Channel Navigation Improvements Feasibility Study - Geotechnical Appendix

Dutch Harbor, Unalaska Island, Alaska

29 November 2017
Status: Draft

Geotechnical and Engineering Services Branch
Alaska District, U.S. Army Corps of Engineers

Department of the Army
Alaska District, U.S. Army Corps of Engineers
P.O. Box 6898
JBER, AK 99506-0898

CEPOA-EC-G 29 November 2017

MEMORANDUM FOR CEPOA-PM-C (Attn: Ms. Kimberly Townsend)

SUBJECT: Draft Geotechnical Appendix, Channel Navigation Improvements Feasibility Study, Dutch Harbor, Unalaska Island, Alaska

This Draft Geotechnical Appendix is provided in support of the Channel Navigation Improvements Feasibility Study, Dutch Harbor, Unalaska Island, Alaska. Please address any questions you may have on the contents to Douglas Bliss at 907-753-2872 or John Rajek at 907-753-5695.

BLISS.DOUGLAS.ALLEN.1170271285

Digitally signed by BLISS.DOUGLAS.ALLEN.1170271285
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=BLISS.DOUGLAS.ALLEN.1170271285
Date: 2017.11.29 13:40:16 -09'00'

DOUGLAS A. BLISS, P.E., P.G.
Chief, Geotechnical and Engineering Services Branch
CEPOA-EC-G

RAJEK.JOHN.J.1289074259

Digitally signed by RAJEK.JOHN.J.1289074259
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=RAJEK.JOHN.J.1289074259
Date: 2017.11.29 13:43:46 -09'00'

JOHN J. RAJEK, P.E.
Chief, Geotechnical and Materials Section
CEPOA-EC-G-GM

Geotechnical Appendix
Channel Navigation Improvements Feasibility Study, Dutch Harbor AK

1. INTRODUCTION.

1.1 Dutch Harbor is located on Amaknak Island, along the Aleutian island chain approximately 800 miles southwest of Anchorage, Alaska (see Figure 1). Dutch Harbor lies within the city limits of Unalaska. The Alaska District is conducting a Civil Works feasibility study with these stated objectives: (1) improve access to Unalaska/Dutch Harbor to decrease transportation inefficiencies in the region; and (2) improve access to Unalaska/Dutch Harbor to increase safety in the region. A known impediment to improving vessel access to Unalaska/Dutch Harbor is the presence of a shallow shoal or bar which crosses the main channel entrance (see Figure 2).

1.2 A number of plausible structural and non-structural measures were developed by the study team, which were subsequently screened and formulated into 6 alternatives to consider in meeting the stated study objectives. Further analysis reduced the number of study alternatives to the following:

- **Alternative 1:** No Action.
- **Alternative 2:** Deepen the shoal in one-foot increments beginning at -42 feet MLLW (Mean Lower Low Water).

1.3 The focus of geotechnical research and investigations performed at the feasibility study phase was to define the engineering characteristics of the shoal which would influence how it could be dredged to depths required for future vessel traffic. It was decided that performing a marine geophysical survey across the study area would yield an adequate site characterization within funding and schedule constraints. The geophysical survey was conducted by R&M Consultants, Inc. (District IDA-E contract task order) in April-May 2017, with the final survey report received on 5 July 2017. The report is provided as Appendix A-1. This cover memorandum summarizes key findings of the geophysical survey and provides preliminary recommendations on further geotechnical work to be performed subsequent to implementation of the Tentatively Selected Plan (TSP), during Preconstruction Engineering and Design (PED).

2. MARINE GEOPHYSICAL SURVEY.

2.1 The marine geophysical survey was performed to characterize the nature of the shoal structure and nearby seafloor materials, and to identify objects on or buried below the seafloor which could be munitions and explosives of concern (MEC), which includes discarded military munitions (DMM) and unexploded ordnance (UXO), or other debris which could pose problems or obstructions during channel dredging. The presence of MEC and non-explosive debris stemming from both military and commercial activities during and after World War II has been established in the general harbor vicinity as documented by the U.S. Navy and identified on the updated October 2010 NOAA nautical chart for Dutch Harbor (see Figure 3).

2.2 Areal limits of the geophysical survey are shown on Figure 4, selected based on the expected location of the channel dredging operation. The inner box on Figure 4, measuring 1000 feet by 1500 feet, delineates more closely where the dredged channel would be located, whereas the outer box measuring 2500 feet by 3500 feet circumscribes a larger area where additional seafloor material conditions are of interest to the study. Both boxes run parallel to the relatively narrow shoal structure. The dimensions of dredging as currently considered by the study team are as follows: dredge to depth -58 feet MLLW; channel bottom width of 600 feet; and 2H:1V side slopes. The highest surface point on the shoal is approximately at elevation -42 feet MLLW (7 fathoms), for a maximum anticipated dredge depth of 16 feet. As noted by the bathymetry on Figure 4, seafloor depths differ dramatically on either side of the shoal: approximately -102 feet MLLW (17 fathoms) on the harbor side and -62 feet MLLW (10 fathoms) on the ocean side, as measured mid-length along the shoal.

2.3 The geophysical survey methods used at the site are detailed on Figures 4 and 5, with some survey differences between the outer and inner box areas indicated on the Figures and discussed below. Photos of deployed geophysical and sampling equipment are given on Figures 6 and 7.

2.3.1 Multibeam Sonar Sounding. Multibeam sonar sounding was performed over the entire survey area to establish accurate bathymetry, assist in delineating surface objects, and to estimate the type of surface seafloor material (clay, silt, sand, cobbles, boulders) based on an analytical process that collects intensity data (Snippets) concurrently with the bathymetric information.

2.3.2 Chirp Subbottom Profiler. This equipment was used to delineate the presence of fine-grained sediments below the seafloor and to assist in detecting buried debris/objects. The sensor was towed with a hydraulic winch behind the vessel to maintain the sensor close to the seafloor. Survey lines were spaced approximately on a 175-foot by 50-foot grid within the outer box and a 5-foot by 5-foot grid within the inner box. Field operation required a 50-meter marine mammal shutdown distance, which did not have to be implemented due to the absence of marine mammals within the shutdown distance.

2.3.3 Bubble Gun Seismic Profiler. This equipment emits low frequency acoustic signals to differentiate bedrock or otherwise high-resistant formations from overlying sediments. The floating acoustic source was towed behind the vessel, with a separately towed hydrophone as the signal receiver. Survey lines were spaced approximately on a 175-foot by 50-foot grid over the entire survey area. Field operation required a 75-meter marine mammal shutdown distance, which did not have to be implemented due to the absence of marine mammals within the shutdown distance.

2.3.4 Gradiometer. A gradiometer consists of dual-mounted magnetometers, used to detect magnetic field anomalies that can be correlated with ferrous objects at and below the seafloor. The equipment was towed with a hydraulic wench behind the vessel, keeping the gradiometer close to the seafloor. The gradiometer was only deployed within the inner box, operating on an approximate 5-foot by 5-foot grid.

2.3.5 Seafloor Sediment Sampling. A Ponar grab sampler was used to collect sediment samples along the seafloor, which were submitted to a USACE-certified materials lab for Unified Soil Classification System (USCS) soil classification. Samples were obtained on an approximate 500-foot grid pattern over the entire survey area. The sediment classifications combined with the multibeam Snippets data allowed the geophysicist to prepare a sediment classification map, useful in assessing stratigraphy and sediment transport conditions across the site (see Figure 8).

2.4 The above geophysical and sampling tools were complementary in detailing subsurface conditions at the study site, explained in detail in the attached report. Results from the separate survey procedures were overlapped to clarify/validate the findings. For example, surface objects on the seafloor as identified by multibeam sonar sounding were compared to targets found by the gradiometer, allowing a determination if the objects were ferrous or non-ferrous. Buried objects identified by the chirp subbottom profiler were similarly compared to buried targets found by the gradiometer. The characterization of surface and shallow sediments made use of data from grab samples, multibeam sonar sounding, and the chirp subbottom profiler. The nature of the shoal structure was determined from multibeam sonar sounding (bathymetry) and the chirp subbottom and bubble gun seismic profiler surveys. Finally, available documents on geologic/geotechnical conditions within the project vicinity were researched, and a geological reconnaissance of soil and rock exposures adjacent to the study area was performed, providing some ground-truthing and a broader perspective to the seafloor conditions and origin of the shoal structure.

3. SUBSURFACE CONDITIONS AT STUDY SITE.

3.1 The report in Appendix A-1 provides a detailed characterization of subsurface conditions at the study site based on the geophysical survey, document research, and geologic reconnaissance performed. Key investigation findings critical to the feasibility study alternative of channel dredging are summarized below.

3.2 The shallow shoal structure has been identified as a submarine glacial moraine, which likely consists of an unsorted and unstratified accumulation of materials such as clay, silt, sand, gravel, cobbles, and boulders, having been transported, deposited, and consolidated by glacial ice. A more exact determination of the material contents of the shoal will require geotechnical drilling and sample recovery during PED, as discussed in Paragraph 5. The moraine was formed during the Pleistocene Epoch, perhaps as a recessional moraine by a retreating glacier, when the region was glaciated and sea levels were much lower.

3.3 The report in Appendix A-1 provides several stratigraphic cross sections aligned parallel and perpendicular to the shoal as indicated on Figure 9, based on the geophysical survey data. Three of these cross sections (EW03, EW04, and EW05), oriented perpendicular to the shoal alignment, are shown on Figures 10, 11 and 12 with material conditions highlighted for clarity.

3.4 Based on correlations with seismic velocity measurements recorded within the shoal (velocities up to 9,800 feet/second), the moraine is characterized as a consolidated, hard, dense, rock-like unit that would be considered non-rippable by published rippability values. The moraine has an estimated maximum thickness on the order of 100 feet in the general area. Actual bedrock, likely consisting of very hard andesite based on surface outcrops adjacent to the site, underlies the moraine at elevations of approximately -90 feet MLLW or greater within the probable dredging location. To achieve a channel depth of -58 feet MLLW, dredging would be totally confined to within this resistant moraine unit.

3.5 An evaluation of standard dredging technologies is given in Appendix A-1. Dredging will have challenges at this site given the hard substrate conditions, water depth, marine environment, and depth of material to be removed. Two of the primary dredging methods that have been considered are discussed below. Drill and blast is judged at this time to be the only feasible means to facilitate removal of the moraine material.

3.5.1 Drill and Blast. Break/loosen the moraine deposit, excavate the material by clamshell or long-reach excavator (backhoe), then place the dredged material on a split hopper barge for transport to the offshore disposal site. Drill and blast operations would have environmental restrictions and safety concerns for use of explosives in the harbor area.

3.5.2 Cutter Suction Dredge. Operate a cutter suction dredge (CSD) and remove the dredged material via suction pipe to a split hopper barge for transport to the offshore disposal site. This would be a large CSD, self-propelled (seagoing vessel) or non-propelled, with side anchors during stationary operation. There are several concerns regarding the use of CSD equipment at this site: availability of capable CSD equipment; ability to break up hard rock boulders sufficiently small to be extracted by suction pipe; vessel posing a large obstruction to channel navigation traffic during operation; sensitivity to wave conditions and rough seas; not easy to move during operation; and high sound and vibration levels emitted. Certain CSD cutter heads may be effective at removing in-place rock, where the grinding action can pulverize the material into a consistent size to be picked up by the suction pipe. At this site, the moraine unit likely contains boulders within a matrix of smaller fragments. In this case, the cutter heads would tend to dislodge boulders without effectively breaking them up, which negates the main function of the CSD equipment.

3.6 As seen on Figures 10, 11, and 12, seafloor elevations and sediment strata are very different between the harbor and seaward sides of the shoal. On the harbor side, the seafloor depth is approximately -102 feet MLLW, with deep sediment above bedrock and lapping against the moraine unit consisting mainly of uniformly layered clay and silt. On the seaward side, the seafloor ranges in depth from approximately -58 feet to -65 feet MLLW within the area of the three cross sections, with deep sediment above bedrock and butting up against the moraine unit consisting of homogeneous sand. If the dredge channel was positioned within the area of cross section EW03, dredging to a depth of -58 feet MLLW would provide a conduit for sand material migrating inward from the seaward side of the moraine. The bathymetric plot on Figure 13 shows the exposed seafloor limits of the shoal/moraine unit. The shoal terminates within the southern portion of the channel before reaching the shoreline. This termination allowed sand to migrate over time from the seaward side around the shoal and into the deeper harbor basin. Appendix A-1 gives other examples illustrating how sand has been migrating in a harbor direction, such as the orientation of surface sand waves. The need for periodic maintenance dredging due to migrating sand will need to be evaluated, depending on the location and depth of dredging. Appendix A-1 provides representative grain size curves for seafloor sediment samples taken from the site.

3.7 A critical site condition to be taken into account for channel dredging and excavation is the probable presence of munitions and explosives of concern (MEC) within the general dredge area. Two NAVFAC reports referenced in Paragraph 6 provide an extensive history and inventory of MEC use and disposal on Unalaska Island and Dutch Harbor. Key information from these references are given below.

- The Navy's Munitions Response Program was established to address potential explosives safety, health, and environmental issues posed by MEC and munitions constituents (MC) used or released during past operations and activities. At Unalaska and Dutch Harbor, this concerns military operations including actual warfare actions during World War II.
- The primary waste of concern within the marine environment at Unalaska is MEC and MC. MEC includes unexploded ordnance (UXO), discarded military munitions (DMM), and MCs in high enough concentrations to present an explosive hazard.
- The use and handling of ordnance and the Japanese attack on two consecutive days in June 1942 at Unalaska resulted in munitions-related waste entering the marine environment by: (1) ordnance fired over water from coastal defense artillery (CDA) and anti-aircraft (AA) gun batteries during target training and gun function testing that did not detonate; (2) ordnance lost into the water during transfer from transport ships to ports on shore; (3) excess ordnance deliberately disposed of (DMM) at the conclusion of hostilities; and (4) for Dutch Harbor, ordnance deliberately dropped or fired by Japanese forces that did not detonate.
- An unknown quantity of MEC, including UXO and DMM, was lost, discarded, or fired into the marine environment surrounding Unalaska Island during World War II.

3.8 The NAVFAC reports should be closely reviewed for a full understanding of known and probable MEC and MC releases into the marine environment on Unalaska Island, Dutch Harbor, and in the vicinity of the study site (e.g. type and caliber of munitions). Example figures of interest are provided as follows: Figure 14 - Gun Battery No 1a located on Amaknak spit near the shoal; Figure 15 - military docks and locations of removed/observed MEC; Figure 16 - land mine and projectile pulled from the seafloor off Dutch Harbor; and Figure 17 - areas in the vicinity of Dutch Harbor surveyed for possible MEC by the U.S. Navy using geophysics followed by a remotely operated underwater vehicle (ROV). The updated October 2010 NOAA nautical chart for Dutch Harbor also identifies reports from 2013 of unexploded ordnance within the harbor area (see Figure 3).

