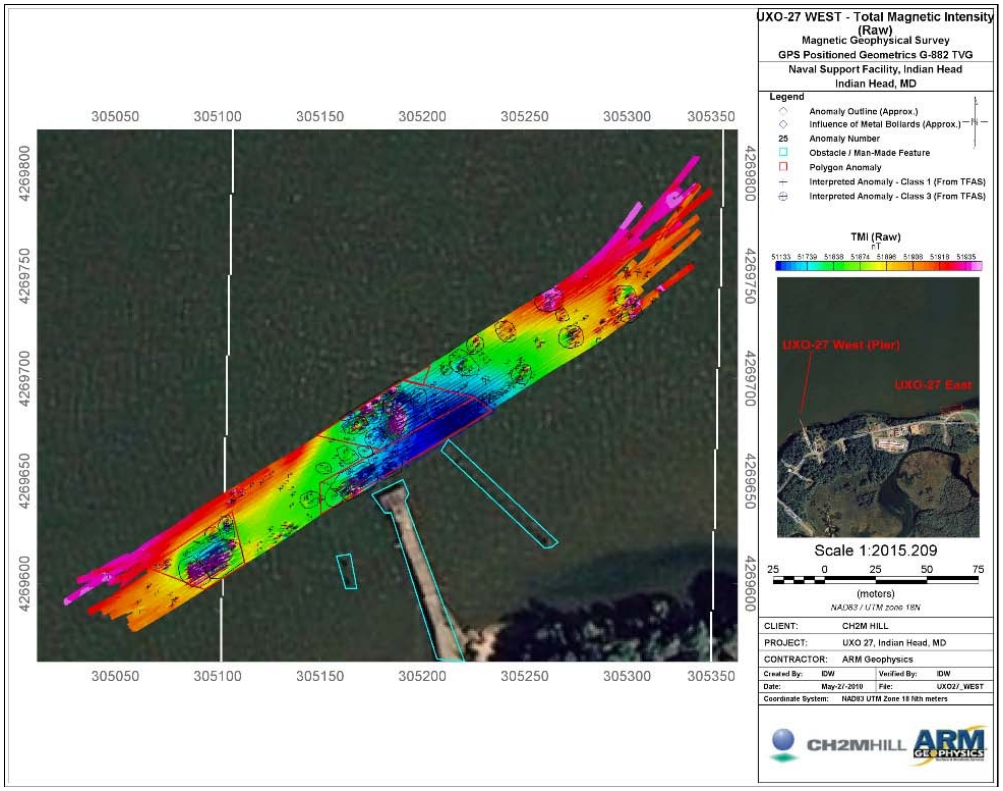


Image of UXO-27 West – Color-Shaded Grid Map Deliverable of Raw TMI

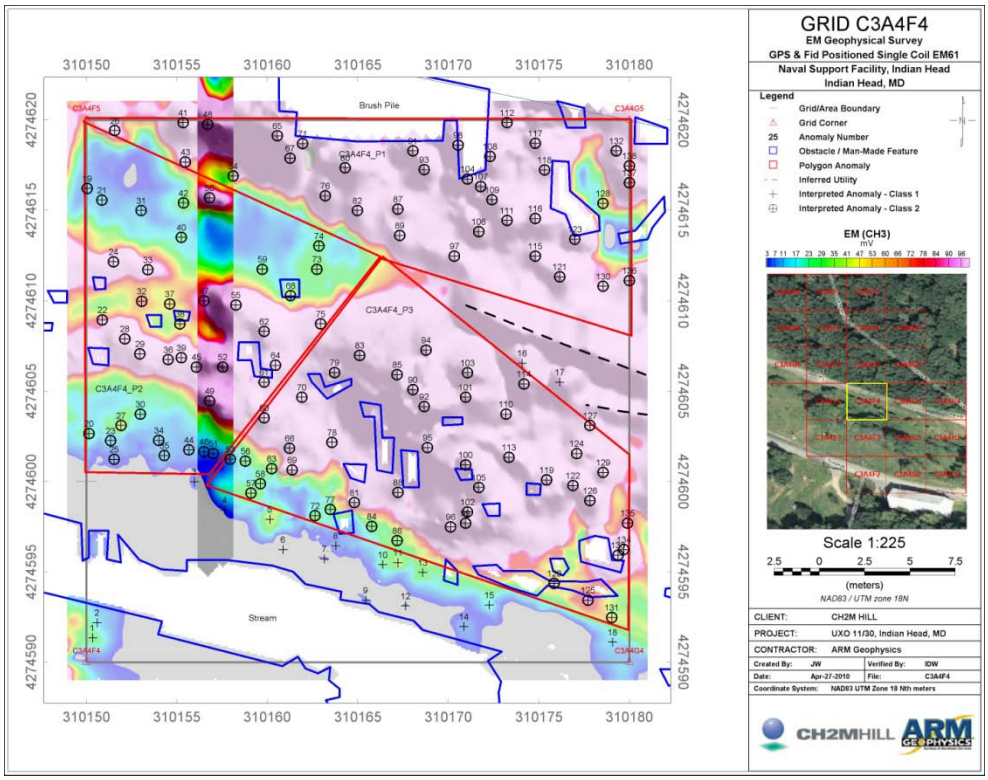


Image of QC Repeat Line Data, C3A4F4

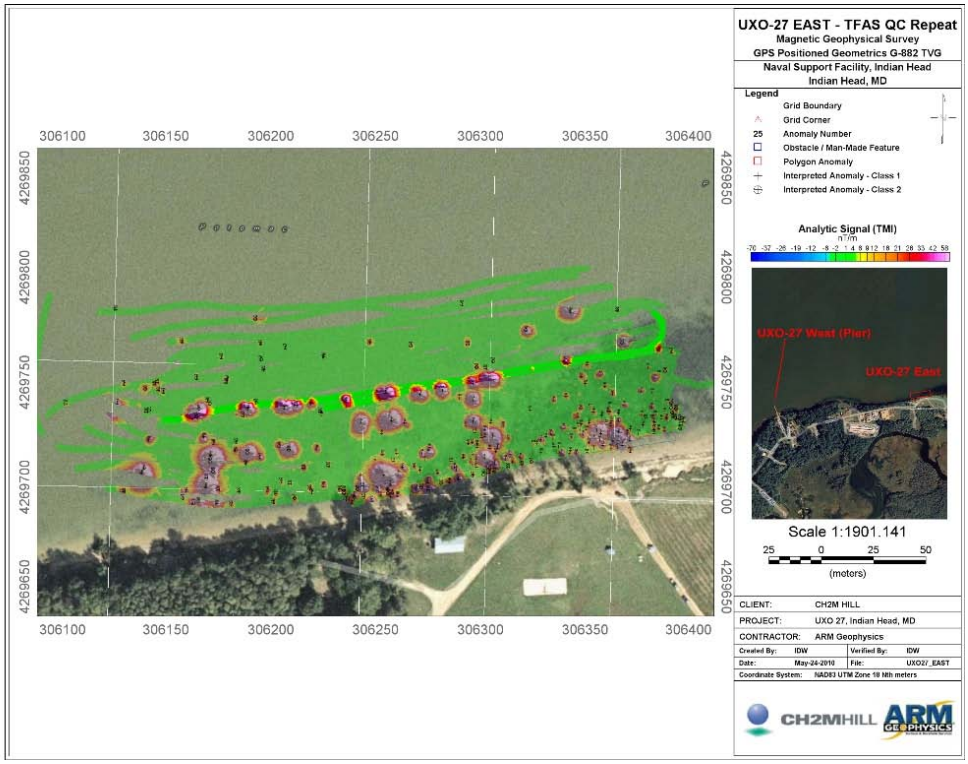
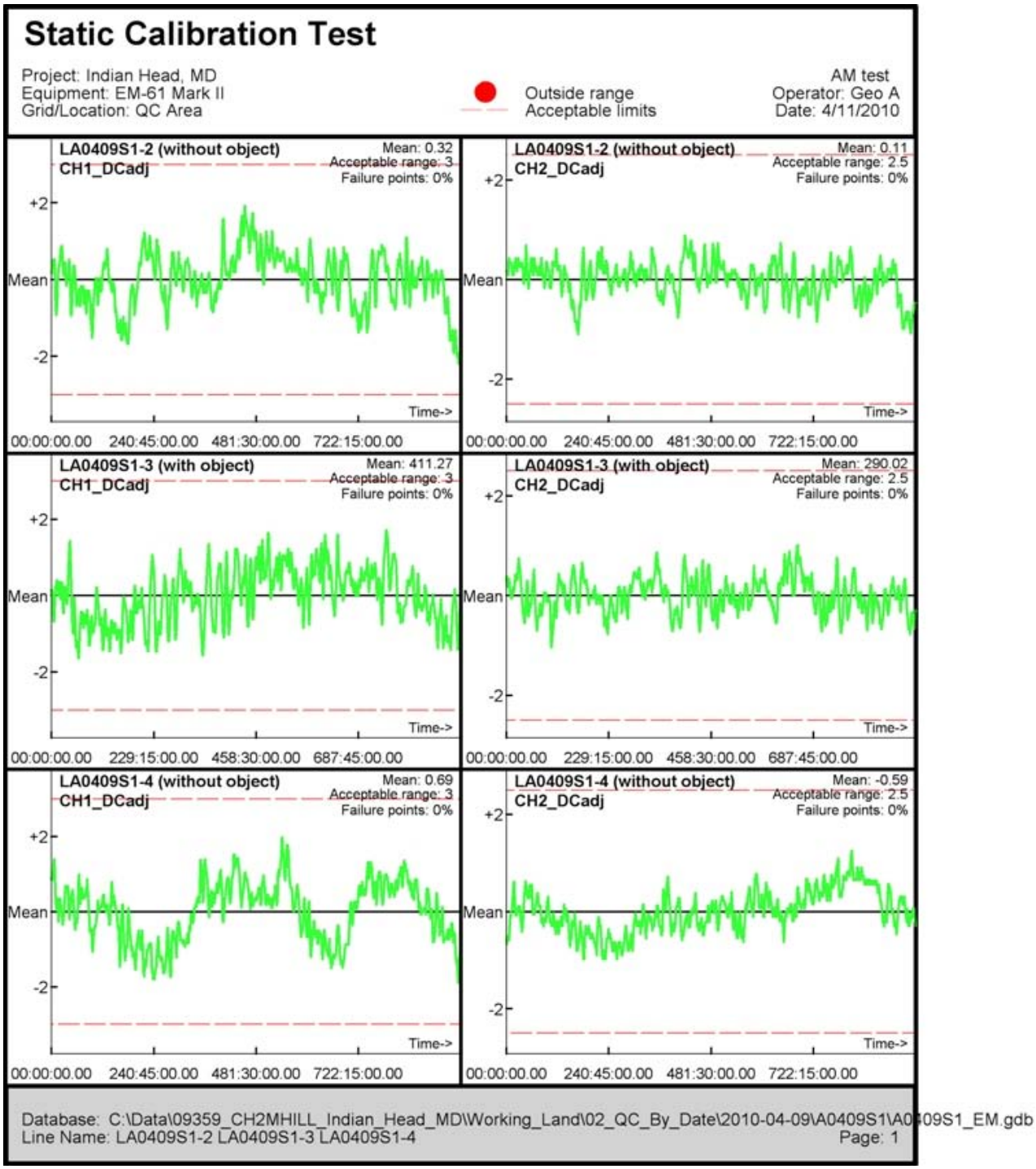


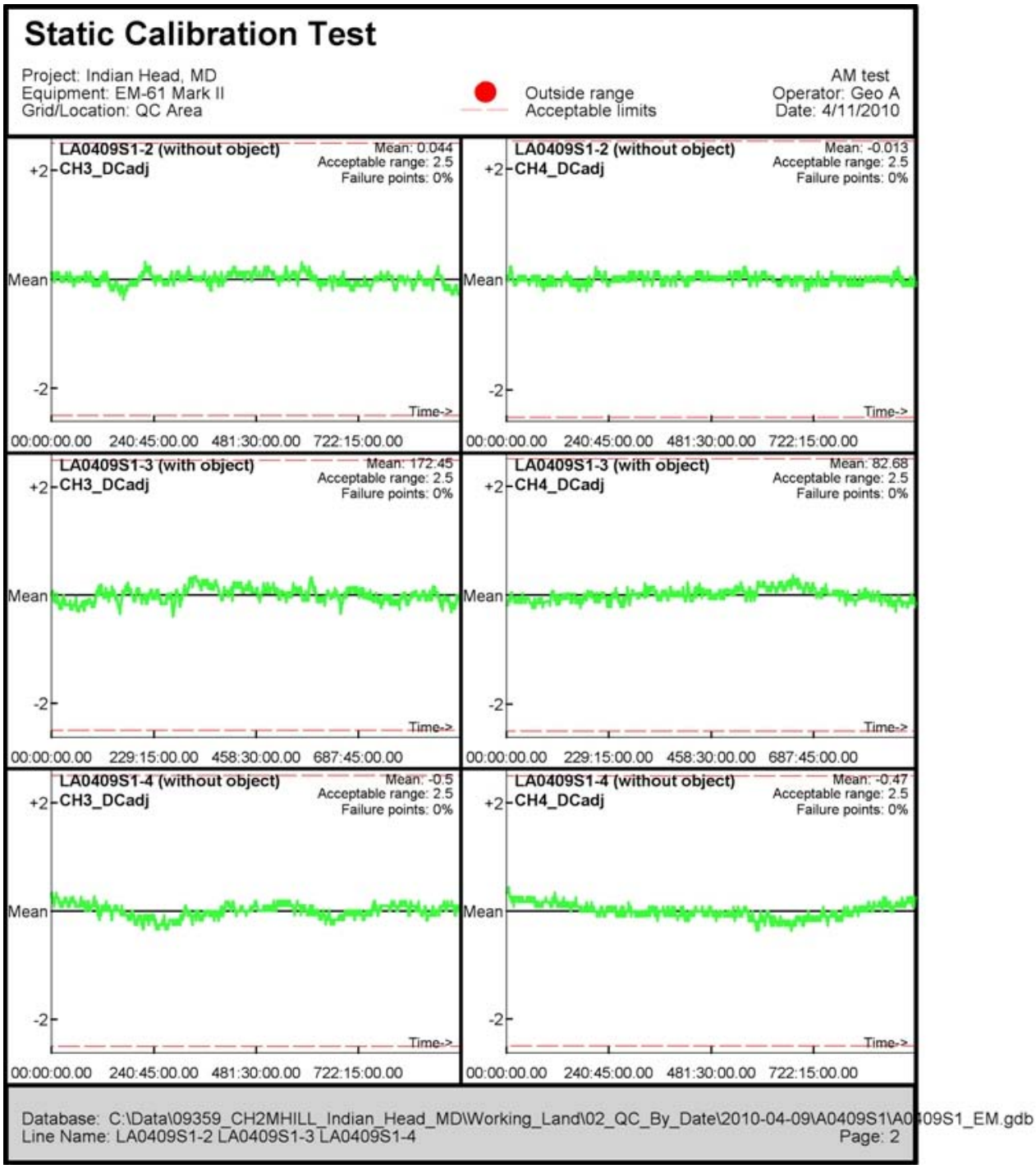
Image of QC Repeat Line Data, UXO-27 East

ID	GRIDCELLI	X1	Y1	X2	Y2	X3	Y3	X4	Y4	TYPE	AMPLITUD	UNITS	X1_UTM	Y1_UTM
1	C3A4D6	310090.4	4274652	0	0	0	0	0	0	1	395.73	mV	0	0
2	C3A4D6	310091.7	4274650	0	0	0	0	0	0	1	77.74	mV	0	0
3	C3A4D6	310096	4274678	0	0	0	0	0	0	1	4.55	mV	0	0
4	C3A4D6	310096.1	4274677	0	0	0	0	0	0	1	10.03	mV	0	0
5	C3A4D6	310096.7	4274678	0	0	0	0	0	0	1	11.33	mV	0	0
6	C3A4D6	310097.3	4274680	0	0	0	0	0	0	1	975.96	mV	0	0
7	C3A4D6	310097.4	4274662	0	0	0	0	0	0	1	118	mV	0	0
8	C3A4D6	310098.3	4274680	0	0	0	0	0	0	1	662.93	mV	0	0
9	C3A4D6	310098.3	4274676	0	0	0	0	0	0	1	10.87	mV	0	0
10	C3A4D6	310100.4	4274678	0	0	0	0	0	0	1	730.08	mV	0	0
11	C3A4D6	310101.3	4274676	0	0	0	0	0	0	1	1215.36	mV	0	0
12	C3A4D6	310101.5	4274680	0	0	0	0	0	0	1	24.48	mV	0	0
13	C3A4D6	310102	4274677	0	0	0	0	0	0	1	7753.88	mV	0	0
14	C3A4D6	310103.6	4274673	0	0	0	0	0	0	1	10.92	mV	0	0
140	C3A4D6	310110.3	4274658	0	0	0	0	0	0	2	71.03	mV	0	0
141	C3A4D6	310111.7	4274651	0	0	0	0	0	0	2	178.59	mV	0	0
142	C3A4D6	310111.8	4274658	0	0	0	0	0	0	2	67.14	mV	0	0
143	C3A4D6	310113.2	4274658	0	0	0	0	0	0	2	76.04	mV	0	0
144	C3A4D6	310114.1	4274657	0	0	0	0	0	0	2	170.87	mV	0	0
145	C3A4D6	310114.7	4274657	0	0	0	0	0	0	2	157.43	mV	0	0
146	C3A4D6	310116.4	4274656	0	0	0	0	0	0	2	17.16	mV	0	0
147	C3A4D6	310116.9	4274657	0	0	0	0	0	0	2	18.4	mV	0	0
148	C3A4D6	310118.4	4274655	0	0	0	0	0	0	2	39.25	mV	0	0
C3A4D6_P	C3A4D6	310119.6	4274650	310101.5	4274650	310091.6	4274657	310092.5	4274659	3	99	mV	0	0
C3A4D6_P	C3A4D6	310119.9	4274656	310119.9	4274654	310096	4274662	310106.8	4274662	3	99	mV	0	0
C3A4D6_P	C3A4D6	310095.4	4274662	310095.2	4274678	310090	4274680	310090.1	4274665	3	99	mV	0	0
C3A4D6_P	C3A4D6	310095.3	4274676	310095.5	4274668	310104.2	4274666	310102.8	4274674	3	99	mV	0	0

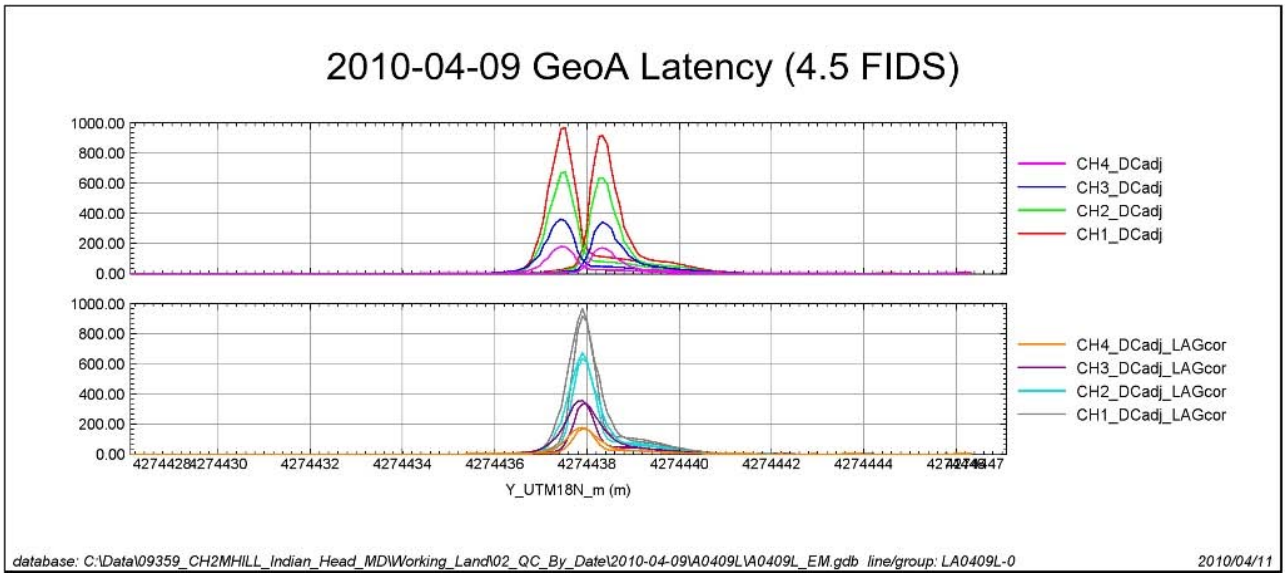
Example of Deliverable Digsheet (Partial) for C3A4D6



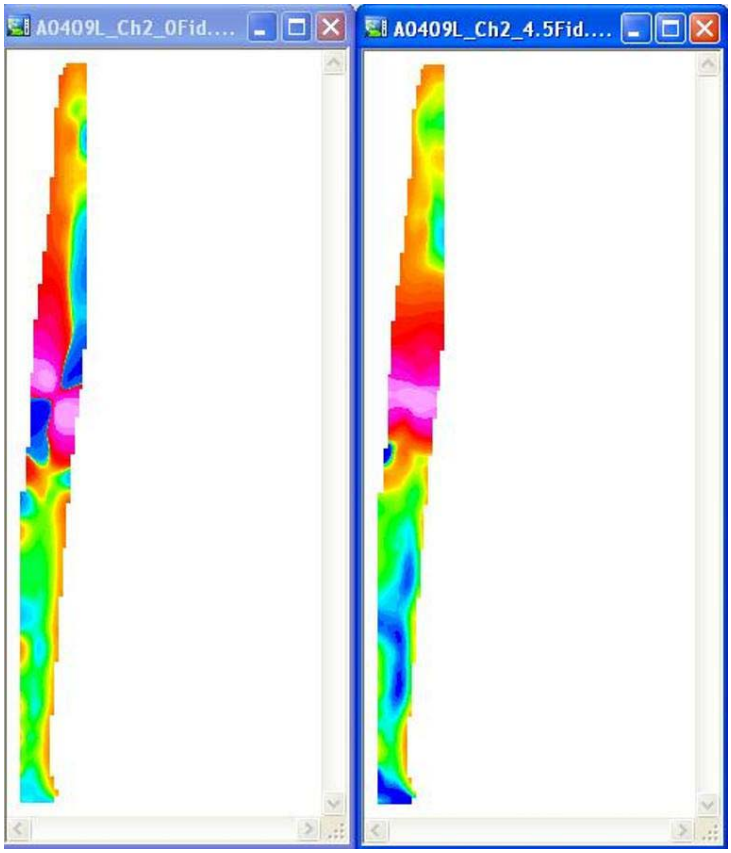
Example of EM61 QC Static-Spike Test Deliverable. April 09, 2010. The left column represents the response of Ch1 while the right column represents the response of Ch2. From top to bottom, the profiles represent pre-item, item and post item tests



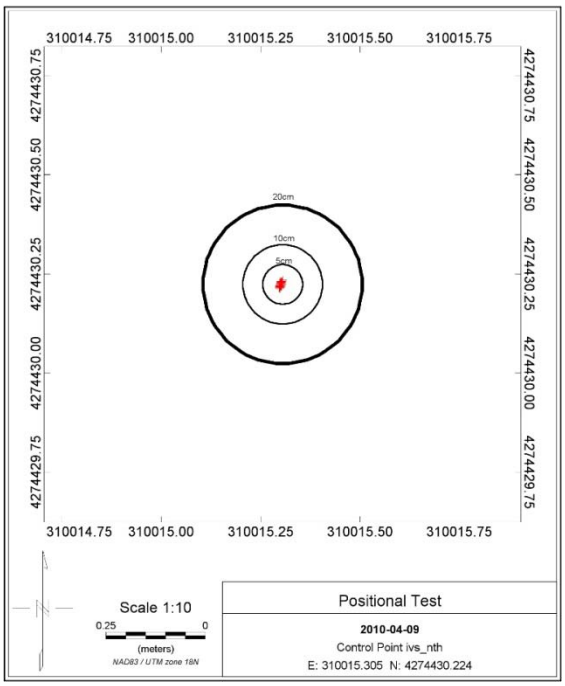
Example of EM61 QC Static-Spike Test Deliverable. April 09, 2010. The left column represents the response of Ch3 while the right column represents the response of Ch4. From top to bottom, the profiles represent pre-item, item and post item tests



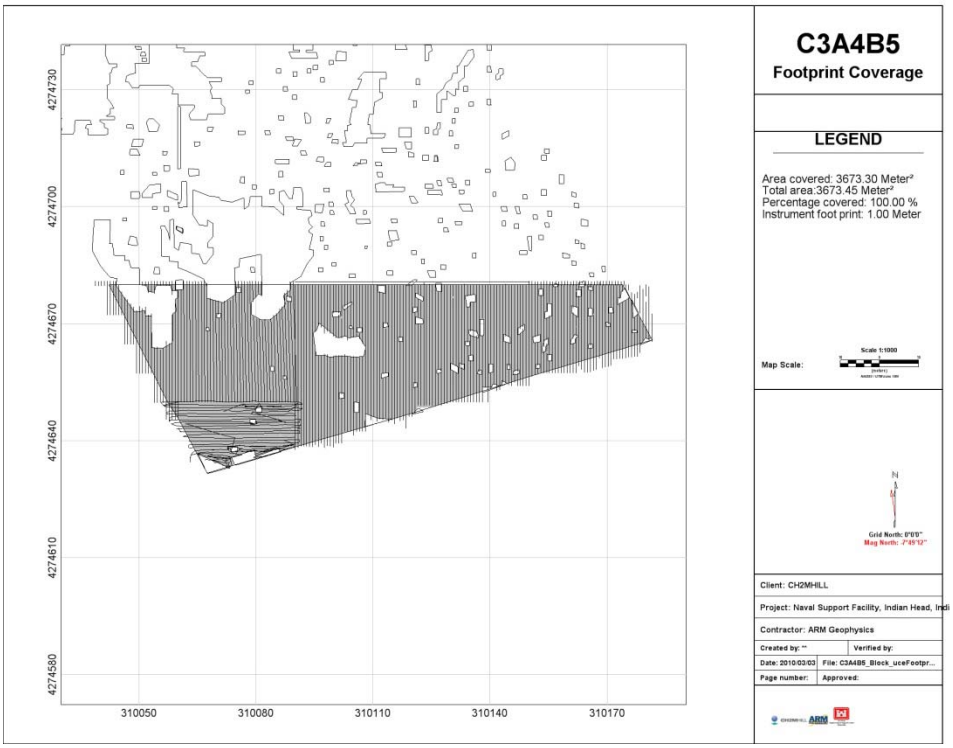
Example of GPS EM61 Latency Test (Profile) for GPS-Positioned Data, April 09, 2010



Example of GPS EM61 Latency Test (Gridded) for GPS-Positioned Data, April 09, 2010

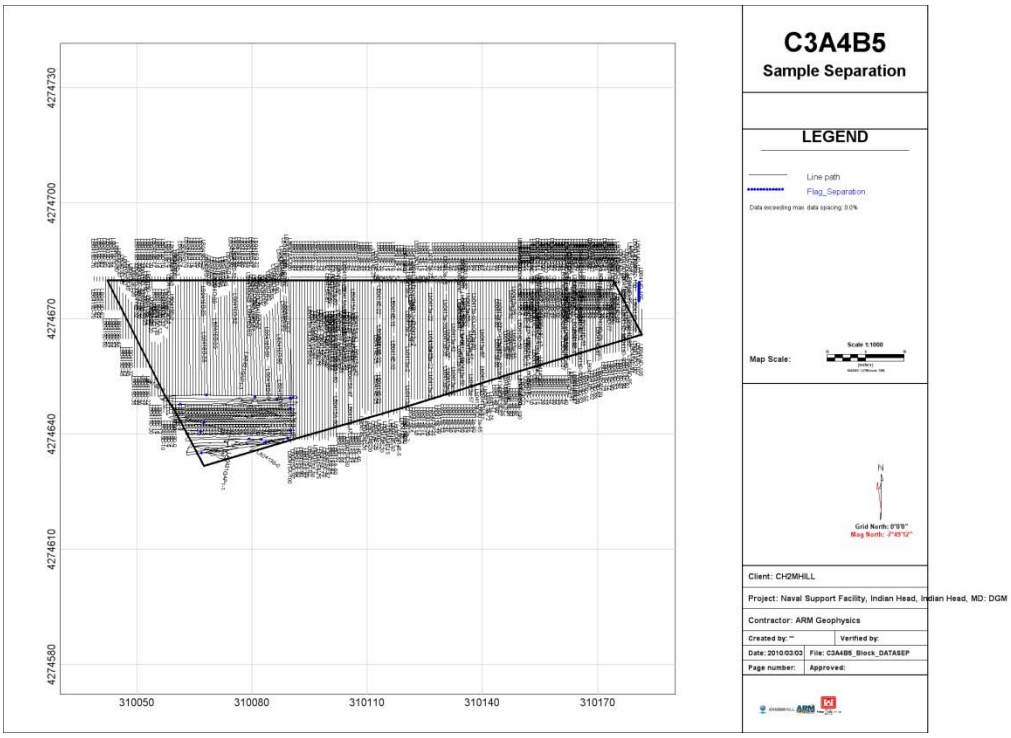


Example of Positional Test, April 09, 2010



Example of Foot Print Coverage Map, Gridblock C3A4B5; Area in Grey

Represents Data Coverage at 1m Swath



Example of Sample Separation Map, Gridblock C3A4B5; Blue Dots

Represent Instances of Separation in Excess of 0.2m

Attachment B
Root Cause Analyses and Corrective Action Plans

ROOT CAUSE ANALYSIS (RCA) & CORRECTIVE ACTION PLAN (CAP)

FOR

Field Data Collection Procedures Pertaining to Improper Check of Initial Mag Base Station Readings

AT

Naval Support Facility Indian Head (NSF-IH)

1.0 BACKGROUND

ARM Geophysics (ARM) discovered on April 18th, 2010, that the *Geometrics* 856 Mag Base station set-up on April 16th, 2010, for transverse gradient (TVG) underwater magnetometer operations had external periodic interference noticed in the data. Although the base station data is not required for the gradient calculations, the base station data may be useful to correct each channel individually for diurnal corrections or as a backup for gradient calculations if one of the TVG sensors no longer responded correctly. After discussion with the field team, one of the field geophysicists noted that they had inadvertently left a metal object near the base. Following this, ARM management discussed with the team members the importance of not only removing all metal objects from the mag base station but also the importance of briefly checking the base station readings after the base is setup to monitor for (and as a reminder of) such possibilities. ARM informed CH2M via email of this development and of their preliminary findings and has subsequently detailed below in the following Root Cause Analysis (RCA).

2.0 ROOT CAUSE ANALYSIS (RCA)

ARM noted large response variations values in the mag base for April 16th, 2010 (**See Figure 1**):

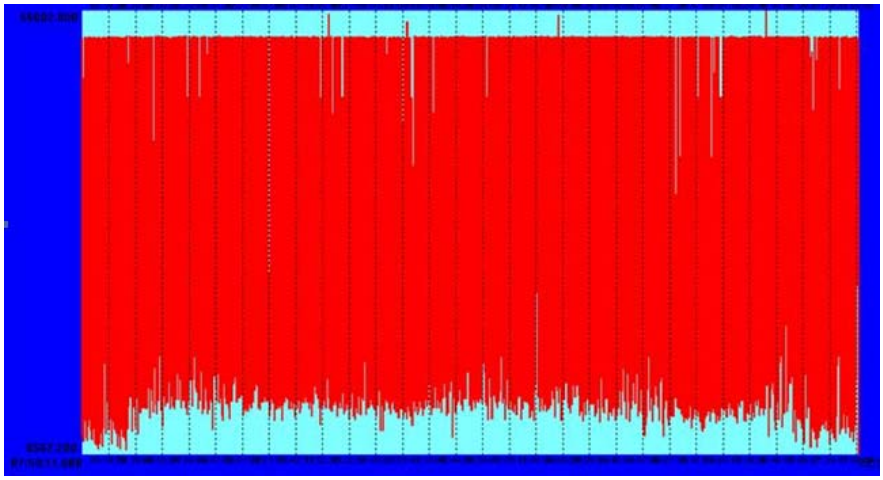


Figure 1 – Mag Base Station Data, 2010-04-16

The significance of oscillations was noticed immediately upon file conversion and processing. After discussing with the field team, one of the field geophysicists noted that they remember inadvertently

leaving a metal object near the base station – the compass used to line up the base station in the correct direction had been left on the sensor for the duration of the survey. The leaving of the compass was a one-time oversight and did not occur on subsequent days' setups.

3.0 CORRECTIVE ACTION PLAN (CAP)

To correct for the error in collecting unusable base station data on the 16th of April, ARM calculated and removed the background field, as a method to reduce the affect of metal response from the pier, to bring anomalies down to a zero background level. A side effect of this process was that it acts to remove long wavelength features from the data, including the diurnal effect. The horizontal gradient between the two underwater mag TVG sensors, which does not rely on base station corrections, was also meaningful to meet the project scope. Additionally, ARM communicated to all field team members the importance of not only removing all metal objects from the mag base station but also the importance of briefly checking the base station readings after the base is setup to monitor for such possibilities from either near surface large metal objects or ambient power line noise interferences, to name a few.

To prevent a reoccurrence of this issue, field procedures will be revised to ensure that the particular incident detailed here does not occur again. First, using the compass to align the base station will be done while the compass is tied (via string or rope) around the operators' neck to reduce the possibility of leaving it within the vicinity of the base station. Second, a number of readings (one reading appears on screen every 5 seconds for the first minute of collection) will be monitored to ascertain if there are any large (unknown) objects or interferences which are currently generating erratic oscillations in the data. Lastly, the data file will be opened and quickly viewed by the field team upon download each evening.

More diligence will be paid to the entire data collection process by the field geophysicists in the future while setting up, briefly monitoring, and collecting mag base station data.

4.0 SUMMARY

ARM Geophysics (ARM) has provided a background, Root Cause Analysis, and Corrective Action Plan for "Field Data Collection Procedures Pertaining to Improper Check of Initial Mag Base Station Readings" at UXO-20 Underwater DGM area, NSF-IH, Maryland. ARM has discussed:

1. the failures in field procedures and the reasons for said failures;
2. the methods by which the data failures have been corrected; and
3. the methods to prevent such failures in the future.

Lastly, ARM will incorporate the summary points of the currently provided RCA & CAP into their current mag base station SOP, commonly provided to CH2M HILL and other clients as an appendix or addendum to their current work plans.

ROOT CAUSE ANALYSIS (RCA) & CORRECTIVE ACTION PLAN (CAP)

FOR

Field Data Collection and Processing Procedures Pertaining to Failure of QC Static-Spike Tests to Meet Data Quality Objectives (DQO)

AT

Naval Support Facility Indian Head (NSF-IH)

1.0 BACKGROUND

On April 19th, CH2MHILL informed ARM that the QC Static-Spike Tests for the *Geometrics* G-882 TVG system did not meet the Data Quality Objectives for the test of no variation greater than 20% from either the expected value (first day's value) or from the previous measurement.

QC test data was being examined prior to production processing by the data processor in profile mode, where the tests appeared to be consistent; however, absolute values had not been compared when CH2M informed ARM via email of this development. The causes and preliminary findings are subsequently detailed below in the following Root Cause Analysis (RCA).

2.0 ROOT CAUSE ANALYSIS (RCA)

The QC Static-Spike Test for the G-822 TVG involved setting the platform on dry land, recording:

1. The background (static) readings,
2. Interrogating the sensors with a standard item (spike) in a jig located between the sensors and,
3. Recording the background (static) readings again.

The item used, as specified in the workplan, was a Nelco 4K Champion Sports 6lb iron shotput. Despite the object's large mass and close proximity to the sensors (Figure 1), the resulting response measured at the sensor was in the order of 3 to 6nT (background reading subtracted from spike reading).

Figure 1: Geometrics G-882 TVG setup for QC Static-Spike test

The current Indian Head ISO (industry standard object) had been used with reasonable success on a previous project (St Juliens Creek Annex) with the G-882 TVG system, albeit with a similar, low amplitude response issue. On that project the item had initially been offset from the sensors at a distance mimicking the response from a sea-floor item. The response at this, greater, offset was in the order of 1nT and the item was brought forward to a location between the sensors where it registered a response in the order of 3 to 5nT and remained relatively stable with differences from the initial (centered) test being in the order of 8 to 18% with one instance of 24% variation.

Since the test had been so consistent on the previous St Juliens Creek Annex project despite the very small response, which would lead to a large percentage variation in response with any small variation in position, the processor inferred, from looking at the profile response of the QC test, that the readings were similarly stable, especially as the shotput had been placed in a fixed jig between the sensors.

Below are tables of the QC test responses:

Table 1: Percentage differences between the values of the AM and PM tests and the percentage difference of each test from its equivalent on the first day

	% Difference Between AM and PM Spike	
	Mag1 Raw	Mag2 Raw
4/16/2010	53.26	57.41
4/17/2010	4.66	6.09
4/18/2010	38.81	31.22

	% Difference Between First Day's Spike			
	AM		PM	
Date	Mag1 Raw	Mag2 Raw	Mag1 Raw	Mag2 Raw
4/16/2010	0.00	0.00	0.00	0.00
4/17/2010	42.28	39.32	-6.98	-13.12
4/18/2010	45.66	42.07	30.96	15.10

Table Error! No text of specified style in document.**2: Instrument values for AM tests**

		AM PRE ITEM Raw Mean		AM ITEM Raw Mean		Spike Values	
		Mag1_Raw	Mag2_Raw	Mag1_Raw	Mag2_Raw	Spike Mag1	Spike Mag2
Fri 16-Apr-10	16-Apr_Static_QC1	51950.13	51913.46	51944.40	51907.16	-5.73	-6.30
Sat 17-Apr-10	17Apr2010_Static_QC1	51947.18	51910.07	51943.45	51905.84	-3.73	-4.23
Sun 18-Apr-10	18Apr2010_Static_QC1	51953.96	51913.72	51950.36	51909.61	-3.60	-4.11

Table 3: Instrument values for PM tests

		PM PRE ITEM RAW Mean		PM ITEM Raw Mean		Spike Values	
		Mag1_Raw	Mag2_Raw	Mag1_Raw	Mag2_Raw	Spike Mag1	Spike Mag2
Fri 16-Apr-10	16-Apr_Static_QC2.Survey	51963.97	51924.32	51960.65	51920.83	-3.32	-3.49
Sat 17-Apr-10	17Apr2010_Static_QC2a	51951.71	51909.40	51948.15	51905.42	-3.56	-3.98
Sun 18-Apr-10	18Apr2010_Static_QC2	51964.88	51927.28	51962.45	51924.28	-2.43	-3.00

The principle cause of the DQO failure was the very small response of the sensors to the test item, even at the relatively close proximity (0.75m). The relatively small response meant that any slight variation in conditions of the test would have a disproportionately large effect on the response compared to the relative effect of the same changes on a larger spike response. The small scale of the response (including both signal and noise contributions) is part of the reason that the QC test variations were not considered significant in the field nor in the office under review. Another factor is that the production data appeared clean with respect to the nominal 5nT picking threshold.

USACE guidelines permit a spike response of up to 500 instrument units; much higher than the 3 to 6 instrument units recorded here. Additionally, at a nominal response of 5nT, the general allowable in-test variance of 1nT is, in and of itself, 20% of the total response.

From viewing the profile data, the processor was under the impression that the tests were consistent and of a quality to warrant acceptance and went on to process the production data and evaluate coverage. No issues were seen with the production data and the final QC tracking was temporarily put on hold in order to catch up on other aspects of the project's data processing.

3.0 CORRECTIVE ACTION PLAN (CAP)

Despite the failure of the QC Static-Spike test to meet project DQOs, the production data showed no degradation of quality that would be attributable to equipment failure; one potential cause of QC test failures. Instead, the DQO failure was the result of the recommended ISO not producing a strong enough response at the sensor offset used despite previous, qualified, success using the same ISO at the same offset on the previous St Juliens Creek Annex project.

To prevent a reoccurrence of this issue on future projects, ARM will utilize an alternate, larger and more responsive test item and/or will interrogate the sensors individually at a closer offset, utilizing an alternate jig to place the item in a repeatable position with respect to each sensor. The result of this will be to produce a larger scale spike response (within USACE guidelines), minimizing the relative influence of small variations on the readings and providing a more appropriate indication of the correct functioning of the equipment.

Greater diligence will be paid to the QC process by all ARM employees. QC test procedures have be re-iterated to field personnel in terms of acceptable and non-acceptable relative spike responses; including making modifications to the test procedure in the field. Processing procedures have been adjusted to ensure that the processing of production data does not commence until QC tests have been fully processed and accepted by ARM QC personnel. Additionally, procedures have been improved to facilitate tracking of QC metrics by means of improved QC tracking spreadsheets. This will give processors and QC personnel immediate feedback regarding the acceptability of results in relation to previous day's tests and will minimize the potential for QC issues to be missed by ARM personnel.

4.0 SUMMARY

ARM Geophysics (ARM) has provided a background, Root Cause Analysis, and Corrective Action Plan for "Field Data Collection Procedures Pertaining to Failure of QC Static-Spike Tests to Meet Data Quality Objectives (DQO)" at UXO-20 Underwater DGM area, NSF-IH, Maryland. ARM has discussed:

- The nature of the DQO failure
- The root cause of the DQO failure and
- The methods by which ARM will endeavor to ensure the DQO failure does not re-occur

On any potential future work involving shallow water marine magnetometer digital geophysical mapping by ARM for CH2MHILL, ARM will demonstrate that the spike test values are significantly higher than those recorded here before commencing mapping.

Attachment C
Photographs of DGM Equipment

This attachment contains photographs of the DGM equipment in operation at NSF-IH.

Image of a single coil EM61 with RTK DGPS antenna mounted on tripod above coil.

Image of a single coil team manuvering the EM61 in Area C.

Single EM61 team. The operator is checking the
data quality indicators before commencing a new line.

QC testing of Geometrics G-882 TVG Marine Magnetometer system.

TVG towfish being deployed in float mode at UXO27.

ARM personnel deploying towfish in float mode with RTK DGPS antenna.

ARM personnel acquiring data with TVG towfish in float mode.

ARM personnel towing floated TVG towfish manually in shallow water in UXO-27

ARM personnel monitoring TVG towfish parameters during data acqusition.

Attachment D
Photographs of Unsurveyable Areas

This Attachment contains photographs of some of the unsurveyable areas of the NSF-IH.

Image showing steep slope along Potomac River in Area B

Image shows a slope that is uncleared and too steep for survey.

Image shows area with steep slope where the vegetation was not suitable for survey

Image shows area where the vegetation was not suitable for survey

Attachment E
QC Summary

This attachment contains a summary of the QC Test Performed

		AM PRE ITEM Mean				AM ITEM Mean				AM PRE ITEM Standard Deviation				AM ITEM Standard Deviation			
Date	AM File Name	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4
Wed 31-Mar-10	033110S1	0.05	0.25	0.14	0.41	402.96	285.42	169.31	81.00	0.53	0.41	0.09	0.08	0.37	0.27	0.12	0.09
Thu 1-Apr-10	040110S1	0.00	0.08	0.11	0.21	408.57	288.18	170.80	81.62	0.79	0.33	0.11	0.07	0.58	0.35	0.12	0.07
Fri 2-Apr-10	040210S1	-1.03	-0.88	-0.04	-0.14	407.50	288.18	171.76	81.98	1.12	0.55	0.19	0.08	0.96	0.44	0.16	0.09
Mon 5-Apr-10	A0405S1	0.43	-0.27	0.07	0.08	409.70	288.39	171.05	81.45	1.35	0.55	0.17	0.07	1.26	0.60	0.21	0.13
Tue 6-Apr-10	B0406S1B	-0.42	-0.69	-0.46	-0.35	408.23	287.87	170.48	81.09	0.69	0.34	0.12	0.09	0.94	0.44	0.19	0.09
Wed 7-Apr-10	B0407S1	0.25	0.16	-0.23	0.00	404.44	284.12	167.21	79.23	0.93	0.60	0.10	0.08	0.73	0.46	0.21	0.10
Thu 8-Apr-10	A0408S1	0.02	-0.14	-0.30	-0.14	409.66	289.17	170.77	81.00	0.64	0.39	0.10	0.07	1.15	0.64	0.24	0.13
Fri 9-Apr-10	A0409S1	0.32	0.11	0.04	-0.01	411.27	290.02	172.45	82.68	0.70	0.36	0.11	0.07	0.72	0.35	0.13	0.11
Mon 12-Apr-10	B0412S1	0.34	-0.07	0.03	-0.01	405.96	286.42	170.08	81.17	0.19	0.12	0.07	0.07	0.23	0.18	0.07	0.07
Tue 13-Apr-10	A0413S1	-0.02	0.01	-0.07	-0.29	407.82	288.18	171.31	81.83	0.63	0.26	0.19	0.21	0.66	0.39	0.21	0.11
Wed 14-Apr-10	B0414S1	0.70	0.14	0.19	0.00	411.10	290.25	172.52	82.54	0.72	0.36	0.11	0.07	0.64	0.30	0.14	0.08
Thu 15-Apr-10	B0415S1	0.22	-0.41	-0.21	-0.20	405.50	286.87	170.63	81.53	0.77	0.27	0.12	0.09	1.88	0.83	0.28	0.09
Fri 16-Apr-10	B0416S1	0.22	-0.18	-0.20	-0.18	410.09	289.31	171.33	81.50	0.77	0.25	0.08	0.07	0.65	0.44	0.17	0.11
Mon 19-Apr-10	B0419S1	-0.06	-0.27	-0.11	-0.15	411.74	290.14	172.00	82.04	0.73	0.32	0.19	0.26	0.69	0.39	0.16	0.11
Tue 20-Apr-10	B0420S1	0.46	0.04	0.26	0.35	407.68	286.93	170.36	81.63	0.65	0.29	0.09	0.07	0.99	0.51	0.18	0.10
Wed 21-Apr-10	B0421S1A	0.03	-0.67	-0.22	-0.16	411.67	290.10	172.22	82.19	0.31	0.21	0.16	0.18	0.30	0.26	0.13	0.12
						402.96	285.42	169.31	81								

EM61 AM Static / Spike Test Results

	PM PRE ITEM Mean				PM ITEM Mean				PM PRE ITEM Standard Deviation				PM ITEM Standard Deviation			
PM File Name	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4
033110S2	0.05	-0.20	-0.16	-0.05	410.52	289.34	171.10	81.31	0.53	0.30	0.08	0.07	0.54	0.33	0.14	0.07
400110S2	-0.12	-0.15	-0.09	-0.08	410.62	288.99	170.39	80.33	0.22	0.12	0.08	0.08	0.40	0.31	0.19	0.09
040210S2A	0.68	0.40	0.45	0.28	405.17	285.49	168.81	79.78	0.26	0.16	0.09	0.07	0.31	0.23	0.12	0.09
A0405S2	-0.51	-0.56	-0.33	-0.19	423.98	298.54	176.15	83.18	0.54	0.38	0.15	0.12	0.52	0.29	0.13	0.09
B0406S2A	-0.33	-0.18	-0.07	-0.05	405.55	285.29	168.03	78.97	0.20	0.11	0.07	0.06	0.34	0.28	0.14	0.09
A0407S2B	0.04	-0.05	0.10	0.10	407.03	287.03	169.39	79.74	0.63	0.36	0.12	0.08	0.72	0.51	0.17	0.10
A0408S2	-0.30	0.00	-0.17	-0.08	407.00	287.30	169.83	80.54	0.73	0.31	0.11	0.09	1.17	0.78	0.27	0.15
B0409S2	-0.23	-0.12	0.13	-0.01	406.09	287.40	170.89	81.45	0.21	0.13	0.08	0.00	0.35	0.20	0.12	0.00
B0412S2	-0.37	-0.38	0.01	-0.16	405.40	286.17	169.60	80.25	0.37	0.27	0.19	0.23	0.38	0.28	0.15	0.09
A0413S2	0.30	0.05	0.09	-0.01	406.25	287.56	171.42	81.97	1.09	0.53	0.13	0.17	0.78	0.40	0.22	0.11
B0414S2	-0.07	-0.17	0.01	-0.02	411.00	289.60	171.50	81.26	0.75	0.21	0.10	0.08	0.69	0.32	0.17	0.14
B0415S2	-0.07	-0.38	-0.05	-0.08	408.11	287.62	170.01	80.28	0.33	0.19	0.12	0.10	0.27	0.23	0.14	0.09
B0416S2	-1.13	-0.75	-0.31	-0.32	406.72	287.30	170.04	80.53	0.57	0.31	0.14	0.10	0.43	0.35	0.19	0.10
B0419S2B	-0.33	-0.26	-0.01	-0.23	407.89	287.95	170.58	80.64	0.27	0.16	0.07	0.06	0.55	0.30	0.17	0.10
B0420S2A	-0.28	-0.53	-0.31	-0.18	410.32	288.94	170.84	80.88	1.06	0.66	0.27	0.17	1.38	0.89	0.29	0.20
B0421S2	0.05	0.12	0.01	-0.03	405.25	287.45	170.59	81.63	0.79	0.28	0.15	0.07	0.69	0.32	0.19	0.09
					410.52	289.34	171.1	81.31								

EM61 PM Static / Spike Test Results

	% Difference Between AM and PM Spike				% Difference Between First Day's AM Spike				% Difference Between First Day's PM Spik			
	Ch1	Ch2	Ch3	Ch4	Ch1	Ch2	Ch3	Ch4	Ch1	Ch2	Ch3	Ch4
31-Mar-10	-1.86	-1.36	-1.05	-0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Apr-10	-0.50	-0.28	0.24	1.59	-1.38	-0.96	-0.88	-0.76	-0.02	0.12	0.42	1.21
2-Apr-10	0.57	0.94	1.73	2.72	-1.12	-0.96	-1.44	-1.20	1.31	1.34	1.35	1.90
5-Apr-10	-3.43	-3.46	-2.94	-2.10	-1.66	-1.04	-1.02	-0.55	-3.23	-3.13	-2.91	-2.27
6-Apr-10	0.66	0.90	1.45	2.65	-1.30	-0.85	-0.69	-0.11	1.22	1.41	1.81	2.92
7-Apr-10	-0.64	-1.02	-1.30	-0.64	-0.37	0.46	1.25	2.21	0.85	0.80	1.00	1.95
8-Apr-10	0.65	0.65	0.55	0.57	-1.65	-1.31	-0.86	0.00	0.86	0.71	0.75	0.95
9-Apr-10	1.27	0.91	0.91	1.50	-2.04	-1.60	-1.84	-2.05	1.08	0.67	0.12	-0.17
12-Apr-10	0.14	0.09	0.28	1.14	-0.74	-0.35	-0.45	-0.21	1.26	1.10	0.88	1.31
13-Apr-10	0.39	0.22	-0.06	-0.17	-1.20	-0.96	-1.17	-1.02	1.05	0.62	-0.19	-0.81
14-Apr-10	0.02	0.22	0.59	1.56	-2.00	-1.68	-1.88	-1.88	-0.12	-0.09	-0.23	0.06
15-Apr-10	-0.64	-0.26	0.36	1.55	-0.63	-0.51	-0.78	-0.65	0.59	0.60	0.64	1.27
16-Apr-10	0.83	0.70	0.76	1.20	-1.75	-1.35	-1.19	-0.62	0.93	0.71	0.62	0.96
19-Apr-10	0.94	0.76	0.83	1.72	-2.16	-1.64	-1.58	-1.28	0.64	0.48	0.30	0.83
20-Apr-10	-0.65	-0.70	-0.28	0.92	-1.16	-0.53	-0.62	-0.77	0.05	0.14	0.15	0.53
21-Apr-10	1.57	0.92	0.95	0.68	-2.14	-1.63	-1.70	-1.46	1.29	0.66	0.30	-0.39

EM61 Percent Differences for Spike Test Values – 1. Between Tests on Same Day; 2. AM Tests as Compared with First Day's Results; 3. PM Tests as Compared with First Day's Results

		AM PRE ITEM Raw		AM ITEM Raw Mean			
Date	AM File Name	Mag1_Raw	Mag2_Raw	Mag1_Raw	Mag2_Raw	Spike Mag1	Spike Mag2
Fri 16-Apr-10	16-Apr_Static_QC1	51950.13	51913.46	51944.40	51907.16	-5.73	-6.30
Sat 17-Apr-10	17Apr2010_Static_QC1	51947.18	51910.07	51943.45	51905.84	-3.73	-4.23
Sun 18-Apr-10	18Apr2010_Static_QC1	51953.96	51913.72	51950.36	51909.61	-3.60	-4.11
				51944.4	51907.16	-5.73	-6.3

G-882 TVG AM Static / Spike Test Results; Mag 1 is Left Sensor, Mag 2 is Right. Spike Values, in nT, are Item Value minus Background Value

	PM PRE ITEM RAW		PM ITEM Raw Mean			
PM File Name	Mag1_Raw	Mag2_Raw	Mag1_Raw	Mag2_Raw	Spike Mag1	Spike Mag2
16-Apr_Static_QC2.Survey	51963.97	51924.32	51960.65	51920.83	-3.32	-3.49
17Apr2010_Static_QC2a	51951.71	51909.40	51948.15	51905.42	-3.56	-3.98
18Apr2010_Static_QC2	51964.88	51927.28	51962.45	51924.28	-2.43	-3.00
			51960.65	51920.83	-3.32	-3.49

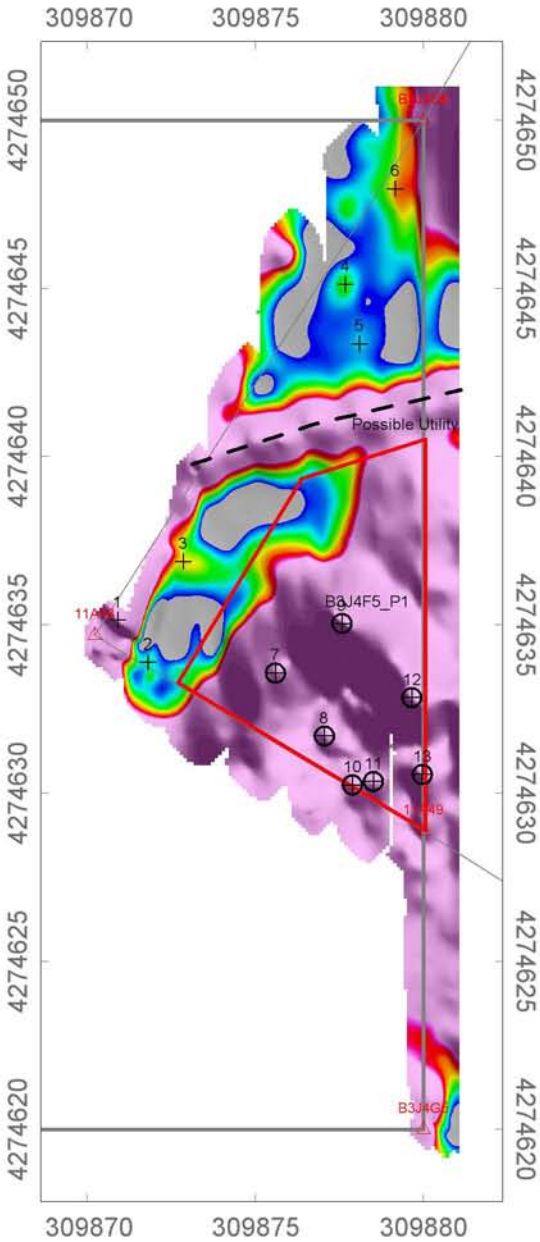
G-882 TVG PM Static / Spike Test Results; Mag 1 is Left Sensor, Mag 2 is Right. Spike Values, in nT, are Item Value minus Background Value

	% Difference Between AM and PM Spike			% Difference Between First Day's Spike			
				AM		PM	
	Mag1 Raw	Mag2 Raw		Mag1 Raw	Mag2 Raw	Mag1 Raw	Mag2 Raw
Fri 16-Apr-10	53.26	57.41	Fri 16-Apr-10	0.00	0.00	0.00	0.00
Sat 17-Apr-10	4.66	6.09	Sat 17-Apr-10	42.28	39.32	-6.98	-13.12
Sun 18-Apr-10	38.81	31.22	Sun 18-Apr-10	45.66	42.07	30.96	15.10

G-882 TVG Percent Differences for Spike Test Values – 1. Between Tests on Same Day; 2. AM Tests as Compared with First Day's Results; 3. PM Tests as Compared with First Day's Results

Attachment F
DVD of Geophysical Data

This attachment is a set of DVD's containing the geophysical data collected



GRID B3J4F5

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-27-2010	File:	B3J4F5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

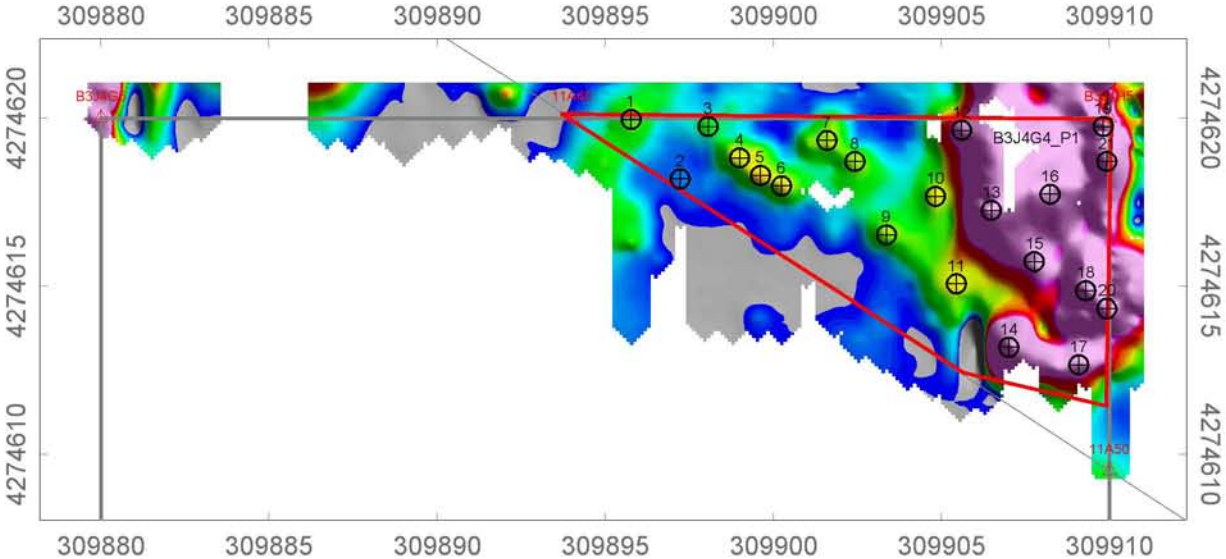
CH2MHILL ARM GEOPHYSICS

GRID B3J4G4

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

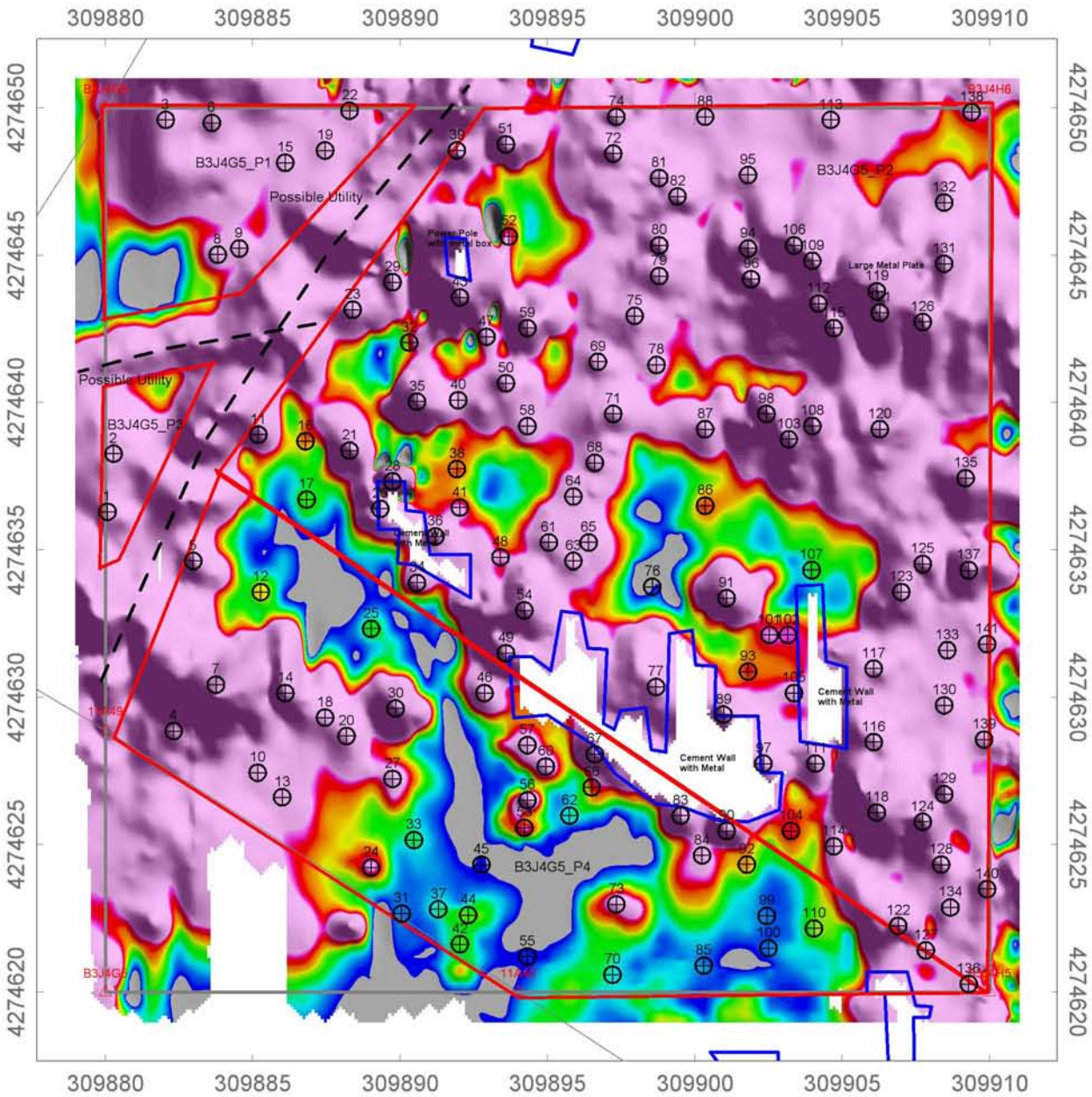
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-27-2010	File:	B3J4G4
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4G5

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

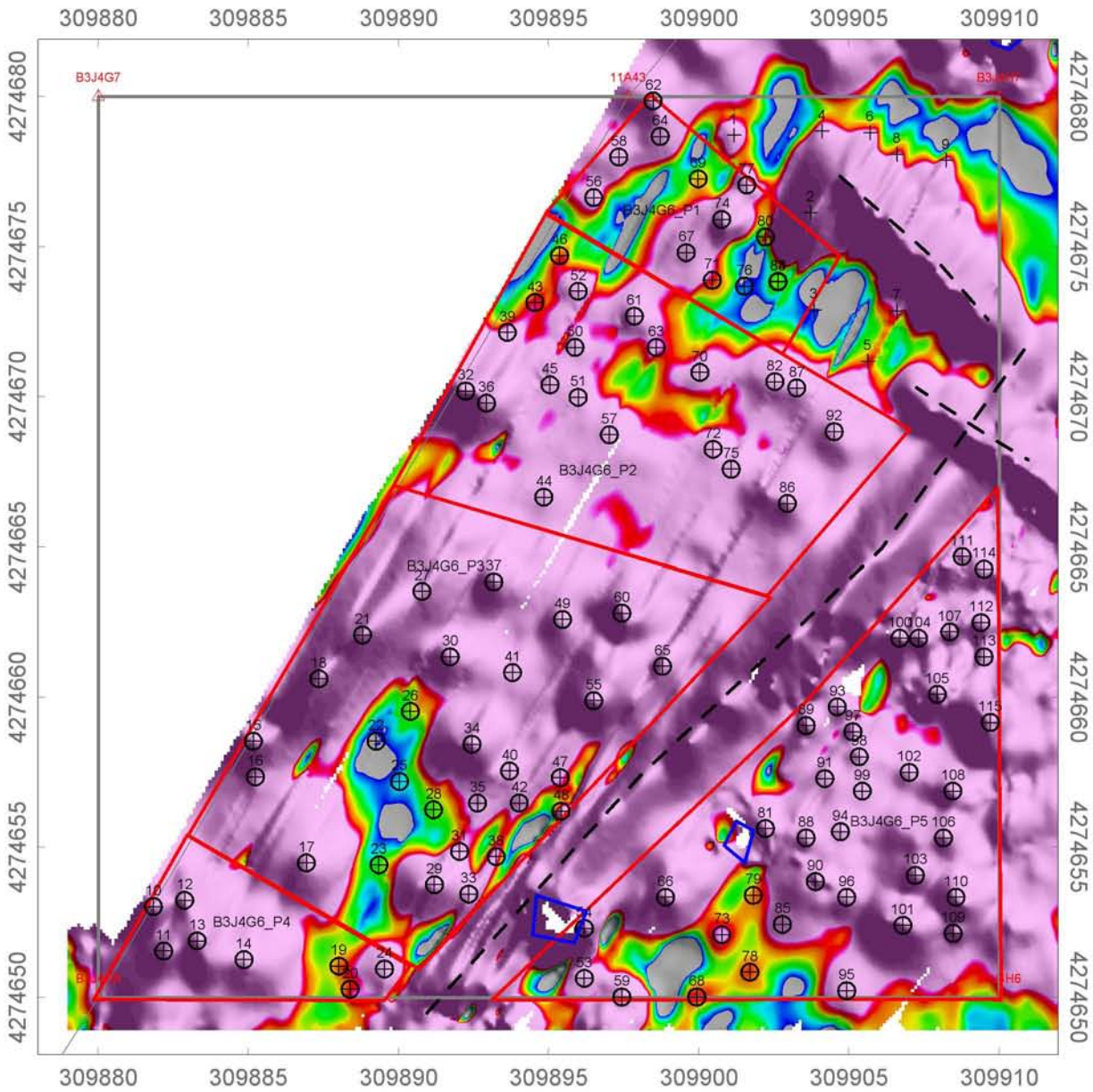
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-27-2010	File:	B3J4G5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4G6

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

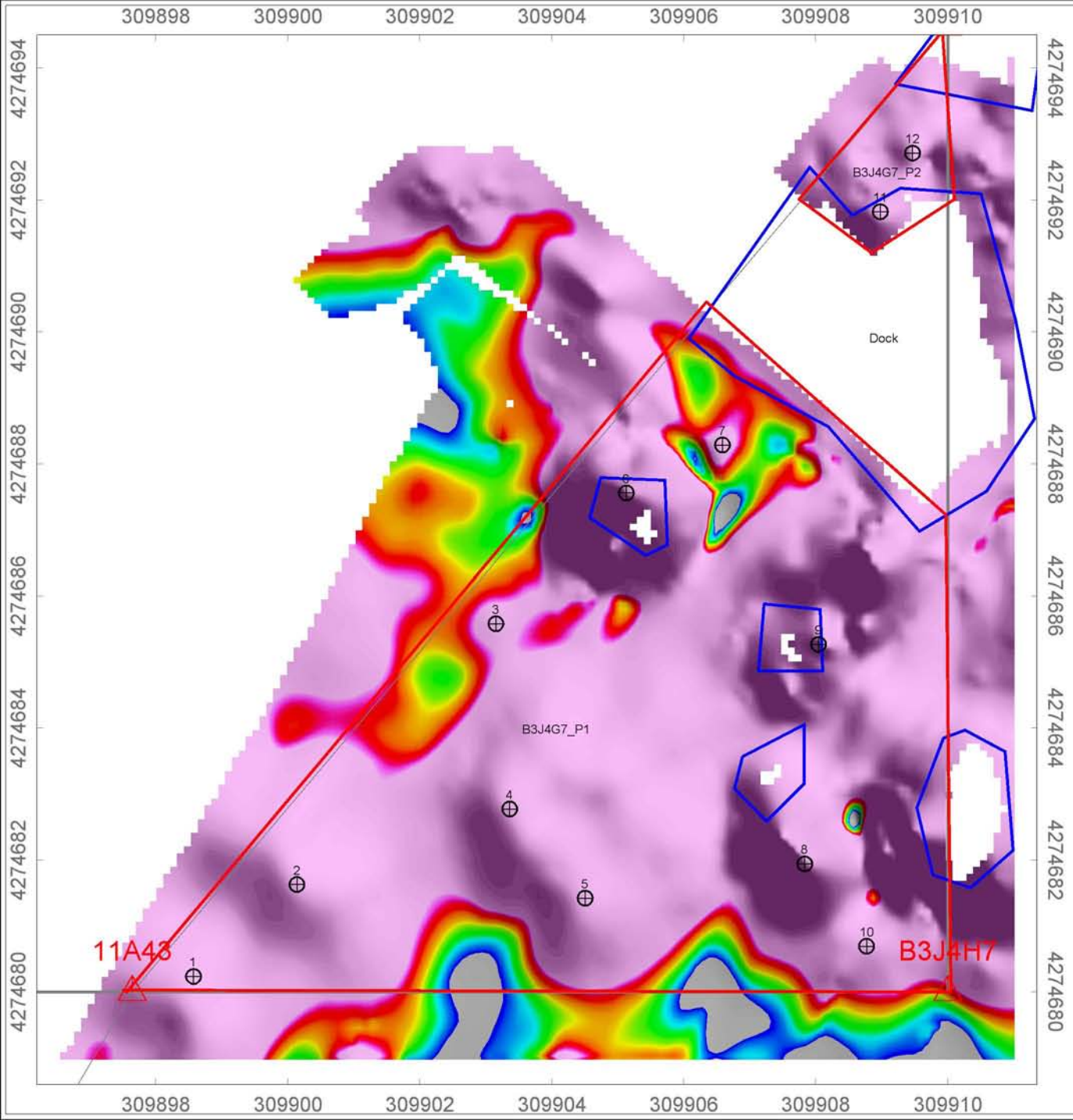
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-27-2010	File:	B3J4G6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4G7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:89.66746

