

**UNDERWATER ARCHEOLOGICAL &
HAZARDS ANALYSIS
REMOTE SENSING SURVEY**

**DREDGED MATERIAL MANAGEMENT
PROGRAM (DMMP)
NEW BEDFORD, MASSACHUSETTS SITE**

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EXECUTIVE SUMMARY

A focused, multi-phase marine geophysical survey of two areas of New Bedford Harbor, Massachusetts was conducted by Apex Environmental, Inc. and its subcontractors. There are two purposes of the survey; to determine the presence or absence of submerged cultural resources potentially eligible for the National Register of Historic Places; and to identify possible hazards to future dredging activities. The presence of submerged cultural resources may affect future dredging operations and harbor development including the removal contaminated sediments or hazards (natural or manmade) on the harbor bottom and the construction of the proposed Confined Aqueous Disposal Cells (CAD) in New Bedford Harbor.

The surveys covered the areas of interest using two different geophysical survey techniques: Side Scan Sonar and Magnetometer. The data was processed and interpreted by geophysicists, and potential targets, which may represent hazards to the future operations, were identified and registered on summary maps of the areas. These target summary maps, included in this report as Figure 7 for the Channel Inner Area and Figure 8 for the Popes Island North, display the locations of the potential targets identified on a basemap of New Bedford Harbor. Specific results of the processing and interpretation of the data collected by each of the two geophysical methods are presented in this report as Figures 1 through 6 and in Appendices A and B. These maps and appendices display the processed images of the data, which were used to identify potential targets and to generate the final summary maps.

Numerous targets of interest, which may represent hazards to the future dredging or construction operations were identified on the summary maps. These targets included both potentially manmade and natural objects and features. The "cultural" objects identified include: linear features which are thought to be indicative of the presence of pipes and cables; individual targets thought to generally represent stand-alone features such as mooring blocks, anchors, and miscellaneous dropped objects; and groups of targets clustered together and thought to generally represent modern vessel debris. Analysis of remote sensing data identified 43 magnetic and/or acoustic targets in the two survey areas. The vast majority of the targets appear to be isolated single source objects, modern debris, or geologically-related objects. While three of the remote sensing targets found in the Channel Inner Survey Area generated magnetic signatures suggestive of submerged cultural resources, they are located within the dredged portion of the federal channel. This indicates that the target sources are very likely modern debris since such areas are subjected to periodic maintenance dredging, as needed.

Therefore, it is recommended that an archaeological monitor be present during dredging operations to ensure that no shipwreck sites are impacted during dredge operations.

Plotting of the targets interpreted from each of the geophysical data sets on the summary maps of the harbor revealed that many of the targets were identified using both geophysical methods. This correspondence between the geophysical surveys lends confidence to the interpretations. The targets where localized Magnetic anomalies are

coincident with localized Side Scan anomalies are presumed to be either metallic or contain significant metallic parts. Objects or features, which are identified by such coincident localized anomalies, are interpreted as being manmade.

From the geophysical data collected during this study, numerous features were identified which may represent significant hazards to future dredging and/or CAD cell construction operations. None of the remote sensing targets are suggestive of submerged cultural resources. No additional underwater archeological investigation is recommended.

It is anticipated that the plans and information presented within this report will be utilized by various project stakeholders in the design of future projects at the New Bedford Harbor Site. Several of the targets identified (such as large sections of old dock), may represent significant and difficult issues for future dredging or other-project operations, and may require further investigation to determine exactly how these features may impact future operations.

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1.0 INTRODUCTION

1.1 Site/Project Location

The New Bedford Dredged Material Management Plan Site is comprised of two proposed locations in New Bedford Harbor, Bristol County, Massachusetts (see Illustration I). Popes Island North Area is located in the middle harbor north of Popes Island and the Route 6 Fairhaven/New Bedford Bridge. It is bounded on the east by the Fairhaven shoreline and extends approximately 1500' west. The western edge of the study area borders the Federal Channel at the southern portion, and bears east (away from the federal channel) at the northern portion. The Channel Inner Area lies in the main portion of the harbor and is bounded by Palmers Island to the south and the New Bedford shoreline to the west. The study area extends approximately 1500' east to the eastern edge of the main federal channel and almost 4000' north to the New Bedford State Pier. The entire study area is located within the designated federal navigation channel and associated maneuvering and 30' anchorage areas. This area has been maintained by the US Army Corps of Engineers (USACE) with dredging of portions of this area occurred as recently as 2002 (State Pier Dredge Project) in which areas of the federal channel and anchorage was dredged by the City of New Bedford to a depth below -30' MLLW.

The harbor is flanked by the City of New Bedford on the west and the Town of Fairhaven on the east. The main portion of the harbor, the area between the Route 6 Bridge and the hurricane barrier (Illustration I), is naturally deep and is the home for one of the largest commercial fishing fleets in the country. In addition to the commercial fishing vessels, hundreds of recreational sail and powerboats are seasonally berthed and moored at marinas and in the various coves that are located in New Bedford Harbor.

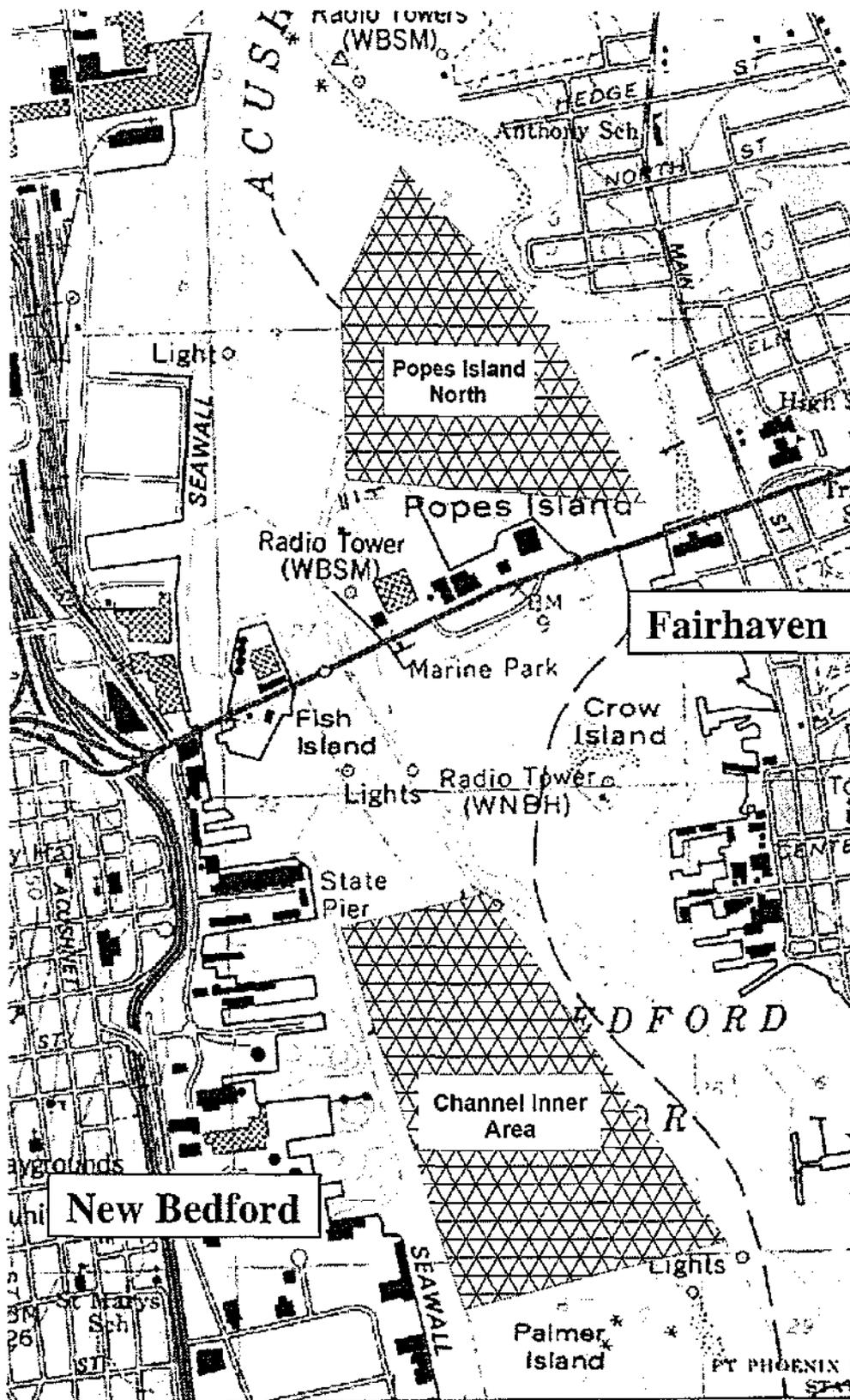


Illustration I - Overview of the Survey Area
New Bedford, Massachusetts

1.2 Project Background Information

This "Report of Marine Cultural Resources & Hazards Analysis Surveys: Side Scan Sonar, and Magnetics" was prepared by Apex Environmental, Inc. for Maguire Group, Inc. The work was completed as part of the Dredged Material Management Plan (DMMP) for New Bedford Harbor. As part of the maintenance for the Upper and Lower New Bedford Harbors it is expected that sediments contaminated with PCBs will be dredged in sections of the harbor and placed in Confined Aqueous Disposal (CAD) cells. The areas of interest for this investigation are Popes Island North and Channel Inner Area in New Bedford, Massachusetts (Illustration I).

Marine geophysical surveys were conducted at New Bedford Harbor to identify possible cultural anomalies and hazards to future dredging activities within the areas.

The information generated by this investigation represents background data that will be used for the following purposes:

- Cultural resources screening of the harbor area prior to dredging and CAD cell construction;
- Hazard/obstruction screening of the harbor areas affected by dredging and CAD cell construction;

This report presents the analysis of the geophysical data for identifying significant cultural and natural features lying on the harbor bottom that could pose an obstacle or a hazard to dredging.

1.3 Report Structure

Sections 1 through 4 will address Background information and field practices used in the collection, processing and Interpretation of data used to identify both Cultural Resources and Potential Hazards to future work. This report incorporates targets from both programs into a single set of maps (Sheets 1 to 8). Section 5 provides additional specific information on Cultural Resources. Section 6 summaries the findings and recommendations of the investigations. Section 7 presents the limitations of the program. Appendices show in greater detail the Side Scan Sonar Images. Section 8 lists the references cited throughout this report. A CD containing AutoCAD versions of the project drawings, target tables and processed datasets is included at the end of the report.

2.0 FIELDWORK INVESTIGATIONS

The following section outlines the fieldwork methodology used to acquire the geophysical data for the Cultural Resources and Hazards Analysis Survey. The geophysical methods utilized for this characterization were Acoustic (Side Scan Sonar) and Magnetometry. The Side Scan Sonar instrument creates images the surface of the harbor bottom, and the magnetometer identifies metallic objects (such as anchors, pipe, cables, moorings, or miscellaneous metallic debris) on the bottom or in the shallow subsurface.

2.1 Survey Operations

Field operations for the New Bedford Harbor Marine Geophysical Survey were conducted from October 21 through October 24, 2002. The marine surveys were conducted from a survey vessel outfitted with Side Scan Sonar and a Magnetometer. Shipboard systems were integrated with a Differential Global Positioning System (DGPS) so that the geophysical data collected from the instruments could be tagged with precise position information at regular intervals.

The survey operations were conducted with a team of Apex and specialty subcontractors onboard the survey vessels. CR Environmental, Inc. (a marine survey and equipment contractor) provided the survey vessels (including a boat captain), the DGPS system with navigation software, and the geophysical equipment (Side Scan Sonar). Dolan Research, Inc. (specialists in marine cultural resource projects) provided a magnetometer and an experienced archaeologist. Apex provided a qualified shipboard geophysicist to oversee and coordinate the collection of the marine geophysical data.

2.2 Survey Equipment

2.2.1 Survey Vessel

The principal survey vessel was the *R/V Cyprinodon*, a 32-foot aluminum workboat. This vessel was equipped with a large pilothouse for protection of the instrumentation and electronics from the elements, a hydraulic winch and A-frame for ease of deployment of equipment into the water, on-board power, and could accommodate two to three on-board scientists and boat captain required for the work.

The survey vessel was outfitted with equipment capable of producing accurate and detailed images of the harbor bottom and shallow sub-bottom. Side Scan Sonar was utilized to produce picture-like acoustic images of the harbor bottom in order to map bottom features and objects. A magnetometer was used to produce magnetic field maps of the harbor areas to detect metallic objects on the harbor bottom or in the shallow harbor sub-bottom. Both geophysical instruments were integrated with a DGPS for

accurate location referencing information. The following provides a summary of the equipment used to complete the task.

2.2.2 Side Scan Sonar

The Side Scan Sonar system used included an Edgetech TD-374 dual frequency Side Scan Sonar tow-fish matched with an Edgetech Digital Control Interface (DCI). The Side Scan tow fish was towed off a stern A-frame in the Channel Inner Area to allow flying depths of approximately 10 feet. In the Popes Island North Area the bow pulpit was utilized to accommodate the shallow water depths and to minimize wake noise. The DCI board was connected to a computerized Side Scan Sonar data acquisition and processing system for shipboard data collection and processing. Chesapeake Technologies SonarWizz software was used for digital data recording from the tow fish and integrated the data with navigation inputs for real-time viewing of the Side Scan image in pseudo-map format. The data was stored digitally for future post-processing and interpretation using Chesapeake's Technologies SonarWeb. The data was recorded and displayed as digital location-corrected pseudo-maps of the acoustic response of the harbor bottom.

2.2.3 Magnetometer

Magnetic data was collected with a Geometrics G-881 Cesium Marine Magnetometer system consisting of a high-sensitivity in-water marine magnetic sensor coupled to a digital data processing computer system running Geometrics MagSea processing software. The MagSea software was utilized to calibrate the system and to record and display the raw digital magnetic data. The G-881 system was designed for shallow water applications (<50m) and is easily deployed from small survey vessels. The magnetic sensor was deployed from the stern of the survey vessel far enough behind the vessel (~45-50 feet) to be beyond the effects of the magnetic field generated by the boat's engines and electronics. In shallow water the depth of the sensor was controlled by attaching the cable leader to a floatation device such that the swim depth of the sensor remained constant, approximately one to two feet below the water surface. This allowed for the survey to be conducted in both shallow and deep-water conditions without the risk of hitting the bottom of the harbor with the sensor. The system was set up to output the raw digital magnetic signature values to a computer screen for on-board real-time initial interpretation and to the project positioning system computer (running HYPACK software) for permanent data storage and later post-processing and interpretation. The HYPACK system logged the raw magnetic data, time stamping each reading and tagging it with DGPS navigation positions obtained from the survey positioning system. Readings were collected at a rate of once per second. The sensor tow fish "layback" was entered into the HYPACK system and the correct position of the sensor was calculated and logged.

2.2.4 Positioning System

Horizontal positioning and navigation for the project was accomplished using a Trimble Ag DGPS. The DGPS consisted of a satellite beacon and radio transmitter mounted on the roof of the vessel and the Trimble Ag processing system mounted shipboard. Satellite positioning data was logged at a rate of once per second, and differential corrections were obtained from the nearest Coast Guard Beacon and processed with the data in real-time for sub-meter position accuracy. The DGPS generated a constant stream of corrected position information which was output to all ship board systems, including the Side Scan System, the Magnetics system, and the HYPACK navigation system. The HYPACK software was utilized to store the time-tagged position data in both latitude-longitude format and in the project datum (US State Plane – NAD83, Zone - Massachusetts Mainland 2001, NGVD-29, US survey feet). The HYPACK system also provided real-time vessel position status on a helmsman's display for the running of track-lines. An outline of the harbor superimposed with the proposed data collection lines (track-lines) were entered into the HYPACK system at the start of the field program. These proposed track-lines were then retrieved onto the helmsman's display as the survey was in progress. The position of the vessel, as determined by the DGPS system, was superimposed in real-time onto the track-line layout, so that the vessel Captain could "steer-to" navigate to stay on course and run straight and accurate data collection lines.

2.3 Study Area Definition and Spacing

Marine geophysical data for this survey was collected from the two areas of New Bedford Harbor which are of interest to the project: Popes Island North and Channel Inner Area (Illustration D). Lines showing the ship's track path are superimposed onto the Magnetic Maps (Channel Inner Area - Figure 1, Popes Island North - Figure 4) generated for each area.

Prior to mobilization, a review of all available information was conducted. This review indicated that the appropriate track-line spacing for the survey was 50-feet for the collection of magnetic data and 100-feet for side scan data (due to swath data collection). The survey direction was primarily north to south, along the length of the harbor. The following number of lines and line-miles were surveyed in each of the harbor segments:

- Channel Inner: 43 survey lines (north-south), total nautical mileage of approximately 19.9 nautical miles.
- Popes Island North: 32 survey lines (north-south), total nautical mileage of approximately 11.6 nautical miles.

3.0 SURVEY PROCEDURES

3.1 Field Data Collection

Geophysical data was collected with both instrument systems (Side Scan Sonar, and Magnetometer) running concurrently. Sequencing of the work required consideration of the tide cycles. In the shallower portions of the Popes Island North Area (mostly near the Fairhaven shoreline), the survey had to be accomplished in pieces as low tides prohibited the entire area from being surveyed at one time. The field data collection occurred between October 21 and October 24, 2002. Daily equipment calibrations, and functional checks, were conducted daily with all field personal prior to starting field surveys. Operations were continuous during the day, except for minor periods of occasional equipment malfunction or loss of DGPS satellite coverage. Over the 4-day survey period over 30 nautical miles of data was collected in the two areas of interest. Water depths over the survey areas ranged from 3 feet to greater than 30 feet.

3.2 Data Processing

Initial data processing and interpretation was carried out as the survey was in progress to ensure that good quality data was being collected and that data quality objectives were being met. The initial shipboard data processing and interpretation varied between the instruments:

- Side Scan Sonar data was processed using the SonarWeb software into pseudo-map images along the data path. The initially processed data appeared as geo-referenced strip images of the harbor bottom displayed on a computer screen. The Side Scan operator would monitor the data collection at all times to ensure that the image was as clear as possible, and to make initial interpretations of the data in real-time. Targets (features of the bottom appearing as anomalous from the rest of the data) were "captured" digitally by the operator using the computerized target capture feature, and were cataloged and stored for later post-processing and enhancement. The Side Scan data was also stored digitally for later post-processing and more intensive interpretation.
- Magnetic data was initially processed in the field by the Edgetech MagSea system. Uncorrected magnetic data was then displayed on a computer screen in cross-sectional form so that the magnetometer operator could make observations concerning the data stream as it appeared on the screen. The magnetometer operator noted and cataloged any significant raw magnetic anomalies (deviations of the magnetic signal from background) identified as the survey was in progress. The magnetic data was also stored digitally for later post-processing and more intensive interpretation.