3.9 Appendix A-1 provides detailed information for every surface and buried object detected by the geophysical survey (ID number, map location, survey coordinates, surface depth, depth below seafloor, object dimensions, description, if the object is potential UXO, and graphic image). Detection resolution of the geophysical survey methods was limited to surface and subsurface objects larger than 1 foot by 1 foot. Smaller targets, such as individual 0.50-caliber machine gun rounds used by the Navy at Dutch Harbor, would not be detected by the geophysical survey. Detected objects may be single objects or an aggregate of closely spaced objects as noted in Appendix A-1.

3.9.1 The geophysical survey detected the following unknown seafloor surface objects within the study area:

- A total of 31 unknown surface objects with ferrous return were detected, 25 within the inner box (general area of possible dredging) and 6 within the outer box. The largest object is 15 feet tall, 10 feet wide, and 18 feet long (noted as possible buoy with chain). The gradiometer was not used in the outer box except for minor calibration activities, so more than 6 surface ferrous objects may be present in the outer box. Locations of ferrous objects within the inner and outer boxes are shown on Figure 18.

- Of the 25 ferrous objects in the inner box, 15 are noted as potential UXO based on their shape (round, oblong, or egg-shaped). Only 6 of these potential UXO objects are located at seafloor depths less than -58 feet MLLW, the maximum depth of expected dredging.

- A total of 8 unknown surface objects with non-ferrous return were detected within the inner box, with the largest object having dimensions of 2.5 feet tall, 4.5 feet wide, and 8 feet long. Locations of these objects are shown on Figure 19.

- A total of 109 unknown surface objects were detected within the outer box, which cannot be classified as ferrous or non-ferrous as the gradiometer was not operated within the outer box except as noted above. These objects range in maximum dimension from 1 foot to 14 feet. Object locations are shown on Figure 20.

3.9.2 Crab pots have a very distinctive high magnetic response and shape, easily identified by data from the combined geophysical survey tools. A total of 48 crab pots were identified within the inner and outer survey boxes, with locations shown on Figure 21. A total of 4 tires were also identified, with locations shown on Figure 22.

3.9.3 The geophysical survey detected the following unknown subsurface objects within the study area:

- A total of 6 unknown subsurface objects with ferrous return were detected in the inner box, with locations shown on Figure 23. It cannot be determined if the objects are potential UXO from the information available. Only 1 of these objects is positioned within the maximum depth of potential dredging (-58 feet MLLW).

- A total of 52 non-ferrous subsurface objects were detected within the inner box, with locations shown on Figure 24. These objects are interpreted as being boulders, with the largest dimension ranging from 1 foot to 12 feet.

- A total of 42 non-ferrous subsurface objects were detected within the outer box, with locations shown on Figure 25. These objects are interpreted as being boulders, with the largest dimension ranging from 1 foot to 6 feet.

- There are a total of 13 unknown subsurface objects detected within the outer box that could not be determined as being either ferrous or non-ferrous, but are being interpreted as non-natural as opposed to natural (e.g. boulder) based on shallow burial, isolated position, and irregular shape. Object locations are given on Figure 26.

3.9.4 Finally, there are 9 locations within the inner box that had strong gradiometer returns, indicating ferrous content, which could not be linked to surface or subsurface objects detected by the other geophysical survey tools. These locations are identified on Figure 27, which occur along both flat and rocky areas of the shoal.

4.0 SUMMARY OF CHANNEL DREDGING RECOMMENDATIONS.

4.1 As discussed earlier, the geophysical survey was designed to concentrate a more intense level of investigative effort within an inner box area where dredging would likely occur, with additional investigation performed within an outer box for further site characterization. Based on current thinking by the study team, the location of the inner box remains valid to cover where dredging would likely occur. The impact of stratigraphic conditions and surface/subsurface objects of potential concern on channel dredging can be assessed more specifically once the position and depth of the dredge prism has been finalized through ongoing study evaluations.

4.2 Based on current site information, recommendations for channel dredging through the shoal structure are as follows:

- Drill and blast to break/loosen the hard moraine unit, excavate the material by clamshell or long-reach backhoe, then transport the excavated material via split hopper barge for deeper offshore disposal.

- Screen and separate any munitions of explosive concern MEC that may be encountered within the excavated material, including unexploded ordnance (UXO) and discarded military munitions (DMM). Include provisions for safety and qualified field oversight of the recovery, handling and disposal of MEC during channel dredging.

- Determine any requirement for screening and separation of non-MEC materials (ferrous and non-ferrous objects and debris, such as crab pots, buoys, anchors, chains, and tires) and oversized rock materials from the excavated material prior to general offshore disposal. This type of pre-disposal material separation has been performed on other marine dredging operations on USACE and U.S. Navy managed projects.
- The possible need for periodic maintenance dredging should be evaluated, depending on the location and depth of the dredge channel relative to sand deposits accumulating on the seaward side of the shoal. Maintenance dredging could also encounter MEC materials and other debris migrating in from the slopes and seaward end of the dredge channel.
- Consider the possibility of implementing a separate contract action to remove objects of concern prior to channel dredging.

5. RECOMMENDATIONS FOR FOLLOW-ON SITE INVESTIGATIONS.

5.1 Geophysical surveys are typically complemented by geotechnical drilling to perform downhole engineering tests, conduct laboratory tests on the recovered samples, classify the material in engineering terms, and provide points of correlation with the geophysical survey data. The cost of performing geotechnical drilling in addition to geophysics during the feasibility study would have easily exceeded the study budget. Also, carrying out the drilling program would be more appropriate once the dredge location and depth are set and approval is given to proceed to design. Accordingly, geotechnical drilling and material testing should be conducted during Preconstruction Engineering and Design (PED).

5.2 A preliminary concept for the PED geotechnical program would be to drill 9 borings along the shoal alignment, 5 being spaced within the 600-foot wide channel bottom, and 2 borings on each side of the channel, near the top of the recommended 2H:1V dredge slopes. The borings would be extend a certain distance below the design dredge depth, conducted from an anchored or jack-up barge stabilized in place for that purpose. Drilling locations would first be surveyed by magnetometer to verify the absence of ferrous objects (potential MEC). It is interpreted that the moraine unit extends northwestward to underlie the adjacent spit (see Figure 13), which would provide an opportunity for land-based drilling. It would also be advantageous to drill one or two additional borings along the spit to further characterize the moraine unit.

5.3 Discussions have been held with USACE and NAVFAC subject matter experts on what means may be available to confirm ferrous objects as being MEC, beyond what has already been performed at the site through geophysical means. Raw geophysical survey data from this study has been provided to NAVFAC, who has agreed to analyze the data using unique algorithms which potentially can provide some clarification on whether or not certain ferrous targets are MEC. Results of the NAVFAC analyses will likely be available for use during PED. There apparently are research-level geophysical tools being developed by the Navy for advanced MEC detection, but would not be ready or available for this study. What has been recommended is to use a remotely operated underwater vehicle (ROV) to visually observe and further characterize the identified seafloor targets of concern. This makes practical sense, with ROVs available for this purpose either through the private section (Branch IDA-E contract) or by a governmental entity (e.g. USACE Huntsville EM MCX). It is therefore recommended that visual examination of surface targets within the finalized dredge channel area be conducted by ROV during PED.

5.4 The estimated cost of geotechnical investigations during PED (borings, ROV, and design support), including in-house and contract costs, would range between $700,000 and $1,200,000. Recommendations and the cost for PED geotechnical investigations can be developed in greater detail after the dredge channel location and depths have been finalized.

6. REFERENCES.

Reference 1: Site Inspection Report (Final), Naval Defensive Sea Area, Unalaska Island, Alaska, by NAVFAC, dated 28 July 2016 (https://navfac.navy.mil/AKNDSA/).

Reference 2: Preliminary Assessment Report for Naval Defensive Sea Area (Final), Unalaska Island, Alaska, by NAVFAC, dated 3 May 2013 (https://navfac.navy.mil/AKNDSA/).

Reference 3: Military Munitions Response Site Prioritization Protocol (MRSPP) Final Scoring Tables for Unalaska Island, Alaska, by NAVFAC (https://navfac.navy.mil/AKNDSA/).

7. APPENDICES.

Appendix A-1: Geophysical Survey Report, Volumes 1 and 2, Channel Navigation Improvements Feasibility Study, Dutch Harbor, Alaska, Final Submittal, dated 5 July 2017, by R&M Consultants, Inc. (Contract W911KB-17-D-0001, Task Order No. 0005).

8. FIGURES.

Figure 1: Dutch Harbor and Vicinity, Alaska
Figure 2: Shallow Shoal Crossing Channel Entrance
Figure 3: October 2010 NOAA Nautical Chart for Dutch Harbor
Figure 4: Areal Limits of Marine Geophysical Survey
Figure 5: Geophysical Survey Details
Figure 6: Deployed Geophysical Survey Equipment
Figure 7: Deployed Geophysical Survey and Sampling Equipment
Figure 8: Seafloor Sediment Classification Map
Figure 9: Stratigraphic Cross Section Locations

Figure 10: Stratigraphic Cross Section EW03
Figure 11: Stratigraphic Cross Section EW04
Figure 12: Stratigraphic Cross Section EW05
Figure 13: Sand Migration around South End of Shoal
Figure 14: Former Gun Battery No. 1A near Study Site
Figure 15: Former Military Docks and Areas of Removed/Observed MEC
Figure 16: Example MEC Items from Dutch Harbor Seafloor
Figure 17: Areas Surveyed by U.S. Navy for Possible MEC
Figure 18: Unknown Surface Objects with Ferrous Return
Figure 19: Unknown Surface Objects in Inner Box with Non-Ferrous Return
Figure 20: Unknown Surface Objects in Outer Box
Figure 21: Crab Pots Identified on Seafloor
Figure 22: Tires Identified on Seafloor
Figure 23: Unknown Subsurface Objects in Inner Box with Ferrous Return
Figure 24: Unknown Subsurface Objects in Inner Box with Non-Ferrous Return
Figure 25: Unknown Subsurface Objects in Outer Box with Non-Ferrous Return
Figure 26: Unknown Subsurface Objects in Outer Box
Figure 27: Areas of Strong Gradiometer Return in Inner Box