1 0 1 2 3

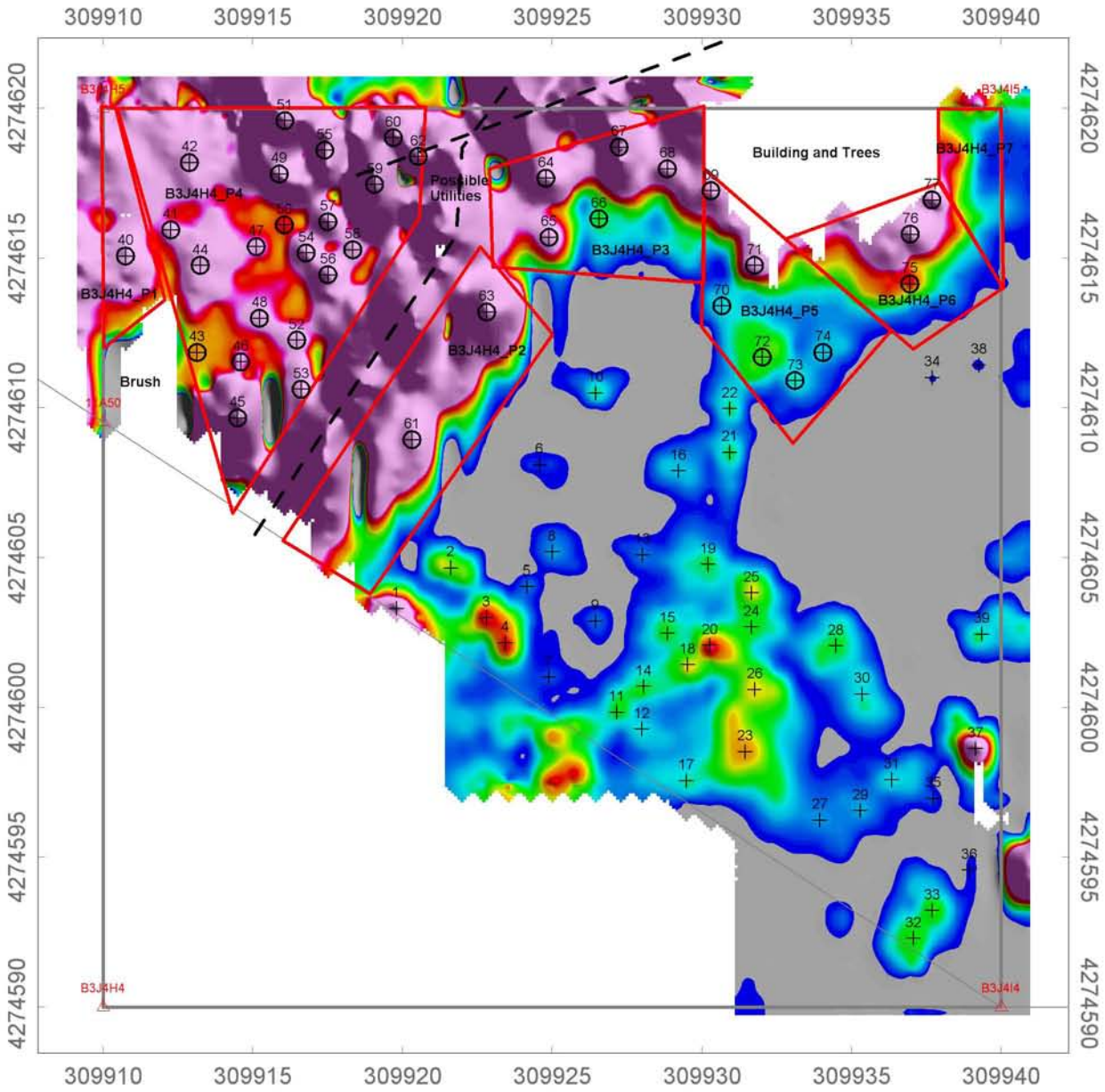
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-27-2010	File:	B3J4G7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4H4

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

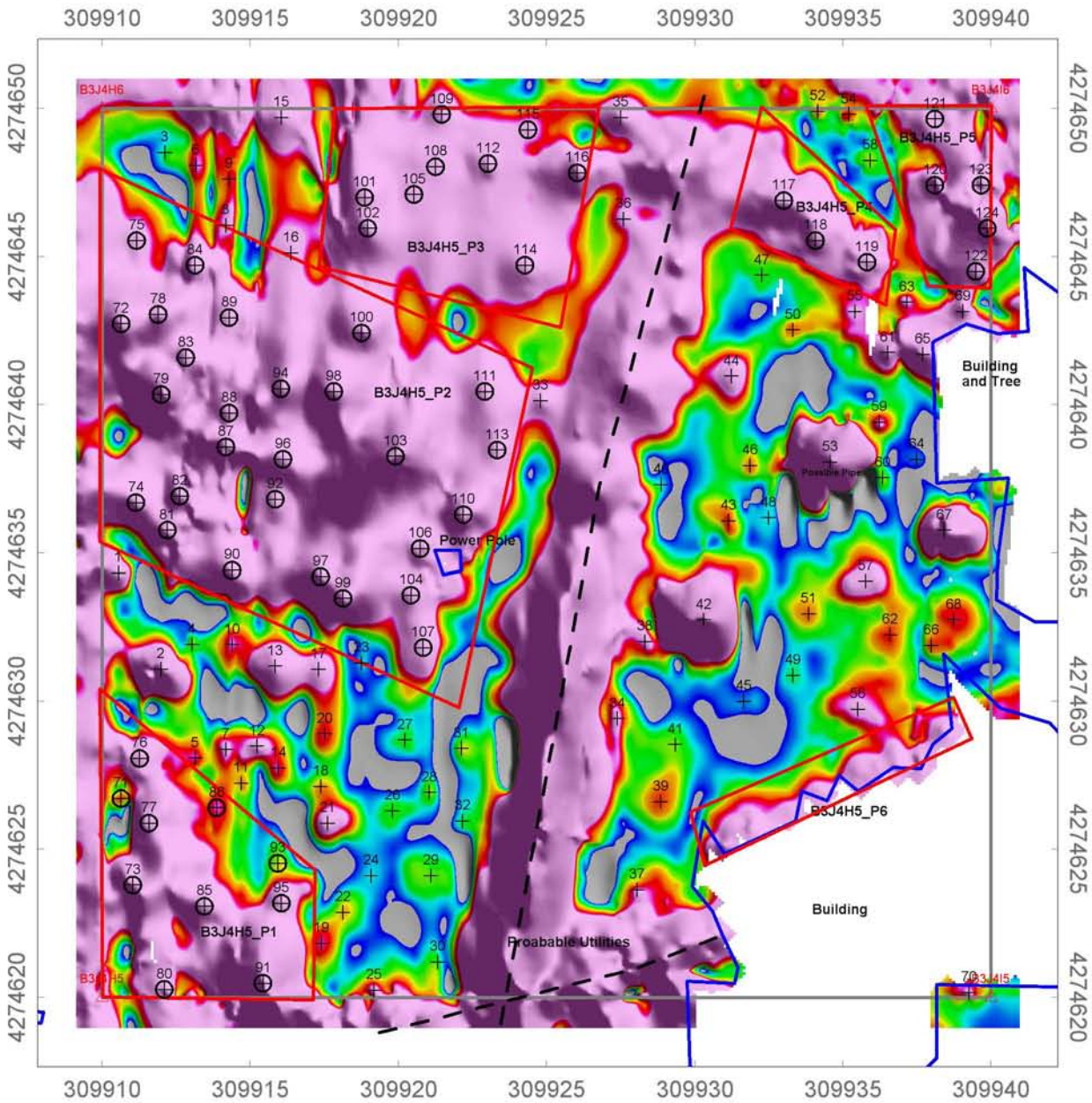
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-26-2010	File:	B3J4H4
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4H5

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

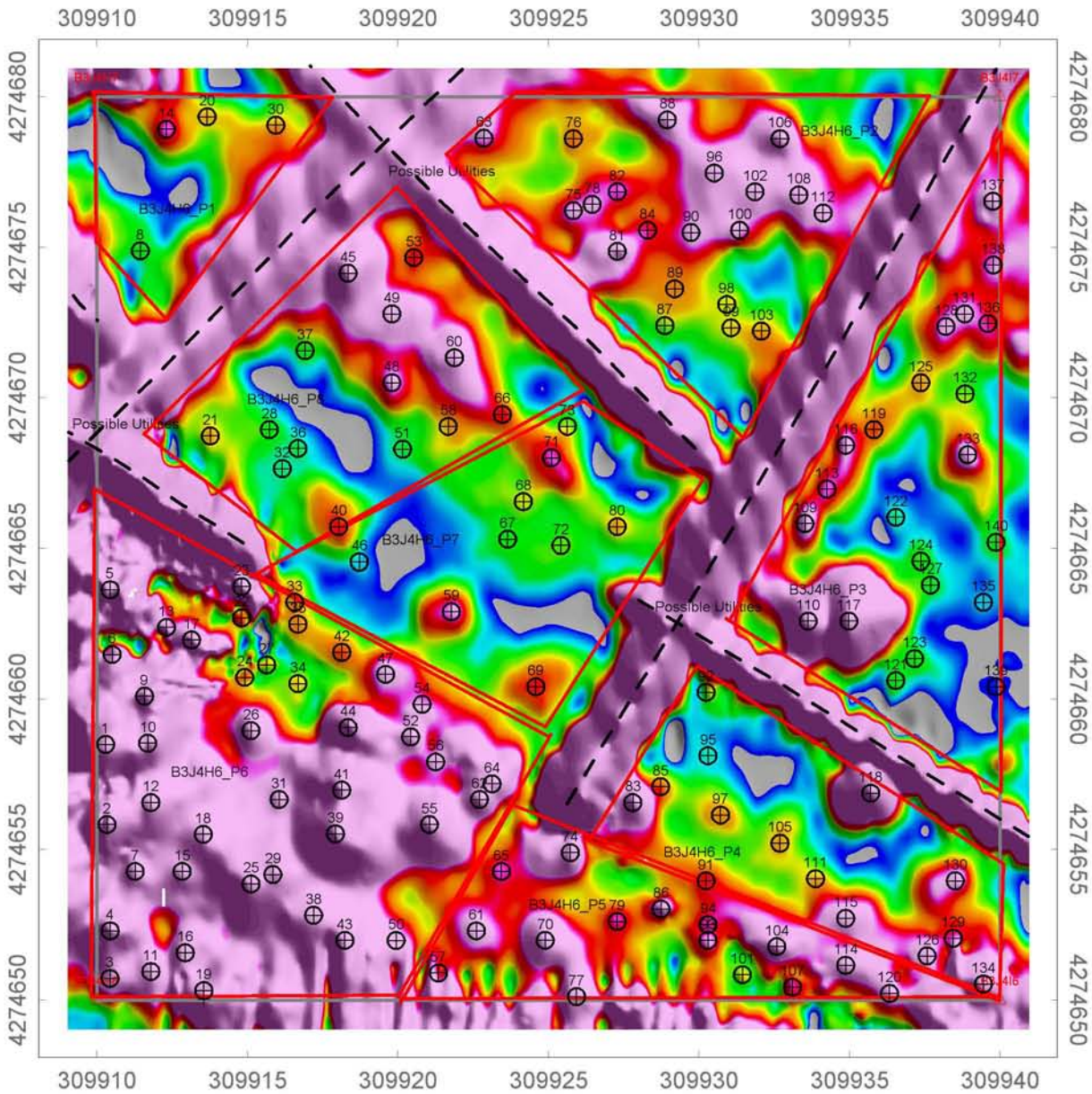
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-26-2010	File:	B3J4H5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4H6

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-27-2010	File:	B3J4H6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

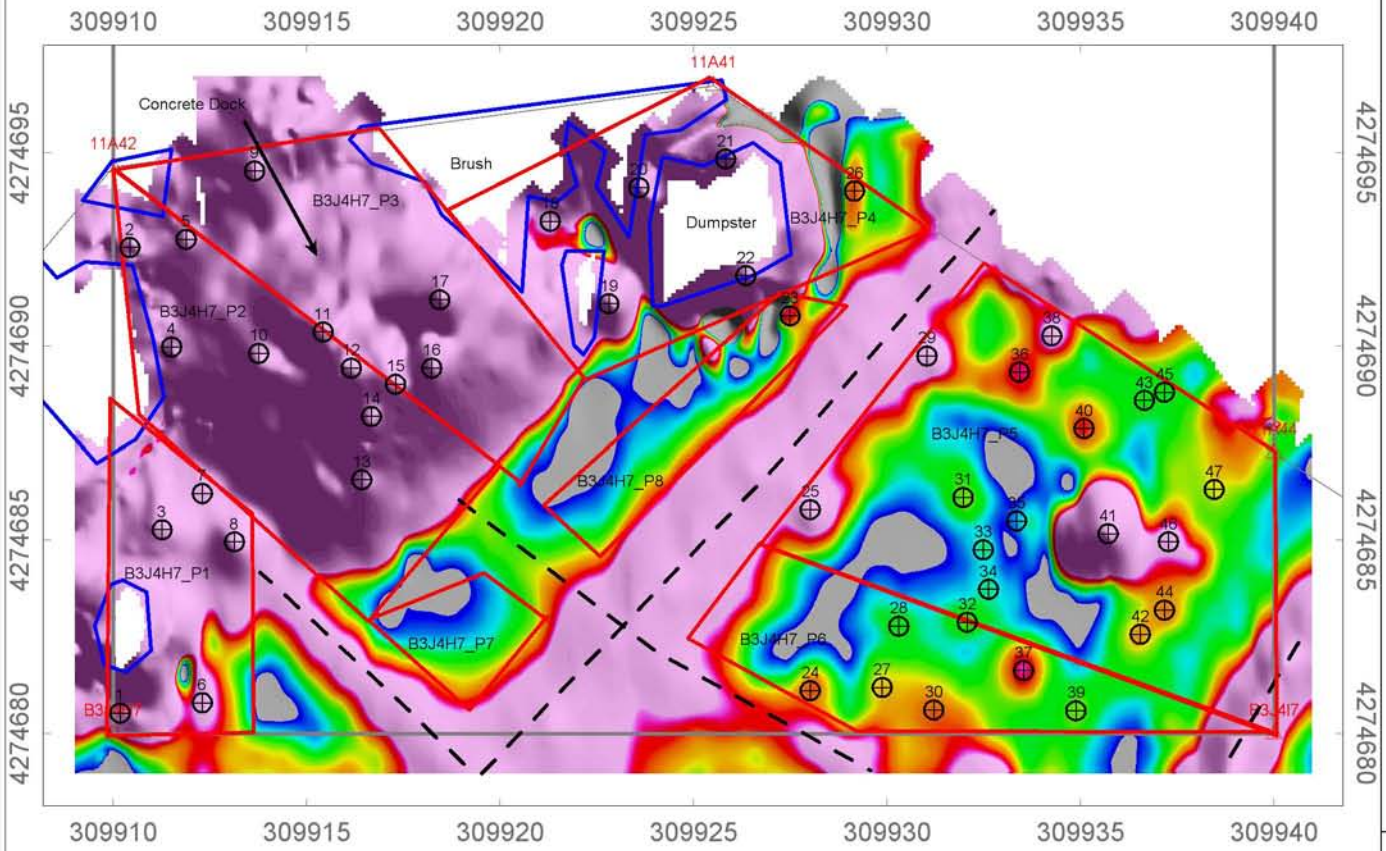
CH2MHILL ARM GEOPHYSICS

GRID B3J4H7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV

3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:195.4545

2.5 0 2.5 5

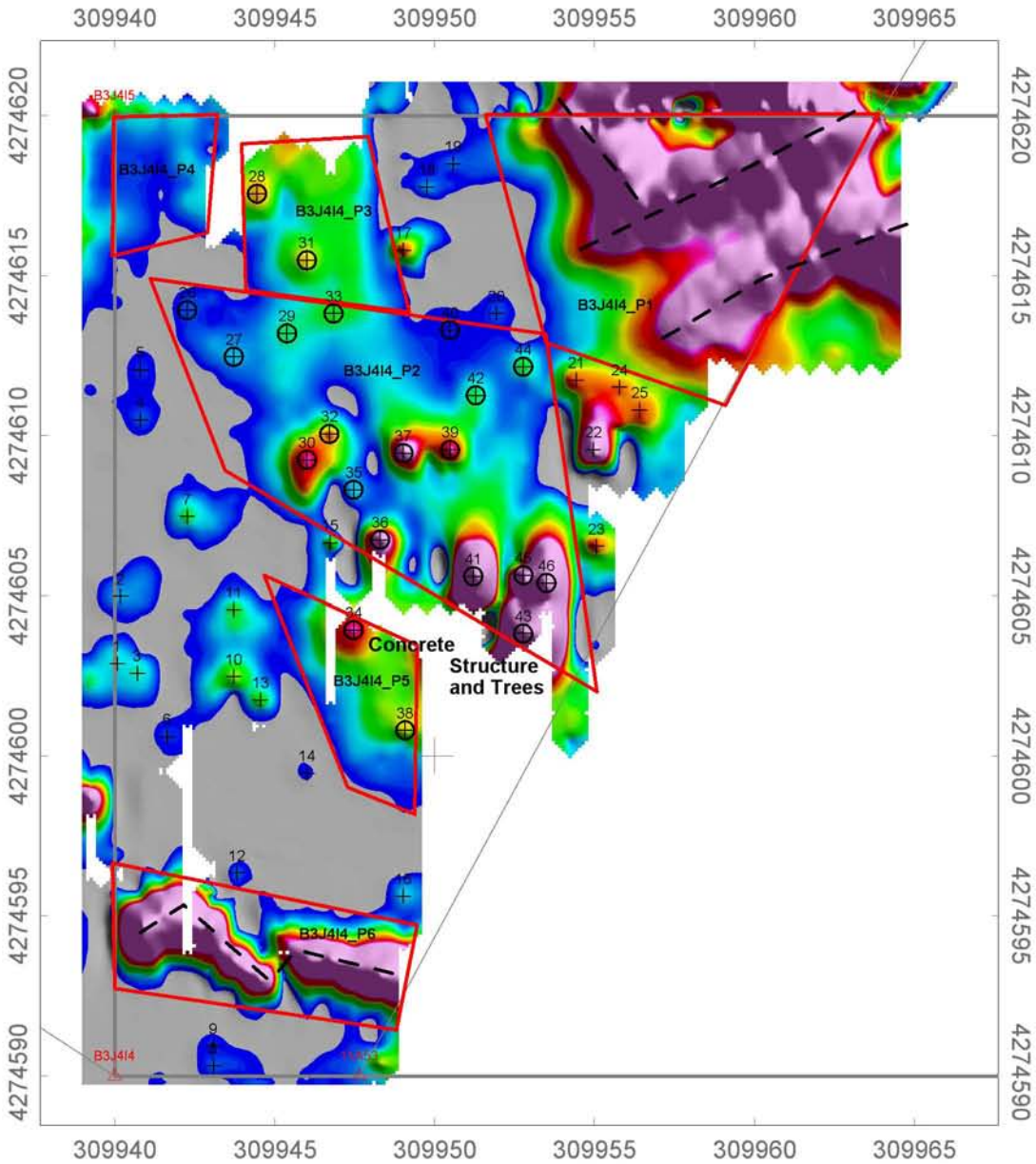
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-27-2010	File:	B3J4H7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4I4

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-26-2010	File:	B3J4I4
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

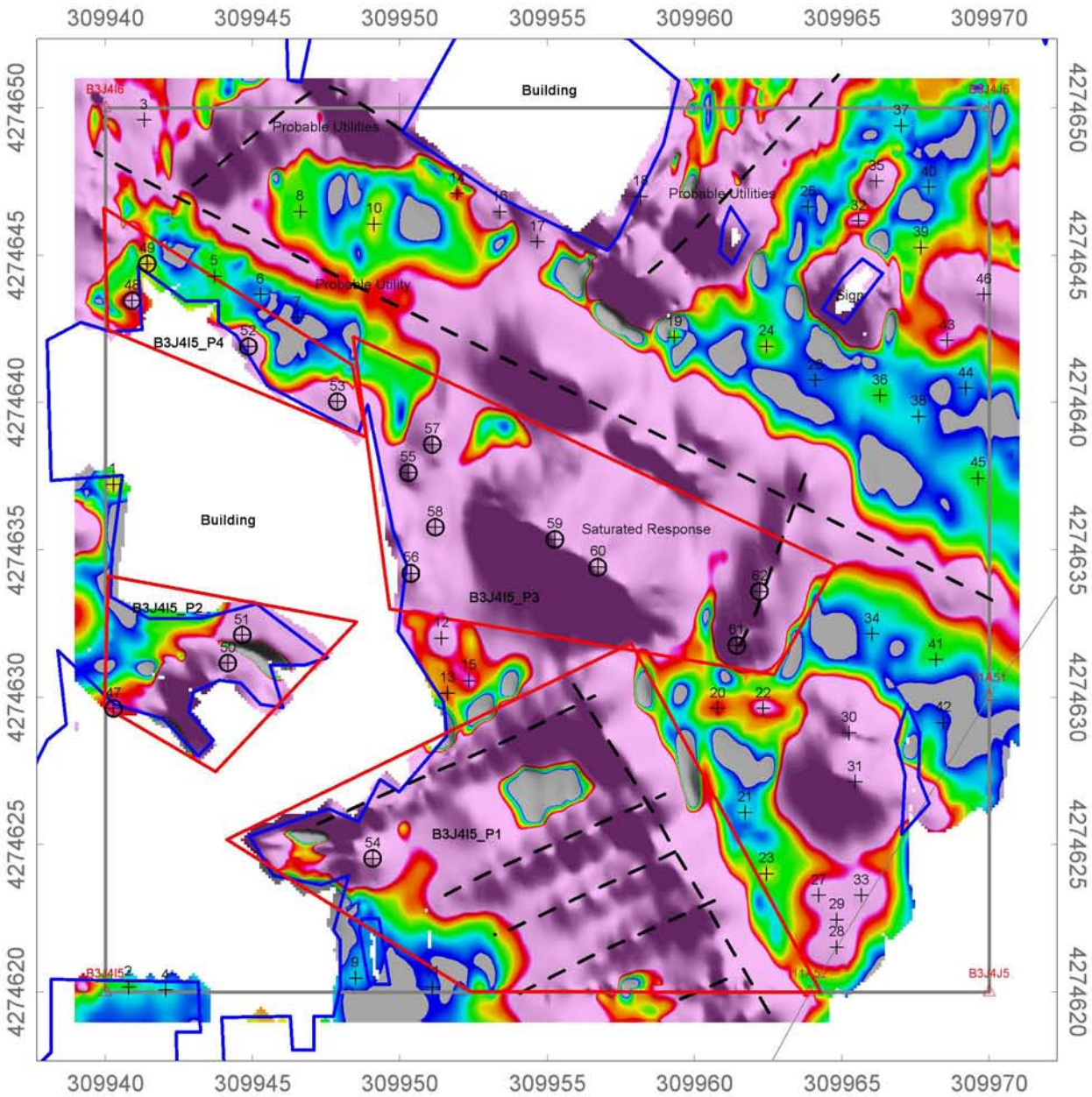
CH2MHILL ARM GEOPHYSICS

GRID B3J4I5

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility / Response From Structure
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-26-2010	File:	B3J4I5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

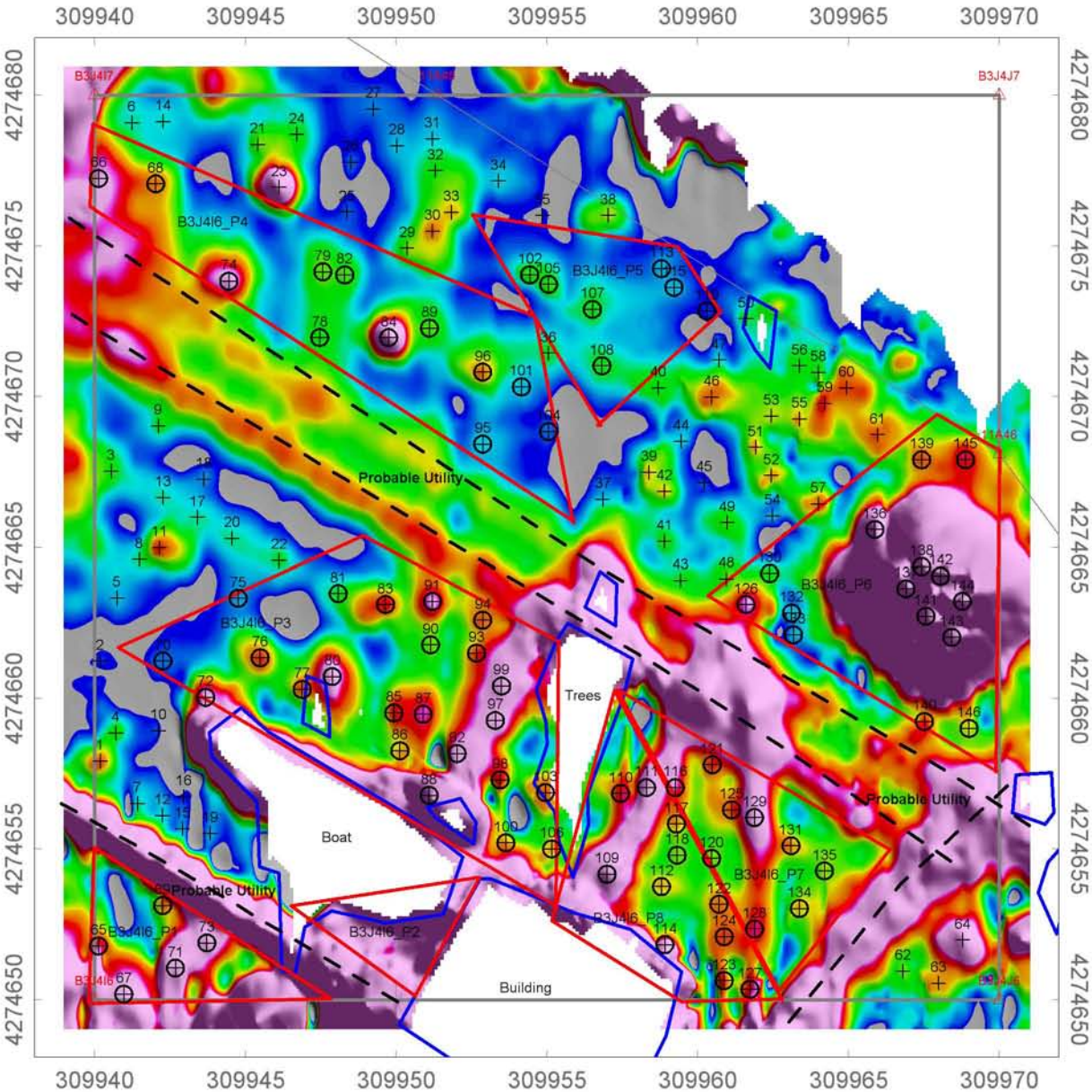
CH2MHILL ARM GEOPHYSICS

GRID B3J4I6

EM Geophysical Survey

GPS Positioned Single Coil EM61

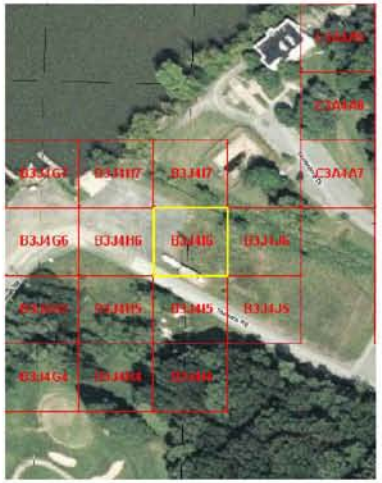
Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96



Scale 1:225

2.5 0 2.5 5 7.5
(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	B3J4I6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

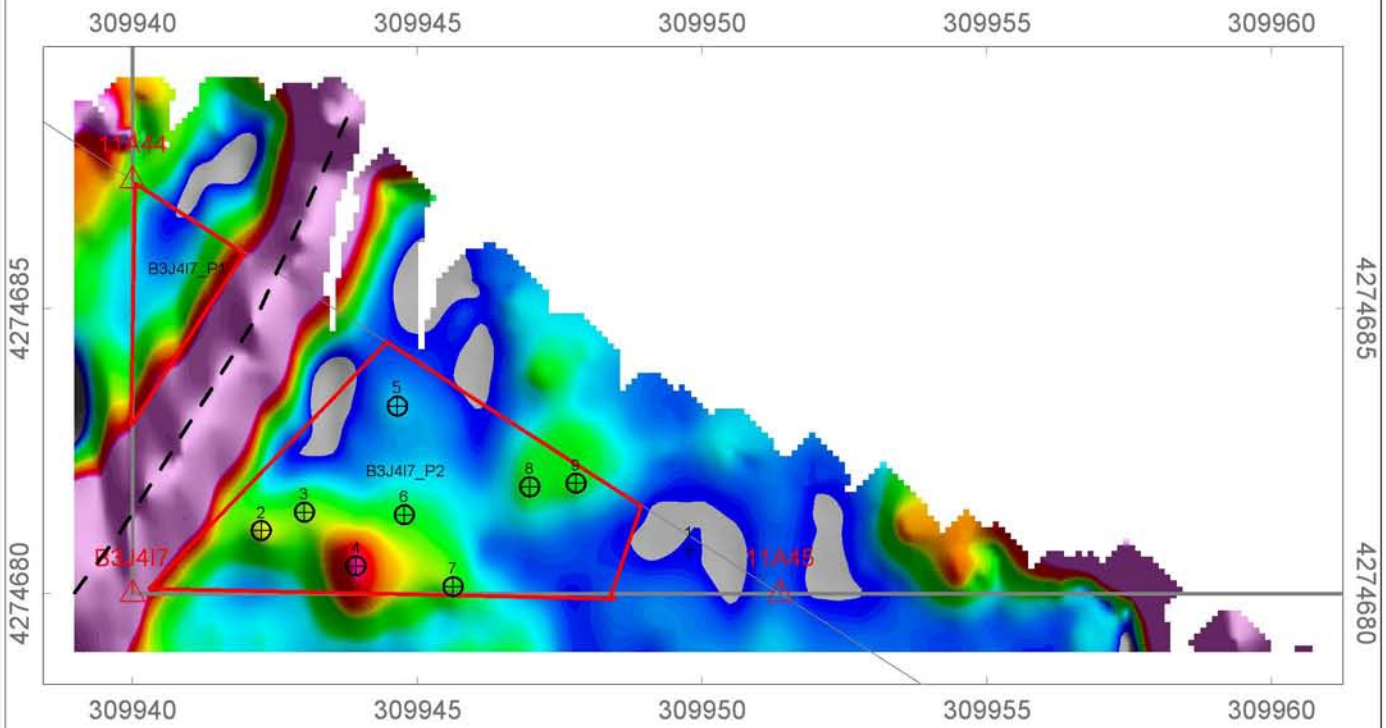
CH2MHILL ARM GEOPHYSICS

GRID B3J4I7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

N

EM (CH3)
mV

3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

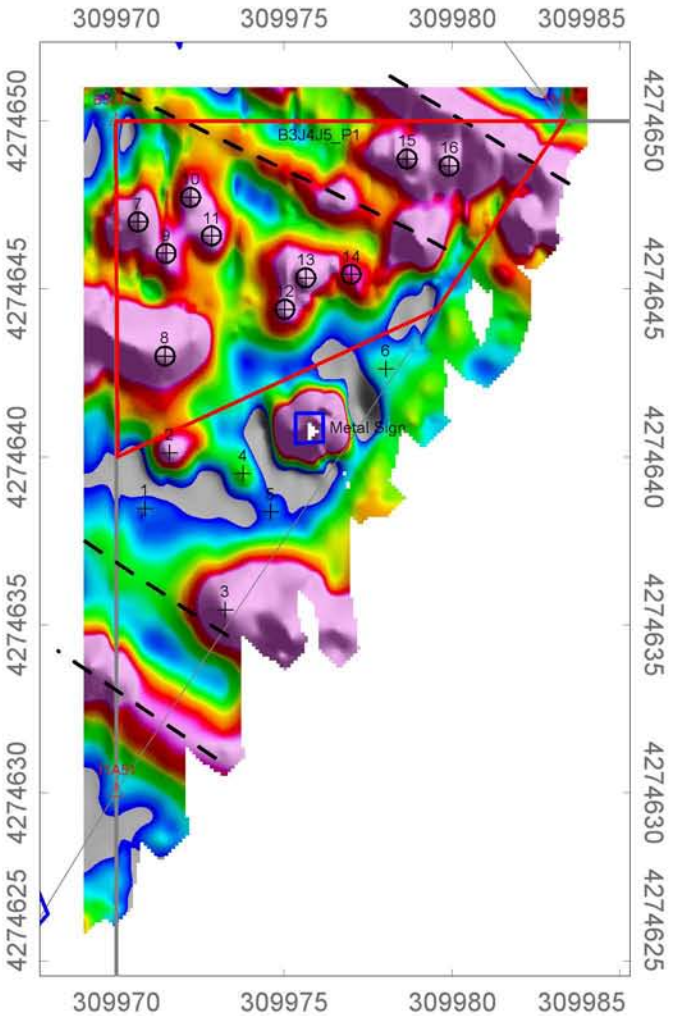
Scale 1:132.8624

2.5 0 2.5

(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	B3J4I7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4J5

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

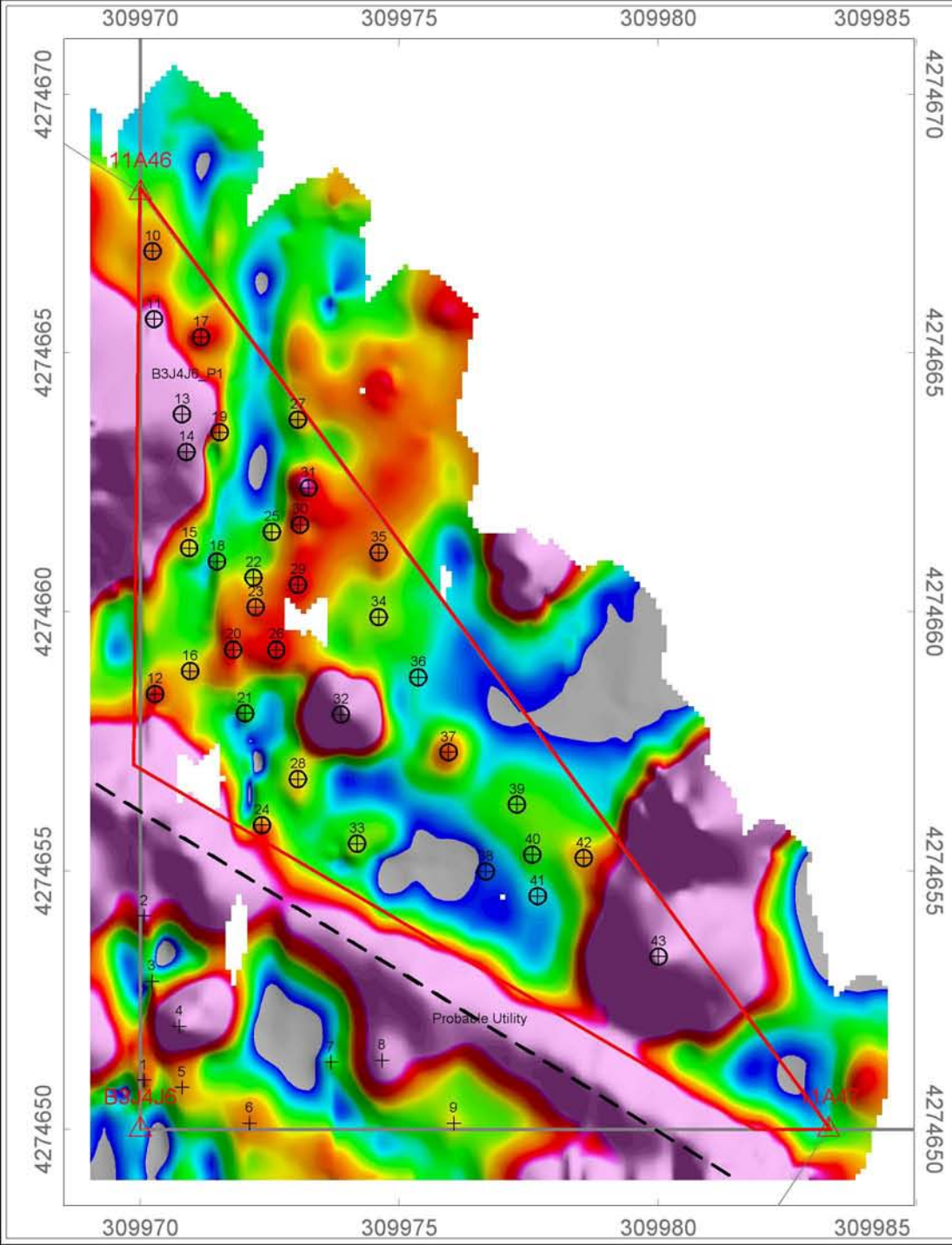
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-26-2010	File:	B3J4J5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B3J4J6

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

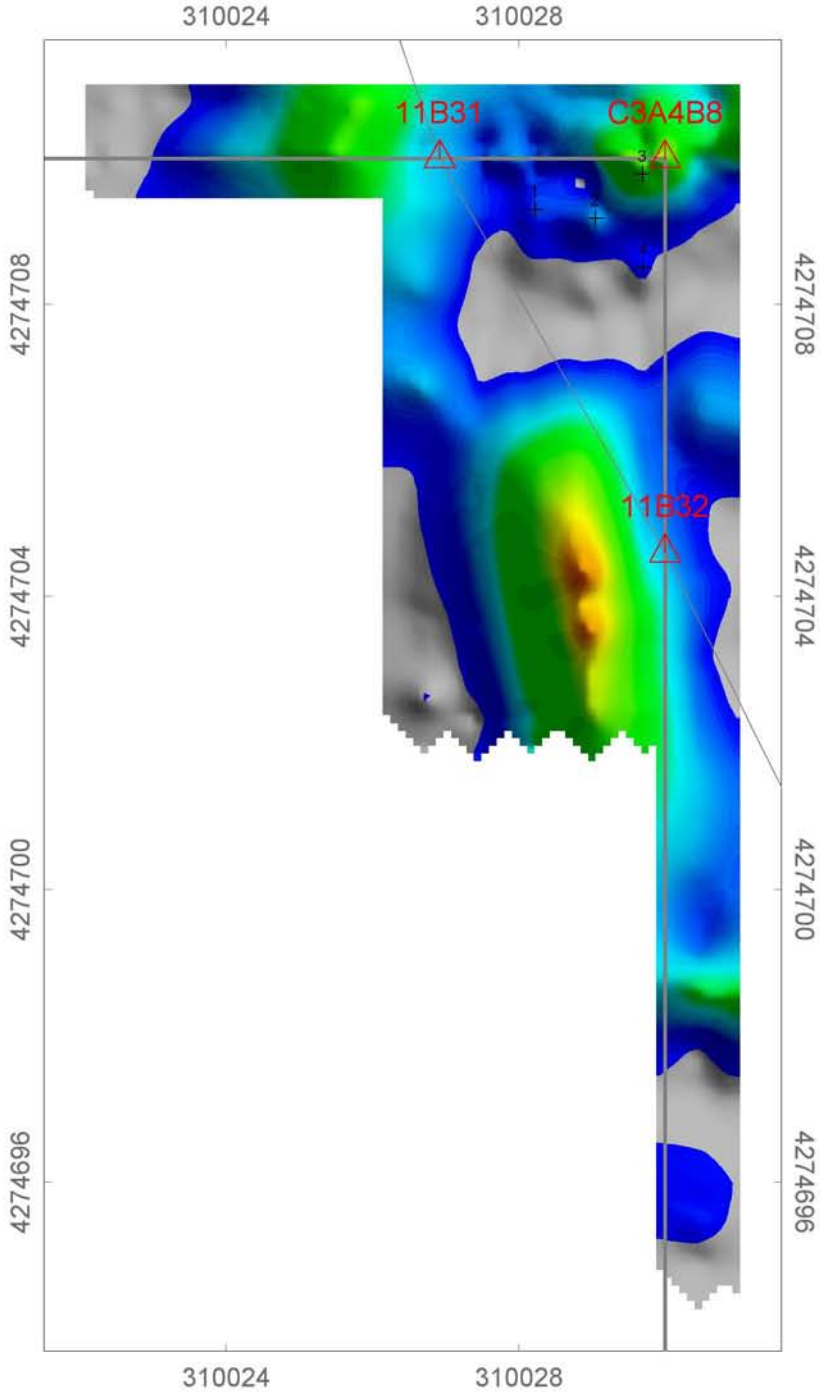
EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:127.0784

2.5 0 2.5
(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	B3J4J6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4A7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:103.4696

2.5 0 2.5

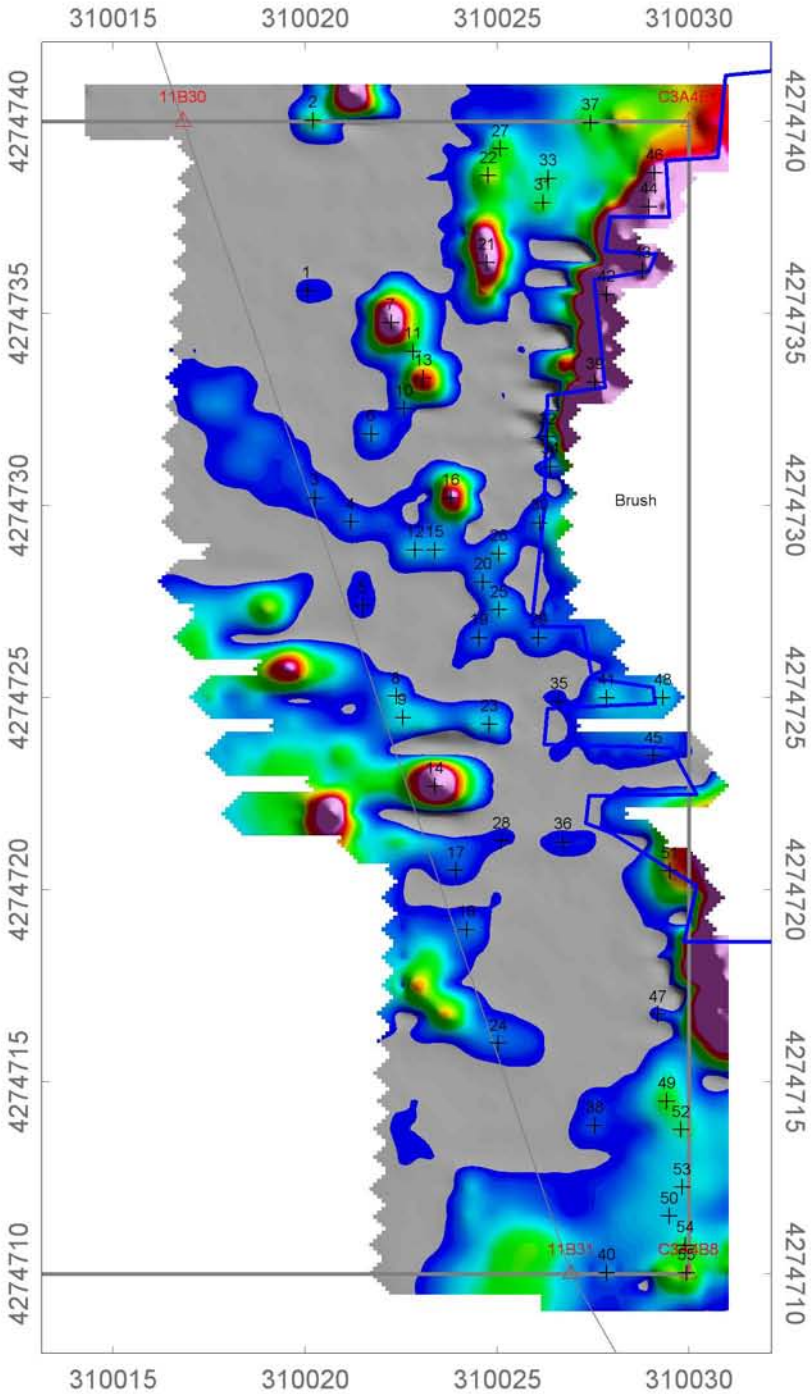
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4A7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4A8

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:197.026

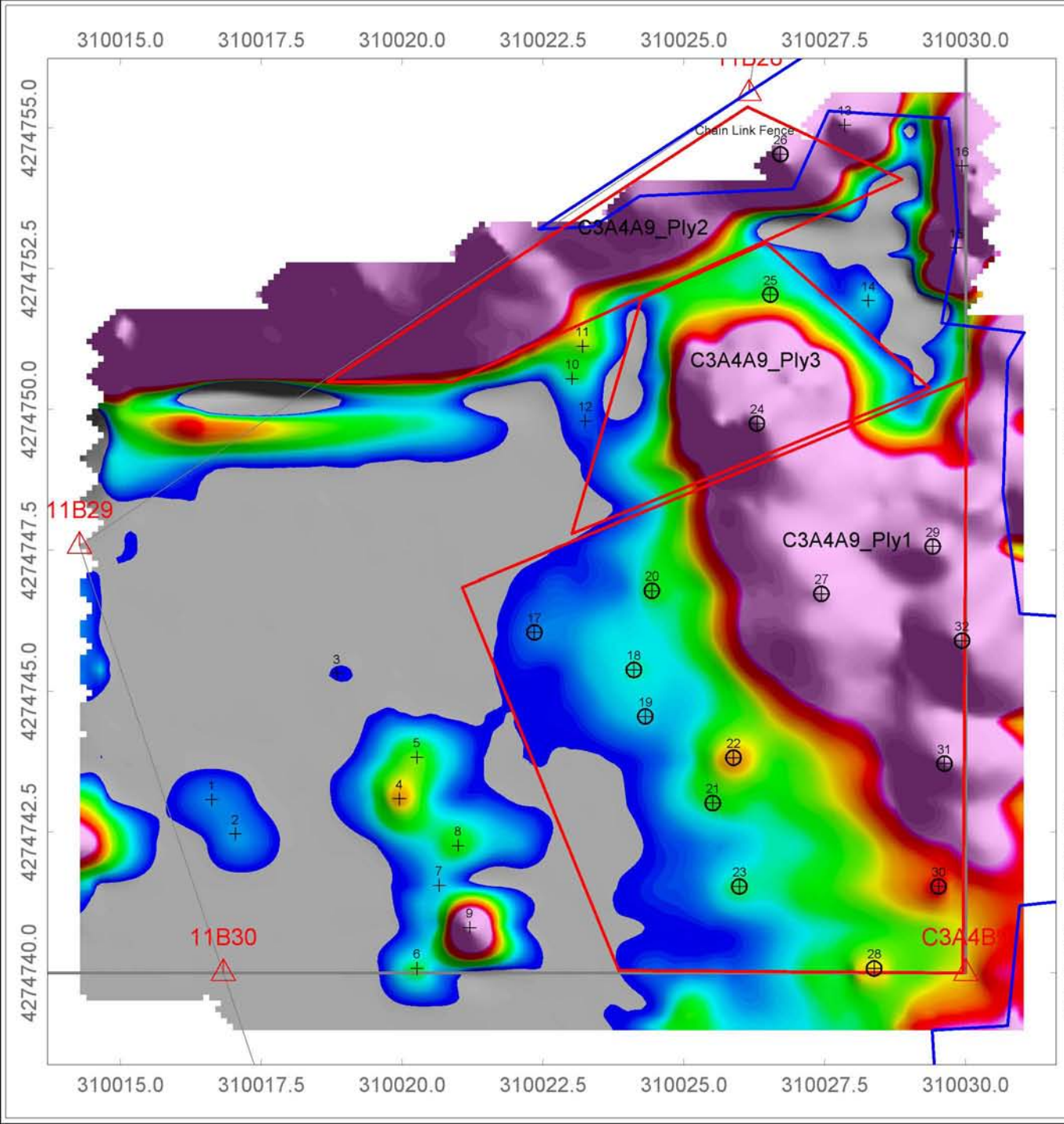
2.5 0 2.5 5
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4A8
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4A9

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:105.4499

2.5 0 2.5
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4A9
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

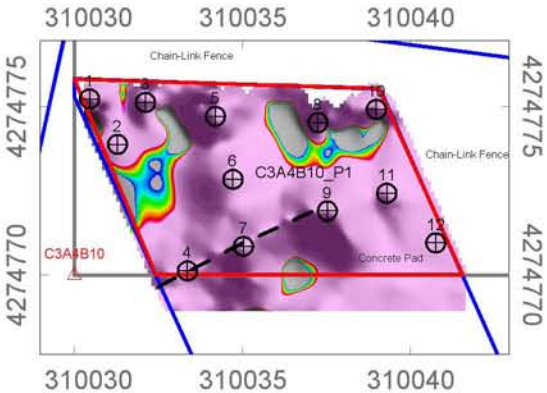
CH2MHILL ARM GEOPHYSICS

GRID C3A4B10

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV

3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

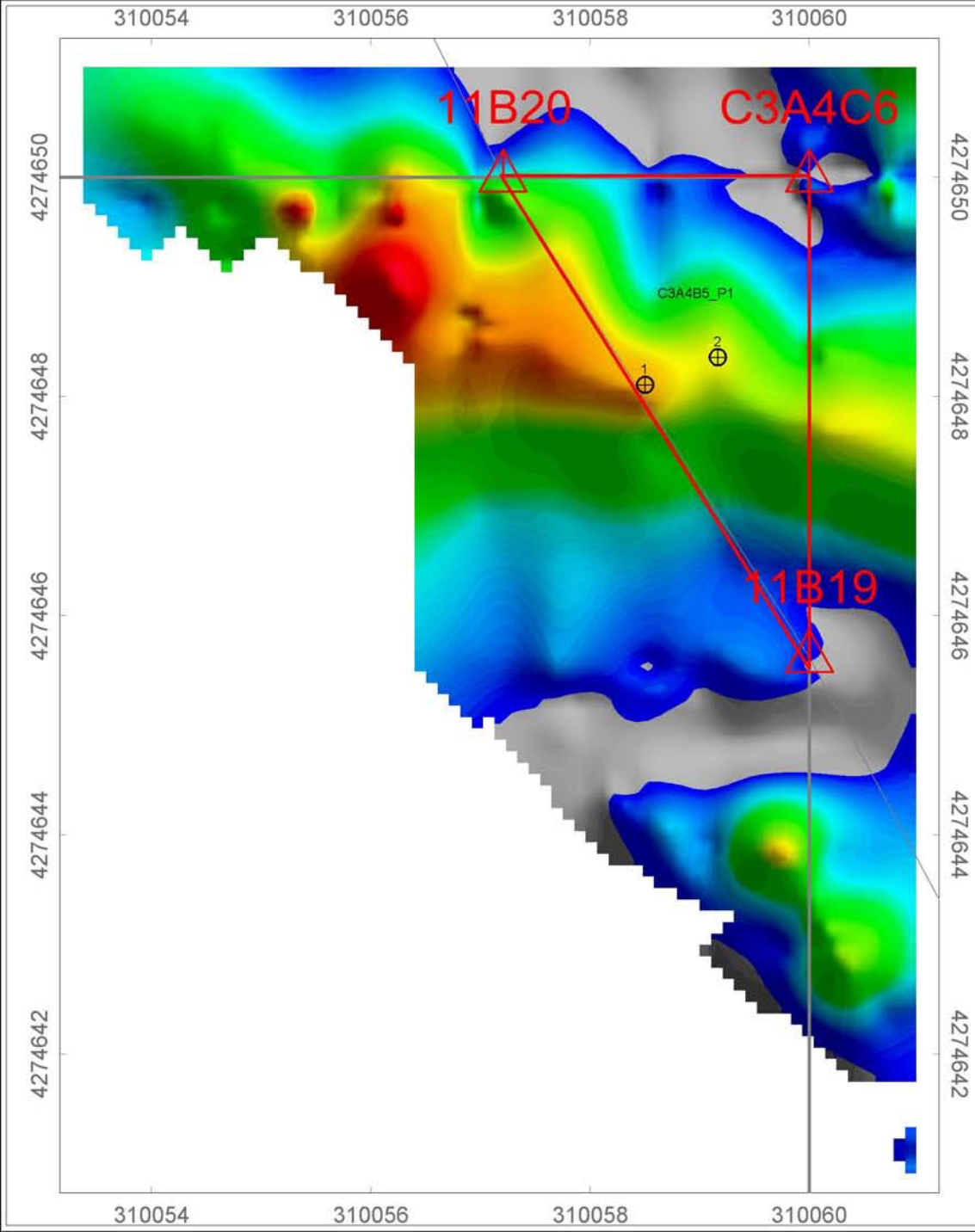
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-30-2010	File:	C3A4B10
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4B5

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

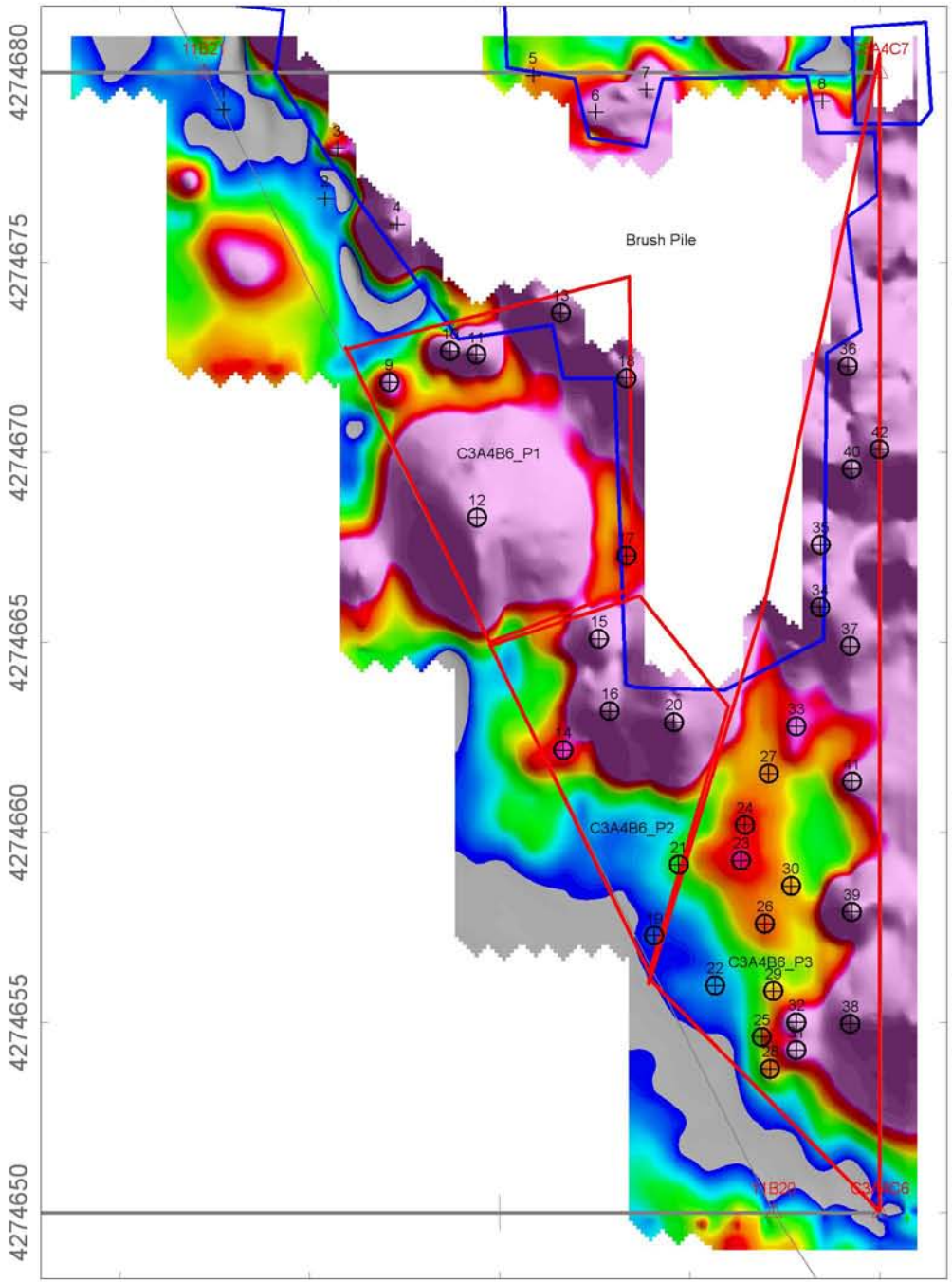
EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:59.38242

1 0 1
(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4B5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4B6

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:188.8361

2.5 0 2.5 5

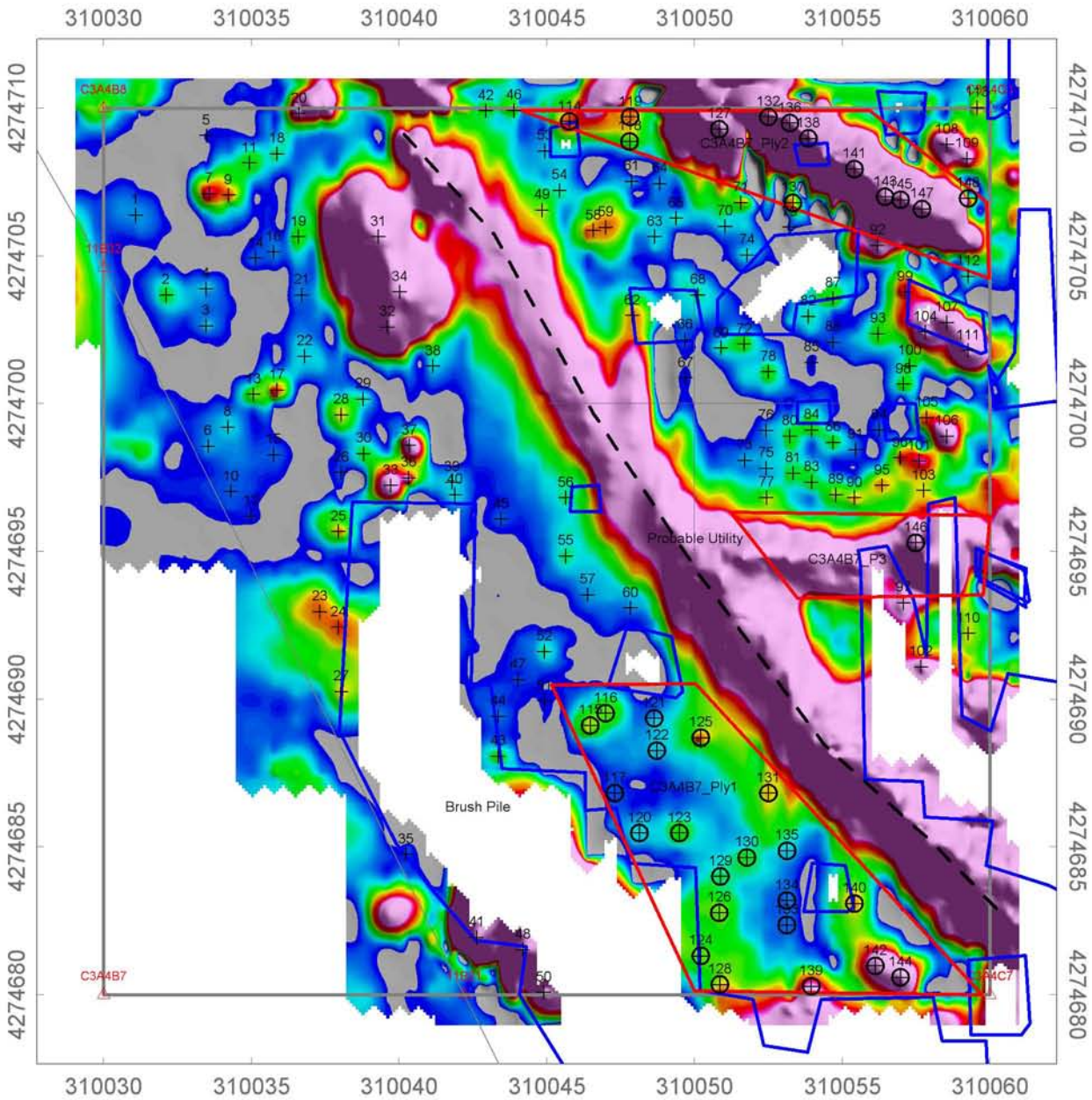
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4B6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4B7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

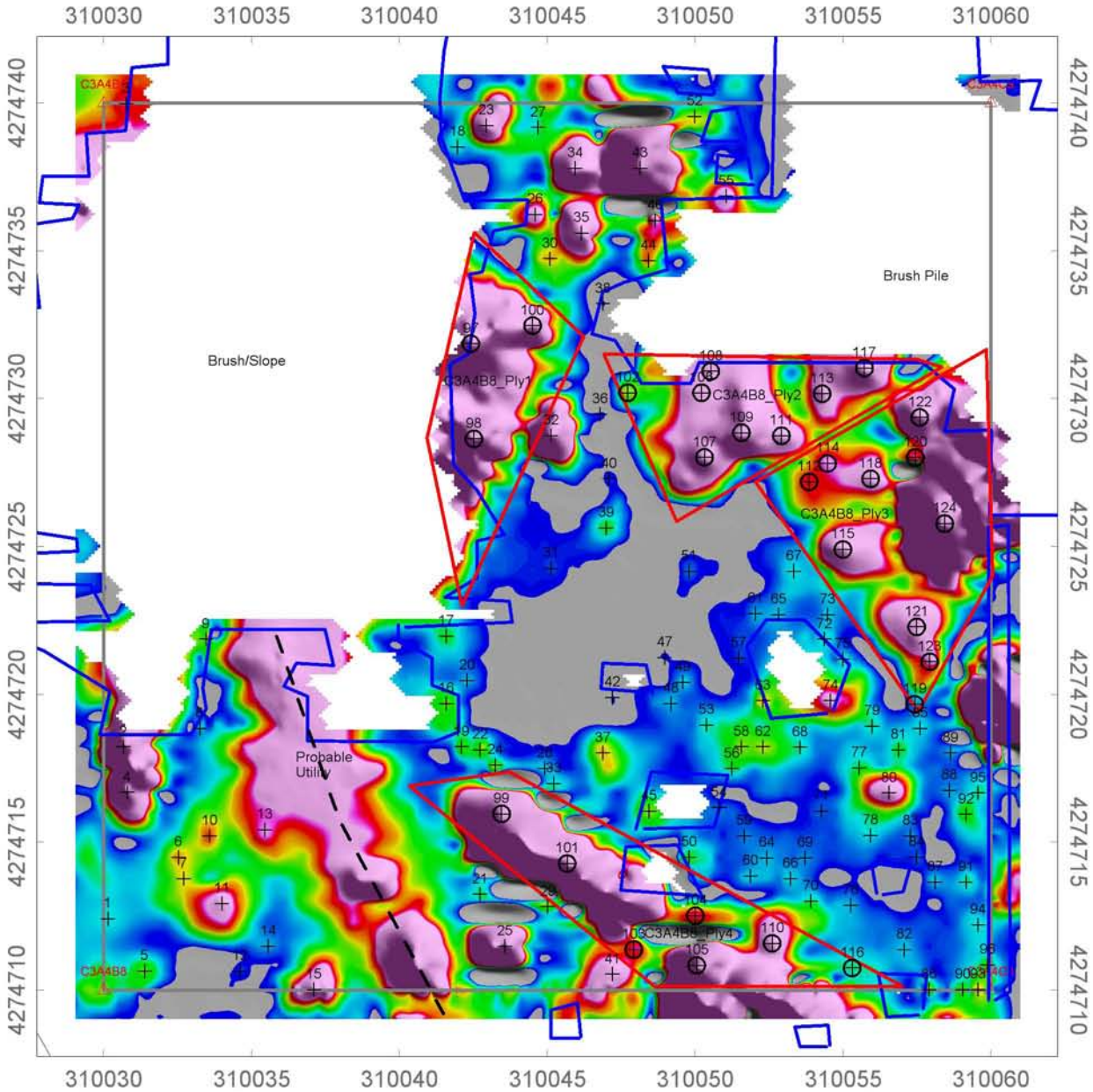
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4B7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4B8

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4B8
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

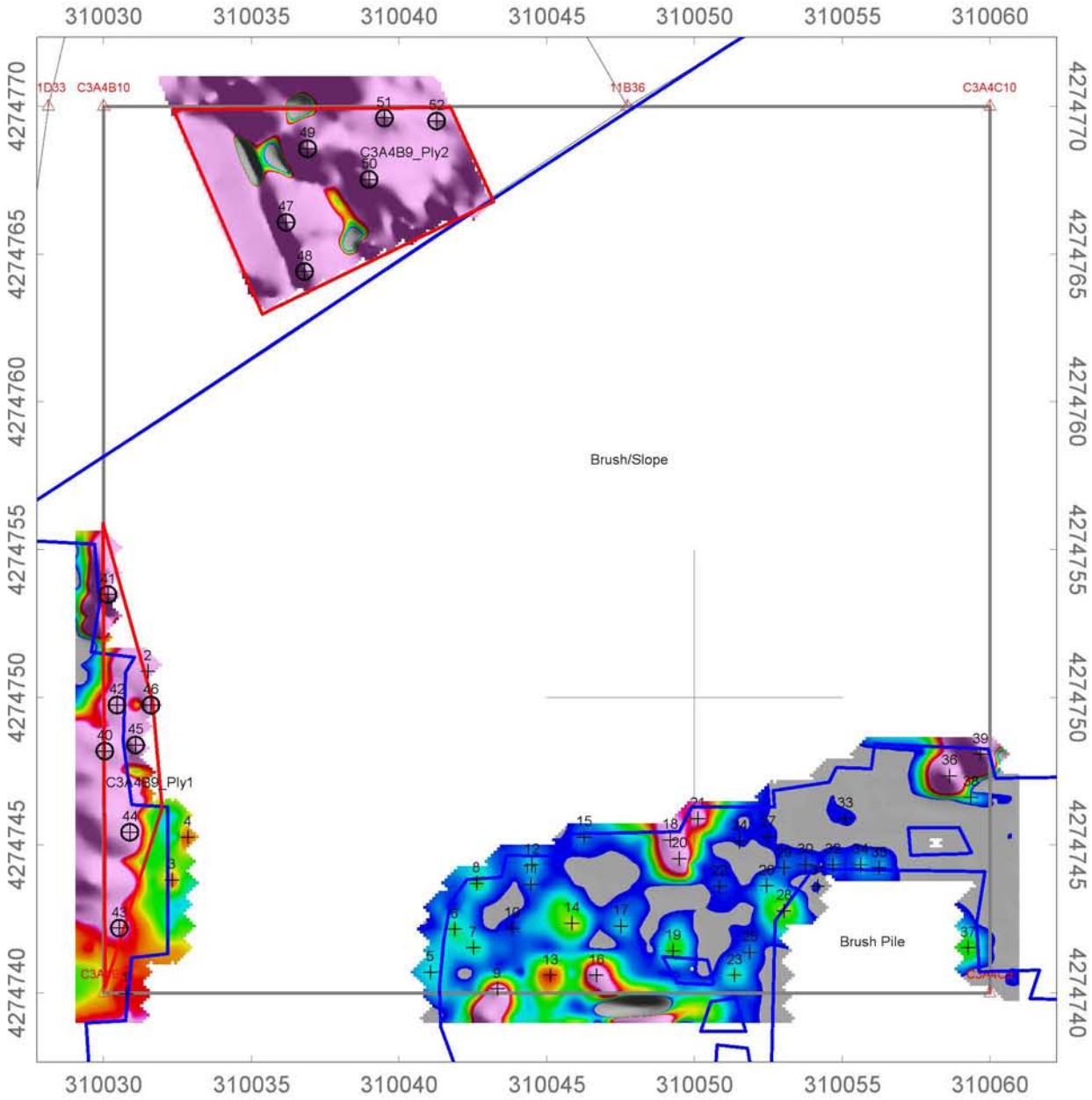
CH2MHILL ARM GEOPHYSICS

GRID C3A4B9

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4B9
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