The initial interpretations of the data made in the field were utilized by the field team to continually assess the data collected and make minor modifications to the field program

in order to ensure the highest possible data quality. Both the initial field interpretations and the raw field data were brought into the office for further post-processing and interpretation upon completion of the survey.

Complete data processing and interpretation was carried out by Apex geophysicists and Dolan Research, Inc. archaeologists. The geophysical data required extensive computer reduction prior to interpretation. The basic processes for reduction of the digitally recorded data are summarized in the sections below.

3.2.1 Magnetism

The magnetic data collected in the field was stored on the navigation system computer in a HYPACK file. The data consisted of the x and y positions of the magnetic sensor, the total field magnetic reading (once per second), and the time that each reading was collected. Because the magnetic field of the earth (which is the parameter measured) varies with time and location, a series of corrections must be made to the raw field data before it can be displayed in map form and contoured. The following steps were involved in the processing of the magnetic data:

- Data files for each survey area were checked for proper geometry and recording interval and any lines corrupted by equipment malfunction or prematurely aborted were weeded out. Coordinate transformations, if necessary, were performed, and position "outliers or fliers" were removed from the data sets.
- A file of magnetic (diurnal) corrections was constructed using data from a magnetic base station that was operating during the field program and data from a U.S. Geological Survey Magnetic Recording Station. The corrections file was time-tagged for later merging with the raw data file from the survey.
- The position-corrected raw data was then merged with the file of magnetic corrections. This was accomplished by matching up the time-tag for each element of the two data sets. The result of the merging of the raw data and corrections was the creation of a file containing the corrected magnetic measurement data for the survey.
- The corrected data set (x, y position, raw and corrected magnetic reading) was then input into Geosoft's Oasis Montaj data processing software. Montaj creates maps of the magnetic readings, grids the data set, and produces a color-coded contour map of the magnetic intensity readings of the survey areas for interpretation.
- Filtering and data manipulation was performed to enhance any anomalies present in the data sets. Targets/anomalies within the data set were then identified by an experienced geophysicist.
- Once the interpreter was satisfied that all anomalies were identified, a target list was generated consisting of x and y positions in the project datum. This

target list was output as a data table for inclusion in this report and as a DXF file for the plotting of a Target Location Plan on the project base map of the harbor.

3.2.2 Side Scan Sonar

The Side Scan data collected in the field was stored as raw data for post-processing. The data was merged with the position data in real-time as the data was collected, so that position-corrected strip images of the bottom were also created in real-time. These strip images are gray tone representations of the strength of the returned acoustic signal from the bottom as the survey was in progress. The Side Scan data files were further processed in the office to enhance the image quality, and mosaic images were created by digitally pasting together the strip images into a pseudo-map of the entire harbor bottom. The following steps were involved in the further processing and interpretation of the Side Scan data:

- All of the Side Scan data files were played back using the Sonar Web software in the office by an experienced geophysicist. The images were "cleaned up" by playing back the data using optimal imaging parameters to create as accurate an image as possible.
- Targets were identified through visual assessment by an experienced geophysicist of the replayed, enhanced strip images. The target images were then "captured" and output to an image enhancement program for final presentation and hard-copy printing.
- A "Side Scan mosaic" was then created by taking all of the Side Scan strip images from each area and merging them together into a single map. One mosaic was generated for each of the areas surveyed.
- The resulting position-corrected Side Scan Mosaic for each area was then output as a geo-referenced image "GeoTIF" file and was overlain on the project standard survey maps of the harbor edge, thus generating an acoustic map image of the harbor bottom features referenced to the shoreline.

Finally, an output file of the locations of all of the targets identified from the Side Scan data interpretation was created for inclusion in the text of this report. A "DXF" file of the target locations was also generated and overlain, along with the magnetics data, on the base map for the project.

3.3 Interpretation Techniques

Preliminary analysis and interpretation of the geophysical survey information was performed each day in order to plan the remaining work or modify the survey program in specific areas. The objective of the data analysis and interpretation phase was to characterize the responses from the geophysical data in terms of their most probable

sources (i.e., rock, buried object, pipe, cable, etc.). An integrated approach to the analysis and interpretation phase was implemented for this project, in which targets and features detected by Magnetic and Side Scan imagery were collectively interpreted. This strategy allowed targets and features detected by both instruments to be more accurately characterized in terms of depth and probable source. The magnetic and Side Scan data was also analyzed and interpreted in concert with the historic structure pattern and lithologic and geotechnical sampling data existent for the harbor.

Experienced geophysicists identified target and feature responses within the data and generated color-coded maps and target anomaly lists of the geophysical anomalies. The software used for the processing, analysis, and interpretation of the magnetic data was Oasis Montage, a geophysical data analysis program developed by Geosoft, Inc. Montage allows intensive mathematical and statistical analysis of geophysical data. The Side Scan data was analyzed on an office based PC using the software SonarWeb for post-processing and data enhancement. Representative symbols of the targets or features of interest were transcribed onto a summary plan map of the Site.

4.0 ANALYSIS OF REMOTE SENSING DATA

Analysis of remote sensing signatures identified during the survey was based on several criteria. Magnetometer data were contour plotted and each anomaly was analyzed according to: magnetic intensity (total distortion of the magnetic background measured in nanotesla-nT); pulse duration (detectable signature duration); signature characteristics (negative monopolar, positive monopolar, dipolar, or multi-component); and spatial extent (total area of disturbance). Acoustic targets were analyzed according to their spatial extent (total area of disturbance), signature characteristics (shape, relief above the bottom, strength of return and contrast with the background) and environmental context.

Criteria for analyzing remote sensing targets have been developed from a database of target signatures that have been compiled over the last three decades. Starting in the 1960s, archaeologists primarily relied on magnetic remote sensing data, collected with proton precession magnetometers, to locate submerged cultural resources. However, magnetic data collected alone often provides inconclusive evidence on submerged cultural resource sites. Underwater archeological research conducted over the last two decades indicates that shipwreck sites may produce a variety of magnetic signatures. Furthermore, modern debris often generates magnetic signatures that may share similar characteristics with certain types of shipwreck sites.

The ambiguous nature of magnetic signatures has led researchers to use acoustic and occasionally sub-bottom remote sensing equipment in conjunction with a magnetometer on most underwater archeological surveys. Side-scan sonar units gather acoustic data by processing sound waves emitted into the water column on both sides of the submerged sensor. The sound waves are then bounced back off the bottom surface and exposed objects. State of the art digital sonar units produce high-resolution records that are almost photographic in quality. However, a certain degree of structural integrity of a shipwreck site must remain above the bottom to produce a reliable shipwreck signature on side scan sonar. Where no structure survives above the bottom surface, researchers must rely on magnetic data to help locate shipwreck remains. Additional data provided by acoustic instruments frequently permits target identification to be made solely from remote sensing information. A combination of magnetic and acoustic remote sensing data has proven to be the most effective method to accurately identify and assess submerged archeological sites. Typically, the most attractive targets produce both a defined magnetic and acoustic signature.

In preparing the technical report, remote sensing targets were characterized according to potential significance. Target locations that generated signature characteristics suggestive of submerged cultural resources were designated as High Probability Targets. All other targets, including single source objects and modern debris, were simply listed as targets. Additional underwater archeological investigations were recommended at the former type of targets.

It must be noted that the entire Channel Inner Area is located within the federally maintained 30' channel MLLW. All targets found within this area were considered debris-related.

4.1 Findings of Remote Sensing Survey

Analysis of the Acoustic and Magnetics data collected during this phase of the geophysical work was completed by Apex geophysicists and the results are summarized on the Geophysical Target Summary Plan Maps presented as Figures 7 and 8 of this report. These plans were generated in order to provide easy and rapid reference and location information on all of the targets identified as a result of the analysis of the both data types.

The targets identified from the data sources fall into two primary categories:

- Those objects or features which appear to be of cultural origin (manmade); and
- Those objects or features, which are natural.

The “natural” objects are thought to consist primarily of large boulders either resting on the harbor bottom or buried in the shallow sub-bottom.

The “cultural” objects identified were of several different types. Linear features are thought to consist mostly of pipelines and cables. Individual targets are thought to generally represent stand-alone features such as mooring blocks, anchors, and miscellaneous dropped objects.

The remote sensing survey identified 43 targets, of them 20 were magnetic and 18 acoustic with 5 having both an acoustic and magnetic signature. The Channel Inner Area had 13 magnetic targets and 17 acoustic targets identified in the survey area. Of these targets identified 2 targets were recorded as coincident targets that possess both a magnetic and an acoustic signature. Appendix A has enlarged images of each of the Side Scan anomalies identified in the Channel Inner Area. The Popes Island North Area had 12 magnetic targets and 6 acoustic targets identified. Three of these targets were coincidence magnetic and acoustic anomalies. Enlarged Side Scan Sonar images identified in the Popes Island North Area can be seen in Appendix B.

Examination of the remote sensing data found no clear evidence of targets in either survey area that would be considered suggestive of potentially significant submerged cultural resources. While no additional underwater archaeological investigations are recommended, an archaeological monitor should be present during dredging operations to ensure no archaeological site are encountered during dredging operations.

The following tables in this section summarize the various anomalies identified for the Cultural and Hazards Analysis. Each of the anomalies will be further described in the following chapters.

Table 1. Channel Inner Area – Side Scan Sonar Targets

Side Scan Target ID	X Easting	Y Northing	Image Size (ft)	Image Characteristic	Associated Magnetic Signature/Target ID
C6-1	815825	2690708	6' x 3'	Debris	Small magnetic signature
C8-1	816258	2689933	<3'	Multiple Rocks	-
C12-1	816365	2690168	<4'	Rocks	-
C18-1	816449	2690409	4' x 6'	Channel Marker	Magnetic signature
C20-1	816822	2690147	20'	Two Pipes/Debris	Magnetic signature
C24-1	817016	2690424	6'	Rocks	-
C29-1	817271	2690460	10'	Rocks	-
C31-1	817408	2690383	10'	Rocks	-
C31-2	817203	2690719	4' x 6'	Channel Marker	Magnetic signature
C33-1	816579	2692460	35'	Section of Dock or Railing	Magnetic signature
C37-1	816881	2691984	25'	Wooden Pile	-
C35-3	817261	2690931	<3'	Area of Rocks	-
C37-2	817581	2690537	<3'	Multiple Tires/Debris	CM-2
C39-1	816841	2692258	20'	Pipe/Debris	CM-12
C39-2	817091	2691809	30'+	Cabling	Small magnetic signature
C39-3	817181	2691592	4' x 7'	Tires/Debris	CM-11
C41-1	817838	2690646	<16'	Multiple Tires/Debris	Small magnetic signature

Table 2. Channel Inner Area – Magnetic Targets

Magnetic ID	X Easting	Y Northing	Anomaly Characteristic	Anomaly Size (nT)	Comments	Side Scan Target ID
CM-1	816030	2690989	dipole	24	Anomalies seen across several lines up to 23 fiducials long. Anomalies extend to CM-7	-
CM-2	817685	2690538	positive monopole	21	small anomaly, 6 fiducials, seen across 3 lines associated with debris	C37-2
CM-3	816580	2690950	positive monopole	50	intense short anomaly seen across two lines (20 fiducials)	-
CM-4	817475	2691191	dipole	89	broad intense anomaly across 2 lines (40 fiducials)	-
CM-5	817193	2691224	positive monopole	39	intense anomaly, 20 fiducials	-
CM-6	817024	2691336	dipole	46	anomaly, 27 fiducials, seen across multiple lines	-
CM-7	816217	2691067	dipole	24	medium intense anomaly, 10 fiducials possibly associated with CM-1	-
CM-8	817083	2691928	positive monopole	56	medium intense anomaly, 12 fiducials, seen across 3 lines	-
CM-9	815631	2691940	positive monopole	30	intense med/large anomaly, 20 fiducials seen across 3 lines	-
CM-10	816264	2690629	dipole	46	large broad anomaly 35 fiducials, possibly a geological effect	-
CM-11	817202	2691515	multi component	19	small anomaly greatly influence by nearby anomaly	C39-3
CM-12	816902	2692251	positive monopole	60	Character influenced by nearby anomalies	C39-1
CM-13	816727	2691385	negative monopole	38	small anomaly seen over 16 fiducials, seen across a single line	-

Table 3. Popes Island North – Side Scan Sonar Targets

Side Scan Target ID	X (Easting)	Y (Northing)	Image Size	Image Characteristic	Associated Magnetic Target
P4-1	815854	2695524	10' x 4'	Debris	Small magnetic signature
P4-2	815720	2695563	60'	Possible Pipe	PM-4
P8-1	816370	2695103	<3'	Multiple Rocks	-
P13-1	815591	2696601	20' x 3'	Debris	PM-6
P22-1	816424	2696140	26'	Possible piling	-
P24-1	817257	2695397	5'	Rocks w/relief	-
P24-2	817184	2695448	5'	Rocks w/relief	-
P26-1	816293	2696661	8' x 4'	Possible sunken wooden boat	-
P28-1	817014	2695934	12'	Debris	PM-1
P28-2	816403	2696829	5'	Rocks	-
P30-1	816345	2697039	<3'	Multiple Rocks/tires/small Debris	-
P30-2	817583	2695503	10'	Rock	-

Table 4. Popes Island North – Magnetic Targets

Magnetic ID	X Easting	Y Northing	Anomaly Characteristic	Anomaly Size (nT)	Comments	Side Scan Target ID
PM-1	817009	2695936	dipole	34	short slight anomaly (6 fiducials), probable small metallic debris	P28-1
PM-2	816499	2695362	monopole	101	medium intense anomaly, 18 fiducials	-
PM-3	816132	2695638	monopole	140	large intense anomaly, 21 fiducials, seen across 3	-
PM-4	815718	2695565	dipole	680	large broad anomaly seen across 5 lines, associated with side scan image. Nearby moored barge may have influenced or altered the anomaly	P4-2
PM-5	815554	2696489	monopole	57	small intense anomaly, 12 fiducials	-
PM-6	815627	2696592	monopole	57	large intense anomaly, 26 fiducials associated with debris side scan	P13-1

4.2 Side Scan Sonar

Composite mosaic images for each of the areas of interest are presented as Side Scan Mosaics on Figures 3, (Channel Inner Area), and Figure 6 (Popes Island North Area).

Because the objects and features of interest to this project are relatively small compared with harbor plan maps, and are difficult to pick out in any detail from the mosaic maps, enlarged “blow-up” images of all of the relevant targets identified from the Side Scan data are included in Appendix A and B. These blow-ups indicate in some detail the nature of many of the objects identified from the Side Scan data and are described below.

4.2.1 Channel Inner Area

- The survey area revealed many areas of rocks (C8-1, C24-1, C29-1, C31-1, C35-3), which could be indicative of a shallow bedrock surface. Some of the rocks imaged (C29-1 and C1-1) are large in size and show relief indicating that they protrude from the harbor bottom.
- Image C6-1 shows a very strong acoustic return from a square object with a small associated magnetic anomaly. This is interpreted to be a wooden object with a small amount of metal.
- C18-1 and C31-2 are aids to navigation (Federal Channel markers) and were used as QA/QC checks in the field and through out the processing and interpretation phases.
- Two images shown are indicative of metallic pipes (C20-1 and C39-1) approximately 20' in length with associated magnetic signature.
- Image C37-1 has similar characteristics to the pipes (C20-1 and C39-1) but has no associated magnetic signature indicating that it could be a possible wooden piling. The image is approximately 25' long and is seen protruding off the harbor bottom.
- Image C33-1 has a definite structure and relief off the harbor bottom. This is interpreted to be a large piece of debris 5' x 35' and is thought to be a section of dock or railing since several similar sections of dock have been removed from the harbor in the vicinity of this target. There is a small coincident magnetic anomaly with this object possibly from the metallic fasteners used to secure the timbers together.
- Images C37-2, C39-3 and C41-1 show collections of debris including miscellaneous metallic items and tires. There are variable magnetic responses to these areas of debris and could indicate the presence of a large amount of metallic items.

- Image C39-2 shows a possible metal cable over 30' in length. There is a slight magnetic response.

4.2.2 Popes Island Area

- Two possible small wooden dinghies were imaged (P4-1 and P26-1). Target P4-1 has a corresponding small magnetic anomaly associated with it.
- Image P4-2 shows a possible pipe approximately 60' in length with a strong corresponding magnetic signature.
- Images P8-1, P24-1, P24-2, P28-2, P30-1 and P30-2 show collections of small rocks (less than 5').
- Two images (P13-1 and P28-1) are large pieces of metallic debris approximately 12' and 20' in length respectively. P13-1 is a rectangular object, approximately 12'X3' with a small debris field clustered nearby. P28-1 is a linear object, 12' long with a hinged piece at one end of the object. They both have large magnetic anomalies associated with them.
- Image P22-1 is a linear object 26' long that is likely a wood piling or timber (no associated magnetic signature).

4.3 Magnetics

Color Contour maps of the magnetic data are presented as Figures 1 & 2, and 4 & 5 in the figures section of this report. Figure 1 and 4 depict the Total Magnetic Intensity (TMI) in the Channel Inner Area and the Popes Island North Area, respectively. The maps display the raw (diurnally corrected) data and illustrate the broad larger trends, which tend to mask the smaller anomalies of interest. From this data the change in TMI is calculated and displayed as a color coded image with 2nT contours (Figures 2 and 5). These maps better depict the smaller anomalies and are used as the main magnetic interpretive tool in conjunction with the TMI maps. The magnetic maps display the data as color-coded magnetic intensity: magnetic highs are displayed as oranges, reds, and pinks; while the magnetic lows are depicted as blues, with greens acting as neutral. TMI maps of both areas show strong geological (long wavelength) anomalies or effects from possible undulating bedrock. The trends of these geological anomalies are predominately northeast – southwest trending and can complicate or alter smaller subsurface anomalies of interest to this report.