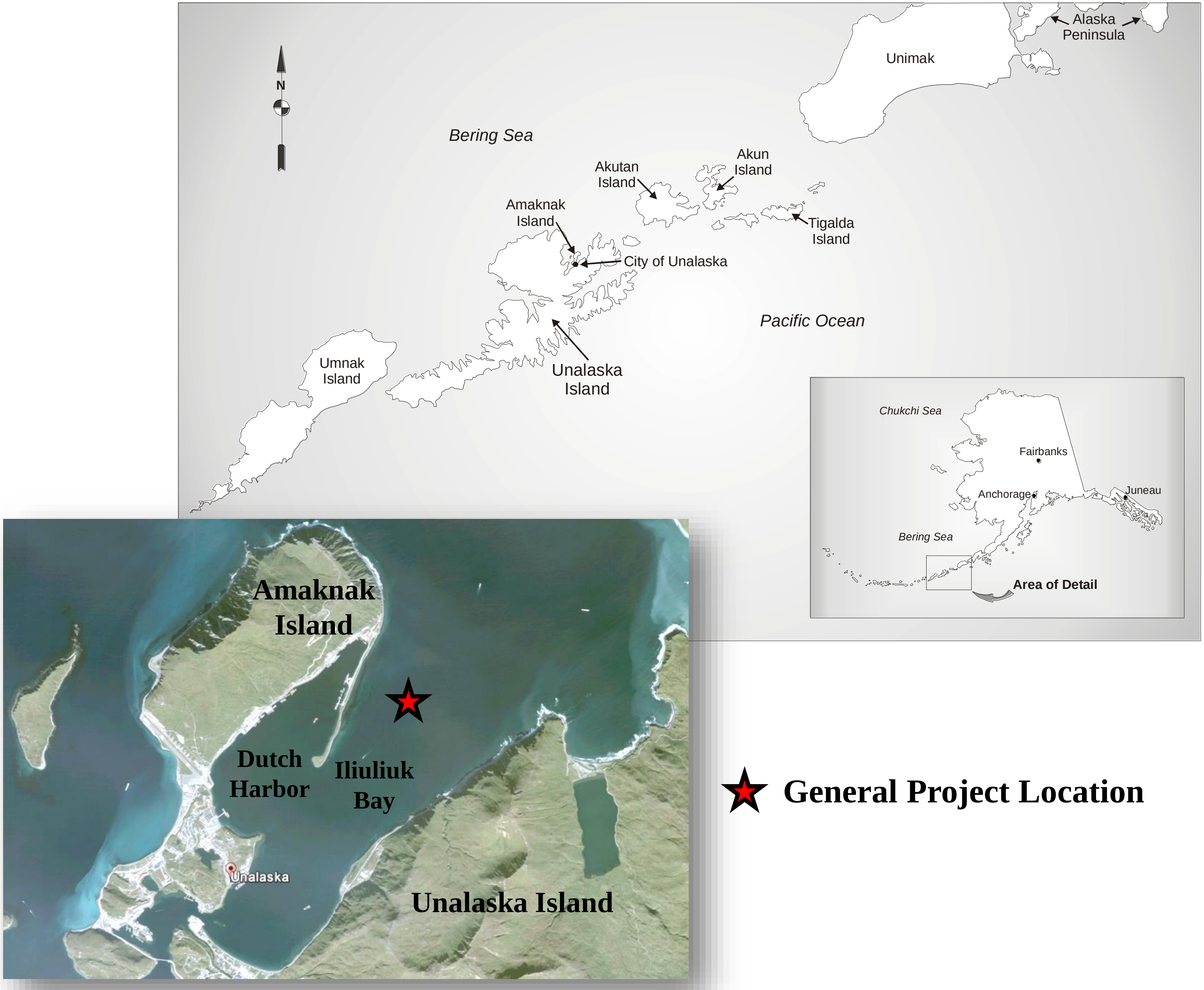


FIGURE 1 – DUTCH HARBOR AND VICINITY, ALASKA

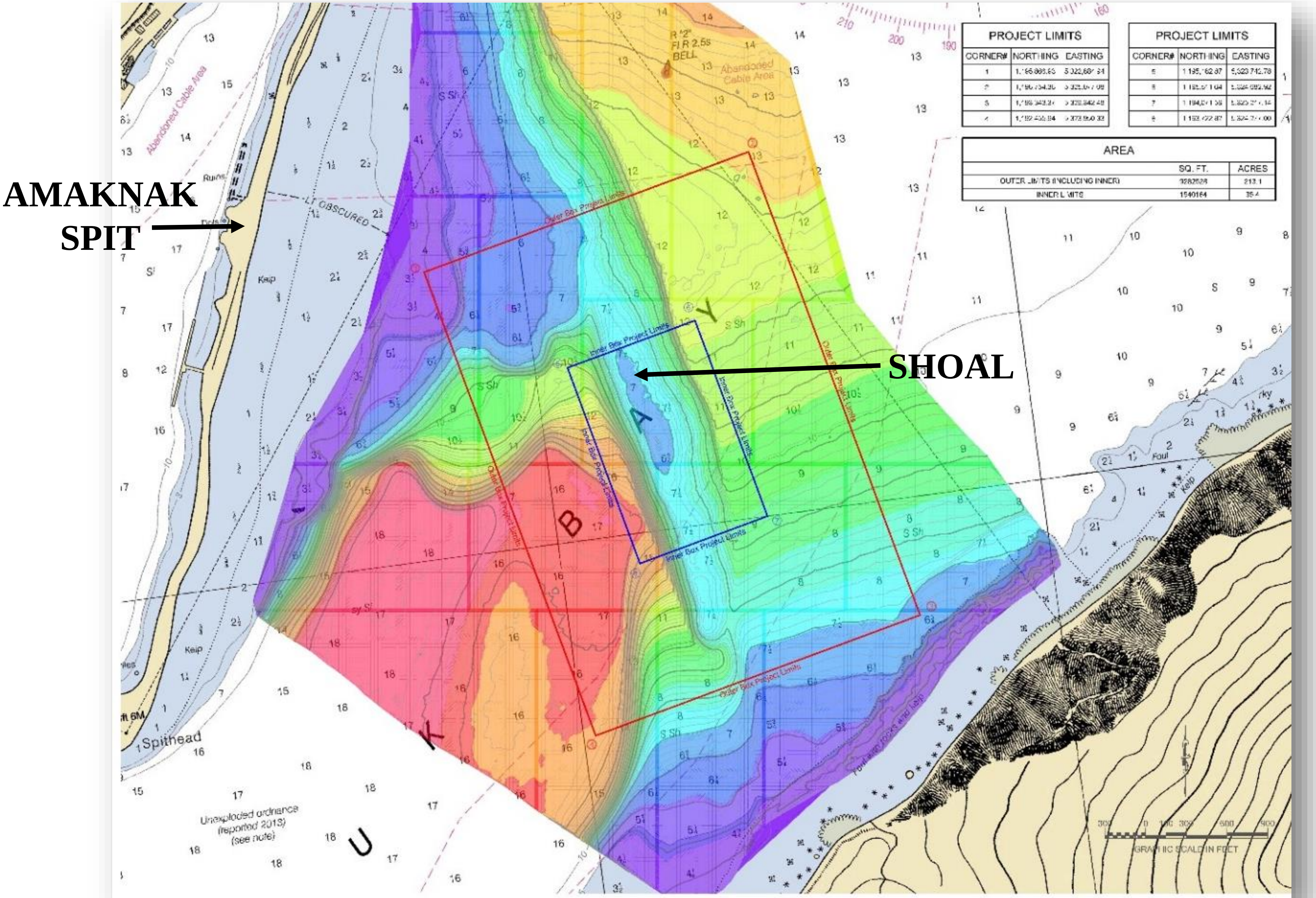
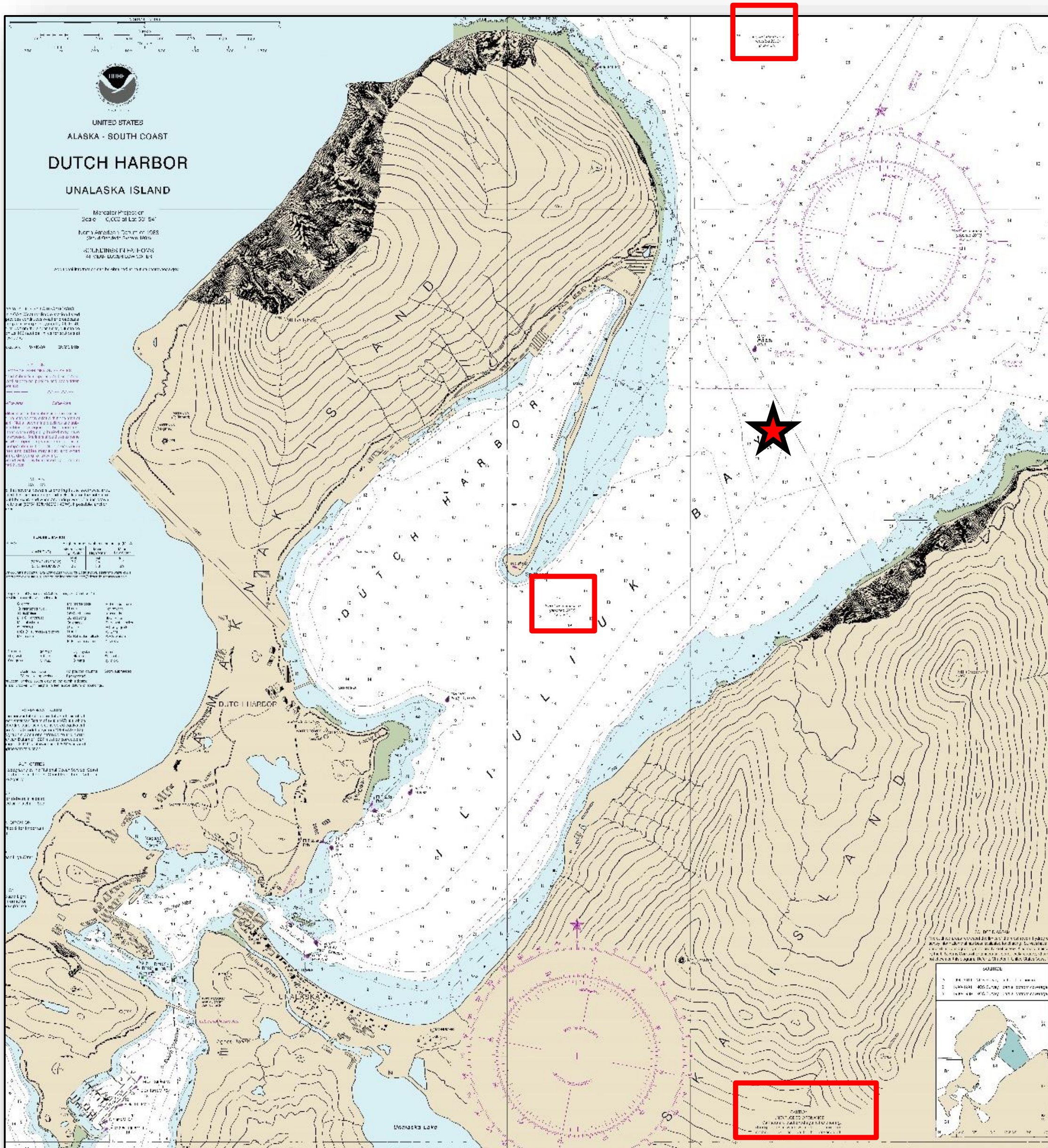


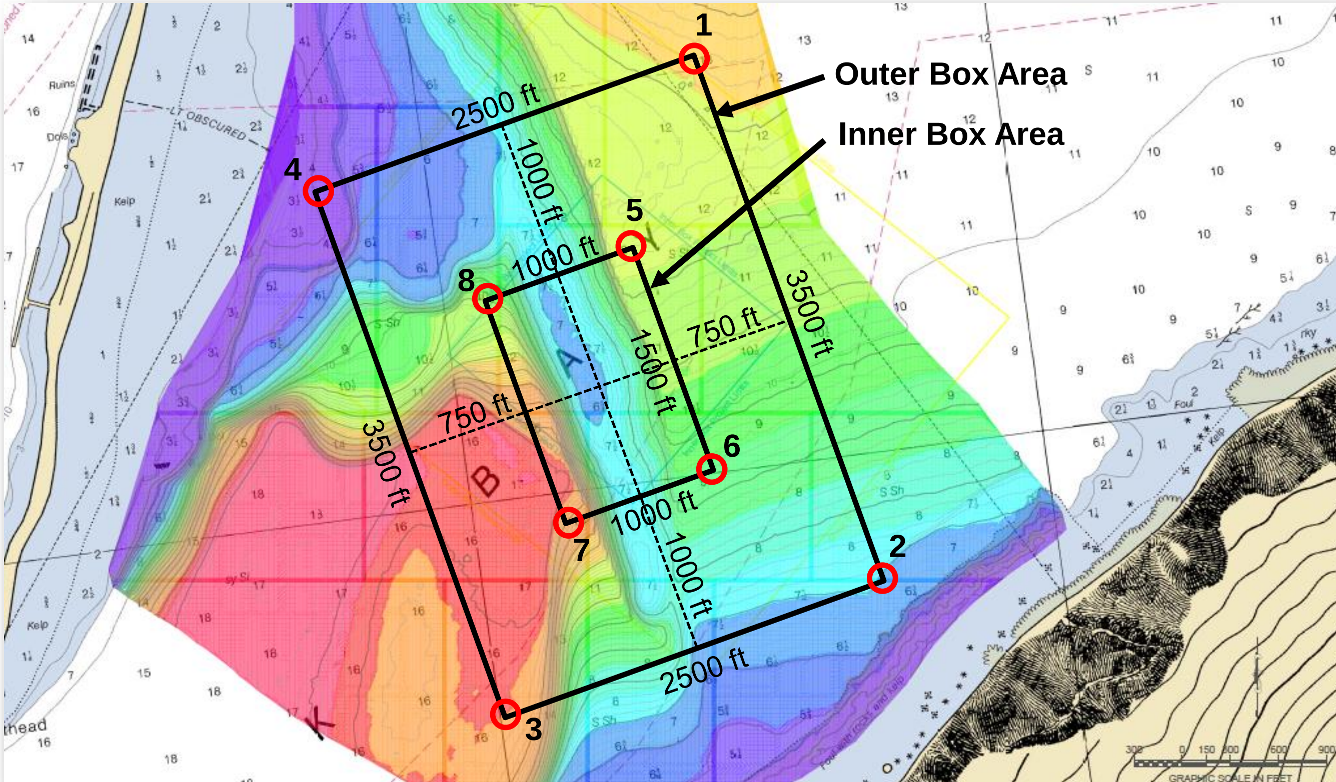
FIGURE 2 – SHALLOW SHOAL CROSSING CHANNEL ENTRANCE



Note Statements:
Unexploded ordnance reported 2013. Mariners are cautioned against anchoring, dredging, or trawling within the area of the dashed black lines due to the presence of unexploded ordnance.

★ **General Project Location**

FIGURE 3 – OCTOBER 2010 NOAA NAUTICAL CHART FOR DUTCH HARBOR

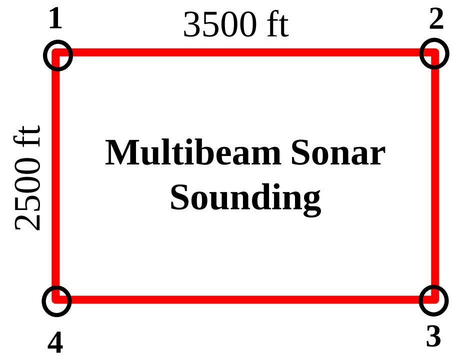


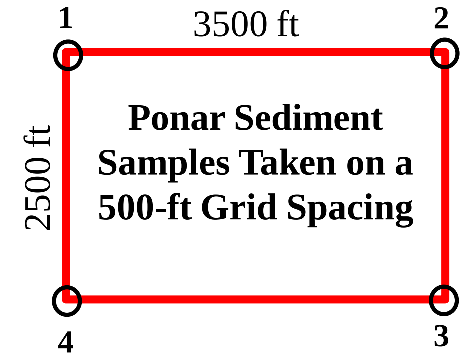
Outer Box Area Multibeam sonar sounding with Snippets intensity data collection; chirp subbottom profiling; bubble gun seismic profiling; Ponar sediment sampling.

Inner Box Area Multibeam sonar sounding with Snippets intensity data collection; chirp subbottom profiling; bubble gun seismic profiling; Ponar sediment sampling; gradiometer survey.

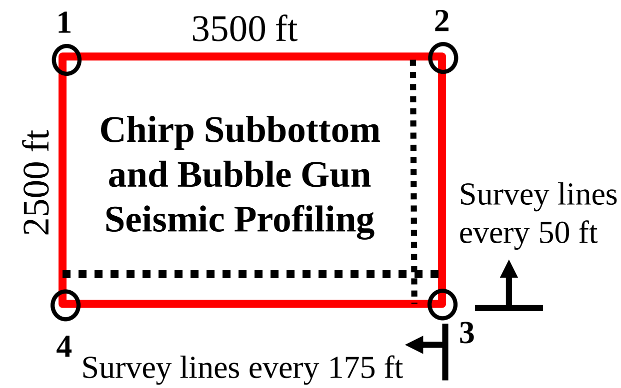
FIGURE 4 – AREAL LIMITS OF MARINE GEOPHYSICAL SURVEY

<u>Phase 1</u>: Multibeam sonar sounding and sediment sampling across outer box. Establish bathymetry and shallow sediment type, detect surface objects.





<u>Phase 2</u>: Chirp subbottom and bubble gun seismic profiling across outer box, deployed together. Define sediment and underlying stratigraphy, detect buried objects.



<u>Phase 3</u>: Chirp subbottom profiling and gradiometer on closely spaced grid within inner grid, deployed separately. Define sediment stratigraphy and detect UXO and debris.