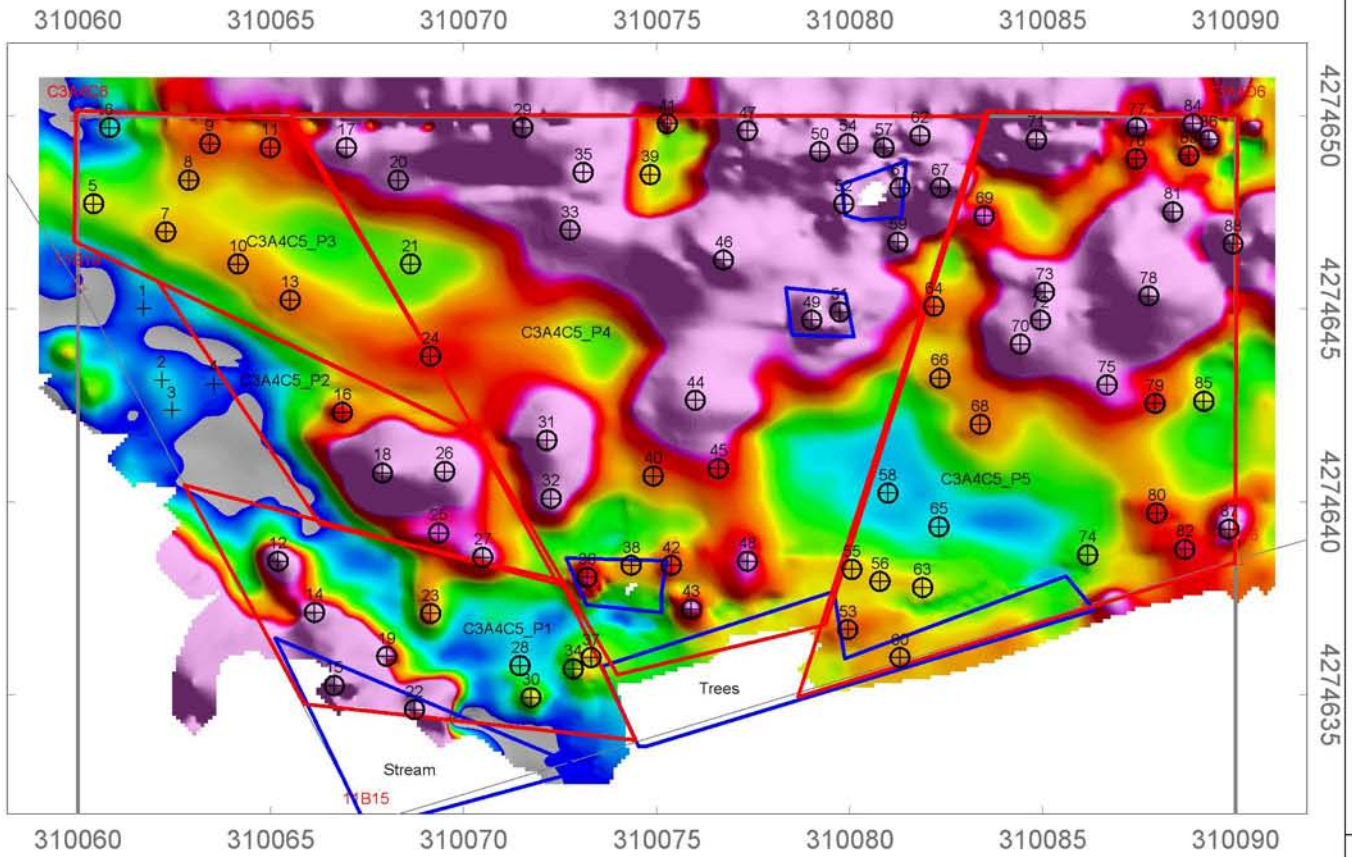
CH2MHILL ARM GEOPHYSICS

GRID C3A4C5

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:196.1302

2.5 0 2.5 5

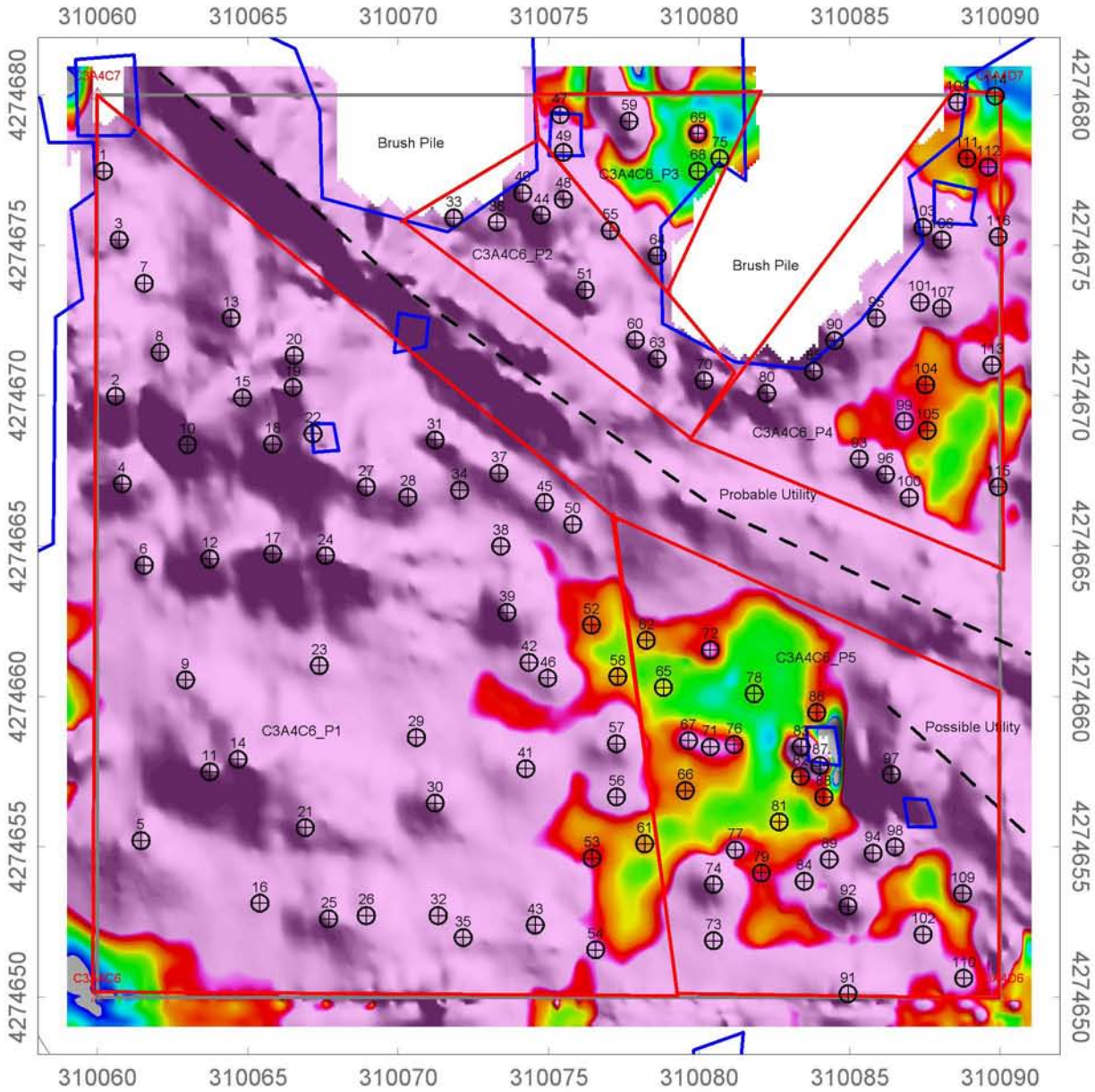
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IDW
Date:	Apr-26-2010	File:	C3A4C5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4C6

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

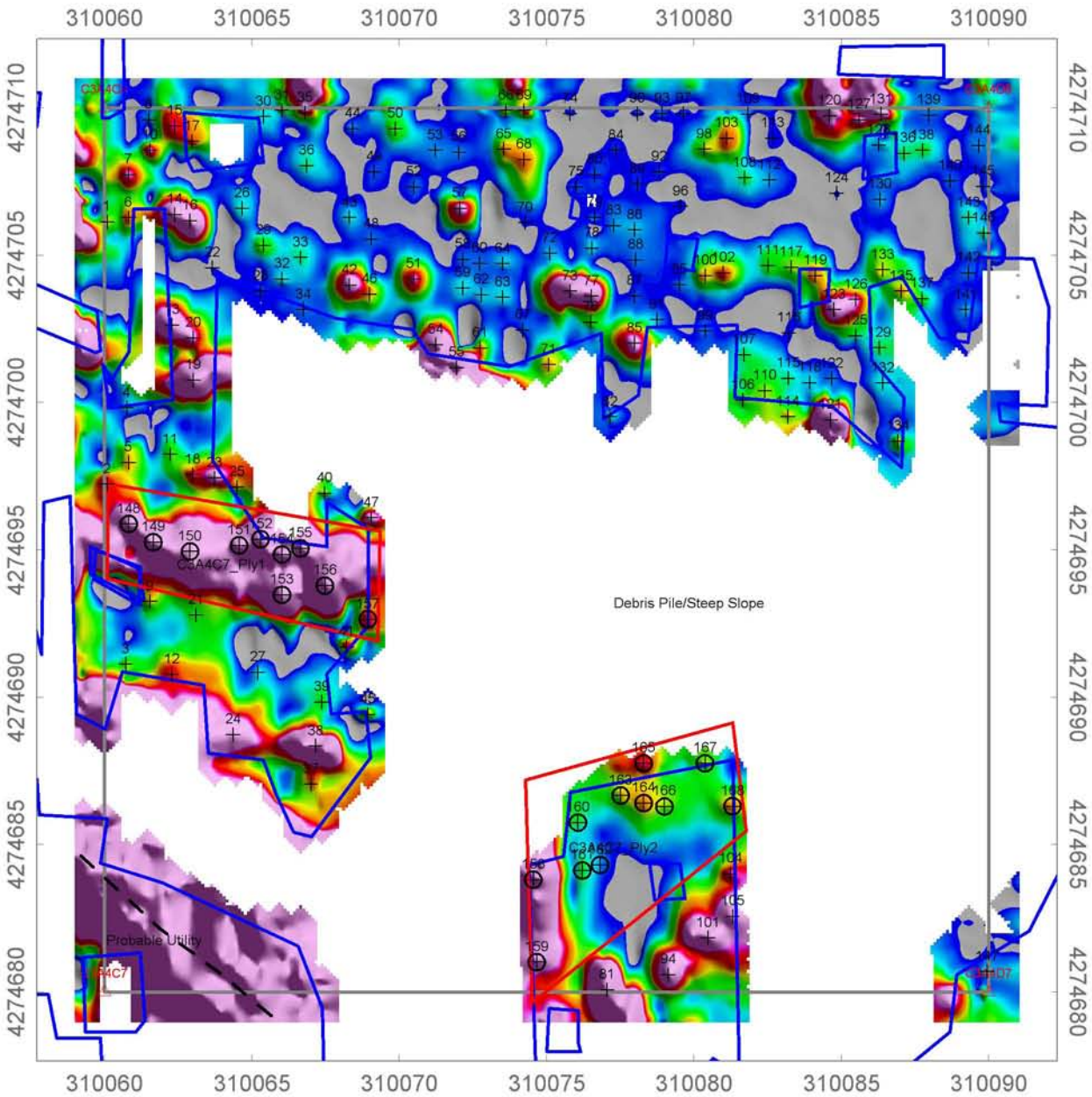
2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4C6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4C7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

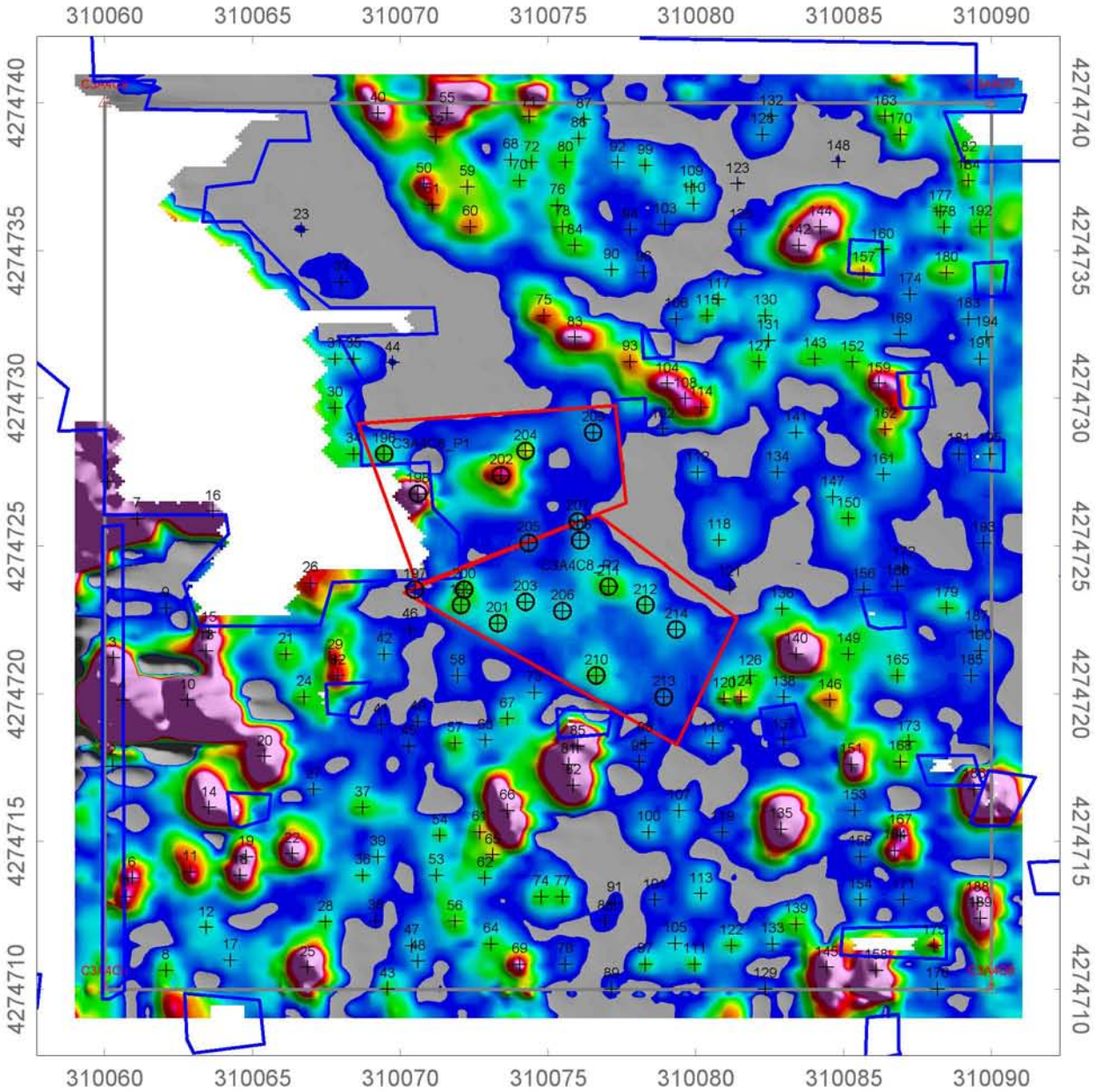
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4C7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4C8

EM Geophysical Survey

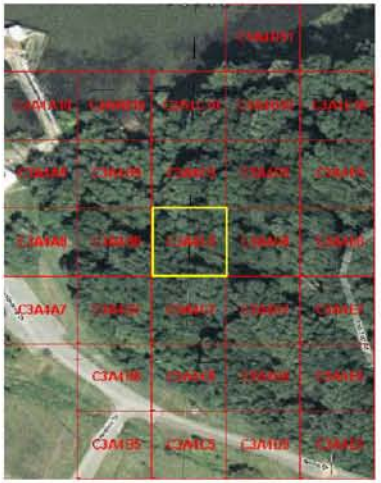
GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96



Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4C8
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

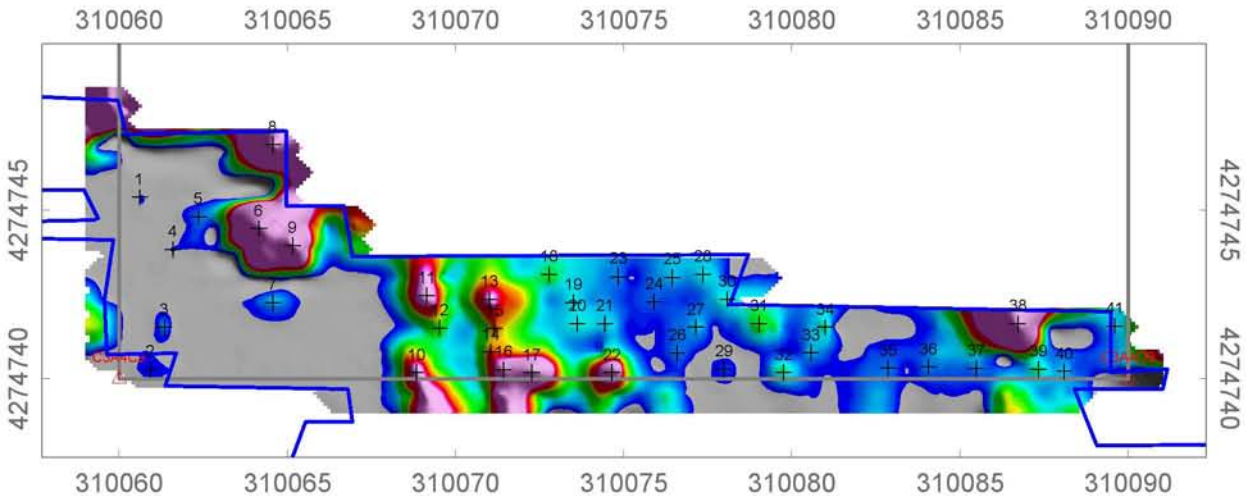
CH2MHILL ARM GEOPHYSICS

GRID C3A4C9

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4C9
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

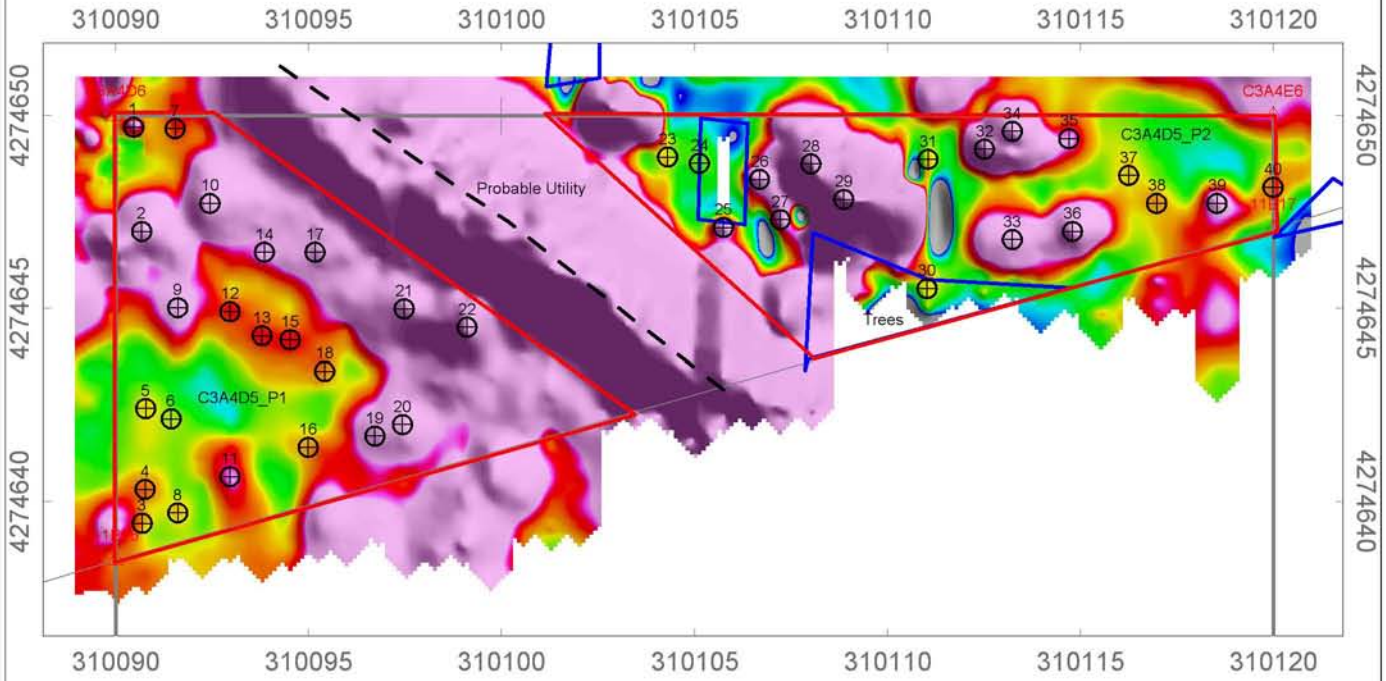
CH2MHILL ARM GEOPHYSICS

GRID C3A4D5

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV

3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:196.1302

2.5 0 2.5 5

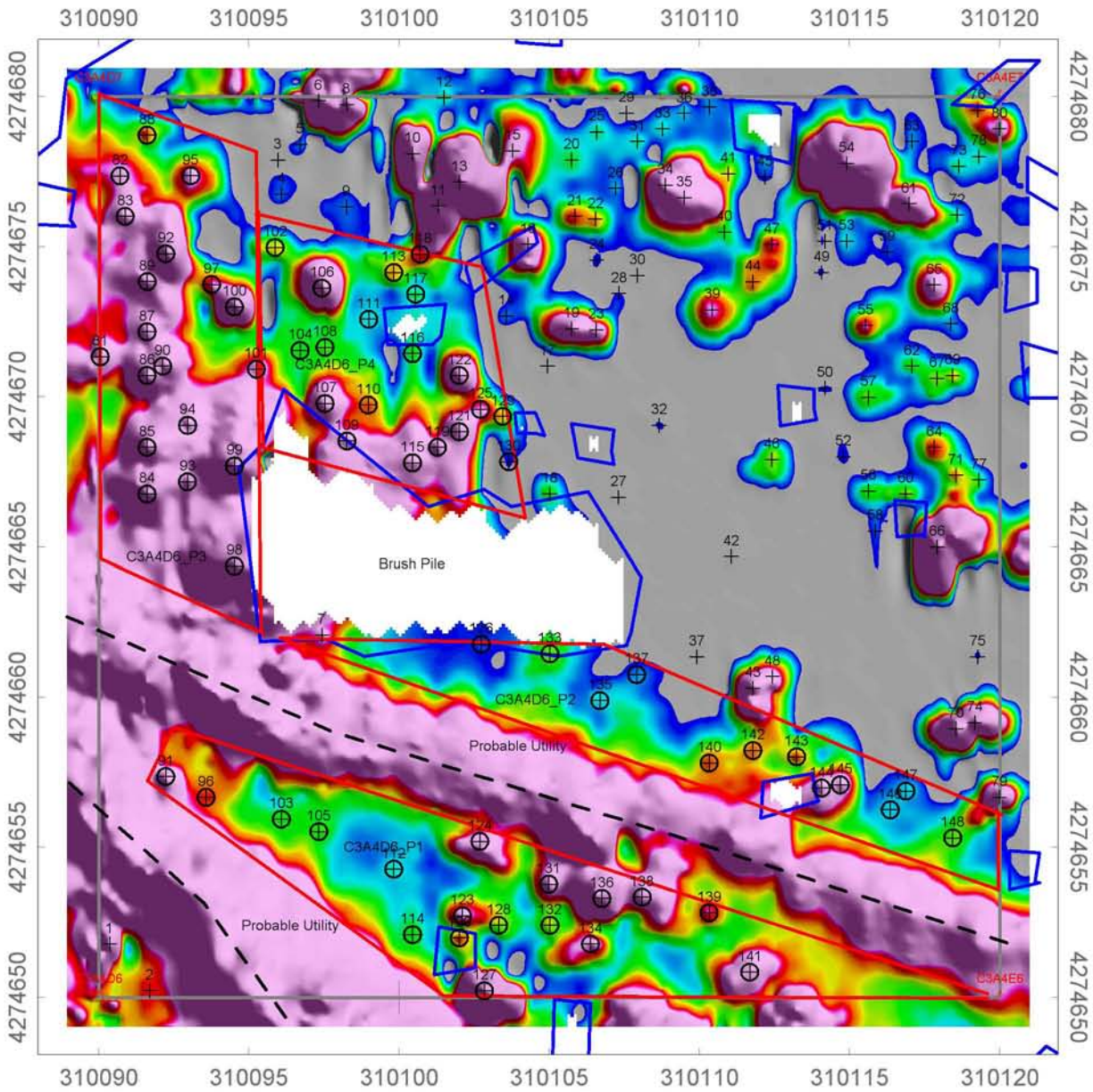
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4D5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4D6

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

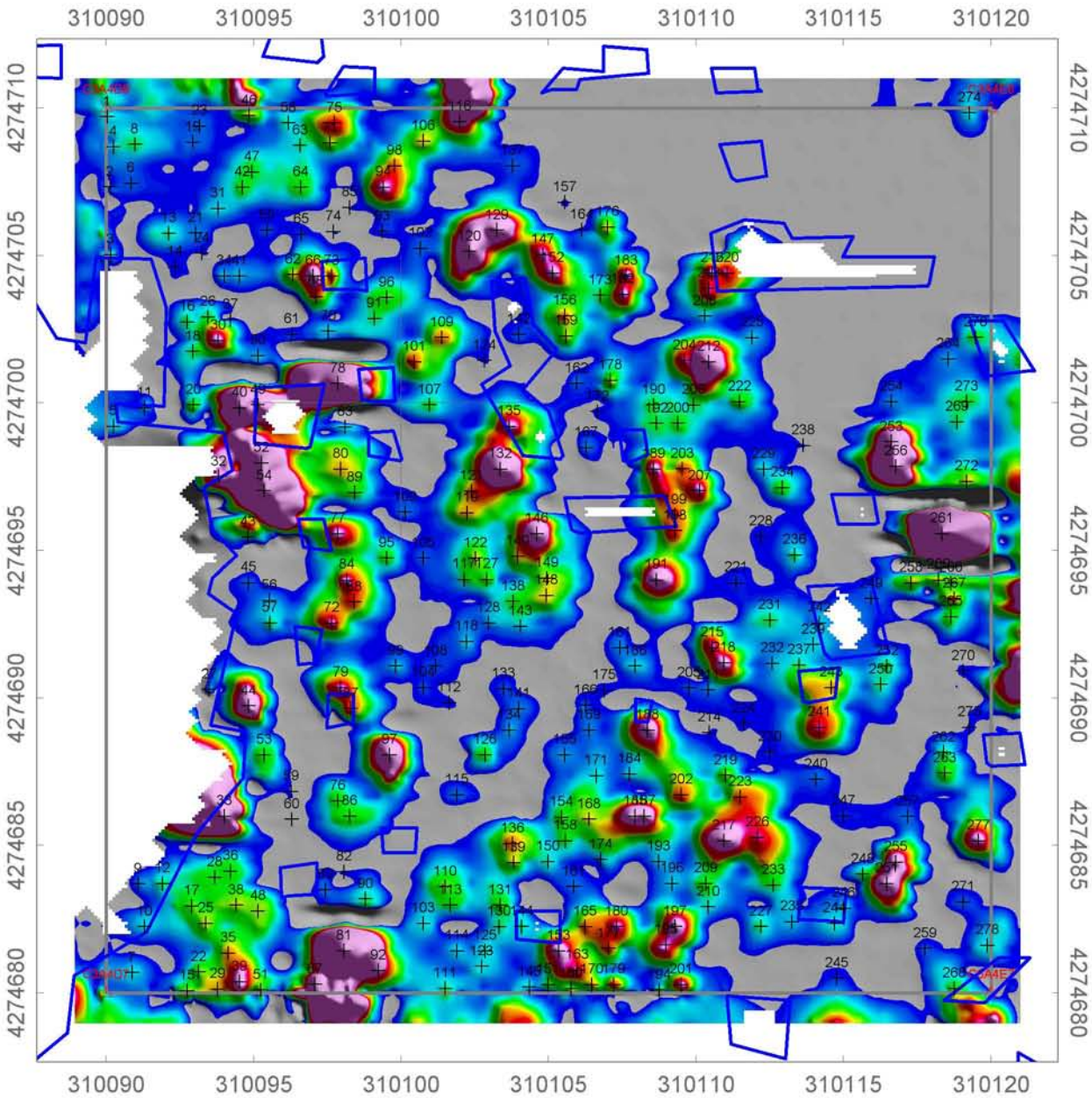
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4D6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4D7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

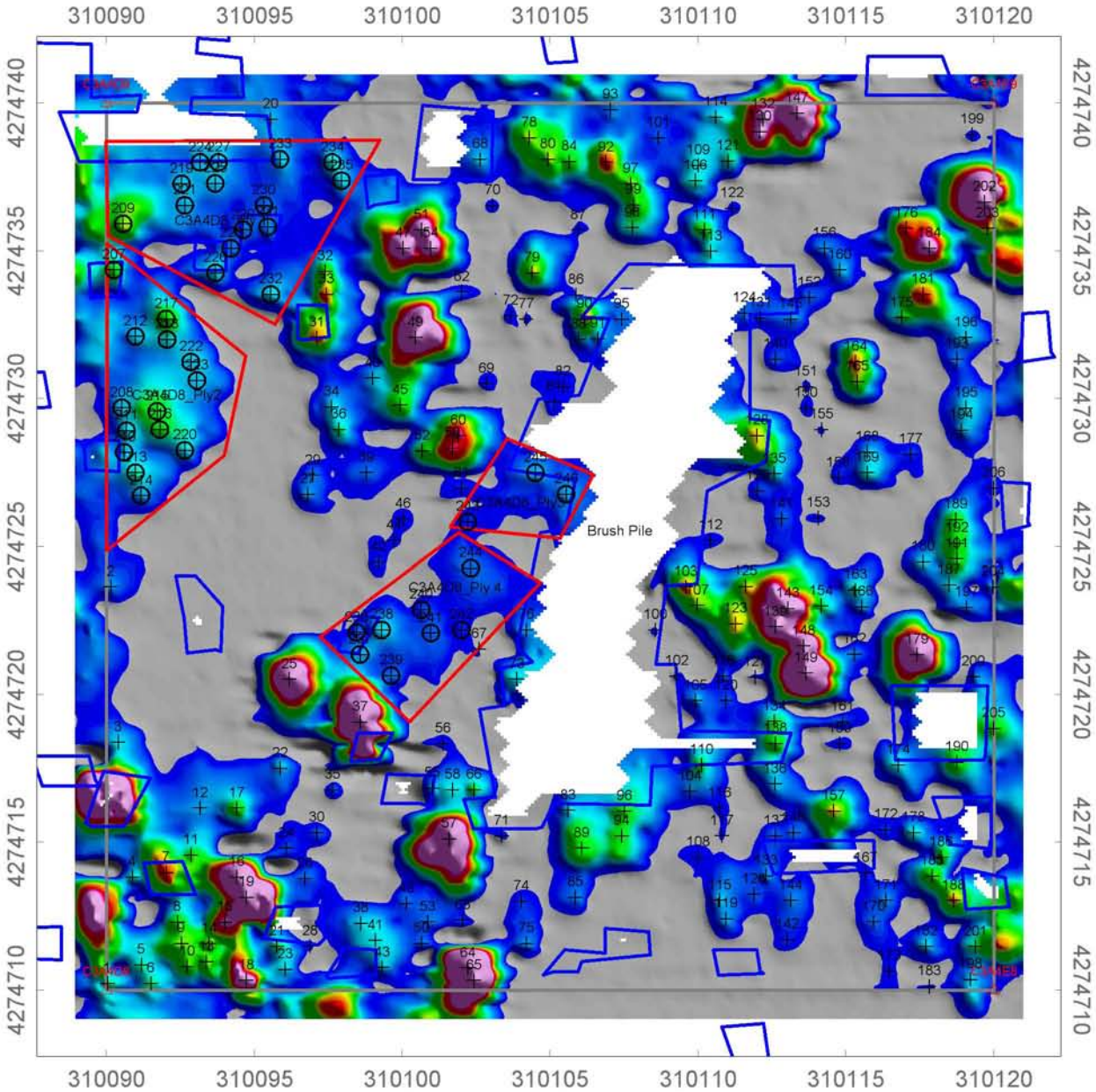
2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4D7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4D8

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

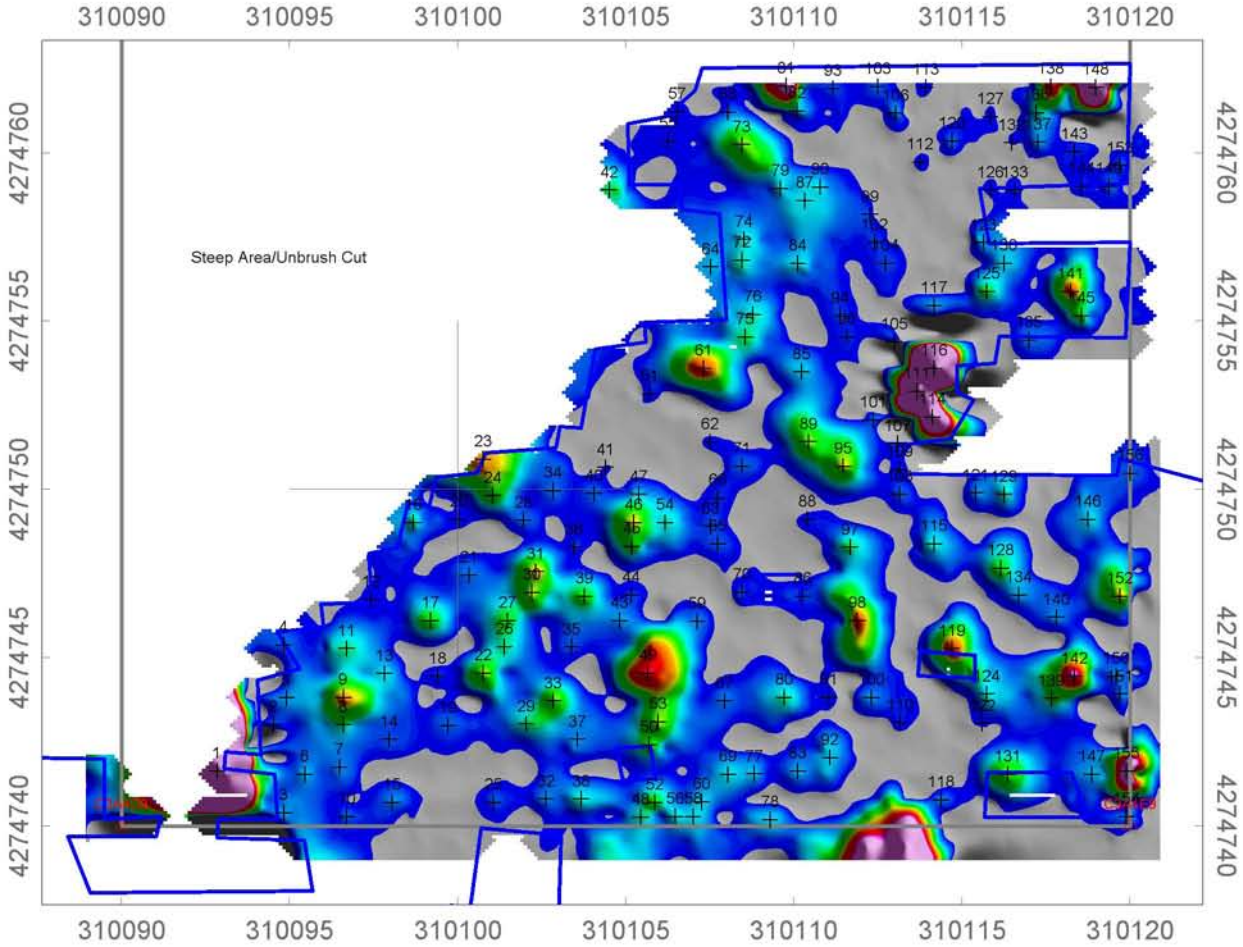
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4D8
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4D9

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

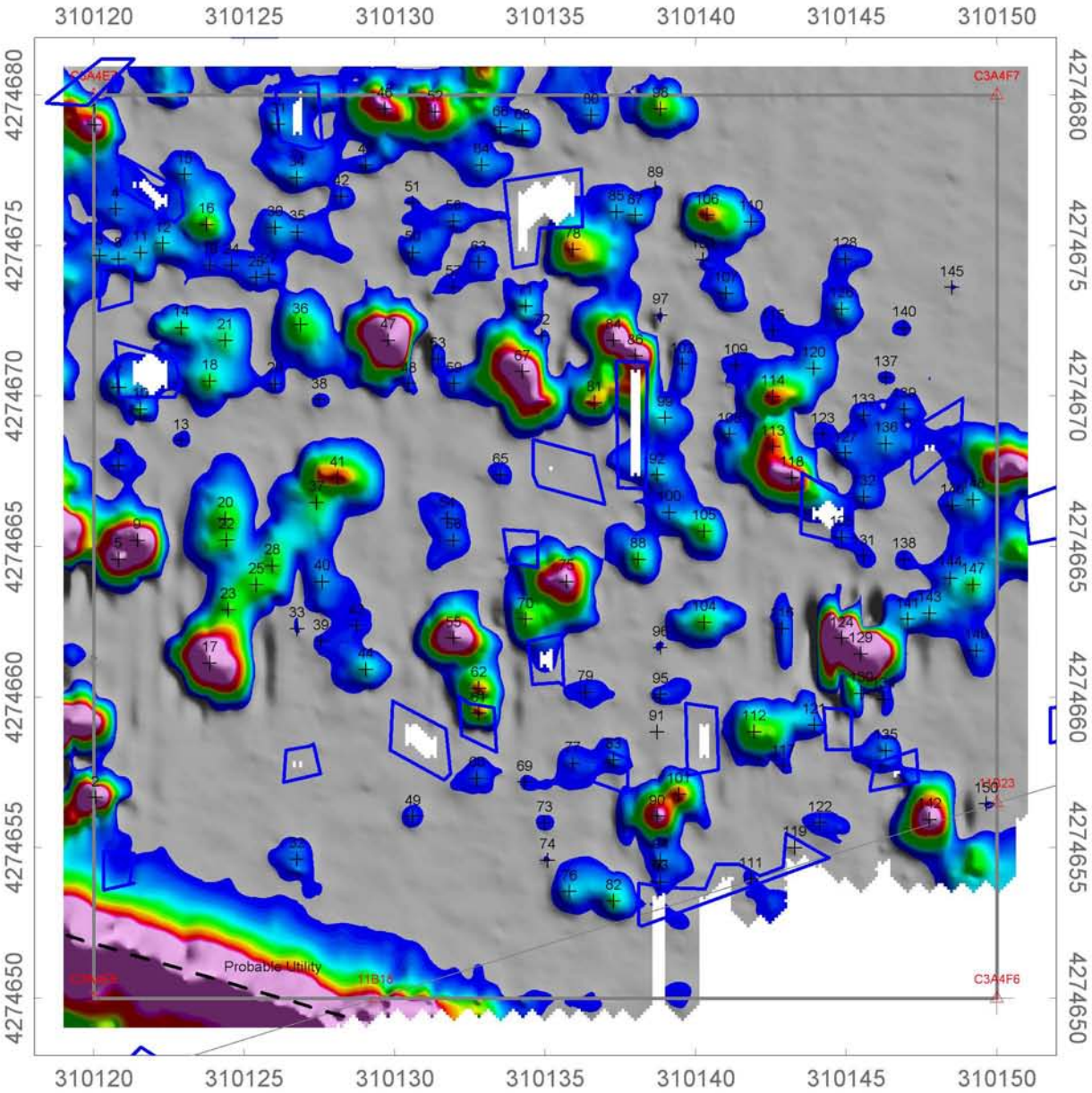
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4D9
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4E6

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

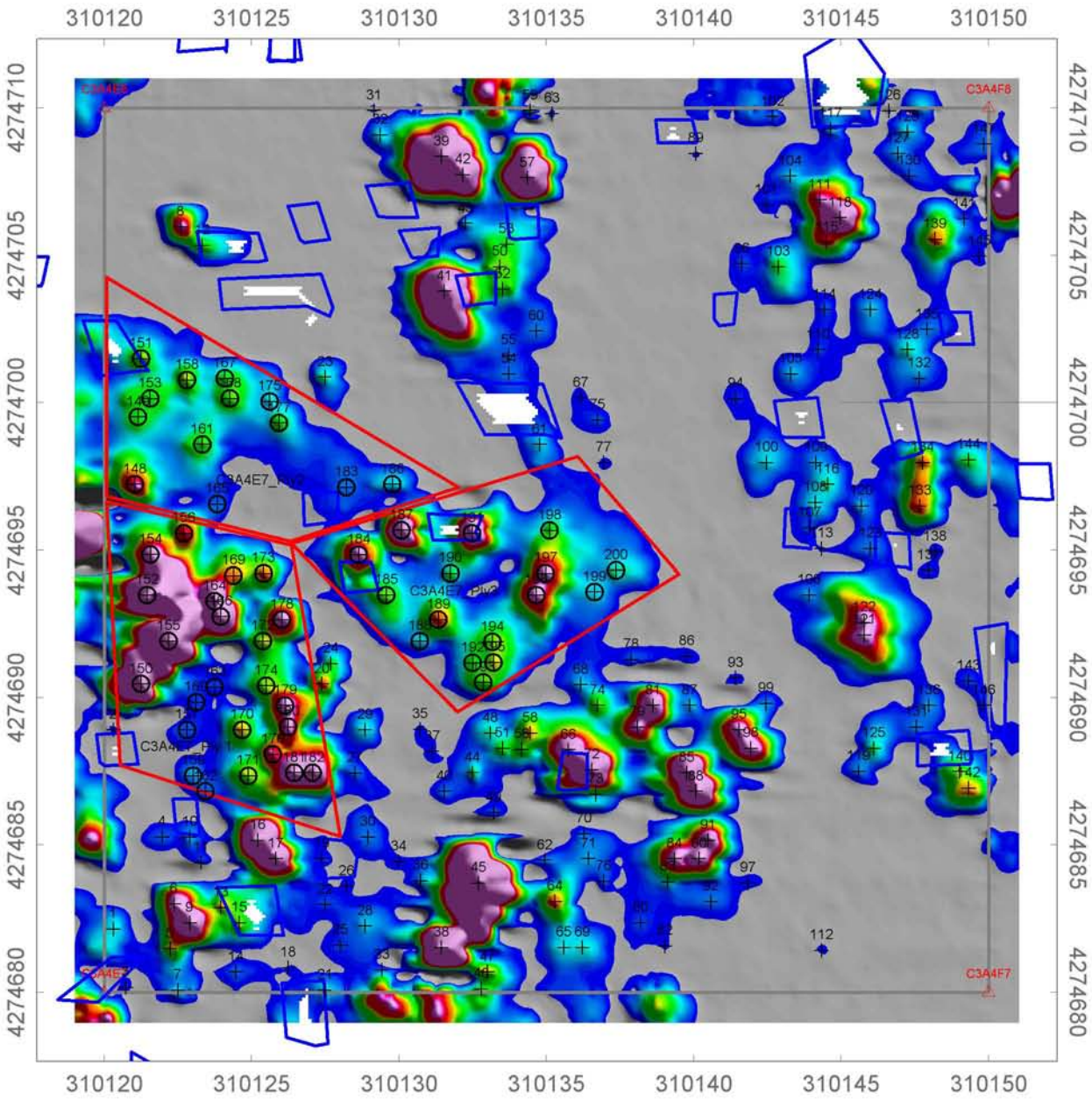
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4E6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4E7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

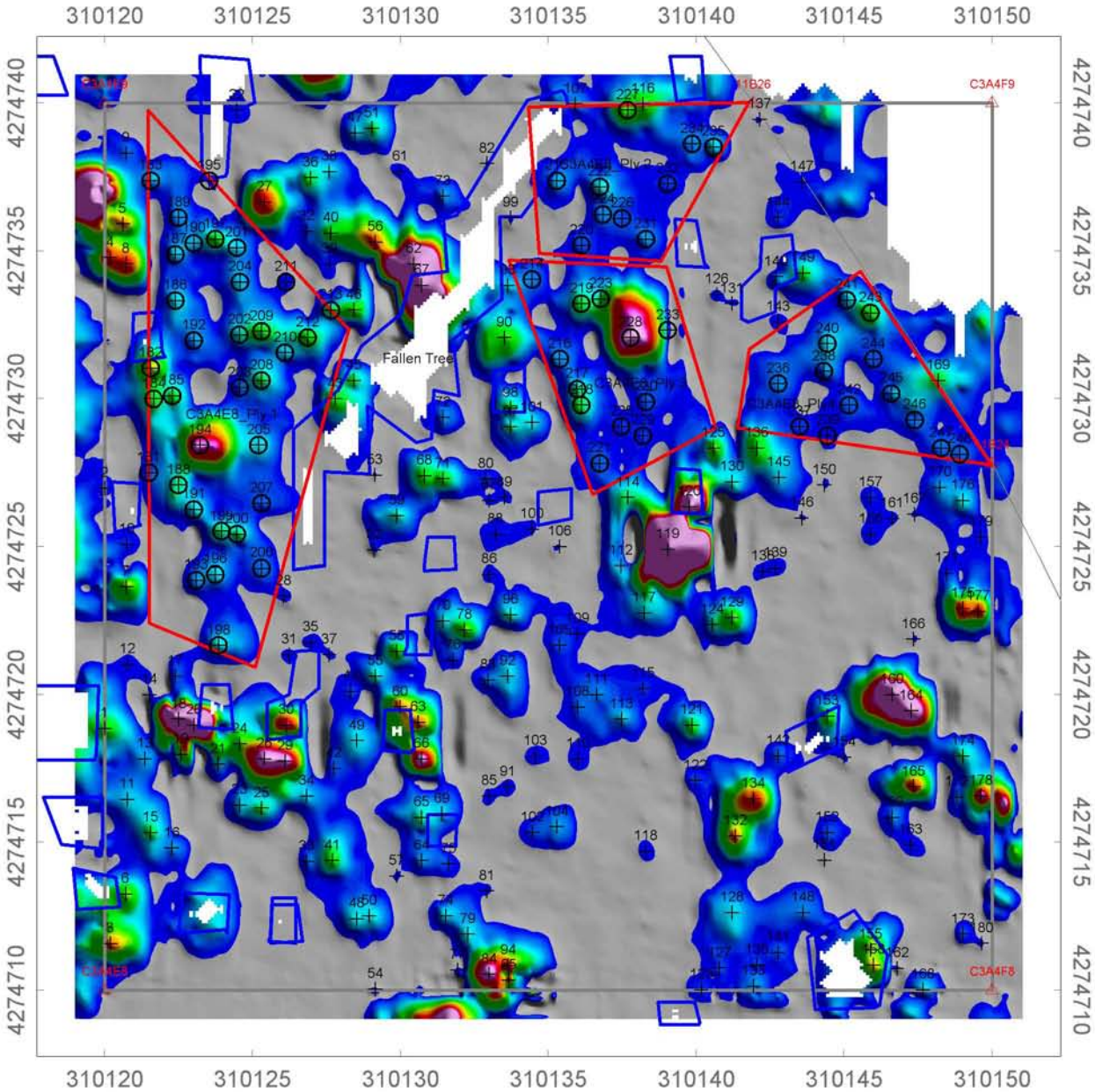
2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4E7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4E8

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

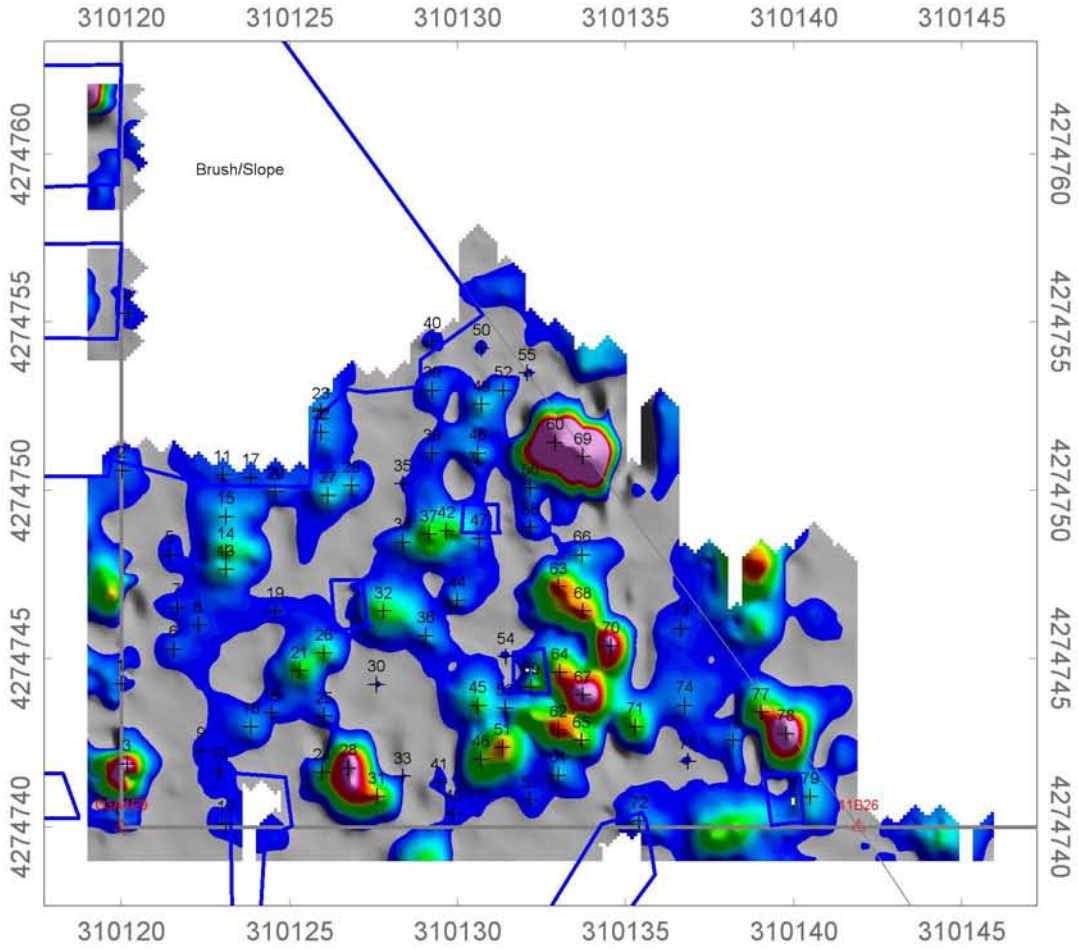
2.5 0 2.5 5 7.5
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4E8
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4E9

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

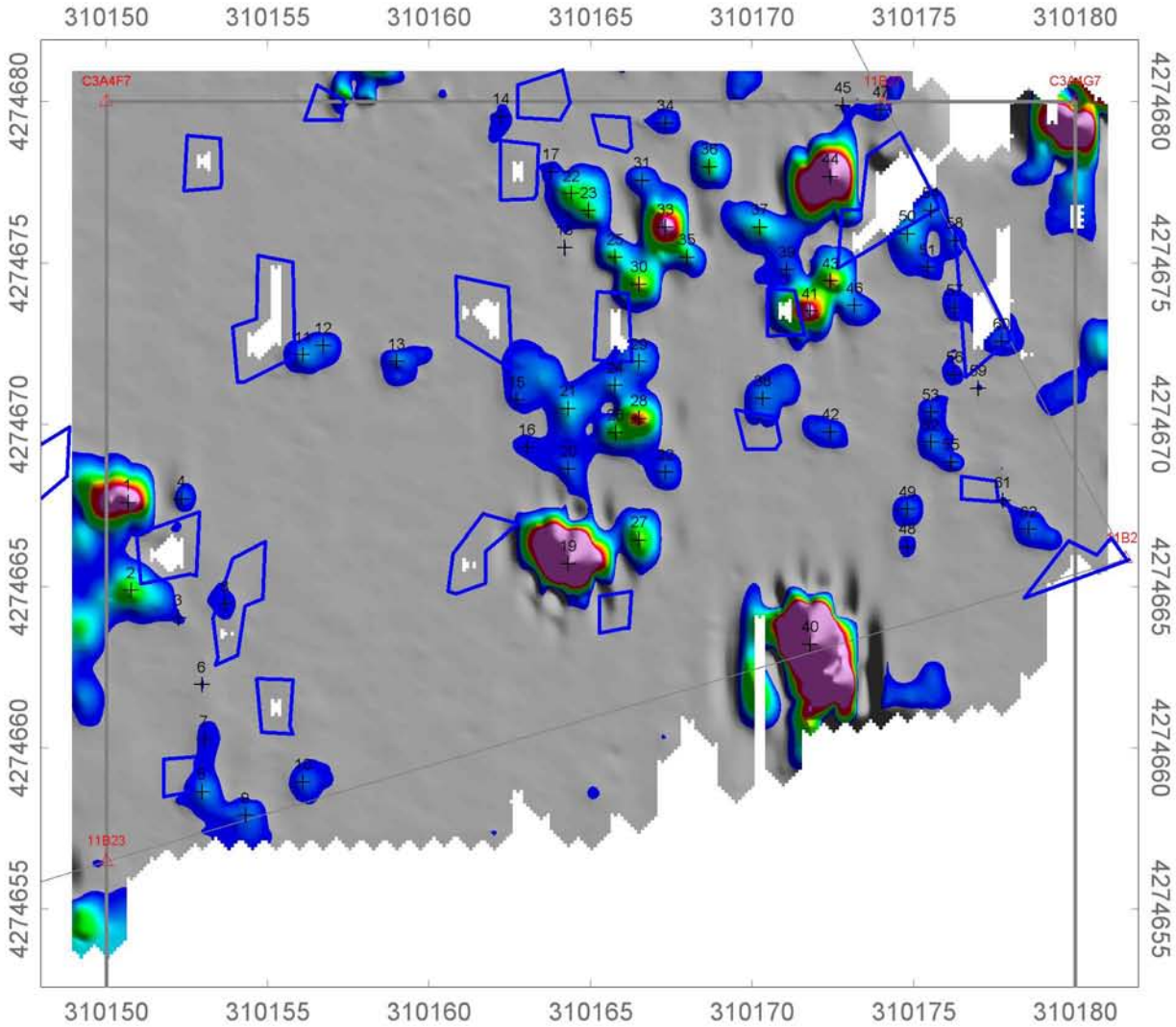
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IDW
Date:	Apr-27-2010	File:	C3A4E9
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4F6

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

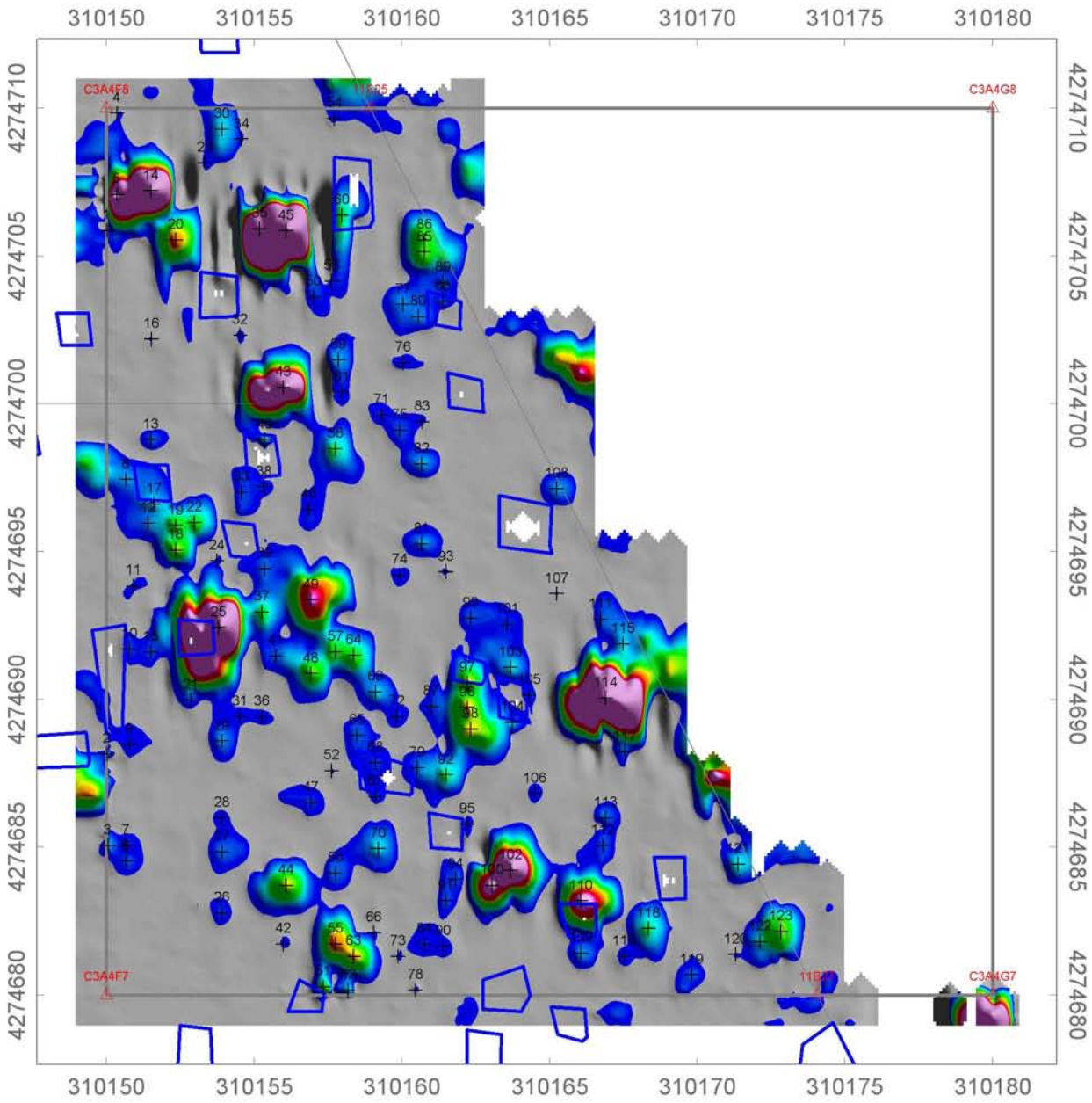
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4F6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4F7

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

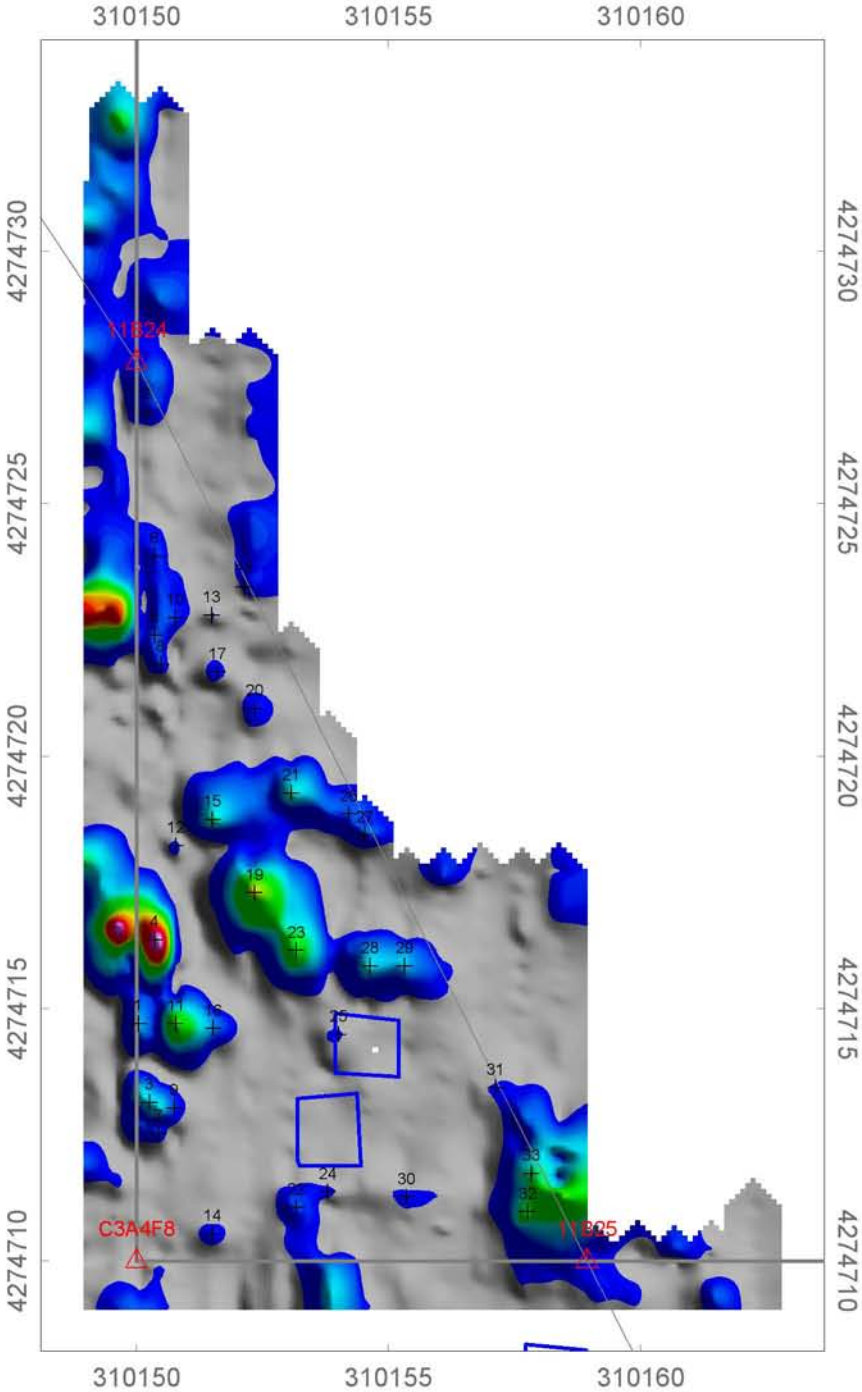
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4F7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4F8

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:149.938

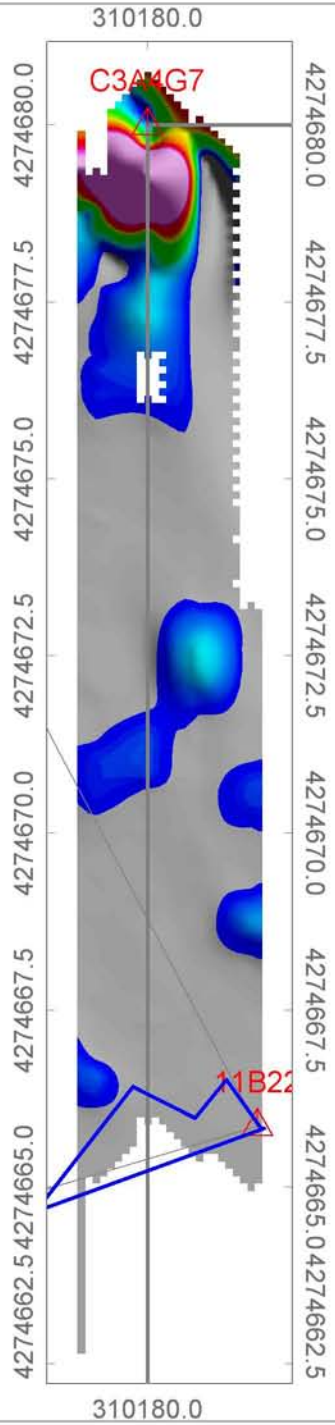
2.5 0 2.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4F8
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4G6

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:106.8884

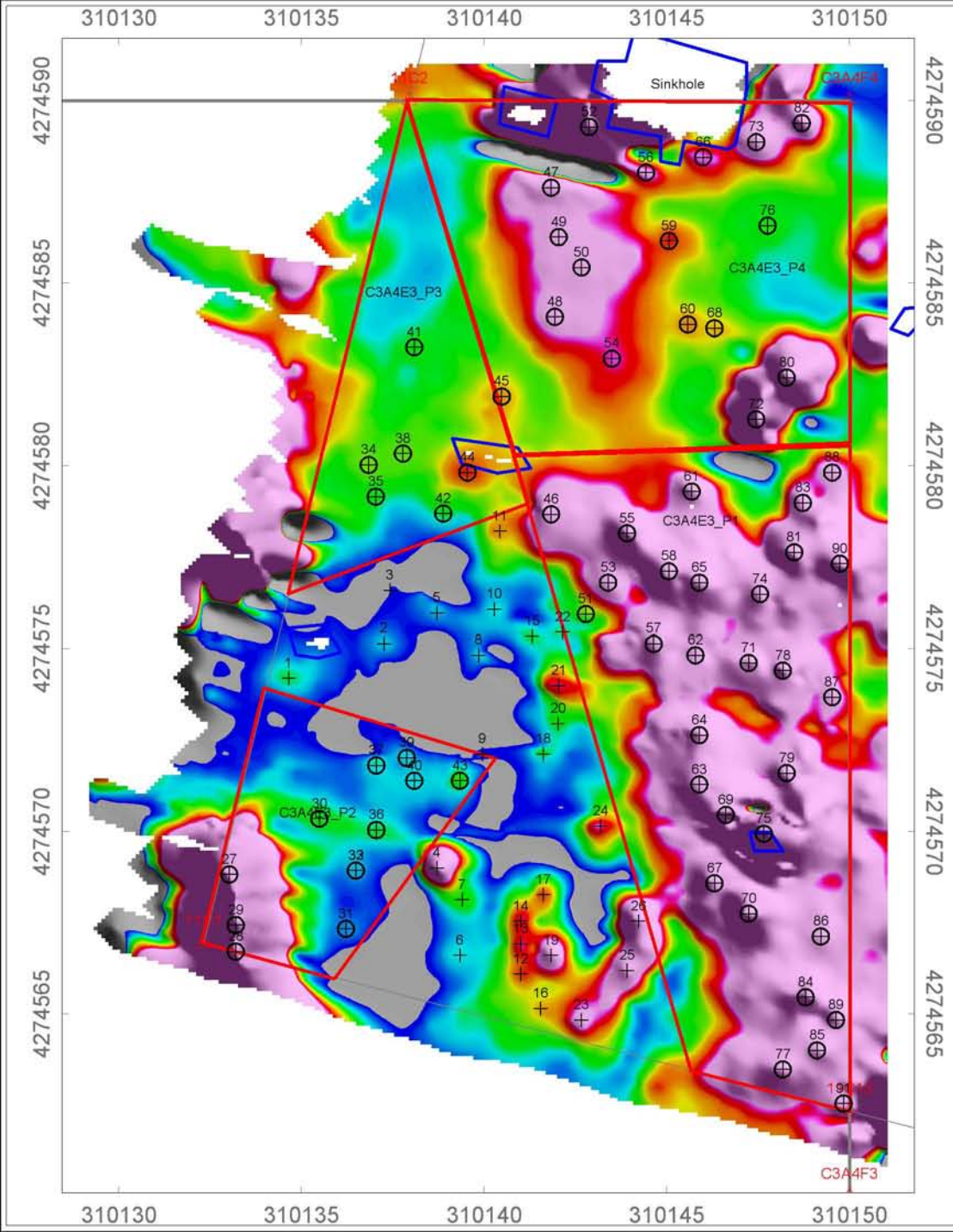
2.5 0 2.5
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4G6
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4E3

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

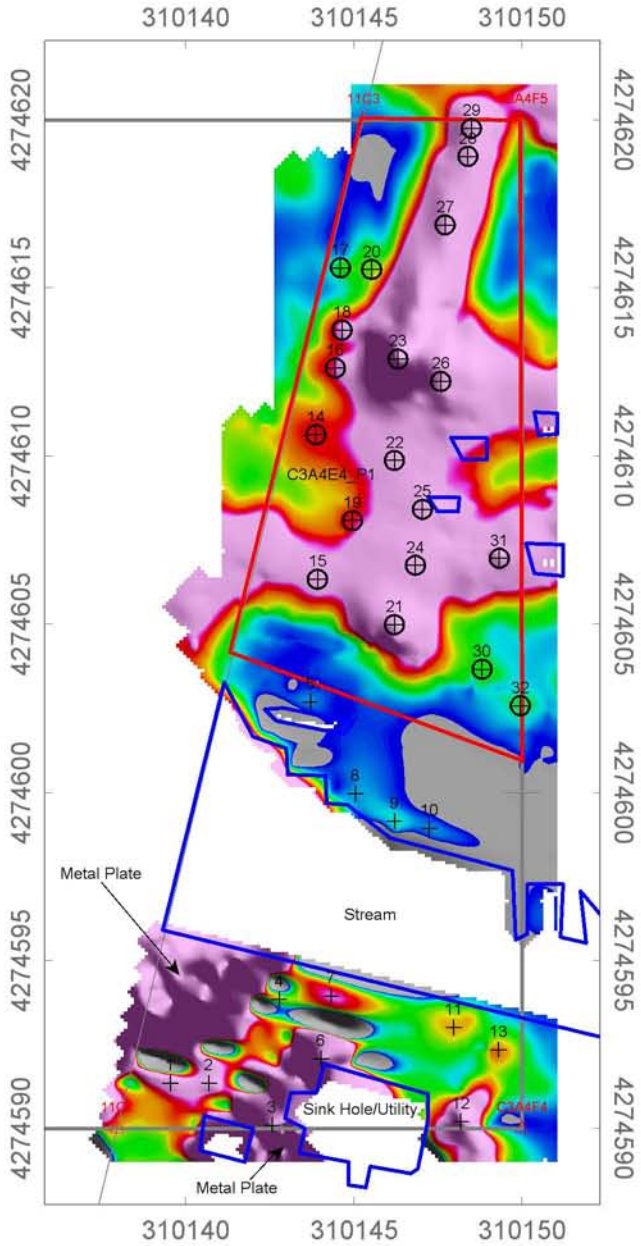
EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:178.1473

2.5 0 2.5 5
(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	BSB
Date:	Apr-26-2010	File:	C3A4E3
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4E4