Potential anomalies were picked by experienced geophysicists utilizing the mapping software, Oasis Montaj. Targets were generally identified by picking anomalies that displayed a significant and localized shift in magnetic intensity from the background data. In particular, anomalies with localized extreme magnetic highs, extreme magnetic

lows, or coupled highs with lows adjacent to one another were interpreted as being indicative of a magnetic target. Anomalies depicted by a cross on figures 2 and 5 indicate an anomaly caused by a surface mooring or boat as observed and noted in the field. Due to the mooring field located north of Popes Island a significant number of anomalies are identified as being moorings. Additional small anomalies in this area are due to sunken moorings.

4.3.1 Channel Inner Area

Due to the sensitivity of the instrument various surface metallic objects and shoreline structures can cause anomalies and are depicted by a cross symbol on Figure 2. At the southern portion of the survey area many magnetic anomalies can be seen and are probably due to shallow bedrock combined with shallow water depths allowing the sensor very close to the harbor bottom.

- CM-1 and CM-7 may be associated with multiple dipole signatures across 5 lines indicating the presence of a possible subsurface pipe or cable.
- CM-2 is a small anomaly associated with an area of debris seen in the Side Scan Target C37-2.
- CM-3 is a moderate anomaly seen across 3 lines probably associated with cable in the subsurface. CM-5 and CM-6 are similar type anomalies possibly enhanced by the geologic feature. While all three generated well-defined magnetic signatures, they are located within the federal channel that has been dredged to a 30' depth. They are not considered to be associated with an historic site.
- CM-10 is a medium intense broad anomaly that could be associated with geological effects or a large deep anomaly.
- CM-11 is a small anomaly, which is distorted by the nearby drilling barge. The anomaly is associated with Side Scan target C39-3 (collection of small metallic and non-metallic modern debris)
- CM-12 is a medium anomaly associated with Side Scan target C39-1 and is a possible metallic pipe/pole.
- CM-13 is a small negative anomaly possibly due to a change in survey boat speed when the data was collected. The anomaly can only be seen across a single line.

4.3.2 Popes Island North Area

Due to the sensitivity of the instrument numerous surface objects and shoreline structures cause anomalies especially within the mooring field. Anomalies caused by boats and moorings are noted as a cross on Figure 5.

- PM-1, PM-4 and PM-6 are anomalies associated with modern debris, as seen in the associated Side Scan Images.
- PM-2, PM-3 and PM-5 show a similar magnetic signature to the moorings in the area. It is suspected that this anomaly could be due to a sunken mooring or mooring anchor.

5.0 CULTURAL RESOURCES PROGRAM

5.1 MARITIME HISTORICAL OVERVIEW

5.1.1 Methodology

Prior to conducting fieldwork investigations, background research was undertaken to develop a generalized historic maritime context of the New Bedford Harbor for evaluation of potential historic submerged sites. However, much of historical research that follows was initially collected and submitted for a very similar study was completed in 2001 (Cox, 2001).

In addition to inspecting primary and secondary historical data, background research efforts included a records check for known archeological sites and National Register properties in the New Bedford project area and vicinity, and a review of Massachusetts state underwater archeological site files and prior technical reports.

While the emphasis of background research focused on maritime activity in the New Bedford Harbor, a broad-based historic overview was essential for providing the proper framework for assessing the potential significance of submerged cultural resources. Historic maps, secondary and primary shipwreck lists, primary historical accounts, newspapers, and county and thematic histories helped to identify a set of expected resources in New Bedford Harbor. During the course of background research staff contacted local archaeologists, watermen, avocational historians, and interested laypersons who may possess knowledge of the harbor area. Project staff also visited local and county libraries and historical societies. Site-specific research, pertaining to individual vessels was reviewed at Peabody Essex Museum, Salem, Massachusetts; New Bedford Whaling Museum, New Bedford, Massachusetts; and Independence Seaport Museum, Philadelphia, Pennsylvania. At each repository, computer indexes were inspected for references to specific ship-types, and maritime activity in and around New Bedford. In addition, sources were checked for data concerning potential shipwreck sites in New Bedford. Primary and secondary sources for shipwreck sites were also accessed during the collection of background data.

Information gathered during the background research was used to generate a framework for the project vicinity. The historical framework identified types of resources that may have been deposited in the New Bedford Harbor vicinity, and to determine the nature and extent of subsequent activities that may have removed or disturbed such resources. Each target or site identified during the fieldwork was analyzed and evaluated for potential historical significance within the context of this framework.

5.1.2 Maritime Historical Overview – New Bedford Harbor

Europeans first documented the Acushnet River and vicinity in 1602 when Englishman Bartholomew Gosnold, aboard the bark *Concord* sailed into the region after sailing from Falmouth, England (Baker, 1980). However, the first permanent European settlement in the study area did not start until 1652 when settlers from Plymouth bought the land presently encompassing Dartmouth, New Bedford, Fairhaven and Westport. New Bedford was part of Dartmouth until the old township was divided in 1787. Fairhaven and New Bedford remained as one township until 1812 (Ricketson, 1858). New Bedford's spacious and naturally deep harbor became an ideal location for the development of the fisheries industry. Whaling soon became the primary industry in New Bedford and Fairhaven. The first whalers in the colonies left from Nantucket and New Bedford as early as 1690.

The country's whaling fleet initially centered on Nantucket Island, began to consolidate on the mainland at and around New Bedford after the Revolutionary War. In 1765, there were only two or three small vessels employed in the whale fishery at New Bedford. In that year, Joseph Russell operated the sloops *Nancy*, *Polly*, *Greyhound*, and *Hannah* (all between 40 and 60 tons) in the local whaling industry. Other boats built and operated by Mr. Russell include; *Joseph & Judith*, *Patience*, *No Duty on Tea*, *Russell*, and *Rebecca*. Russell was instrumental in founding the town of New Bedford to serve as homeport for his growing fleet of whaling vessels. As the principle landowner, Russell had designed the town from the start to be a whaling center. In sub-dividing and selling off his tract, Russell provided sites for shipwrights, boat builders, blacksmiths, coopers and other artisans essential to the fishery industry. (Kugler, 1980). Other notable early vessels launched at New Bedford include the merchant vessel *Dartmouth*. She was owned by Francis Roth and later became one of the vessels involved in the Boston Tea Party demonstration in Boston Harbor (Ricketson, 1858).

Another prominent family associated with the formation of New Bedford was the Rotch family. Joseph Rotch and his sons, initially of Nantucket, moved to New Bedford in 1767. They soon became the leading whaling merchants in the colonies. In 1768, Rotch also built New Bedford's first candleworks (Kugler, 1980).

By 1775, almost 50 boats were involved with the expanding whaling industry. However, the British destroyed the eighteenth century whaling industry in Massachusetts during the Revolutionary War. Almost the entire whaling fleet of New Bedford was wiped out during the Revolution: only four or five ships remained out of 200 sail before the war; the rest were lost, buried or captured (Morisson, 1921).

New Bedford was active during the Revolutionary War. Early in the war, New Bedford and Fairhaven inhabitants constructed a fort on the east side of the Acushnet River at Nobscot. Many privateers were fitted out of Boston and Providence, and many of the prize vessels they captured were sent to New Bedford. Once the British discovered the town was stored with prize goods of every description, Sir Henry Clinton dispatched an expedition under the command of General Gray. On September 5, 1778, a British fleet

that consisted of 32 vessels, the largest of which was a 40-gun ship, entered Clark's Cove and formed a bridge of boats to the shore. Approximately 4,000 or 5,000 British soldiers and sailors landed at New Bedford to destroy the vessels in the harbor. Local resident, Mr. Gilbert Russell listed 34 ships that the British destroyed: seven ships, one barque, one snow, eight brigs, seven schooners, and 10 sloops (Russell, cited in Ricketson, 1858).

After the war, the whaling industry slowly revived. It took several years after the peace before any vessels were fitted out in New Bedford. In 1787, there was only one ship (180 tons) and 2 or 3 brigs in the business; but soon after this period the whaling industry revived (Ricketson, 1858). In the last decade of the eighteenth century, both New Bedford and Fairhaven competed with Nantucket and began their rise to world prominence in the whale trade. In 1789, more than 100 whaling vessels operated out of Massachusetts, mostly from Nantucket and New Bedford. In the 1790s New England whalers headed into the Pacific Ocean for the first time. Related maritime industries sprung up in New Bedford, and particularly Fairhaven, in support of the whaling industry, including shipbuilding, ropewalks, and candle factories.

In addition to whaling, merchants also began to ship cargo out of New Bedford after the Revolutionary War. In 1802, some 20 square-rigged merchantmen were sailing from New Bedford. They were carrying cargoes from New York and the southern ports of Europe. Occasionally, voyages were made to the East and West Indies directly from New Bedford. By 1807, New Bedford's waterfront had seven commercial wharves, between 90 and 100 ships and brigs, containing each on an average 250 tons, and between 20 and 30 small vessels: Twelve of the ships were whalers. By that year, three ropewalks were established in New Bedford and one in Fairhaven. Water depth in the harbor was reported between 18 and 24 feet (Ricketson, 1858).

During the War of 1812, the Navy Department provided four Jeffersonian gunboats for defense in Massachusetts; two at Newburyport and two at New Bedford. However, they proved useless. The two New Bedford boats remained hidden in the Acushnet River and did not even attack the *Nimrod* when she stranded on Great Ledge offshore New Bedford. Quaker ship owners who made fortunes by neutral trading before 1812, perceived the future of commerce trading from New Bedford was limited and refitted most of their vessels' as whalers. Typically, local ship owners converted their merchant ships that had outlived their usefulness in the trade service into whalers, a ship type that required capacity rather than speed as its main attribute (Morison, 1921).

In 1796, a company was created to construct the first bridge across the Acushnet River to connect New Bedford with Fairhaven and Oxford. The bridge was 4,000 feet long including abutments and the two islands it crossed over. The initial bridge was swept away in March, 1807 and was rebuilt later that year. In September, 1815, the second bridge was also washed away. A third bridge was built over the Acushnet River in 1819 and was still being used as of 1858. It was reported that the bridge significantly contributed to the shoaling up of the harbor (Ricketson, 1858). Despite the presence of a bridge, ferries connecting Fairhaven and New Bedford remained active for more than 100 years. The last of these ferries, the Fairhaven, a small side-wheel steamer was launched

into service on February, 24, 1896. Typically, she made 19 daily roundtrips across the Acushnet River (Whitman, 1994).

New Bedford was made a city in 1847. Whaling was the primary industry and remained so for most of the nineteenth century. In 1838 there were 170 whaling vessels in New Bedford. By 1857, New Bedford's whaling fleet surpassed all other Massachusetts ports combined with 329 whalers, with a tonnage of 111,364 (Sayer, 1889). Fairhaven provided most of the support services required by the whaling industry. With oil refineries, coopers shops, tool works and the other industries subsidiary to whaling, New Bedford Harbor became a center of industry. It became the fifth largest port for shipping in the country. Whaling and the manufacture of whaling products became the leading industry in Massachusetts after shoes and cotton and provided commerce with an important export medium (Morison, 1921). However, by 1888, whaling had declined dramatically. Only 74 whalers worked out of New Bedford in that year, with a tonnage of 18,911 (Sayer, 1889).

New Bedford was an urban center and was served by several steamboat lines during the nineteenth and twentieth centuries. Steamboat service from New Bedford to Nantucket dates to 1829, when Jacob Barker's steamer *Marco Bozzaris* made three trips a week. The New Bedford and Martha's Vineyard Steamboat Company was formed in 1846. In that year, the steamer *Naushon* made three trips a week between Edgartown and New Bedford, with a stop at Woods Hole (Foster & Weiglin, 1989). Steamboat service between New Bedford and New York began in 1853. The New Bedford and New York Steamship Company occupied a long, narrow roofed over wharf that could accommodate the large steamers operating in Long Island Sound (Whitman, 1994). Their boats connected with the Boston, Clinton & Fitchburg Railroad. In 1879 the Old Colony Steamboat Line took over the New Bedford-New York line (Foster & Weiglin, 1989). A second steamboat line, New Bedford, Martha's Vineyard and Nantucket Steamboat Company started service between New Bedford and the two islands in 1854. Assets from this company passed through several mergers and were acquired by the New England Steamship Company in 1945. Ships from the Fall River Steam Ship Line also served New Bedford.

Over fishing, a cheaper source of oil, and the Civil War, (Confederate Commerce Raiders captured and destroyed a vast number of New Bedford whalers on the high seas) combined to reduce the role of the whale industry and related maritime commerce. More than 50 whaling vessels were captured by rebel cruisers, 28 of which sailed out of New Bedford. All but a few of the whalers were burned. In June 1865, Confederate Cruiser *Shenandoah* alone captured 25 whalers in Behring strait. Many other whalers were bought by the government during the Civil War. Forty New Bedford whalers purchased by the United States formed the major portion of the two famous stone fleets which in 1861 were sunk off the harbors of Charleston and Savannah to impede blockade runners and privateers (Sayer, 1889). Numerous whalers were also lost in Arctic ice. In September 1871, 33 whaling ships (22 from New Bedford) were crushed by ice in the Arctic Ocean. Arctic mishaps in 1876 and 1888, claimed 17 more whaling ships.

Ultimately, the future of whaling as a source of oil was sealed once Colonel Drake discovered oil in the ground in northwestern Pennsylvania in 1859.

By the end of the nineteenth century, whaling had given way to textile mills as the leading industry in the New Bedford economy. Cotton mills, ushered in with the advent of the Industrial Revolution, began to replace the fish-processing and candle-making plants on the New Bedford waterfront. And with the decline of whaling, the shipyards and associated maritime industries were slowly abandoned. It was not until the after the First World War when the introduction of diesel powered fishing boats allowed vessels to economically reach the rich offshore fishing banks that New Bedford once again became a prominent fishing port.

5.2 SUBMERGED CULTURAL RESOURCES

5.2.1 National Register of Historic Places Evaluation Criteria

Nautical vessels and shipwreck sites are generally, excepting reconstructions and reproductions, considered historic if they are eligible for listing in the National Register of Historic Places. As set forth at 36 CFR 60.4, to be eligible for the National Register of Historic Places, a vessel or site must be significant "in American history, architecture, archeology, engineering, or culture" and "possess integrity of location, design, setting, materials, workmanship, feeling, and association" and meet one or more of the following criteria:

- a. be associated with events that have made a significant contribution to the broad patterns of our history; or
- b. be associated with the lives of persons significant in our past; or
- c. embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- d. have yielded, or may be likely to yield, information important in prehistory or history.

National Register of Historic Places Bulletin 20 clarifies the National Register review process with regard to shipwrecks and other submerged cultural resources. Shipwrecks must meet at least one of the above criteria and retain integrity of location, design, settings, materials, workmanship, feelings and association. Determining the significance of a historic vessel depends on establishing whether the vessel is:

1. the sole, best, or a good representative of a specific vessel type; or
2. is associated with a significant designer or builder; or
3. was involved in important maritime trade, naval recreational, government, or commercial activities.

Properties that qualify for the National Register must have significance in one or more "Areas of Significance" that are listed in *National Register Bulletin 16A*. Although 29 specific categories are listed, only some are relevant to the submerged cultural resources in New Bedford Harbor. Architecture, commerce, engineering, industry, invention, maritime history and transportation are potentially applicable data categories for the type of submerged cultural resources that may be expected in the Acushnet River study area.

5.2.2 Shipwrecks in the New Bedford Vicinity

A wide variety of shipwrecks may exist in New Bedford's harbor. Historic records indicate that maritime activity in the region's waterways dates to the first decade of the seventeenth century. The first documented shipwreck losses in the region are associated with Revolutionary War activity in September 1778. In the nineteenth century, New Bedford became the principal whaling port in the country and was home for hundreds of square-rigged whalers. Although whaling was phased out as an industry by the end of the nineteenth century, New Bedford has remained a preeminent commercial fishing port throughout the twentieth century. Shipwrecks undoubtedly occurred in and around New Bedford harbor during each phase of the port's historical development. However, it is highly unlikely that any intact wrecks remain within the navigable portions of the harbor, since they would have been removed long ago as a hazard to navigation. Nonetheless, a list of shipwrecks and derelict vessels provides insights into the expected vessel types that might be found in and around New Bedford.

A number of sources were accessed during the compilation of wrecked vessels in New Bedford's Harbor. The lists have been divided according to the sources. In all, more than 65 different vessels are documented as wrecked in or around New Bedford Harbor.

The following is a shipwreck list maintained at the Massachusetts Board of Underwater Archaeological Resources (MBUAR). It was provided by Mr. Victor Mastone, MBUAR Director. The vast majority of the sites included in the list were derived from data gathered by Mr. Brad Luther, local expert on New Bedford Harbor, and Mr. John Fish, an underwater researcher.

Vessel Name	Date	Type	Location
Wasp	6/12/1903	Barge	New Bedford
Thomas H. Lawrence	9/21/1938	Schooner	West of Palmer's Island, New Bedford Harbor
H.M.S. Nimrod	1815		Mass.
Unidentified	1/7/1844	Schooner	Near New Bedford
Rival	10/14/1844	Brig	Ashore at New Bedford
Caravan	11/6/1847	Schooner	Off New Bedford
Chopaquoit	1947	Ketch	Off West Beach, Westport
Aloha	3/13/1870	Bark	New Bedford
A. Francis Edwards	5/26/1892	Schooner	New Bedford
Freeman	9/15/1898	Schooner	New Bedford
Rattler	10/13/1915	Oil	New Bedford
Sally W. Ponder	10/9/1916	Schooner	New Bedford
Lorna	11/1/23	Gas	New Bedford
Mogadore	9/11/1930	Gas	New Bedford
Althea Louke	12/4/1932		New Bedford
Eurybia	8/9/1935	Gas	New Bedford
Winifred	9/21/1938	Oil	New Bedford
Alma Bell	9/14/1944	Oil	New Bedford
Marion Dorothy	9/14/1944	Oil	New Bedford
Alice May	1950		New Bedford
Debbie II	8/1/54	Gas	New Bedford
Rose Mary Mello	8/31/1954	Oil	New Bedford
Phillip R.	11/15/1954	Barge	New Bedford
Onward	3/17/1956	Oil	New Bedford
Mariner	1956	Yacht	Fairhaven, 1 mile east of West Island
Francis Edward	5/1892		Fairhaven

Shipwrecks listed for the New Bedford/Fairhaven vicinity in *Encyclopedia of American Shipwrecks* (Berman, 1972) include:

Lizzie W. Hannum, a two-masted schooner, wrecked at Great Ledge, Buzzards Bay on April 10, 1895

Marjorie Parker, an oil screw vessel, 76 tons, built in 1923, foundered at Fairhaven on August 31, 1954

Olive M. Williams, an oil screw fishing boat, 50 tons, built in 1928, sank in a storm at Fairhaven on September 1, 1954.