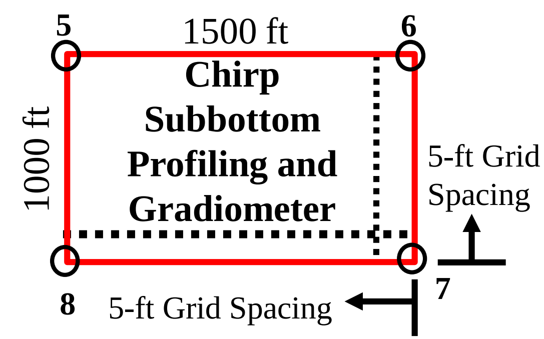


FIGURE 5 – GEOPHYSICAL SURVEY DETAILS

R2Sonic 2024 Multibeam Sonar Sounding System

EdgeTech 216s Chirp Subbottom Profiler System with 3200 Topside Unit

Falmouth HMS-620 Bubble Gun Seismic Profiler System

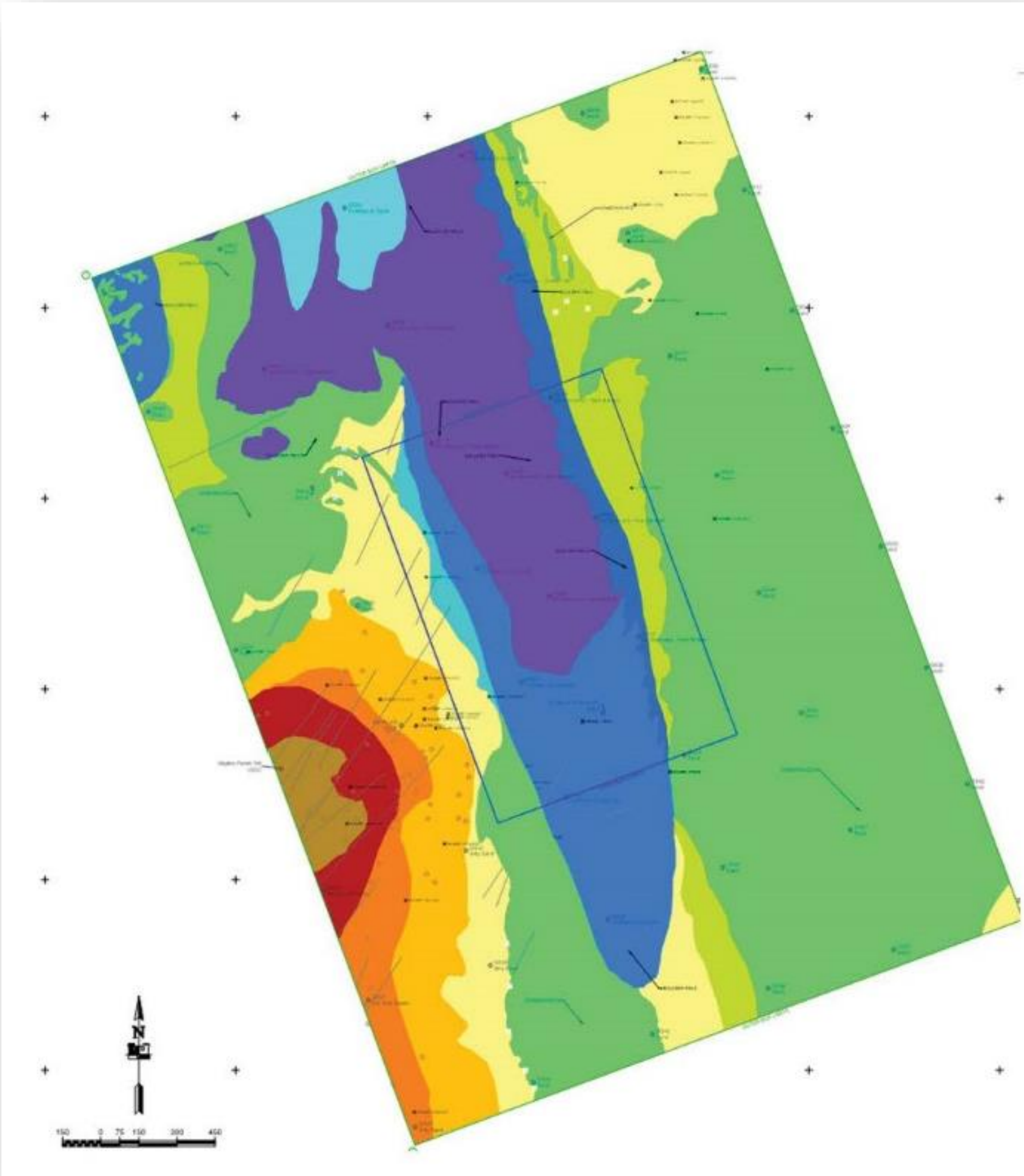
FIGURE 6 – DEPLOYED GEOPHYSICAL SURVEY EQUIPMENT

Geometrics Transverse Gradiometer Model G-882

WILDCO Petite Ponar Grab Sampler

Winch control set up within vessel cabin for control of deployed geophysical instruments

FIGURE 7 – DEPLOYED GEOPHYSICAL SURVEY AND SAMPLING EQUIPMENT



SEDIMENT CLASSIFICATION COLOR LEGEND	
Bottom Material	COLOR
Hard Bottom	
Boulder (0.90'-1.30')	
Rock (0.10'-0.40')	
Cobbles on Sand	
Gravelly Sand	
Sand	
Sand with Silt	
Silty Sand	
Sandy Silt	
Silt	
Slightly Plastic Silt	
Clay with Silt	

FIGURE 8 – SEAFLOOR SEDIMENT CLASSIFICATION MAP

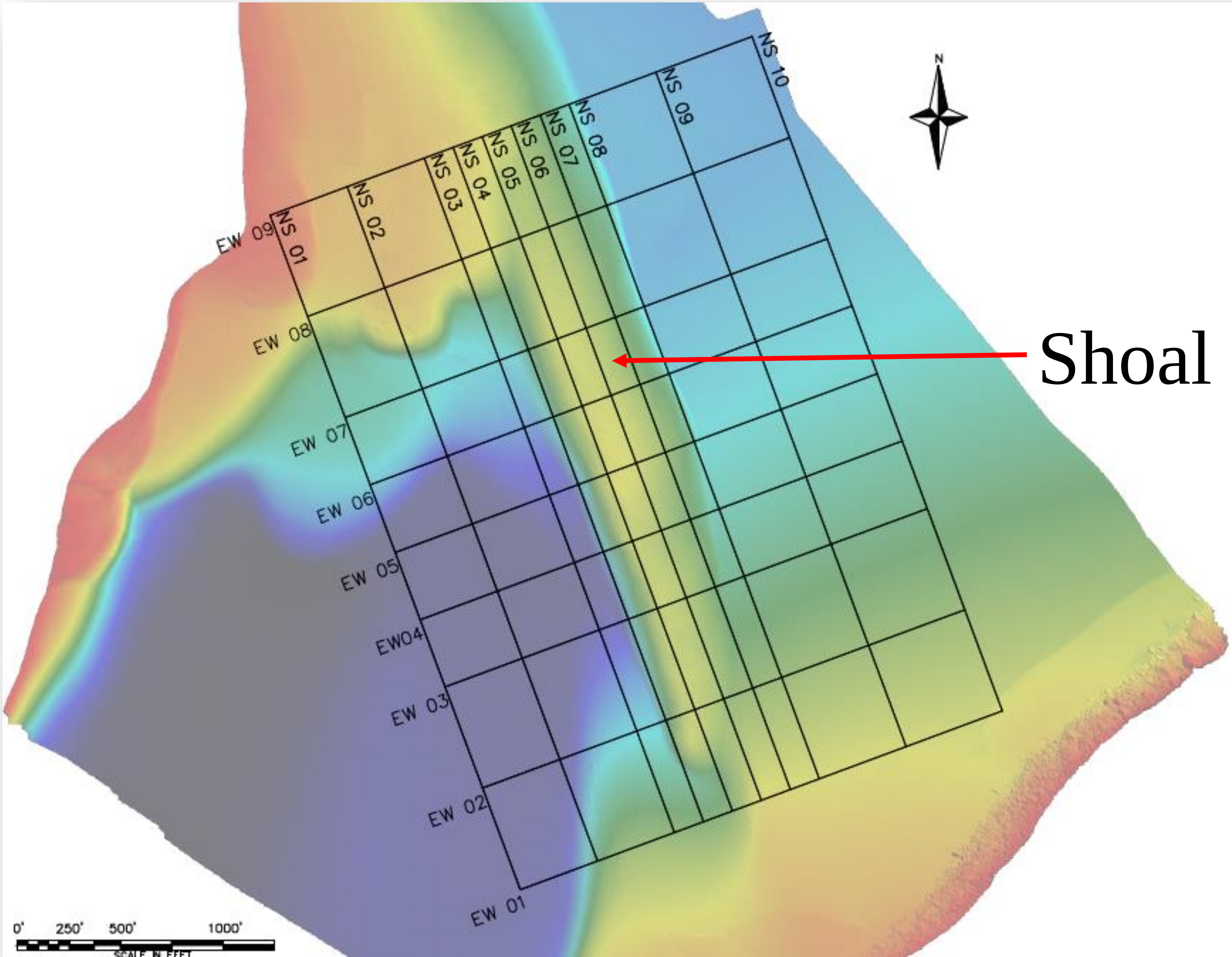
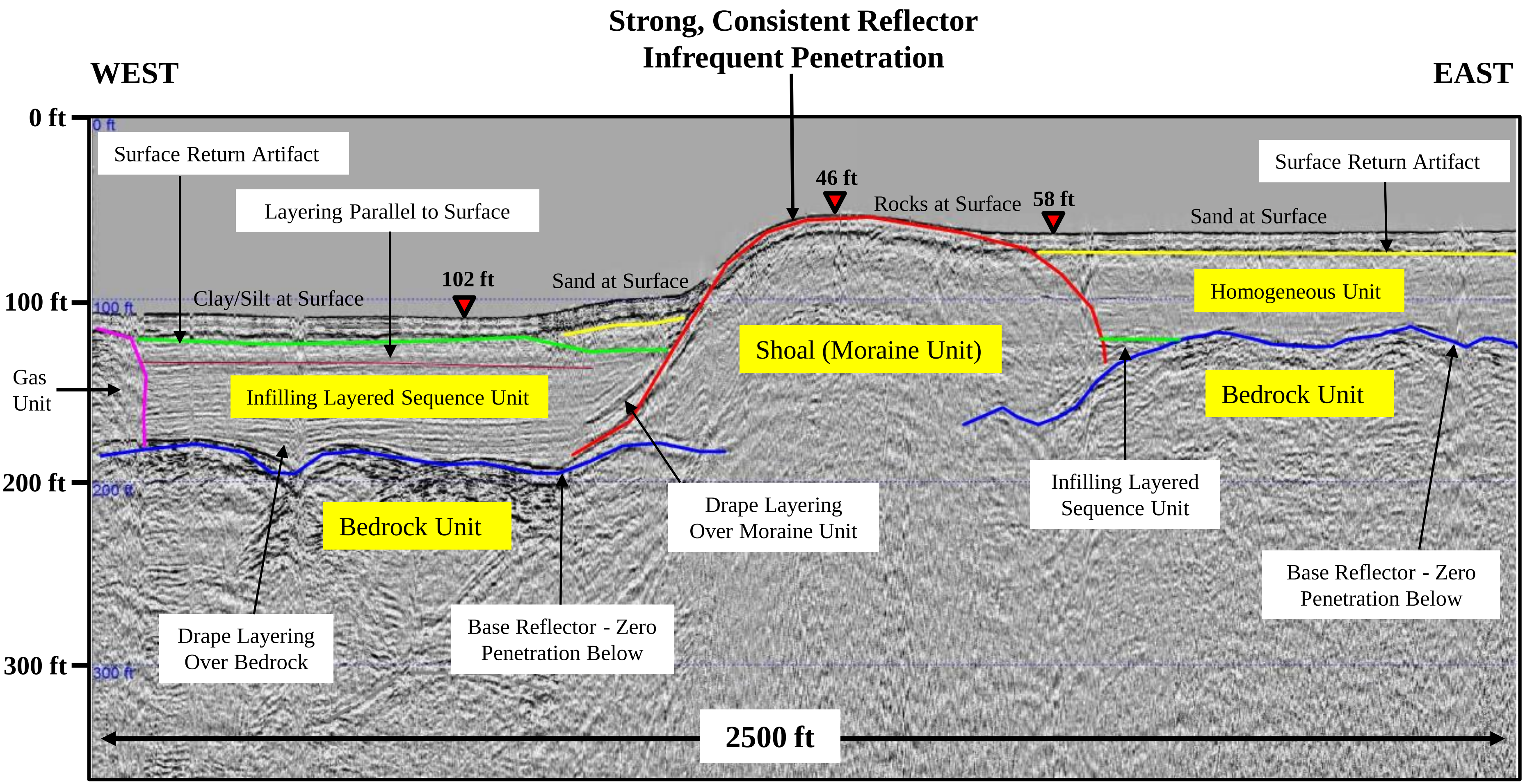


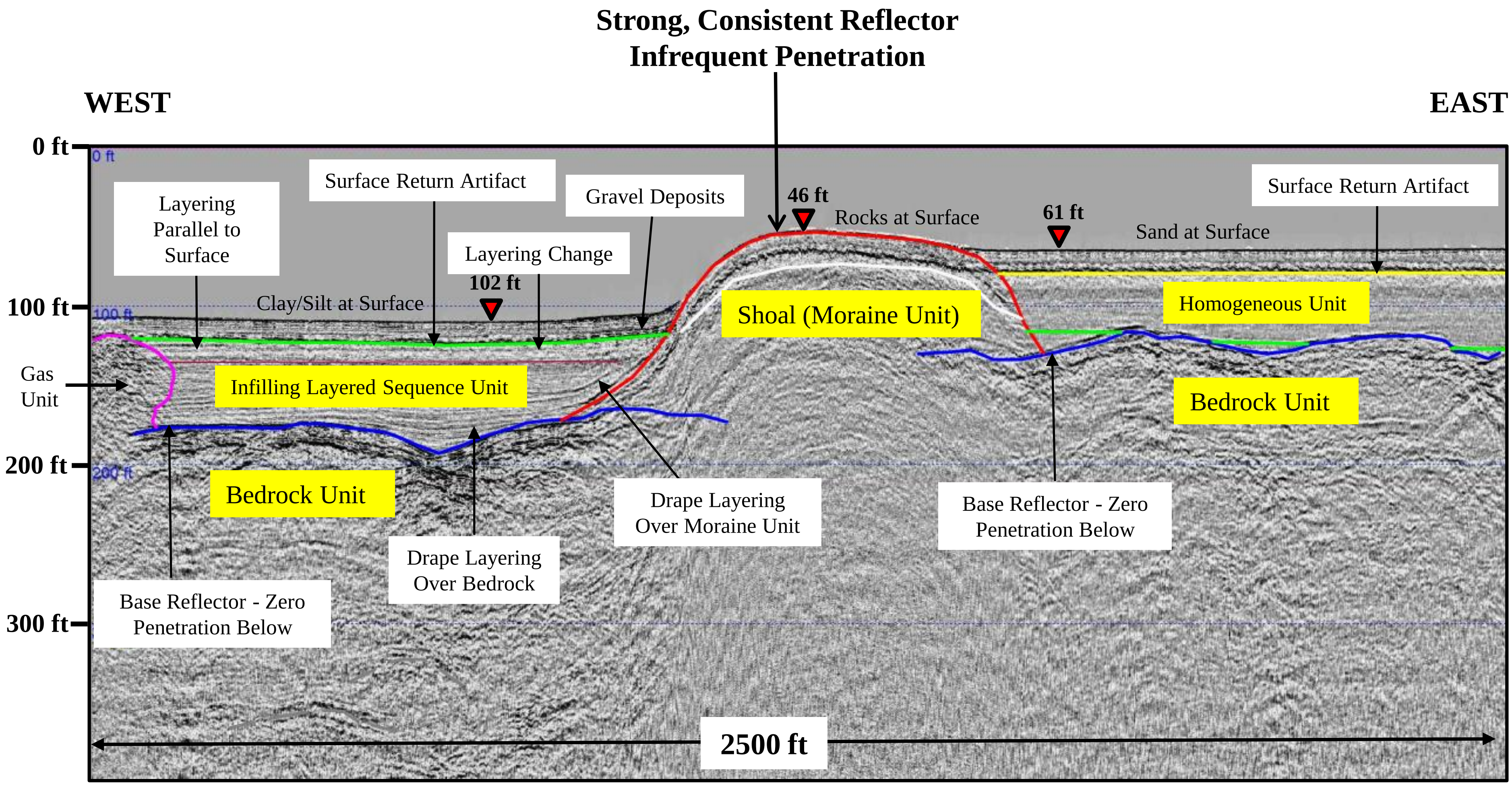
FIGURE 9 – STRATIGRAPHIC CROSS SECTION LOCATIONS



Notes:

1. Plot derived from bubble gun seismic profiler data.
2. Depths shown below MLLW.
3. Depth point. ▼

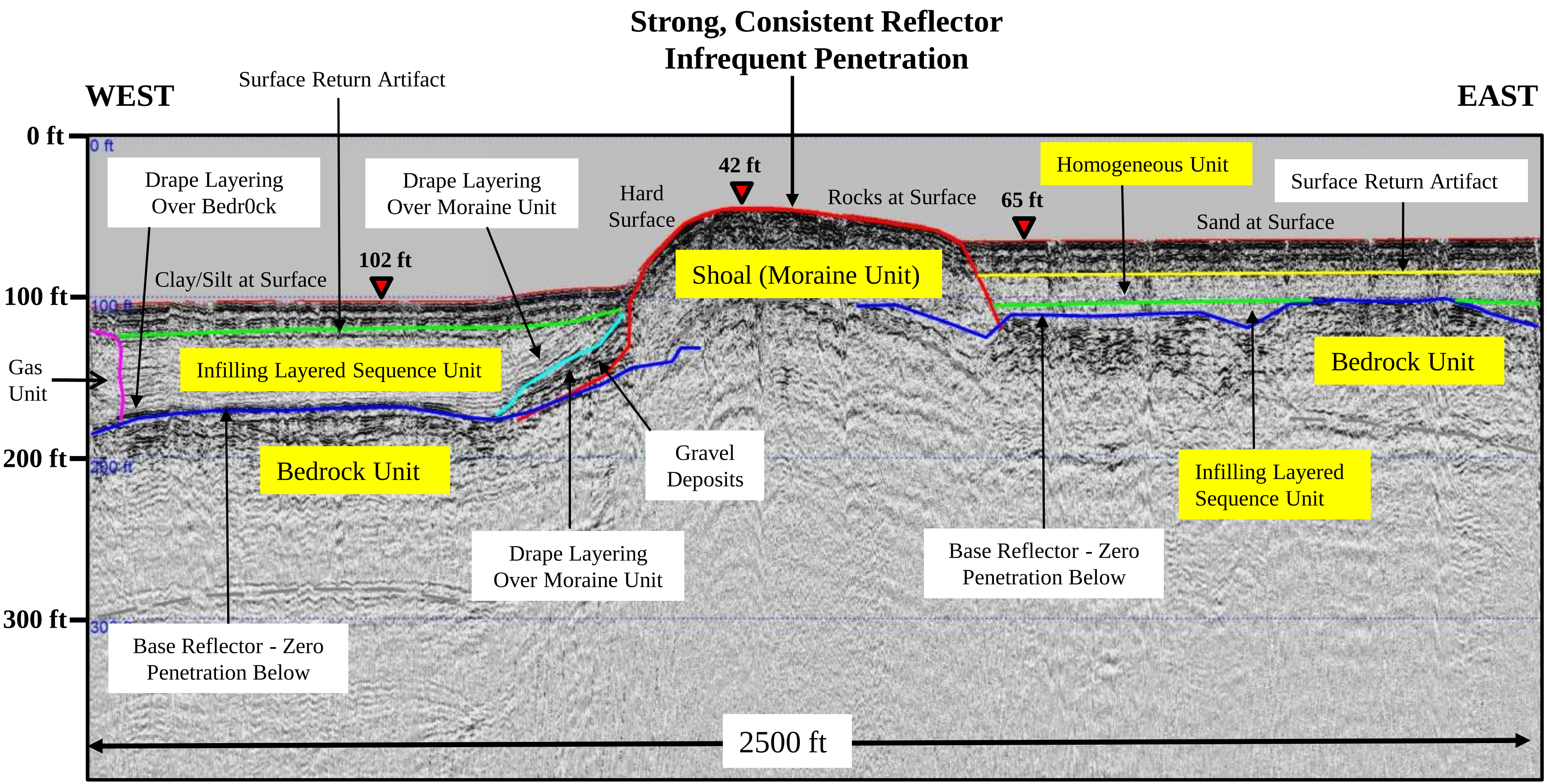
FIGURE 10 – STRATIGRAPHIC CROSS SECTION EW03



Notes:

1. Plot derived from bubble gun seismic profiler data.
2. Depths shown below MLLW.
3. Depth point. ▼

FIGURE 11 – STRATIGRAPHIC CROSS SECTION EW04



Notes:

1. Plot derived from bubble gun seismic profiler data.
2. Depths shown below MLLW.
3. Depth point.

FIGURE 12 – STRATIGRAPHIC CROSS SECTION EW05

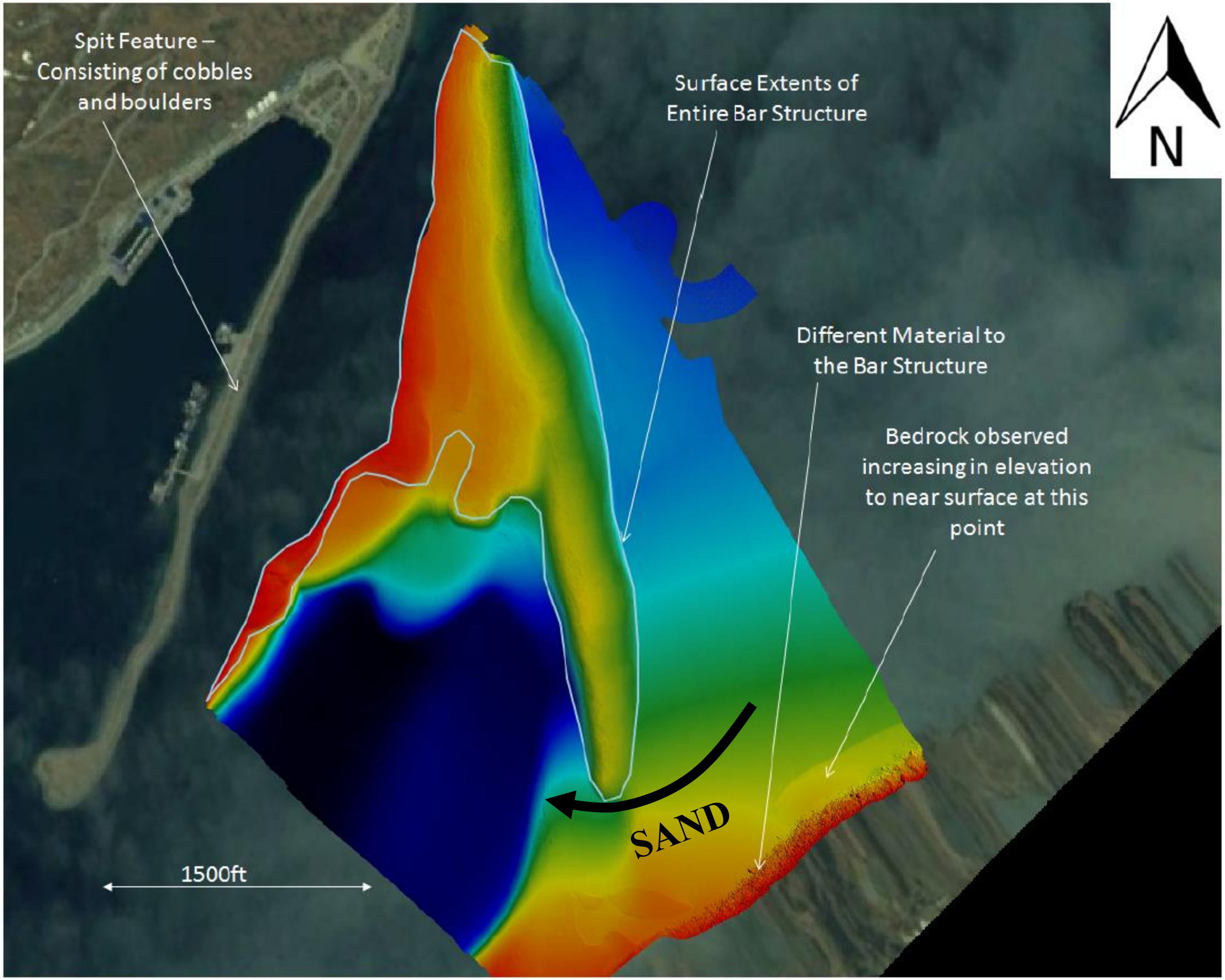


FIGURE 13 – SAND MIGRATION AROUND SOUTH END OF SHOAL

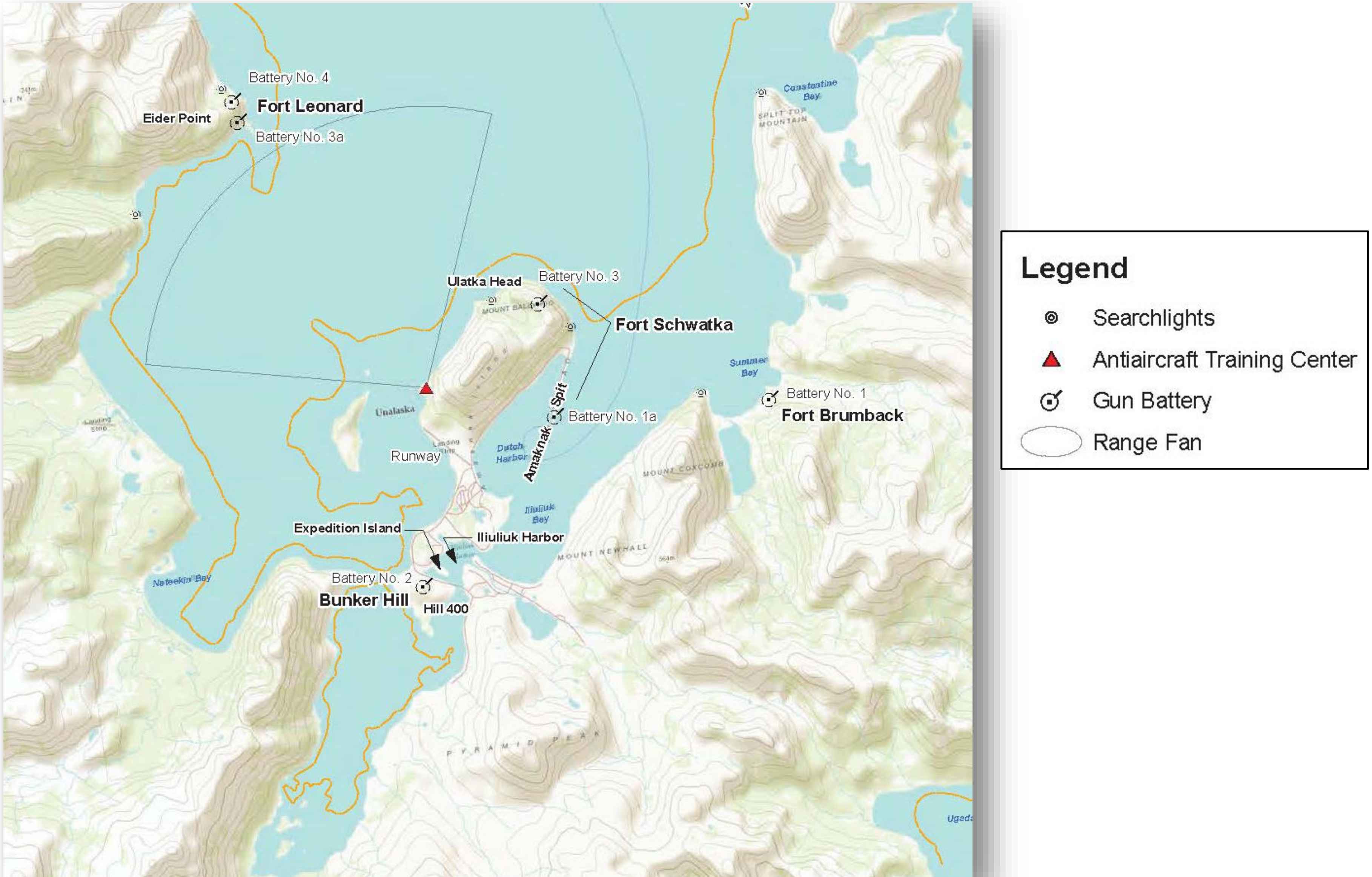


FIGURE 14 – FORMER GUN BATTERY NO. 1A NEAR STUDY SITE

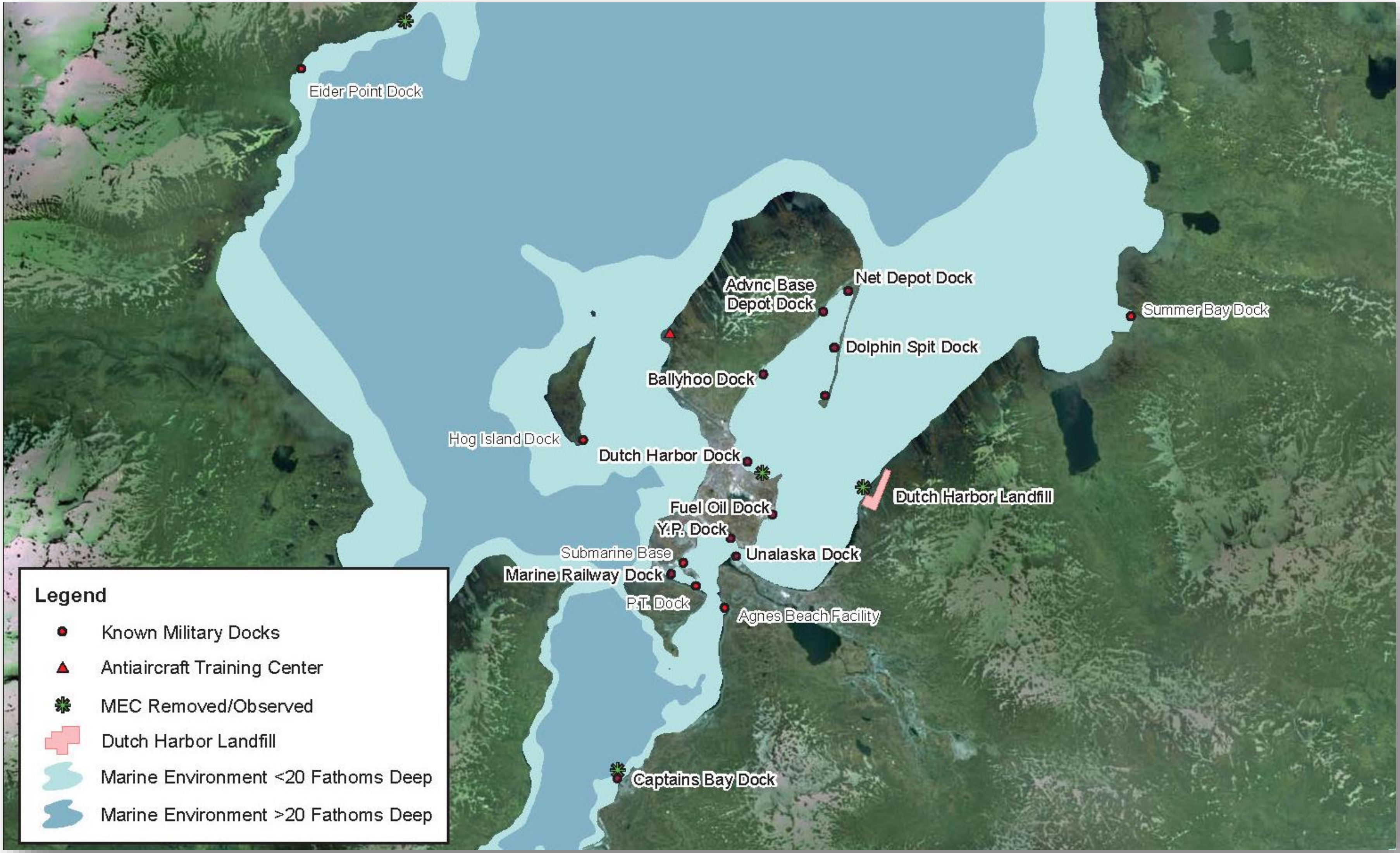


FIGURE 15 – FORMER MILITARY DOCKS AND AREAS OF REMOVED/OBSERVED MEC

Land Mine Pulled from Seafloor During Deep-Water Fishing Off Dutch Harbor in June 2012