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

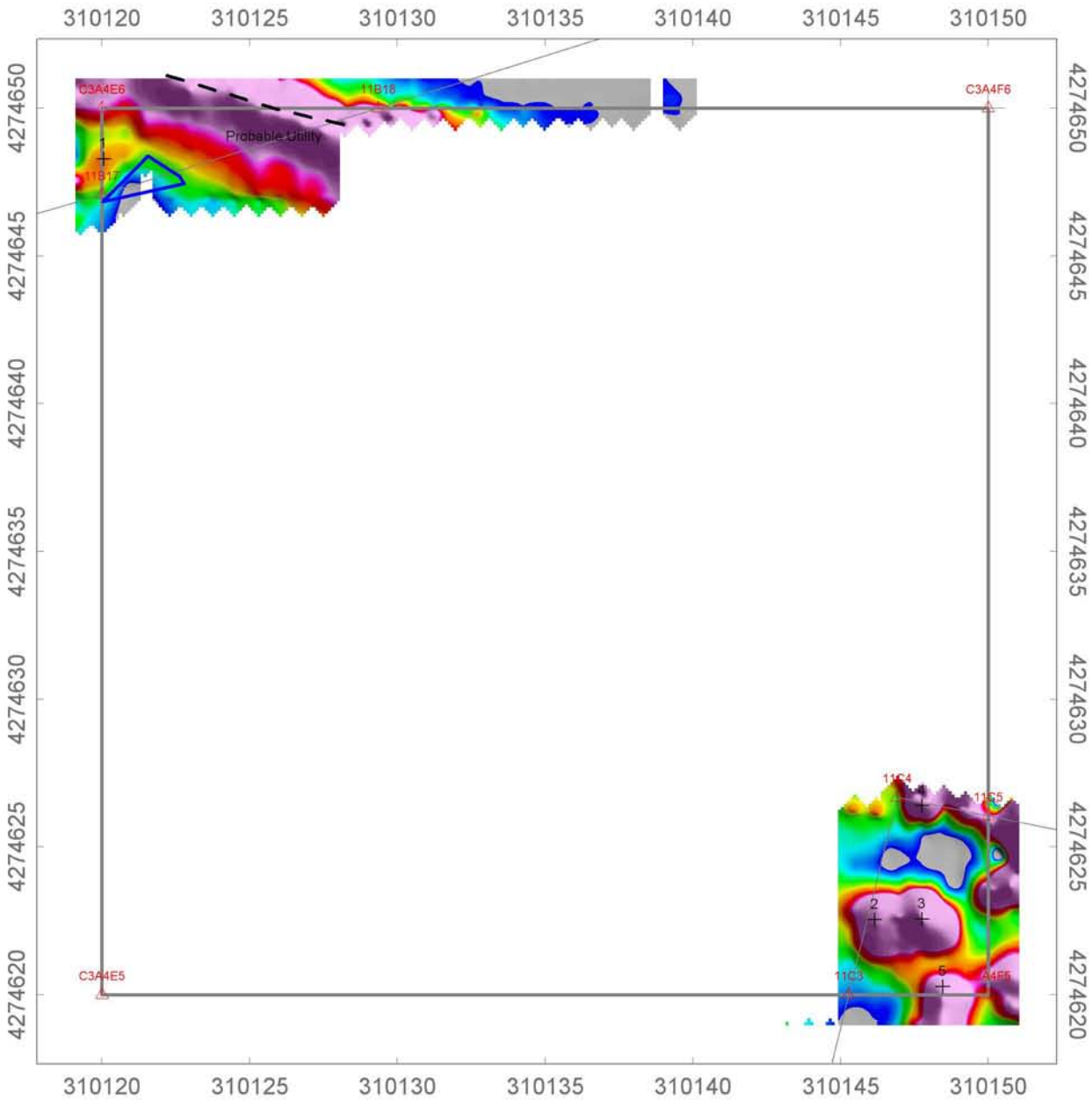
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IDW
Date:	Apr-27-2010	File:	C3A4E4
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4E5

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

N

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IDW
Date:	Apr-27-2010	File:	C3A4E5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

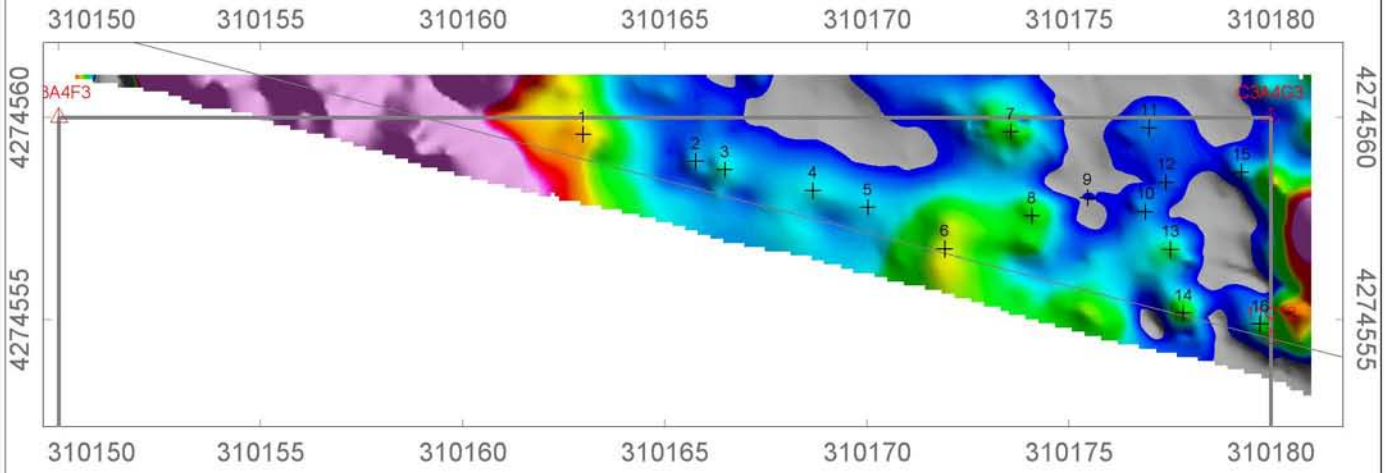
CH2MHILL ARM GEOPHYSICS

GRID C3A4F2

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV

3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

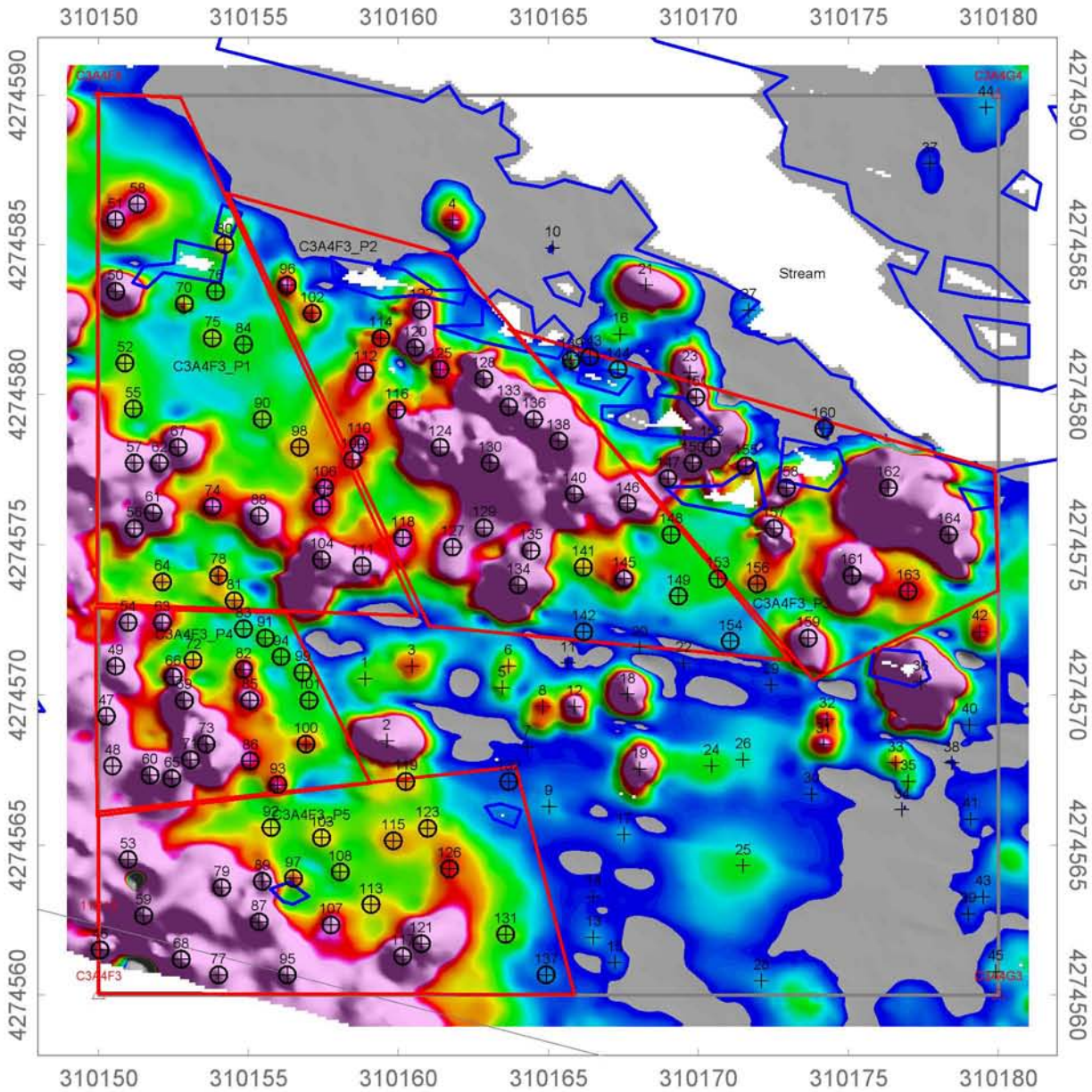
Scale 1:187.2236

2.5 0 2.5 5

(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4F2
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4F3

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

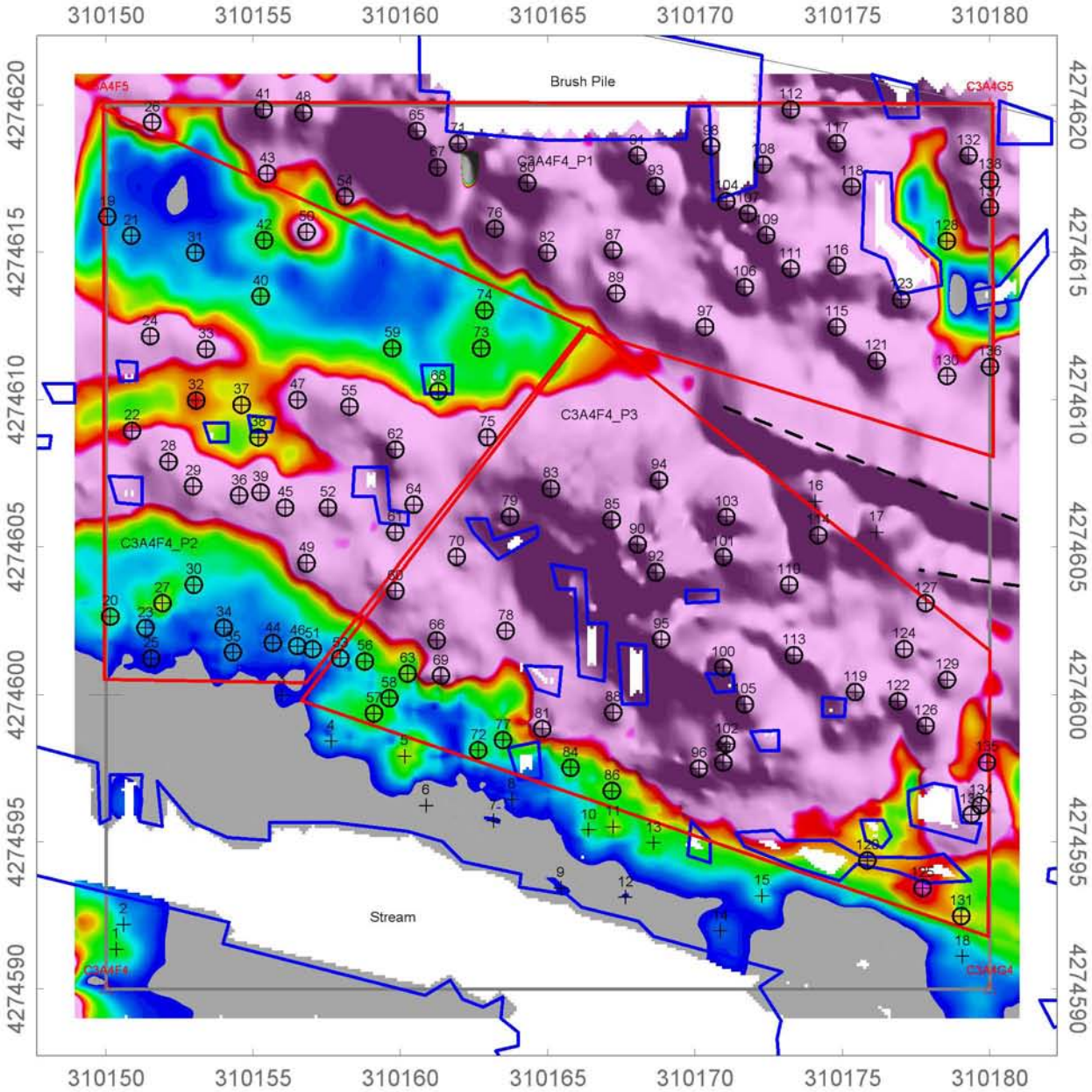
EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5
(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IDW
Date:	Apr-26-2010	File:	C3A4F3
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4F4

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

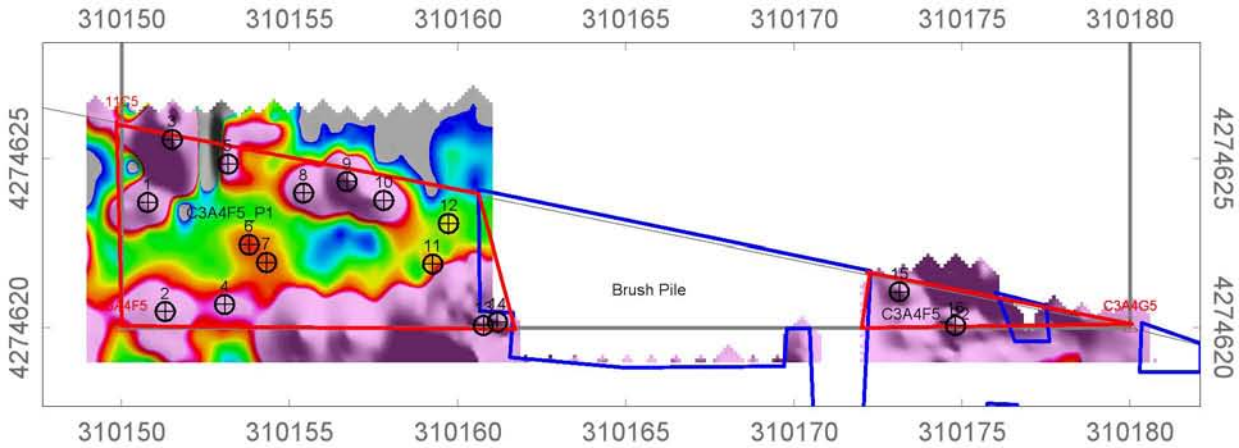
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IDW
Date:	Apr-27-2010	File:	C3A4F4
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4F5

EM Geophysical Survey

Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IDW
Date:	Apr-27-2010	File:	C3A4F5
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

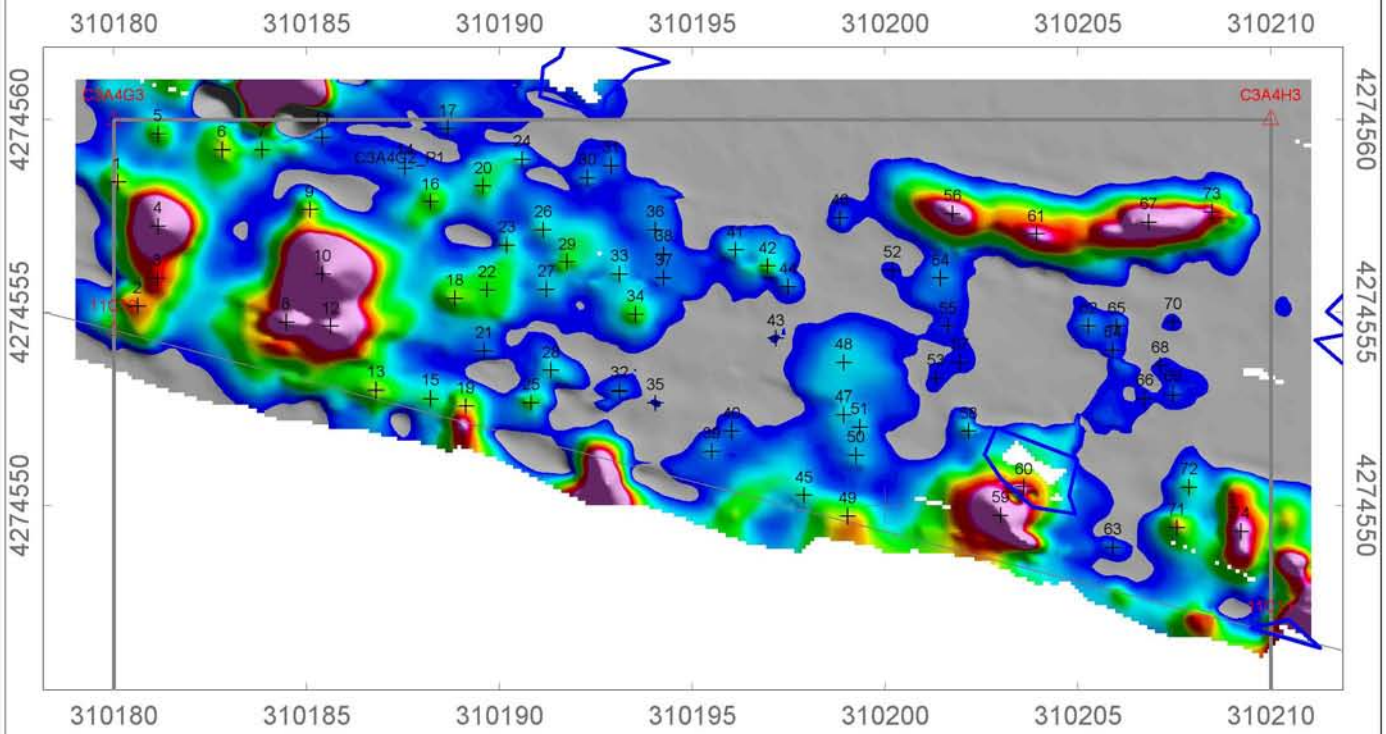
CH2MHILL ARM GEOPHYSICS

GRID C3A4G2

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

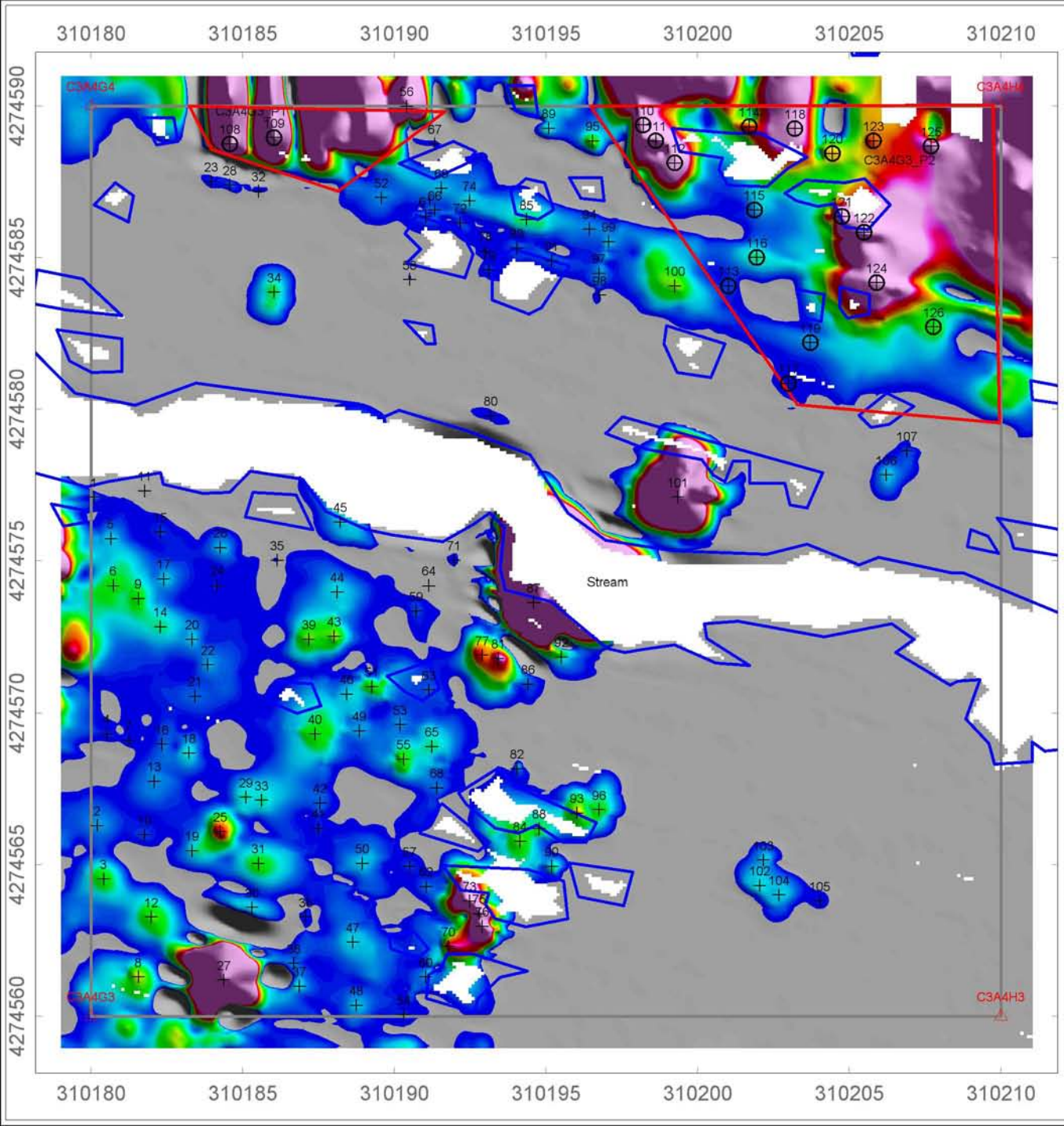
Scale 1:196.1302

2.5 0 2.5 5
(meters)

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4G2
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4G3

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

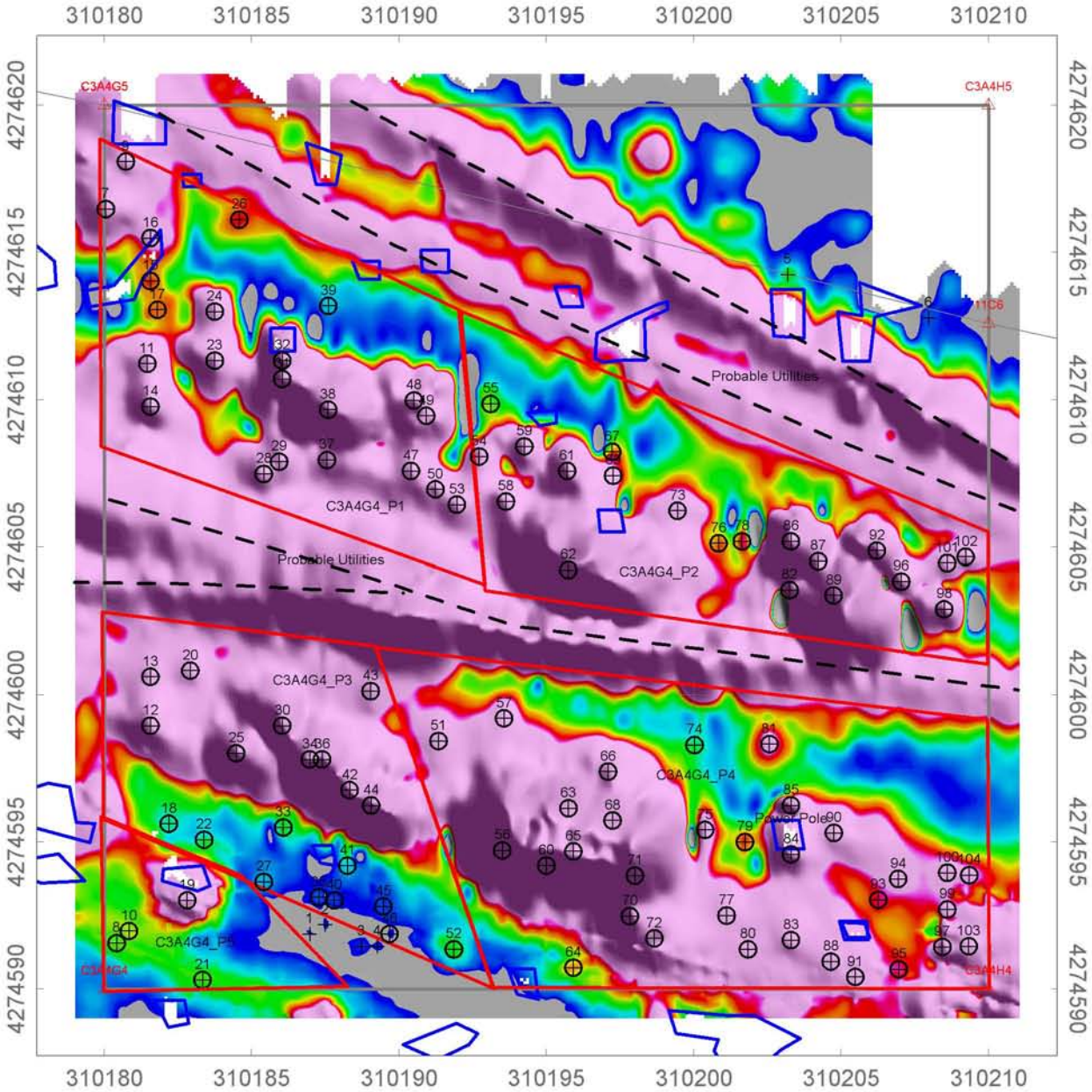
Scale 1:196.1302

2.5 0 2.5 5
(meters)

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4G3
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4G4

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IDW
Date:	Apr-27-2010	File:	C3A4G4
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

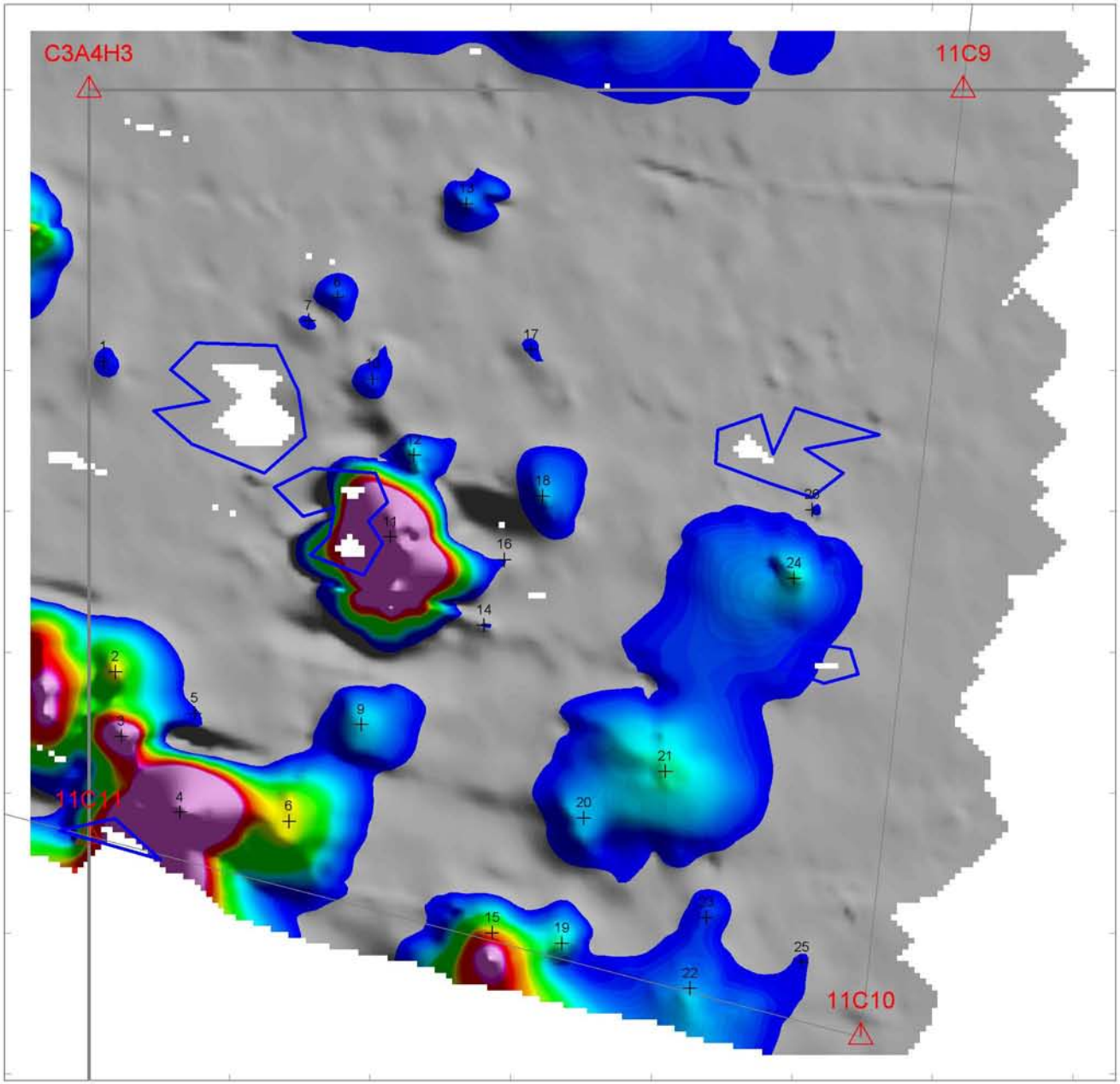
CH2MHILL ARM GEOPHYSICS

GRID C3A4H2

EM Geophysical Survey

GPS Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV

3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

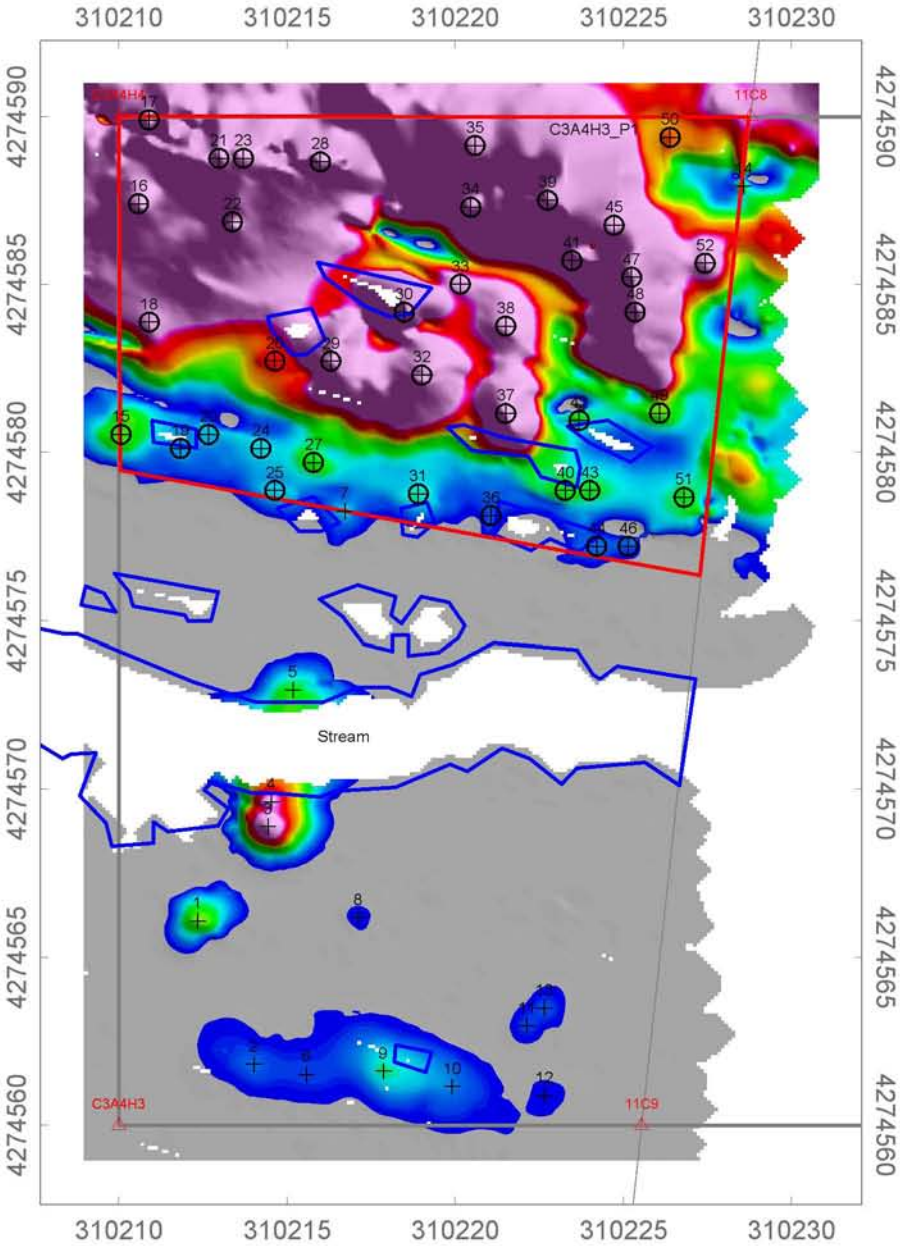
Scale 1:114.9877

2.5 0 2.5

(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IW
Date:	Apr-26-2010	File:	C3A4H2
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID C3A4H3

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL		
PROJECT:	UXO 11/30, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	JW	Verified By:	IDW
Date:	Apr-28-2010	File:	C3A4H3
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

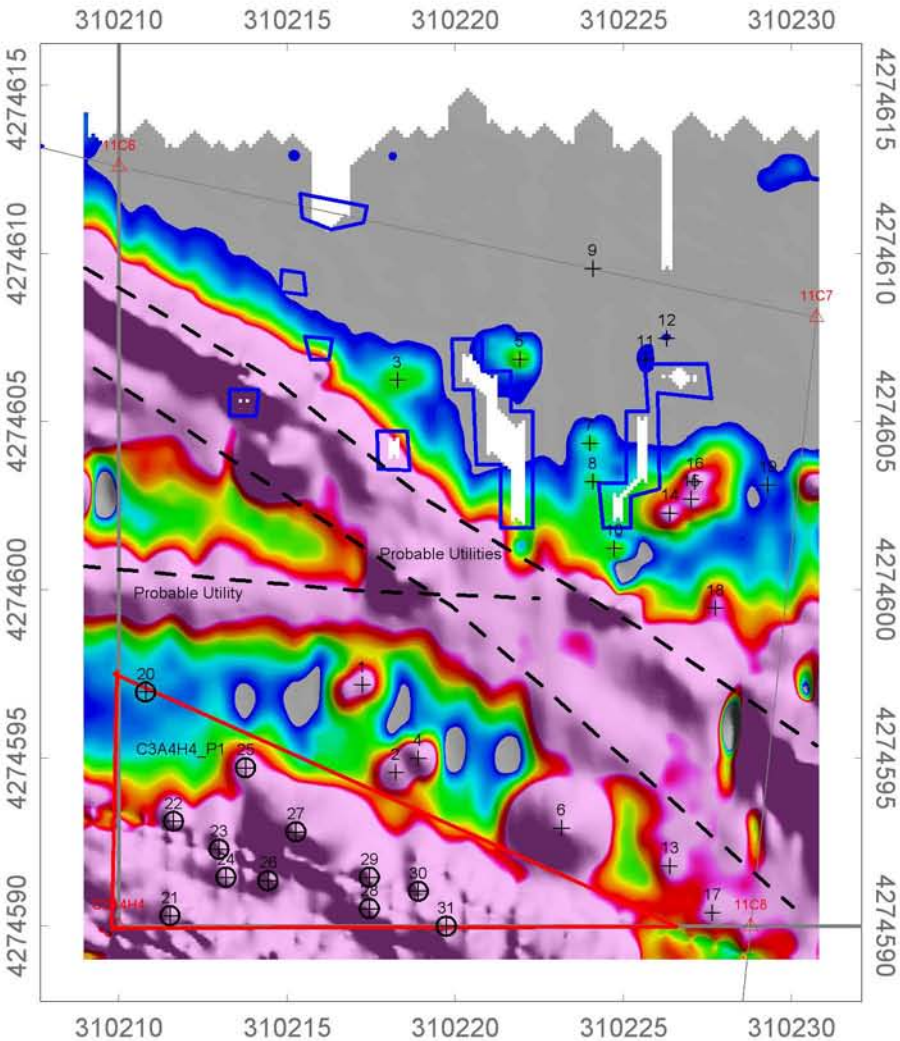
CH2MHILL ARM GEOPHYSICS

GRID C3A4H4

EM Geophysical Survey

GPS & Fid Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96

Scale 1:225

2.5 0 2.5 5 7.5

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IDW
Date:	Apr-27-2010	File:	C3A4H4
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS

UXO-27 EAST - Horizontal Gradient

Magnetic Geophysical Survey

GPS Positioned Geometrics G-882 TVG

Naval Support Facility, Indian Head

Indian Head, MD

Legend

- Grid Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Interpreted Anomaly - Class 1 (From TFAS)
- Interpreted Anomaly - Class 2 (From TFAS)

Horizontal Gradient

nT/m

-70 -37 -26 -19 -12 -6 -2 1 4 6 9 12 16 21 26 33 42 58

Scale 1:1901.141

25 0 25 50

(meters)

CLIENT:	CH2M HILL		
PROJECT:	UXO 27, Indian Head, MD		
CONTRACTOR:	ARM Geophysics		
Created By:	IDW	Verified By:	IDW
Date:	May-24-2010	File:	UXO27_EAST
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS

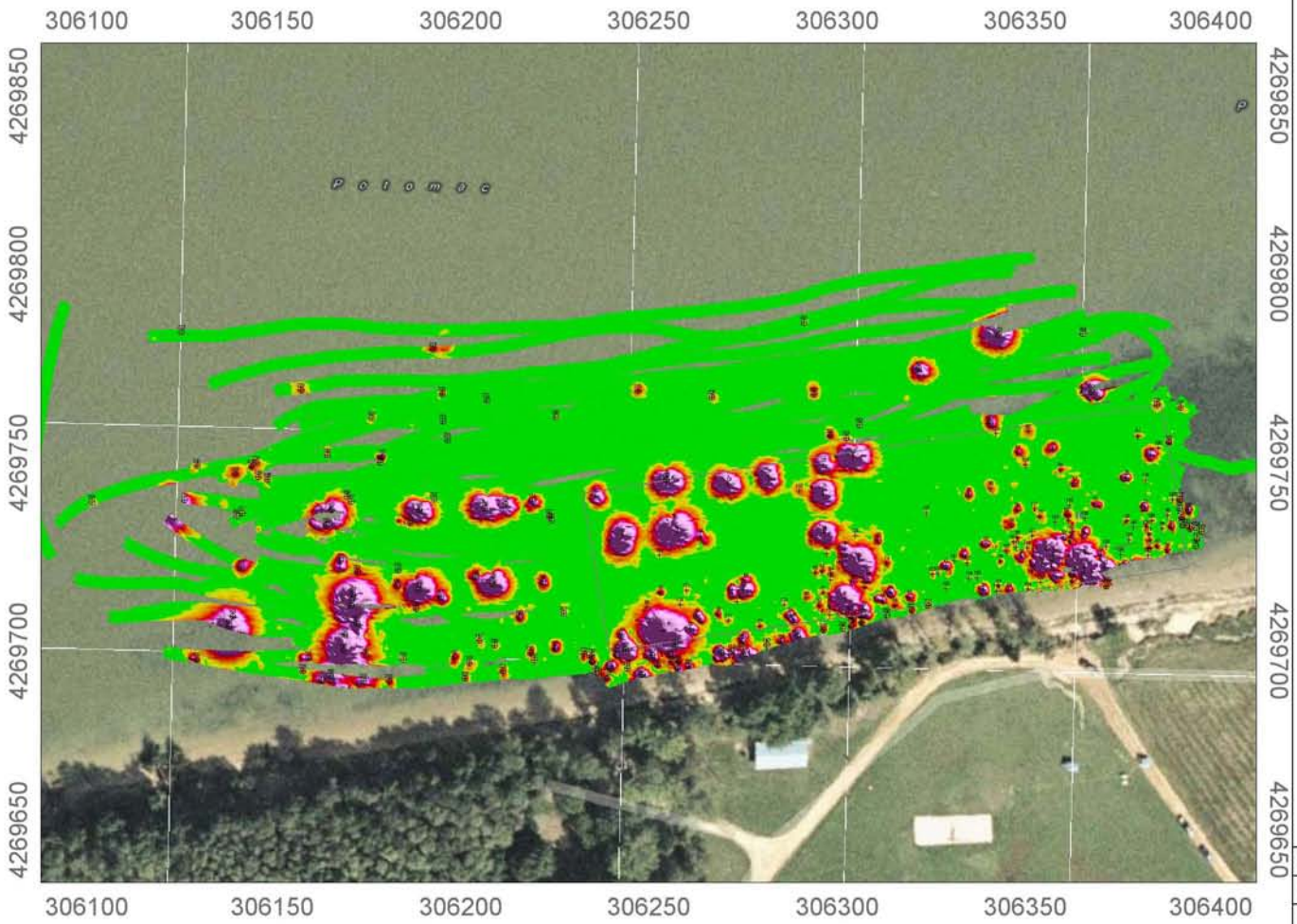
UXO-27 EAST - Analytic Signal

Magnetic Geophysical Survey

GPS Positioned Geometrics G-882 TVG

Naval Support Facility, Indian Head

Indian Head, MD



Legend

- Grid Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

Analytic Signal (TMI)

nT/m

-70 -37 -26 -19 -12 -6 -2 1 4 6 9 12 16 21 26 33 42 58

Scale 1:1901.141

25 0 25 50

(meters)

CLIENT:	CH2M HILL
PROJECT:	UXO 27, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	May-24-2010	File:	UXO27_EAST

Coordinate System: NAD83 UTM Zone 18 Nth meters

CH2MHILL ARM GEOPHYSICS

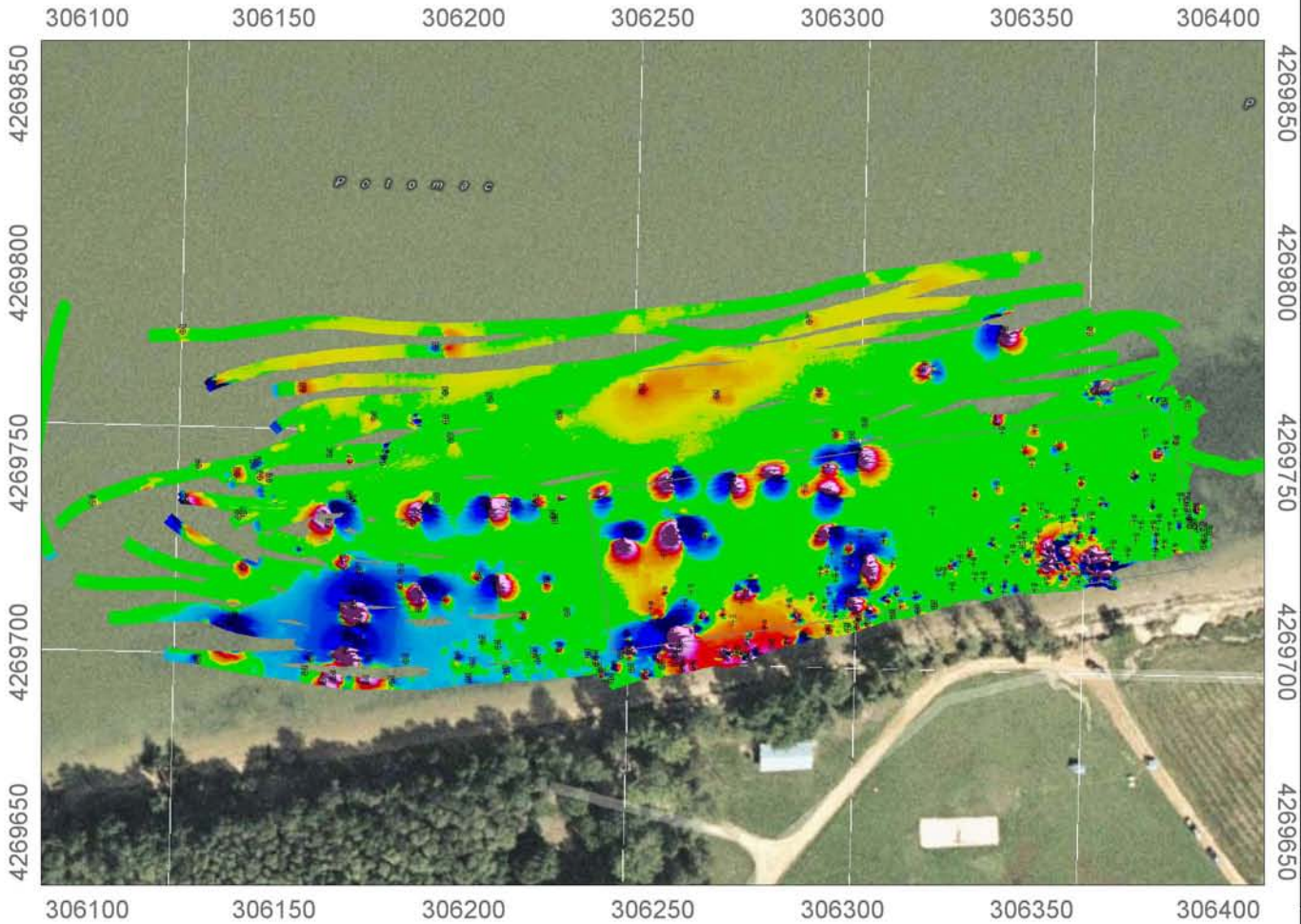
UXO-27 EAST - Total Magnetic Intensity

Magnetic Geophysical Survey

GPS Positioned Geometrics G-882 TVG

Naval Support Facility, Indian Head

Indian Head, MD



Legend

- Grid Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Interpreted Anomaly - Class 1 (From TFAS)
- Interpreted Anomaly - Class 2 (From TFAS)

TMI

nT

-70 -37 -26 -19 -12 -6 -2 1 4 6 9 12 16 21 26 33 42 58

Scale 1:1901.141

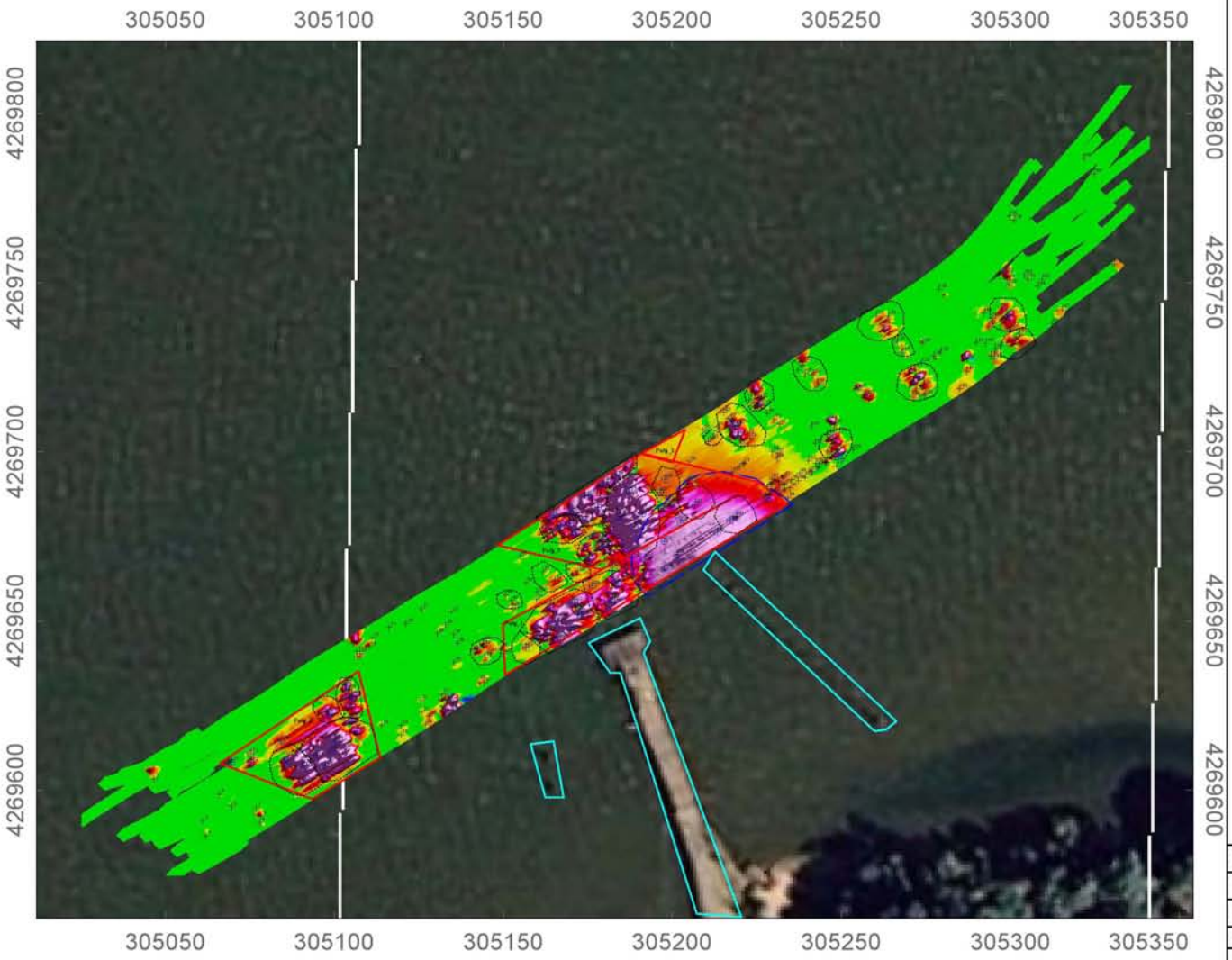
25 0 25 50

(meters)

CLIENT:	CH2M HILL
PROJECT:	UXO 27, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	May-24-2010	File:	UXO27_EAST
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



UXO-27 WEST - Horizontal Gradient

Magnetic Geophysical Survey

GPS Positioned Geometrics G-882 TVG

Naval Support Facility, Indian Head

Indian Head, MD

Legend

- Anomaly Outline (Approx.)
- Influence of Metal Bollards (Approx.)
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Interpreted Anomaly - Class 1 (From TFAS)
- Interpreted Anomaly - Class 3 (From TFAS)

N

Horizontal Gradient

nT/m

-70 -37 -26 -19 -12 -6 -2 1 4 6 9 12 16 21 26 33 42 58

Scale 1:2015.209

25 0 25 50 75

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 27, Indian Head, MD
CONTRACTOR:	ARM Geophysics

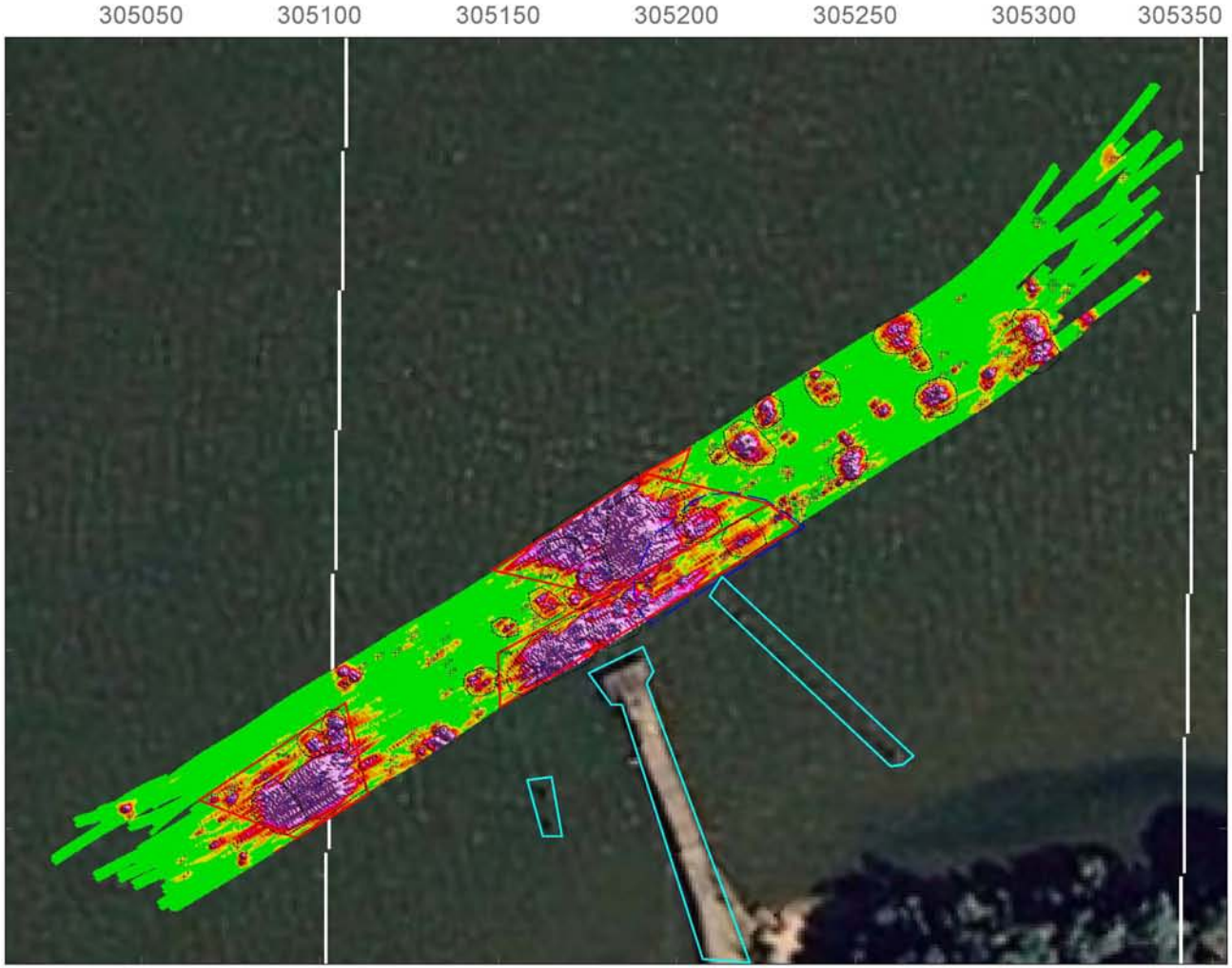
Created By:	IDW	Verified By:	IDW
Date:	May-27-2010	File:	UXO27_WEST
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS

UXO-27 WEST - Analytic Signal

Magnetic Geophysical Survey
GPS Positioned Geometrics G-882 TVG

Naval Support Facility, Indian Head
Indian Head, MD



Legend

- Anomaly Outline (Approx.)
- Influence of Metal Bollards (Approx.)
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Interpreted Anomaly - Class 1 (From TFAS)
- Interpreted Anomaly - Class 3 (From TFAS)

N

Analytic Signal (TMI)
nT/m

-70 -37 -26 -19 -12 -6 -2 1 4 6 9 12 16 21 26 33 42 58

Scale 1:2015.209

25 0 25 50 75

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 27, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	May-27-2010	File:	UXO27_WEST
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS

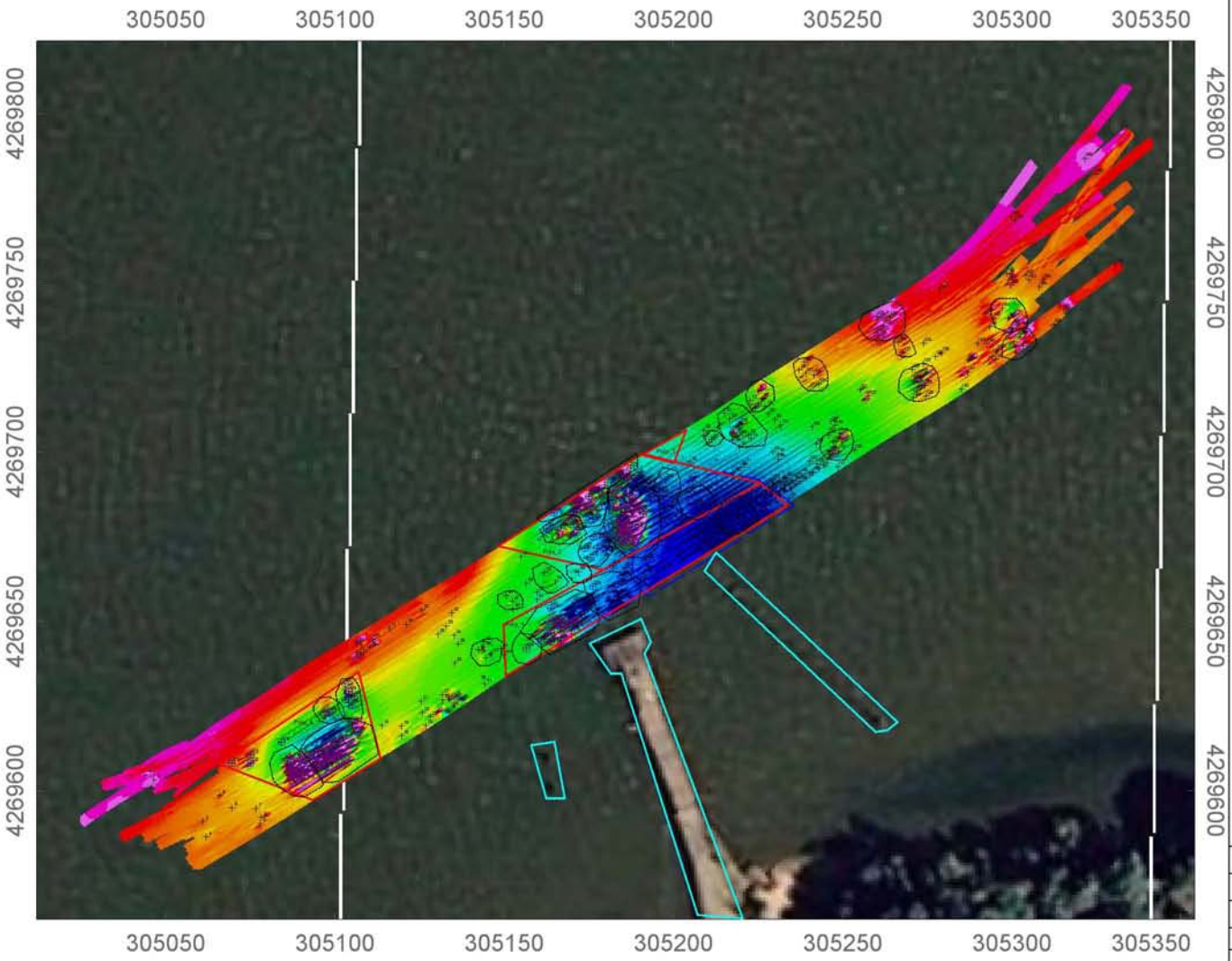
UXO-27 WEST - Total Magnetic Intensity (Raw)

Magnetic Geophysical Survey

GPS Positioned Geometrics G-882 TVG

Naval Support Facility, Indian Head

Indian Head, MD



Legend

- Anomaly Outline (Approx.)
- Influence of Metal Bollards (Approx.)
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Interpreted Anomaly - Class 1 (From TFAS)
- Interpreted Anomaly - Class 3 (From TFAS)

N

TMI (Raw)

nT

51133 51739 51838 51874 51896 51908 51918 51935

Scale 1:2015.209

25 0 25 50 75

(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 27, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	May-27-2010	File:	UXO27_WEST
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS

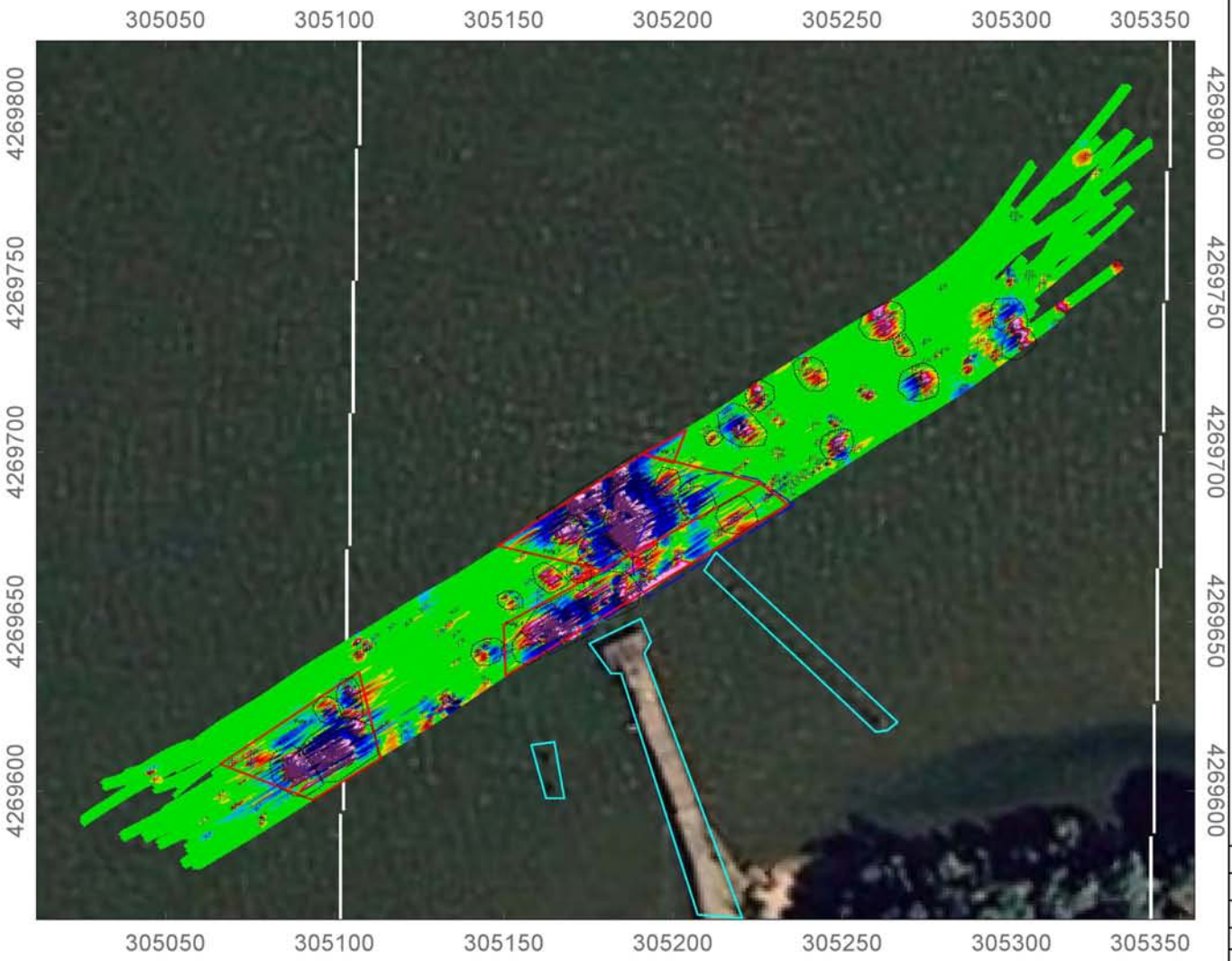
UXO-27 WEST - Total Magnetic Intensity (Residual)

Magnetic Geophysical Survey

GPS Positioned Geometrics G-882 TVG

Naval Support Facility, Indian Head

Indian Head, MD



Legend

- Anomaly Outline (Approx.)
- Influence of Metal Bollards (Approx.)
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Interpreted Anomaly - Class 1 (From TFAS)
- Interpreted Anomaly - Class 3 (From TFAS)

N

TMI (Residual)

nT

-70 -37 -26 -19 -12 -6 -2 1 4 6 9 12 16 21 26 33 42 58

Scale 1:2015.209

25 0 25 50 75

(meters)

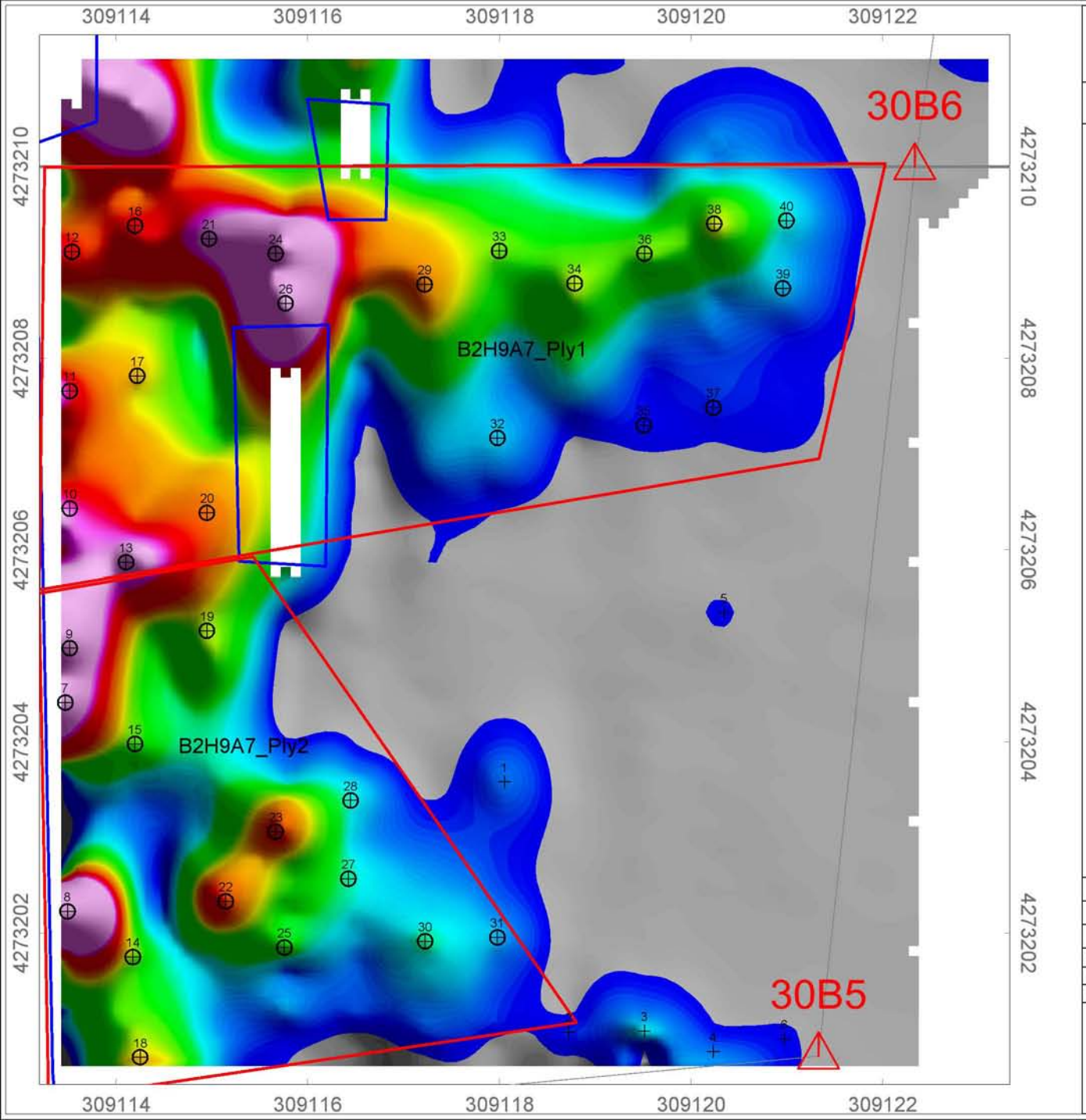
NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 27, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	May-27-2010	File:	UXO27_WEST

Coordinate System: NAD83 UTM Zone 18 Nth meters

CH2MHILL ARM GEOPHYSICS



GRID B2H9A7

EM Geophysical Survey

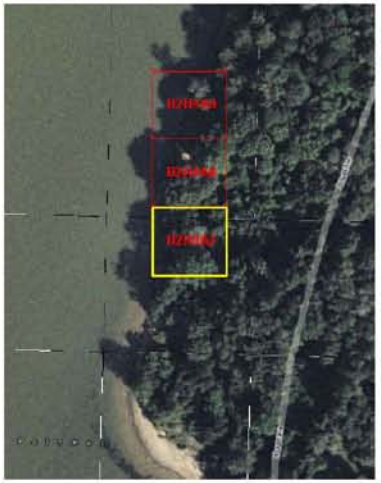
Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96



Scale 1:61.75772

1 0 1 2

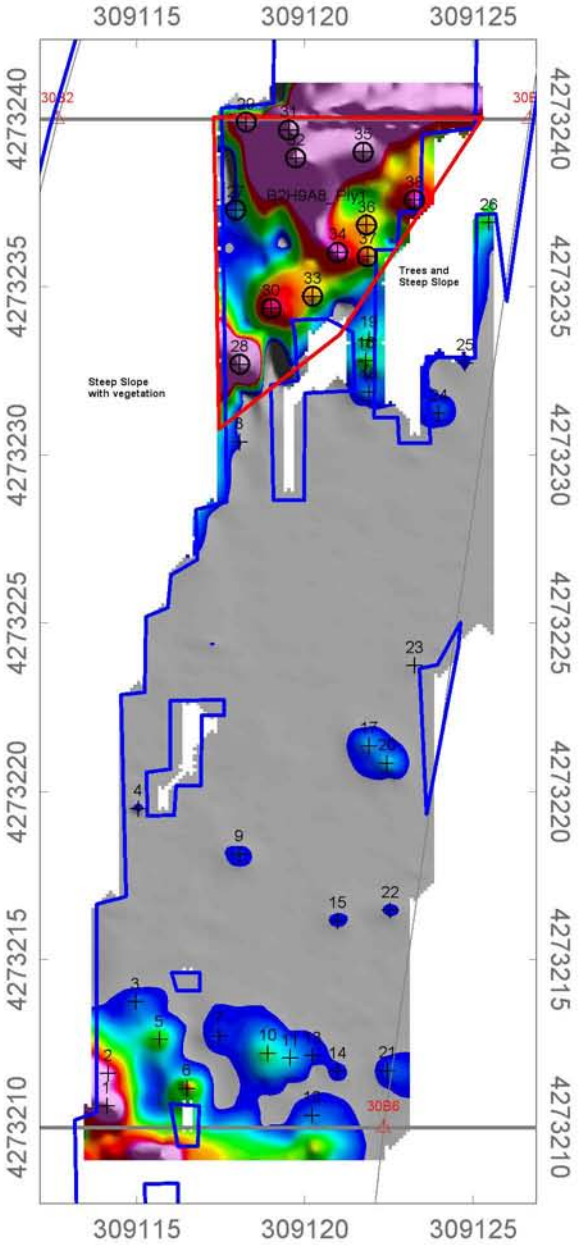
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	JW	Verified By:	IW
Date:	May-3-2010	File:	B2H9A7
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B2H9A8

EM Geophysical Survey

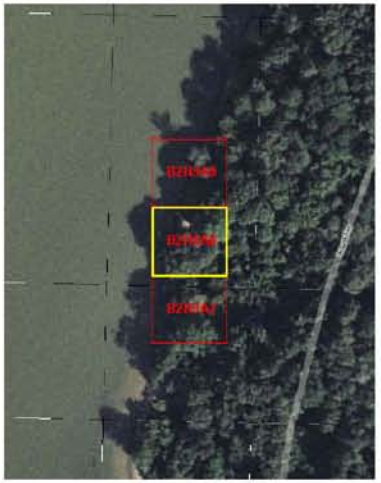
Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96



Scale 1:225

2.5 0 2.5 5 7.5

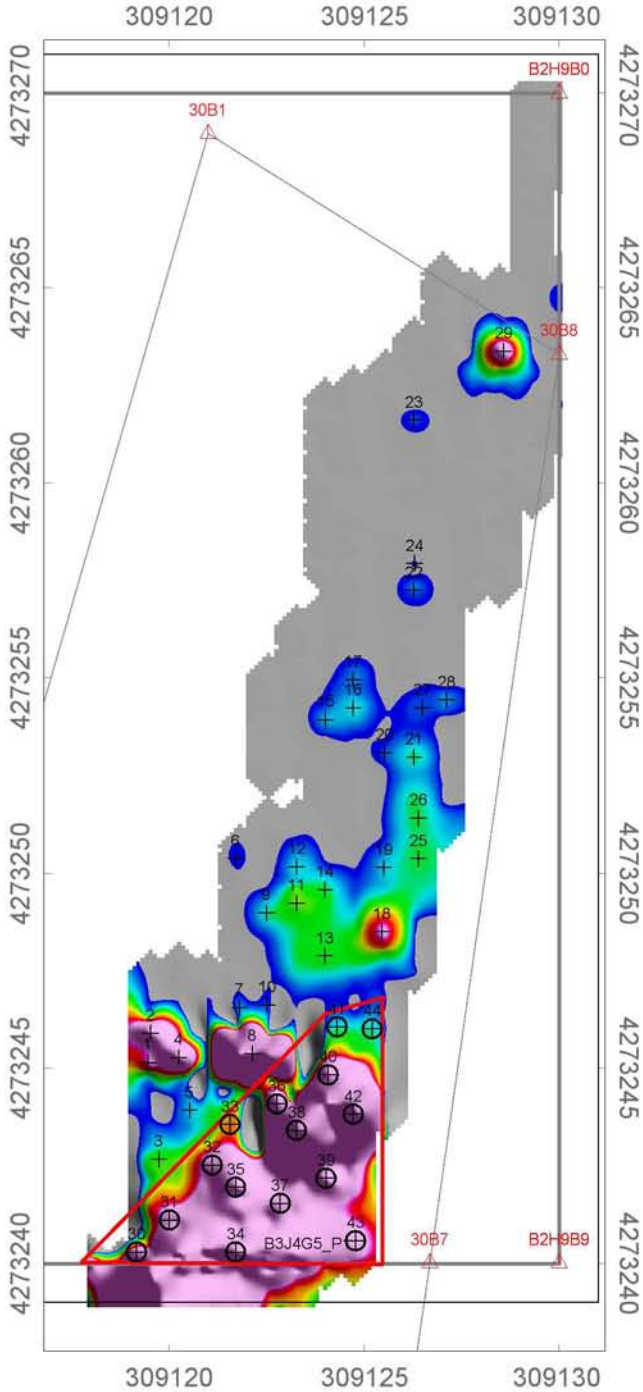
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	IDW	Verified By:	IDW
Date:	Apr-30-2010	File:	B2H9A8
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS



GRID B2H9A9

EM Geophysical Survey

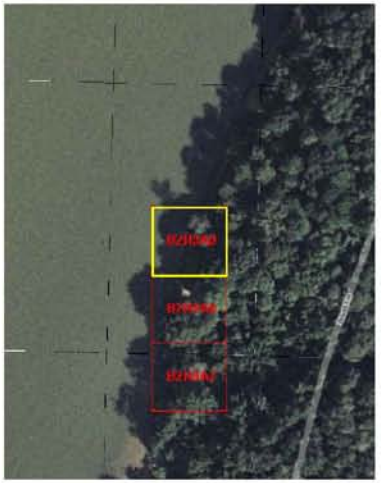
Fiducial Positioned Single Coil EM61

Naval Support Facility, Indian Head
Indian Head, MD

Legend

- Grid/Area Boundary
- Grid Corner
- 25 Anomaly Number
- Obstacle / Man-Made Feature
- Polygon Anomaly
- Inferred Utility
- Interpreted Anomaly - Class 1
- Interpreted Anomaly - Class 2

EM (CH3)
mV
3 7 11 17 23 29 35 41 47 53 60 66 72 78 84 90 96



Scale 1:193.9281

2.5 0 2.5 5
(meters)

NAD83 / UTM zone 18N

CLIENT:	CH2M HILL
PROJECT:	UXO 11/30, Indian Head, MD
CONTRACTOR:	ARM Geophysics

Created By:	RG	Verified By:	IW
Date:	Apr-30-2010	File:	B2H9A9
Coordinate System:	NAD83 UTM Zone 18 Nth meters		

CH2MHILL ARM GEOPHYSICS

Appendix C
Utility Report for UXO 11

Buried Utility Location Tracking Form

(Submit to CH2M HILL PM within 24 hrs of location activities)

Project Location: NSF Indian Head, UXO 6, 11, 30
CH2M HILL Project No.: 380785
CH2M HILL Project Manager: Name/Phone: Margaret Kasim
Phone: 703-376-5154
Email: Margaret.Kasim@ch2m.com
CH2M HILL Field Team Leader: Name/Phone:

CH2M HILL Purchase Order: 933977

Utility Location Subcontractor: Accumark, Inc.
Subcontractor POC: Dan Clatterbuck
804-550-7740
804-310-6329

Dates of location activities: 4/13/10

Check each box using an "X" if a buried utility is present within 5 feet of a marked Station ID. If color of the flag or paint differs from listed color, note change in color on the form.