Sally W. Ponder, schooner, 107 tons, built in 1855, foundered at New Bedford on October 9, 1916.

Sankaty, steam screw, 677 tons, built in 1911, burned at New Bedford on June 30, 1924.

Wm A. Grozier, schooner, 116 tons, built in 1865, foundered off New Bedford on July 1, 1913.

Local New Bedford resident, Mr. Gilbert Russell listed by name and type each vessel that was destroyed by the British expedition on September 5, 1778 (in Ricketson, 1858, pg. 75).

<i>Leopard</i> , Ship	<i>No Duty on Tea</i> , Brig
<i>Spaniard</i> , Ship	<i>Sally</i> , Schooner
<i>Caesar</i> , Ship	<i>Bowers</i> , Sloop
<i>Nanny</i> , Barque	<i>Sally</i> (12 guns), Sloop
<i>Rosin</i> , Brig	<i>Ritchie</i> , Brig
<i>Sally</i> , Fishing Brig	<i>Dove</i> , Brig
<i>Simeon</i> , Snow	<i>Holland</i> , Brig
<i>Sally</i> , Continental Brig	<i>Joseph R</i> , Sloop
<i>Adventure</i> , Schooner	<i>Bociron</i> , Sloop
<i>Loyalty</i> , Continental Schooner	<i>Pilot Fish</i> , Sloop
<i>Nelly</i> , Sloop	<i>The Other Side</i> , Schooner
<i>Fly Fish</i> , Sloop	<i>Sally</i> , Brig
<i>Captain Lawrence</i> , Sloop	<i>Retaliation</i> , Sloop
<i>Defiance</i> , Schooner	<i>J. Brown's</i> , Sloop
<i>Captain Jenny</i> , Schooner	<i>Eastward</i> , Schooner

Other documented wrecks in the vicinity include:

Capt. Lavoeiro, 75-foot long New Bedford fishing vessel sank at the State Pier on December 26, 1984, after it struck a barge outside the harbor and returned to the pier where it sank. However, salvagers used a crane and divers to raise it three days later (Quinn, 1988)

5.2.3 Removal of Derelict Vessels

In 1989, a project was conducted to identify and remove derelict vessels from around the harbor. Parson, Brinckerhoff, Quade, & Douglas, Inc., (Parsons) organized the project that removed 13 derelict boats from New Bedford Harbor, in the municipalities of Fairhaven and New Bedford (Parsons 1989). Seven of those vessels were located in Fairhaven and six were in New Bedford.

One of the derelict vessels, the 85-foot long *Evelina Goulart*, in Fairhaven, was raised on May 25, 1989. She was towed to the Essex Shipbuilding Museum where it was to be restored, near where it was launched in 1927, as one of the last sail-driven fishing schooners.

Other derelict vessels that were removed in 1989 include:

1. a 30-foot wood hull boat (Fairhaven),
2. three construction barges, approximately 60-feet x 20-feet (Fairhaven),
3. a 40-foot fiberglass (Fairhaven),
4. a 20-foot wood vessel (Fairhaven),
5. a barge, approximately 150-feet x 32-feet (New Bedford),
6. a fishing vessel, *Alydar*, approximately 92-feet x 26-feet (New Bedford),
7. a fishing trawler, *Plymouth*, approximately 100-feet x 28 feet (New Bedford),
8. two barges, each approximately 150-feet x 32-feet (New Bedford),
9. a Navy Launch, approximately 150-feet x 32-feet (outside of Hurricane Barrier, New Bedford).

In 2001/2002, 16 derelict and abandoned vessels at the Melville Ship Yard in New Bedford were removed and destroyed as part of the ongoing Superfund Clean-Up of New Bedford Harbor. An archaeological project documented each of the derelict vessels and evaluated their significance in terms of National register of Historic Places eligibility criteria (Cox, 2001a). The report concluded that none of the vessels satisfied NRPA criteria.

5.2.4 Potential Submerged Cultural Resource Types

Recorded maritime activity in the New Bedford region dates to the first decade of the seventeenth century. However, it was not until the middle of the eighteenth century that the port of Dartmouth/New Bedford became a prominent fishing harbor. From that era to present, the harbor in the Acushnet River has hosted a consistently high volume of maritime traffic.

Historic documentation confirms that many types of ships and vessels were wrecked in the New Bedford vicinity. A preliminary list of documented vessels wrecked or lost in New Bedford (see Section 3.2) provides an indication of the quantity and types of shipwreck sites that have been deposited on the bottom of the waterway. Drawing from a variety of primary and secondary sources, these lists, while far from comprehensive, give an indication of the wide variety of shipwrecks that have been lost in the waterway over the last 225 years.

Potential shipwreck types in/near New Bedford may include a variety of material dating from Revolutionary War-era through the twentieth century. To discuss the types of vessels potentially present, it is necessary to include vessels from all phases of the commercial and naval activity in this portion of Massachusetts. Wood-hulled ships, ranging from small fishing sloops, shallops, brigs, recreational sailing craft, gas/diesel powered fishing trawlers and coastal schooners, to ship-rigged whalers, have been likely lost near New Bedford. Numerous steamers and ferries also plied the Acushnet River for well over 150 years. Iron-hulled vessels, including paddle wheel and screw steamboats, have been used extensively in the harbor. Indigenous, small rowed- and sailed-vessels were also used throughout all active harbors. Since such a wide range of vessels has been

used in New Bedford over such an extended time period, it is almost impossible to feature one particular type of vessel type most likely to be found. Many of these types of vessels would lend historic insights into a wide-range of maritime-related topics and would be considered historically significant.

5.3 PREVIOUS UNDERWATER ARCHEOLOGICAL INVESTIGATIONS

MBA files contained information on four previous underwater archeological surveys in the project vicinity. Robert Cembrola served as the Principal Investigator for the Marine Archaeological Report that was completed for the New Bedford Phase II Facilities Plan (Cembrola, 1989). Potential submerged cultural resources were identified within a three-mile vicinity of two candidate outfall diffuser sites and within 0.5 miles on either side of the proposed outfall pipeline alignment that extended from the southern tip of New Bedford out 3.5 miles into Buzzards Bay. Two known wrecks sites, the *Margeret Kehoe*, a 62-ton fishing boat sank near Church Rock in 1963, and the *Yankee*, a 6,225 ton, 391-foot steam ship ran aground and sank on Great Ledge on September 23, 1908, were identified in Buzzards Bay, near the mouth of the Acushnet River. The wrecks were outside the area affected by the outfall pipeline and no additional fieldwork was conducted.

J, Lee Cox, Jr., served as the Principal Investigator for the other three local underwater archaeology projects. Two of the projects were completed in conjunction with the New Bedford Harbor Superfund Project in the towns of New Bedford, Fairhaven and Acushnet. The primary project was a magnetic and acoustic remote sensing investigation to determine the presence or absence of submerged cultural resources potentially eligible for the National Register of Historic Places that might be affected by dredging to remove contaminated sediments (Cox, 2001). Analysis of remote sensing data identified sixty magnetic and/or acoustic targets. The vast majority of the targets appear to be related to isolated, single source objects, modern debris, or shoreline-related objects. Two of the remote sensing targets are suggestive of submerged cultural resources. However, divers confirmed that modern debris was the target source at both locations.

In conjunction with Superfund Project, archaeologists also documented the derelict vessels at the Melville Shipyard, New Bedford (Cox, 2001a). Sixteen vessels were documented and evaluated according to NRHP criteria. The report concluded that none of the vessels satisfied NRHP criteria.

A remote sensing investigation was conducted by Apex Environmental for the New Bedford State Pier Dredge Project. Mr. Cox served as the Principal Investigator for the project. The report concluded that several miscellaneous objects were present on the river bottom within the 800'-long by 150'-wide project area, along the New Bedford waterfront. However, all of the objects were scattered pieces of debris that were not suggestive of historically significant submerged cultural resources (Cox, 2001b).

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Cultural Resources

Historic sources confirm a sustained level of maritime activity in New Bedford harbor since the middle of the eighteenth century. Dozens of vessels were documented as having been stranded, foundered, burned, capsized and destroyed in the New Bedford vicinity. Secondary sources have listed numerous wrecks in the project vicinity. Many of these vessels, including a number of Revolutionary War wrecks, were lost in the section of the harbor between the Route 6 Bridge and the Hurricane Wall. However, large portions of the harbor have been dredged during navigational improvements and many potential submerged sites were likely removed long ago as hazards to navigation. Since New Bedford is still a very busy commercial port, it is unlikely that potentially significant submerged cultural resources have been deposited within New Bedford harbor and have remained undetected and unknown. Local residents and watermen familiar with the harbor were unaware of any potential wreck sites within the harbor. Nonetheless, the harbor potentially contains cultural material from each phase of the port's extensive maritime history.

In an effort to identify submerged cultural resources that may be affected by the construction of CAD Cells in New Bedford Harbor, a comprehensive Phase I remote sensing survey was conducted across two project areas: Channel Inner Area and Pope Island North Area. Magnetic and acoustic remote sensing records were processed and correlated to determine the presence of targets that possessed signature characteristics suggestive of submerged cultural resources. Although analysis of the remote sensing data identified 43 magnetic and/or acoustic targets in the two project areas, only three of the targets were considered to be significant targets (CM-3, CM-5 and CM-6). However, the three magnetic targets are located within the Channel Inner Area which has been previously dredged. The source of the target signatures is therefore considered to be either debris-related material or associated with a geological feature. No additional underwater archaeological investigations are recommended. All of the rest of the target signatures were suggestive of modern debris, geologic features or isolated, single source targets.

Examination of the remote sensing data found no clear evidence of targets that would be considered suggestive of potentially significant submerged cultural resources. Numerous objects were identified on sonar records; however each sonar target appeared to be associated with debris or discarded objects. There were also numerous magnetic anomalies found. In the opinion of Principal Investigator, none of the magnetic anomalies generated signatures clearly suggestive of submerged cultural resources. However, prominent geologic features found throughout the project areas generated magnetic signatures that could have masked the presence of submerged cultural resources.

While the project area has very likely been dredged and the historic waterfront filled in over the last 200 years, the historic significance of the port should be taken into consideration when evaluating the potential presence of submerged cultural resources. While remote sensing records do not indicate the presence of potentially significant

targets, archaeological sites could remain undetected in these sections of the New Bedford harbor. During the Revolutionary War dozens of ships that were reportedly destroyed along this New Bedford waterfront close to the Channel Inner Area.

While no additional underwater archaeological investigation is proposed, it is recommended that an archaeological monitor be present during dredging operations to ensure that no undetected shipwreck sites or other archaeological sites are impacted during dredge operations.

6.2 Hazards Analysis

Numerous targets were identified in this remote sensing survey as shown in Figures 7 and 8. It can be seen that a large number of the identified targets are located outside of the current CAD cell footprints. Several of the targets identified may represent significant issues to future work performed in the vicinity of these targets. For example, a large section of dock identified as target C33-1 located just north of the current CAD footprint as well as several pipes and piles (C20-1, C37-1 and C39-1) could potentially impact dredging and construction operations.

Additionally, it can be seen from Side Scan mosaics and the Change in Total Magnetic Intensity maps that there are numerous smaller debris (both metallic and non-metallic) that may effect dredging operations.

Finally, it should be noted that interpretations stated in this report are not necessarily exclusive but are rather the best-fit interpretations of the currently available information and data. This interpretation may be improved upon as additional information becomes available.

7.0 LIMITATIONS

The following limitations apply to all geophysical surveys conducted by Apex Environmental, Inc, its subsidiaries and subcontractors. Every attempt has been made to conduct this survey in such a fashion so as to maximize the quality of the data collected and the interpretations rendered. However, a geophysical investigation is an indirect method of subsurface exploration whereby subsurface characteristics are inferred or interpreted from measurements collected at the ground or water surface. Many variables may affect these measurements. Due to the indirect, interpretive nature of geophysics, findings are generally considered precursory and subject to verification by more direct methods of investigation such as test borings or test pits. The following limitations are considered when evaluating geophysical data:

1. Subsurface features can be interpreted from the appropriate geophysical methods only insofar as they produce a discernible geophysical signature. They must have adequate homogeneity, size, and appropriate physical or chemical properties sufficient to contrast with the surrounding medium and be within reasonable proximity to the sensors. Additionally, their signature must be distinguishable from and not masked by background noise or interference.
2. Lithologic data inferred on the basis of geophysical data may not be identical to geologic or hydrogeologic data. Lithologies are generally interpreted from some geophysical signature (e.g., velocity differences) that may be the result of many factors (including density, susceptibility, angle to the sensors, amount of weathering, etc.). Lithology divisions based upon seismic velocity for example may not necessarily be identical to lithology changes identified by drilling. The discrepancy is generally related to formation density and/or compaction (i.e., a dense till may have a higher density than a weathered bedrock, and the difference can be difficult to resolve with seismic data).
3. Complex geological configurations may be impossible to resolve with surface geophysical methods. The resolution of geophysical data is limited by the spatial geometry of sensors, strength of signal, and distance of the object or layer of interest from the energy source and the sensor array used. Resulting interpretations are rendered by modeling geophysical response to known or presumed geometric relationships. The complexity of the relationships that can be modeled is limited by the resolution allowed by the method and geometry of equipment layout used, and the limitations of the software used.
4. Apex Environmental, Inc. is not responsible for data quality in areas having excessive "background noise" which affect the specific physical parameters that are being measured by a particular geophysical technique. Examples of background noise include: water traffic (large fishing boat); or underground utilities (such as electric lines, tunnels, sewers, etc.), which can interfere with magnetic instrumentation.

No guarantee or warranty (other than that stipulated in the contract under which this work was promulgated), expressly stated or implied, is given concerning the data and interpretations rendered in this report. All information is presented as "for information only". Apex Environmental, Inc., or any subsidiary, is not liable for any losses resulting from the misuse, misrepresentation, or misinterpretation of any information presented in this report by any person or entity.

8.0 REFERENCES CITED

Baker, William Avery

1980 "Vessel Type of Colonial Massachusetts." In *Seafaring in Colonial Massachusetts*, The Colonial Society of Massachusetts, Volume 52. Boston.

Berman, Bruce

1972 *Encyclopedia of American Shipwrecks*. The Mariners Press, Boston.

Cembrola, Robert

1989 "Draft Report on Marine Archaeology." Report submitted to Camp, Dresser and McKee, Inc. Report on file with the BUAR. Boston.

Cox, J. Lee

2001 "New Bedford Harbor Superfund Site, New Bedford, Massachusetts, Underwater Archaeology Remote Sensing Survey." Report submitted by John Milner Associates to Foster Wheeler Environmental Corporation and the USACE (New England Division).

2001a "Documentation of Derelict Vessels at Melville Shipyard, New Bedford Harbor Superfund Site, Bristol County, Massachusetts." Report submitted by John Milner Associates to Foster Wheeler Environmental Corporation and the USACE (New England Division).

2001b "Submerged Cultural Resources Investigation New Bedford State Pier Dredge Project, New Bedford Harbor, Massachusetts." Report submitted by Apex Environmental, Boston.

Crapo, William

1876 *Centennial in New Bedford*. E. Anthony & Sons, New Bedford.

Foster, George and Peter Weiglin

1989 *Splendor Sailed the Sound, The New Haven Railroad and The Old Fall River Line*. Potentials Group, Inc., San Mateo.

Foster Wheeler Environmental Corporation (FWENC)

2001 "Report of Marine Geophysical Surveys: Side Scan Sonar, Sub-Bottom Profiler, and Magnetics, New Bedford Harbor Superfund Site Operable Unit #1, New Bedford, Massachusetts." Report submitted to the USACE (New England Division).

Kugler, Richard

1980 "The Whale Oil Trade, 1750-1775." In *Seafaring in Colonial Massachusetts*, The Colonial Society of Massachusetts, Volume 52. Boston.

McAdam, Roger

1972 *Floating Palaces, New England to New York on the Old Fall River Line.*
Mowbray Company. Providence.

Morison, Samuel Eliot

1921 *Maritime History of Massachusetts, 1783-1860.* Houghton Mifflin Company,
Boston.

Parson, Brinckerhoff, Quade & Douglas, Inc. (Parsons)

1989 "Vessel Removal & Disposal, New Bedford and Fairhaven Massachusetts."
Report submitted to the Massachusetts Department of Environmental
Management. Report on file with BUAR, Boston.

Quinn, William

1988 *Shipwrecks Along the Atlantic Coast.* Arcata Graphics-Halliday, Braintree.