Projectile Pulled from Seafloor During Deep-Water Fishing Off Dutch Harbor in June 2012

FIGURE 16 – EXAMPLE MEC ITEMS FROM DUTCH HARBOR SEAFLOOR

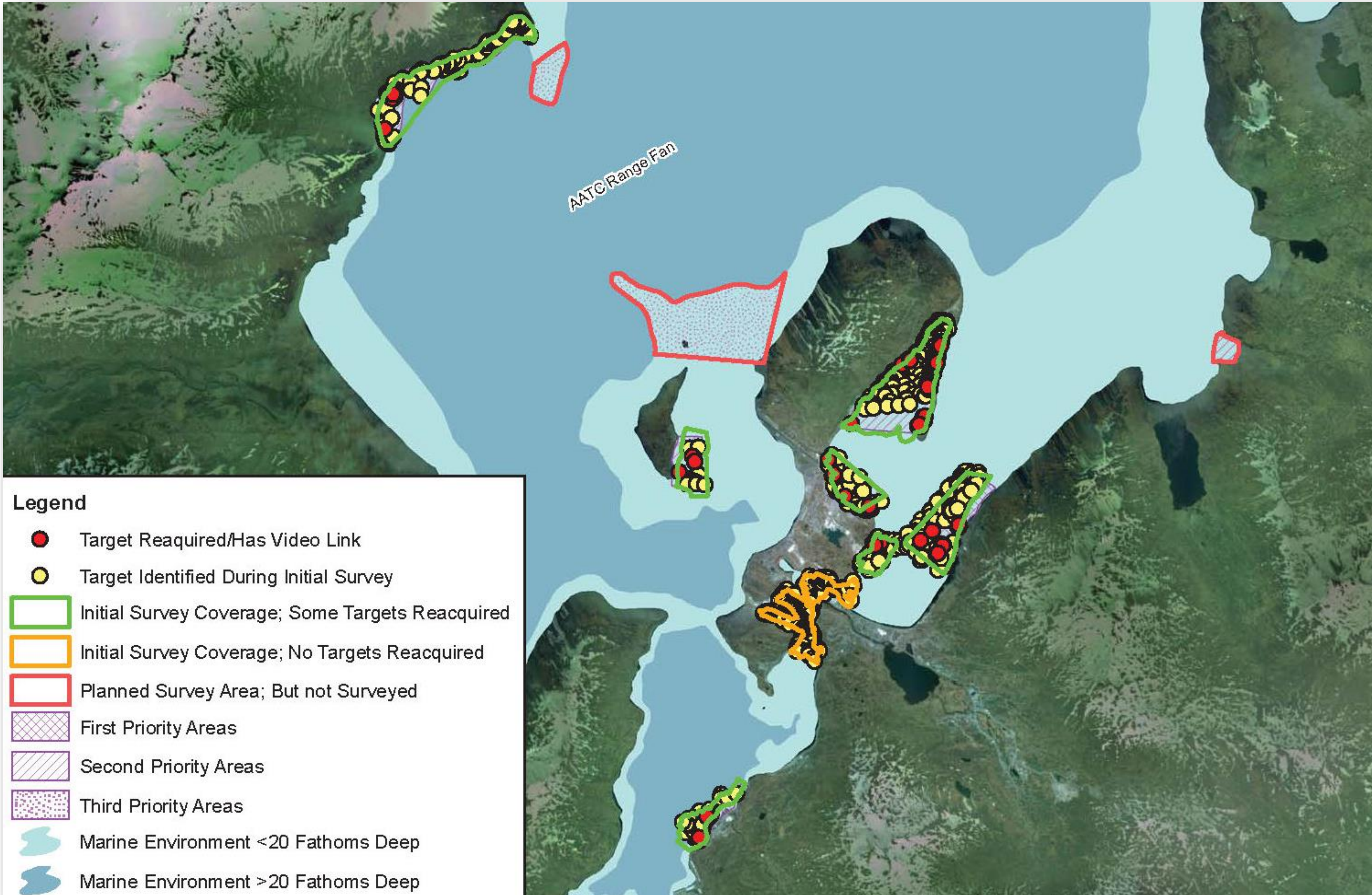
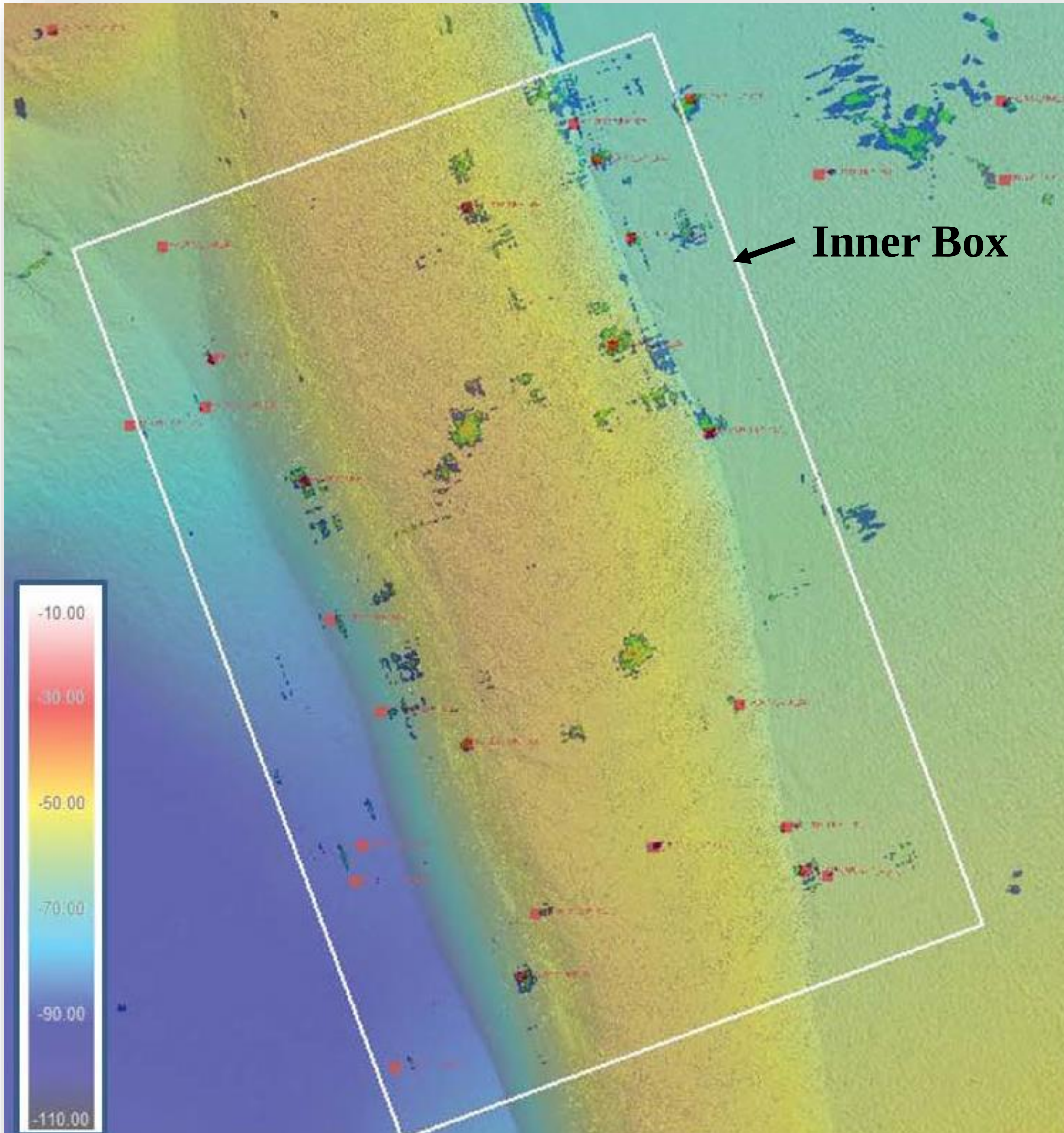
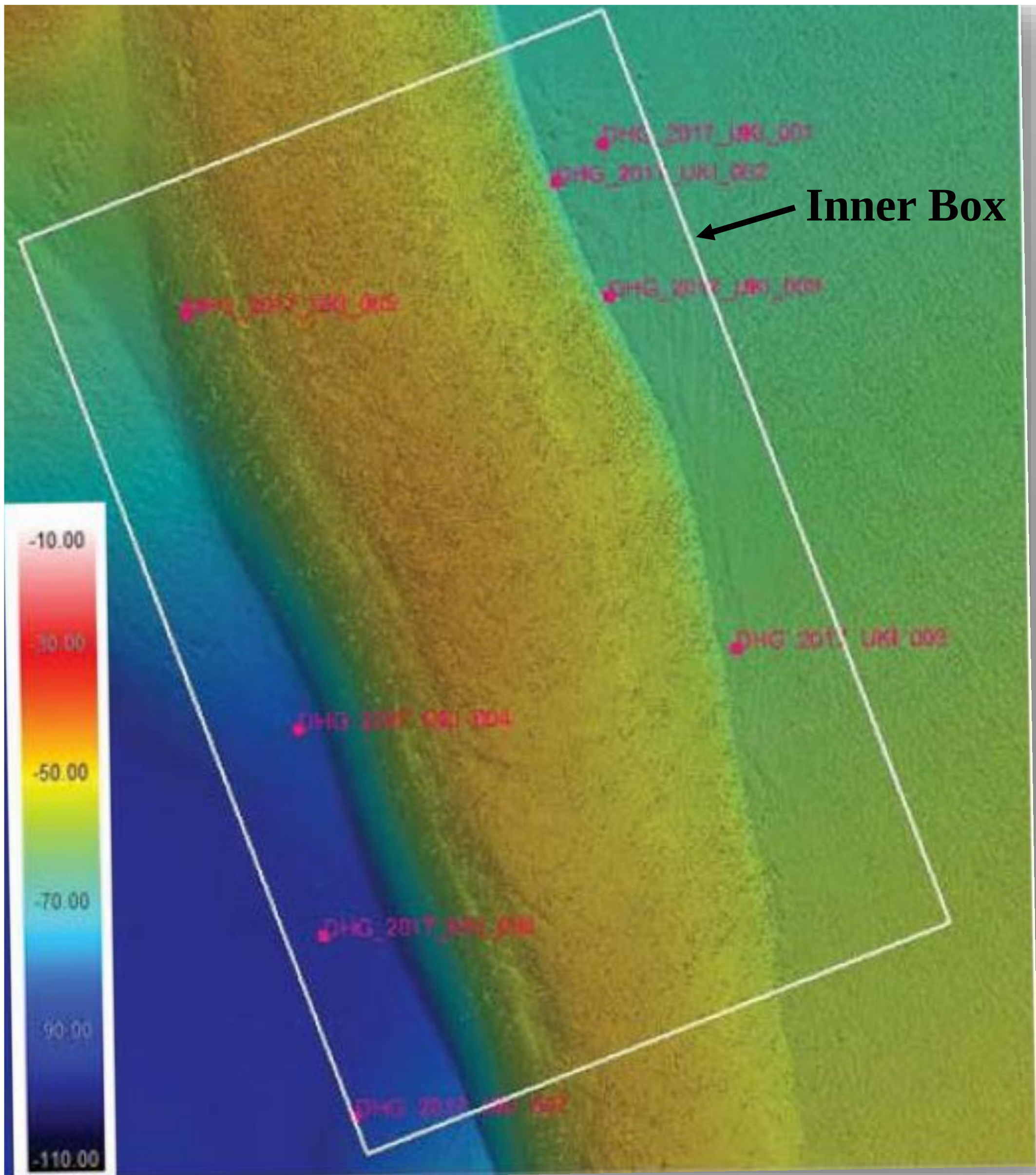


FIGURE 17 – AREAS SURVEYED FOR POSSIBLE MEC BY U.S. NAVY



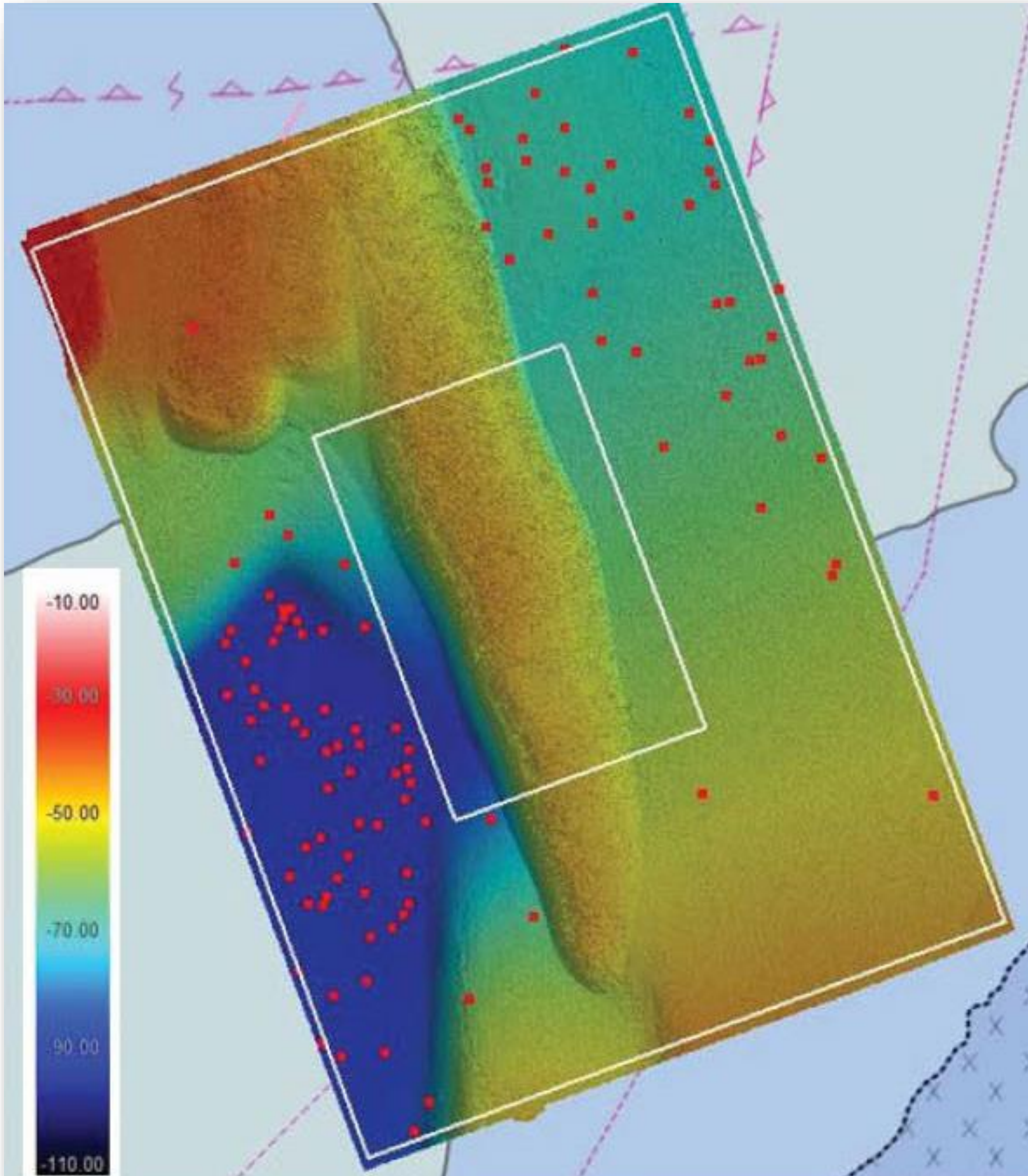
31 unknown surface objects with ferrous return were detected, 25 within inner box and 6 within outer box. Object locations shown in red.