Station ID	Gas (Yellow)	Electric (Red)	Fiber optic (Orange)	Cable (Orange)	Water (Blue)	San. Sewer (Green)	Storm Sewer (Green)	Steam (Yellow)	Petroleum (Yellow)	Compressed air (Yellow)	Other UNKNOWN (PINK)	Other ___	Other ___	Other ___	Date completed	Technician Initials	Notes (methods/tools used)
UXO-11 Area A				X											4-13-10	KP	
UXO-11 Area B					X										4-13-10	KP	
UXO-11 Area C											X				4-13-10	KP	
UXO-11 Area E				X													

The findings of the buried utility location activities summarized herein were conducted in strict accordance with the CH2M HILL scope of work.

Subcontractor's Signature

4-13-10
Date

Appendix D
Soil Boring Logs for UXOs 6, 11, and 30

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO6-DP01

SOIL BORING LOG

PROJECT : UXO 6 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 15 feet bgs | START : 4-28-10 | END : 4-28-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	48"	1-S	NA	0-5" **Topsoil** 5-48" **Clay**, yellowish brown, 10YR 5/6, dry, stiff, low plasticity	CL	
5	5 - 10	60"	2-S	NA	0-60" **Clay**, grayish brown, 2.5Y 5/3, dry, very stiff, low plasticity	CL	
10	10 - 15	24"	3-S	NA	0-24" Same as above	CL	
15	15 - 20	60"	4-S	NA	0-24" Same as above	CL	
					24-36" **Clay** with sand, yellowish brown, 10YR 5/6, wet, soft, low plasticity, poorly graded sand	CL	
					36-60" **Clay**, grayish brown, 10YR 5/2, wet to moist, soft, high plasticity	CH	
20	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO6-DP02

SOIL BORING LOG

PROJECT : UXO 6 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : unknown | START : 4-29-10 | END : 4-29-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	42"	1-S	NA	0-30" **Clay**, yellowish brown, 10YR 5/6, dry, stiff, low plasticity, little fine sand 30-42" **Clay**, yellowish brown, 10YR 5/6, dry, very stiff, low plasticity	CL CL	
5	5 - 10	50"	2-S	NA	0-50" **Clay**, grayish brown, 10YR 5/2, moist, very stiff to stiff, low plasticity	CL	
10	10 - 15	42"	3-S	NA	0-14" Same as above 14-42" **Clay**, brown, 7.5YR 5/3, moist, soft, low plastcity, little fine sand	CL	
15	15 - 20	36"	4-S	NA	0-36" Same as above	CL	
20	20 - 25	48"	5-S	NA	0-24" **Clay**, gray, 10YR 6/1, moist, soft, low plasticity 24-48" **Clay**, brown, 7.5YR 5/3, moist, soft to stiff, low plasticity, little	CL	
25	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO6-DP03

SOIL BORING LOG

PROJECT : UXO 6 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 17.5 feet bgs | START : 4-29-10 | END : 4-29-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	60"	1-S	NA	0-3" **Topsoil** 3-60" **Clay**, brown, 10YR 5/3, dry, very stiff, low plasticity	CL	
5	5 - 10	60"	2-S	NA	0-60" **Clay**, 10YR 5/3 to 10YR 4/3, dry, very stiff, low plasticity	CL	
10	10 - 15	54"	3-S	NA	0-54" **Clay**, brown, 10YR 4/3, moist, soft to stiff, low plasticity, little fine sand	CL	
15	15 - 20	60"	4-S	NA	0-60" Same as above, except becoming 10YR 5/6 at 56"	CL	
20	20 - 25	60"	5-S	NA	0-60" Same as above	CL	
25	25 - 30	60"	6-S	NA	0-36" Same as above 36-60" **Clay**, grayish brown, 10YR 5/2, moist, stiff, low plasticity	CL CL	
30	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP01

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 7 feet bgs | START : 4-20-10 | END : 4-20-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	31"	1-S	NA	0-5" **Topsoil** 5-11" **Gravel**, light gray, dry, loose, 11-31" **Clay,** strong brown, 7.5YR 5/8 becoming 7.5YR 3/1, moist, stiff, low plasticity, trace brick fragments	GP CL	
5	5 - 10	20"	2-S	NA	0-20" **Sandy Clay (fill),** moist becoming wet at 14", trace brick fragments, wood pieces, and slag		Water measured at 7 ft through DPT boring.
10	End of boring						
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP02

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-21-10 | END : 4-21-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	60"	1-S	NA	0-2" **Topsoil** 2-14" **Clay** with sand, strong brown, 7.5YR 5/8, moist, stiff, low plasticity, poorly graded 14-60" **Clay**, grayish brown with strong brown mottles, moist, stiff, low plasticity	CL	
5	5 - 10	60"	2-S	NA	0-60" **Clay** with sand, grayish brown, moist, stiff, low plasticity, poorly graded sand	CL	
10	10 - 14	15"	3-S	NA	0-15" **Clay**, grayish brown with strong brown mottles, moist, stiff, low plasticity	CL	
14	14 - 17	24"	4-S	NA	0-24" Same as above	CL	
17	17 - 20	36"	5-S	NA	0-36" Same as above	CL	
20	20 - 22	24"	6-S	NA	0-24" **Clay**, gley 1 5Y/N, moist, very stiff, low plasticity	CL	
22	22 - 25	36"	7-S	NA	0-36" Same as above, except dry	CL	
25	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP03

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Perched water level at Approx 6 ft bgs | START : 4-22-10 | END : 4-22-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	22"	1-S	NA	0-4" **Topsoil** 4-58" **Clay**, yellowish brown, 10YR 5/4, moist, stiff, low plasticity 58-60" **Silt**, very dark grayish brown, 10YR 3/2, moist, soft, low plasticity	CL ML	
5	5 - 10	48"	2-S	NA	0-10" Same as above 10-16" **Gravel** with sand, black, 10YR 2/1, wet, loose, sub-angular gravel to .25" in diameter, poorly 16-48" **Clay,** light brownish gray, 10YR 6/2, moist, stiff, low plasticity	GP CL	Perched water level at approx 6 ft bgs
10	10 - 14	36"	3-S	NA	0-12" Same as above 12-36" **Clay**, greenish gray, gley 1 6/1, dry, very stiff, low plasticity	CL	
14	End of boring						
17							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP04

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 7 feet bgs | START : 4-20-10 | END : 4-20-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	36"	1-S	NA	0-3" **Topsoil** 3-12" **Silty Sand**, brownish yellow, 10YR 6/6, moist, dense, little sub-angular gravel to .5" in diameter 12-36" Same as above except 10YR 4/4, dark yellowish brown	SM	
5	5 - 10	39"	2-S	NA	0-24" **Clay**, brownish gray, 10YR 6/2 with 7.5 YR 5/8 mottles, moist, very stiff, low plasticity 24-39" **Silty Sand**, 10YR 5/4, yellowish brown, wet, loose, well graded	CL SM	
10	End of boring						
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP05

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-22-10 | END : 4-22-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	38"	1-S	NA	0-3" **Topsoil** 3-16" **Clay**, yellowish brown, 10YR 5/4, moist, soft, low plasticity 16-24" **Silty Sand**, dark yellowish brown, 10YR 4/6, moist, dense, poorly graded sand 16-38" **Clay**, light brownish gray, 10YR 6/2, dry, stif, low plasticity	CL SM CL	
5	5 - 10	60"	2-S	NA	0-36" Same as above 36-60" **Clayey Sand,** reddish brown, 7.5YR 6/8, dry, stiff, poorly graded sand	SC	
10	10 - 15	60"	3-S	NA	0-36" **Clay**, light brownish gray, 10YR 6/2, dry, very stiff, low plasticity 36-48" **Sandy Clay**, light brownish gray, 2.5Y 6/2, dry, very stiff 48-60" **Clay**, greenish gray, gley 1 5/5GY, dry, very stiff, low plasticity	CL SC CL	
15	End of boring						
20							

PROJECT NUMBER	BORING NUMBER
380785	ISUXO11-DP06

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-21-10 | END : 4-21-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	36"	1-S	NA	0-24" **Clay**, yellowish brown, moist, stiff, low plasticity, little fine sand 24-36" **Clay**, brownish gray, moist , stiff, low plasticity	CL	
5	5 - 7	24"	2-S	NA	0-10" **Clay**, brownish gray, moist, 10-16" **Gravel**, dry, loose, sub angular to 1" diameter 16-24" **Clay**, gray, moist, stiff	CL GP CL	
7	7 - 10	36"	3-S	NA	0-36" **Clay,** gray with reddish brown mottles, moist, very stiff, low	CL	
10	10 - 13	36"	4-S	NA	0-36" Same as above	CL	
13	13 - 15	24"	5-S	NA	0-24" Same as above	CL	
15	15 - 17	24"	6-S	NA	0-24" Same as above except little fine sand	CL	
17	17 - 20	36"	7-S	NA	0-36" **Clay** with sand, gray, gley 1 5Y/N, moist, very stiff, poorly graded sand	CL	
20	20 - 22	24"	8-S	NA	0-24" Same as above	CL	
22	22 - 25	36"	9-S	NA	0-36" Same as above	CL	
25	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP07

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-21-10 | END : 4-22-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	22"	1-S	NA	0-3" **Topsoil** 3-22" **Clay**, reddish brown, moist, soft, low plasticity	CL	
5	5 - 10	29"	2-S	NA	0-19" Same as above 19-29" **Clayey Sand**, grayish brown, moist, dense, little sub-rounded	SC	
10	10 - 14	22"	3-S	NA	0-11" Same as above, increasing dryness with depth 11-22" **Clay**, light grayish brown, dry, very stiff, low plasticity	CL	
14	14 - 17	36"	4-S	NA	0-24" Same as above 24-36" **Sandy Clay**, gley 1 5Y/N, dry, very stiff, low plasticity	SC	
17	17 - 20	12"	5-S	NA	0-12" Same as above	SC	Refusal of drilling equipment at 20 ft bgs
20	End of boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP08

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 5 feet bgs | START : 4-20-10 | END : 4-21-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	24"	1-S	NA	0-4" **Topsoil** 4-11" **Sand (fill)**, black, 10YR 2/1, wet, loose 11-24" **Clay**, light brownish gray, 10YR 6/2 with 7.5YR 5/8 mottles, moist, very stiff, low plasticity	 SP CL	
5	5 - 10	40"	2-S	NA	0-4" **Fill**, black, 10YR 2/1, wet, loose, sub-angular gravel to .5" in 4-40" **Clay**, light brownish gray, 10YR 6/2, moist, some fine sand decreasing with depth	GP CL	
10	10 - 15	0"	3-S	NA	No Recovery		Sample liner stuck in macro core sampler. Sample destroyed during liner removal.
15	End of boring						
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP09

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-28-10 | END : 4-28-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	60"	1-S	NA	0-2" **Topsoil** 2-60" **Clay**, light yellowish brown, 2.5Y 6/3 with 10YR 5/8 and 2.5YR 4/4 mottles, dry, stiff	CL	
5	5 - 10	60"	2-S	NA	0-60" Same as above	CL	
10	10 - 15	60"	3-S	NA	0-60" Same as above	CL	
15	15 - 20	60"	4-S	NA	0-60" Same as above	CL	
20	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP10

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-28-10 | END : 4-28-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	0-60"	1-S	NA	0-2" **Topsoil** 2-60" **Clay**, light grayish brown with dark reddish brown and brownish yellow mottles, 10YR 6/2 with 22.5YR 3/4 and 10YR 6/6 mottles, dry, very stiff	CL	
5	5 - 10	60"	2-S	NA	0-60" Same as above	CL	
10	10 - 15	60"	3-S	NA	0-60" Same as above	CL	
15	15 - 20	60"	4-S	NA	0-60" Same as above	CL	
20	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP11

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 3 feet bgs | START : 4-28-10 | END : 4-28-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	42"	1-S	NA	0-4" **Topsoil** 4-36" **Clay**, yellowish brown, 10YR 5/6, moist, stiff, low plasticity 36-42" **Gravelly Sand**, black, 10YR 2/1, wet loose, poorly graded sand, sub-angular gravel to .25" in diameter	CL SP-GP	
5	5 - 8	36"	2-S	NA	0-36" **Clay**, yellowish brown, 10YR 5/6, moist, stiff, low plasticity	CL	refusal each time. Wood fragments in drive shoe.
8	End of boring						
10							
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP12

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 5 feet bgs | START : 4-28-10 | END : 4-28-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	25"	1-S	NA	0-4" **Topsoil** 4-18" **Clay,** dark yellowish brown, 10YR 4/4, moist, stiff, low plasticity	CL	
5	5 - 10	30"	2-S	NA	0-6" **Clay**, gray, 10YR 5/1, moist, stiff, low plasticity 6-18" **Clayey Sand**, yellowish red, 5YR 5/8, wet, loose, low plasticity 18-30" **Clay**, grayish brown, 10YR 5/2, moist, stiff, low plasticity	CL SC CL	
10	10 - 15	25"	3-S	NA	0-25" Same as above, except soft from 10-20"	CL	
15	15 - 20	60"	4-S	NA	0-8" Same as above 8-60" **Clay**, gray to yellowish red, 10YR 6/1 to 5YR 5/6, dry, very stiff, low plasticity	CL	
20	End of boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP13

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-28-10 | END : 4-28-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	48"	1-S	NA	0-48" **Clay**, yellowish brown, 10YR 5/6, moist, stiff, low plasticity	CL	
5	5 - 10	60"	2-S	NA	0-60" **Clay**, light brown, 10YR 5/6, moist, stiff, low plasticity		
10	10 - 15	60"	3-S	NA	0-60" Same as above except 2.5Y 7/1, light gray	CL	
15	15 - 20	60"	4-S	NA	0-60" Same as above	CL	
20	End of boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP14

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-27-10 | END : 4-27-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	42"	1-S	NA	0-1" **Topsoil** 1-42" **Clay**, brown to light gray, 10YR 5/3 to 10YR 7/1, moist, stiff, low plasticity	CL	
5	5 - 10	0"	2-S	NA	No Recovery		Sample liner stuck in macro core sampler
10	10 - 15	60"	3-S	NA	0-60" **Clay**, grayish brown, with dark red mottles, 10YR 5/2 with 2.5YR 3/6 mottles, dry, very stiff, low plasticity	CL	
15	15 - 20	27"	4-S	NA	0-27" Same as above	CL	
20	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP15

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-27-10 | END : 4-27-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	60"	1-S	NA	0-1" **Topsoil** 1-60" **Clay**, strong brown to light yellowish brown with red mottles, 7.5YR 4/6 to 2.5Y 6/3 with 5YR 5/8 mottles, moist, stiff, low plasticity	CL	
5	5 - 10	60"	2-S	NA	0-60" **Clay**, light yellowish brown with strong brown mottles, 2.5Y 6/3 with 7.5YR 5/8 mottles, dry, stiff, low plasticity	CL	
10	10 - 15	60"	3-S	NA	0-60" Same as above	CL	
15	15 - 20	60"	4-S	NA	0-60" Same as above	CL	
20	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP16

SOIL BORING LOG

PROJECT : UXO 11 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown START : 4-27-10 END : 4-27-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	60"	1-S	NA	0-2" **Topsoil** 2-60" **Clay**, strong brown to light yellowish brown, 7.5YR 5/8 to 2.5Y 6/3, moist, stiff, low plasticity	CL	
5	5 - 10	60"	2-S	NA	and mottles are 10YR5/8 and 2.5YR 3/6	CL	
10	10 - 15	60"	3-S	NA	0-60" **Clay**, 2.5Y 6/3 and 10YR 5/8, dry, very stiff, low plasticity	CL	
15	15 - 20	60"	4-S	NA	0-60" Same as above	CL	
20	End Of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP17

SOIL BORING LOG

PROJECT : UXO 11 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown START : 4-26-10 END : 4-26-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	60"	1-S	NA	0-1" **Topsoil** 1-60" **Clay,** light yellowish brown, 2.5Y 6/3, dry, stiff, plastic	CL	
5							
	5 - 10	60"	2-S	NA	0-60" Same as above	CL	
10							
	10 - 15	60"	3-S	NA	0-60" Same as above, except very stiff	CL	
15							
	15 - 19	48"	4-S	NA	0-48" Same as above	CL	
19							
	19 - 24	48"	5-S	NA	0-48" Same as above	CL	
24							
	24 - 29	48"	6-S	NA	0-36" Same as above	CL	
29	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP18

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 5 feet bgs | START : 4-26-10 | END : 4-26-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	36"	1-S	NA	0-2" **Topsoil** 2-12" **Clay**, strong brown, 7.5YR 5/6, moist, soft, plastic 12-36" **Silt** with clay, olive brown, 2.5Y 4/3, moist to wet at 35", soft, plastic	CH MH	
5							Water measured at 5 ft though DPT hole.
	5 - 10	9"	2-S	NA	0-9" Same as above	MH	
10							
	10 - 15	18"	3-S	NA	0-18" Same as above, except grayish brown, 2.5Y 5/2	ML	
15	End of boring						
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP19

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-27-10 | END : 4-27-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	60"	1-S	NA	0-5" **Topsoil** 5-60" **Clay**, light olive brown with yellowish brown motttles, 2.5Y 5/3, moist, very stiff	CL	
5	5 - 10	60"	2-S	NA	0-60" Same as above, except dry	CL	
10	10 - 15	60"	3-S	NA	0-60" Same as above	CL	
15	15 - 20	60"	4-S	NA	0-60" Same as above	CL	
20	End of Boring						

PROJECT NUMBER	BORING NUMBER
380785	ISUXO11-DP20

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 1 foot bgs | START : 4-27-10 | END : 4-27-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	33"	1-S	NA	0-3" **Topsoil** 3-15" **Silt**, brown, 10YR 5/3, moist, dense, low plasticity 15-20" **Silty Sand**, brownish yellow, 10YR 6/6, wet, loose, poorly graded 20-33" **Clay**, olive brown, 2.5Y 4/3, wet to moist, soft, plastic	ML SM CL	Measured water at 15" through DPT hole.
5	End of boring						
10							
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP21

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 7 feet bgs | START : 4-23-10 | END : 4-23-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	19"	1-S	NA	0-4" **Topsoil** 4-19" **Silty Sand**, dark yellowish brown, 10YR 4/4, dry, dense	SM	
5							
	5 - 10	34"	2-S	NA	0-12" **Clay**, brown, 7.5YR 5/4, moist, soft, low plasticity, trace sub-rounded gravel 12-34" **Silt**, dark gray, 10YR 4/1, moist, soft, little clay	CL ML	Water measured at 7 ft through DPT hole.
10							
	10 - 15	18"	3-S	NA	0-18" Same as above, except grayish brown, 2.5Y 5/2	ML	
15	End of boring						
20							

PROJECT NUMBER	BORING NUMBER
380785	ISUXO11-DP22

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Unknown | START : 4-27-10 | END : 4-27-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
5	0 - 5	60"	1-S	NA	0-1" **Topsoil** 1-60" **Clay**, light olive brown with red mottles, 2.5Y 5/3 with 2.5Y 4/6, moist, stiff, low plasticity	CL	
10	5 - 10	60"	2-S	NA	1-60" **Clay**, light olive brown with red mottles, 2.5Y 5/3 with 2.5Y 4/6, dry, very stiff, low plasticity	CL	
15	10 - 15	60"	3-S		0-60" **Clay**, light yellowish brown, 2.5Y 6/3, dry, very stiff, low plasticity	CL	
20	15 - 20	60"	4-S	NA	0-60" Same as above	CL	
25	20 - 25	38"	5-S	NA	0-38" Same as above	CL	
	End of Boring						

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP23

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 2 feet bgs | START : 4-27-10 | END : 4-27-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	42"	1-S	NA	0-4" **Topsoil**		
					4-28" **Silt**, brown, 10YR 5/3, moist, dense, low plasticity	ML	
					28-32" **Silty Sand,** brownish yellow, 10YR 6/6, wet, poorly graded	SM	
					32-42" **Clay**, olive brown, 2.5Y 4/3, wet to moist, soft, plastic	CL	
5	End of boring						
10							
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO11-DP24

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 3 feet bgs | START : 4-22-10 | END : 4-22-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	36"	1-S	NA	0-4" **Topsoil** 4-30" **Clay**, olive brown, 2.5Y 4/3, moist, soft, trace silt	CL	
					30-36" **Clayey Sand,** dark grayish brown, 2.5Y 4/2, wet, soft, low plasticity	SC	
5	End of boring						
10							
15							
20							

PROJECT NUMBER	BORING NUMBER
380785	ISUXO11-DP25

SOIL BORING LOG

PROJECT : UXO 11 | LOCATION : Indian Head, MD

ELEVATION : | DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 6 feet bgs | START : 4-20-10 | END : 4-20-10 | LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	24"	1-S	NA	0-12" **Poorly graded sand**, dark brown, loose, dry, fine to medium sand	SP	This location was sampled via hand auger.
			2-S		12-24" **Clay,** moist, low plasticity	CL	
5							
	5 - 10	12"	3-S	NA	0-12" **Clay**, gray, moist, low plasticity	CL	Water measured at 6 ft through bore hole.
	End of boring						
10							
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO30-DP01

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 5 feet bgs START : 4-16-10 END : 4-16-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
5	0 - 5	12"	1-S	NA	0-2" **Topsoil** 2-12" **Clay**, brown, 7.5YR 5/2, moist, stiff, low plasticity	CL	
10	5-10	26"	2-S	NA	0-4" **Clayey Sand**, gray, 7.5YR 5/1, wet, soft, poorly graded 4-26" **Clay**, brown, 7.5YR 5/4, moist, stiff, low plasticity	SC CL	
15	10-15	36"	3-S	NA	0-12" **Silty Sand**, brown, 7.5YR 5/2, wet, loose, poorly graded 12-36" **Clay**, pinkish gray, 7.5YR 6/2 with 7.5YR 5/8 mottles, moist, very stiff, low plasticity, little fine sand	SM CL	
	End of Boring						
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO30-DP02

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 2 feet bgs START : 4-16-10 END : 4-16-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	20"	1-S	NA	0-3" **Topsoil** 3-20" **Clayey Sand**, brown, 7.5YR 5/4, moist becoming wet at 10", dense, poorly graded, low plasticity	SC	Water measured at 20" through DPT hole
5							
	5-10	50"	2-S	NA	0-36" Same as above 36-50" **Clay**, gray, 7.5YR 6/1, moist to dry, very stiff, low plasticity, little fine sand	SC CL	
10	End of boring						
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO30-DP03

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 4 feet bgs START : 4-16-10 END : 4-16-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	14"	1-S	NA	0-6" **Topsoil** 6-14" **Clay**, gray, 7.5YR 5/1, moist to wet, soft, low plasticity	CL	Water measured at 4ft through DPT hole.
5							
	5 - 10	36"	2-S	NA	0-9" Same as above 9-36" **Clay**, gray, 7.5YR 5/1 with 7.5YR 5/8 mottles, dry, very stiff	CL	
10	End of boring						
15							
20							

CH2MHILL	PROJECT NUMBER	BORING NUMBER
	380785	ISUXO30-DP04

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 1 feet bgs START : 4-16-10 END : 4-16-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	9"	1-S	NA	0-9" **Poorly Graded Sand** with gravel, brownish yellow, 10YR 6/6, moist to wet, medium to coarse grained with sub-rounded gravel to 2" diammeter	SP	Water measured at 13" through DPT hole.
5	End of boring						
10							
15							
20							

CH2MHILL	PROJECT NUMBER	BORING NUMBER
	380785	ISUXO30-DP05

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 3.5 feet bgs START : 4-16-10 END : 4-16-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.)	USCS	COMMENTS
	0 - 5	36"	1-S	NA	0-7" **Topsoil** 7-24" **Clay**, strong brown, 7.5YR 4/6, moist, stiff, low plasticity 24-36" **Clayey Sand**, brown, 7.5YR 5/4 wet, stiff, low plasticity	 CL SC	Water measured at 3.5 ft through DPT hole
5	5-10	21"	2-S	NA	0-11" **Silty Sand**, brown, 7.5YR 5/4, wet, loose, fine to coarse grained with depth 11-21" **Clay**, gray, 5Y 6/1, dry, very stiff, low plasticity	SM CL	
10	End of boring						
15							
20							

PROJECT NUMBER	BORING NUMBER
380785	ISUXO30-DP06

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 21 feet bgs (est.) START : 4-14-10 END : 4-16-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
5	0 - 5	37"	1-S	NA	0-3" **Topsoil** 3-18" **Silty Sand**, strong brown, 7.5YR 5/6, moist, loose, fine-medium grained 18-37" **Clay**, light brownish gray, 10YR 6/2, moist, stiff, little mottling 2.5YR 4/6, low plasticity	SM CL	
10	5 - 10	60"	2-S	NA	0-21" **Clay**, light brownish gray, 10YR 6/2, dry, stiff, low plasticity 21-27" Same as above, except reddish brown, 2.5YR 4/4 27-41" Same as above 41-60" **Clay**, brownish yellow, 10YR 6/, dry, very stiff, low plasticity	CL	
12	10 - 12	21"	3-S	NA	0-21" **Clay**, light gray, 7.5YR 7/1, dry, very stiff, low plasticity		On first attempt on 4-14-10 sample liner stuck in Macro Core Sampler. Additional samples from 10ft onward were collected with a split spoon sampler.
14	12 - 14	24"	4-S	NA	0-24" Same as above except 5YR 6/4		
16	14 - 16	24"	5-S	NA	0-24" Same as above		
18	16 - 18	0"	2-Jun	NA	No recovery		Split spoon sampler broke off in hole due to metal fatigue from excessive hammer force.
	End of boring						
20							

CH2MHILL	PROJECT NUMBER	BORING NUMBER
	380785	ISUXO30-DP07

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 2 feet bgs START : 4-15-10 END : 4-15-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	22"	1-S	NA	0-3" **Topsoil** 3-22" **Silty Sand**, brown, 7.5YR 4/4, moist, loose, fine-medium grained	SM	Water measured at 2ft through DPT hole.
5	End of Boring						
10							
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO30-DP08

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 5 feet bgs START : 4-15-10 END : 4-15-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	24"	1-S	NA	0-2" **Topsoil** 2-24" **Silty Sand**, brown, 7.5YR 4/4, moist, loose, fine-medium grained	SM	
5							
	5-10	38"	2-S	NA	0-38" **Silty Sand**, brown, 7.5YR 4/4, wet, loose to dense, fine to medium grained	SM	
10	End of boring						
15							
20							

CH2MHILL	PROJECT NUMBER	BORING NUMBER
	380785	ISUXO30-DP09

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 11 feet bgs START : 4-15-10 END : 4-15-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	21"	1-S	NA	0-4" **Topsoil** 4-21" **Silty Sand**, brown, 7.5YR 4/4, moist, loose, fine-medium grained	SM	
5							
	5-10	17"	2-S	NA	0-17" Same as above	SM	
10							
	10-15	24"	3-S	NA	0-24" Same as above except wet at 19"	SM	
15							
	15-20	0"	4-S	NA	No Recovery		Sample material washed out by water
20	End of Boring						

CH2MHILL	PROJECT NUMBER	BORING NUMBER
	380785	ISUXO30-DP10

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 1.5 feet bgs START : 4-15-10 END : 4-15-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	30"	1-S	NA	0-3" **Topsoil** 3-30" **Poorly Graded Sand** with gravel, brown, 7.5YR 5/4, mosit to wet at 10", dense, 30% sub-rounded gravel	SP	Water measured at 18" through DPT hole.
5	End of Boring						
10							
15							
20							

CH2MHILL	PROJECT NUMBER	BORING NUMBER
	380785	ISUXO30-DP11

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 1 feet bgs START : 4-15-10 END : 4-15-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	8"	1-S	NA	0-8" **Poorly graded sand** with gravel, light brown, 7.5YR 6/4, moist, loose, sub-rounded gravel to .5" diameter	SP	Water measured at 13" through DPT hole.
5	End of Boring						
10							
15							
20							

CH2MHILL	PROJECT NUMBER 380785	BORING NUMBER ISUXO30-DP12

SOIL BORING LOG

PROJECT : UXO 30 LOCATION : Indian Head, MD

ELEVATION : DRILLING CONTRACTOR : Vironex

DRILLING METHOD AND EQUIPMENT USED : Direct Push Drill Rig

WATER LEVELS : Approx. 2 feet bgs START : 4-16-10 END : 4-16-10 LOGGER : A. Bogdanski

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS
	0 - 5	17"	1-S	NA	0-4" **Topsoil** 4-10" **Clay**, brown, 7.5YR 5/4, moist stiff, low plasticity 10-17" **Poorly Graded Sand** with gravel, brownish yellow, 10YR 6/6, moist to wet, loose, medium to coarse grained with sub rounded gravel to 2" in diameter	CL SP	Water measured at 2 ft through DPT hole.
5	End of Boring						
10							
15							
20							

Appendix E
IDW Analytical Results

ANALYSIS DATA SHEET

ISUXO06-IS052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Solid	Laboratory ID:	1005226-01	File ID:	0522601T.D
Sampled:	05/27/10 08:20	Prepared:	06/07/10 13:22	Analyzed:	06/07/10 23:51
Solids:		Preparation:	5030B	Dilution:	1

Batch: 0F07021 Sequence: 0F16109 Calibration: 0153002 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
71-43-2	Benzene		0.5	0.0100	U
78-93-3	2-Butanone		200	0.100	U
56-23-5	Carbon tetrachloride		0.5	0.0100	U
108-90-7	Chlorobenzene		100	0.0100	U
67-66-3	Chloroform		6	0.0100	U
106-46-7	1,4-Dichlorobenzene		7.5	0.0100	U
107-06-2	1,2-Dichloroethane		0.5	0.0100	U
75-35-4	1,1-Dichloroethene		0.7	0.0100	U
156-59-2	cis-1,2-Dichloroethene		0	0.0100	U
127-18-4	Tetrachloroethene		0.7	0.0100	U
79-01-6	Trichloroethene		0.5	0.0100	U
75-01-4	Vinyl chloride		0.2	0.0200	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	0.03000	0.02984	99.5	75 - 120	
Dibromofluoromethane	0.03000	0.03270	109	85 - 115	
1,2-Dichloroethane-d4	0.03000	0.03287	110	70 - 120	
Toluene-d8	0.03000	0.03093	103	85 - 120	

ANALYSIS DATA SHEET

ISUXO06-IW052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Ground Water	Laboratory ID:	1005226-02	File ID:	0522602T.D
Sampled:	05/27/10 08:45	Prepared:	06/03/10 12:00	Analyzed:	06/03/10 20:50
Solids:		Preparation:	5030B	Dilution:	10

Batch: 0F03020 Sequence: 0F15708 Calibration: 0152003 Instrument: MS-VOA4

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
71-43-2	Benzene		0.5	0.100	U
78-93-3	2-Butanone		200	1.00	U
56-23-5	Carbon tetrachloride		0.5	0.100	U
108-90-7	Chlorobenzene		100	0.100	U
67-66-3	Chloroform		6	0.100	U
106-46-7	1,4-Dichlorobenzene		7.5	0.100	U
107-06-2	1,2-Dichloroethane		0.5	0.100	U
75-35-4	1,1-Dichloroethene		0.7	0.100	U
156-59-2	cis-1,2-Dichloroethene		0	0.100	U
127-18-4	Tetrachloroethene		0.7	0.100	U
79-01-6	Trichloroethene		0.5	0.100	U
75-01-4	Vinyl chloride		0.2	0.200	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	0.03000	0.03030	101	75 - 120	
Dibromofluoromethane	0.03000	0.02888	96.3	85 - 115	
1,2-Dichloroethane-d4	0.03000	0.02818	93.9	70 - 120	
Toluene-d8	0.03000	0.03025	101	85 - 120	

ANALYSIS DATA SHEET

ISUXO30-IW052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Ground Water	Laboratory ID:	1005226-03	File ID:	0522603T.D
Sampled:	05/27/10 09:00	Prepared:	06/03/10 12:00	Analyzed:	06/03/10 21:20
Solids:		Preparation:	5030B	Dilution:	10

Batch: 0F03020 Sequence: 0F15708 Calibration: 0152003 Instrument: MS-VOA4

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
71-43-2	Benzene		0.5	0.100	U
78-93-3	2-Butanone		200	1.00	U
56-23-5	Carbon tetrachloride		0.5	0.100	U
108-90-7	Chlorobenzene		100	0.100	U
67-66-3	Chloroform		6	0.100	U
106-46-7	1,4-Dichlorobenzene		7.5	0.100	U
107-06-2	1,2-Dichloroethane		0.5	0.100	U
75-35-4	1,1-Dichloroethene		0.7	0.100	U
156-59-2	cis-1,2-Dichloroethene		0	0.100	U
127-18-4	Tetrachloroethene		0.7	0.100	U
79-01-6	Trichloroethene		0.5	0.100	U
75-01-4	Vinyl chloride		0.2	0.200	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	0.03000	0.03180	106	75 - 120	
Dibromofluoromethane	0.03000	0.03009	100	85 - 115	
1,2-Dichloroethane-d4	0.03000	0.02955	98.5	70 - 120	
Toluene-d8	0.03000	0.03204	107	85 - 120	

ANALYSIS DATA SHEET

ISUXO30-IS052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Solid	Laboratory ID:	1005226-04	File ID:	0522604T.D
Sampled:	05/27/10 09:15	Prepared:	06/07/10 13:22	Analyzed:	06/08/10 00:21
Solids:		Preparation:	5030B	Dilution:	1

Batch: 0F07021 Sequence: 0F16109 Calibration: 0153002 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
71-43-2	Benzene		0.5	0.0100	U
78-93-3	2-Butanone		200	0.100	U
56-23-5	Carbon tetrachloride		0.5	0.0100	U
108-90-7	Chlorobenzene		100	0.0100	U
67-66-3	Chloroform		6	0.0100	U
106-46-7	1,4-Dichlorobenzene		7.5	0.0100	U
107-06-2	1,2-Dichloroethane		0.5	0.0100	U
75-35-4	1,1-Dichloroethene		0.7	0.0100	U
156-59-2	cis-1,2-Dichloroethene		0	0.0100	U
127-18-4	Tetrachloroethene		0.7	0.0100	U
79-01-6	Trichloroethene		0.5	0.0100	U
75-01-4	Vinyl chloride		0.2	0.0200	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	0.03000	0.03022	101	75 - 120	
Dibromofluoromethane	0.03000	0.03244	108	85 - 115	
1,2-Dichloroethane-d4	0.03000	0.03411	114	70 - 120	
Toluene-d8	0.03000	0.03126	104	85 - 120	

ANALYSIS DATA SHEET

ISUXO06-IS052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Solid	Laboratory ID:	1005226-01	File ID:	0522601T.D
Sampled:	05/27/10 08:20	Prepared:	06/08/10 14:40	Analyzed:	06/25/10 06:47
Solids:		Preparation:	EXT_3510	Dilution:	1

Batch: 0F04016 Sequence: 0F17601 Calibration: 0110002 Instrument: MS-BNA1

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
106-46-7	1,4-Dichlorobenzene		0	0.00500	U
121-14-2	2,4-Dinitrotoluene		0.13	0.00500	U
118-74-1	Hexachlorobenzene		0.13	0.00500	U
87-68-3	Hexachlorobutadiene		0.5	0.00500	U
67-72-1	Hexachloroethane		3	0.00500	U
95-48-7	2-Methylphenol		200	0.00500	U
108-39-4	3-Methylphenol		200	0.00500	U
106-44-5	4-Methylphenol		200	0.00500	U
98-95-3	Nitrobenzene		2	0.00500	U
87-86-5	Pentachlorophenol		100	0.0200	U
110-86-1	Pyridine		5	0.00500	U
88-06-2	2,4,6-Trichlorophenol		2	0.00500	U
95-95-4	2,4,5-Trichlorophenol		400	0.00500	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
2-Fluorobiphenyl	0.5000	0.4340	86.8	50 - 110	
2-Fluorophenol	1.000	0.3932	39.3	20 - 110	
Nitrobenzene-d5	0.5000	0.4179	83.6	40 - 110	
Phenol-d6	1.000	0.2439	24.4	15 - 110	
Terphenyl-d14	0.5000	0.4573	91.5	50 - 135	
2,4,6-Tribromophenol	1.000	0.8337	83.4	40 - 125	

ANALYSIS DATA SHEET

ISUXO06-IW052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Ground Water	Laboratory ID:	1005226-02	File ID:	0522602T.D
Sampled:	05/27/10 08:45	Prepared:	06/08/10 14:40	Analyzed:	06/25/10 07:19
Solids:		Preparation:	EXT_3510	Dilution:	1

Batch: 0F04016 Sequence: 0F17601 Calibration: 0110002 Instrument: MS-BNA1

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
106-46-7	1,4-Dichlorobenzene		0	0.00500	U
121-14-2	2,4-Dinitrotoluene		0.13	0.00500	U
118-74-1	Hexachlorobenzene		0.13	0.00500	U
87-68-3	Hexachlorobutadiene		0.5	0.00500	U
67-72-1	Hexachloroethane		3	0.00500	U
95-48-7	2-Methylphenol		200	0.00500	U
108-39-4	3-Methylphenol	0.0241	200	0.00500	
106-44-5	4-Methylphenol	0.0241	200	0.00500	
98-95-3	Nitrobenzene		2	0.00500	U
87-86-5	Pentachlorophenol		100	0.0200	U
110-86-1	Pyridine		5	0.00500	U
88-06-2	2,4,6-Trichlorophenol		2	0.00500	U
95-95-4	2,4,5-Trichlorophenol		400	0.00500	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
2-Fluorobiphenyl	0.5000	0.2820	56.4	50 - 110	
2-Fluorophenol	1.000	0.1902	19.0	20 - 110	*
Nitrobenzene-d5	0.5000	0.2903	58.1	40 - 110	
Phenol-d6	1.000	0.1432	14.3	15 - 110	*
Terphenyl-d14	0.5000	0.2596	51.9	50 - 135	
2,4,6-Tribromophenol	1.000	0.5708	57.1	40 - 125	

ANALYSIS DATA SHEET

ISUXO30-IW052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Ground Water	Laboratory ID:	1005226-03	File ID:	0522603T.D
Sampled:	05/27/10 09:00	Prepared:	06/08/10 14:40	Analyzed:	06/25/10 14:47
Solids:		Preparation:	EXT_3510	Dilution:	1

Batch: 0F04016 Sequence: 0F17612 Calibration: 0110002 Instrument: MS-BNA1

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
106-46-7	1,4-Dichlorobenzene		0	0.00500	U
121-14-2	2,4-Dinitrotoluene		0.13	0.00500	U
118-74-1	Hexachlorobenzene		0.13	0.00500	U
87-68-3	Hexachlorobutadiene		0.5	0.00500	U
67-72-1	Hexachloroethane		3	0.00500	U
95-48-7	2-Methylphenol		200	0.00500	U
108-39-4	3-Methylphenol		200	0.00500	Y, U
106-44-5	4-Methylphenol		200	0.00500	Y, U
98-95-3	Nitrobenzene		2	0.00500	X, U
87-86-5	Pentachlorophenol		100	0.0200	U
110-86-1	Pyridine		5	0.00500	U
88-06-2	2,4,6-Trichlorophenol		2	0.00500	U
95-95-4	2,4,5-Trichlorophenol		400	0.00500	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
2-Fluorobiphenyl	0.5000	0.2519	50.4	50 - 110	
2-Fluorophenol	1.000	0.1922	19.2	20 - 110	*
Nitrobenzene-d5	0.5000	0.2666	53.3	40 - 110	
Phenol-d6	1.000	0.1306	13.1	15 - 110	*
Terphenyl-d14	0.5000	0.07632	15.3	50 - 135	*
2,4,6-Tribromophenol	1.000	0.4947	49.5	40 - 125	

ANALYSIS DATA SHEET

ISUXO30-IS052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Solid	Laboratory ID:	1005226-04	File ID:	0522604T.D
Sampled:	05/27/10 09:15	Prepared:	06/08/10 14:40	Analyzed:	06/25/10 07:52
Solids:		Preparation:	EXT_3510	Dilution:	1

Batch: 0F04016 Sequence: 0F17601 Calibration: 0110002 Instrument: MS-BNA1

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
106-46-7	1,4-Dichlorobenzene		0	0.00500	U
121-14-2	2,4-Dinitrotoluene		0.13	0.00500	U
118-74-1	Hexachlorobenzene		0.13	0.00500	U
87-68-3	Hexachlorobutadiene		0.5	0.00500	U
67-72-1	Hexachloroethane		3	0.00500	U
95-48-7	2-Methylphenol		200	0.00500	U
108-39-4	3-Methylphenol		200	0.00500	U
106-44-5	4-Methylphenol		200	0.00500	U
98-95-3	Nitrobenzene		2	0.00500	U
87-86-5	Pentachlorophenol		100	0.0200	U
110-86-1	Pyridine		5	0.00500	U
88-06-2	2,4,6-Trichlorophenol		2	0.00500	U
95-95-4	2,4,5-Trichlorophenol		400	0.00500	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
2-Fluorobiphenyl	0.5000	0.4216	84.3	50 - 110	
2-Fluorophenol	1.000	0.3847	38.5	20 - 110	
Nitrobenzene-d5	0.5000	0.4390	87.8	40 - 110	
Phenol-d6	1.000	0.2453	24.5	15 - 110	
Terphenyl-d14	0.5000	0.4559	91.2	50 - 135	
2,4,6-Tribromophenol	1.000	0.7538	75.4	40 - 125	

ANALYSIS DATA SHEET

ISUXO06-IS052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Solid	Laboratory ID:	1005226-01	File ID:	038F3901.D
Sampled:	05/27/10 08:20	Prepared:	06/08/10 15:20	Analyzed:	06/28/10 02:12
Solids:		Preparation:	EXT_3510	Dilution:	1

Batch: 0F04013 Sequence: 0F18035 Calibration: 0180004 Instrument: GL-ECD4

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
72-20-8	Endrin		0.02	0.000200	U
58-89-9	gamma-BHC (Lindane)		0.4	0.00100	U
76-44-8	Heptachlor		0.008	0.00100	U
1024-57-3	Heptachlor epoxide		0.008	0.00100	U
72-43-5	Methoxychlor		10	0.00100	U
57-74-9	Chlordane (tech)		0.03	0.000500	U
8001-35-2	Toxaphene		0.5	0.0100	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
Tetrachloro-m-xylene	0.005000	0.002911	58.2	25 - 140	
Tetrachloro-m-xylene [2C]	0.005000	0.003077	61.5	25 - 140	
Decachlorobiphenyl	0.005000	0.001800	36.0	40 - 135	*
Decachlorobiphenyl [2C]	0.005000	0.001464	29.3	40 - 135	*

* Values outside of QC limits

ANALYSIS DATA SHEET

ISUXO06-IW052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Ground Water	Laboratory ID:	1005226-02	File ID:	041F4201.D
Sampled:	05/27/10 08:45	Prepared:	06/08/10 15:20	Analyzed:	06/28/10 03:09
Solids:		Preparation:	EXT_3510	Dilution:	1

Batch: 0F04013 Sequence: 0F18035 Calibration: 0180004 Instrument: GL-ECD4

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
72-20-8	Endrin		0.02	0.000200	U
58-89-9	gamma-BHC (Lindane)		0.4	0.00100	U
76-44-8	Heptachlor		0.008	0.00100	U
1024-57-3	Heptachlor epoxide		0.008	0.00100	U
72-43-5	Methoxychlor		10	0.00100	U
57-74-9	Chlordane (tech)		0.03	0.000500	U
8001-35-2	Toxaphene		0.5	0.0100	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
Tetrachloro-m-xylene	0.005000	0.003110	62.2	25 - 140	
Tetrachloro-m-xylene [2C]	0.005000	0.002824	56.5	25 - 140	
Decachlorobiphenyl	0.005000	0.0001046	2.09	40 - 135	*
Decachlorobiphenyl [2C]	0.005000	0.00008157	1.63	40 - 135	*

* Values outside of QC limits

ANALYSIS DATA SHEET

ISUXO30-IW052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Ground Water	Laboratory ID:	1005226-03	File ID:	042F4301.D
Sampled:	05/27/10 09:00	Prepared:	06/08/10 15:20	Analyzed:	06/28/10 03:28
Solids:		Preparation:	EXT_3510	Dilution:	1

Batch: 0F04013 Sequence: 0F18035 Calibration: 0180004 Instrument: GL-ECD4

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
72-20-8	Endrin	0.000124	0.02	0.000200	JXP
58-89-9	gamma-BHC (Lindane)		0.4	0.00100	U
76-44-8	Heptachlor		0.008	0.00100	U
1024-57-3	Heptachlor epoxide		0.008	0.00100	U
72-43-5	Methoxychlor		10	0.00100	U
57-74-9	Chlordane (tech)		0.03	0.000500	U
8001-35-2	Toxaphene		0.5	0.0100	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
Tetrachloro-m-xylene	0.005000	0.002593	51.9	25 - 140	
Tetrachloro-m-xylene [2C]	0.005000	0.002503	50.1	25 - 140	
Decachlorobiphenyl	0.005000	0.0001590	3.18	40 - 135	*
Decachlorobiphenyl [2C]	0.005000	0.0001287	2.57	40 - 135	*

* Values outside of QC limits

ANALYSIS DATA SHEET

ISUXO30-IS052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Solid	Laboratory ID:	1005226-04	File ID:	043F4401.D
Sampled:	05/27/10 09:15	Prepared:	06/08/10 15:20	Analyzed:	06/28/10 03:47
Solids:		Preparation:	EXT_3510	Dilution:	1

Batch: 0F04013 Sequence: 0F18035 Calibration: 0180004 Instrument: GL-ECD4

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
72-20-8	Endrin		0.02	0.000200	U
58-89-9	gamma-BHC (Lindane)		0.4	0.00100	U
76-44-8	Heptachlor		0.008	0.00100	U
1024-57-3	Heptachlor epoxide		0.008	0.00100	U
72-43-5	Methoxychlor		10	0.00100	U
57-74-9	Chlordane (tech)		0.03	0.000500	U
8001-35-2	Toxaphene		0.5	0.0100	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
Tetrachloro-m-xylene	0.005000	0.003510	70.2	25 - 140	
Tetrachloro-m-xylene [2C]	0.005000	0.003692	73.8	25 - 140	
Decachlorobiphenyl	0.005000	0.001559	31.2	40 - 135	*
Decachlorobiphenyl [2C]	0.005000	0.001336	26.7	40 - 135	*

* Values outside of QC limits

ANALYSIS DATA SHEET

ISUXO06-IS052710

Laboratory:	Empirical Laboratories, LLC			SDG:	1005226
Client:	CH2M Hill, Inc.			Project:	Indian Head CTO-012 IH 2010
Matrix:	Solid	Laboratory ID:	1005226-01	File ID:	005F0501.D
Sampled:	05/27/10 08:20	Prepared:	06/09/10 14:55	Analyzed:	06/12/10 17:58
Solids:		Preparation:	EXT_8151	Dilution:	1

Batch: 0F09011 Sequence: 0F17029 Calibration: 0162001 Instrument: GL-ECD3

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
93-72-1	2,4,5-TP (Silvex)		1	0.000500	U
94-75-7	2,4-D		10	0.00500	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
2,4-Dichlorophenylacetic acid	0.01000	0.004489	44.9	20 - 140	
2,4-Dichlorophenylacetic acid [2C]	0.01000	0.003426	34.3	20 - 140	

* Values outside of QC limits

ANALYSIS DATA SHEET

ISUXO06-IW052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Ground Water	Laboratory ID:	1005226-02	File ID:	008R0801.D
Sampled:	05/27/10 08:45	Prepared:	06/09/10 14:55	Analyzed:	06/12/10 20:08
Solids:		Preparation:	EXT_8151	Dilution:	1

Batch: 0F09011 Sequence: 0F17029 Calibration: 0162001 Instrument: GL-ECD3

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
93-72-1	2,4,5-TP (Silvex)		1	0.000500	U
94-75-7	2,4-D		10	0.00500	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
2,4-Dichlorophenylacetic acid	0.01000	0.002940	29.4	20 - 140	
2,4-Dichlorophenylacetic acid [2C]	0.01000	0.002836	28.4	20 - 140	

* Values outside of QC limits

ANALYSIS DATA SHEET

ISUXO30-IW052710

Laboratory:	Empirical Laboratories, LLC			SDG:	1005226
Client:	CH2M Hill, Inc.			Project:	Indian Head CTO-012 IH 2010
Matrix:	Ground Water	Laboratory ID:	1005226-03	File ID:	009R0901.D
Sampled:	05/27/10 09:00	Prepared:	06/09/10 14:55	Analyzed:	06/12/10 20:52
Solids:		Preparation:	EXT_8151	Dilution:	1

Batch: 0F09011 Sequence: 0F17029 Calibration: 0162001 Instrument: GL-ECD3

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
93-72-1	2,4,5-TP (Silvex)		1	0.000500	U
94-75-7	2,4-D		10	0.00500	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
2,4-Dichlorophenylacetic acid	0.01000	0.002001	20.0	20 - 140	
2,4-Dichlorophenylacetic acid [2C]	0.01000	0.001040	10.4	20 - 140	*

* Values outside of QC limits

ANALYSIS DATA SHEET

ISUXO30-IS052710

Laboratory:	Empirical Laboratories, LLC		SDG:	1005226	
Client:	CH2M Hill, Inc.		Project:	Indian Head CTO-012 IH 2010	
Matrix:	Solid	Laboratory ID:	1005226-04	File ID:	007F0701.D
Sampled:	05/27/10 09:15	Prepared:	06/09/10 14:55	Analyzed:	06/12/10 19:25
Solids:		Preparation:	EXT_8151	Dilution:	1

Batch: 0F09011 Sequence: 0F17029 Calibration: 0162001 Instrument: GL-ECD3

CAS NO.	COMPOUND	CONC. (mg/L)	TCLP Reg Limit	MRL	Q
93-72-1	2,4,5-TP (Silvex)		1	0.000500	U
94-75-7	2,4-D		10	0.00500	U

SYSTEM MONITORING COMPOUND	ADDED (mg/L)	CONC (mg/L)	% REC	QC LIMITS	Q
2,4-Dichlorophenylacetic acid	0.01000	0.004886	48.9	20 - 140	
2,4-Dichlorophenylacetic acid [2C]	0.01000	0.004208	42.1	20 - 140	

* Values outside of QC limits

ANALYSIS DATA SHEET

ISUXO06-IS052710

Laboratory: Empirical Laboratories, LLC
Client: CH2M Hill, Inc.
Matrix: Solid
Sampled: 05/27/10 08:20
% Solids: 0.00

SDG: 1005226
Project: Indian Head CTO-012 IH 2010
Laboratory ID: 1005226-01
Received: 05/28/10 08:45

CAS NO.	Analyte	Conc. (mg/L)	MDL	RL	D.F.	Q	Method	Batch	Analyzed
7439-97-6	Mercury TCLP		0.000800	0.00200	1	U	SW7470A	0F08004	06/09/10 08:44
7440-38-2	Arsenic TCLP		0.0300	0.100	1	U	SW6010B	0F08001	06/10/10 22:56
7440-39-3	Barium TCLP	0.305	0.0500	0.400	1	J	SW6010B	0F08001	06/09/10 14:32
7440-43-9	Cadmium TCLP	0.0208	0.0100	0.0500	1	J	SW6010B	0F08001	06/09/10 14:32
7440-47-3	Chromium TCLP		0.0200	0.100	1	Y U	SW6010B	0F08001	06/09/10 14:32
7439-92-1	Lead TCLP		0.0150	0.0300	1	U	SW6010B	0F08001	06/09/10 14:32
7782-49-2	Selenium TCLP	0.0493	0.0300	0.0600	1	J	SW6010B	0F08001	06/09/10 14:32
7440-22-4	Silver TCLP		0.0100	0.100	1	U	SW6010B	0F08001	06/09/10 14:32
CAS NO.	**Analyte**	**Conc. (mg/Kg dry)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
57-12-5	Cyanide		0.148	0.296	1	U	SW9012A	0F07018	06/08/10 14:11

ANALYSIS DATA SHEET

ISUXO06-IW052710

Laboratory: Empirical Laboratories, LLC
Client: CH2M Hill, Inc.
Matrix: Ground Water
Sampled: 05/27/10 08:45
% Solids: 0.00

SDG: 1005226
Project: Indian Head CTO-012 IH 2010
Laboratory ID: 1005226-02
Received: 05/28/10 08:45

CAS NO.	Analyte	Conc. (mg/L)	MDL	RL	D.F.	Q	Method	Batch	Analyzed
57-12-5	Cyanide	0.0853	0.00500	0.0100	1	N	SW9012A	0F07017	06/08/10 14:02
7439-97-6	Mercury TCLP		0.000800	0.00200	1	U	SW7470A	0F08004	06/09/10 08:46
7440-38-2	Arsenic TCLP		0.0300	0.100	1	U	SW6010B	0F08001	06/09/10 14:37
7440-39-3	Barium TCLP	0.403	0.0500	0.400	1		SW6010B	0F08001	06/09/10 14:37
7440-43-9	Cadmium TCLP	0.0258	0.0100	0.0500	1	J	SW6010B	0F08001	06/09/10 14:37
7440-47-3	Chromium TCLP	0.211	0.0200	0.100	1	Y	SW6010B	0F08001	06/09/10 14:37
7439-92-1	Lead TCLP	0.0260	0.0150	0.0300	1	J	SW6010B	0F08001	06/09/10 14:37
7782-49-2	Selenium TCLP	0.0569	0.0300	0.0600	1	J	SW6010B	0F08001	06/09/10 14:37
7440-22-4	Silver TCLP		0.0100	0.100	1	U	SW6010B	0F08001	06/09/10 14:37

ANALYSIS DATA SHEET

ISUXO30-IW052710

Laboratory: Empirical Laboratories, LLC
Client: CH2M Hill, Inc.
Matrix: Ground Water
Sampled: 05/27/10 09:00
% Solids: 0.00

SDG: 1005226
Project: Indian Head CTO-012 IH 2010
Laboratory ID: 1005226-03
Received: 05/28/10 08:45

CAS NO.	Analyte	Conc. (mg/L)	MDL	RL	D.F.	Q	Method	Batch	Analyzed
57-12-5	Cyanide	0.104	0.00500	0.0100	1	N	SW9012A	0F07017	06/08/10 14:08
7439-97-6	Mercury TCLP	0.00103	0.000800	0.00200	1	J	SW7470A	0F08004	06/09/10 08:47
7440-38-2	Arsenic TCLP	0.0347	0.0300	0.100	1	J	SW6010B	0F08001	06/09/10 14:42
7440-39-3	Barium TCLP	0.563	0.0500	0.400	1		SW6010B	0F08001	06/09/10 14:42
7440-43-9	Cadmium TCLP	0.0218	0.0100	0.0500	1	J	SW6010B	0F08001	06/09/10 14:42
7440-47-3	Chromium TCLP	0.394	0.0200	0.100	1	Y	SW6010B	0F08001	06/09/10 14:42
7439-92-1	Lead TCLP	0.403	0.0150	0.0300	1		SW6010B	0F08001	06/09/10 14:42
7782-49-2	Selenium TCLP	0.0643	0.0300	0.0600	1		SW6010B	0F08001	06/09/10 14:42
7440-22-4	Silver TCLP		0.0100	0.100	1	U	SW6010B	0F08001	06/09/10 14:42

ANALYSIS DATA SHEET

ISUXO30-IS052710

Laboratory: Empirical Laboratories, LLC
Client: CH2M Hill, Inc.
Matrix: Solid
Sampled: 05/27/10 09:15
% Solids: 0.00

SDG: 1005226
Project: Indian Head CTO-012 IH 2010
Laboratory ID: 1005226-04
Received: 05/28/10 08:45

CAS NO.	Analyte	Conc. (mg/L)	MDL	RL	D.F.	Q	Method	Batch	Analyzed
7439-97-6	Mercury TCLP		0.000800	0.00200	1	U	SW7470A	0F08004	06/09/10 08:48
7440-38-2	Arsenic TCLP		0.0300	0.100	1	U	SW6010B	0F08001	06/09/10 14:47
7440-39-3	Barium TCLP	0.643	0.0500	0.400	1		SW6010B	0F08001	06/09/10 14:47
7440-43-9	Cadmium TCLP	0.0234	0.0100	0.0500	1	J	SW6010B	0F08001	06/09/10 14:47
7440-47-3	Chromium TCLP		0.0200	0.100	1	Y U	SW6010B	0F08001	06/09/10 14:47
7439-92-1	Lead TCLP		0.0150	0.0300	1	U	SW6010B	0F08001	06/09/10 14:47
7782-49-2	Selenium TCLP	0.0590	0.0300	0.0600	1	J	SW6010B	0F08001	06/09/10 14:47
7440-22-4	Silver TCLP		0.0100	0.100	1	U	SW6010B	0F08001	06/09/10 14:47
CAS NO.	**Analyte**	**Conc. (mg/Kg dry)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
57-12-5	Cyanide		0.176	0.351	1	U	SW9012A	0F07018	06/08/10 14:12

ANALYSIS DATA SHEET

ISUXO06-IS052710

Laboratory: Empirical Laboratories, LLC
Client: CH2M Hill, Inc.
Matrix: Solid
Sampled: 05/27/10 08:20
% Solids: 0.00

SDG: 1005226
Project: Indian Head CTO-012 IH 2010
Laboratory ID: 1005226-01
Received: 05/28/10 08:45

CAS NO.	Analyte	Conc. (pH Units)	MDL	RL	D.F.	Q	Method	Batch	Analyzed
GIS-210-014	Corrosivity	3.63	0.100	0.100	1		SW9045B	0F08017	06/01/10 12:24
CAS NO.	**Analyte**	**Conc. (mg/Kg)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
C-015	Reactive Sulfide		50.0	150	1	U	WChap.7.3.4.2MODIFIE	0F14023	06/14/10 16:22
CAS NO.	**Analyte**	**Conc. (°F)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
	Ignitability	> 158			1		SW1010A	0F02002	06/07/10 16:39

ANALYSIS DATA SHEET

ISUXO06-IW052710

Laboratory:	Empirical Laboratories, LLC	SDG:	1005226
Client:	CH2M Hill, Inc.	Project:	Indian Head CTO-012 IH 2010
Matrix:	Ground Water	Laboratory ID:	1005226-02
Sampled:	05/27/10 08:45	Received:	05/28/10 08:45
% Solids:	0.00		

CAS NO.	Analyte	Conc. (pH Units)	MDL	RL	D.F.	Q	Method	Batch	Analyzed
GIS-210-014	Corrosivity	9.27	0.100	0.100	1		SW9040B	0F07005	06/02/10 11:58
CAS NO.	**Analyte**	**Conc. (mg/L)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
C-015	Reactive Sulfide		50.0	150	1	U	WChap.7.3.4.2MODIFIE	0F09014	06/09/10 15:28
CAS NO.	**Analyte**	**Conc. (°F)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
NA	Flashpoint	> 158			1		SW1010A	0F02002	06/07/10 16:39

ANALYSIS DATA SHEET

ISUXO30-IW052710

Laboratory: Empirical Laboratories, LLC
Client: CH2M Hill, Inc.
Matrix: Ground Water
Sampled: 05/27/10 09:00
% Solids: 0.00

SDG: 1005226
Project: Indian Head CTO-012 IH 2010
Laboratory ID: 1005226-03
Received: 05/28/10 08:45

CAS NO.	Analyte	Conc. (pH Units)	MDL	RL	D.F.	Q	Method	Batch	Analyzed
GIS-210-014	Corrosivity	8.89	0.100	0.100	1		SW9040B	0F07005	06/02/10 11:58
CAS NO.	**Analyte**	**Conc. (mg/L)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
C-015	Reactive Sulfide		50.0	150	1	U	WChap.7.3.4.2MODIFIE	0F09014	06/09/10 15:29
CAS NO.	**Analyte**	**Conc. (°F)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
NA	Flashpoint	> 158			1		SW1010A	0F02002	06/07/10 16:39

ANALYSIS DATA SHEET

ISUXO30-IS052710

Laboratory: Empirical Laboratories, LLC
Client: CH2M Hill, Inc.
Matrix: Solid
Sampled: 05/27/10 09:15
% Solids: 0.00

SDG: 1005226
Project: Indian Head CTO-012 IH 2010
Laboratory ID: 1005226-04
Received: 05/28/10 08:45

CAS NO.	Analyte	Conc. (pH Units)	MDL	RL	D.F.	Q	Method	Batch	Analyzed
GIS-210-014	Corrosivity	3.90	0.100	0.100	1		SW9045B	0F08017	06/01/10 12:24
CAS NO.	**Analyte**	**Conc. (mg/Kg)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
C-015	Reactive Sulfide		50.0	150	1	U	WChap.7.3.4.2MODIFIE	0F14023	06/14/10 16:23
CAS NO.	**Analyte**	**Conc. (°F)**	**MDL**	**RL**	**D.F.**	**Q**	**Method**	**Batch**	**Analyzed**
	Ignitability	> 158			1		SW1010A	0F02002	06/07/10 16:39

Table E-1
UXO 6 Water IDW Anaytical Results
SI Report
NSF-IH, Indian Head, MD

Sample ID	ISUXO06-IW052710
Sample Date	5/27/10
Chemical Name	
TCLP Volatile Organic Compounds (MG/L)	
1,1-Dichloroethene	0.1 U
1,2-Dichloroethane	0.1 U
2-Butanone	1 U
Benzene	0.1 U
Carbon tetrachloride	0.1 U
Chlorobenzene	0.1 U
Chloroform	0.1 U
cis-1,2-Dichloroethene	0.1 U
Tetrachloroethene	0.1 U
Trichloroethene	0.1 U
Vinyl chloride	0.2 U
TCLP Semivolatile Organic Compounds (MG/L)	
1,4-Dichlorobenzene	0.005 U
2,4,5-Trichlorophenol	0.005 U
2,4,6-Trichlorophenol	0.005 U
2,4-Dinitrotoluene	0.005 U
2-Methylphenol	0.005 U
3- and 4-Methylphenol	0.0241
Hexachlorobenzene	0.005 U
Hexachlorobutadiene	0.005 U
Hexachloroethane	0.005 U
Nitrobenzene	0.005 U
Pentachlorophenol	0.02 U
Pyridine	0.005 U
TCLP Pesticides/Polychlorinated Biphenyls (MG/L)	
Chlordane	0.0005 U
Endrin	0.0002 U
gamma-BHC (Lindane)	0.001 U
Heptachlor	0.001 U
Heptachlor epoxide	0.001 U
Methoxychlor	0.001 U
Toxaphene	0.01 U
TCLP Herbicides (MG/L)	
2,4,5-TP (Silvex)	0.0005 U
2,4-D	0.005 U
TCLP Metals (MG/L)	
Arsenic	0.1 U
Barium	0.403
Cadmium	0.0258 J
Chromium	0.211
Lead	0.026 J
Mercury	0.002 U
Selenium	0.0569 J
Silver	0.1 U
Wet Chemistry (MG/L)	
Cyanide	0.0853
Reactive Sulfide	150 U
Corrosivity (PH)	
Corrosivity (pH Units)	9.27
Ignitability (DEG/F)	
Flash point	158 >

Notes:

J - Analyte present. Value may or may not be accurate or precise

NS - Not sampled

U - The material was analyzed for, but not detected

DEG/F - Degrees Fahrenheit

MG/L - Milligrams per liter

PH - pH units

> the sample did not ignite at the temperature

Indian Head
CTO-12, Site-UXO 6
Water IDW Detected Analytical Results
May 2010 - Unvalidated

Sample ID		ISUXO06-IW052710
Sample Date	**TCLP Limits**	5/27/10
Chemical Name		
TCLP Volatile Organic Compounds (MG/L)		
No Detections		
TCLP Semivolatile Organic Compounds (MG/L)		
3- and 4-Methylphenol		0.0241
TCLP Pesticides/Polychlorinated Biphenyls (MG/L)		
No Detections		
TCLP Herbicides (MG/L)		
No Detections		
TCLP Metals (MG/L)		
Barium	100	0.403
Cadmium	1	0.0258 J
Chromium	5	0.211
Lead	5	0.026 J
Selenium	1	0.0569 J
Wet Chemistry (MG/L)		
Cyanide	NSL	0.0853
Corrosivity (PH)		
Corrosivity (pH Units)	<2 or >12.5	9.27
Ignitability (DEG/F)		
Flash point	<140	158 >

Notes:

Shading indicates detection

J - Analyte present. Value may or may not be accurate or precise

NS - Not sampled

NSL- No Screening Limit. 200 mg/kg for solid samples.