Ricketson, Daniel

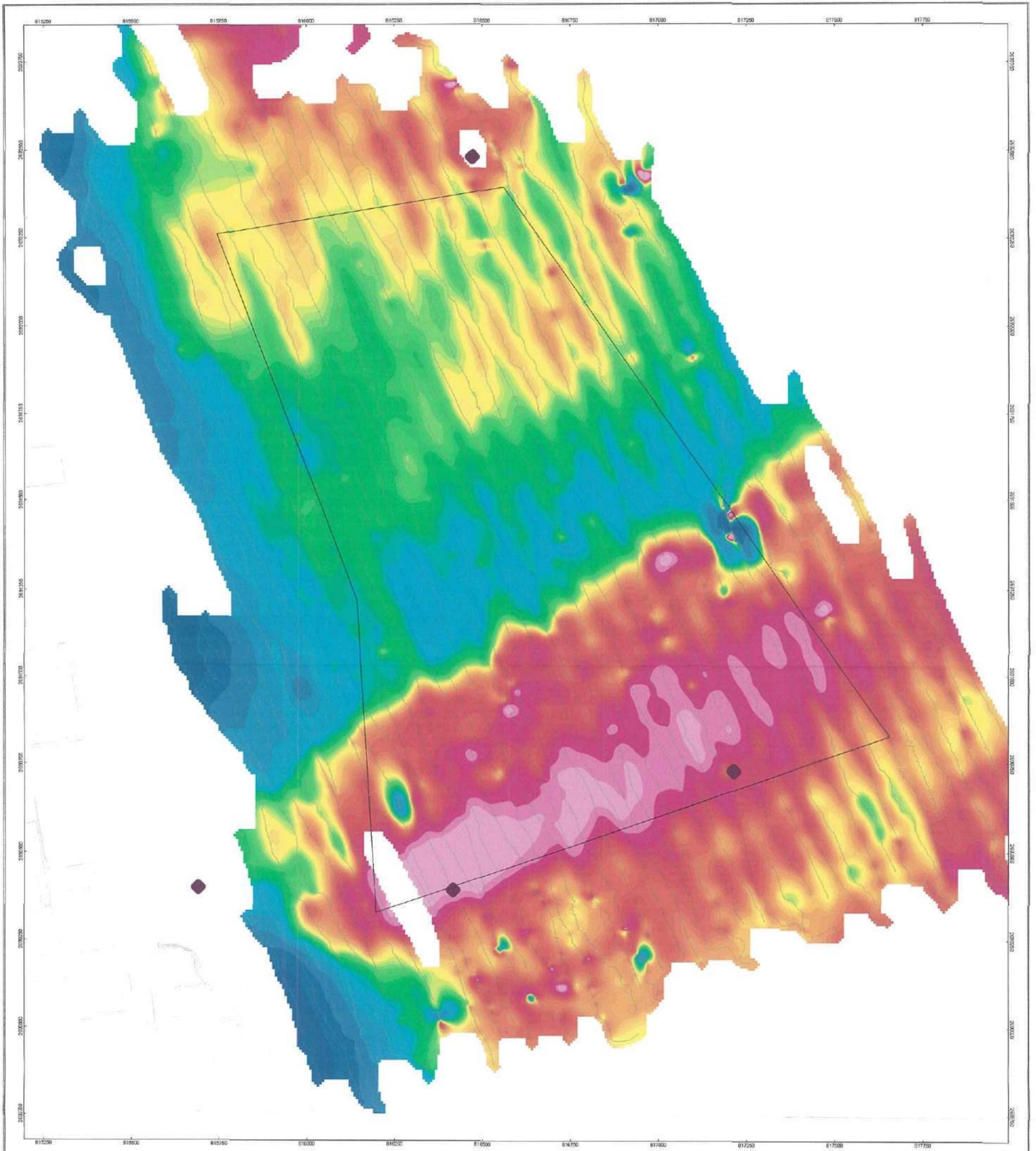
1858 *The History of New Bedford, Bristol County Massachusetts: Including a History
of the Old Township of Dartmouth and the Present Townships of Westport,
Dartmouth, and Fairhaven From Their Settlement to the Present Time.* Published
by the Author, New Bedford.

Sayer, William, editor

1889 *New Bedford, Massachusetts, Its History, Industries, Institutions, and Attractions.*
Mercury Publishing, New Bedford.

Whitman, Nicholas

1994 *A Window Back, Photography in a Whaling Port.* Spinner Publications. New
Bedford.

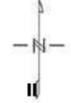


NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using a G-881 Caesium magnetometer flown at a depth of approximately 6 feet. Planned line spacing of 50 feet.

LEGEND:

- ◆ Aids To Navigation
- - - Area of Proposed Coil
- ~ Survey Line Path



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Feet

NO.	DESCRIPTION	BY	DATE

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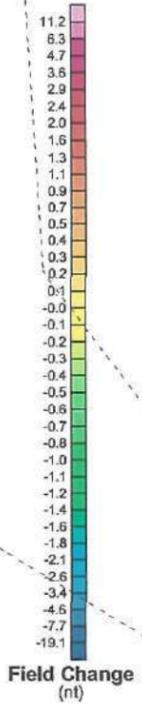
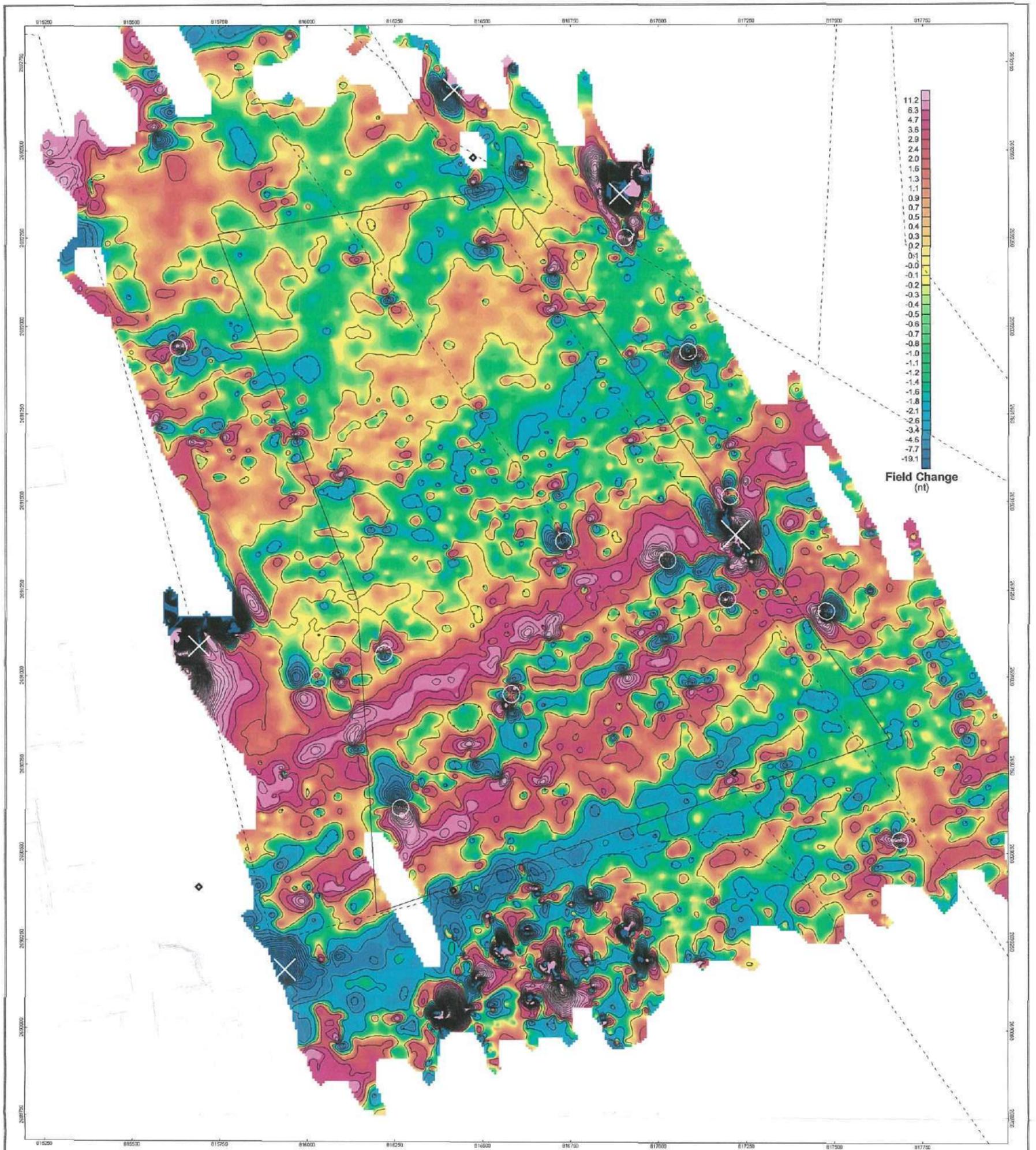
CHANNEL INNER AREA
NEW BEDFORD HARBOR, MA

TOTAL MAGNETIC INTENSITY (TMI)

Apex
geospatial inc.

374 Cummings St.
Salem MA 01970
617.728.0370

SCALE: 1"=300'	DRAWN BY: TM	DESIGN BY: TM	CHECKED BY: JAB	PROJECT: 0510.M02	DATE: 12-28-02	SHEET 1 OF 8
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NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using a G-881 Cesium magnetometer flown at a depth of approximately 6 feet. Planned line spacing of 50 feet.

LEGEND:

- ◆ Aids To Navigation
- Area of Proposed Coil
- 2nT Contour
- Magnetic Anomaly
- Anomaly Due To Surface Boats
- Federal Navigation Channel



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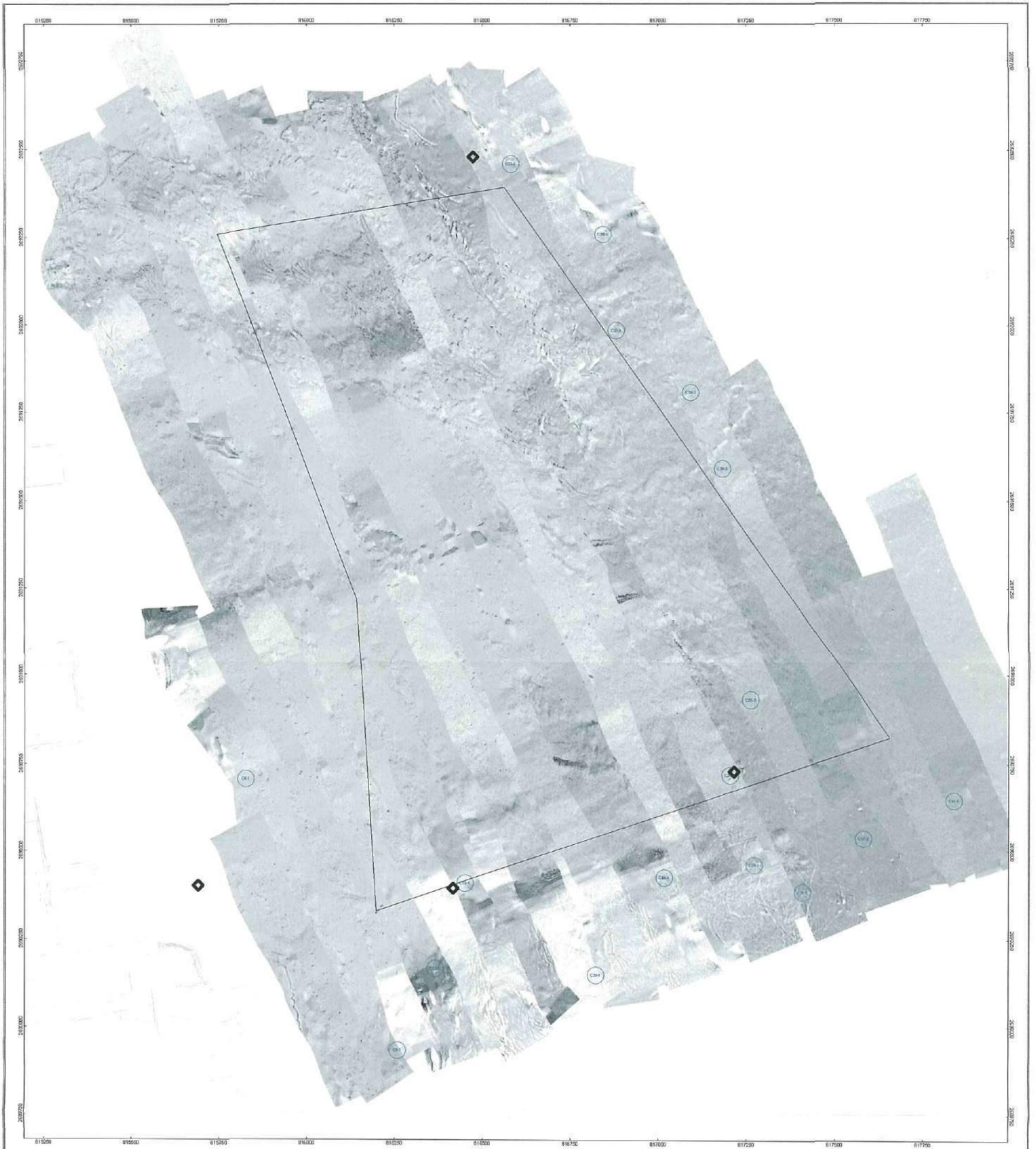
HAZARDS & CULTURAL IDENTIFICATION - MAGNETICS
CHANNEL INNER AREA
NEW BEDFORD HARBOR, MA

CHANGE IN TOTAL MAGNETIC INTENSITY

Apex
geospatial inc.

374 Congress St
Suite 507
Boston, MA 02210
(617) 728-0278

SCALE: 1"=300'	DRAWN BY: TM	DESIGN BY: TM	CHECKED BY: TM	PROJECT: 0318JAZ	SHEET: 2 OF 8
DATE: 12-20-02					

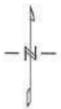


NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001 Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using an EdgeTech 272D towfish operating at 500KH from a depth of approximately 10 feet. Planned line spacing of 150 feet.

LEGEND:

- ◆ Aids To Navigation
- Area of Proposed Cell
- Side Scan Target



REV	DESCRIPTION	BY	DATE

HAZARDS & CULTURAL IDENTIFICATION - SIDE SCAN

**CHANNEL INNER AREA
NEW BEDFORD HARBOR, MA**

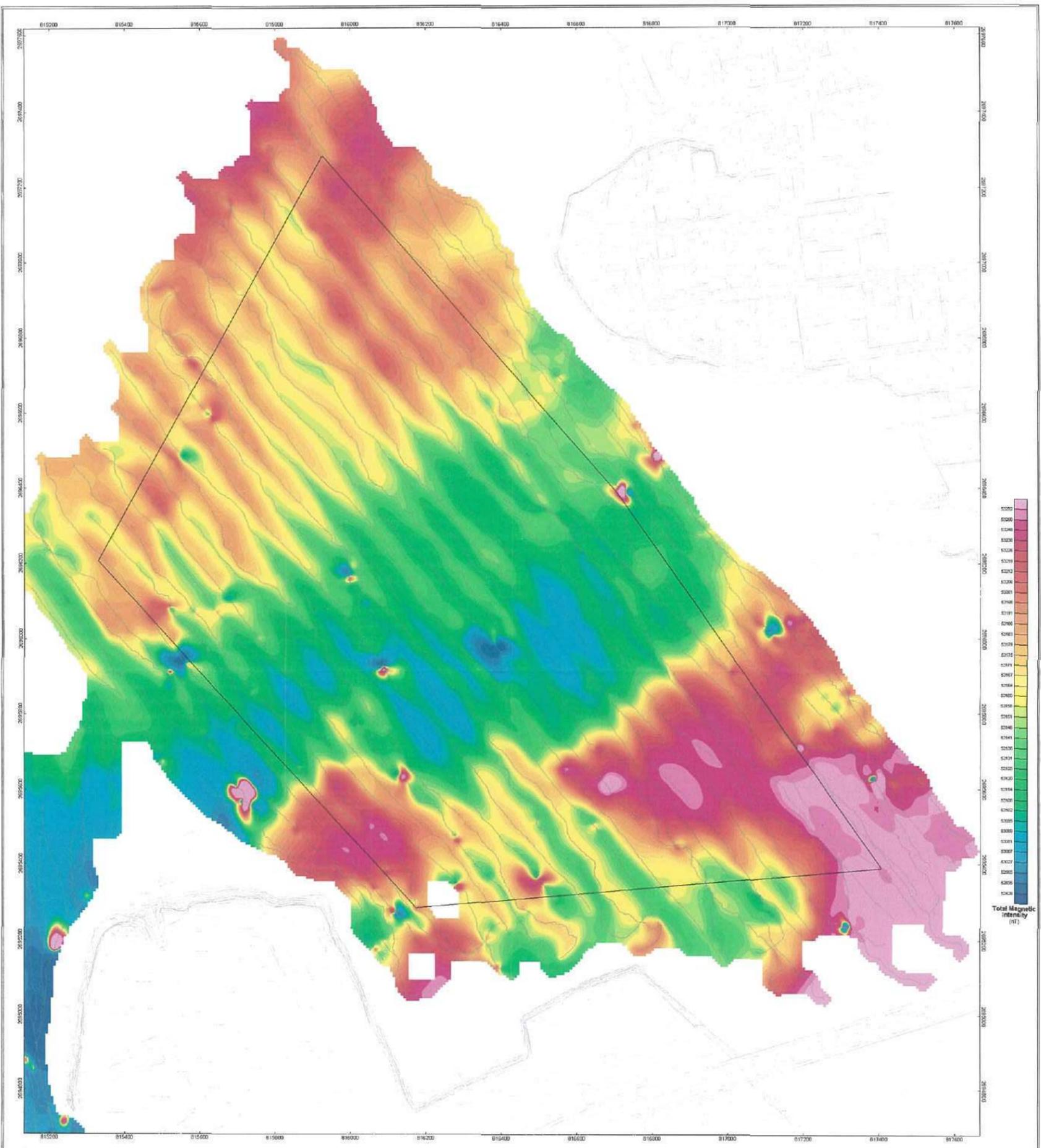
SIDE SCAN SONAR MOSAIC

374 Coggeshall St.
Boston MA 02210
(617) 738-0070

SCALE: 1"=300'
DATE: 12-26-02

DRAWN BY: TM
DESIGN BY: TM
CHECKED BY: JAO

PROJECT: 0510.002
SHEET 3 OF 8



NOTES

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using a Geometrics G-831 Cesium magnetometer flown on the water surface. Flown line spacing of 50 feet.