FIGURE 18 – UNKNOWN SURFACE OBJECTS WITH FERROUS RETURN



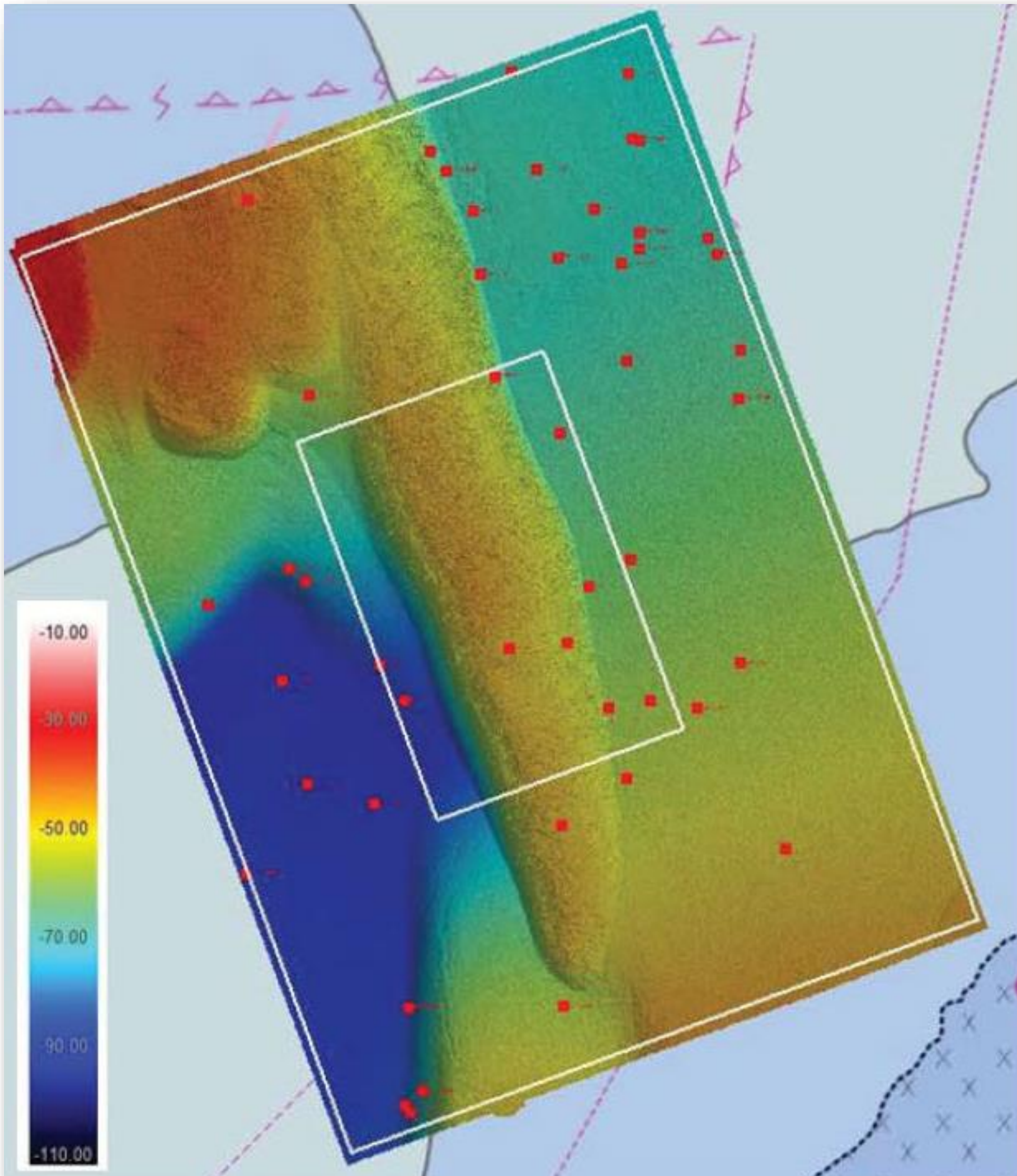
8 unknown surface objects with non-ferrous return were detected within inner box Object locations shown in red.

FIGURE 19 – UNKNOWN SURFACE OBJECTS IN INNER BOX WITH NON-FERROUS RETURN



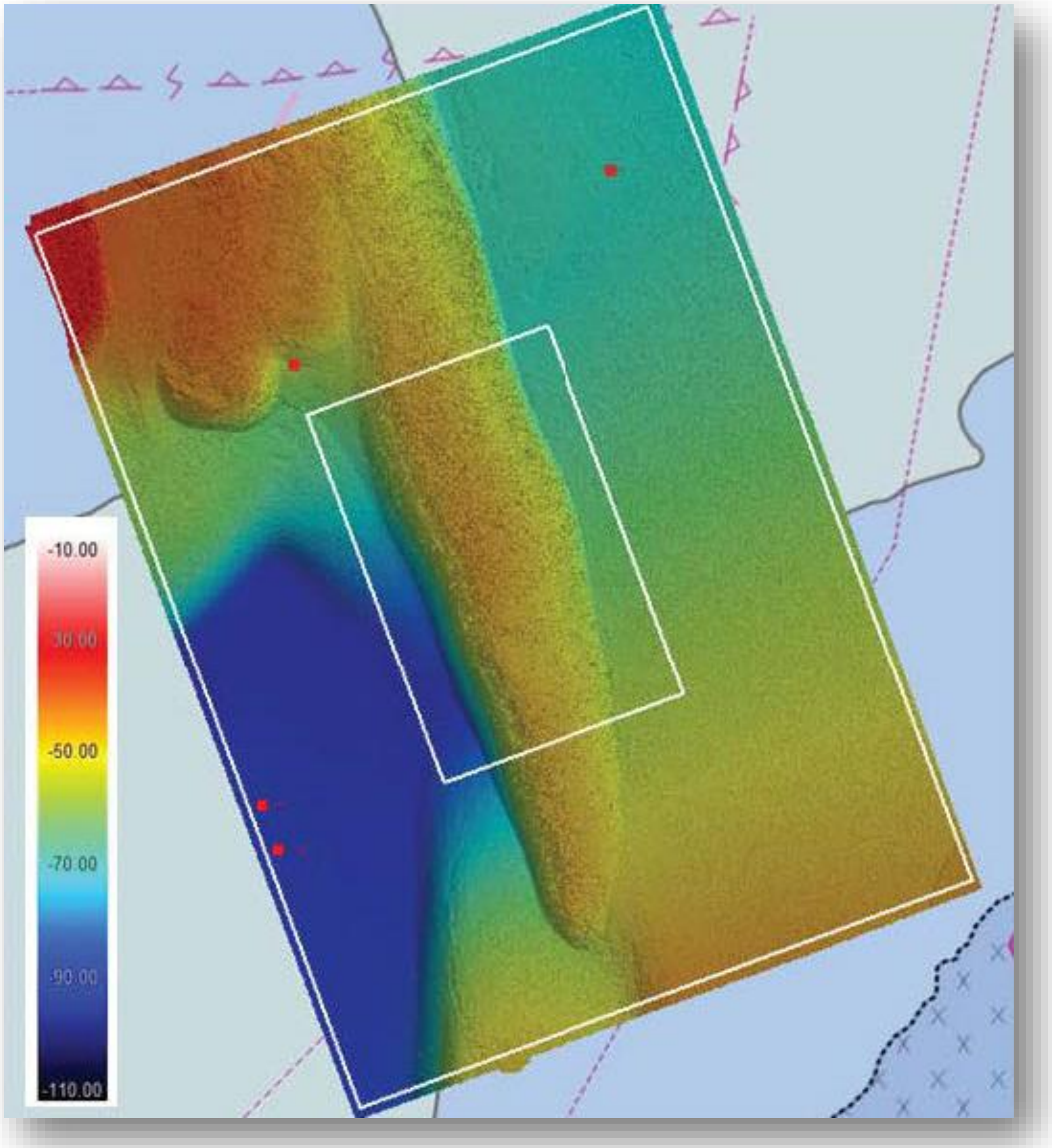
109 unknown surface objects were detected within the outer box, which cannot be classified as ferrous or non-ferrous as gradiometer was not operated within the outer box. Object locations are shown in red.

FIGURE 20 – UNKNOWN SURFACE OBJECTS IN OUTER BOX



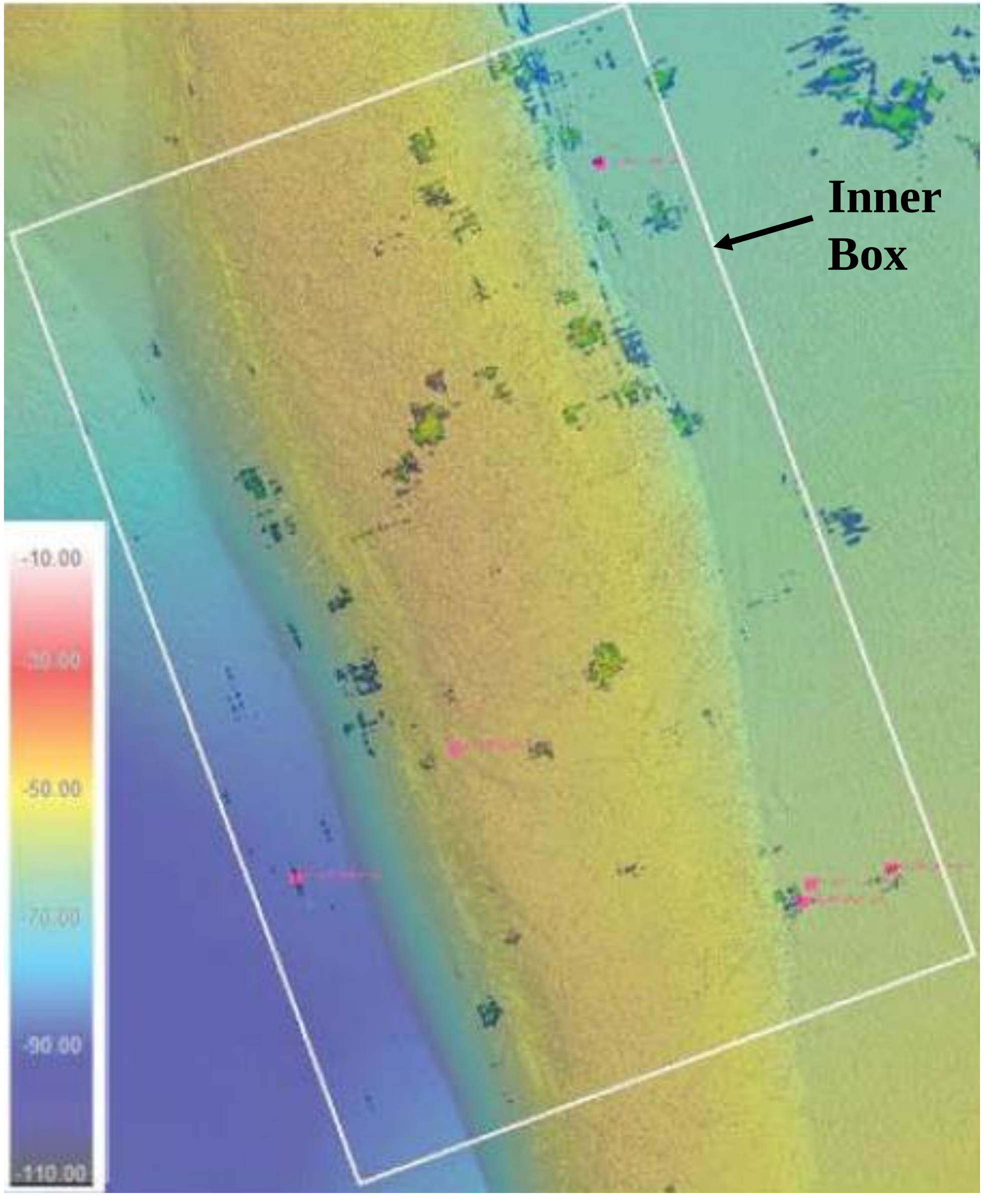
48 crab pots were identified on the seafloor within inner and outer boxes, with locations shown in red.