U - The material was analyzed for, but not detected

DEG/F - Degrees Fahrenheit

MG/L - Milligrams per liter

PH - pH units

> the sample did not ignite at the temperature

Table E-2
UXO 6 Solid IDW Analytical Results
SI Report
NSF-IH, Indian Head, MD

Sample ID	ISUXO06-IS052710
Sample Date	5/27/10
Chemical Name	
TCLP Volatile Organic Compounds (MG/L)	
1,1-Dichloroethene	0.01 U
1,2-Dichloroethane	0.01 U
2-Butanone	0.1 U
Benzene	0.01 U
Carbon tetrachloride	0.01 U
Chlorobenzene	0.01 U
Chloroform	0.01 U
cis-1,2-Dichloroethene	0.01 U
Tetrachloroethene	0.01 U
Trichloroethene	0.01 U
Vinyl chloride	0.02 U
TCLP Semivolatile Organic Compounds (MG/L)	
1,4-Dichlorobenzene	0.005 U
2,4,5-Trichlorophenol	0.005 U
2,4,6-Trichlorophenol	0.005 U
2,4-Dinitrotoluene	0.005 U
2-Methylphenol	0.005 U
3-Methylphenol	0.005 U
4-Methylphenol	0.005 U
Hexachlorobenzene	0.005 U
Hexachlorobutadiene	0.005 U
Hexachloroethane	0.005 U
Nitrobenzene	0.005 U
Pentachlorophenol	0.02 U
Pyridine	0.005 U
TCLP Pesticides/Polychlorinated Biphenyls (MG/L)	
Chlordane	0.0005 U
Endrin	0.0002 U
gamma-BHC (Lindane)	0.001 U
Heptachlor	0.001 U
Heptachlor epoxide	0.001 U
Methoxychlor	0.001 U
Toxaphene	0.01 U
TCLP Herbicides (MG/L)	
2,4,5-TP (Silvex)	0.0005 U
2,4-D	0.005 U
TCLP Metals (MG/L)	
Arsenic	0.1 U
Barium	0.305 J
Cadmium	0.0208 J
Chromium	0.1 U
Lead	0.03 U
Mercury	0.002 U
Selenium	0.0493 J
Silver	0.1 U
Wet Chemistry (MG/KG)	
Cyanide	0.296 U
Reactive Sulfide	150 U
Corrosivity (PH)	
Corrosivity (pH Units)	3.63
Ignitability (DEG/F)	
Ignitability	158 >

Notes:

J - Analyte present. Value may or may not be accurate or precise
NS - Not sampled
U - The material was analyzed for, but not detected
DEG/F - Degrees Fahrenheit
MG/KG - Milligrams per kilogram
MG/L - Milligrams per liter
PH - pH units
> the sample did not ignite at the temperature

Indian Head
CTO-12, Site-UXO 6
Soil IDW Detected Analytical Results
May 2010 - Unvalidated

Sample ID		ISUXO06-IS052710
Sample Date	**TCLP Limits**	5/27/10
Chemical Name		
TCLP Volatile Organic Compounds (MG/L)		
No Detections		
TCLP Semivolatile Organic Compounds (MG/L)		
No Detections		
TCLP Pesticides/Polychlorinated Biphenyls (MG/L)		
No Detections		
TCLP Herbicides (MG/L)		
No Detections		
TCLP Metals (MG/L)		
Barium	100	0.305 J
Cadmium	1	0.0208 J
Selenium	1	0.0493 J
Wet Chemistry (MG/KG)		
No Detections		
Corrosivity (PH)		
Corrosivity (pH Units)	<2 or >12.5	3.63
Ignitability (DEG/F)		
Ignitability - No samples ignited	<140	158 >

Notes:

Shading indicates detection

J - Analyte present. Value may or may not be accurate or precise

NS - Not sampled

U - The material was analyzed for, but not detected

DEG/F - Degrees Fahrenheit

MG/KG - Milligrams per kilogram

MG/L - Milligrams per liter

PH - pH units

> the sample did not ignite at the temperature

Table E-3
UXO 30 Water IDW Analytical Results
SI Report
NSF-IH, Indian Head, MD

Sample ID	ISUXO30-IW052710
Sample Date	5/27/10
Chemical Name	
TCLP Volatile Organic Compounds (MG/L)	
1,1-Dichloroethene	0.1 U
1,2-Dichloroethane	0.1 U
2-Butanone	1 U
Benzene	0.1 U
Carbon tetrachloride	0.1 U
Chlorobenzene	0.1 U
Chloroform	0.1 U
cis-1,2-Dichloroethene	0.1 U
Tetrachloroethene	0.1 U
Trichloroethene	0.1 U
Vinyl chloride	0.2 U
TCLP Semivolatile Organic Compounds (MG/L)	
1,4-Dichlorobenzene	0.005 U
2,4,5-Trichlorophenol	0.005 U
2,4,6-Trichlorophenol	0.005 U
2,4-Dinitrotoluene	0.005 U
2-Methylphenol	0.005 U
3-Methylphenol	0.005 U
4-Methylphenol	0.005 U
Hexachlorobenzene	0.005 U
Hexachlorobutadiene	0.005 U
Hexachloroethane	0.005 U
Nitrobenzene	0.005 U
Pentachlorophenol	0.02 U
Pyridine	0.005 U
TCLP Pesticides/Polychlorinated Biphenyls (MG/L)	
Chlordane	0.0005 U
Endrin	1.24E-04 J
gamma-BHC (Lindane)	0.001 U
Heptachlor	0.001 U
Heptachlor epoxide	0.001 U
Methoxychlor	0.001 U
Toxaphene	0.01 U
TCLP Herbicides (MG/L)	
2,4,5-TP (Silvex)	0.0005 U
2,4-D	0.005 U
TCLP Metals (MG/L)	
Arsenic	0.0347 J
Barium	0.563
Cadmium	0.0218 J
Chromium	0.394
Lead	0.403
Mercury	0.00103 J
Selenium	0.0643
Silver	0.1 U
Wet Chemistry (MG/L)	
Cyanide	0.104
Reactive Sulfide	150 U
Corrosivity (PH)	
Corrosivity (pH Units)	8.89
Ignitability (DEG/F)	
Flash point	158 >

Notes:

J - Analyte present. Value may or may not be accurate or precise
NS - Not sampled
U - The material was analyzed for, but not detected
DEG/F - Degrees Fahrenheit
MG/L - Milligrams per liter
PH - pH units
> the sample did not ignite at the temperature

Indian Head
CTO-12, Site-UXO 30
Water IDW Detected Analytical Results
May 2010 - Unvalidated

Sample ID		ISUXO30-IW052710
Sample Date	**TCLP Limits**	5/27/10
Chemical Name		
TCLP Volatile Organic Compounds (MG/L)		
No Detections		
TCLP Semivolatile Organic Compounds (MG/L)		
No Detections		
TCLP Pesticides/Polychlorinated Biphenyls (MG/L)		
Endrin	0.02	0.000124 J
TCLP Herbicides (MG/L)		
No Detections		
TCLP Metals (MG/L)		
Arsenic	5	0.0347 J
Barium	100	0.563
Cadmium	1	0.0218 J
Chromium	5	0.394
Lead	5	0.403
Mercury	0.2	0.00103 J
Selenium	1	0.0643
Wet Chemistry (MG/L)		
Cyanide	NSL	0.104
Corrosivity (PH)		
Corrosivity (pH Units)	<2 or >12.5	8.89
Ignitability (DEG/F)		
Flash point	<140	158 >

Notes:

Shading indicates detection

J - Analyte present. Value may or may not be accurate or precise
NS - Not sampled
NSL- No Screening Limit. 200 mg/kg for solid samples.
U - The material was analyzed for, but not detected
DEG/F - Degrees Fahrenheit
MG/L - Milligrams per liter
PH - pH units
> the sample did not ignite at the temperature

Table E-4
UXO 30 Solid IDW Analytical Results
SI Report
NSF-IH, Indian Head, MD

Sample ID	ISUXO30-IS052710
Sample Date	5/27/10
Chemical Name	
TCLP Volatile Organic Compounds (MG/L)	
1,1-Dichloroethene	0.01 U
1,2-Dichloroethane	0.01 U
2-Butanone	0.1 U
Benzene	0.01 U
Carbon tetrachloride	0.01 U
Chlorobenzene	0.01 U
Chloroform	0.01 U
cis-1,2-Dichloroethene	0.01 U
Tetrachloroethene	0.01 U
Trichloroethene	0.01 U
Vinyl chloride	0.02 U
TCLP Semivolatile Organic Compounds (MG/L)	
1,4-Dichlorobenzene	0.005 U
2,4,5-Trichlorophenol	0.005 U
2,4,6-Trichlorophenol	0.005 U
2,4-Dinitrotoluene	0.005 U
2-Methylphenol	0.005 U
3-Methylphenol	0.005 U
4-Methylphenol	0.005 U
Hexachlorobenzene	0.005 U
Hexachlorobutadiene	0.005 U
Hexachloroethane	0.005 U
Nitrobenzene	0.005 U
Pentachlorophenol	0.02 U
Pyridine	0.005 U
TCLP Pesticides/Polychlorinated Biphenyls (MG/L)	
Chlordane	0.0005 U
Endrin	0.0002 U
gamma-BHC (Lindane)	0.001 U
Heptachlor	0.001 U
Heptachlor epoxide	0.001 U
Methoxychlor	0.001 U
Toxaphene	0.01 U
TCLP Herbicides (MG/L)	
2,4,5-TP (Silvex)	0.0005 U
2,4-D	0.005 U
TCLP Metals (MG/L)	
Arsenic	0.1 U
Barium	0.643
Cadmium	0.0234 J
Chromium	0.1 U
Lead	0.03 U
Mercury	0.002 U
Selenium	0.059 J
Silver	0.1 U
Wet Chemistry (MG/KG)	
Cyanide	0.351 U
Reactive Sulfide	150 U
Corrosivity (PH)	
Corrosivity (pH Units)	3.9
Ignitability (DEG/F)	
Ignitability	158 >

Notes:

J - Analyte present. Value may or may not be accurate or precise
NS - Not sampled
U - The material was analyzed for, but not detected
DEG/F - Degrees Fahrenheit
MG/KG - Milligrams per kilogram
MG/L - Milligrams per liter
PH - pH units
> the sample did not ignite at the temperature

Indian Head
CTO-12, Site-UXO 30
Soil IDW Detected Analytical Results
May 2010 - Unvalidated

Sample ID		ISUXO30-IS052710
Sample Date	**TCLP Limits**	5/27/10
Chemical Name		
TCLP Volatile Organic Compounds (MG/L)		
No Detections		
TCLP Semivolatile Organic Compounds (MG/L)		
No Detections		
TCLP Pesticides/Polychlorinated Biphenyls (MG/L)		
No Detections		
TCLP Herbicides (MG/L)		
No Detections		
TCLP Metals (MG/L)		
Barium	100	0.643
Cadmium	1	0.0234 J
Selenium	1	0.059 J
Wet Chemistry (MG/KG)		
No Detections		
Corrosivity (PH)		
Corrosivity (pH Units)	<2 or >12.5	3.9
Ignitability (DEG/F)		
Ignitability	<140	158 >

Notes:

Shading indicates detection

J - Analyte present. Value may or may not be accurate or precise

NS - Not sampled

U - The material was analyzed for, but not detected

DEG/F - Degrees Fahrenheit

MG/KG - Milligrams per kilogram

MG/L - Milligrams per liter

PH - pH units

> the sample did not ignite at the temperature

Appendix F
Background Data Tables

TABLE A-8

STATISTICAL SUMMARY OF ANALYTICAL RESULTS FOR NON-TURBID UNFILTERED GROUNDWATER SAMPLES
BACKGROUND INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Minimum Detection	Maximum Detection	Average of Positive Detections	Location of Maximum	Distribution of Data	95% Upper Confidence Limit	95% Upper Tolerance Limit	Federal Maximum Contaminant Level[1]	Risk-Based Concentration[2]
Volatile Organic Compounds (ug/L)										
Carbon disulfide	1/2	6	6	6	RPLMW001U001	Undefined	6	6	NA	1000
Chloroform	1/2	**2**	**2**	**2**	RPLMW001U001	Undefined	2	2	100/80[3]	0.15
Toluene	1/2	7	7	7	RPLMW001U001	Undefined	7	7	1000	750
Semivolatile Organic Compounds (ug/L)										
Bis(2-Ethylhexyl)phthalate	1/2	1	1	1	RPLMW001U001	Undefined	1	1	6	4.8
Di-N-butyl phthalate	1/2	1	1	1	RPLMW001U001	Undefined	1	1	NA	3700
Diethyl phthalate	1/2	3	3	3	RPLMW001U001	Undefined	3	3	NA	29000
Energetics (ug/L)										
RDX	1/1	**1.2**	**1.2**	**1.2**	RN3MW001U001	Undefined	1.2	1.2	NA	0.61
Inorganics (ug/L)										
Aluminum	3/4	71	**9620**	**3607**	BGDMW004U001	Lognormal	9620	286545198	50-200[3]	37000
Barium	6/6	12.9	139	64	BGDMW004U001	Lognormal	139	254	2000	2600
Cadmium	1/6	2.8	2.8	2.8	BGDMW001U001	Undefined	2.8	2.8	5	18
Calcium	4/4	2340	18100	7402.5	BGDMW001U001	Lognormal	18100	599450	NA	NA
Chromium	3/6	2.5	16.4	7.7	BGDMW004U001	Lognormal	16.4	20.9	100	110
Cobalt	5/6	2.1	15.6	6.48	BGDMW004U001	Lognormal	15.6	39.6	NA	730
Copper	2/6	4.4	22.4	13.4	BGDMW004U001	Undefined	22.4	22.4	1300[4]	1500
Iron	4/4	156	**19900**	**9846.5**	BGDMW004U001	Normal	19900	57199	300[3]	11000
Magnesium	4/4	1250	3980	2157.5	BGDMW002U001	Lognormal	3980	31254	NA	NA
Manganese	4/4	**104**	**824**	**354.5**	BGDMW002U001	Lognormal	824	28160	50[3]	730
Mercury	1/6	0.13	0.13	0.13	RPLMW001U001	Undefined	0.13	0.13	2	11
Nickel	4/6	2.6	16.6	7.65	BGDMW004U001	Lognormal	16.6	39.0	NA	730
Potassium	4/4	1340	6040	2745	BGDMW003U001	Lognormal	6040	83058	NA	NA
Sodium	4/4	3580	33000	16995	BGDMW002U001	Normal	31307	79585	NA	NA
Vanadium	1/6	20.9	20.9	20.9	BGDMW004U001	Lognormal	20.9	24.1	NA	260
Zinc	1/6	45.2	45.2	45.2	BGDMW004U001	Undefined	45.2	45.2	5000[3]	11000
Miscellaneous (mg/l)										
Chloride	4/4	4.3	40.1	19.3	BGDMW002U001	Lognormal	40.1	1863	250[3]	NA
Nitrate (ug/l)	4/4	0.05	0.40	0.158	BGDMW003U001	Lognormal	0.40	11.8	10000	58000
Sulfate	4/4	9.3	23.6	16.8	BGDMW001U001	Normal	23.6	47.0	250[3]	NA
Total Organic Carbon	5/5	1.11	6.9	3.44	BGDMW004U001	Lognormal	6.9	45.0	NA	NA

Notes:
1 - Drinking Water Regulations and Health Advisories, www.epa.gov/sofewater, July, 2002.
2 - EPA Region III Risk-Based Concentrations, October, 2002. Values presented are tap water values.
3 - Secondary Maximum Contaminant Level (SMCL), Drinking Water Regulations and Health Advisories, EPA 822-B-96-002, Summer, 2002.
4 - Action Level, Drinking Water Regulations and Health Advisories, www.epa.gov/safewater, July, 2002.
Value is bolded which exceeds Region III RBCs or MCLs.
NA - Not available

TABLE A-12

STATISTICAL SUMMARY OF ANALYTICAL RESULTS FOR FRESHWATER SEDIMENT SAMPLES
BACKGROUND INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Minimum Detection	Maximum Detection	Average of Positive Detections	Location of Maximum	Distribution of Data	95% Upper Confidence Limit	95% Upper Tolerance Limit	Eastern U.S. Soils[1]	Maryland Soils[2]	Residential Risk-Based Concentration[3]	Industrial Risk-Based Concentration[3]
Pesticides/PCBs (ug/kg)												
4,4'-DDD	4/10	1.0	40	17.1	BGDSD0090101	Lognormal	29.9	118	NA	NA	2700	24000
4,4'-DDE	5/10	1.6	12	4.84	BGDSD0090101	Lognormal	6.85	26.1	NA	NA	1900	17000
4,4'-DDT	3/10	1.9	14	6.57	BGDSD0090101	Undefined	14	14	NA	NA	1900	17000
Inorganics (mg/kg)												
Aluminum	10/10	639	16600	4393	BGDSD0070101-D	Lognormal	13234	52362	7000 - 100000	NA	78000	2000000
Arsenic	9/10	0.25	**10.6**	**3.3**	BGDSD0070101	Lognormal	10.6	63	<0.1 - 73	1.1 - 7.1	0.43	3.8
Barium	10/10	5.8	175	42.0	BGDSD0070101, BGDSD0070101-D	Lognormal	145	577	10 - 1500	150 - 700	5500	140000
Beryllium	7/10	0.13	1.0	0.52	BGDSD0100101	Lognormal	1.0	10.9	<1 - 7	ND - 3	160	4100
Cadmium	7/10	0.13	0.86	0.35	BGDSD0090101	Lognormal	0.57	1.85	NA	<0.01 - 5.6	78	2000
Calcium	6/10	110	10100	2917	BGDSD0090101	Lognormal	10100	88137	100 - 280000	NA	NA	NA
Chromium	10/10	3.3	29.7	11.6	BGDSD0070101-D	Lognormal	22.9	79.2	1 - 1000	15 - 100	230	6100
Cobalt	10/10	0.67	17.6	5.97	BGDSD0070101	Lognormal	17.6	118	<0.3 - 70	ND - 20	1600	41000
Copper	10/10	0.62	28.3	9.5	BGDSD0070101-D	Lognormal	28.3	297	<1 - 700	5 - 70	3100	82000
Iron	10/10	1780	**42900**	13202	BGDSD0070101	Lognormal	42900	193218	100 - >100000	NA	23000	610000
Lead	10/10	1.8	79.3	23.1	BGDSD0060101	Lognormal	79.3	476	<10 - 300	10 - 50	400[4]	750[4]
Magnesium	10/10	96.7	**3030**	914	BGDSD0090101	Lognormal	3030	19043	50 - 50000	NA	NA	NA
Manganese	10/10	11.2	444	162	BGDSD0090101	Lognormal	444	2561	<2 - 7000	NA	1600	41000
Mercury	10/10	0.01	0.25	0.07	BGDSD0070101	Lognormal	0.196	0.778	0.01 - 3.4	0.04 - 0.14	23	610
Nickel	8/10	0.54	25.2	9.2	BGDSD0010101	Lognormal	25.2	382	<5 - 700	ND - 30	1600	41000
Potassium	10/10	95.2	2050	567	BGDSD0020101	Lognormal	1328	5061	50 - 37000	NA	NA	NA
Selenium	7/10	0.45	2.3	0.93	BGDSD0070101	Lognormal	1.73	6.45	<0.1 - 3.9	<0.1 - 0.5	390	10000
Silver	2/10	0.31	0.92	0.62	BGDSD0090101	Undefined	0.92	0.92	NA	NA	390	10000
Sodium	8/10	30.2	303	85.7	BGDSD0090101	Lognormal	144	472	<500 - 50000	NA	NA	NA
Vanadium	10/10	3.2	46.3	18.6	BGDSD0100101	Lognormal	46.3	196	<7 - 300	20 - 150	550	14000
Zinc	9/10	4.4	158	41.2	BGDSD0070101-D	Lognormal	158	1660	<5 - 2900	8 - 113	23000	610000
Miscellaneous (mg/kg)												
Total organic carbon	10/10	444	43500	10052	BGDSD0070101-D	Lognormal	43500	395297	NA	NA	NA	NA

Notes:
1 - Shacklette and Boerngen, (1984).
2 - Dragun (1991). Values presented in table are surface soil values.
3 - EPA Region III Risk-Based Concentrations, October, 2002.
4 - EPA Region 9 PRGs Table, October, 2002.
Bolded values are exceedances of Region III RBCs.
NA - Not available

TABLE 4-2

SUMMARY OF DESCRIPTIVE STATISTICS FOR SURFACE SOILS
BACKGROUND INVESTIGATION REPORT FOR SOILS
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Cas Number	Frequency of Detection	Minimum Detection	Minimum Qualifier	Maximum Detection	Maximum Qualifier	Average of Positive Detections	Average of All Detections	Minimum Nondetect	Maximum Nondetect	Location of Maximum	Distribution of Data	95% Upper onfidence Lim	95% Upper Tolerance Limit	Eastern U.S. Soils [1]	Maryland Soils [2]	Residential Risk-Based Concentration [3]	Industrial Risk-Based Concentration [3]
Volatile Organic Compounds (ug/kg)																		
ACETONE	67-64-1	2/23	2200		13000	L	7600	660	1.9	23	RN6SS0170101	UNDEFINED	13000	13000	NA	NA	7800000	200000000
CYCLOHEXANE	110-82-7	1/14	3.6	J	3.6	J	3.6	5.3	5.4	15	IS11SS420001	UNDEFINED	3.6	3.6	NA	NA	NA	NA
ETHYLBENZENE	100-41-4	1/23	2.4	J	2.4	J	2.4	5.0	1.5	15	IS11SS400001	UNDEFINED	2.4	2.4	NA	NA	7800000	200000000
GASOLINE RANGE ORGANICS	TTNUS005	2/5	0.1225		0.17		0.15	15	0.13	150	IS11SS420001	UNDEFINED	0.17	0.17	NA	NA	NA	NA
METHYL ACETATE	79-20-9	1/14	2.3	J	2.3	J	2.3	5.3	5.4	15	IS11SS390001	UNDEFINED	2.3	2.3	NA	NA	78000000	2000000000
STYRENE	100-42-5	1/23	1.3	J	1.3	J	1.3	5.2	0.34	15	BGDSS0120101-AVG	UNDEFINED	1.3	1.3	NA	NA	16000000	410000000
TOLUENE	108-88-3	3/23	32.5		140	J	81	15	1.9	15	IS11SS400001	UNDEFINED	140	140	NA	NA	16000000	410000000
TOTAL XYLENES	1330-20-7	3/15	1.7	J	9.9	J	5.6	6.4	0.78	17	IS11SS420001	UNDEFINED	9.9	9.9	NA	NA	160000000	4100000000
TRICHLOROFLUOROMETHANE	75-69-4	3/23	1.7	J	2.5	J	2.1	5.2	0.33	15	BGDSS0200101	UNDEFINED	2.5	2.5	NA	NA	23000000	610000000
Semivolatile Organic Compounds (ug/kg)																		
2-METHYLNAPHTHALENE	91-57-6	1/23	73	L	73	L	73	140	42	490	IS21SS200001	UNDEFINED	73	73	NA	NA	1600000	41000000
ACENAPHTHENE	83-32-9	1/23	140		140		140	160	38.7	490	BGDSS0160101	UNDEFINED	140	140	NA	NA	4700000	120000000
ACETOPHENONE	98-86-2	3/23	46	J	64	J	58	140	52	490	IS11SS400001	UNDEFINED	64	64	NA	NA	7800000	200000000
ANTHRACENE	120-12-7	1/23	260		260		260	160	26.2	490	BGDSS0160101	UNDEFINED	260	260	NA	NA	23000000	610000000
BENZALDEHYDE	100-52-7	1/20	59	J	59	J	59	160	130	490	IS25SS190001	UNDEFINED	59	59	NA	NA	7800000	200000000
BENZO(A)ANTHRACENE	56-55-3	1/23	480		480		480	170	13.6	490	BGDSS0160101	UNDEFINED	480	480	NA	NA	870	7800
BENZO(A)PYRENE	50-32-8	1/23	390		**390**		390	170	16.9	490	BGDSS0160101	UNDEFINED	390	390	NA	NA	**87**	780
BENZO(B)FLUORANTHENE	205-99-2	1/23	420		420		420	170	35	490	BGDSS0160101	UNDEFINED	420	420	NA	NA	870	7800
BENZO(G,H,I)PERYLENE	191-24-2	1/23	130		130		130	160	45	490	BGDSS0160101	UNDEFINED	130	130	NA	NA	2300000	61000000
BENZO(K)FLUORANTHENE	207-08-9	1/23	360	J	360	J	360	170	41.6	490	BGDSS0160101	UNDEFINED	360	360	NA	NA	8700	78000
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	8/23	51	J	7500	J	1100	470	58	490	BGDSS0200101	UNDEFINED	7500	7500	NA	NA	46000	410000
CARBAZOLE	86-74-8	1/20	130	J	130	J	130	160	35	490	BGDSS0160101	UNDEFINED	130	130	NA	NA	32000	290000
CHRYSENE	218-01-9	1/23	440		440		440	170	21	490	BGDSS0160101	UNDEFINED	440	440	NA	NA	87000	780000
DIBENZOFURAN	132-64-9	1/23	65	J	65	J	65	150	28.7	490	BGDSS0160101	UNDEFINED	65	65	NA	NA	310000	8200000
FLUORANTHENE	206-44-0	2/23	65	J	1100		580	190	35	490	BGDSS0160101	UNDEFINED	1100	1100	NA	NA	3100000	82000000
FLUORENE	86-73-7	1/23	150		150		150	160	27.1	490	BGDSS0160101	UNDEFINED	150	150	NA	NA	3100	82000
INDENO(1,2,3-CD)PYRENE	193-39-5	1/23	100		100		100	160	46.4	490	BGDSS0160101	UNDEFINED	100	100	NA	NA	870	7800
NAPHTHALENE	91-20-3	1/23	110	L	110	L	110	150	34.5	490	IS21SS200001	UNDEFINED	110	110	NA	NA	1600000	41000000
PHENANTHRENE	85-01-8	1/23	1100		1100		1100	200	35	490	BGDSS0160101	UNDEFINED	1100	1100	NA	NA	2300000	61000000
PYRENE	129-00-0	2/23	120	J	880		500	180	35	490	BGDSS0160101	UNDEFINED	880	880	NA	NA	2300000	61000000
Explosives (ug/kg)																		
2-NITROTOLUENE	88-72-2	1/9	150	J	150	J	150	110	81.4	250	IS11SS400001	UNDEFINED	150	150	NA	NA	780000	20000000
4-NITROTOLUENE	99-99-0	1/9	210	J	210	J	210	120	87.2	250	IS11SS400001	UNDEFINED	210	210	NA	NA	780000	20000000
Pesticides/PCBs (ug/kg)																		
4,4'-DDE	72-55-9	6/20	0.23	J	10	J	2.2	1.6	1.4	4.1	BGDSS0080101	UNDEFINED	10	10	NA	NA	1900	17000
4,4'-DDT	50-29-3	4/19	0.38	J	9.4	J	3.1	2.2	2.225	4.6	BGDSS0080101	UNDEFINED	9.4	9.4	NA	NA	1900	17000
Inorganics (mg/kg)																		
ALUMINUM	7429-90-5	32/32	2010		15500	J	7540	7540	NA	NA	BGDSS0150101	LOGNORMAL	9000	19700	7000 - > 100000	NA	78000	2000000
ARSENIC	7440-38-2	30/34	0.78		**18.3**		4.3	4.0	1.6	3.8	BGDSS0190101	LOGNORMAL	5.2	14.9	<0.1 - 73	**1.1 - 7.1**	**0.43**	**3.8**
BARIUM	7440-39-3	34/34	12.5		84.8		42.5	42.5	NA	NA	S26-MW03-001	NORMAL	47.6	80.4	10 - 1500	150 - 700	5500	140000
BERYLLIUM	7440-41-7	24/34	0.05	J	1.1		0.44	0.33	0.047	0.53	BGDSS0120101-AVG	UNDEFINED	1.1	1.1	<1 -7	ND - 3	160	4100
CADMIUM	7440-43-9	12/34	0.12	J	2.5		0.4	0.2	0.06	0.57	IS25SS190001	UNDEFINED	2.5	2.5	NA	<0.01 - 5.6	78	2000
CALCIUM	7440-70-2	22/32	83.9	J	2420		504	369	98.8	275	IS13SS100001	LOGNORMAL	573	2060	100 - 280000	NA	NA	NA
CHROMIUM	7440-47-3	34/34	3.5	K	28.9	L	13.6	13.6	NA	NA	IS13SS100001	LOGNORMAL	15.9	33.4	1 - 1000	15 - 100	230	6100
COBALT	7440-48-4	34/34	0.58		15		5.4	5.4	NA	NA	S26-MW03-001	LOGNORMAL	7.5	22.3	<0.3 - 70	ND -20	1600	41000
COPPER	7440-50-8	32/34	1.8		19.4		6.7	6.5	4.5	4.6	BGDSS0120101-AVG	LOGNORMAL	8.0	20.3	<1 - 700	5 - 70	3100	82000
CYANIDE	57-12-5	4/10	0.59		0.73		0.66	0.42	0.073	1.1	IS21SS190001	UNDEFINED	0.73	0.73	NA	NA	1600	41000
IRON	7439-89-6	32/32	2770		31800	J	13000	13000	NA	NA	BGDSS0120101-AVG	LOGNORMAL	16000	38500	100 - > 100000	NA	47000	1200000
LEAD	7439-92-1	32/34	3.5	J	**149**		18.7	17.9	9.4	10	BGDSS0080101	LOGNORMAL	21.7	62.5	<10 - 300	**10 - 50**	400	750
MAGNESIUM	7439-95-4	32/32	143	K	1990		604	604	NA	NA	IS13SS100001	LOGNORMAL	722	1620	50 - 50000	NA	NA	NA
MANGANESE	7439-96-5	32/32	17.4		882	J	227	227	NA	NA	S26-MW03-001	LOGNORMAL	388	1390	<2 - 7000	NA	1600	41000
MERCURY	7439-97-6	23/34	0.03		0.13	L	0.06	0.05	0.02	0.077	BGDSS0150101	LOGNORMAL	0.060	0.16	0.01 - 3.4	0.04 - 0.14	23	610
NICKEL	7440-02-0	34/34	1.7		14		5.4	5.4	NA	NA	IS11SS410001-AVG	LOGNORMAL	6.6	15.4	<5 - 700	ND - 30	1600	41000
POTASSIUM	09/07/40	32/32	128		2620		497	497	NA	NA	IS13SS100001	LOGNORMAL	597	1470	50 - 37000	NA	NA	NA
SELENIUM	7782-49-2	14/34	0.168	L	**1.2**		0.67	0.54	0.16	1.9	IS11SS400001	NORMAL	0.62	1.2	<0.1 - 3.9	**<0.1 - 0.5**	390	10000
SILVER	7440-22-4	9/34	0.27	L	0.84		0.6	0.29	0.06	0.92	IS11SS400001	UNDEFINED	0.84	0.84	NA	NA	390	10000
SODIUM	7440-23-5	15/32	38.5		120		64.2	65.6	19.2	407	IS11SS400001	UNDEFINED	120	120	<500 - 50000	NA	NA	NA
THALLIUM	7440-28-0	7/34	1.2		2.3	L	1.5	0.62	0.22	3	BGDSS0160101	UNDEFINED	2.3	2.3	NA	NA	5.5	140
VANADIUM	7440-62-2	34/34	9.83	L	63.7		23.3	23.3	NA	NA	BGDSS0150101	LOGNORMAL	26.7	53.3	<7 - 300	20 - 150	550	14000
ZINC	7440-66-6	34/34	6.2		42.95	J	20.2	20.2	NA	NA	BGDSS0120101-AVG	NORMAL	23.6	37.5	<5 - 2900	8 - 113	23000	610000
Miscellaneous (mg/kg)																		
AMMONIA	7664-41-7	2/2	21.9		49.9		35.9	35.9	NA	NA	S26-MW03-001	UNDEFINED	---	---	NA	NA	NA	NA
DIESEL RANGE ORGANICS	TTNUS004	4/5	4.3		47		18.4	15.1	4	4	IS11SS400001	LOGNORMAL	47.0	1350	NA	NA	NA	NA
NITRITE/NITRATE	TTNUS029	1/2	1.9		1.9		1.9	1.3	1.5	1.5	S25-MW03-001	UNDEFINED	---	---	NA	NA	NA	NA
PH (S.U.)	TTNUS002	7/7	4.5		7		5.3	5.3	NA	NA	IS13SS100001	LOGNORMAL	6.0	8.8	NA	NA	NA	NA
TOTAL ORGANIC CARBON	TTNUS003	29/29	1410	J	40100		10900	10900	NA	NA	IS11SS420001	LOGNORMAL	16800	57200	NA	NA	NA	NA
TOTAL PETROLEUM HYDROCARBONS	TTNUS001	1/1	33.7	L	33.7	L	33.7	33.7	NA	NA	S26-MW03-001	UNDEFINED	---	---	NA	NA	NA	NA
TOTAL SOLIDS (%)	TTNUS046	7/7	66		79.2		75.4	75.4	NA	NA	IS25SS180001	UNDEFINED	79.2	79.2	NA	NA	NA	NA

TABLE 4-2

SUMMARY OF DESCRIPTIVE STATISTICS FOR SURFACE SOILS
BACKGROUND INVESTIGATION REPORT FOR SOILS
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

1 - Shacklette, Hansford T. and Josephine G. Boerngen, Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 1984 (surface soil values are presented in table)
2 - Dragun, James, Ph.D., Elements in North American Soils. HMCRI, Green Belt, MD, 1991 (surface soil values are presented in table)
3 - EPA Region III Risk-Based Concentrations, September 2001.
Bolded values represent exceedances of Region III RBC's or background concentrations reported in literature background references
NA - Not available
J Positive detection is qualified as an estimate.
K Positive detection is qualified as biased high.
L Positive result is qualified as biased low.
--- Upper confidence and tolerance limits cannot be calculated because of the size of the data set.
NA - Not available

TABLE 4-3

SUMMARY OF DESCRIPTIVE STATISTICS FOR CLAY-LIKE SUBSURFACE SOILS
BACKGROUND INVESTIGATION REPORT FOR SOILS
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Cas Number	Frequency of Detection	Minimum Detection	Minimum Qualifier	Maximum Detection	Maximum Qualifier	Average of Positive Detections	Average of All Detections	Minimum Nondetect	Maximum Nondetect	Location of Maximum	Distribution of Data	95% Upper Confidence Limit	95% Upper Tolerance Limit	Eastern U.S. Soils [1]	Maryland Soils [2]	Residential Risk-Based Concentration [3]	Industrial Risk-Based Concentration [3]
Volatile Organic Compounds (ug/kg)																		
TOTAL XYLENES	1330-20-7	1/4	2.4	J	2.4	J	2.4	4.7	0.82	18	IS11SB260203	NORMAL	9.4	25	NA	NA	160000000	4100000000
TRICHLOROFLUOROMETHANE	75-69-4	2/7	2.5	J	2.7	J	2.6	4.4	0.35	14	BGDSB0110101	NORMAL	6.3	13	NA	NA	23000000	610000000
Semivolatile Organic Compounds (ug/kg)																		
1,3-DINITROBENZENE	99-65-0	1/3	32	J	32	J	32	120	250	393	IS11SB260203	NORMAL	260	750	NA	NA	7800	200000
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	3/7	77	J	120	J	94	110	76.8	450	BGDSB0160101-AVG	LOGNORMAL	120	980	NA	NA	46000	410000
Pesticides/PCBs (ug/kg)																		
4,4'-DDE	72-55-9	1/8	0.68	J	0.68	J	0.68	1.2	1.5	4.2	BGDSB0150101	UNDEFINED	0.68	0.68	NA	NA	1900	17000
4,4'-DDT	50-29-3	1/8	0.79	J	0.79	J	0.79	2.1	3.8	5.7	BGDSB0150101	NORMAL	2.5	3.9	NA	NA	1900	17000
Inorganics (mg/kg)																		
ALUMINUM	7429-90-5	11/11	6840	J	25300		16800	16800	NA	NA	BGDSB0030101	NORMAL	20400	35400	7000 - > 100000	NA	78000	2000000
ANTIMONY	7440-36-0	3/11	0.68	J	1.8	J	1.4	0.78	0.21	2.1	BGDSB0030101	UNDEFINED	1.8	1.8	<1 - 8.8	NA	31	820
ARSENIC	7440-38-2	10/11	1.9	J	**14.15**		8.1	7.6	4.5	4.5	BGDSB0160101-AVG	NORMAL	9.8	18.9	<0.1 - 73	**1.1 - 7.1**	**0.43**	**3.8**
BARIUM	7440-39-3	11/11	34.7	J	101		55.0	55.0	NA	NA	BGDSB0030101	LOGNORMAL	68.0	134	10 - 1500	150 - 700	5500	140000
BERYLLIUM	7440-41-7	9/11	0.23	J	1.1	L	0.57	0.49	0.18	0.36	BGDSB0030101	LOGNORMAL	0.96	3.3	<1 -7	ND - 3	160	4100
CADMIUM	7440-43-9	1/11	0.14	J	0.14	J	0.14	0.11	0.07	0.59	IS11SB250203	LOGNORMAL	0.14	0.61	NA	<0.01 - 5.6	78	2000
CALCIUM	7440-70-2	6/11	50.7		479	J	308	190	49.6	134	BGDSB0110101	LOGNORMAL	479	2590	100 - 280000	NA	NA	NA
CHROMIUM	7440-47-3	11/11	13.4		46.5	J	27.6	27.6	NA	NA	BGDSB0150101	NORMAL	33.9	60.1	1 - 1000	15 - 100	230	6100
COBALT	7440-48-4	11/11	1.5	K	**133**		16.8	16.8	NA	NA	BGDSB0030101	UNDEFINED	133	133	**<0.3 - 70**	**ND -20**	1600	41000
COPPER	7440-50-8	11/11	5.2	L	25.9		12.0	12.0	NA	NA	BGDSB0150101	LOGNORMAL	17.9	48.6	<1 - 700	5 - 70	3100	82000
CYANIDE	57-12-5	1/3	0.68		0.68		0.68	0.84	1.2	2.5	IS11SB250203	LOGNORMAL	0.68	16.1	NA	NA	1600	41000
IRON	7439-89-6	11/11	13800	J	**61600**	J	36400	36400	NA	NA	BGDSB0150101	NORMAL	45400	83100	100 - > 100000	NA	**47000**	1200000
LEAD	7439-92-1	9/11	5.4	J	27.9		13.4	12.9	12.7	28.8	BGDSB0150101	LOGNORMAL	17.4	40.5	<10 - 300	10 - 50	400	750
MAGNESIUM	7439-95-4	11/11	498	J	1990		943	943	NA	NA	BGDSB0030101	LOGNORMAL	1220	2640	50 - 50000	NA	NA	NA
MANGANESE	7439-96-5	11/11	15.9	J	1270	J	242	242	NA	NA	BGDSB0030101	LOGNORMAL	1150	4130	<2 - 7000	NA	1600	41000
MERCURY	7439-97-6	6/11	0.03	K	**0.18**	L	0.09	0.06	0.04	0.063	IS11SB250203	UNDEFINED	0.18	0.18	0.01 - 3.4	**0.04 - 0.14**	23	610
NICKEL	7440-02-0	11/11	1.005		18.2	L	7.8	7.8	NA	NA	BGDSB0030101	UNDEFINED	18.2	18.2	<5 - 700	ND - 30	1600	41000
POTASSIUM	09/07/40	11/11	385		1610		756	756	NA	NA	BGDSB0030101	LOGNORMAL	1050	2610	50 - 37000	NA	NA	NA
SELENIUM	7782-49-2	4/11	1.2		**2.6**		2.0	1.0	0.18	1.75	BGDSB0040101	LOGNORMAL	2.6	13.3	<0.1 - 3.9	**<0.1 - 0.5**	390	10000
SILVER	7440-22-4	4/11	0.66	J	2.25	J	1.1	0.5	0.09	0.78	BGDSB0160101-AVG	LOGNORMAL	2.2	11.4	NA	NA	390	10000
SODIUM	7440-23-5	7/11	62.1		131	L	99.2	90.7	21.4	447	BGDSB0030101	NORMAL	123	258	<500 - 50000	NA	NA	NA
THALLIUM	7440-28-0	5/11	0.85	L	**6.05**	L	2.9	1.6	0.3	2.2	BGDSB0160101-AVG	LOGNORMAL	5.5	21.8	NA	NA	**5.5**	140
VANADIUM	7440-62-2	11/11	23.9		127		50.1	50.1	NA	NA	BGDSB0150101	LOGNORMAL	72.7	194	<7 - 300	20 - 150	550	14000
ZINC	7440-66-6	11/11	18.4	J	70.4		29.5	29.5	NA	NA	BGDSB0030101	UNDEFINED	70.4	70.4	<5 - 2900	8 - 113	23000	610000
Miscellaneous (mg/kg)																		
AMMONIA	7664-41-7	1/1	9.5		9.5		9.5	9.5	NA	NA	S26-MW03-002	UNDEFINED	9.5	9.5	NA	NA	NA	NA
TOTAL ORGANIC CARBON	TTNUS003	9/9	261		8300		3420	3420	NA	NA	BGDSB0110101	LOGNORMAL	8300	66500	NA	NA	NA	NA
TOTAL ORGANIC HALIDES	TTNUS043	1/4	55.2		55.2		55.2	32.3	39.8	57.1	BGDSB0040101	LOGNORMAL	55.2	281	NA	NA	NA	NA
TOTAL PETROLEUM HYDROCARBONS	TTNUS001	1/1	39.1	L	39.1	L	39.1	39.1	NA	NA	S26-MW03-002	UNDEFINED	39.1	39.1	NA	NA	NA	NA

1 - Shacklette, Hansford T. and Josephine G. Boerngen, Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 1984
(surface soil values are presented in table)
2 - Dragun, James, Ph.D., Elements in North American Soils. HMCRI, Green Belt, MD, 1991 (surface soil values are presented in table)
3 - EPA Region III Risk-Based Concentrations, September 2001.
Bolded values represent exceedances of Region III RBC's or background concentrations reported in literature background references
NA - Not available
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K Positive detection is qualified as biased high.
L Positive result is qualified as biased low.
NA - Not available

Appendix G
Photo Log

Site Photographs: UXO 6

Photo 1 – General location of UXO 6 site. View is to the northeast from Hussey Road. Mattawoman Creek is in the background. Photo was taken on 11/25/08.

Site Photographs: UXO 9

Photo 1 – Medium propellant grain (approximately 1.25 inches in length) found along railroad tracks, southeast of Bldg. 210. Photo was taken on 3/30/10.

Photo 2 – High concentration of propellant grain locations found beneath the Bldg. 207 loading dock. Each location is marked by a yellow flag. Photo was taken on 3/30/10.

Photo 3 – Close-up view of a cluster of five medium sized propellant grains found beneath the Bldg. 207 loading dock. Photo was taken on 3/30/10.

Site Photographs: UXO 9

Photo 4 – Cluster of four small sized propellant grains found in grass-covered area along the perimeter of Bldg. 188. Grains are shown deteriorated from exposure. Photo was taken on 3/30/10.

Photo 5 – View of concentrated areas of propellant grains found beneath walkways on northern side of Bldg. 210. Grain clusters are marked by yellow flags. Photo was taken on 3/30/10.

Photo 6 – Close-up view of nine-flag area beneath the northwesterly walkway on the northern side of Bldg. 210. The area was found to contain approximately 100 small sized propellant grains. Photo was taken on 3/30/10.

Site Photographs: UXO 9

Photo 7 – View of eroded downspout area along the Bldg. 175 loading dock. Four propellant grains were found in the area. Photo was taken on 3/30/10.

Photo 8 – Close-up view of a six propellant grain cluster found along Bldg. 175. Both black and orange small sized grains were found. Photo was taken on 3/30/10.

Photo 9 – View of back entrance to Bldg. 176. Propellant grains were typically found in close proximity to building entrances throughout the site. Photo was taken on 3/30/10.

Site Photographs: UXO 9

Photo 10 – Close-up view of nine propellant grain cluster found next to the concrete pillar of the Bldg. 176 loading dock. The small sized grains are difficult to see as they are similar in color to the surrounding multi-colored gravel. Photo was taken on 3/30/10.

Photo 11 – View of a 47 propellant grain cluster found beneath the Bldg. 176 loading dock. Since the area periodically accumulates water and mud, the grains and surrounding gravel are again similarly colored and difficult to distinguish. Photo was taken on 3/30/10.

Photo 12 – Close-up view of eight propellant grain cluster found below the Bldg. 176 loading dock. The cluster contains a mix of both small and medium sized grains. Photo was taken on 3/30/10.

Site Photographs: UXO 9

Photo 13 – View of eight propellant grain cluster found beneath the Bldg. 177 loading dock. The grains ranged in size from small (approximately 0.5 inch in length) to large (approximately 2-3 inches in length). Photo was taken on 3/30/10.

Photo 14 – View of a six propellant grain cluster found beneath the Bldg. 177 loading dock. A propellant grain container lid is also shown nearby. Photo was taken on 3/30/10.

Photo 15 – View of loading dock area along the northern side of Bldg. 181. A large concentration of propellant grains was found next to the stairway. Each cluster of grains is marked with a yellow flag. Photo was taken on 3/30/10.

Site Photographs: UXO 9

Photo 16 – View of a single propellant grain found in the wet area along the south side of Bldg. 181. "Lightning holes," typically found on grains throughout the site, can be seen on the end of the grain. Photo was taken on 3/30/10.

Photo 17 – View of Bldg 204 crawlspace area facing south. Not all buildings have crawlspaces. Typically crawlspaces were found to contain less propellant grains than loading dock areas. Photo was taken on 3/30/10.

Photo 18 – View of typical propellant grain container lid found beneath the Bldg. 204 loading dock. Photo was taken on 3/30/10.

Site Photographs: UXO 9

Photo 19 – Close-up view of a cluster of three propellant grains found beneath the Bldg. 204 loading dock. The grains were observed to be multiple sizes and were difficult to distinguish from surrounding gravel. Photo was taken on 3/30/10.

Photo 20 – Close-up view of seven propellant grain cluster found beneath the Bldg. 183 loading dock. "Lightning holes" can again be seen in some of the grains. Photo was taken on 3/30/10.

Photo 21 – Close-up view of a six propellant grain cluster found beneath the Bldg. 187 loading dock. Grains found at Bldg. 187 were typically small sized. Photo was taken on 3/30/10.

Site Photographs: UXO 9

Photo 22 – Close-up view of a four propellant grain cluster found beneath the Bldg. 187 loading dock. Since the grains were multiple sizes and were located in a muddy area, they were difficult to distinguish among surrounding gravel. Photo was taken on 3/30/10.

Photo 23 – Close-up view of a single propellant grain found beneath the Bldg. 206 loading dock. Medium grains similar to this were typically found to be associated with this building. Photo was taken on 3/30/10.

Site Photographs: UXO 11

Photo 1 – View is to the east looking towards the valley. Photograph was taken on November 25, 2008.

Photo 2 – View is to the east looking towards the valley. Area A is to the right and Areas B through D are to the left. Photograph was taken on November 25, 2008.

Photo 3 – View is to the southeast looking at Building 44 (Bomb Proof Area in Area E) within Area A. Photograph was taken on November 25, 2008.

Site Photographs: UXO 11

Photo 4 – View is to the east. Entranceway into the Bomb Proof is on this side of the building. Photograph taken November 25, 2008.

Photo 5 – View is to the north; the back of Building 44. Photograph was taken on April 22, 2009.

Photo 6 – Inside Building 44. Photograph was taken on April 22, 2009.

Site Photographs: UXO 11

Photo 7 – MEC fieldwork. Area A DPT soil sampling. Photograph was taken in April 2010.

Photo 8 – MEC fieldwork. Surface scan using EM-61 uphill in Area A. Photograph was taken in April 2010.

Photo 9 – MEC fieldwork in Area B. Photograph was taken in April 2010.

Site Photographs: UXO 11

Photo 10 – View is to the west towards the Potomac River. MEC fieldwork; final drop-off area in Area B. Photograph was taken in April 2010.

Photo 11 – MEC fieldwork. EM-61 being used in Area B. Photograph was taken in April 2010.

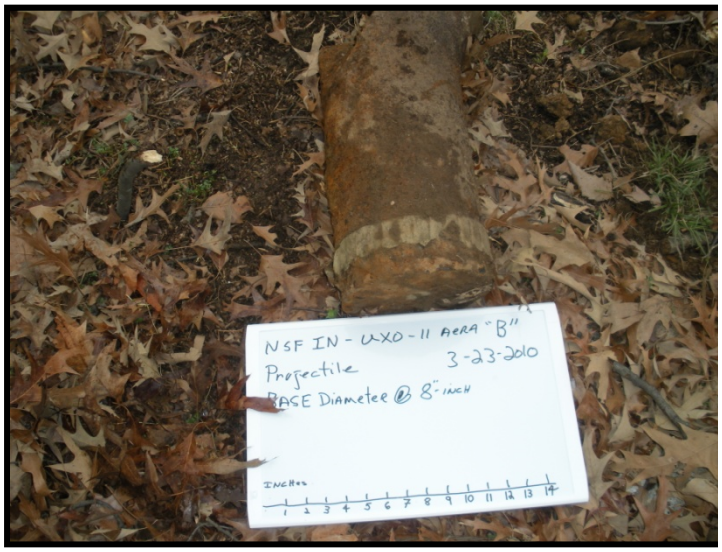

Photo 12 – MEC fieldwork. 8-inch diameter projectile found in Area B. Photograph was taken in April 2010.

Site Photographs: UXO 11

Photo 13 – MEC fieldwork. Projectile with 8-inch diameter base found in Area B. Photograph was taken in April 2010.

Photo 14 – MEC fieldwork. 8-inch diameter projectile found in Area B. Photograph was taken in April 2010.

Photo 15 – MEC fieldwork. Projectile (MD) found in Area B. Photograph was taken in April 2010.

Site Photographs: UXO 11

Photo 16 – MEC fieldwork. Projectile (MD) fragment. Photograph was taken in April 2010.

Photo 17 – MEC fieldwork. MD Collection Point 1 in Area B. Photograph was taken in April 2010.

Photo 18 – MEC fieldwork. EM-61 being used along stream the in Area C. Photograph was taken in April 2010.

Site Photographs: UXO 11

Photo 19 – MC fieldwork. Soil sampling in Area D.

Site Photographs: UXO 13

Photo 1 – Possibly remnants of a trap house Photograph was taken in June 2010.

Photo 2 – Metal container. Photograph was taken in June 2010.

Site Photographs: UXO 19

Photo 1 – View to the north with Mattawoman Creek in the background. MEC items litter the shoreline. Photograph was taken on November 25, 2008.

Photo 2 – MEC items in Mattawoman Creek. Photograph was taken on November 25, 2008.

Photo 3 – MEC items in Mattawoman Creek. Photograph was taken on March 17, 2009.

Site Photographs: UXO 19

Photo 4 – MEC items and debris in Mattawoman Creek. Photograph was taken on October 26, 2009.

Photo 5 – MEC items in the frozen Mattawoman Creek. Photograph was taken on January 12, 2010.

Site Photographs: UXO 20

Photo 1 – View is to the north. It shows a grassy foreground (bare in some areas) with MEC items in the background. Photograph was taken on November 25, 2008.

Photo 2 – View is to the south with Mattawoman Creek in the background. Burn tanks and other miscellaneous testing items Photograph was taken on November 25, 2008.

Photo 3 – View is to the southeast. Explosives testing equipment. Photograph was taken in November 25, 2008.

Site Photographs: UXO 20

Photo 4 – Explosive burn tank. Photograph was taken on November 25, 2008.

Photo 5 – Old artillery. Photograph was taken on November 25, 2008.

Photo 6 – View to the south with Mattawoman Creek in the background. Photograph was taken on April 22, 2009.

Site Photographs: UXO 27

Photo 1 – Transport boat for underwater array. Photograph was taken in April 2010.

Photo 2 – Deployment of underwater array. Photograph was taken in April 2010.

Photo 3 – Towing underwater array behind boat. Photograph was taken in April 2010.

Site Photographs: UXO 27

Photo 4 – Onboard data collection station. Photograph was taken in April 2010.

Photo 5 – Underwater array in surf. Photograph was taken in April 2010.

Photo 6 – Hand-towing underwater array. Photograph was taken in April 2010.

Site Photographs: UXO 27

Photo 7 – Shoreline-located GPS station. Photograph was taken in April 2010.

Site Photographs: UXO 29

Photo 1 – View is to the east. Terrain is grassy and hummocky. Potomac River is in the background. Photograph was taken on November 25, 2008.

Photo 2 – View is to the southeast. Terrain is grassy and hummocky. Potomac River is in the background. Photograph was taken on November 25, 2008.

Site Photographs: UXO 30

Photo 1 – View is to the northeast with the Potomac River in the background. Photograph was taken on November 25, 2008.

Photo 2 – Gas line monument. Photograph was taken on November 25, 2008.

Photo 3 – Empty drum. Photograph was taken on November 25, 2008.

Site Photographs: UXO 30

Photo 4 – Non-MEC metal debris. Photograph was taken on November 25, 2008.

Photo 5 – View is to the southwest. Steep slopes are to the left and shoreline is to the right. Photograph was taken on April 22, 2009.

Photo 6 – Charred ground. Photograph was taken on April 22, 2009.

Site Photographs: UXO 30

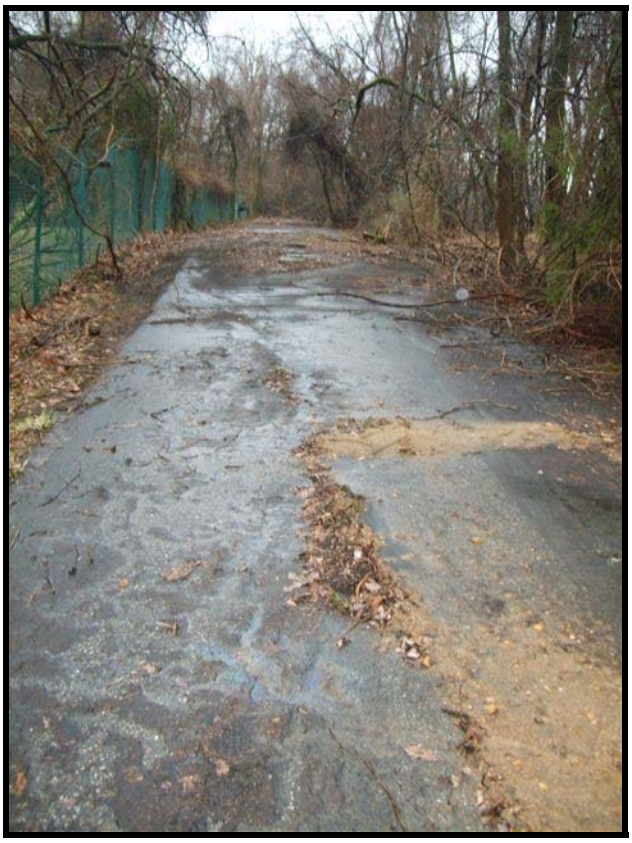

Photo 7 – Strauss Avenue. Road was cleared prior to DGM and MC investigations. Photograph was taken on March 12, 2010.

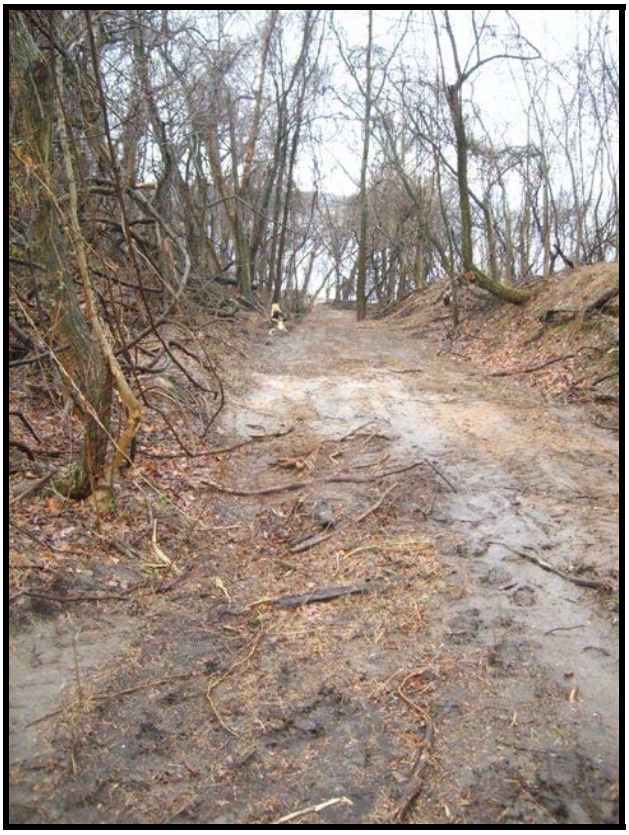

Photo 8 – Cleared area between Strauss Road and the shoreline for equipment access. Photograph was taken on March 12, 2010.

Appendix H
Expanded Preliminary Assessment for UXOs 18, 31, and 33

Expanded Preliminary Assessment of UXOs 18, 31, and 33, Naval Support Facility Indian Head, Indian Head, MD

PREPARED FOR: Joe Rail/NAVFAC Washington
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Kevin Lombardo/CH2M HILL

DATE: June 25, 2010

Introduction

This technical memorandum presents an Expanded Preliminary Assessment (PA) for the Battle Range Firing Area (UXO 18), Pope's Creek (UXO 31), and Water Impact Area (UXO 33) at the Naval Support Facility Indian Head (NSF-IH) in Indian Head, Maryland (Figure 1). It summarizes the key findings from a review of available documents and recommends a site management decision on the basis of the document review findings. This work was completed under the Comprehensive Long-Term Environmental Action Navy 1000, Contract N62470-02-D-1000, Contract Task Order 0012.

Rationale and Objective

The *Final Water Area Munitions Study* (Malcolm Pirnie, 2005) (herein referred to as WAMS) recommended the following for each site:

1. UXO 18—a site inspection (SI) for munitions and explosives of concern (MEC) and no further action (NFA) for munitions constituents (MC). The SI would consist of a geophysical investigation of 5 acres in the 340-acre site to determine if MEC is present and whether further action is necessary. NFA was proposed for MC because activities at the site are based on anecdotal evidence, and there was limited historical documentation to support the presence of MC. If the presence of MEC was confirmed during the SI, further action may be recommended for MC.

2. UXO 31—an SI for MEC over the entire 44-acre testing area and NFA for MC. The SI for MEC would consist of a geophysical investigation of 44 acres to determine if MEC is present and whether further action would be necessary. NFA was proposed for MC because activities at the site are based on anecdotal evidence.

If the presence of MEC was confirmed during the SI, further action may be recommended for MC.

3. UXO 33—an SI/Remedial Investigation (RI) for MEC and an RI for MC. The SI for MEC would focus on determining if MEC is present in 85 acres of the site; a geophysical investigation and remote underwater vehicle inspection were also proposed. The RI would be based on the SI results for MEC and MC. The SI for MC would consist of collecting 122 sediment samples in the Potomac River for explosives and metals using remote underwater inspection to select sample locations.

Because these are large water sites (covering more than 300 acres), and because of the uncertainty associated with the types of munitions that could have been used or the exact locations where activities or operations could have occurred, CH2M HILL recommended an expanded PA to augment, but not duplicate, the information provided in the WAMS. Information collected as part of the expanded PA would be used in conjunction with the WAMS information to provide recommendations for each site.

CH2M HILL accomplished this objective by: (1) reviewing existing information in the WAMS; (2) performing a records search to obtain additional information on operations at the sites (herein referred to as supplemental data, presented in Attachment A); (3) reviewing information on sediment dynamics; and (4) performing a risk analysis. All the information was used to propose the recommendation for each site presented in this technical memorandum.

Site Descriptions and Operational Histories

Information on the site descriptions was taken from the WAMS. Information on operational histories was taken from the WAMS and supplemental data. The supplemental data consisted of interviews with NSF-IH personnel; reports from the Navy historian, Mr. Jim Dolph; and historical resources that might indicate specific locations of potentially hazardous releases to the environment, specifically MEC. CH2M HILL conducted the records search and personnel interviews from May 2009 through August 2009. A complete list of resources identified and investigated for this study is provided in Attachment A. Attachment B provides copies of references referred to as “Exhibits’ cited in the “Supplemental Data” sections.

UXO 18—Battle Range Firing Area

WAMS Report

UXO 18 is a 340-acre water site in the north-central section of Stump Neck Annex. It extends from the Potomac River to the north bluff along the shoreline of the Mattawoman Creek (Figure 1). Approximately 184 acres of the site is within UXO 33—Water Impact Area, which makes the overlapped area an MEC area and the remaining 156 acres a suspected MEC area. The site was potentially used in the 1900s for battle range firing, high-powered firing, and for studying underwater impacts. Projectiles tested may have consisted of 3-, 5-, 8-, 12-, and 14-inch armor-piercing (AP) shells, which were fired at the KATAHDIN target, an experimental Navy ram ship which was assumed to have been in the Potomac River close to its confluence with Mattawoman Creek. It is also documented that high-powered firing using the same munition types as those used for the KATAHDIN target or pasteboard

Legend

Installation Boundary

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0 5,500 11,000
Feet

Figure 1
Facility and Site Locations
Expanded Preliminary Assessment for UXOs 18, 31, and 33
NSF-IH, Indian Head, Maryland

Imagery Source: Google Earth Pro

CH2MHILL

targets would have been conducted into the north bluff. Other munitions types that could be present at this site would include those related to UXO 33 because of site overlap.

The WAMS could not confirm firing from the water to these targets or development of the pasteboard targets, nor determine the exact dates of usage. As part of the WAMS, a visual survey was performed, but yielded no evidence of MC or MEC scraps or fragments. Neither the visual survey nor the historical information could definitively confirm that this site was used for battle range firing.

Supplemental Data

Additional research conducted indicated 12-inch projectiles hitting the water at Stump Neck within 100 feet of the Navy-owned dock, and underwater experiments have been reported from the Explosives Investigation Lab (EIL) at Stump Neck (Carlisle, 1990). These impact areas could well have been within the Battle Range Firing Area. CH2M HILL was unable to locate any historical copies of the EIL reports or Ordnance Investigation Memoranda from this testing. As a result, the specific locations of the impact areas could not be identified.

The Battle Range Firing Area is located at the mouth of Mattawoman Creek, which borders the town of Indian Head on the southeast. Mattawoman Creek is listed as impaired under Section 303 of the Clean Water Act for excess nutrients, sediment, and loss of living resources. It is also listed by the Maryland Department of State Planning as an Area of Critical State Concern.

UXO 31—Pope's Creek

WAMS Report

UXO 31 is an offsite water site approximately 30 miles downstream and southeast of NSF-IH within the Potomac River and south of Pope's Creek, near the town of Pope's Creek, Maryland (Figure 1). Figure 2 (which is Figure 7.1-1 in the WAMS) shows the locations of the test area and safety zone, which are about 2 miles north of the Potomac River Bridge. According to the WAMS, the testing area was approximately 44 acres, whereas the publicized safety zone was approximately 841 acres. On June 2, 1947, a public notice was issued to advise that underwater testing of demolition charges or explosive material would be conducted in the Potomac River in the area of Pope's Creek (War Department, 1947). The types of munitions used in activities associated with this area are unknown. Based on information collected for the WAMS, there are no known MEC areas at the site. However, the site is categorized as a suspected MEC area on the basis of its reported use for underwater testing of demolition charges or explosive material.

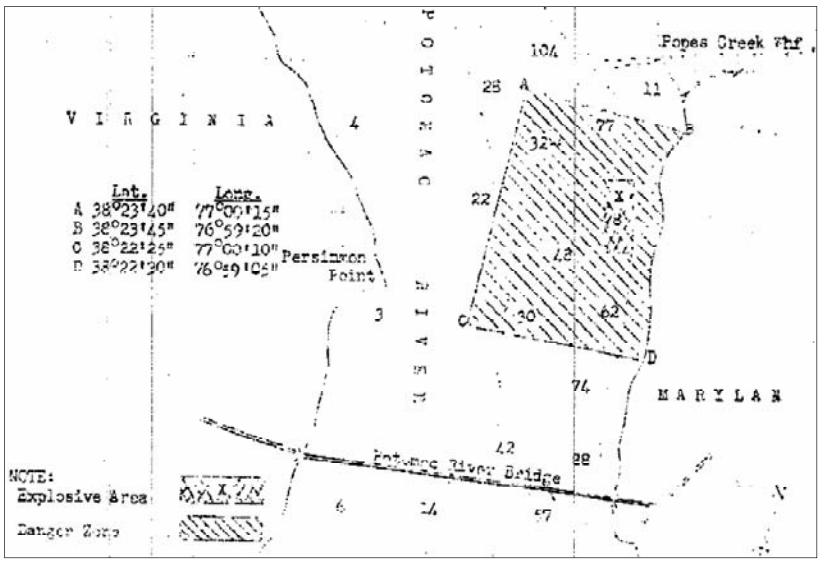
Supplemental Data

The area used for explosives testing near Pope's Creek was on the eastern shore of the Potomac River. Testing was conducted in the deepest portion of the navigation channel (War Department, 1947). While references to underwater explosions at Pope's Creek were identified by Carlisle (1990), no specific information on locations and type of explosives used during testing was. A 1947 memorandum (Exhibit A[1]) refers to the firing of charges of 80 pounds or less for underwater explosives research if the location were satisfactory. It

[1] Documents cited by letter ("Exhibit A," etc.) are from the collection of files provided to CH2M HILL by Mr. Jim Dolph, Navy historian; the files were obtained from the National Archives.

further notes that large charges could be fired in the area near Pope's Creek, but that explosives testing should be suspended during spring months. The memorandum notes that precautions should be taken in the summer months to prevent possible injury to bathers in the Potomac River. No other information regarding activities at Pope's Creek was available during the research activities.

FIGURE 2
Explosive Area and Danger Zone
From the WAMS, where it is shown as Figure 7.1-1.



UXO 33—Water Impact Area

WAMS Report

UXO 33 is a 12,296-acre water site located between Chapman's Point, Maryland, and the mouth of Chopawamsic Creek (Figure 1). Part of UXO 18 (Battle Range Firing Area) and all of UXO 27 (Sonar Training Area) are within this site. The entire site is classified as a suspected MEC area because of historical operations, which included the following:

1. Strayed ordnance from battleship gun testing from January 24, 1891, until July 21, 1921, from UXO 11 (The Valley). Rockets were also fired from a dock firing station at UXO 11 until 1946 or 1947. Guns and rockets fired from UXO 11 may have missed intended targets and landed in UXO 33.

2. Underwater explosions in the Potomac River, which may have occurred in 1961. On December 23, 1960, a public notice was issued by the U.S. Army Corps of Engineers that underwater explosions in the Potomac River would occur between Chapman's Point and the mouth of Chicamuxen Creek between January 2, 1961, and March 15, 1961. The types of munitions used for the explosions are unknown. In a memorandum dated October 12, 1979, from the Chief of Naval Material, underwater explosions in the Potomac River were documented. Figure 5.2-1 in the WAMS shows the locations of the test sites described in the 1979 memorandum. (The information in this bullet is the same as that obtained from Exhibit J, described in the "Supplemental Data" section below.)

NAVFAC Washington personnel informed Malcolm Pirnie that this area was dredged in 1952 to recover munitions scrap for metal recycling.

3. Accidental releases of ordnance remnants and bulk propellant from the large motor test facility.

Supplemental Data

The WAMS mentions that the area was dredged in 1952 to recover scrap metal, but no details on the location or quantity of dredged material were available. A 1915 memorandum **(Exhibit B)** discusses ricochets and the angles of elevation at which shells and shots should be fired. It indicated that "all firing over Stump Neck should be with long pointed shell, at an angle of elevation not less than 8°." The memo also outlines the "boundary line for danger zone at Stump Neck" — a "line from the bomb proof at Indian Head tangent to the shoreline at Deep Point, and cutting Stump Neck peninsula about its narrowest point." Furthermore, areas on Stump Neck south and west of the boundary line were designated the "Stump Neck danger zone" (Figure 2).

A 1918 document (Exhibit C) notes that there was a danger to life and property because of the inadequacy of the base to conduct some types of experiments. The document describes (1) issues regarding testing at the 8° elevation (it was pointed out that the angle was too small for land and sea practices; experimental shells landed in very shallow water); and (2) testing of 16-inch projectiles that would have landed among residential homes.

Correspondence from 1917 through 1922 (Exhibit D) indicates that a Danger Zone was established in the Potomac River near the town of Indian Head. The Danger Zone consisted of a portion of the Potomac River lying between a line drawn from Indian Head Point, Maryland, to High Point, Virginia, and a line drawn from Fair Oak, Maryland, to Chopawamsic Island, Virginia (Figure 2). Most of the shell fragments that fell into the Danger Zone have been attributed to (1) proofing the fuses from 3- and 4-inch guns, (2) detonator tests, (3) shell fragments that disintegrated in flight or broke up within a gun, and (4) testing of time fuses. In November 1922, the Danger Zone was cancelled.

A review of six weekly memoranda for an ongoing project in 1946 (Exhibit E) revealed the following:

1. A marine way had been installed, and testing of the effects of rope charges on 3/16-inch mild steel plating had started (August 2, 1946).

2. Marine ways were removed, and a submerged crib for firing charges was constructed. The effects of linear cavity charges on 5-inch barbette were tested, as were the effects of rope charges on 5/16-, 3/8-, and ½-inch steel plates (August 16, 1946).

3. A new crib was placed in the river, and experiments using rope charges on 5/16- and 1-inch steel plates were completed; experiments using linear charges on 1¾-inch steel plates started (August 30, 1946).