LEGEND
 AREA OF PROPOSED CAD CELL
 SURVEY LINE PATH



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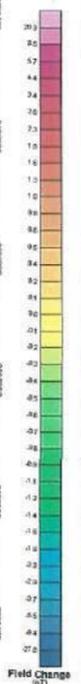
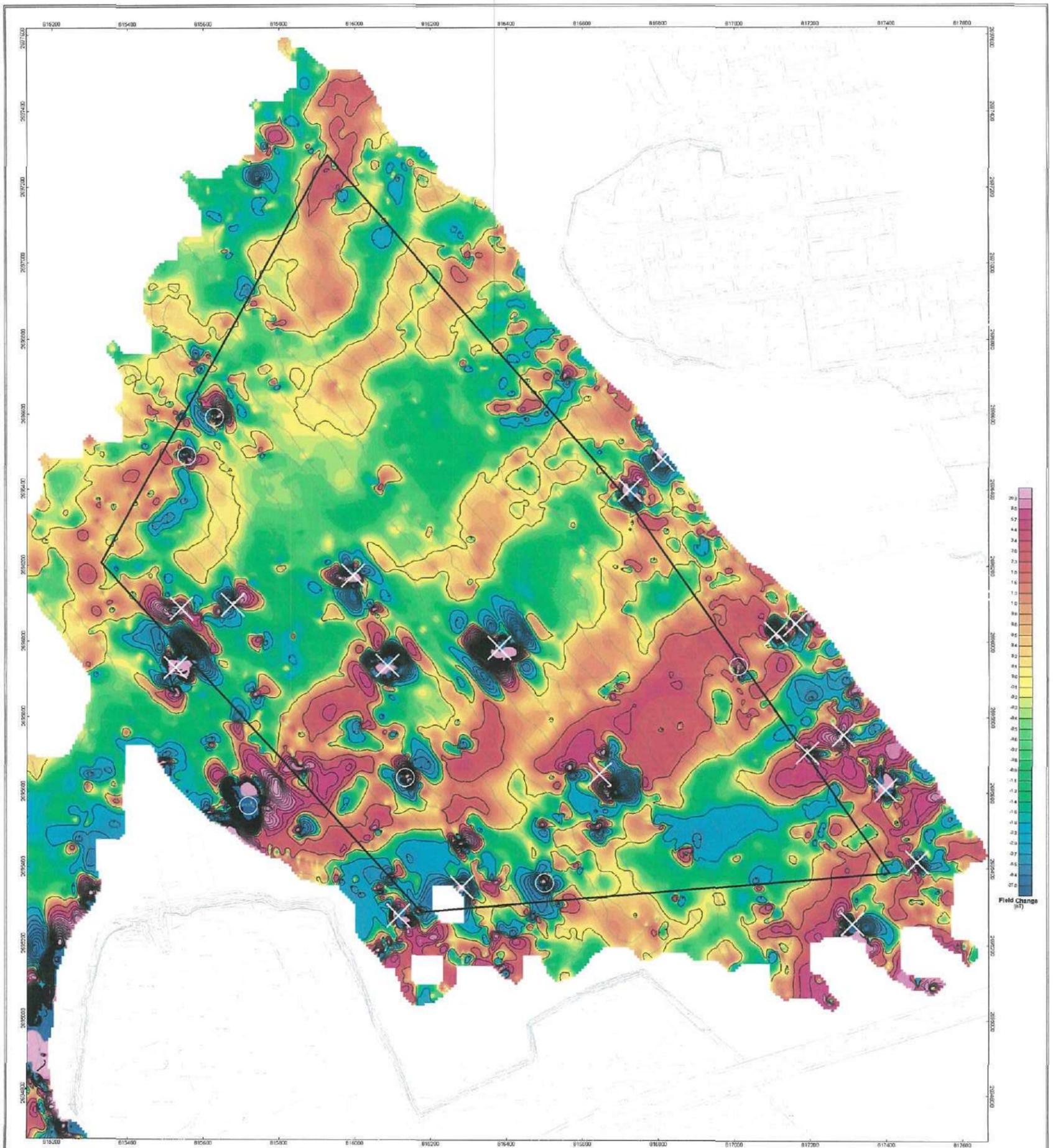
HAZARDS & CULTURAL IDENTIFICATION - MAGNETICS

**POPES ISLAND NORTH AREA
 NEW BEDFORD HARBOR, MA**

TOTAL MAGNETIC INTENSITY (TM)

Apex
 www.apexinc.com
 314 Congress St
 Boston, MA 02216
 (617) 724-0478

SCALE: 1"=300'
 DATE: 12-26-02
 DRAWN BY: TM
 CHECKED BY: TM
 PROJECT: 0503.012
 SHEET 4 OF 9



NOTES

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using a Geometrics G-881 Cesium magnetometer flown on the water surface. Planned line spacing of 50 feet.

LEGEND:

- AREA OF PROPOSED CAD CELL
- ANCHORAGE TO MOORING OR PLEASURE BOAT
- CONT. CONTOUR
- SURVEY LINE PATH
- MAGNETIC TARGET



REV.	DESCRIPTION	BY	DATE

HAZARDS & CULTURAL IDENTIFICATION - MAGNETICS

**POPES ISLAND NORTH AREA
NEW BEDFORD HARBOR, MA**

CHANGE IN TOTAL MAGNETIC INTENSITY

Apex
environmental, inc.
324 Congress St.
Bridgewater, MA 02216
(978) 728-0078

SCALE: 1"=300'

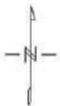
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12/29/02	TM	TM	JAB	6218/002	5 OF 8



NOTES

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts, Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using an Edgetech 2720 towfish operating at 500kHz from a depth of approximately 6 feet. Planned line spacing of 100 feet.

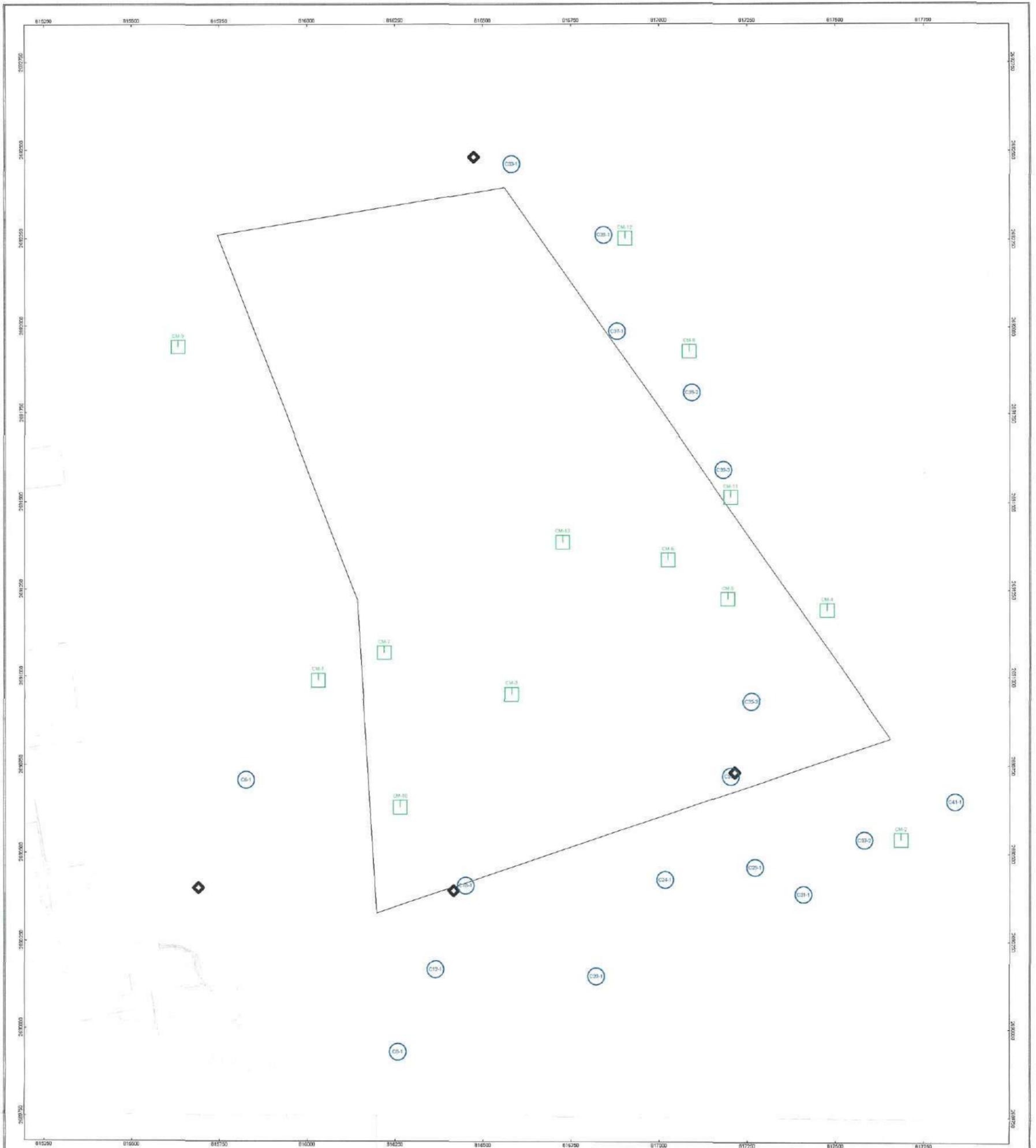
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 ✓ AREA OF PROPOSED CAD CELL
 (P-1) POSSIBLE TARGET



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 Feet
 Horizontal Distances in Feet unless noted

REV	DESCRIPTION	BY	DATE

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POPES ISLAND NORTH AREA NEW BEDFORD HARBOR, MA			
SIDE SCAN SONAR MOSAIC			
		374 Congress St. Suite 202 Boston, MA 02210 (617) 720-0376	
SCALE: 1"=500'	DRAWN BY: TM	DESIGN BY: YW	CHECKED BY: JMS
DATE: 12-04-02			PROJECT: 0518-002
			SHEET 6 OF 8



NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).

LEGEND:

- ◆ Aids To Navigation
- Area of Proposed Cell
- Magnetic Anomaly
- Side Scan Sonar Target



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 Feet

REV	DESCRIPTION	BY	DATE

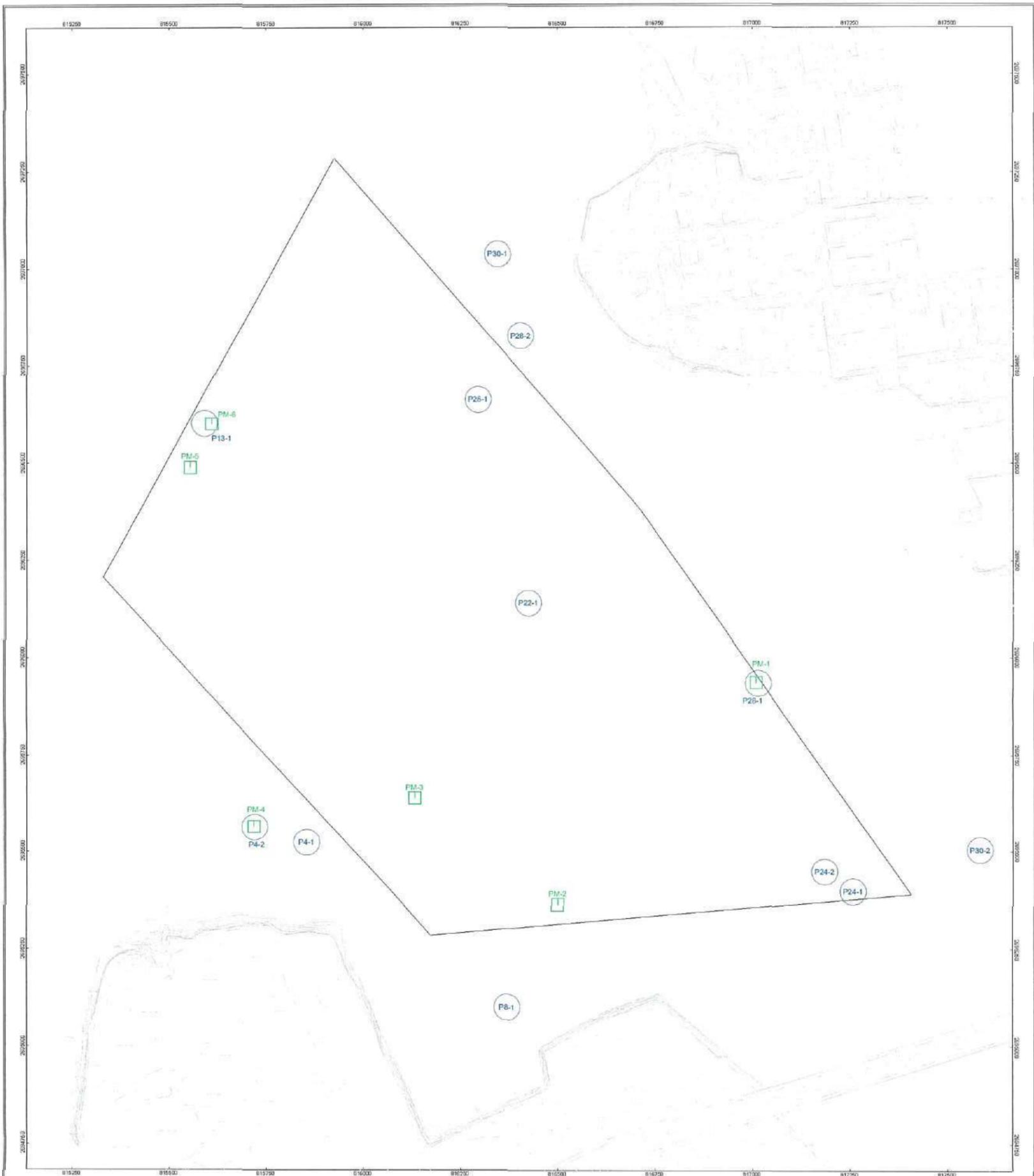
HAZARDS & CULTURAL IDENTIFICATION - MAGNETICS
CHANNEL INNER AREA
NEW BEDFORD HARBOR, MA

INTERPRETED TARGETS

374 029944337
 State 200
 District MA-02210
 8173204070

Apex
 Environmental, Inc.

SCALE: 1"=300'	DRAWN BY: TM	DESIGN BY: TM	CHECKER BY: JAD	PROJECT: 0019.002	SHEET: 7 OF 8
DATE: 12.20.02					



NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using a Geometrics G-861 Cesium magnetometer flown on the water surface. Planned line spacing of 50 feet.

LEGEND:

- AREA OF PROPOSED CAD CELL
- MAGNETIC ANOMALY - TARGET
- EDGE SCAN SONAR ANOMALY



REV	DESCRIPTION	BY	DATE

HAZARDS & CULTURAL IDENTIFICATION - SUMMARY

**POPES ISLAND NORTH AREA
NEW BEDFORD HARBOR, MA**

INTERPRETED TARGETS

Apex
www.apexinc.com

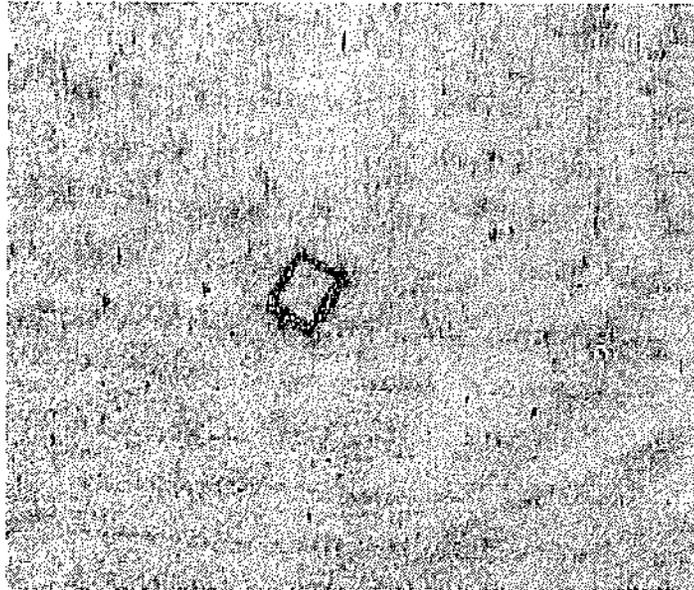
211 Congress St.
Salem MA 02210
(617) 234-0710

SCALE: 1"=300'
DATE: 12-20-02

DRAWN BY: TM
DESIGN BY: TM
CHECKED BY: JAB

PROJECT: 6510/002
SHEET 17 OF 18

APPENDIX A
Detail Side Scan Images
Channel Inner Area



Target # C6-1

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First Target Ping Num: 2225 at 10/22/2002 20:14:13
Target Location: 41° 37.7976' N 070° 54.9543' W



Target # C8-1

SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\08chan-BAC.CMN
File Creation Time: 11/19/02 15:24:27
First Target Ping Num: 50 at 10/22/2002 20:08:03
Target Location: 41° 37.6653' N 070° 54.8564' W



Target # C12-1

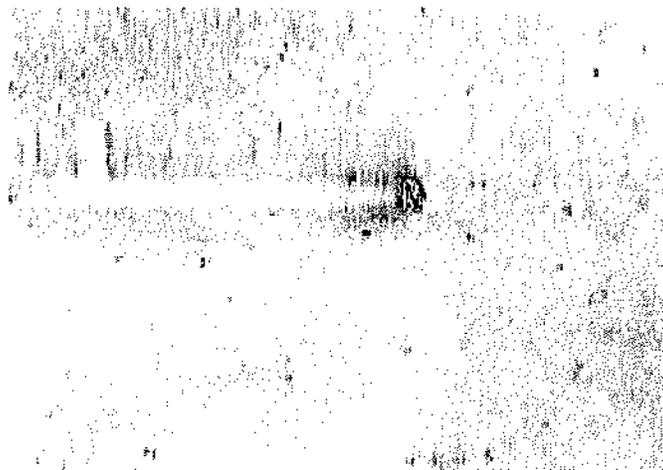
Sonar Web V3.13M PRO

Sonar Filename: C:\Program Files\Chesapeake Technology,
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File Creation Time: 11/19/02 15:26:30

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Target Location: 41° 37.7051' N 070° 54.8291' W



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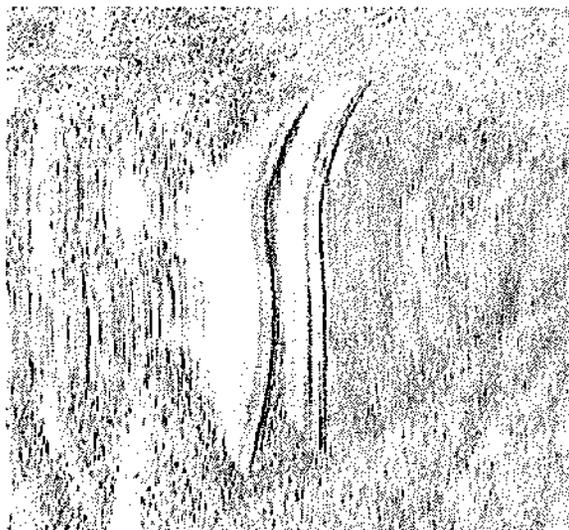
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File Creation Time: 11/19/02 15:27:25