FIGURE 21 – CRAB POTS IDENTIFIED ON SEAFLOOR



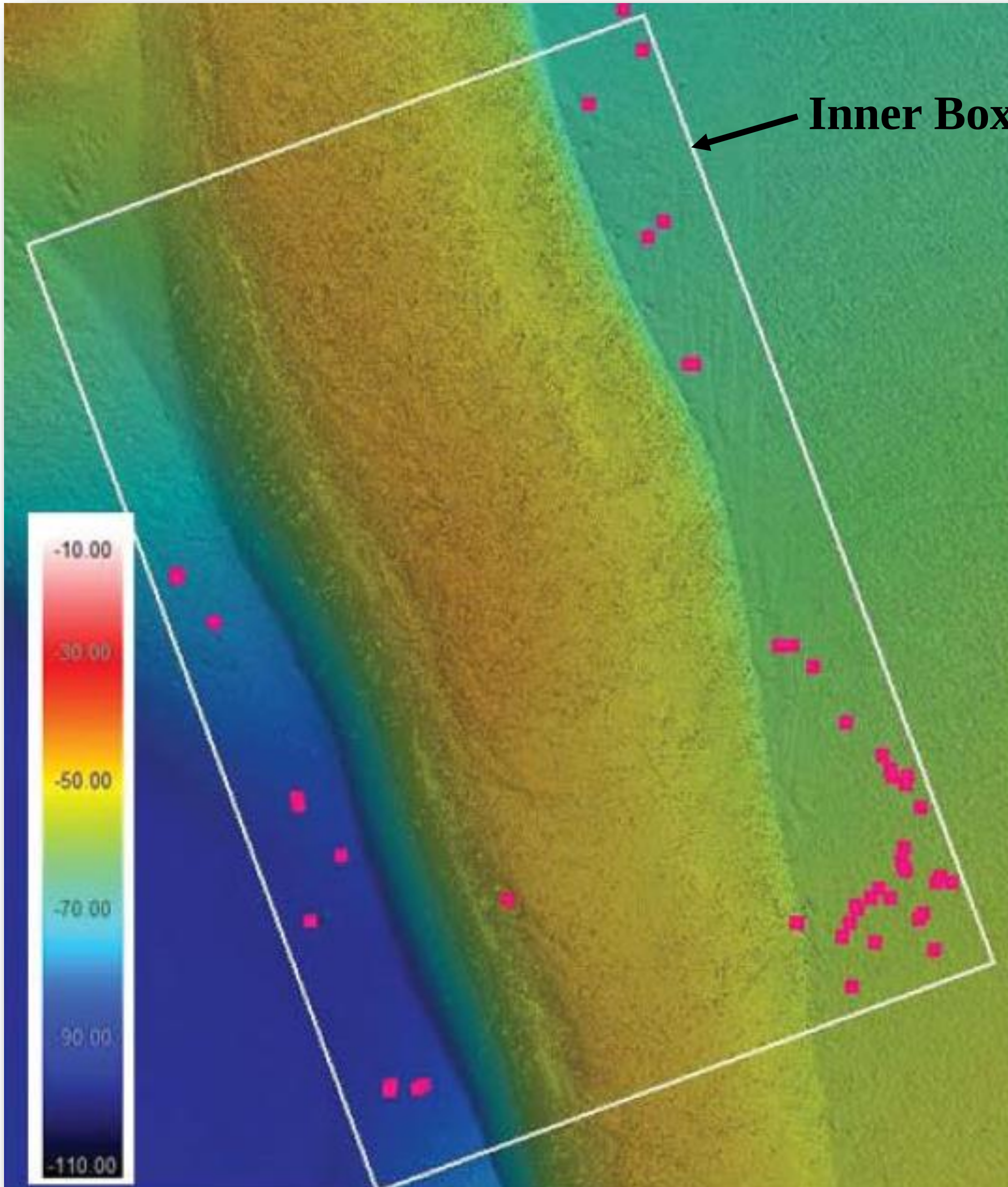
4 tires were identified on the seafloor within outer box, with locations shown in red.

FIGURE 22 – TIRES IDENTIFIED ON SEAFLOOR



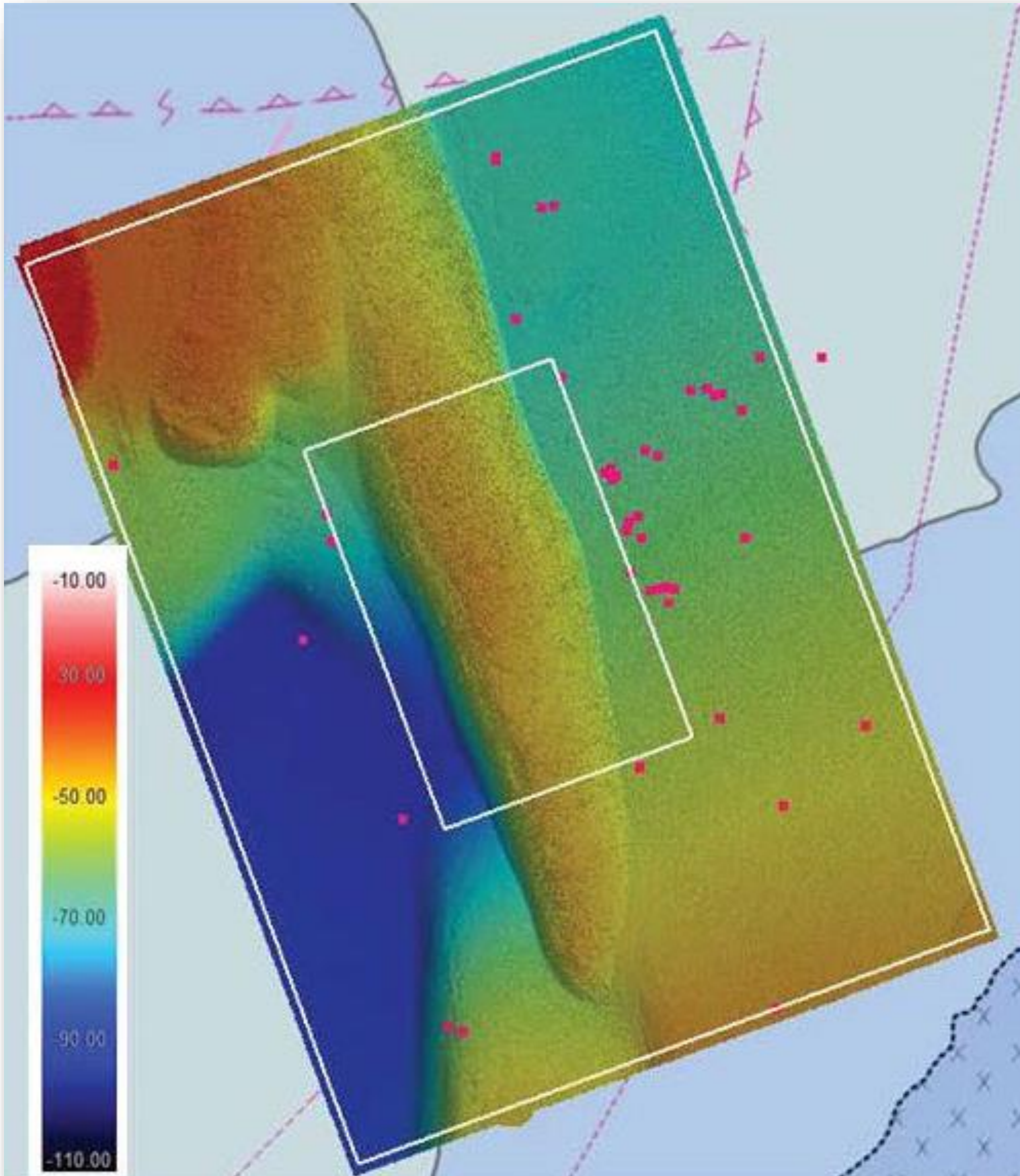
6 unknown subsurface objects with ferrous return were detected in the inner box which cannot be determined as potential UXO from the information available. Object locations are shown in red.

FIGURE 23 – UNKNOWN SUBSURFACE OBJECTS IN INNER BOX WITH FERROUS RETURN



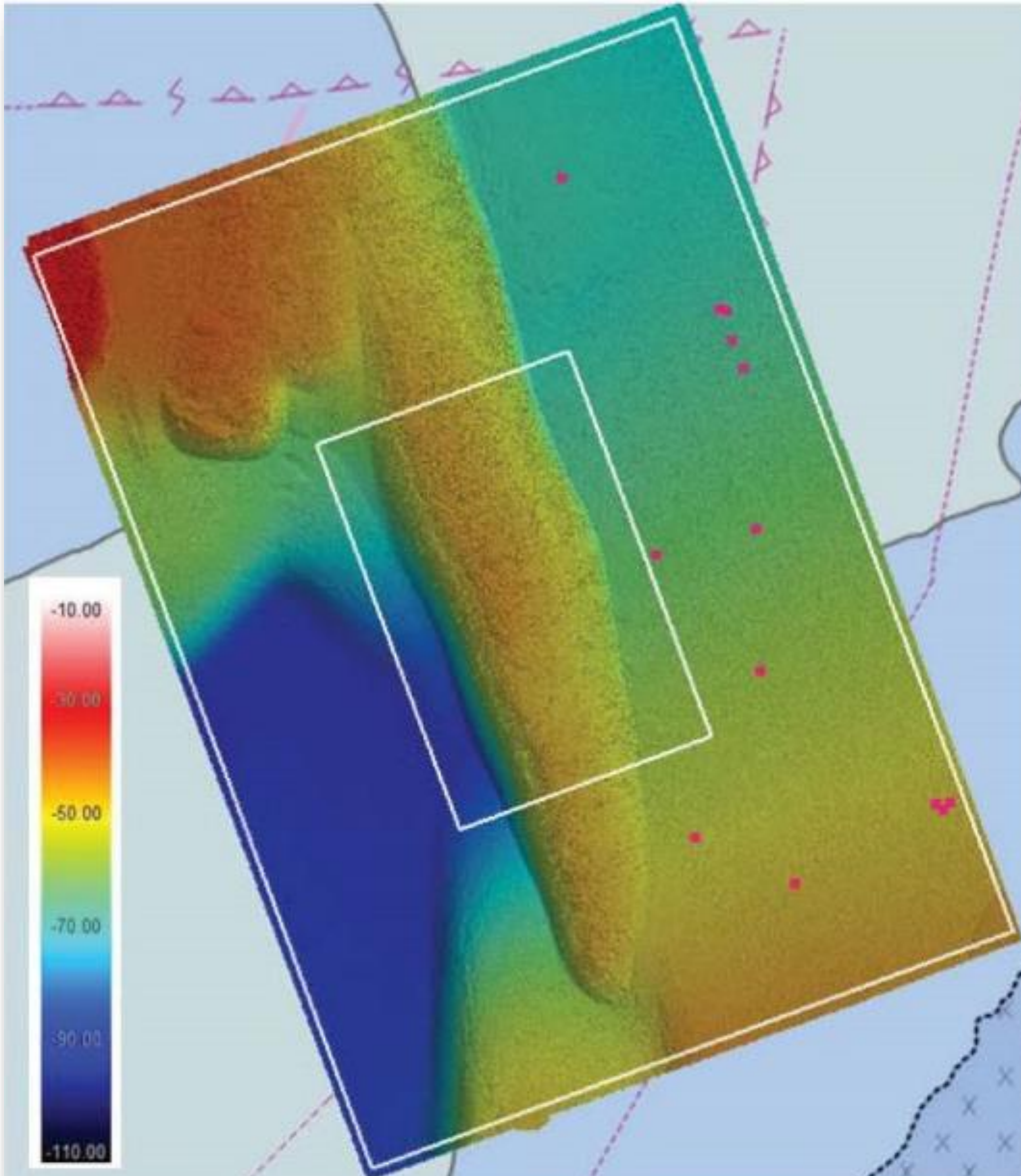
52 non-ferrous subsurface objects were detected within inner box, interpreted as boulders. Object locations are shown in red.

FIGURE 24 – UNKNOWN SUBSURFACE OBJECTS IN INNER BOX WITH NON-FERROUS RETURN



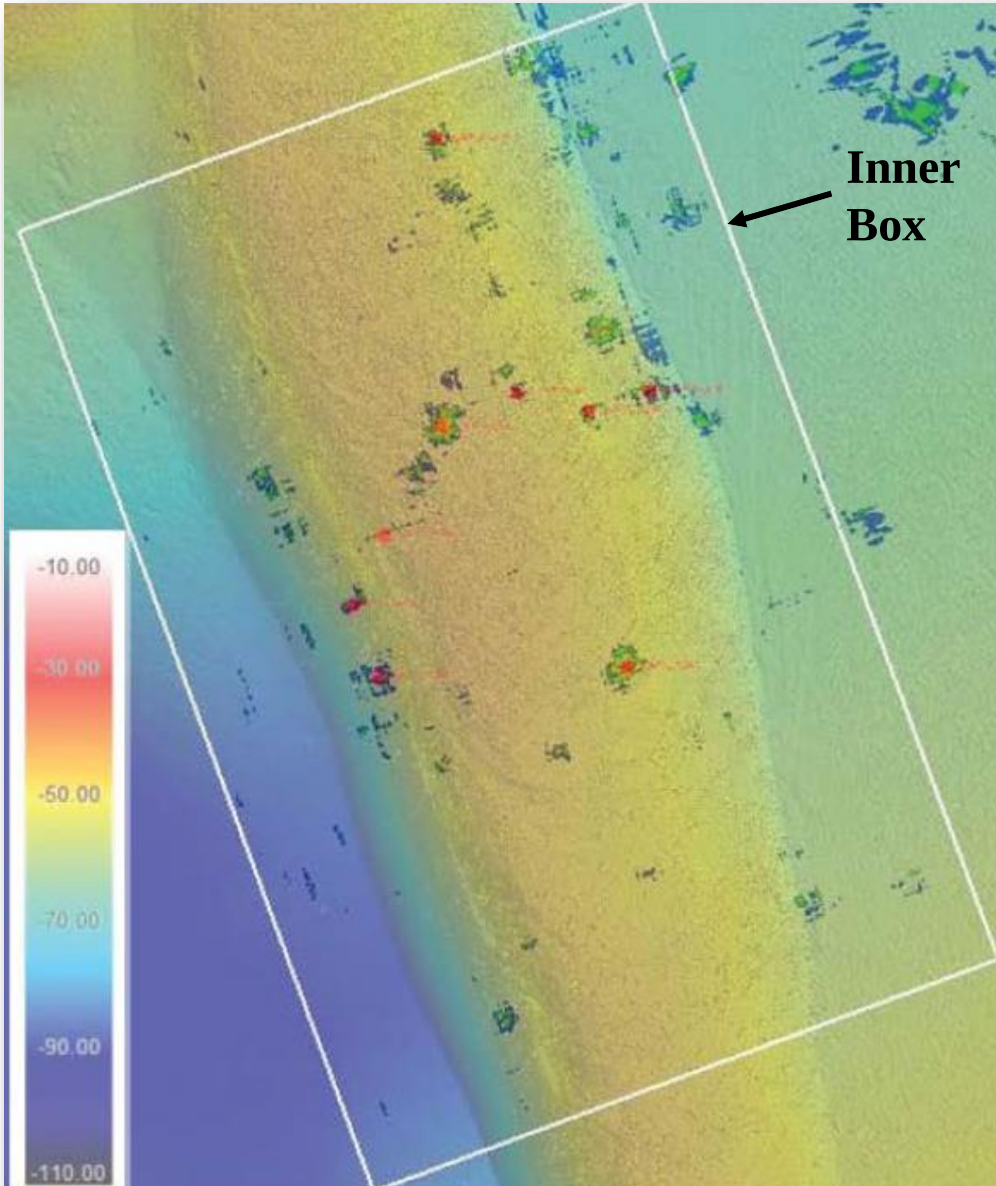
42 non-ferrous subsurface objects were detected within the outer box, interpreted as boulders. Object locations are shown in red.

FIGURE 25 – UNKNOWN SUBSURFACE OBJECTS IN OUTER BOX WITH NON-FERROUS RETURN



13 unknown subsurface objects detected within the outer box could not be determined as being either ferrous or non-ferrous, but are being interpreted as non-natural based on shallow burial, isolated position, and irregular shape. Object locations are shown in red.

FIGURE 26 – UNKNOWN SUBSURFACE OBJECTS IN OUTER BOX



9 locations within inner box have strong gradiometer returns indicating ferrous content, but could not be linked to surface or subsurface objects detected by the other geophysical survey tools. These locations are identified in red.

FIGURE 27 – AREAS OF STRONG GRADIOMETER RETURN IN INNER BOX