4. Experiments using rope charges were completed and experiments using linear cavity charges on 1¼-inch steel plates with varying weights of explosives were started. The blasting crib was removed from the river bottom for repairs (September 6, 1946).

5. There was more testing of charges and application of results (September 20, 1946).

6. Tests using linear cavity charges and triangular charges were performed (October 4, 1946).

A 1946 memorandum (Exhibit F) indicates that an underwater demolition team had been working on an underwater wreck demolition and disposal project since July 11, 1946, and that the project would end about September 15, 1946. There is no information on where this project took place in the bodies of water adjacent to Indian Head.

A 1947 letter (Exhibit G) discusses transferring part of the "underwater explosion research program" from the Patuxent River to Indian Head to "fire six preliminary charges in the Potomac River Channel… to ascertain vibration effects at various distances and to determine the suitability of the location for future research…." The letter notes that the findings will "consist of 600-pound depth charges…." It is mentioned that a particular area will not be set aside for that purpose because the best location for the project would be in the deepest part of the channel.

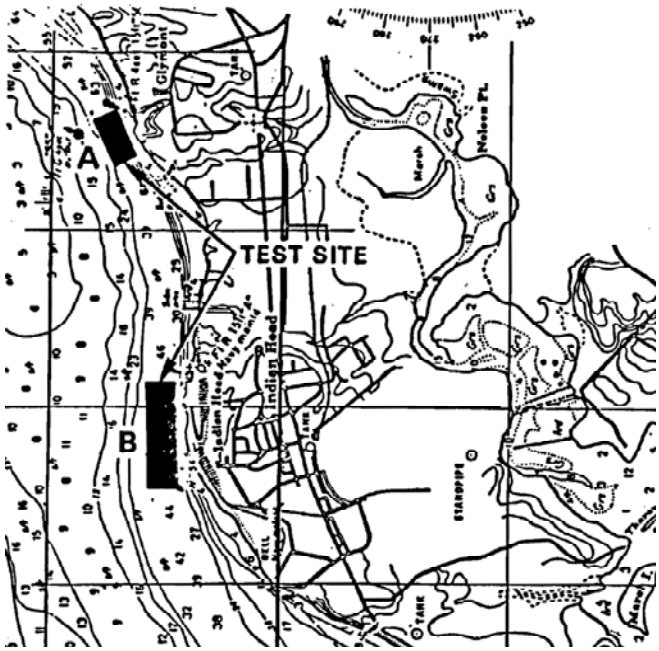
A 1978 report (Exhibit H) provides information on three test sites: two in the Potomac River and one on land at Stump Neck. The report documents that explosive tests in the two sites in the river were "staged out of a berth." Both sites are in an area designated as a "Danger Zone" on navigational charts. The two test sites were within ½ to 1½ miles from the berth. One of the sites was 500 feet by 2,000 feet and 45 feet deep; it was 790 feet from land and 850 feet from the nearest inhabited area. The other site was 150 feet by 400 feet in an area of the river that was 80 feet deep; it was 455 feet from the land and 600 feet from an inhabited area. It appears that the berthing pier was 1,000 feet long with 10 feet of water depth. The report notes that tests were not conducted in April and May because it was the spawning season for perch. Testing in January and February was limited because of ice on the river. The report also states that there was a self-imposed explosives limit of 80 pounds at both test sites.

An August 5, 1987, document (Exhibit I) summarizes information on testing in the Potomac River. Until 1977, no controls existed for underwater explosions. On October 12, 1979, testing was reinstituted in the Bay region water. From 1979 to 1987, testing occurred in specific test sites using maximum permissible charge weight. Test sites were selected on the basis of water depth, bottom conditions, and the known marine environment. In addition, specifying the maximum charge weight was important to prevent recurrence of a 1977 test incident. In the Potomac River/Explosive Ordnance Disposal (EOD) Technology Center (for Maryland waters), a 5-pound-maximum weight was used, and five to 10 tests were conducted annually. The report mentions that the range of charge weight was less than 1 pound, and a typical test used ½ pound.

A memorandum dated October 23, 1987 (Exhibit J), lists underwater explosion test sites, of which the Potomac River/Indian Head is one of nine sites with a maximum charge weight of 80 pounds. The coordinates of two test sites ("A" and "B") are provided, and it is noted that there was a permit already in place (Permit NABOP-F/4 [Naval Surface Warfare Center] 75-652, dated May 12, 1978, and issued by the U.S. Army Corps of Engineers) that allowed for underwater explosion testing (Figure 3). The areas of these test sites are different from those presented in Exhibit H; however, the water depths are the same. One test site is about 600 feet by 1,200 feet with an average depth of 80 feet. The other test site is about 750 feet by 3,000 feet with an average depth of 45 feet. These test areas are shown on

Figure 4, which shows approximate locations of some of the test areas that are described in this technical memorandum.

FIGURE 3
Two Test Sites in the Potomac River
From Exhibit J



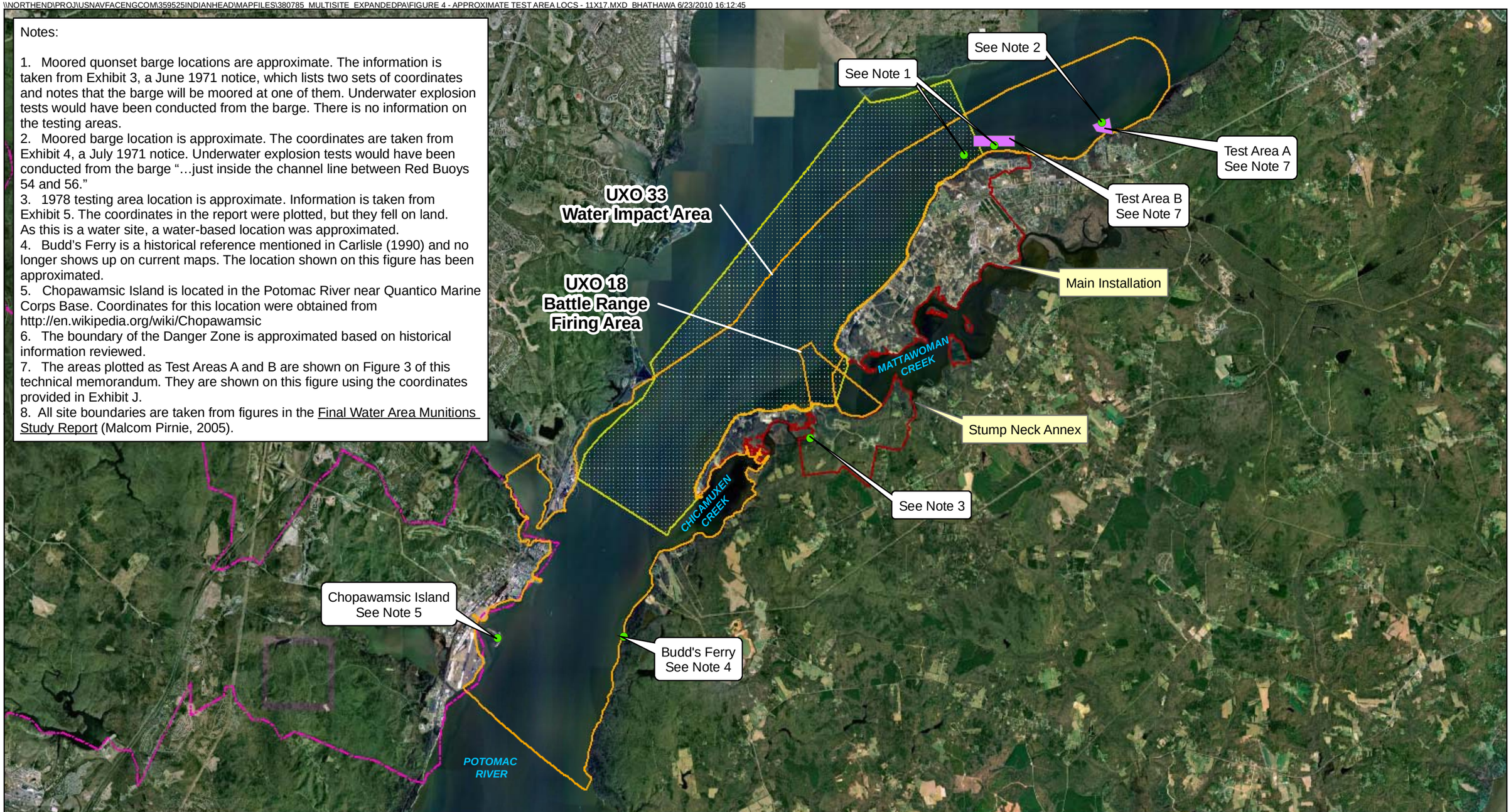
A September 29, 1988, memorandum (Exhibit K) requested that the Navy Explosive Ordnance Disposal (EOD) Technical Center conduct tests in the Chesapeake Bay and its tributaries; the site labeled "Potomac River/Indian Head" was one of the sites. Approximately 24 tests would be conducted in fiscal year 1989 with explosive charge weights of 1 gram to 25 pounds. The request was approved as noted on the memorandum.

A September 30, 1988, report (Exhibit L) documented that EOD had conducted tests on underwater ordnance (such as mines, torpedoes, and depth charges) and conducted underwater explosive training in mine neutralization. Charges varied in size from 1 gram (pre-packed shaped charges) to 20 pounds of C-4 or similar explosives. The underwater mines used for training may have been moored or bottom mines. EOD personnel were "trained to locate, neutralize, tow, and beach for exploitation and disposal." Table 2-1 of this report indicates that in 1984, five tests were conducted with charges weighing up to 15 pounds and 63 tests with charges weighing up to 80 pounds. In 1985, 13 tests were conducted with charges weighing up to 15 pounds.

According to Carlisle (1990), while specific locations of weapons testing have not been identified, there have been references to gunshots being fired over Stump Neck and into the water from 1899-1911. Shots designed to travel 12,000 yards (about 7 miles) down river from the original Proving Ground Range often fell in surrounding inlets (Carlisle, 1990). Ten-, 12-,

Notes:

1. Moored quonset barge locations are approximate. The information is taken from Exhibit 3, a June 1971 notice, which lists two sets of coordinates and notes that the barge will be moored at one of them. Underwater explosion tests would have been conducted from the barge. There is no information on the testing areas.
2. Moored barge location is approximate. The coordinates are taken from Exhibit 4, a July 1971 notice. Underwater explosion tests would have been conducted from the barge "…just inside the channel line between Red Buoys 54 and 56."
3. 1978 testing area location is approximate. Information is taken from Exhibit 5. The coordinates in the report were plotted, but they fell on land. As this is a water site, a water-based location was approximated.
4. Budd's Ferry is a historical reference mentioned in Carlisle (1990) and no longer shows up on current maps. The location shown on this figure has been approximated.
5. Chopawamsic Island is located in the Potomac River near Quantico Marine Corps Base. Coordinates for this location were obtained from http://en.wikipedia.org/wiki/Chopawamsic
6. The boundary of the Danger Zone is approximated based on historical information reviewed.
7. The areas plotted as Test Areas A and B are shown on Figure 3 of this technical memorandum. They are shown on this figure using the coordinates provided in Exhibit J.
8. All site boundaries are taken from figures in the Final Water Area Munitions Study Report (Malcom Pirnie, 2005).



Legend
- Approximate Site Boundary
- Approximate Danger Zone
- Installation Boundary
- Quantico Marine Corps Base Boundary

N
W E
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0 3,500 7,000
Feet

Figure 4
Approximate Locations of Test Areas at UXOs 18 and 33
Expanded Preliminary Assessment for UXOs 18, 31, and 33
NSF-IH, Indian Head, Maryland

Imagery Source: Google Earth Pro

CH2MHILL

and 14-inch gun projectiles were also noted to have traveled approximately 9 miles downstream to pass within 1,000 yards of Chopawamsic Island on the right and 500 yards from Budd's Ferry on left (Figure 4). Impacts closer to the shorelines were also noted. On occasion, shells were reported to have richocheted across the Potomac to Quantico. Underwater testing was also performed within the Water Impact Area, from Chapman's Point to mouth of Mattawoman Creek (Carlisle, 1990).

Other records (Exhibit 1[2]) indicated that in 1952, nitrocellulose that was not captured by process vats and filters was discharged into Mattawoman Creek in the vicinity of the sewer outflow. The deposition area was surveyed to have been at least 8,000 square feet, with varying depth, but having a maximum depth of 18 inches. When dry, the nitrocellulose material can burn or be made to detonate. Three disposal options were considered: (1) pressure wash the material into the channel; (2) dredge the material from the creek, followed by drying and burning; and (3) dredge the material from the creek and dump at sea. It is unclear which option was ultimately selected, if any. Although it is not clear at what point along Mattawoman Creek the discharges occurred, it is likely that the source of discharge would have been the powder factory, located farther upstream near the northern border of the installation. It is not known if nitrocellulose deposition could have migrated downstream to the Battle Range Firing Area.

Other documentation (Exhibit 2) indicated plans to perform underwater explosion tests of slurry explosives in February 1969. Plans included the firing of four 10-pound slurries to compare their output to standard military explosives. The explosives tested were DBA-65T, DBA-22M, DBA-105T2, Dynagel, Pourvex, and HBX-1.

A June 1971 memorandum from the Naval Ordnance Laboratory (Exhibit 3) informed navigation interests that underwater explosion tests would be conducted until December 1971 at the installation, using a quonset barge moored in the Potomac River (Figure 1). The following month, another memorandum from the laboratory informed navigation interests that underwater explosion tests would be conducted from August through December 1971 near Indian Head and Glymont, MD. The testing would be conducted using a 20- x 80-foot barge moored in the Potomac River. Explosive charges weighing up to 80 pounds would be detonated under water.

A study was conducted in 1972 to analyze the Potomac River water and sediment, with a focus on heavy metals. The conclusions drawn from this study indicated that

> *…while most of the metals present in the sediments are chemically bound and require both heat and low pH to convert them to a soluble form, disturbance of the sediments- whether by turbulence, dredging, changes in chemical and physical environment, biological activity of organisms, or other factors- may induce redistribution and partial solution of some of these metals*. (Houser and Fauth, 1972)

Results of the sediment analysis showed that there had been an extensive buildup of lead in the sediments adjacent to areas where there was propellant and other waste.

A 1975 Environmental Impact Assessment (this report was cited in a document reviewed at the EOD Library, but copying of the document was not approved) documented underwater

[2] Documents cited by number ("Exhibit 1," etc.) were obtained by CH2M HILL from the NSF-IH EOD Library.

explosion tests in the Potomac River at Indian Head using charges with a maximum weight of 80 pounds. No copies of the assessment were available to find out where in the Potomac River the testing occurred.

A 1978 notice from the Army (Exhibit 4) informed navigation interests that Indian Head would relocate its underwater demolition training site from the Potomac River to a 30-foot x 100-foot area in Chicamuxen Creek (Figure 1). Explosions would occur approximately 150 times per year and would be restricted during April and May.

Water Dynamics

The WAMS shows the locations of two test sites (WAMS Figure 5.2-1) in UXO 33 and the Explosive Area/Danger Zone in UXO 31 (WAMS Figure 7.1-1). The report does not contain any specific details regarding the deposition or erosion of river sediments in the water areas, or any information on historic dredging that would assist in characterizing the sediment transport regime at the project sites. Therefore, information on water dynamics (such as tidal actions, erosion and sedimentation processes, sediment types, and past dredging activities) was based on a review of available literature. The review findings were used to assess sediment transport in the Potomac River, with specific focus on the river segment adjacent to NSF-IH. The review was intended to characterize the sediment transport regime with respect to the fate and transport of munitions in defined water areas near the installation.

Potomac River

The Potomac River extends 383 miles from its headwaters at the Fairfax Stone in West Virginia to the Chesapeake Bay in Maryland, and drains approximately 14,700 square miles. The average flow at Washington, D.C., is 10,800 cubic feet per second (cfs), with a peak measured flow of 425,000 cfs (PotomacRiver.org, 2009). The mean tidal range in the Potomac River varies considerably through its length, averaging 1.8 feet at NSF-IH. The Potomac River below Washington, D.C., is tidal because of tidal variations in stage, but is primarily freshwater upstream of Quantico, Virginia.

Glenn (1988) defines three divisions of the Potomac River: river, transition, and estuary. NSF-IH is located within the river division, which extends 30 nautical miles from Chain Bridge, in Washington, D.C., to Quantico, just downstream of NSF-IH. The Potomac River has been subject to sedimentation since colonial times, as the transition of forested lands to cultivated fields increased sediment yields to the Potomac River and its tributaries (Callender et al., 1984). The Potomac River and its tributaries have been listed as impaired under Section 303(d) of the Clean Water Act for excess nutrients, sediment, toxics, and/or loss of living resources (EPA, 2005; Jordan et al., 2000).

Literature Review

Houser and Fauth (1972) documented the results of a field sampling program to characterize water quality and sediment quality in the lower Potomac River below Washington, D.C. Sampling was conducted to assess the effect of activities at the Naval Ordnance Station at Indian Head on the estuary. Samples were taken at 27 stations in a 94-mile reach of the Potomac River, from Key Bridge (26 miles upstream of the Indian Head location) to Piney Point (68 miles downstream). EPA personnel conducted sampling in

August 1970, December 1970, and April 1971. Samples were analyzed for metals concentrations. No information was found in this report characterizing the physical nature of the sediments in the Potomac River.

Brush (1984) summarized estimates of sediment accumulation rates in tributaries of the Chesapeake Bay. Analysis of sediment cores indicated that the sediment accumulates at an average rate of 0.30 centimeter (cm)/year, and that rates have increased with increased agricultural land use in the watershed.

DeFries (1986) reported results of a sedimentation analysis conducted with pollen grains in sediment cores collected throughout the lower Potomac River. A change in the concentration of pollen grains in sediment samples can be correlated with large-scale changes in land use in the watershed. Results of the analysis indicated a range in sedimentation from 0.21 to 1.72 cm per year, with the higher values occurring farther upstream near Washington, DC. Analysis of sediment cores taken near NSF-IH revealed sedimentation rates exceeding 0.72 cm per year for the period from 1840 to 1978. No variation in sedimentation rates was found between an upstream sample in 1.5 meters of water (shallow flat) and a downstream sample in 8.5 meters of water (main channel). DeFries claimed that the study demonstrated that extensive construction in the 1950s did not affect sedimentation rates throughout much of the estuary.

Blanchard and Hahl (1987) calculated sediment loads from the main stem of the Potomac River at Chain Bridge, in Washington, DC, from December 1977 to September 1981. Their review of long-term flow records indicated that the flow regime during the 4-year sampling period was similar to the long-term record (1931 to 1981). Load duration curves indicated a mean sediment load of 270 metric tons per day. Considerable variability existed in the annual suspended sediment loads, as presented below:

Water Year	Load (Metric Tons)
1978	2,150,840
1979	2,395,549
1980	1,286,116
1981	359,374

Source: Blanchard and Hall, 1987.

Analysis of storm events demonstrated the relative contribution of episodic transport events to the annual totals. The largest three storms from water year 1979 accounted for 77 percent of the total annual sediment load. Furthermore, the largest single storm in 1979 contributed almost three times as much sediment to the system as the entire 1981 water year. The storm loads of suspended sediment are summarized below:

Storm (Water Year 1979)	Load (Metric Tons)
Jan. 21 to Feb. 4	486,200
Feb. 24 to March 23	1,018,000
April 26 to May 16	139,300
Sept. 6 to 13	336,900
Oct. 1 to 27	410,600

Source: *Blanchard and Hall*, 1987.

Miller (1987) performed an analysis quantifying the contribution of shoreline erosion to the sediment load into the Potomac River. Through comparison of digitized historical shoreline maps and aerial photographs, Miller measured erosion rates over periods from 38 to 109 years. The analysis found higher rates of erosion in the estuary portion of the Potomac River system than in the tidal river portion. In the estuary, Miller found a higher contribution from the Virginia shoreline (49 to 60 percent of total shoreline erosion load) than from the Maryland shoreline (14 to 18 percent of total load). The remaining 23 to 36 percent of total shoreline erosion load was supplied by shoreline erosion in the tidal river and transition zones. Average annual linear erosion rates ranged from 0.42 to 0.52 meter along the Virginia shoreline in the estuary zone, 0.31 to 0.41 meter along the Maryland shoreline in the estuary zone, and 0.15 meter in the tidal river and transition zones. The total contribution of sediment from shoreline erosion was found to range from 0.375 to 0.565 million metric tons per year. Storm surge and wind-induced waves were likely responsible for the majority of shoreline erosion in the estuary zone.

Glenn et al. (1986) and Glenn (1988) provided information on bottom sediment composition throughout the Potomac River. The average bottom sediment sample collected in the Potomac was composed of 36 percent clay, 27 percent silt, and 37 percent sand. The average value of the median grain size was 0.010 millimeter (silt).

Hickman (1987) calculated nutrient and sediment loads from local nonpoint sources to the lower Potomac River system from October 1978 to September 1981. The results indicated a total load of 2.7 million metric tons of suspended sediment to the Potomac River from all tributary sources downstream of Chain Bridge. On an annual basis, this equates to 0.9 million metric tons of suspended sediment. Average stream flow during this 3-water-year period yielded sediment loads from individual watersheds up to 2.3 times higher than long-term averages. This should be taken into account when resultant loads are compared to long-term averages. When scaled to account for the higher-than-average stream flow during this 3-year sampling period, the load could be as low as 0.39 million metric tons per year.

Loads were calculated from measurements of suspended sediment and stream flow (Figure 5) and so did not account for bed load sediment transport, which is expected to be approximately 10 percent of the total sediment load. Gauged tributaries included Rock Creek, the Occoquan River, Saint Clements Creek, and the Anacostia River. Loads from the Anacostia watershed were scaled and applied to all urban watersheds, and loads from Saint Clements Creek were scaled and applied to all rural watersheds. Measurements were not uniform for each tributary; Hickman notes that the Saint Clements Creek watershed results may be skewed by the concentration of samples during the dry period.

FIGURE 5
Flow–Suspended Sediment Relationship for Northeast Branch of the Anacostia River
From Hickman (1987).

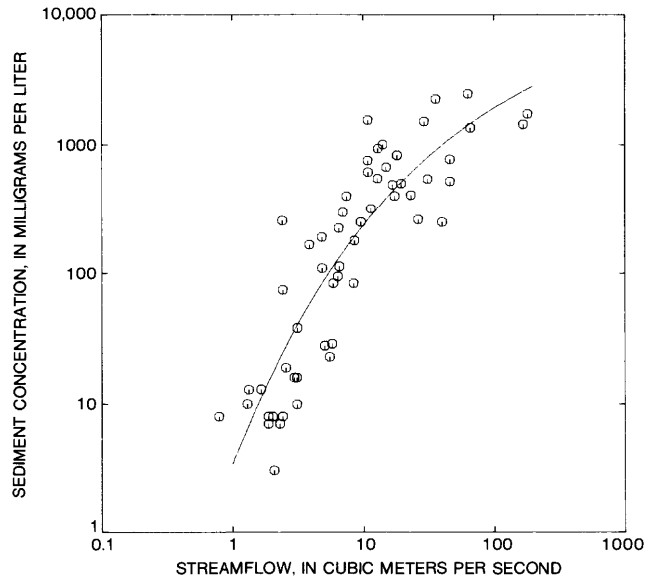


Figure 5. Sediment concentration versus streamflow for the Northeast Branch, 1979–81 water years.

Hickman compared his results to those of Wark and Keller (1963) to demonstrate the sensitivity of the results to the calculation method. Hickman noted that the mean annual sediment yields from his method are only 11 to 29 percent of those presented by Wark and Keller. By using Wark and Keller's calculation method with the current dataset, Hickman found that his results were only 50 percent lower than those of Wark and Keller. Hickman pointed out that the results of Wark and Keller could lead to overestimates of the sediment load.

Hickman compared his results to other sources of sediment to the Potomac River estuary over the same 3-year period (October 1978 to September 1981). Total sediment load from the Potomac River upstream of Chain Bridge totaled 4 million metric tons, whereas shoreline erosion added 0.45 million metric tons. When converted to annual rates, loads to the lower Potomac River were as follows (uncorrected for above-average flows):

- Upstream sources: 1.33 million metric tons per year
- Tributary sources: 0.9 million metric tons per year
- Shoreline erosion: 0.15 million metric tons per year

Schaffranek (1987) discussed the application of a one-dimensional branched hydrodynamic model to the lower Potomac River from Chain Bridge to NSF-IH. The model solved the full dynamic, unsteady, open-channel flow equations commonly known as the St. Venant equations. The model accounted for wind forcing, which can have a significant influence on the tidal propagation in the study area. The model was composed of 25 branches and used

66 cross-sections to specify the channel geometry. Hydrographic survey data obtained by National Oceanic and Atmospheric Administration's (NOAA's) National Ocean Service were used to develop the cross sections. The model was driven by flow at Chain Bridge and all tributaries, and tidally varying water surface elevations at NSF-IH. Schaffranek (1998) discussed additional modeling studies conducted with the one-dimensional branched hydrodynamic model of the lower Potomac River. The model predicted peak tidal flows at NSF-IH to be between 4,400 and 4,700 cubic meters per second (m^3/sec), or(155,000 to 166,000 cfs during periods with minimal riverine inflows (under 100 m^3/sec). This provides a measure of the relative strength between riverine and tidal flows.

Langland and Cronin (2003) provided a comprehensive summary of sediment processes in the Chesapeake Bay and its watershed. They discussed the origin of sediment transported through rivers and streams to the Chesapeake Bay, and correlated land use to sediment yield. Their study demonstrated that agricultural land use leads to high sediment yields, whereas watersheds with the highest percentage of forest cover have the lowest sediment yield. The report discusses the change in land use over time and its influence on sediment yield, noting that urbanization and development can cause a doubling of the sediment yield. Furthermore, the report mentions that even after development stops, the increased runoff associated with the development can increase erosion in stream banks, thereby sustaining elevated sediment yields. Finally, the report states that sediment transport is episodic, with most sediment transport occurring during storm events with bank-full flow (at average intervals of 1 to 2 years).

Navigation Charts

NOAA navigation charts of the Potomac River were reviewed, with particular attention paid to the areas adjacent to NSF-IH and Pope's Creek. The Potomac River is relatively shallow, but it has a deeper main navigation channel that meanders through several large radius bends and that in some places requires dredging to maintain a navigable depth. River channels have a natural tendency to migrate outward around large-radius bends. The Potomac River is no exception, and the navigation charts show how the deeper navigation channel is right against the outside bank just above NSF-IH (Figure 6). The main channel in the vicinity of Pope's Creek is also adjacent to the outside bank after a major bend in the river alignment (Figure 7).

The outward migration of channels in river bends can be the proximate cause of local shoreline erosion. At NSF-IH, a shoreline protection program was initiated in fall 2007 to combat shoreline erosion of 1.5 feet per year along a 17-mile shoreline (Dcmilitary.com, 2008). Construction of breakwaters and sills should reduce erosion and stabilize portions of the shoreline. At Pope's Creek, visual evidence demonstrated active erosion from steep banks (Figure 8).

The navigation charts also showed a dredged channel off NSF-IH. This channel, approximately 3 miles long (Figure 6), was dredged to a 21-foot depth mean lower low water datum through a region of shallow water in the Potomac. The river width increases considerably as the river passes the northern tip of Indian Head. This increase in flow area causes the river to slow, and the capacity to carry sediment in suspension is reduced. The shallow depths in the vicinity of the navigation channel demonstrate that this is a

depositional environment. Figure 9 shows how the deeper channel shoals and narrows just upstream of the dredged channel.

The NOAA charts also show the extent of the Danger Zone in the vicinity of NSF-IH. The regulations associated with the Danger Zone (33 CFR 334.240) state the following:

> *(1) Firings consisting of controlled explosions within the danger zone, and controlled shore operations, or accidental explosions, hazardous to vessel traffic within the limits of the danger zone, may take place at any time of the day or night and on any day of the week; (2) Flashing red lights, horns, and signs established at appropriate points will warn vessels of impending tests or operations considered to be hazardous to vessels within the danger zone; (3) No persons or vessels except vessels of the United States or vessels authorized by the enforcing agency shall enter or remain in the danger zone while lights are flashing, when warning horns are in operation, or when warned or directed by a patrol vessel; (4) Nothing in this section shall prohibit the use of Mattawoman Creek or Chicamuxen Creek as a harbor of refuge because of stress of weather; (5) Except as prescribed in paragraph (b)(3) of this section, persons and vessels may enter and proceed through the danger zone without restriction. However, accidental explosions may occur at any time and persons and vessels entering the area do so at their own risk; (6) Fishermen operating in the danger zone when warning signals are sounded shall evacuate the area immediately.; and (7) The regulations in this section shall be enforced by the Commanding Officer, U.S. Naval Surface Warfare Center, Indian Head Division, Indian Head, Maryland.*

FIGURE 6
Potomac River Bathymetry near NSF-IH
From NOAA (2009a).

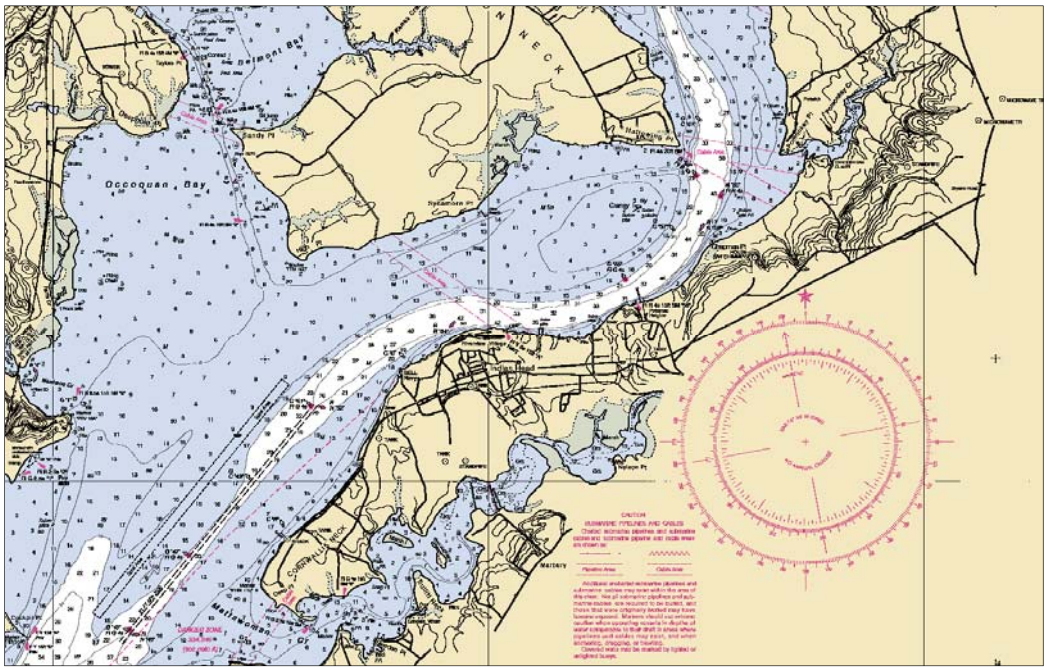


FIGURE 7
Potomac River Bathymetry near Pope's Creek
From NOAA (2009b).

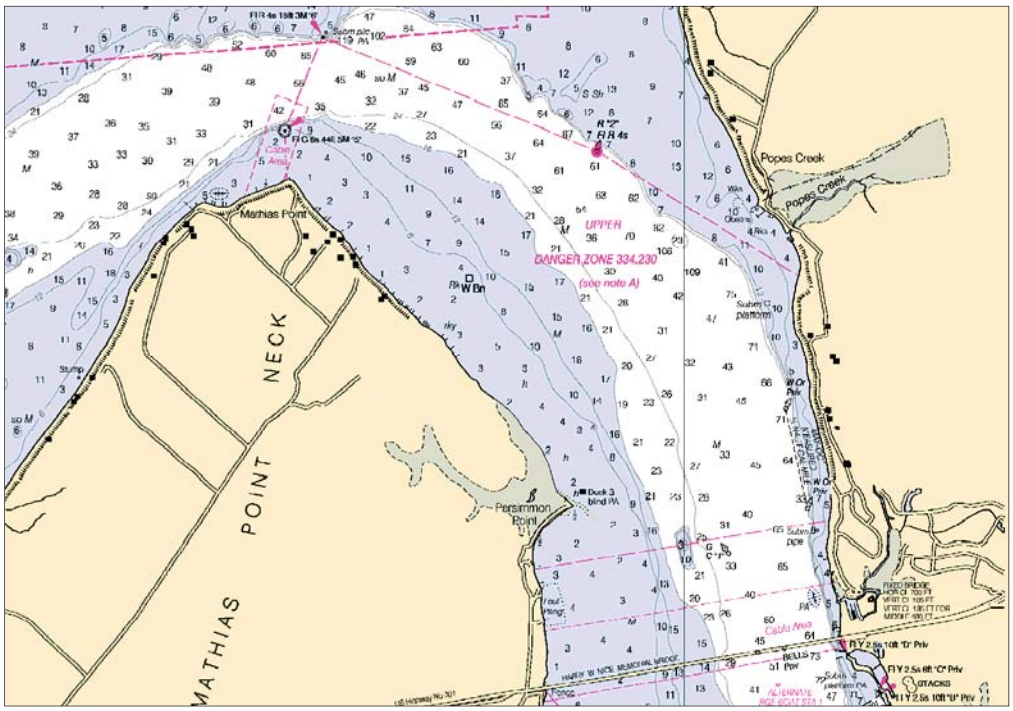
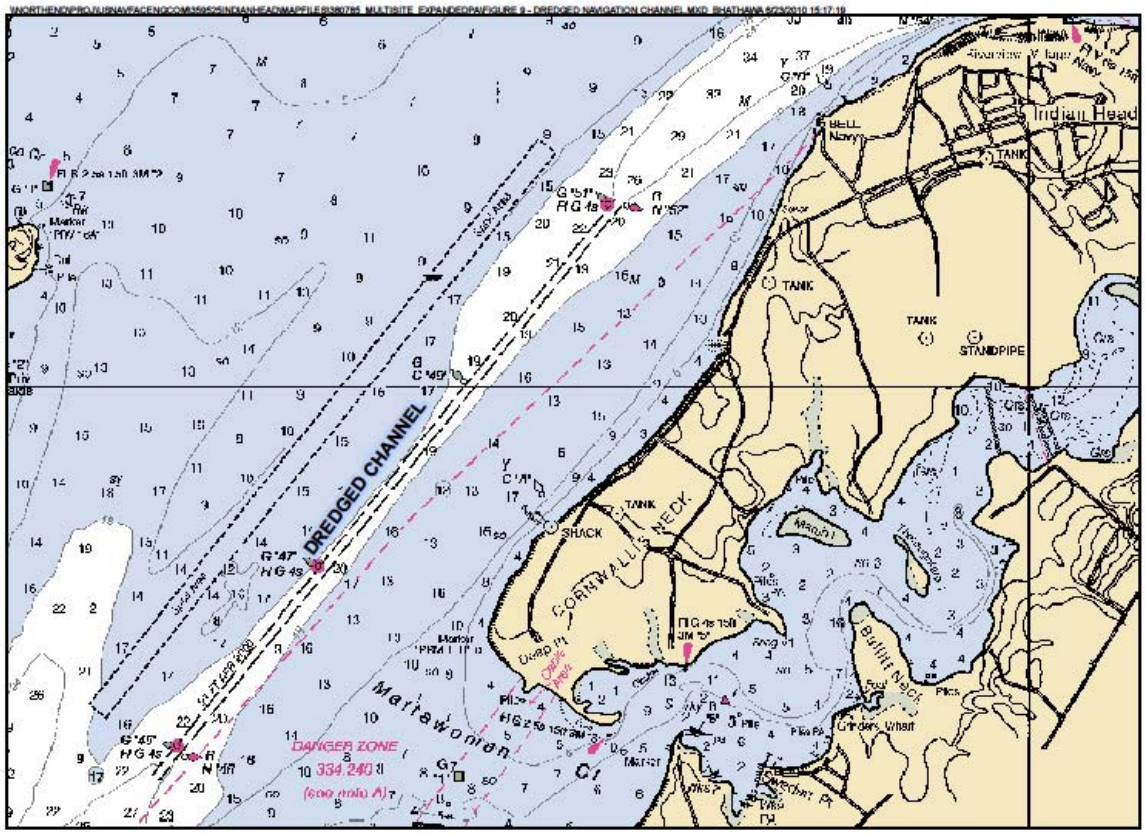


FIGURE 8
Eroding Bank (about 6 meters high) composed of Cohesive Miocene Sediment, Near Pope's Creek, Virginia.
From Miller (1987).

FIGURE 9
Dredged Navigation Channel off Indian Head, Maryland
From NOAA (2009a).



Summary and Implications for Water Sites

The lower Potomac River, like most large estuaries, is generally a depositional environment. Localized shoreline erosion occurs generally in regions of channel curvature where the bank is migrating outward, or in areas where wind waves are undercutting channel banks. The river has a high sediment load, with annual average supply from upstream, tributaries, and shoreline erosion exceeding 2 million metric tons per year. The bottom sediments are primarily fines, composed of 36 percent clay, 27 percent silt, and 37 percent sand. Median grain sizes average 0.010 mm (silt). Estimated rates of sediment deposition in the Potomac River in the vicinity of Indian Head exceed 0.72 cm/year. Over a 30-year period, this equates to 21.6 cm, or 8.5 inches.

Estuarine bottom sediments are generally soft, and the potential exists for munitions to sink into bottom sediments under their own weight. Inman and Jenkins (2003) stated that in soft sediments, 75 percent to 100+ percent burial of munitions can occur on impact. The combination of continued deposition of sediment and the potential for munitions burial in soft sediments may have removed historic munitions from the sediment surface, so visual surveys would not reveal the presence of MEC.

UXO 18—Battle Range Firing Area

The Battle Range Firing Area is located at the mouth of Mattawoman Creek. Average depths in the region are 7 to 10 feet. The area is depositional in nature; sediment carried by Mattawoman Creek deposits near the mouth of the creek as the cross-sectional area increases and flow velocities decrease. Estimates of deposition in Mattawoman Creek were not available, but it is assumed that measured deposition rates at Indian Head are also representative of deposition rates in the Battle Range Firing Area. MEC items from the explosive fragments of gun firing may have been partially or fully buried by a combination of sediment deposition and sinking into soft bottom sediments.

UXO 31—Pope's Creek

The area used for explosives testing near Pope's Creek was on the eastern shore of the Potomac River. Testing was conducted in the deepest portion of the navigation channel, which had a depth of 78 feet (War Department, 1947). The channel appears to be migrating eastward; the eastern bank of the navigation channel shallows from more than 70 feet to under 10 feet over a short distance (Figure 5). As the channel migrates to the east, the western portion of the channel is filled by sediment. MEC items may have been partially or fully buried by a combination of sediment deposition and sinking into soft bottom sediments.

UXO 33—Water Impact Area

The Water Impact Area encompasses more than 12,000 acres and covers the full range of bathymetric features in the lower Potomac River, from shallow flats to deep portions of the main river channel. This area also contains the dredged navigation channel off NSF-IH. MEC items from the explosive fragments of gun firing and underwater explosion testing may have been partially or fully buried by a combination of sediment deposition and sinking into soft bottom sediments.

Risk Analysis

A risk analysis was performed to assess risks associated with UXO 18, UXO 31, and UXO 33 past military operations over, on, and under water using OPNAVINST 3500.39B, Operational Risk Management (dated July 30, 2004) processes and procedures. The analyses included a risk assessment, risk decision, and recommendations for potential risk mitigations or controls. Table 1 presents a hazard analysis matrix for all three sites.

Table 1
Hazard Analysis Matrix
Expanded Preliminary Assessment for UXO 18, UXO 31; and UXO 33

		Mishap Probability[1]			
		A	**B**	**C**	**D**
Hazard Severity [2]	**I**	1	1	2	3
	II	1	2	3	4
	III	2	3	4	5
	IV	3	4	5	5

Mishap Probability[1]	Hazard Severity [2]	Risk Assessment Codes:
A Likely to occur immediately B Probably will occur in time C May occur in time D Unlikely to occur	I May cause death II May cause severe injury III May cause minor injury IV Presents a minimal threat	1 Critical 2 Serious 3 Moderate 4 Minor 5 Negligible

Process Step	**Hazard**	**Triggering Event**	**Initial Risk Index**	**Hazard Mitigation**	**Final Risk Index**
Battle Range Firing Area, UXO 18	MEC, Discarded Military Munitions (DMM) Unexploded Ordnance (UXO), Material Potentially Presenting an Explosive Hazard (MPPEH)	Contact with MEC/UXO/DMM/ MPPEH – shock or movement; dredging	B/II/2	Dredges may not use direct impeller or auger processes. Suction methods with screens over intakes will be used to keep MEC from entering dredging equipment. Discharge points on land will have secondary catch screens to prevent MEC from dispersing. Brief crew on 3R Training. If dredge spoils are discharged on land, UXO-qualified persons, in accordance with Department of Defense Explosives Safety Board Technical Paper 18, shall monitor discharges screens for MEC. Signage along shorelines should alert the public of the potential dangers of military munitions on the river bottom and to avoid contact.	D/IV/5
Pope's Creek, UXO 31	MEC, DMM, UXO, MPPEH	Contact with MEC/UXO/DMM/ MPPEH – shock or movement; dredging	B/II/2	Dredges may not use direct impeller or auger processes. Suction methods with screens over intakes will be used to keep MEC from entering dredging equipment. Discharge points on land will have secondary catch screens to prevent MEC from dispersing. Brief crew on 3R Training. If dredge spoils are discharged on land, UXO qualified persons, in accordance with Department of Defense Explosives Safety Board Technical Paper 18, shall monitor discharges screens for MEC. Signage along shorelines should alert the public of the potential dangers of military munitions on the river bottom and to avoid contact.	D/IV/5
Water Impact Area, UXO 33	MEC, DMM, UXO, MPPEH	Contact with MEC/UXO/DMM/ MPPEH – shock or movement; dredging	B/II/2	Dredges may not use direct impeller or auger processes. Suction methods with screens over intakes will be used to keep MEC from entering dredging equipment. Discharge points on land will have secondary catch screens to prevent MEC from dispersing. Brief crew on 3R Training. If dredge spoils are discharged on land, UXO qualified persons, in accordance with Department of Defense Explosives Safety Board Technical Paper 18, shall monitor discharges screens for MEC. Signage along shorelines should alert the public of the potential dangers of military munitions on the river bottom and to avoid contact.	D/IV/5
Water Impact Area, UXO 33 Test Area 1	MEC, DMM, UXO, MPPEH	Contact with MEC/UXO/DMM/ MPPEH – shock or movement; dredging; anchoring Scuba diving on old target; and moving MEC	B/II/2	Dredges may not use direct impeller or auger processes. Suction methods with screens over intakes will be used to keep MEC from entering dredging equipment. Discharge points on land will have secondary catch screens to prevent MEC from dispersing. Brief crew on 3R Training. If dredge spoils are discharged on land, UXO qualified persons, in accordance with Department of Defense Explosives Safety Board Technical Paper 18, shall monitor discharges screens for MEC. Signage along shorelines should alert the public of the potential dangers of military munitions on the river bottom and to avoid contact.. Mark area on navigation maps as "No Anchor Area" and restrict scuba diving from old target location. Signage along shorelines should alert the public of the potential dangers of military munitions on the river bottom and to avoid contact.	D/IV/5
Water Impact Area, UXO 33 Test Area 2	MEC, DMM, UXO, MPPEH	Contact with MEC/UXO/DMM/ MPPEH – shock or movement; dredging; anchoring Scuba diving on old target; and moving MEC	B/II/2	Dredges may not use direct impeller or auger processes. Suction methods with screens over intakes will be used to keep MEC from entering dredging equipment. Discharge points on land will have secondary catch screens to prevent MEC from dispersing. Brief crew on 3R Training. If dredge spoils are discharged on land, UXO qualified persons, in accordance with Department of Defense Explosives Safety Board Technical Paper 18, shall monitor discharges screens for MEC. Signage along shorelines should alert the public of the potential dangers of military munitions on the river bottom and to avoid contact. Mark area on navigation maps as "No Anchor Area" and restrict scuba diving from old target location. Signage along shorelines should alert the public of the potential dangers of military munitions on the river bottom and to avoid contact.	D/IV/5

UXO 18 and UXO 31 are large areas where MEC may or may not remain; bottom conditions have silted over, and swift currents with winter flooding may have moved potential sources down the river or creek. The likelihood of encountering MEC through recreational activities associated with water sports is remote. However, commercial activities such as channel dredging could actively disturb bottom sediment conditions to cause a potential MEC item to be vacuumed from the bottom into a marine vessel.

UXO 33 spans both shallow and fairly deep waters of the Potomac River, with most of the area in fast-moving currents, the main channel, or in the intersections of tributaries with the confluence of creek and river waters. Annual spring and winter flooding, combined with occasional hurricane conditions, has made the river bottom over the past 100 years a changing and evolving one. The likelihood for MEC to remain where fired is "occasional," with a greater probability for downriver movement from the initial intended impact area. This suspicion is the case for most of UXO 33, except for the two test sites shown on Figure 3. Both test areas were at some time fixed for either surface firing or underwater testing. As a result, both areas have the potential for underwater remains of targets or test facilities that may still contain MEC.

Recommendations

UXO 18

The water dynamics study showed that any munitions items that may be present have likely been buried by sediment deposition. This would result in an incomplete pathway to human receptors (recreational) from MEC items and MC. Based on the findings from the expanded PA, no further investigation is recommended. However, because of the potential for MEC to be present, it is recommended that the existing Danger Zone on the National Oceanic and Atmospheric Administration (NOAA) maps should be expanded to include the potential impact area from UXO 18. In addition, the Danger Zone regulations should be updated to reflect the current site use and to restrict intrusive activities (such as anchoring and dredging) into the underlying sediments unless UXO avoidance procedures are performed.

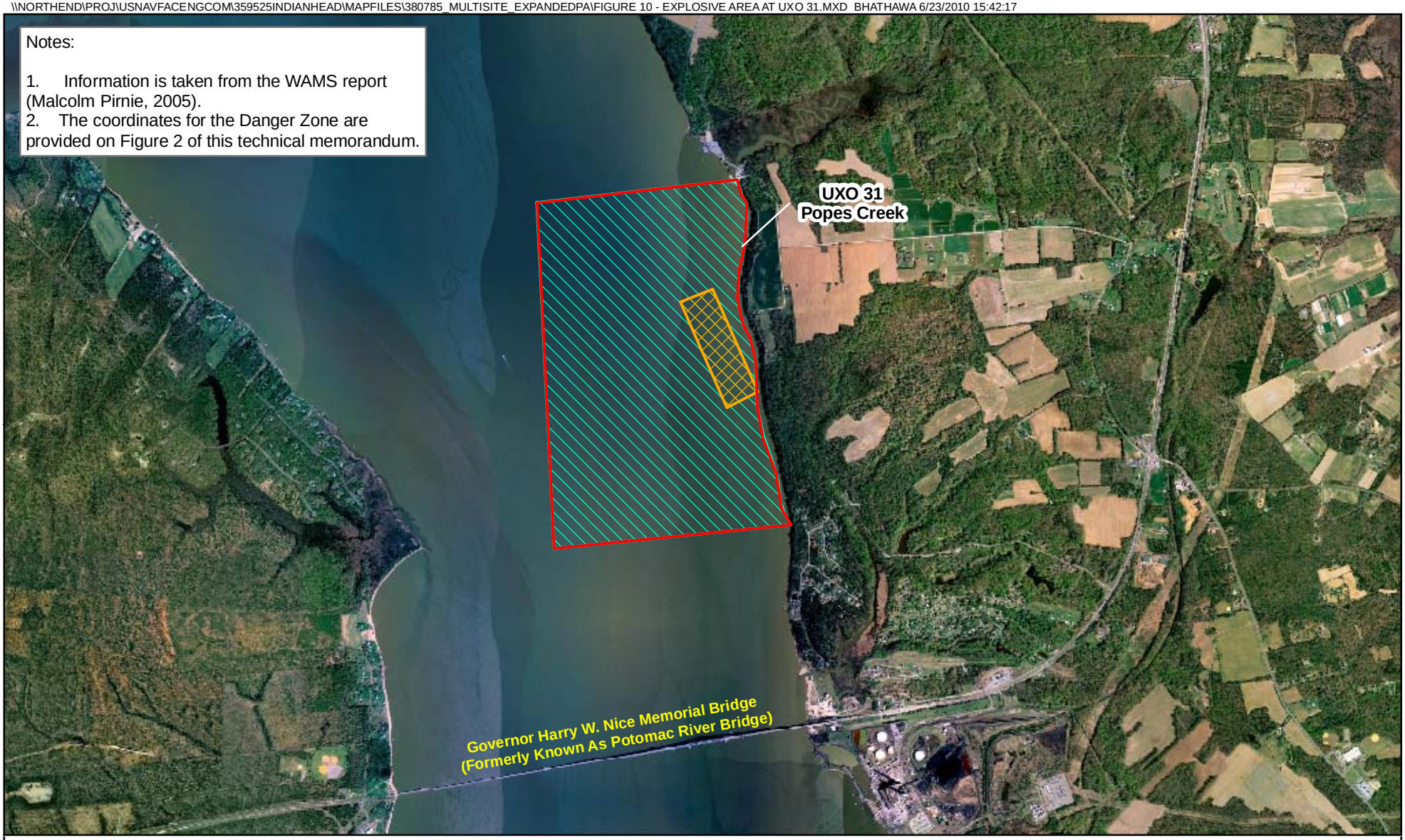
UXO 31

Figure 10 shows the explosive area where underwater testing was done. Given the time since munitions were last used at this site (1947) the MEC and associated fragments would likely have been buried by sediment deposition over time. As a result, there is an incomplete pathway to human receptors (recreational) from MEC items and MC. Channel dredging will disturb the sediment bottom, which could create a condition in which MEC items could be encountered. Because of the low explosive safety risk and the absence of documented releases of MEC or MC at the site, no further MEC and MC investigations are recommended. However, Because of the potential for MEC to be present, it is recommended that the existing Danger Zone on the NOAA maps should be expanded to include the potential impact area from UXO 31. In addition, the Danger Zone regulations should be updated to reflect the current site use and to restrict intrusive activities (such as anchoring or dredging) into the underlying sediments unless UXO avoidance procedures are performed first.

UXO 33

Figure 4 in Appendix H shows two test areas (Test Area A and Test Area B) within the site that were used for explosives testing with a limit not to exceed 80 pounds. It is reported that UXO 33 may have been affected by munitions since 1891 (strayed ordnance from testing at UXO 11—The Valley). Any munitions items that were fired into the site would likely be partially or fully buried over time by sediment deposition in the deep navigation channel. As a result, there is an incomplete pathway to human receptors (recreational) from MEC items and MC. No further MEC or MC investigations are recommended for UXO 33. However, because of the potential for MEC to be present, it is recommended that the existing Danger Zone on the NOAA maps should be expanded to include the potential impact area from UXO 33. In addition, the Danger Zone regulations should be updated to reflect the current site use and to restrict intrusive activities (such as anchoring or dredging) into the underlying sediments unless UXO avoidance procedures are performed first.

\\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\380785_MULTISITE_EXPANDEDPA\FIGURE 10 - EXPLOSIVE AREA AT UXO 31.MXD BHATHAWA 6/23/2010 15:42:17



Legend
- Danger Zone
- Explosive Area
- Approximate Site Boundary

N
W E
S

0 1,500 3,000
Feet

Image Source: Google Earth Pro

Figure 10
Explosive Area at UXO 31
Expanded Preliminary Assessment for UXOs 18, 31, and 33
NSF-IH, Indian Head, Maryland

CH2MHILL

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Nautical Software. 1996. *Tides and Currents Program*.

NOAA. 2009a. *Electronic Navigation Charts. Chart 12289. Potomac River, Mattawoman Creek to Georgetown*.

NOAA. 2009b. *Electronic Navigation Charts. Chart 12288. Potomac River, Lower Cedar Point to Mattawoman Creek*.

PotomacRiver.org, 2009. Available at: http://www.potomacriver.org/cms/index.php?option=com_content&view=article&id=70&Itemid=57

Schaffranek, R.W. 1987. *A Flow Simulation Model of the Tidal Potomac River*. U.S. Geological Survey Water Supply Paper 2234-D. 41 pp.

Schaffranek, R.W., 1998. Simulation Model for Open-Channel Flow and Transport. Paper presented at First Federal Interagency Hydrologic Modeling Conference, April 19–23, 1998, Las Vegas, Nev.

War Department, 1947. Public Notice No. 108. U.S. Army Corps of Engineers, Office of the District Engineer. June 2.

Wark, J.W. and Keller, F.J., 1963. Preliminary study of sediment sources and transport in the Potomac River Basin, Washington, D.C., Interstate Commission on the Potomac River Basin technical Bulletin 63-11, 28 p.

Attachment A
Resource List

ATTACHMENT A

Resource Review Summary

The following table provides a summary of the specific references identified for review, interview, or contact for the archival report.

Resource	Actions Completed
Malcolm Pirnie, Final Water Area Munitions Study	Reviewed document to identify additional resources to review.
Charles County Public Library, Potomac Branch, 3225 Ruth B. Swann Drive, Indian Head 20640, 301/375-7375	Reviewed all applicable resources related to Indian Head as identified through library's online search tool.
Washington National Records Center, 4205 Suitland Road, Suitland, MD 20746-8001	Reviewed all applicable resources related to Indian Head as identified through library's online search tool.
US National Archives (NARA II) Historical Files, provided by Jim Dolph, Naval Historian	Historical files collected by Jim Dolph and submitted to CH2M HILL were reviewed.
US National Archives	Historical files for dredging records
Naval Undersea Museum Library, Washington 360/396-5547	No response to inquiries.
Indian Head, Dept of Public Works EOD Library	Reviewed topical index for applicable site maps from Dept. of Public Works and all accessible EOD records available through EOD library.
Army Corp of Engineers, Baltimore District	Reported that all historical files have been sent to US National Archives

A.1 Charles County Public Library, Potomac Branch

Contact: 301/375-7375
Site Visit: May 21, 2009

List of Documents Reviewed from Potomac Branch Library

Reviewed all applicable resources related to Indian Head as identified through library's online search tool.

1) Brown, Jack (and others). *Charles County, MD, A History*. 1976 Charles County Bicentennial Committee, year unknown.
2) Hammer, Andrea, *Praising the Bridge That Brought Me Over*, Charles County Community College, 1990.
3) Bartelson, John D., Civil War Explosive Ordnance 1861-1865: A field Guide for Civil War Explosive Ordnance, US Naval Ordnance Station, Indian Head, Maryland, 1972

4) Carlisle, Rodney. *Powder and Propellants: Energetic Materials at Indian Head, Maryland, 1890-1990,* 1990.

Items #1-3 did not provide relevant information regarding munitions/ordnance use or locations of use. #2 was primarily a documentation of oral history of residents and workers of Indian Head and Charles County. #3 provided a detailed technical description of ordnance types used during the Civil War era.

A.2 Washington National Records Center

Contact: 301/778-1600
Site Visit: May 28, 2009

Documents Reviewed from WNRC

Reviewed all applicable resources related to Indian Head as identified through Center's online search tool.

-A review of records did not provide relevant information regarding munitions/ordnance use or locations of use. Documentation was primarily related to personnel records. According to WNRC staff, any applicable information has already been transferred to the National Archives.

A.3 Indian Head, Department of Public Works and EOD Library

Contact: Nick Carros/IR Manager, 301-744-2263
Site Visit: August 24, 2009

List of Documents Reviewed from Dept. of Public Works

Reviewed Drawing List by Building #, Bldg. 900-3108 and Projects with no Bldg. #

00870246- Explosive Ordnance Tech Facility (copied)

00870284- Explosive Ordnance Tech Facility

00870289- Explosive Ordnance Tech Facility

00870291-xxx95 - Explosive Ordnance Tech Facility

00024457 (1968)- EDS Underwater Ordnance Bldg.

OSK-7001 (1969)- Soundings in Mattawoman Creek (12)

01298738 (1970)- Boat Launching Ramp at Old Dock- see map

00015599 (1970)- Hydrographic Map at Mattawoman Creek (27)

OSK-7269 (1970)- Proposed Jetty in Potomac River (12)

03119046-51 (1981)- Reconstruction of Riverfront Access Road

03124849 (1983)- Reconstruction of Riverfront Access Road

03129334 (1985)- Sediment Control Plan

03076350-57 (1995)- Removal of Contaminated Soil-Channel Realignment Plan (109)

03089737-41 (1995)- Explosive Test Facility (108)-located inland mid-base

List of Documents Reviewed from EOD Library

- EOD librarian reviewed key words in the card catalog records. Records are classified and old dredging records, if available, may be in card catalog.
- CH2M HILL was able to review the following non-classified documents:
  - A Study of Tidal Dispersion in the Potomac River, Federal Water Pollution Control Administration, Tech Paper 7
  - Potomac River Sediment Study by Marilyn E. Houser and Mae I. Fauth, June 1972.
  - Introduction to Ordnance Technology, January 1976.
  - Environmental Protection Report for 1982 by Thomas H. Woo and Phillip Rochlin, August 1982.

A.4 US National Archives Historical Files, provided by Jim Dolph, Naval Historian

Reviewed CD of historical information provided by Jim Dolph. Documented were originally obtained by Jim Dolph from the US National Archives.

Attachment B
Exhibits

Attachments A-L

NPB April 1947 Box 230 1674 Indian Head

Op-411B3/HW
Serial 075P411
(SC) 868
Doc. 212546

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~
In reply refer to
and No.

NAVY DEPARTMENT

OFFICE OF THE CHIEF OF NAVAL OPERATIONS

25 APR 1947

NP8
NP42
X 78-1
Re 2
ES
Jul

End. #3 on District Engineer, U. S. Engineer Office, Washington, D. C., ltr. 800.2121(Potomac River) NAWVG dtd. 1 April 1947.

From: Chief of Naval Operations.
To : Commandant, Potomac River Naval Command.

Subject: Underwater Explosives Research, Use of Potomac River for.

Reference: (d) NOL Ltr. EN6-27/S68(7-57) over (Q3) of 26 Feb. 1947 to PRNC, w/PRNC End-1, RC1/S68(1)(Code 22) Serial 097 of 27 Feb. 1947 to CNO.
(e) CNO Ltr. Serial 274P411 of 18 Mar. 1947 to District Engineer. NP42 - Re 2
(f) CNO Ltr. Serial 295P411 of 18 Mar. 1947 to Fish & Wildlife Service. NP8
(g) CNO Ltr. Serial 303P411 of 18 Mar. 1947 to Maryland State Dept. of Tidewater Fisheries.

1. Forwarded.

2. In regard to the proposal of reference (d), referred to this office for consideration, firing of the six 600-pound charges is approved subject to the following comments:

(a) These shots can be fired without approval of the Secretary of War, according to the reply to reference (e).
(b) The Department of Interior, Fish and Wildlife Service, in replying to reference (f), recommended that because of fish runs in the Potomac during spring months, explosive tests in the river be conducted during the summer, fall and early winter. This recommendation is concurred in.
(c) In reply to reference (g), the Department of Tidewater Fisheries, Maryland, stated that advice as to the best manner of carrying out the tests for minimizing damage to the fish population will be offered. This information has not been received to date, but will be forwarded when received.

REGISTERED MAIL
3245791

3. In regard to the continuing underwater explosive research program in the Potomac River, there is no objection to the firing of charges of 80-pounds and below at Indian

DECLASSIFIED
NND 763547
Authority
By NARA Date 12/15/06

REPRODUCED AT THE NATIONAL ARCHIVES

Op-411B3/HW
Serial 075P411
(SC) 868
Doc. 212548

~~CONFIDENTIAL~~

25 APR 1947

In reply refer to Initials and No. End. #3 on

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON

District Engineer, U. S. Engineer Office, Washington, D. C., ltr. 800.2121 (Potomac River) NAWG dtd. 1 April 1947.

Subject: Underwater Explosives Research, Use of Potomac River for.

- -

Head, if the location proves satisfactory for the purpose. Concerning the firing of charges in the area near Pope's Creek, it is understood that large charges will be fired in this location. No objection is interposed in this regard, however, it is desired that all explosive firings be deferred during spring months. Furthermore, in view of the fact that during the summer months, the Potomac River is used by bathers, it is desired that precautions be taken to prevent possible injury to bathers.

J.
BY DIRECTION

042947 02967

Copy to:

BuOrd

NOL, Naval Gun Factory
Washington, D. C.

Naval Powder Factory
Indian Head, Maryland

Naval Proving Grounds
Dahlgren, Virginia

DECLASSIFIED
NWD 79-157
Authority
By NARA Date 12/15/06

REPRODUCED AT THE NATIONAL ARCHIVES

2511
Gen Cor. 1912-26
R674
Box 47

N. Ord. 6

In reply refer to No.

NAVY DEPARTMENT

BUREAU OF ORDNANCE

WASHINGTON, D. C.

December 11, 1915.

MEMORANDUM FOR BUREAU DESKS.

The Desks concerned will please go over these Regulations, note any changes, and also note objections, if any, to the changes that have been made.

[illegible]

[illegible] P2 par 6. + P22, par 211.

Page 28 par 267 - ten rounds is excessive for 12" guns. Believe this should be reduced to eight. The regulations give no limit of rds for 14" other than 6 proof rds. Suggest 8 rds be allowed as a maximum in cases of proving powder during proof of gun.

OK. Bull concurs in "D"'s remarks

No comments - [illegible]

No [illegible]

Incs comments rec'd

[illegible] OK.

[illegible] DIC [illegible]

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Navy Department,
Bureau of Ordnance.
December 20 1915

The within confidential regulations governing the conduct of proof work at the naval proving ground are approved.

Chief of Bureau of Ordnance.

Jy 1915

Stump Neck Danger Zone

RANGES.

101. Ranges are shown on naval proving ground blueprint No. 643.

102. Except when ricochets can not be dangerous, long pointed shell should be fired at an angle of elevation of not less than 8°; blunt nose shell at not less than 7° 30'; square headed proof shot, 5°.

103. All firing over Stump Neck should be with long pointed shell, at an angle of elevation of not less than 8°. When the velocity falls below service, care must be taken that shells are clearing the land.

104. When a strong wind is blowing across the range ricochets are most probable even at the prescribed angle of elevation. Even with 8° elevation long pointed shell ricochet. No rule can be given for the direction and distance of ricochets, but the greater number are to the right, especially when the wind is blowing toward that direction. 14" and 16" shell frequently ricochet 1,000 yards. No risks shall be taken in firing when ricochets may put a vessel in actual or possible danger. It must be borne in mind that the landing of a shell in close proximity to vessels has the undesirable effect of intimidating navigators. This shall be avoided.

105. Rules giving limits within which firing may take place when vessels are approaching or near the line of fire

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are given in Volume I of these regulations. They are to be thoroughly understood by lookouts, and by every officer conducting proof work.

106. When firing down the range is in progress the battery lookout must be on the bridge. In case the gun is not properly laid, he will so report to the officer conducting the firing. Before each round he will report to that officer when the valley is clear, and whether the range is clear as far as he can see. When he is not sure of the condition of the range around the point of fall, he will so report.

107. The officer conducting firing must assure himself before firing that the gun is properly laid and range is clear.

108. A line drawn from the bomb proof at Indian Head tangent to the shore line at Deep Point, and cutting Stump Neck peninsula at about its narrowest point, is designated as the "Boundary line for danger zone at Stump Neck." All areas on Stump Neck to the southward and westward of this line are designated as the "Stump Neck danger zone."

109. Fifteen minutes before it is desired to start firing over the long range, notice to that effect will be given the marines at Winthrop, who will immediately withdraw from the danger zone, and report to the bombproof when clear.

110. In all firing over the long range there must be telephone communication with an officer or other fully com-

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petent person stationed at Chicamuxen, or some similar point from which the fall or shot can be observed.

111. Immediately before each round over the lower range the officer conducting the firing will assure himself by telephone that the range is clear. After each round the lower lookout will report to him the fall of the shot.

112. Tracers are fired down the range at dusk. Before firing, telephone communication must be had with the lookout at Stump Neck to be sure that the range is clear.

113. The central telephone operator at Indian Head shall be informed when firing is about to take place over the long range, or firing of tracers, and shall keep the line to Stump Neck ready for immediate use, giving this duty strict attention and preference over all other duties while firing is in progress.

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Telegraph Address:
via Navy Yard, Washington, D.
Express and Freight Address:
Indian Head, via Navy Yard, Washington, D. C.

N. P. G. 765.

AGK-JY

NAVAL PROVING GROUND,
INDIAN HEAD, MD.

Refer to No. .....
And address all communications to
Inspector of Ordnance in Charge.

16 July 1918.

To: Bureau of Ordnance.

Subject: Inadequate facilities of present Proving Ground.

Reference (a): N. P. G. letter 2750-20 of 8 April 1918.
(b): " " 2790-10 of 7 June 1918.
(c): " " 2815-16 of 24 June 1918.

1. The inadequacy of the present proving ground for certain classes of experimental work, and the danger to life and property resulting from the continued use of this station, have been demonstrated so conclusively by certain recent occurrences that it is considered necessary to present the situation to the Bureau under separate report.

2. This station has been called upon to hold certain firings in order to develope light long-range projectiles. Without going into details, it is sufficient to state that this projectile is intended for immediate use in the present war. Because of the very high velocity, the range obtained is considerably greater than with ordinary projectiles; and because of a turn to the eastward of the Potomac River above Mathias Point the clear deep-water range from Indian Head is limited to 18,000 yards. Firing at 8° elevation, an angle which the present war has shown to be very small for both land and sea practice, the resulting range has landed the experimental shells in very shallow water. In the test reported in reference (a), two projectiles ricocheted and landed in Virginia on the property of Mr. Picket Wallace. Again, on July 2, 1918, a third shell of this type richocheted and fell in a chicken yard near Widewater, Va. In both cases firing was discontinued. As the matter now stands, the Proving Ground is unable to determine by firing what velocity or what range these projectiles may be given; the Proving Ground is totally unable to obtain any data on the action of these shells at any angle of elevation above 8°. In both instances the lives and property of private citizens living in the state of Virginia at or near Widewater, Virginia, have been in danger.

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3. Another example may be taken from the test reported in reference (b). In the development of a poison gas shell numerous firings of highly toxic substances have been conducted in the large explosion chamber. This structure is about 300 yards from the main proof battery. On the occassion reported in reference (b) the gas cloud from one shell drifted out of the explosion chamber and settled over the main bomb proof. The entire personnel of this building were attacked by the gases and 20 men were "sick and nauseated for about two hours". It is needless to say that proof work had to be suspended until this experimental work was completed.

4. The third instance was that of the test of a 16" projectile tested for the U. S. Army. Although all possible precautions were put into effect, the projectile passed through the plate, through the sand, and went about 2500 yards down the river. As mentioned in reference (c), the inhabitants of houses inside the reservation proper were removed to a safe distance, yet had the shell turned left instead of right it would have landed among houses occupied by persons not subject to Government control. In this connection it should be remembered that the first 16" projectiles ever fired at Indian Head did wreck a house, although, fortunately, no loss of life resulted. Considerable publicity was given this occurrence in the press and also in the moving picture summaries of weekly occurences.

5. From these three instances it will be seen:

(a) That light long range high velocity projectiles for immediate war use cannot be tested at the Navy's proving ground.

(b) That gas shell for use in the present war cannot be tested at the present proving ground without exposing personnel to grave danger, or unless all other work be stopped.

(c) That 16" projectiles for both the Army and the Navy cannot be tested at the present proving ground without exposing lives and property to grave danger.

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6. In addition to the above, attention is invited to the fact that Indian Head proper is growing to be more and more a purely manufacturing station, and that with the building of the new nitric acid plant on Cornwallis' Neck, it seems almost certain that the fuse battery will have to be moved; also that the area now used for exploding depth charges, aerial bombs, etc., will have to be abandoned for this purpose as soon as building operations begin on the above plant, owing to the liability of damage to same.

7. It is believed that it would be well to consider seriously at this time the question of more land adjacent to the Lower Station on Machodoc Creek, to which locality all fuse work, high explosive work, and plate and shell work should be removed, leaving the Proving Ground at Indian Head for use purely as an experimental station except for the long range and high angle work which is to be conducted at the Lower Station.

In accordance with earlier instructions received from the Bureau, a survey of the whole of Mathias Point Neck has been started in order that the Station may be in a position to prepare charts of this property in connection with the advised purchase of same.

8. It is recommended that the above property be secured at the earliest practicable date in order that the plans for the development of same can proceed coincidentally with the work now in hand at the Lower Station.

9. In connection with the above, attention is invited to Naval Proving Ground 2nd Indorsement 2005-O of July 22nd, 1918, referring to terminal facilities at Pope's Creek, which facilities are believed to be intimately related to the above recommendation, in view of the fact that such terminal facilities will permit of freight being brought to the station there by water from Washington, or railroad from Pope's Creek, without having same pass in front of the battery, as it will be necessary to do for awhile until a dock with connecting railroad can be built at Mathias Point.

W. G. Lackey, J.

REPRODUCED AT THE NATIONAL ARCHIVES

Telegraph Address:
via Navy Yard, Washington, D. C.
Express and Freight Address:
Indian Head, via Navy Yard, Washington, D. C.

N. P. G. 76 b.

NAVAL PROVING GROUND,
INDIAN HEAD, MD. HDB.

Refer to No. 2204-1.
And address all communications to Inspector of Ordnance in Charge.

October 15th, 1917.

To: Bureau of Ordnance.

Subject: Danger to persons outside of Proving Ground due to fragments.

Reference: (a) Bu.Ord. letter 27182 (A2)-Q of October 5, 1917.

1. Referring to reference (a) above, the Bureau is informed that by far the greater number of fragments that have fallen within the danger zone, both on the Reservation and on private property, are those incident to the proof of fuses in three and four-inch guns (Owing to the increased danger from same, fuses are not tested in five inch guns and above, as they should be.)

Until recently the guns used in this work were located on the down-Valley circle of the north battery, but now are located on the secondary battery behind the armor butts and fire through 3/8" and 5/16" plates mounted on a small cause-way recently erected down the River from the basin.