First Target Ping Num: 13340 at 10/22/2002 17:39:49

Target Location: 41° 37.6982' N 070° 54.7568' W



Target # C20-1

SonarWeb V3.13M PRO

Sonar Filename: C:\Program Files\Chesapeake Technology,
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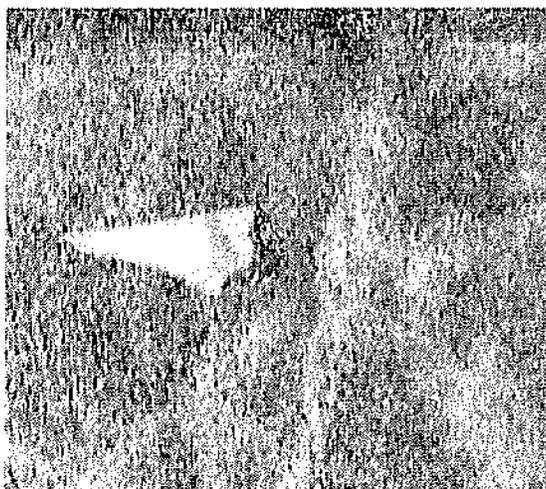
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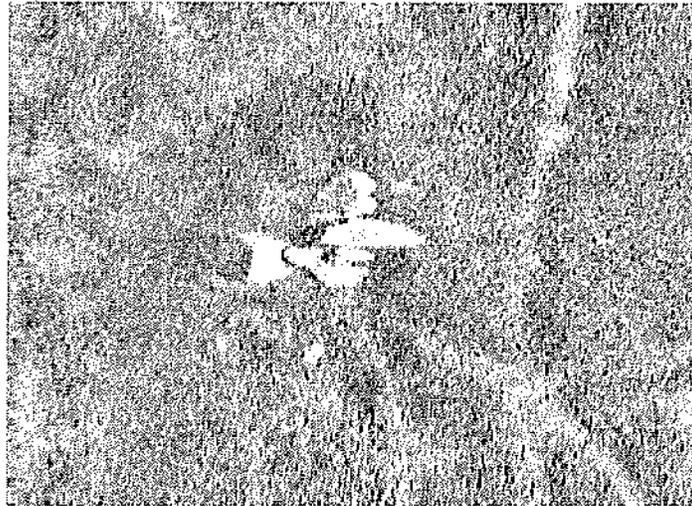
Sonar Web V3.13M PRO

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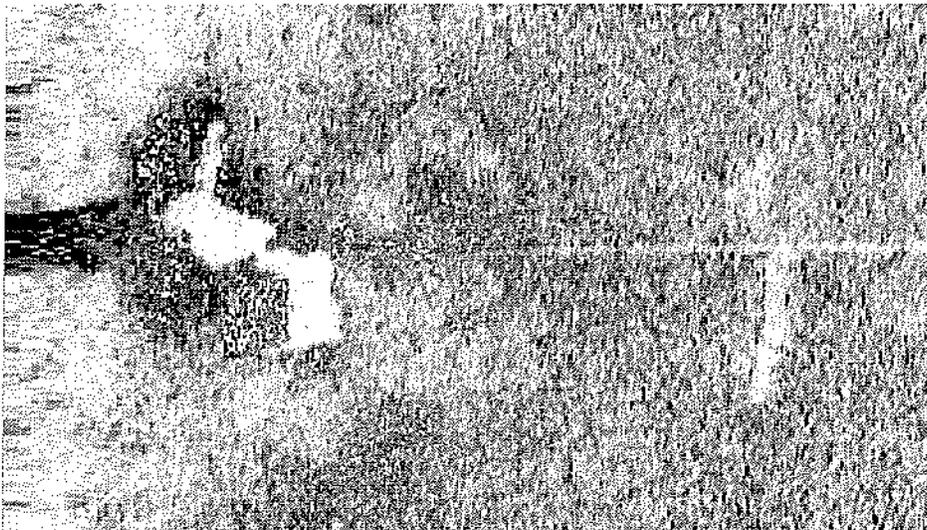
SonarWeb V3.13M PRO

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Inc\SonarWeb\Channel\SlantRangeCorrected\31chan-BAC.CMN

File Creation Time: 11/19/02 15:33:07

First Target Ping Num: 139 at 10/21/2002 14:51:05

Target Location: 41° 37.7317' N 070° 54.6163' W



Target # C31-2

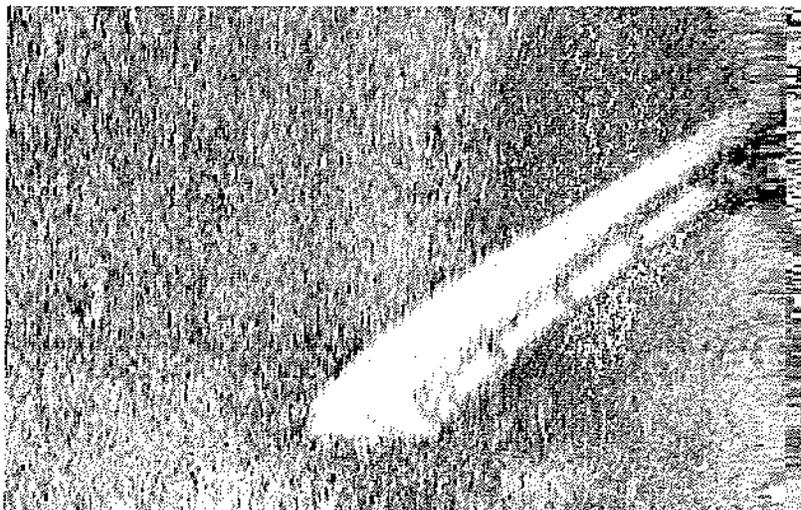
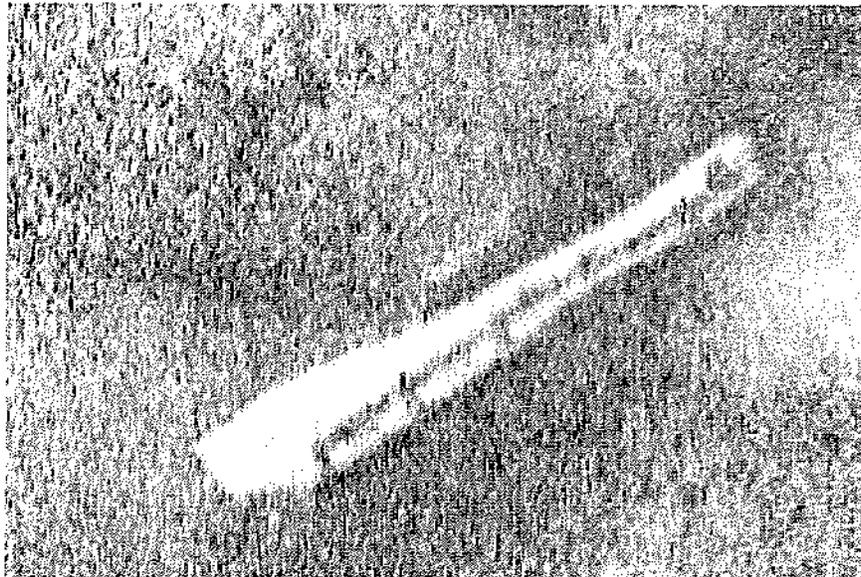
SonarWeb V3.13M PRO

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\31chan-BAC.CMN

File Creation Time: 11/19/02 15:33:27

First Target Ping Num: 2399 at 10/21/2002 14:52:29

Target Location: 41° 37.7909' N 070° 54.6584' W



Target # C33-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\33chan-BAC.CMN
File Creation Time: 11/19/02 15:34:26
First Target Ping Num: 1246 at 10/21/2002 15:03:06
Target Location: 41° 38.0824' N 070° 54.7976' W



Target # C35-3

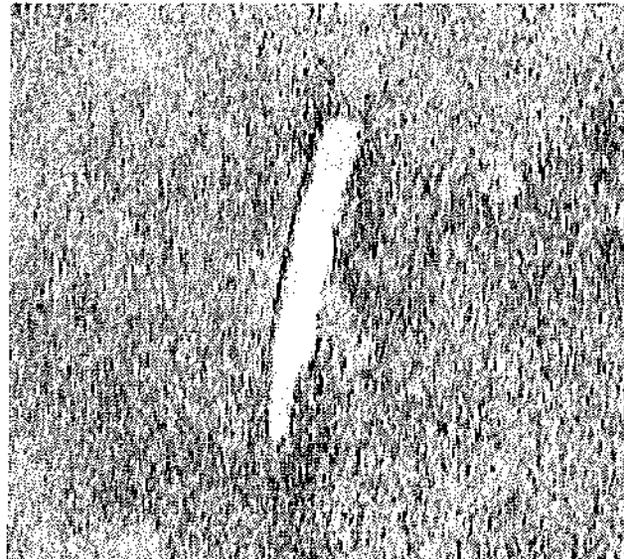
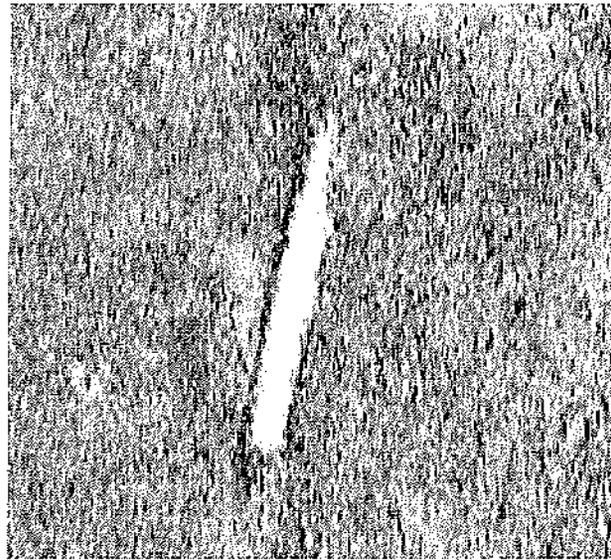
SonarWeb V3.13M PRO

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\35chan-BAC.CMN

File Creation Time: 11/19/02 15:37:59

First Target Ping Num: 415 at 10/21/2002 15:11:14

Target Location: 41° 37.7420' N 070° 54.5754' W



Target # C37-1

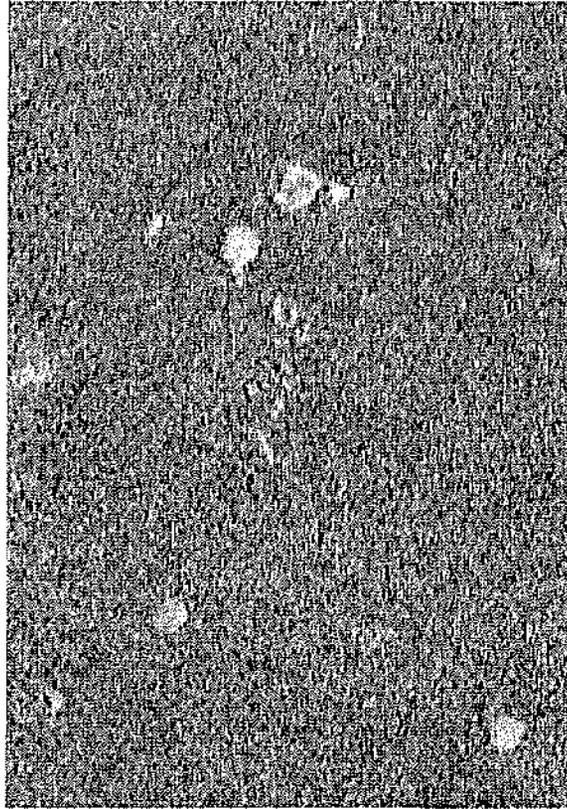
SonarWeb V3.13M PRO

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\37chan-BAC.CMN

File Creation Time: 11/19/02 15:38:25

First Target Ping Num: 3337 at 10/21/2002 15:23:07

Target Location: 41° 38.0097' N 070° 54.7183' W



Target # C37-2

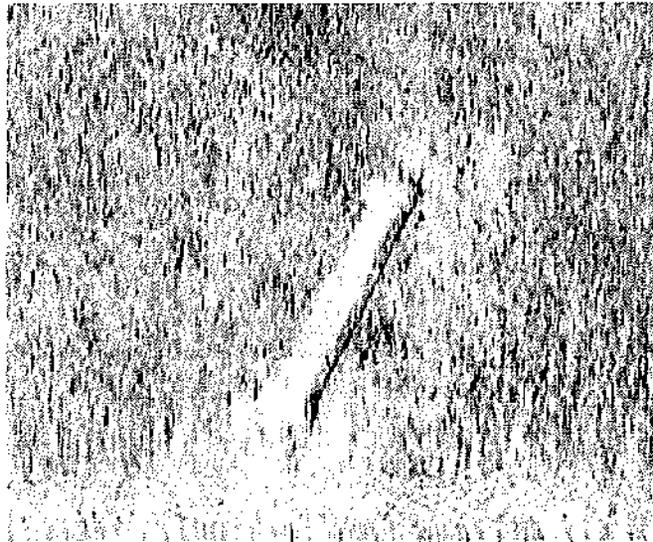
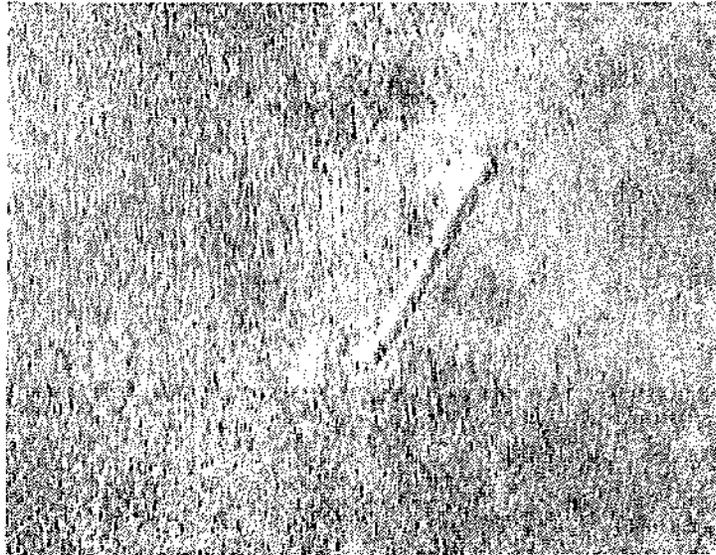
SonarWeb V3.13M PRO

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\37chan-BAC.CMN

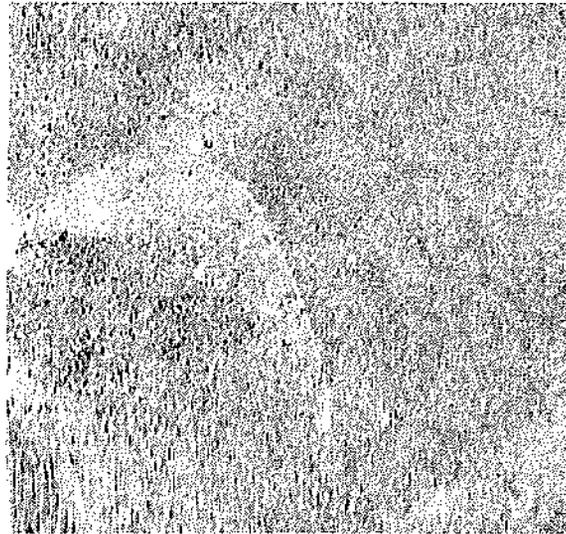
File Creation Time: 11/19/02 15:40:54

First Target Ping Num: 10851 at 10/21/2002 15:27:49

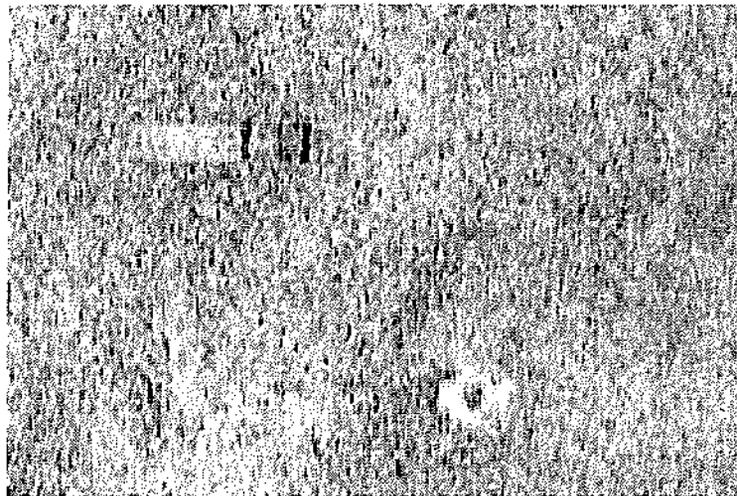
Target Location: 41° 37.7658' N 070° 54.5651' W