2. Besides fragments incident to fuse work there are those caused by tests of detonators in the covered butt, whence fragments manage to get out, despite the use of an armored hood around the impact in front of the plate.

These fragments are of course, no where near as numerous as those resulting from fuse work, but are none the less dangerous.

3. Besides these again are those fragments of shell that go to pieces in flight, as in the case of Raleigh target shell, more or less recently, and those that break up within the gun from one cause or another, as in the case of 14-inch shell a few days ago. A fragment of this nature, weighing 3-pounds, being forwarded to the Bureau under separate cover and separate correspondence, fell near Swann's store on Cornwallis' Neck, and is claimed to have missed the wife of one R.E.Fairfax, a machinist's helper, employed at this Station, by a few feet only.

4. Another source of danger is that from fragments of shell in connection with tests of time fuses, where in at least one instance, fragments have fallen in the neighborhood of Quantico, but as yet no complaints on this score have reached this Station, a communication having been received simply stating the fact that a fragment fell in that locality on a date which corresponded with the one on which time fuse firing was done at this Station.

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Every precaution possible is taken to protect the lives of those residing in the danger zone. Notices have been posted calling attention to the danger from falling fragments, and prior to each lot of firing the Station steam launch is sent down along the beach of Cornwallis' Neck with instructions to blow the danger signal of four whistles.

6. The question of re-locating the plates and laying the guns farther to the right has been looked into with a view to throwing the left side of the cone of dispersion clear of Cornwallis' Neck, but this cannot be done without endangering the Virginia shore. Should the shell fail to burst on impact or keyhole, the live shell would reach Virginia, with the possibility of bursting with disastrous results.

Four inch shell which fail to burst on impact from one cause or another, now fall frequently below the lookout's station on Stump Neck, and as the River at this point narrows materially, the Bureau will realize that the line of fire cannot be shifted to the right sufficiently to lessen the danger on Cornwallis' Neck, as the line of fire now passes midway between the dock on Stump Neck and Cock Pit Point.

7. With a view to securing immediate relief, the Inspector, accompanied by the Powder Expert, the Proof Officer and his assistants, including the gunners, and the Experimental Officer, visited Stump Neck on Sunday, October 14th, and went over the ground very thoroughly without, however, being able to find a suitable location for the emplacement of a battery for the purpose of testing fuses, without encountering the same difficulty that now obtains at the present location.

This feature of Stump Neck will be covered under other correspondence as well.

While on the subject, however, it might be well to point out that considerable extra land would have to be purchased, and owing to the narrowness of the River at this point, it is not believed that the Virginia shore would be entirely free from danger from fragments, which is almost out of the question to arrest, although the shell itself might be caught, should the fuse fail on impact.

While the Government owns a considerable tract of land at this point, same extends to the eastward and is so located as to be of little value for this work with a battery located at Stump Neck. However, another solution has been arrived at, which will be laid before the Bureau under other correspondence.

H. E. Lackey

REPRODUCED AT THE NATIONAL ARCHIVES

Copy of 106509/1.

WAR DEPARTMENT

NOTICE TO NAVIGATORS AND ALL NAVIGATION INTERESTS ON THE POTOMAC RIVER.

1. Under the present emergency of war, notice is hereby given that that portion of the Potomac River lying between a line drawn from Indian Head Point, Md., to High Point, Va., and a line drawn from Fair Oak, Md., to Chopawamsic Island, Va., is hereby designated as a Danger Zone. This zone will be closed to all traffic except vessels propelled by mechanical power and having a speed of not less than 5 miles per hour, during the hours from 9.00 a.m. to 4.00 p.m. on all days except Sundays and during the hours from 7.00 p.m. to 9.00 p.m. on all days except Saturdays and Sundays.

2. Sailing vessels, tugs with tows, etc., unable to move at a speed greater than 5 miles per hour, fishing boats, pleasure boats and small craft of any kind are forbidden to enter or remain in the Danger Zone during the specified hours of closure. Small craft, the property of riparian owners within the Danger Zone, may be retained therein during hours of closure if special permit therefor is obtained from the Inspector of Ordnance in charge of the Naval Proving Ground. A patrol will be maintained by the United States to enforce these regulations and violators thereof will be promptly arrested and prosecuted to the full extent of the law.

3. Vessels authorized to pass the Danger Zone during the hours of closure will signal their approach thereto by 4 blasts of a whistle or horn, or by such other method as will be effective. Upon such signal the vessel will be met by a United States Patrol Boat and escorted through the zone. No vessel will enter the Danger Zone during hours of closure unless so escorted by a patrol boat.

4. During periods of closure and for 15 minutes before and after such periods danger signals will be conspicuously shown on Indian Head Point at the Indian Head Proving Ground Wharf and at the lower end of Stump Neck, Md. During daylight each signal will consist of a large red flag. During the hours of darkness the signal will consist of four red lights in a vertical line.

5. On and after April 9, 1917, these regulations will be effective for all fishing boats, pleasure boats and small craft generally, and on and after April 16, 1917, they will be effective for all other craft.

NEWTON D. BAKER.

April 6, 1917.

Secretary of War.

APR 16 1917
RECORDED
BUREAU OF
NAVIGATION

REPRODUCED AT THE NATIONAL ARCHIVES

Letter prepared for Secretary's signature Bureau Ordnance File #27182/306-(B4)-11/17/22, MEW.

6692-410

NOV 15 1922

To: Secretary of War.

Subject: Notice to Navigators, dated April 6, 1917, restricting use of Potomac River in vicinity of Naval Proving Ground, Indian Head, Md.

Reference: (a) War Department letter No. 106509 Engrs., dated November 6, 1922.

In reply to your letter of November 6, 1922, reference No. 106509 Engrs., I desire to inform you that the emergency regulations designating the firing range at the Naval Proving Ground, Indian Head, Md., as a danger zone and forbidding it to certain classes of vessels, promulgated by the Secretary of War's order of April 6, 1917, are no longer necessary and may be cancelled, as the Navy is not at present conducting proving or ranging operations on this range.

In view of the above, it is not recommended that these regulations be included in Chapter XIX of the Army Act approved July 9, 1918, when it was reissued.

T. Roosevelt

Acting Secretary of the Navy

NAVY DEPARTMENT
Secretary's Office
RECORD DIVISION
NOV 16 1922
RECEIVED

NAVY DEPARTMENT
Secretary's Office
RECORD DIVISION
NOV 16 1922
FORWARDED

REPRODUCED AT THE NATIONAL ARCHIVES

WAR DEPARTMENT
WASHINGTON

In reply refer to
106509 Engrs.

November 6, 1922.

REC'D
NOV 11 1922
BU ORDN.
NAVY

The Honorable,
The Secretary of the Navy.

My dear Mr. Secretary:

I desire to call your attention to the copy herewith of Notice to Navigators promulgated by this Department under date of April 6, 1917, restricting, under the emergency of war, the use of the Potomac River in the vicinity of the Naval Proving Ground at Indian Head, Maryland.

As the emergency of war has terminated, the wording of the notice is no longer appropriate, and it is believed that if the restrictions are still necessary they should be prescribed as regulations under authority of Chapter XIX of the Army Act approved July 9, 1918, as has been done in the case of the Naval Proving Ground at Dahlgren, Virginia.

It is accordingly requested that this Department be advised whether the Navy is still conducting proving operations at Indian Head which make necessary the continuance of any restrictions on the use of the Potomac River in the vicinity, and if so, what changes, if any, your Department desires to have made in the notice when it is reissued under Chapter XIX of the Army Act of July 9, 1918.

Sincerely yours,

John W. Weeks,
Secretary of War.

1 Incl., viz:
Copy of 106509/1 - Notice of April 6, 1917.

NAVY DEPARTMENT
SEC'Y'S OFFICE - RECORD DIV.
RECEIVED
OP.
OP. MAT.
J.A.G.
SOL.
G. O.
APPT.
NOV 9 1922
6692-410

REPRODUCED AT THE NATIONAL ARCHIVES

WAR DEPARTMENT

NOTICE TO NAVIGATORS AND ALL NAVIGATION INTERESTS ON THE POTOMAC RIVER.

1. Under the present emergency of war, notice is hereby given that that portion of the Potomac River lying between a line drawn from Indian Head Point, Md., to High Point, Va., and a line drawn from Fair Oak, Md., to Chopawamsic Island, Va., is hereby designated as a Danger Zone. This zone will be closed to all traffic except vessels propelled by mechanical power and having a speed of not less than 5 miles per hour, during the hours from 9.00 a.m. to 4.00 p.m. on all days except Sundays and during the hours from 7.00 p.m. to 9.00 p.m. on all days except Saturdays and Sundays.

2. Sailing vessels, tugs with tows, etc., unable to move at a speed greater than 5 miles per hour, fishing boats, pleasure boats and small craft of any kind are forbidden to enter or remain in the Danger Zone during the specified hours of closure. Small craft, the property of riparian owners within the Danger Zone, may be retained therein during hours of closure if special permit therefor is obtained from the Inspector of Ordnance in charge of the Naval Proving Ground. A patrol will be maintained by the United States to enforce these regulations and violators thereof will be promptly arrested and prosecuted to the full extent of the law.

3. Vessels authorized to pass the Danger Zone during the hours of closure will signal their approach thereto by 4 blasts of a whistle or horn, or by such other method as will be effective. Upon such signal the vessel will be met by a United States Patrol Boat and escorted through the zone. No vessel will enter the Danger Zone during hours of closure unless so escorted by a patrol boat.

4. During periods of closure and for 15 minutes before and after such periods danger signals will be conspicuously shown on Indian Head Point, at the Indian Head Proving Ground Wharf and at the lower end of Stump Neck, Md. During daylight each signal will consist of a large red flag. During the hours of darkness the signal will consist of four red lights in a vertical line.

5. On and after April 9, 1917, these regulations will be effective for all fishing boats, pleasure boats and small craft generally, and on and after April 16, 1917, they will be effective for all other craft.

Secretary of War.

April 6, 1917.

REPRODUCED AT THE NATIONAL ARCHIVES

Danger Zone on Potomac River be cancelled.

Letter prepared for Secretary's signature Bureau Ordnance File #27182/306-(E4)-11/17/22, MEW.

6692-410

NOV 15 1922

To: Secretary of War.

Subject: Notice to Navigators, dated April 6, 1917, restricting use of Potomac River in vicinity of Naval Proving Ground, Indian Head, Md.

Reference: (a) War Department letter No. 106509 Engrs., dated November 6, 1922.

In reply to your letter of November 6, 1922, reference No. 106509 Engrs., I desire to inform you that the emergency regulations designating the firing range at the Naval Proving Ground, Indian Head, Md., as a danger zone and forbidding it to certain classes of vessels, promulgated by the Secretary of War's order of April 6, 1917, are no longer necessary and may be cancelled, as the Navy is not at present conducting proving or ranging operations on this range.

In view of the above, it is not recommended that these regulations be included in Chapter XIX of the Army and approved July 9, 1918, when it was reissued.

Theodore Roosevelt

Acting Secretary of the Navy.

R674
Doc 169
25A

Gen Corr
1912-26

NAVY DEPARTMENT
Secretary's Office
RECORD DIVISION

NOV 16 1922

NOV 16 1922

FORWARDED

REPRODUCED AT THE NATIONAL ARCHIVES

UNDERWATER DEMOLITION TEAM FOUR
A-1 U.S. NAVAL POWDER FACTORY
Serial: 004 INDIAN HEAD, MARYLAND

SPS
Re 2
MH

2 August 1946.

From: The Commanding Officer.
To : Ships Salvage, Bureau of Ships Code 882.

Subject: Research Project No. 31/47, Progress Report From 29 July 1946 to 2 August 1946.

Reference: (a) Research Program Outline prepared by Lt. (jg) V. MORRISSEY, Ships Salvage Branch, Bureau of Ships.

080746 0447

1. This is the third of a series of weekly progress reports which will be distributed each Friday until Project No. 31/47 is completed.

2. Monday, 29 July 1946.
Completed construction of marine ways. Abandoned blasting and dredging at test area because the nature of the river bottom is such that it fills in in a very short while. Arranged to install ways at pier.

3. Tuesday, 30 July 1946.
Installed marine ways at pier. Began testing effects of rope charge on 3/16 inch mild steel plating. Began fabricating ship sections.

4. Wednesday, 31 July 1946.
Modified marine ways to adapt it to use from pier. Fabricated sample cavity charge form. Continued tests began in (3) above.

5. Thursday, 1 August 1946.
Arranged for fabrication of cavity charge forms. Tests and construction work discontinued because of foul weather.

6. Friday, 2 August 1946.
Captain's Inspection.

H. IVERSON.

cc: Dir of Research, BuShips, Code 332(2)
BuOrd, Re2C(2)
ComPhibsLant (2)
ComPhibsTraLant (2)
CTG 22.7 (2)
C.O. Ordnance Investigation Laboratory
C.O. Naval Powder Factory.
File.

REPRODUCED AT THE NATIONAL ARCHIVES

UNDERWATER DEMOLITION TEAM FOUR
U.S.NAVAL POWDER FACTORY
INDIAN HEAD, MARYLAND

A-1
Serial:007 ½

NP8
RE2

16 August 1946.

From: The Commanding Officer.
To : Ships Salvage, Bureau of Ships Code 882.

Subject: Research Project No. 31/47 Progress report from 12 August 1946 through 16 August 1946.

Reference: (a) Research Program Outline prepared by Lt.(jg) V. MORRISSEY, Ships Salvage Branch, Bureau of Ships.

1. This is the fifth of a series of weekly progress reports which will be distributed each Friday until project number 31/47 is completed.

2. Monday, 12 August 1946.
Removed Marine ways from pier. Commenced construction of submerged crib for firing charges. Tested effect of linear cavity charges on 5" barbette.

3. Tuesday, 13 August 1946.
Continued construction of submerged crib. Tested effect of linear cavity charges on 5" barbette.

4. Wednesday, 14 August 1946.
Completed construction of submerged crib. Tested effect of linear cavity charges on 5" barbette.

5. Thursday, 15 August 1946.
Tested effect of rope charges on 5/16, 3/8 and 1/2 inch steel plates. Tested effect of linear cavity charges on 5" barbette.

6. Friday, 16 August 1946.
No work accomplished because of foul weather.

H. IVERSON.

cc:Dir of Research,BuShips, Code 332
BuOrd, Re2C
ComPhibsLant
ComPhibsTraLant
CTG 22.7
C.O. Ordnance Investigation Laboratory
C.O. Naval Powder Factory
File.

082646 0851

REPRODUCED AT THE NATIONAL ARCHIVES

NP8 Box 310

UNDERWATER DEMOLITION TEAM FOUR
A-1 US NAVAL POWDER FACTORY
Serial: 0010 INDIAN HEAD, MARYLAND

30 August 1946.

NP8
Re2
M4

From: The Commanding Officer.
To : Ships Salvage, Bureau of Ships Code 882.

Subject: Research Project No. 31/47 Progress Report from 26 August through 30 August 1946.

Reference: (a) Research Program Outline prepared by Lt.(jg) V. MORRISSEY, Ships Salvage Branch, Bureau of Ships.

1. This is the seventh of a series of weekly progress reports which will be distributed each Friday until project number 31/47 is completed.

2. Monday, 26 August 1946.
Placed new crib on river bottom.

3. Tuesday, 27 August 1946.
Completed experimentation using rope charges on 5/16" steel plating.

4. Wednesday, 28 August 1946.
Completed experimentation using rope charges on 1" steel plating.

5. Thursday, 29 August 1946.
Began experimentation using linear cavity charges on 1 3/4" steel plating.

6. Friday, 30 August 1946.
Cold weather and lack of proper equipment prevented the use of divers. No experimentation accomplished this date.

H. IVERSON.

cc: Dir of Research, BuShips Code 332
BuOrd, Re2c
ComPhibsLant
ComPhibsTraLant
CTG 22.7
C.O. Ordnance Investigation Laboratory
C.O. Naval Powder Factory
File.

090546 0015

REPRODUCED AT THE NATIONAL ARCHIVES

NPS Box 310

UNDERWATER DEMOLITION TEAM FOUR
US NAVAL POWDER FACTORY
INDIAN HEAD, MARYLAND.

NPS

A-1
Serial: 0011

6 September 1946

RE2

From: The Commanding Officer.
To : Ships Salvage, Bureau of Ships Code 882.

Subject: Research Project No. 31/47, Progress Reprot from 3 September through 6 September 1946.

Reference: (a) Research Program Outline prepared by Lt. (jg) V. MORRISSEY, Ships Salvage Branch, Bureau of Ships.

1. This is the eighth of a series of weekly progress reports which will be distributed each Friday until project number 31/47 is completed.

2. Tuesday, 3 September 1946
Completed experimentation using rope charges.

3. Wednesday, 4 September 1946
Began experimentation with linear cavity charges on 1-1/4" mild steel plating varying the weight of explosive.

4. Thursday, 5 September 1946
Removed blasting crib from river bottom for repairs.

5. Friday, 6 September 1946
Completed repairs on blasting crib.

H. IVERSON

cc: Dir of Research, BuShips Code 332
BuOrd, Re2c
ComPhibsLant
ComPhibsTraLant
CTG 22.7
C.O. Ordnance Investigation Laboratory
C.O. Naval Powder Factory
File.

091146 0349

REPRODUCED AT THE NATIONAL ARCHIVES

UNDERWATER DEMOLITION TEAM FOUR
US NAVAL POWDER FACTORY
INDIAN HEAD, MARYLAND

A-1
Serial: 0015

20 September 1946

From: The Commanding Officer
To : Ships Salvage, Bureau of Ships Code 882

Subject: Research Project No. 31/47, Schedule for the week of 23 September 1946 through 27 September 1946.

1. Monday, 23 September 1946
Test effect of charges on I-Beams and angles on land for comparison with results obtained underwater.

2. Tuesday, 24 September 1946.
Application of results - cavity charges on 3/16", 5/16" and 1/2" plating.

3. Wednesday, 25 September 1946.
Application of results - cavity charges on 3/4", 1" and 1-3/4" plating.

4. Thursday, 26 September 1946.
Application of results - cavity charges on reinforced 3/16" plating.

5. Friday, 27 September 1946.
Application of results - cavity charges on reinforced 1/2" plating.

H. IVERSON

cc: Dir of Research, BuShips, Code 332
BuOrd, Re2c
ComPhibsLant
ComPhibsTraLant
CTG 22.7
C. O. Ordnance Investigation Laboratory
C. O. Naval Powder Factory
File

092446 0195

REPRODUCED AT THE NATIONAL ARCHIVES

DPI Oct 46 → Dec 46
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UNDERWATER DEMOLITION TEAM FOUR
U.S. NAVAL POWDER FACTORY
INDIAN HEAD, MARYLAND

A-1
Serial: 0026

4 October 1946.

From: The Commanding Officer.
To : Ships Salvage, Bureau of Ships Code 882.

Subject: Research Project no. 31/47, Scheaule for the week of 7 October through 11 October 1946.

1. Monday 7 October 1946.
Devote entire day to making up test plates.

2. Tuesday 8 October 1946.
Complete linear cavity charge tests.

3. Wednesday 9 October 1946.
Continue tests with triangular charges.

4. Thursday 10 October 1946.
Continue tests with triangular charges.

5. Friday 11 October 1946.
Complete tests with triangular charges.

H. IVERSON.

cc: Dir of Research, BuShips Code 332.
BuOrd Re2c
ComPhibsLant
ComPhibsTraLant
CTG 22.7
C.O. Ordnance Investigation Laboratory
C.O. Naval Powder Factory
File.

101046 0196

RE-FILMED AT THE NATIONAL ARCHIVES

NPS - Sep 46 - Box 310

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FF 13

10 SEP 1946

From: The Chief of the Bureau of Ordnance
To: Commander in Chief, Atlantic Fleet

Subject: Underwater Demolition Team, Temporary Additional Duty for.

Reference: (a) CNO ltr 782P34 to CinCPac copy to CinCLant of 16 Apr 1946.

1. In response to a request from the Chief of the Bureau of Ships, Commander Amphibious Force, Atlantic Fleet approved a transfer of one Underwater Demolition Team from Little Creek, Virginia, to the Naval Powder Factory, Indian Head, Maryland, to work on an experimental underwater demolition project that was initiated by the Bureau of Ships on wreck disposal. This Underwater Demolition Team has been performing tasks in connection with this project at the Naval Powder Factory since 11 July 1946. Their present period of temporary duty on this project ends about 15 September 1946.

2. Since reference (a) has stated a desire in paragraph 3 to have Underwater Demolition Teams made available for such experimental projects as may be assigned by the Department, it seems appropriate that the Underwater Demolition Team now located at Naval Powder Factory, Indian Head, might be authorized to continue at their present location on temporary additional duty in connection with performance of such tasks as may be assigned by the Bureau of Ordnance in connection with their demolition research and development program. The following demolition items will be available for tests in the near future:

(a) Arming Cell for Concussion Detonating Firing Device.
(b) Firing Device Mark 15.
(c) Hand Placed Demolition Charges.
(d) A New Type Demolition Reel.

This team would also be available for conducting appropriate tests requested by other branches of the Navy Department.

3. It is believed that the demolition research and development program of the Bureau of Ordnance will provide a sufficient amount of experimental tasks on underwater demolitions to warrant that a team be maintained at the Naval Powder Factory continuously. Discussions with representatives of the Underwater Demolition Team now at the Naval

10 SEP 1946

CROSS INDEX SUBJECT

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(Re2) S76-3

Ad

Powder Factory and representatives of the Chief of Naval Operations indicate that they agree that this should provide excellent training [illegible] in the carrying out of the demolition research program. Suggestions have been made that the two teams in the Atlantic Fleet alternate at this temporary additional duty at approximate four-month intervals.

Re

4. It is, therefore, recommended that one Underwater Demolition Team of the Atlantic Fleet be assigned to temporary additional duty at the Naval Powder Factory, Indian Head, Maryland, in connection with experimental underwater demolition work. If this is approved, the team now at the Naval Powder Factory would remain at that station until about 1 November, at which time the teams will shift stations between Little Creek and Indian Head, and the periodic shifting of teams between these two stations will continue until such time as the tasks required by the demolition research program do not warrant further continuance of this temporary duty.

2c CM

Fl

Mn

G. F. HUSSEY, Jr.

ne

CC:
CNO
BuShips
ComPhibLant
CO, Naval Powder Factory
Pr
Pacific
ASLB

J. H. Carter
Acting

Prepared 9-6-46
Ext. 3330

10 SEP 1946

CROSS INDEX SUBJECT

NP42
March 16-31, 1947
Box 264

Op-411B3/HW
Serial 274P411

NP42
NP8
Re2

In reply refer to Initials and No.

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON

Corps of Engineers
War Department
1st & Douglas Streets, N.W.
Washington 25, D. C.

18 MAR 1947

031947 0152

Attention: Colonel D. G. White, District Engineer

Dear Colonel White:

It is presently contemplated to transfer part of the underwater explosives research program from Naval Mine Warfare Test Station, Solomons, Md., to the Naval Powder Factory, Indian Head, Md. In this connection, it is desired to fire six preliminary charges in the Potomac River Channel, in the vicinity of Indian Head, in order to ascertain vibration effects at various distances and to determine the suitability of the location for future research into underwater explosion characteristics. The preliminary firings will consist of 600-pound depth charges, fired statically. It is presently intended that any future firings in the vicinity of Indian Head will not exceed 80-pounds per shot, and that such firings will occur intermittently.

The preliminary firings, and any which may be performed subsequently, will be so scheduled as to avoid any possibility of obstructing or delaying river traffic, and adequate precautions will be taken to insure the safety of all river craft. It is not desired that any particular area should be set aside for this program, since, in general, the most satisfactory location for prosecution of the program lies in the channel, where the deepest water is to be found.

It is requested that comment or recommendations be furnished in regard to the program outlined above.

Yours very truly,

A. G. NOBLE
Rear Admiral, USN

Copy to:
The Bureau of Ordnance
C.O., Naval Powder Factory, I.H., Md.
Commandant, Potomac River Naval Command
OinC, NavOrdLab, Naval Gun Factory, Washington, D.C.

DECLASSIFIED
NHS Authority 929647
By NARA Date 8-18-6

NPP
Mar 16-31 1947
N Y 230

Op-411B3/HW
Serial 295P411

In reply refer to Initials and No.

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON

NPP
ER

18 MAR 1947

Director,
Fish and Wildlife Service,
U. S. Department of the Interior.
Washington 25, D. C.

Attention: Mr. E. Higgins, Division of Fishery Biology

Dear Mr. Higgins:

The Navy contemplates static firing of explosive charges in the Potomac River Channel in the vicinity of Indian Head, in connection with its researches into underwater explosion effects. This work will be initiated by the firing of six 600-pound TNT charges, to be followed by occasional firing of small charges not exceeding 80-pounds per charge.

It is understood that Potomac River oyster beds will not be affected by this program; however, information is desired in regard to fishing activities in the vicinity of Indian Head, and also in regard to the possibility of conflict with, or damage to, fishing interests generally. It is requested that this information be provided, together with any comments or recommendations you may desire to make.

Yours very truly,

A. G. NOBLE
Rear Admiral, USN

Copy to:
The Bureau of Ordnance
C.O., Naval Powder Factory, I.H., Md.
Commandant, Potomac River Naval Command
OinC, NavOrdLab, Naval Gun Factory,
Washington, D.C.

031947 0161

REPRODUCED AT THE NATIONAL ARCHIVES

RESULTS OF THE CHIEF OF NAVAL MATERIAL

AD HOC GROUP

ON

UNDERWATER EXPLOSIONS TEST SITES

15 JUNE 1978

Test and Evaluation Data, distribution limited to U.S. Government agencies only. Other requests for this document must be referred to the Deputy Chief of Naval Material for Acquisition (NAVMAT 08).

HEADQUARTERS, NAVAL MATERIAL COMMAND

WASHINGTON, D.C.

Box 854
OP archives, NHC, WASHINGTON DC
R+D files

4. Operations

Naval Surface Weapons Center has three test sites available at NOS Indian Head, two in the Potomac River and one on land at Stump Neck. Explosive tests in the river are staged out of a berth at the Station The explosive charges are brought to the berth by truck from the magazine area. The two test areas are within one-half to one and a half miles from the berth. Construction of firing arrays is accomplished on a flat area near the waterfront. The in-air and on water shots are conducted at the Stump Neck annex of NOS where an instrumented explosive site and a shallow drainable pond are available.

There are other explosive sites on the Station. The Naval Explosive Ordnance Disposal Facility and the Naval Explosive Ordnance Disposal School both conduct explosive tests. The majority of these tests are on station above ground.

5. Facilities

The Potomac River provides a sheltered test area with a soft muddy bottom. There are two test sites, one is 500' X 2000' in area and 45' deep, the other site is 150' X 400' and provides 80' of water depth The center of the more shallow test site is 790 feet from land and 850 feet from the nearest inhabited area. The deeper site is 455 feet from land and 600 feet from inhabited area. In the past there has been a self imposed explosives limit of 80-pound at both test sites. The above ground test site occupies approximately two acres. Located at this area is a level test site and a shallow test pond. Both of these sites are wired into one common instrumentation van. The pond also has the ability to be drained and filled as required.

Facilities at Indian Head include 5300 sq ft of office and lab space, and 2000 sq ft of covered storage. A 150,000 sq ft open storage and assembly area is located near the waterfront and used primarily for constructing firing arrays. There is also a 1000 ft berthing pier with 10 feet of water depth. A small machine shop and boat repair facility are available on station. Lift capacity is limited to a 50 ton mobile crane. The Explosive Ordnance Disposal Facility can provide complete scuba diving capability.

Explosives are stored at one of two magazines available to NSWC. The total storage capacity is 20 tons. There are other magazines on the station. The wharf used to load explosives onto the boats has no legal explosive limits.

6. Environmental

The two explosive test sites used by NSWC are within river areas controlled by Notices to Mariners promulgated by the Secretary of Army pursuant to the provisions of the River and Harbor Act and the Army Appropriation Act. The above ground site is located on the Stump Neck portion of the Station and is in the general area used by Explosive Ordnance Disposal Facility and School for the detonation of explosives.

As the major employer in Charles County, the relations between the Ordnance Station and the surrounding community have not been a problem. Across the river from Indian Head is a large power plant that keeps the ambient noise level above a normal sound range. The situation that has existed in the past is likely to change, however, as the area surrounding the Station develops and the recreational use of the Potomac River continues to increase.

The area of the Potomac River along the Naval Ordnance Station is not utilized by the commercial fishing community to the extent that other River areas and the Bay are. There are no exotic or rare fish and commercial interests are limited to eel pots in season. Consideration is taken to reduce the fish kill and no tests are conducted in April or May, which is the spawning season for perch. Since this area of the River is sheltered, the sea state rarely exceeds 2.0. The months of January and February do find ice on the River that could curtail testing operations.

POSITIVE ASPECTS

1) The two test holes are located in an area designated as a danger zone on navigation charts.

2) The underwater explosive tests do coincide with the other work performed.

3) Close proximity to East Coast Labs.

4) Ambient noise level near explosive sites is higher than normal due to the power plant.

5) Limited commercial fishing activities.

PROBLEM AREAS

1) Test sites are relatively close to inhabited areas.

2) Close proximity to metropolitan Washington, D. C. area can be expected to produce increased use of the Potomac River for recreation.

3) No ordnance handling pier exists.

Indian Head

DEPARTMENT OF THE NAVY
SPACE AND NAVAL WARFARE SYSTEMS COMMAND
WASHINGTON, D.C. 20363-5100

IN REPLY REFER TO:
8505
Ser 005C/87-294
5 August 1987

MEMORANDUM FOR THE ASSISTANT SECRETARY OF THE NAVY, RESEARCH, ENGINEERING AND SYSTEMS

Subj: APPROVAL OF PROPOSED SECNAVINST 8500.

Encl: (1) Background

1. The purpose of this memorandum is to provide background for and solicit your assistance in ensuring issuance of proposed SECNAVINST 8500. The instruction establishes policy, procedures, and controls under a central approval authority, Commander, Space and Naval Warfare Systems Command (COMSPAWARSYSCOM), for the conduct of underwater explosion (UNDEX) tests in the navigable waters of the Chesapeake Bay region. The authority is extended to cover all UNDEX tests in these waters that are sponsored by and/or conducted by all components of the Navy. The instruction specifically defines nine test sites in Bay region waters where UNDEX tests can be conducted and defines permissible maximum explosive charge weights at each site. It expresses very strongly the Navy's responsibility and commitment to preserve the marine environment where the tests are conducted and to ensure the public safety, and implements policy and procedure to fulfill those commitments. Further, it states that compliance with federal, state, and local safety and environmental requirements and procedures shall be mandatory in accordance with OPNAVINST 5090.1.

2. This proposed instruction, which has been in the preparation and approval chain for one and one-half years, replaces NAVMATINST 8500.1 dated 12 October 1979 that addresses the same subject. Test site and charge weight definitions and most operational procedures have been modified only slightly. The two major differences between the two instructions are as follows:

a. The proposed instruction extends coverage to <u>all</u> Navy components and places controls and responsibilities under a single approval authority, namely COMSPAWARSYSCOM.

b. The proposed instruction emphasizes the Navy's commitment to the environment and public safety by making mandatory the compliance to federal, state, and local safety and environmental requirements and procedures in accordance with OPNAVINST 5090.1.

3. The policies and procedures of the former NAVMATINST proved to be entirely effective in ensuring the public safety and protecting the region's environment while preserving the Navy's prerogative to conduct its critical test programs. Those controls were reviewed by interested Virginia and Maryland state government agencies on several occasions and were found adequate to protect the interests of those bodies. Moreover, representatives of those agencies have often witnessed tests in progress and uniformly expressed satisfaction with the procedures and safeguards employed by the Navy. The instruction, however, no longer is in effect due to the disestablishment of the Naval Material Command; hence, the need for a successor policy directive.

OP Park here

Subj: APPROVAL OF PROPOSED SECNAVINST 8500.

4. It is our understanding that the proposed SECNAV issuance received favorable endorsements from the Chief of Naval Operations (OPNAV) and ASSTSECNAV RES, but received a nonconcurrence from the Office of Legislative Affairs (OLA). The reason given for nonconcurrence was that the instruction should be a SPAWAR instruction in order to provide SECNAV maximum options to deal with any public and congressional concerns or complaints. We take issue with this position for the following reasons:

a. There is a delicate balance between the Navy's interests in using test sites within the Bay region to conduct its UNDEX operations on the one hand, and the private sector's fishing, charter boat and ecological interests on the other. A strong policy statement complemented by adequate procedural controls issued at the SECNAV level provides the Secretary and the Navy a sound basis for satisfying the Navy's operational needs while demonstrating to the public a strong commitment to preserving the ecology of the Bay and minimizing disruption of area fishing and recreational activities. We believe such a policy would materially strengthen the Secretary's position in dealing with public and congressional concerns which will undoubtedly arise as we pursue our test programs in the Bay area.

b. A SPAWAR instruction would provide control over only one SYSCOM and its Research and Development (R&D) Centers. It could not extend coverage to other OPNAV, SYSCOM and OCNR sponsors or other performers, such as EOD, Fleet, and contractors.

c. Control of all UNDEX tests in the Bay region under a single approval authority is not possible via a SPAWAR instruction.

d. The Navy must act and respond as a single unit to public and congressional pressures in this area if the Navy intends to carry out an effective and efficient UNDEX test program. It is therefore critically important that SECNAV visibly support the Navy's need to conduct UNDEX tests, support the Navy activities that sponsor and conduct these tests, and establish a single activity to carry out his policy and be responsible and accountable for all procedures involved in such tests.

We believe these to be critical issues in executing an effective UNDEX test program to meet Navy needs and in addressing public concerns in a responsive and satisfactory manner. It is our opinion that these goals can only be achieved via a SECNAV instruction.

5. Your taking the necessary steps to recommend to the Secretary that he override the OLA nonconcurrence and approve the proposed SECNAV instruction with his signature would be very much appreciated.

Glenwood Clark

GLENWOOD CLARK
Commander

Copy to:
NAVSWC
DTNSRDC

BACKGROUND

Until 1977 no controls existed for underwater explosion (UNDEX) testing by the Navy in the navigable waters of the Chesapeake Bay region. That year the David W. Taylor Naval Ship Research and Development Center (DTNSRDC) conducted a 10,000 lb. UNDEX test in the Chesapeake Bay that resulted in a massive fish kill which was reported widely by the press and loudly protested by fishermen, boating, and environmental groups plus state and local officials. The Commander, Naval Sea Systems Command (COMNAVSEASYSCOM), whose command sponsored the test, ordered an immediate and indefinite shutdown of all UNDEX tests in the Bay region under COMNAVSEASYSCOM sponsorship. Since at that time nearly all UNDEX testing was under COMNAVSEASYSCOM sponsorship, testing in the waters of the Bay region ceased.

Problems associated with the action were elevated to the NAVMAT level where an extensive study was performed. The final result of the study was the issuance of NAVMATINST 8500.1 dated 12 October 1979 which reinstituted testing in the Bay region waters. This instruction established policy, procedures, and controls for all NAVMAT activities to conduct UNDEX tests. Specifically included in the coverage were UNDEX tests sponsored by and/or conducted by the CNM or HQNAVMAT, the Systems Commands (SYSCOMS), the NAVMAT RDT&E Centers, and other NAVMAT shore activities. Essentially, this covered all UNDEX tests in the Bay region waters. The instruction also established specific test sites and maximum permissible charge weights. Test sites were selected according to water depths, bottom conditions, and the known marine environment. Specifying maximum charge weights was deemed necessary to prevent a recurrence of a situation similar to that created by the 1977 test. The level of maximum charge weight was established for each site based on the maximum needed to meet expected test technical objectives consistent with the water depth, bottom condition, and marine conditions and to minimize adverse environmental impact at the test site. The prescription of those limits within the proposed SECNAV instruction is considered necessary in order to ensure that all organizations which sponsor or conduct UNDEX tests clearly know the parameters within which their test programs must be planned and that public and congressional interests know "up front" the full extent of the Navy's policy governing UNDEX tests within the Bay region.

For the past eight years, the Navy has operated very successfully under this instruction. There have been no significant fish kills, no permanent or adverse disturbances of the environment, and no endangerment of public safety. There has been minimal interference with boat traffic and fishing desires. Experience under this instruction has shown that the criteria used to establish maximum charge weights were sound, and the weights are not excessive or overburdening on the sites. The Maryland Department of Natural Resources and the Virginia Marine Resources Commission have been consulted on test procedures. They have witnessed many Navy tests, and have found the Navy procedures to be acceptable. Following the last series of tests in the Bay in September 1986, the Maryland Saltwater Sports Fisherman's Association ran a press release in a Baltimore paper expressing satisfaction with the general conduct of the tests and the minimal negative impact on the environment.

Since the issuance of the instruction, only five of the nine approved sites have been used for UNDEX tests by the Navy. The activity at these sites is given below.

Chesapeake Bay/Cape Charles (VA waters) - 1500 lbs. maximum

Only one series of eight tests in 1980

one test - 125 lbs. explosive

three tests - 250 lbs. explosive each

four tests - 1200 lbs. explosive each

Virginia state officials witnessed all tests, were extremely pleased with precautions taken, and were surprised at the very small fish kill.

Chesapeake Bay/Solomons (MD waters) - 1500 lbs. maximum

Only one series of 13 tests in 1986

Charge weights varied between 1 and 9 lbs.

Norfolk Naval Shipyard/Turning Basin (VA waters) - 150 lbs. maximum

25 to 30 tests annually

Range of charge weights - 2 to 125 lbs.

Typical test is 50 to 60 lbs.

Potomac River/Dahlgren Range (MD waters) - 150 lbs. maximum

50 to 60 tests annually

Range of charge weights - 1 to 110 lbs.

Typical test is 30 to 35 lbs.

Potomac River/EODTC (MD waters) - 5 lbs. maximum

5 to 10 tests annually

Range of charge weights - less than 1 lb.

Typical test is 1/2 lb.

In summary, it is observed that the Navy conducts approximately 100 UNDEX tests annually in the Bay region waters with the predominance of these occurring in the Potomac River at Dahlgren and the Turning Basin at the Norfolk Naval Shipyard. It is also noted that the Bay proper, which is the most public sensitive, is used very infrequently and only then, when test criteria are not compatible with the other sites.

With the disestablishment of NAVMAT, it became necessary to reissue the instruction on UNDEX testing. In order to cover the Navy activities formerly under CNM and to extend coverage to all Navy activities that could conceivably sponsor or conduct tests in the Bay region waters, it was considered a requirement to issue an instruction at the SECNAV level. At this level the instruction would establish a single control and approval authority that would be responsible and accountable for the operations surrounding this type of

testing in the Bay region waters. Also, in the preparation and approval chain the instruction was altered to strengthen the Navy's commitment to protect the marine environment and ensure the public safety. It specifically was changed to state explicitly that compliance, in accordance with OPNAVINST 5090.1, to federal, state, and local safety and environmental requirements and procedures was mandatory.

While the proposed new instruction was being prepared, a series of small charge tests were scheduled for the Solomons test site in the Chesapeake Bay for August and September 1986 - the RED SNAPPER test series. All of the normal procedures had been followed with notifications to the Maryland Department of Natural Resources and the Army Corps of Engineers. The public, recently sensitized by the Navy's EMPRESS II problems, immediately feared the Navy was going to conduct an UNDEX test that would result in a massive fish kill similar to that in 1977. There was absolutely no chance of this occurring because of the small charge weights involved. Unfortunately, the Navy responded in a confused state to the public and congressional protests. Various Navy comments, some with no immediate knowledge of the tests, resulted in conflicting orders and press releases - ranging from the tests will continue as scheduled, the tests will be postponed, to the tests will be cancelled. It finally culminated in Secretary Lehman ordering the tests to continue on schedule.

The incidents surrounding this test series plus the fact that other similar test series are planned for FY-87 and FY-88 indicate clearly the critical need for the proposed SECNAV instruction. It would permit the Navy to respond to future public concerns with a single voice with the full authority of the Secretary of the Navy and would permit the Navy to plan, schedule, and conduct important UNDEX tests in an efficient and timely manner. The proposed SECNAV instruction progressed up the approval chain with endorsements from OPNAV and ASSTSECNAV RES. OLA responded with a nonconcurrence, indicating that the instruction should be issued by the COMSPAWARSYSCOM which would give the Secretary maximum flexibility in responding to public and congressional concerns. Issue is taken with this position because a SPAWAR instruction could not extend coverage to all Navy activities and could not establish a single control and approval authority. But the most important reason is described in the following paragraph.

Public concerns and occasional protests will continue over the Navy's UNDEX test activities. This in itself is not bad because it keeps the Navy on its toes and ensures that we are living up to commitments on environmental and safety issues. With a strong SECNAV policy and position stated in a SECNAV instruction, such concerns can be addressed in an effective manner without unduly jeopardizing the conduct of the Navy's job. However, if the precedent is set that concerns and complaints can be appealed directly to the Secretary and he responds in varying ways, it is not difficult to project that concerns will increase and test schedules will be interrupted, postponed, or halted. Given that some 100 UNDEX tests are performed annually in these waters, the ability of the Navy to conduct these tests will be severely stifled.

Potomac River - Indian Head

BT 637 OP archive R+D File

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20350-1000

SECNAVINST 8500.1
SPAWAR 005T
23 October 1987

SECNAV INSTRUCTION 8500.1

From: Secretary of the Navy

Subj: UNDERWATER EXPLOSION TESTING IN NAVIGABLE WATERS OF THE CHESAPEAKE BAY REGION

Ref: (a) OPNAVINST 5090.1 (NOTAL)

Encl: (1) Designated Test Sites in the Chesapeake Bay Region

1. Purpose. To establish policy, procedures, and controls for the conduct of research and development activities involving underwater explosions (UNDEX) in navigable waters of the Chesapeake Bay Region.

2. Cancellation. NAVMATINST 8500.1.

3. Background

a. The Navy has a long-term requirement for underwater explosion test sites. The Navy Judge Advocate General has issued an opinion that the Navy has a legal right to conduct underwater explosion tests in U.S. navigable waters; however, this right must only be pursued with proper regard for public concerns. The Navy fully recognizes and accepts its responsibility to the public with regard to underwater explosion testing and reaffirms its commitments to preserve the marine environment in which tests are conducted and to ensure the public safety.

b. The Chesapeake Bay and its tributaries have been and continue to be a very important region for conducting underwater explosion tests. There are several technical reasons for the importance of this region. These include:

(1) Existence of a wide variety of bottom conditions.

(2) Relatively deep water.

(3) Favorable year-around climate.

(4) Existence of a large amount of sheltered waters.

Naval activities involved in underwater explosion tests in the Chesapeake Bay Region must continue to demonstrate extreme sensitivity to public concerns of environment and safety, as well as to perform the necessary job of developing test procedures to ensure public safety, preparing environmental impact assessments, coordinating with state fishery agencies, and providing advance notice to appropriate local, state, and federal officials.

c. This instruction provides for specific charge weight limits for underwater explosion tests in designated test areas in the Chesapeake Bay Region. It establishes the Director of Navy Laboratories (DNL) (SPAWAR 005) (under the Commander, Space and Naval Warfare Systems Command (COMSPAWARSYSCOM)), as the central approval and control authority for this type of testing. It also establishes the requirement for annual test plans on the extent of underwater explosion tests in the region. These test plans will enable COMSPAWARSYSCOM to fulfill oversight responsibilities and to efficiently respond to Congress and to the general public regarding utilization of the Chesapeake Bay Region for underwater explosion tests.

4. Scope. This instruction applies to all underwater explosion tests in navigable waters of the Chesapeake Bay Region sponsored by and/or conducted by all components of the Navy.

5. Policy

a. Underwater explosion tests in navigable waters of the Chesapeake Bay Region shall be limited to the designated test sites listed below, and the charge weights shall not exceed the maximum listed for the various sites.

TEST SITE	MAX. CHARGE WEIGHT (LB)
Chesapeake Bay/Solomons	1,500
Chesapeake Bay/Cape Charles	1,500
Explosive Anchorage/Hampton Flats	150
Patuxent River/Solomons	150
Potomac River/Dahlgren Range	150
Norfolk Naval Shipyard/Turning Basin	150
Craney Island/Elizabeth River	150
Potomac River/Indian Head	80
Potomac River/Naval Explosive Ordnance Disposal Technology Center	5

These sites are defined and located by coordinates in enclosure (1); they are approved by the U.S. Army Corps of Engineers and are listed in either Notices to Navigation Interests or the Code of Federal Regulations, either for continuing usage or for specific test series on a per case basis. Each test shall be scheduled in advance under the requirements of this instruction.

POTOMAC RIVER/INDIAN HEAD

Permit NABOP-F/4 (Naval Surface Warfare Center) 75-652, dated 12 May 1978, issued by the Army Corps of Engineers permits underwater explosions testing by the Navy at two specific sites in the Potomac River near Indian Head. These sites are defined by the following coordinates.

A. Test site about 600 ft x 1,200 ft with an average water depth of 80 ft:

38° 36' 43" N, 77° 08' 39" W
38° 36' 38" N, 77° 08' 35" W
38° 36' 48" N, 77° 08' 23" W
38° 36' 42" N, 77° 08' 20" W

B. Test site about 750 ft x 3,000 ft with an average water depth of 45 ft:

38° 36' 27" N, 77° 10' 29" W
38° 36' 35" N, 77° 10' 29" W
38° 36' 27" N, 77° 09' 51" W
38° 36' 35" N, 77° 09' 51" W

These sites are shown in Figure 10; the maximum DNL (SPAWAR 005) approved explosive charge weight for these sites is 80 lbs.

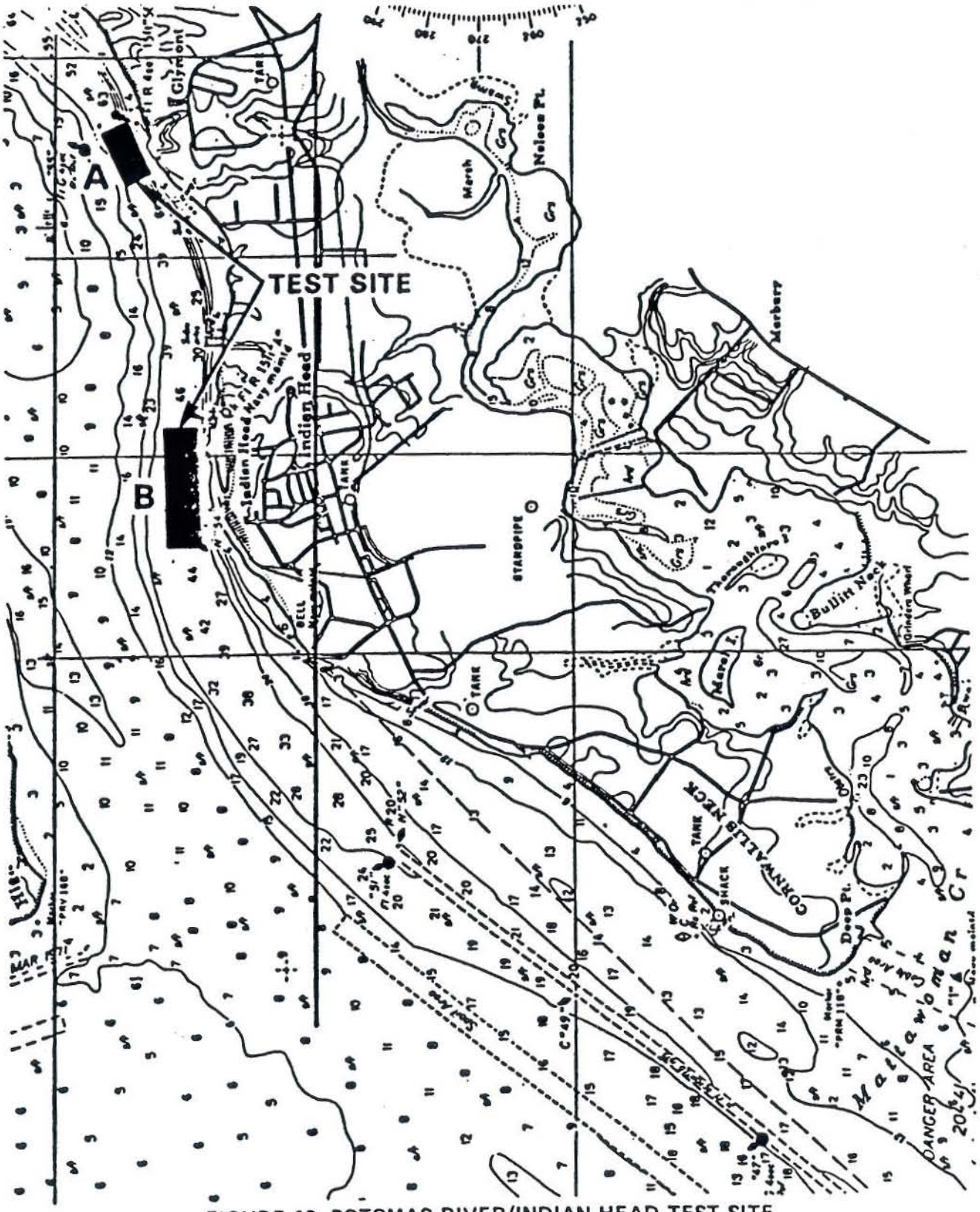

FIGURE 10 POTOMAC RIVER/INDIAN HEAD TEST SITE

Indian Head

R+D
Op ar

8500
Ser 00515/88-616

MEMORANDUM

From: SPAWAR 005
To: SPAWAR 00

Subj: UNDERWATER EXPLOSION TEST SITES

Ref: (a) Issue Paper: STATUS OF UNDERWATER EXPLOSION STUDY, SPAWAR 005-15 of 29 Sep 88

Encl: (1) SECNAVINST 8500.1 of 23 Oct 87
(2) Encl (1), SECNAVINST 8500.1 of 23 Oct 87

1. Reference (a) provided current information on the status of the underwater explosion (UNDEX) test site study. Reference (a) also indicated that NAVSWC, DTRCEN, Navy Explosive Ordnance Disposal Technical Center (NAVEODTECHCEN), Indian Head MD, and the Naval School, Explosive Ordnance Disposal (NAVSCOLEOD), Indian Head MD, requested authority to test in specific sites in the Chesapeake Bay and its tributaries until a decision is made relative to the findings in the study.

2. Enclosure (1) provides the policy and procedures for the conduct of underwater explosion tests in the Chesapeake Bay and its tributaries. Enclosure (2) is annotated to reflect the test sites that are requested for future use and also annotated showing sites that will not be used.

3. The four activities identified above have requested use of the Chesapeake Bay area testing sites. The specific location and requirements follows: Sir - recommend

O.K.

a. NAVSCOLEOD has requested the use of the test site labeled "Patuxent River/Solomons". They plan to perform training operations with their EOD personnel with 1 gram to 20 lbs. of explosive charge weight. They anticipate about 24 explosive events for FY 89. - approval

O.K.

b. NAVEODTECHCEN requests performing R&D testing at the site labeled "Potomac River/Indian Head". They plan to conduct about 24 tests in FY 89 with explosive charge weights of 1 gram to 25 lbs. - approval

O.K.

c. NAVSWC has requested authority to test in the "Potomac River/Dahlgren Range" site. They are planning for approximately 50 R&D test events in FY 89, using explosive charge weights from 10-100 lbs. approval

approve?

d. DTRCEN has requested permission to test at the sites labeled "Chesapeake Bay/Cape Charles" and "Norfolk Naval Shipyard/Turning Basin". They anticipate 13 tests for FY 89 would have explosive charge weights from 60-1200 lbs. no approval

Most Public ~~Attention~~

4. I believe that the tests sites requested by the two EOD organizations and NAVSWC can be supported for approval. These sites have not had any known media/public interest in the past. It may be noted that NAVSWC's

Concur
no approval in turning basin

ISSUE — after 10th NOV

testing in the Anderson Deep area (see the label on enclosure (2) as "Chesapeake Bay/Solomons") in FY 88 that has media/public attention, is not being requested as a test site. However, I am very concerned that the requests by DTRCEN to use the Cape Charles site and especially the Turning Basin area, may cause serious problems for the Navy as soon as we allow just one test. These areas are very visible to the media, the public and to state and Congressional representatives.

5. I propose that the two EOD organizations and NAVSWC be authorized to test in the requested areas and that DTRCEN exercise their contingency plan for FY 89 to test at non-Bay sites or until a acceptable resolution to the situation is decided.

JERRY L. REED

30 SEPTEMBER 1988

FINAL COMMITTEE REPORT

ALTERNATE SITE STUDY FOR UNDERWATER EXPLOSION TESTING

Box 566
R+D Orchard

INDIAN HEAD - EOD

other armed services, departments of Justice and Treasury, Secret Service, FBI, DOE, CIA, DIA, Coast Guard, FAA, and civil authorities. To provide this support, the Naval Explosive Ordnance Disposal Technology Center (NAVEODTECHCEN) was established at Indian Head, MD to be the Research and Development agent as well as the In-service Engineering Agent (ISEA) for EOD systems, tools, and other equipment. The Center also is the primary depot level maintenance activity for EOD and is the focal point for all EOD (Navy and other Services) technical matters. To fulfill the joint service training function, the Naval School, Explosive Ordnance Disposal (NAVSCOLEOD) was formed at Indian Head, MD, to serve as the primary EOD training activity for the Navy, other services, and the other activities mentioned earlier.

The explosive test sites located at Patuxent River/Solomons, and Potomac River/Indian Head have been available for NAVSCOLEOD to conduct underwater explosive training for EOD personnel in mine neutralization. NAVEODTECHCEN uses the Potomac River/Indian Head area to carry out tests on underwater ordnance, and to establish EOD procedures used by EOD technicians in the Fleet.

<u>EOD Technology</u>. NAVEODTECHCEN, the technical manager for explosive ordnance disposal (EOD), develops render-safe procedures for joint service EOD forces. A significant portion of these tests are for underwater ordnance, i.e., mines, torpedoes, depth charges, etc. The objectives for these tests are threefold:

- An EOD technician can be required to assist in clearing a shipping lane through a minefield planted by a hostile nation. In the neutralization process, explosives are frequently used. The amount and placement must be tested to provide the most effect and safety for the diver.

- Foreign underwater ordnance exploitation requires locating, neutralizing, raising, towing, and beaching. The procedure also requires the use of explosives.

- Public safety encompasses the removal of explosive hazards, foreign and domestic, which are discovered on our beaches and coastal waters. Dangerous items ranging from Revolutionary war cannon balls to modern day ordnances are found on a regular basis. Some of these items can be

rendered safe, using non-explosive means; however, others are too sensitive to risk performing a render-safe procedure and must be detonated in place.

Charge sizes vary from 1 gram to 20 lbs. of C-4 or similar explosives. The charges must be used in real-world conditions (underwater) to gauge the effect of the charge, the degree of difficulty in placing the charge, and the relative hazards to the EOD diver. The water depth required is from 10 to 100 feet; the Potomac River provides this environment.

EOD Training. NAVSCOLEOD conducts underwater explosive training for EOD personnel in mine neutralization, to clear harbors, shipping lanes and to remove hazards to navigation. Explosives are required to render safe underwater ordnance (i.e., mines, torpedoes) so the hazardous items can be safely removed from the water or blown in place. EOD students require the hands on training in the correct procedures to render safe underwater ordnance in a controlled training exercise before they are qualified to perform render safe procedures in an actual emergency situation. Today, with the emphasis on using mines to deny ship's access to the sea lanes and choke off supply lines, the potential for Navy EOD personnel to be called upon to clear these hazards is very real. The explosive charge weights used in underwater training for EOD personnel vary from 1 gram to 20 pounds, depending on the type of procedures performed on an underwater target. The cost of training EOD personnel at other locations, based on a minimum of 25 students per class, 10 instructors, and 15 support personnel, for a two-week period, with six trips a year, would be prohibitive. Factors that would have to be addressed to determine the costs are: availability of berthing and messing, transportation of personnel, equipment (i.e., boats, diving equipment, recompression chamber) transportation of explosives, and, are the sites privately or government owned? If equipment assets have to remain on location, this will require a maintenance and instructor detachment. Other requirements would include a magazine storage facility with proper security to store Category II explosives. The estimated cost to train EOD personnel at other locations would be about $100K per class.

EOD Training and Testing Requirements

There are no NAVEODTECHCEN tests scheduled at this time. However, for planning purposes, a realistic estimate is 24 shots per year ranging from 1 gram to 20 lbs. dependent upon the munition and/or the type of render-safe procedure to be accomplished. The type of testing conducted at NAVEODTECHCEN is developmental, verification, and validation. Elimination of the Indian Head/Potomac River test area will have a significant adverse effect on the mission of this Command. This will also entail a large increase in funding for off-station security of classified material and the protection of Category II arms, ammunition, and explosive requirements with the attending increase of risk by transporting explosives over public highways.

NAVSCOLEOD is planning underwater ordnance explosive training exercises for use at Patuxent River/Solomons, and Potomac River/Indian Head. The projected number of explosive charges used for underwater training per year will be approximately 24. The size of the charges will vary from 1 gram (pre-packed shaped charges) to a 20 pound charge of C-4. The charges are dependent on the type of ordnance used as a target. The underwater ordnance used for UNDEX training are inert full size mines and torpedoes. The mines may be moored or bottom mines. EOD students are trained to locate, neutralize, tow, and beach for exploitation and disposal. Elimination of these UNDEX training areas will have a signficant impact on the mission of NAVSCOLEOD. NAVSCOLEOD's training schedule would not allow for delays in training due to travel time or bad weather on the site.

TABLE 2-1. UNDERWATER EXPLOSIVE TESTING IN THE CHESAPEAKE BAY AND ITS TRIBUTARIES FROM 1984 to 1988

SITE	CHARGE WEIGHT (LBS)	NUMBER OF TESTS FISCAL YEAR 84	85	86	87	88
DTRC, Carderock, MD						
Test Pond, Carderock	1 to 10	159	74	118	127	100
UERD, Norfolk, VA	1 to 10	3	8	1	1	1
Turning Basin, NNSY	11 to 50	0	0	0	5	0
	51 to 100	5	7	0	9	9
	100 to 500	2	0	4	4	4
NAVEODTECHEN, Indianhead, MD*	0 to 15	5	13	0	0	0
	15 to 80	63	0	0	0	0
NAVSCOLEOD, Indianhead, MD*	0 to 15	0	0	0	0	0
	15 to 80	0	0	0	0	0
NSWC, Dahlgren, VA						
Potomac River	1 to 10	17	29	-	4	-
	11 to 50	2	34	33	24	-
Norfolk	Various	4	5	-	-	-
Chesapeake Bay	1 to 10	-	-	14	-	4

*All testing done on shore in tanks since 1986.

Potomac River Indian Head

TABLE E-1

NAVY TEST SITES IN THE CHESAPEAKE BAY REGION

Designation	Charge Weight Limit (lb)	Users
Chesapeake Bay/Solomons Areas A, B, and C	1500	DTRC, NSWC
Chesapeake Bay/Cape Charles	1500	DTRC, NSWC
Explosives Anchorage/Hampton Flats	150	DTRC
Patuxent River/Solomons Areas A, B, and C	150	NSWC, NAVSCOLEOD
Potomac River/Dahlgren Range Areas A, B, C, and D	150	NSWC
Norfolk Naval Shipyard/Turning Basin	150	DTRC
Craney Island/Elizabeth River	150	DTRC
Potomac River/Indian Head Areas A and B	80	NSWC, NAVSCOLEOD
Potomac River/Naval Explosive Ordnance Disposal Technology Center Pier	5	NAVEODTECHCEN

TABLE E-14

FISH MORTALITY DATA FROM POTOMAC RIVER/INDIAN HEAD TESTS

YEAR	NO. OF TESTS	TOTAL EXPLOSIVE WEIGHT, W (lb)	TOTAL FISH-KILL, F (lb)	RATIO F/W lb/lb	COMMERCIAL CATCH C (tons)	RATIO F/C lb/lb
1962	25	1039	23	0.02	11,865.9	.000001
1963	94	2443	1002	0.41	8,244.2	.00006
1964	180	685	209	0.30	11,253.0	.000009
1965	77	213	0		13,165.4	0
1966	21	639	98	0.15	10,815.4	.000005
1967	86	449	249	0.55	7,687.2	.00002
1968	219	195	525	2.69	6,740.8	.00004
1969	232	1101	1497	1.36	4,515.6	.0002
1970	58	278	162	0.58	7,201.4	.00001
1971	164	2111	257	0.12	5,240.1	.00002
1972	246	1569	8518	5.43	4,387.2	.001
1975	86	675	3265.4	4.84	7,617.6	.0002
1976	70	1004	2667	2.66	7,121.3	.0002
1977	128	1489	4527.9	3.04	10,424.1	.0002
1978	39	332	346.4	1.04		

1979 - Moved to Dahlgrean

Attachments 1-5

DECLASSIFIED-IAW DOD DIR. 5200.1R

for PEACE OF MIND-BUY SAVINGS BONDS

ADDRESS ALL COMMUNICATIONS TO:
COMMANDING OFFICER
AND REFER TO

H1-22(1)
MES:mhb

U. S. NAVAL POWDER FACTORY
INDIAN HEAD, MD.

14 May 1952

From: Commanding Officer
To: Chief, Bureau of Ordnance

Subj: Nitrocellulose Deposit in Mattawoman Creek

1. During normal operation of the powder line at the Naval Powder Factory, small amounts of nitrocellulose get past the "save-all" vats and the filter and reach Mattawoman Creek. These amounts increased during the period 1949-1951 when it was necessary to produce three grades of nitrocellulose. During this operation it was not possible to use either the "save-all" vats or the filter.

2. As a result of this loss of nitrocellulose a considerable deposit of the material has built up over the years in Mattawoman Creek in the vicinity of the sewer outflow. A survey by the Naval Powder Factory indicates that nitrocellulose is exposed at low tides over an area of at least 8000 square feet, the deposit varying in depth, but reaching in places a depth of 18 inches. Samples collected have been shown to contain up to ninety percent (90%) of nitrocellulose when dried. The material will burn when dry but not when wet. It can be made to detonate when dry but not when wet.

3. Steps are being taken to reduce to a minimum the loss of nitrocellulose to the creek and it is believed that acceptable arrangements for so doing can be made. The problem of dealing with the existing deposit remains.

4. It is the view of the Powder Factory that the existence of so large an amount of explosive in an uncontrolled situation cannot be accepted.

5. Three courses have been considered for disposal of the deposit. These are:

(a) That the material should be washed into the channel with water pressure from hoses.

(b) That the material should be dredged from the creek, dried and burned.

(c) That the material should be dredged from the creek and dumped at sea.

It has been observed that if course (a) is adopted, quantities of nitrocellulose may be washed ashore on beaches bordering

WNRC
RG74
3010681
Box 102
19/67:39-2-5
UP8
5-1-52 5-30-52

EXHIBIT 1

DECLASSIFIED-IAW DOD DIR. 5200.1R

H1-22(1)
MES:mhb
14 May 1952

the creek on the Potomac River. For this reason the adoption of this course is not recommended. Course (b) is open to the objection that the drying and burning of so large a quantity of nitrocellulose in increments safe to handle would be a long and tedious process. No serious objection has been advanced to course (c). If the services of the necessary dredging equipment can be obtained, this course would be preferred.

6. It is requested that consideration be given to this matter by the Bureau. If it is not considered that a better course than either (b) or (c) above is available, it is requested that Bureau approval be given for the adoption of either of these courses.

F. W. SCANLAND

051952 0253

Heathcote

U. S. NAVAL ORDNANCE LABORATORY
White Oak, Silver Spring, Maryland

243:DEP:jbb

19 December 1968

MEMORANDUM

From: D. E. Phillips (243)
To: 243

Subj: Slurry explosives; testing of

1. We have been asked by NOSC (ORD-033) to perform underwater explosion tests of slurry explosives. These type explosives have been developed primarily for mining purposes; because they are readily available they are being investigated for potential military use. Apparently NOSC has done some background work on this and at least one company is interested in supplying such explosives to the Navy. This company is Intermountain Research and Engineering Co (IRECO), West Jordan, Utah.

2. I have been in touch with IRECO on the possibility of firing some of their slurries to measure their underwater output. They will be mixing slurries at NOS, Indian Head, on 13 Jan 1969 for characterization tests by NOS and are willing to prepare charges for us at this time. Since the compositions of these slurries are proprietary information and have not been released to either us or NOSC, I asked IRECO to recommend four possible slurries for such testing. My plans are to fire four 10-lb of each of these slurries and determine their output relative to standard military explosives. If these results look promising, larger charge tests will be required. These 10-lb tests are considered only a first look at the performance of slurries.

3. Barring unforeseen difficulties, we will fire these charges as part of another 10-lb program scheduled to begin about 1 Feb 1969. Charge cases and boosters are on order and should be delivered on time. Work will be charged to Jor Order No. 824-0104.

4. NOSC is quite interested in these tests and in slurry explosives. Funds for future years apparently will be available to pursue this further, if they prove promising.

D. E. PHILLIPS
Underwater Explosions Division

Copy to:
240, 230, 243 (Phillips), 243 (Heathcote)

EXHIBIT 2

DAMAGE EFFECTIVENESS FACTORS

RELATIVE TO TNT

(WEIGHT BASIS)

EXPLOSIVE	S/W ENERGY	HULL RUPTURE	DAM TO MACHINERY & EQTT
DBA-65T	1.34	1.29	1.87
DBA-22M	1.27	1.27	1.79
DBA-105T2	1.23	1.20	1.66
DYNAGEL	1.07	1.04	1.35
POURVEX	0.72	0.74	0.70
HBX-1	1.41	1.40	1.62

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1715
BALTIMORE, MARYLAND 21203

NABOP-P(Potomac River) 24 June 1971

NOTICE TO NAVIGATION INTERESTS

Navigation interests and others are advised that the U. S. NAVAL ORDNANCE LABORATORY, SILVER SPRING, MARYLAND 20910, will continue to conduct underwater explosion tests in the POTOMAC RIVER AT INDIAN HEAD, MARYLAND until 31 December 1971. NOTICE TO NAVIGATION INTERESTS NO. 70-24, issued by this office on 15 December 1970, advised that the tests would be concluded on 30 June 1971.

During the test operations a quonset barge will be moored in the Potomac River, downstream from the U. S. Navy Dock at Indian Head, Maryland. The barge will be moored either at Latitude 38°36'28"N, Longitude 77°10'10"W or Latitude 38°36'21"N, Longitude 77°10'38"W. A copy of a section of USC&GS Chart No. 560, showing the locations of the barge, is reproduced on the reverse side of this sheet.

Explosions will occur at irregular and intermittent periods during daylight hours only, near the moored quonset barge. A warning patrol will be maintained during explosives operations, and charges will not be detonated at such times as they might endanger marine traffic passing the area. Proper recognition lights will be displayed at night and at any other time they may be needed. Vessels are advised not to remain within one-eighth mile of the moored quonset barge.

Responsibility for patrol of the area will be with the U. S. Naval Ordnance Laboratory, Silver Spring, Maryland.

FOR THE DISTRICT ENGINEER:

John P. O'Hagan
JOHN P. O'HAGAN
Chief, Operations Division

Baltimore District, CofE
Notice No. 71-7
24 June 1971

EXHIBIT 3

Z TLS
NOS
RS-2280-71
A-D2C Action

U.S. NAVAL ORDNANCE LABORATORY
WHITE OAK
SILVER SPRING, MARYLAND 20910

IN REPLY REFER TO:
243:DEP:jbb
8010
SER 4260
26 JUL 1971

From: Commander, Naval Ordnance Laboratory
To: District Engineer, U. S. Army Corps of Engineers
P. O. Box 1715
Baltimore, Maryland 21203

Subj: Underwater Explosion Tests in Potomac River, Indian Head, Md.

Ref: (a) NABOP-P (Potomac River) Notice to Navigation Interests of 24 Jun 1971

Encl: (1) Map of Proposed Test Area

1. During the period 15 August through 31 December 1971 the Naval Ordnance Laboratory is scheduled to conduct underwater explosion tests in the Potomac River near Indian Head and Glymont, Maryland. A Notice to Navigation Interests for firings in the Indian Head area was issued as reference (a); it is requested that similar approval be granted for firings near Glymont.

2. It is planned to conduct the test operations using a 20 x 80-foot barge moored in the Potomac River. The tests will be conducted just inside the channel line between Red Buoys 54 and 56. The mooring position of the barge will be:

38° 36' 45" N
77° 08' 30" W

A map showing the location of the proposed tests is forwarded as enclosure (1).

3. Intermittently, explosive charges weighing up to eighty (80) pounds will be detonated under water. The barge will display a red flag during explosive operations. A warning patrol will be maintained during explosive operations and charges will not be detonated at any time marine traffic will

CORRESPONDENCE
JUL 28 10 31 AM
RECEIVED

EXHIBIT 4

Page 1 of 1

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

R N1

REPLY TO ATTENTION OF:

NABOP-F/4(Chicamuxen Creek) 3 April 1978

NOTICE TO NAVIGATION INTERESTS

Navigation interests and others are advised that the Naval School Explosive Ordnance Disposal, Naval Ordnance Station, Indian Head, Maryland, 20640, will relocate its site of underwater demolition training from the Potomac River to a 30 x 100 foot area in Chicamuxen Creek.

The demolition training operations will take place in Chicamuxen Creek at latitude 38° 22'55"N, longitude 77° 13'00"W, as shown on the attached drawing.

Explosions will occur at irregular and intermittent periods during daylight hours only, approximately 150 times per year, at the training site. A warning patrol will be maintained during explosive operations and charges will not be detonated at such times as they might endanger marine traffic passing the area. The demolition training area will be indicated by displaying a BRAVO flag on flagpole. Vessels are advised not to remain within one-eighth mile of the training site. No tests are to be conducted during the months of April and May in any year.

Responsibility for patrol of the area will be with the Naval School Explosive Ordnance Disposal, Naval Ordnance Station, Indian Head, Maryland.

FOR THE DISTRICT ENGINEER:

RONALD A. CUCINA
Assistant Chief, Operations Division

Baltimore District, CofE
Notice No. 78-1
Date: 3 April 1978

EXHIBIT 5