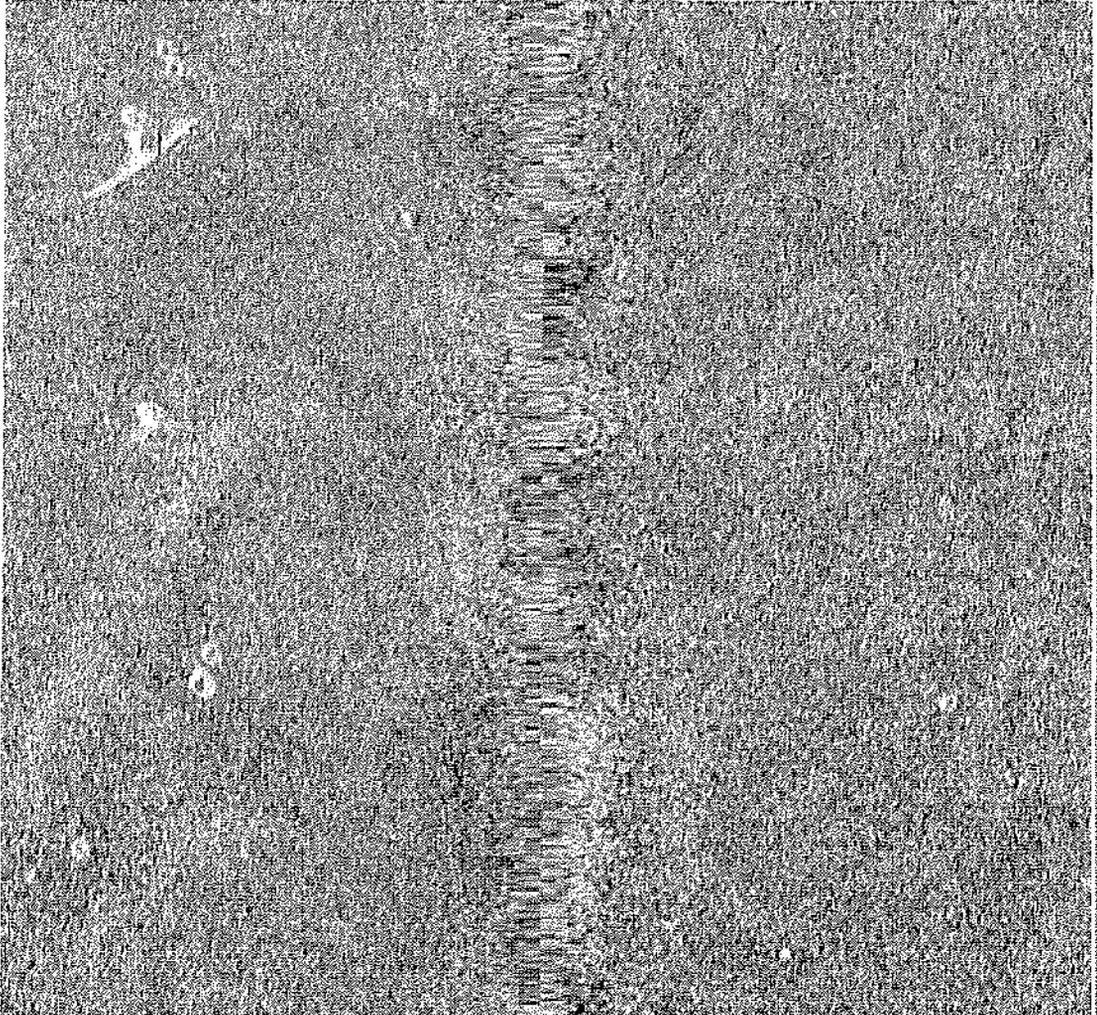
Target # C39-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\39chan-BAC.CMN
File Creation Time: 11/19/02 16:38:07
First Target Ping Num: 12674 at 10/21/2002 15:37:14
Target Location: 41° 38.0526' N 070° 54.7209' W



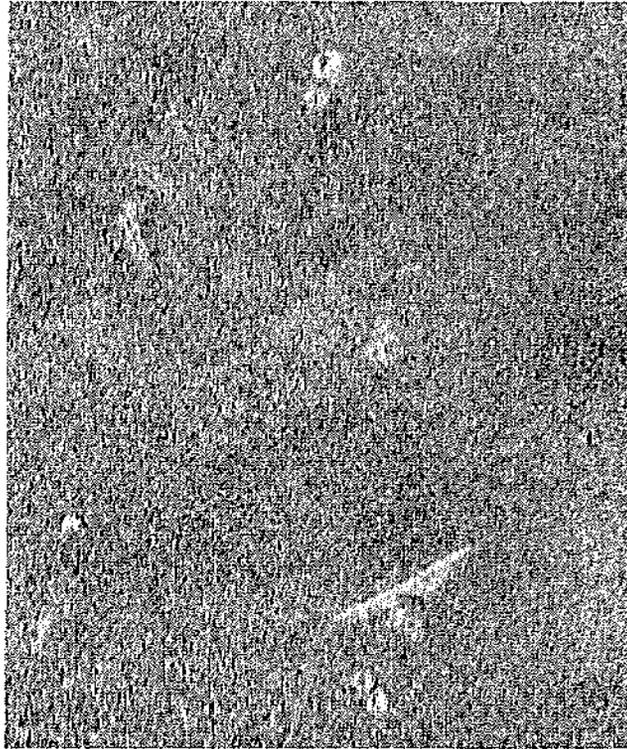
Target # C39-2
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\39chan-BAC.CMN
File Creation Time: 11/19/02 16:38:29
First Target Ping Num: 9321 at 10/21/2002 15:35:08
Target Location: 41° 37.9714' N 070° 54.6694' W



Target # C39-3
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\39chan-BAC.CMN
File Creation Time: 11/19/02 16:38:43
First Target Ping Num: 7943 at 10/21/2002 15:34:17
Target Location: 41° 37.9385' N 070° 54.6510' W



Target # C41-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\41rchan-BAC.CMN
File Creation Time: 11/19/02 16:39:44
First Target Ping Num: 5711 at 10/21/2002 17:02:49
Target Location: 41° 37.7838' N 070° 54.5322' W



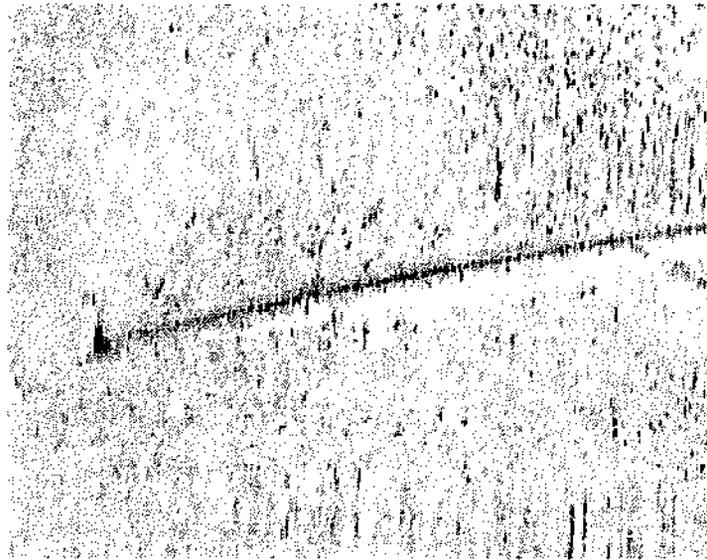
Target # C41-1
SonarWeb V3.13M PRO
**Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\Channel\SlantRangeCorrected\41rchan-BAC.CMN**
File Creation Time: 11/19/02 16:39:44
First Target Ping Num: 5711 at 10/21/2002 17:02:49
Target Location: 41° 37.7838' N 070° 54.5322' W

APPENDIX B
Detail Side Scan Images
Popes Island North Area



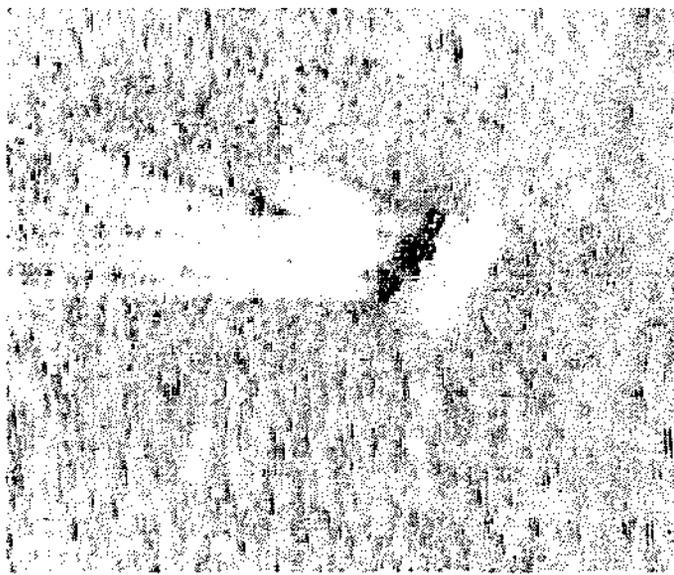
Target # P4-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\04popes-BAC.CMN
First Target Ping Num: 4117 at 10/23/2002 17:59:56
Target Location: 41° 38.5894' N 070° 54.9566' W



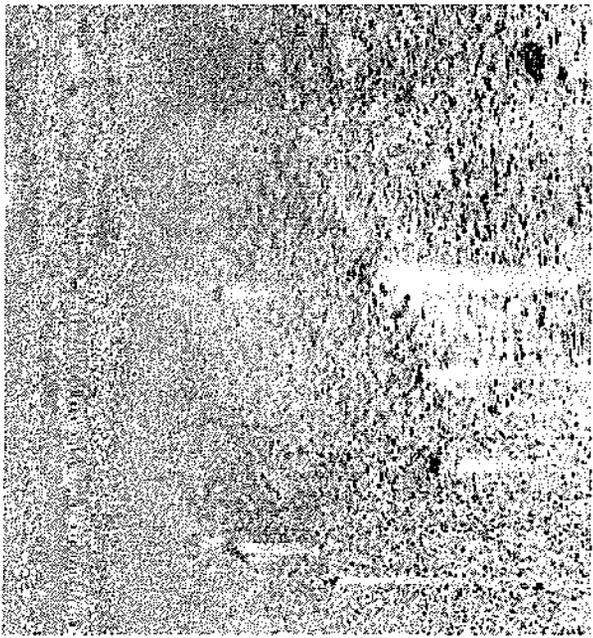
Target # P4-2

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\04popes-BAC.CMN
First Target Ping Num: 3520 at 10/23/2002 17:59:33
Target Location: 41° 38.6064' N 070° 54.9768' W



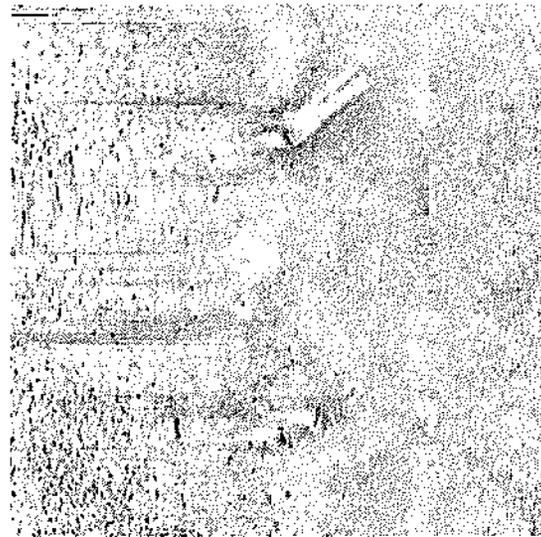
Target # P6-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\06popes-BAC.CMN
First Target Ping Num: 6434 at 10/23/2002 17:54:43
Target Location: 41° 38.6559' N 070° 54.9933' W



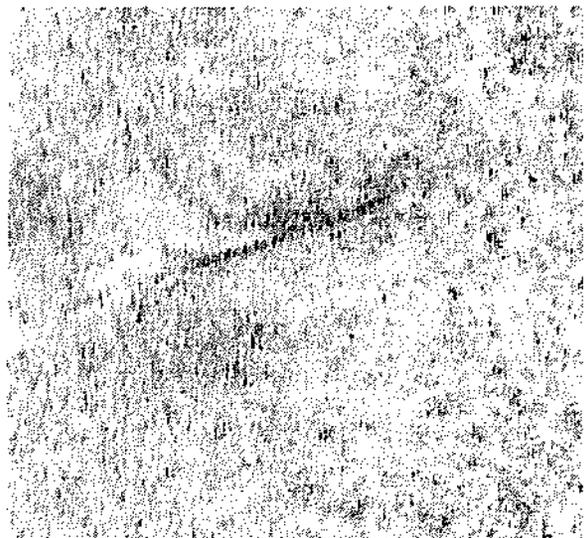
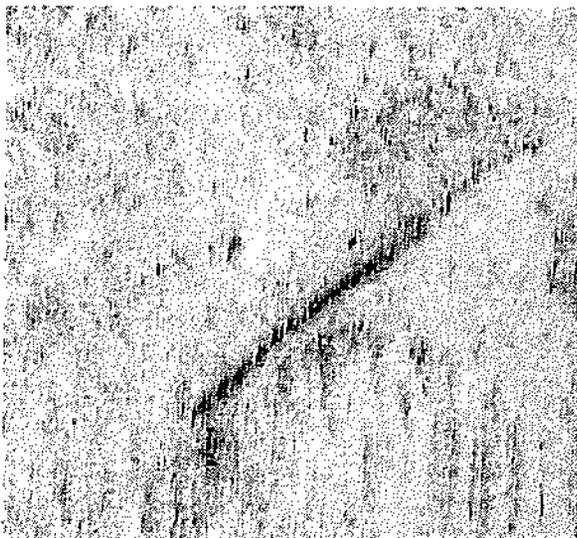
Target # P8-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\08popes-BAC.CMN
First Target Ping Num: 7346 at 10/23/2002 17:48:25
Target Location: 41° 38.5349' N 070° 54.8380' W



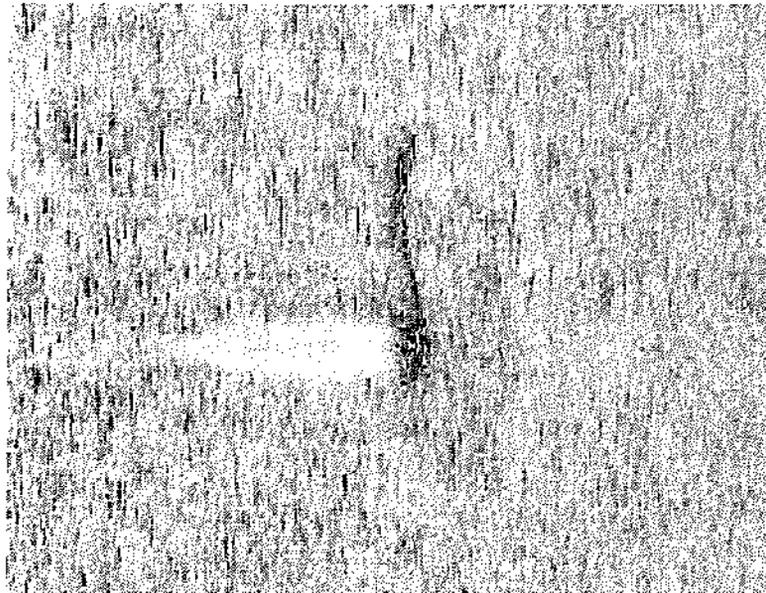
Target # P13-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\13popes-BAC.CMN
First Target Ping Num: 383 at 10/23/2002 12:45:34
Target Location: 41° 38.7706' N 070° 55.0220' W



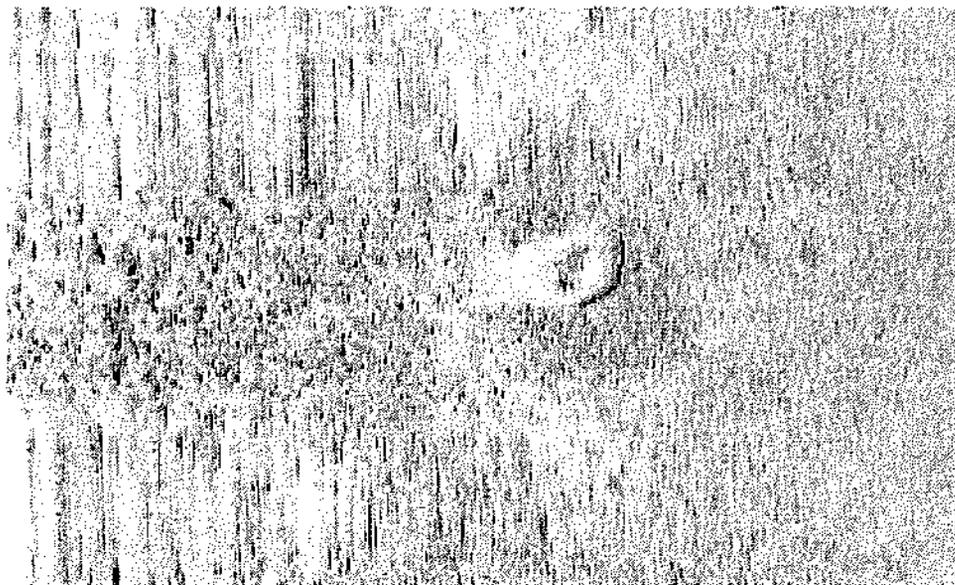
Target # P22-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\22rpopes-BAC.CMN
First Target Ping Num: 6604 at 10/23/2002 15:26:44
Target Location: 41° 38.7015' N 070° 54.8190' W



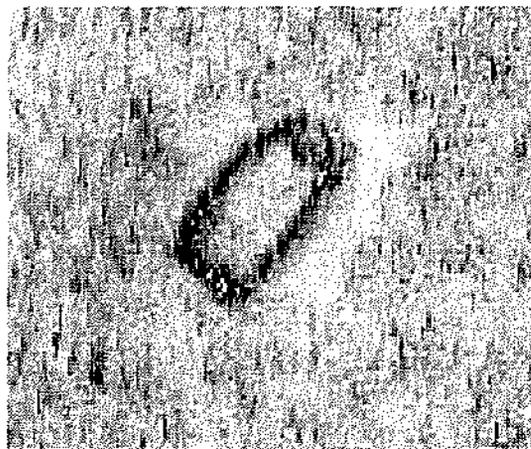
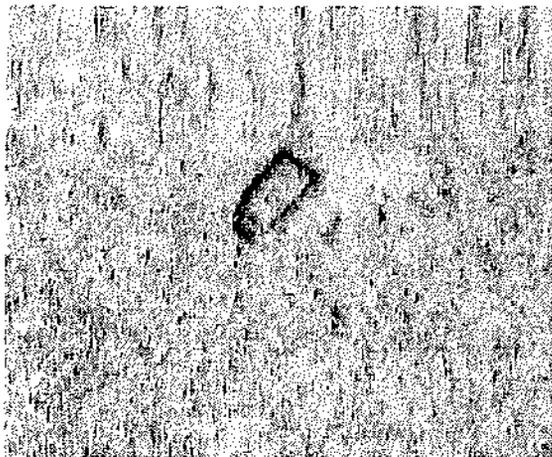
Target # P24-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\24popes-BAC.CMN
First Target Ping Num: 1716 at 10/23/2002 14:58:10
Target Location: 41° 38.5588' N 070° 54.6286' W



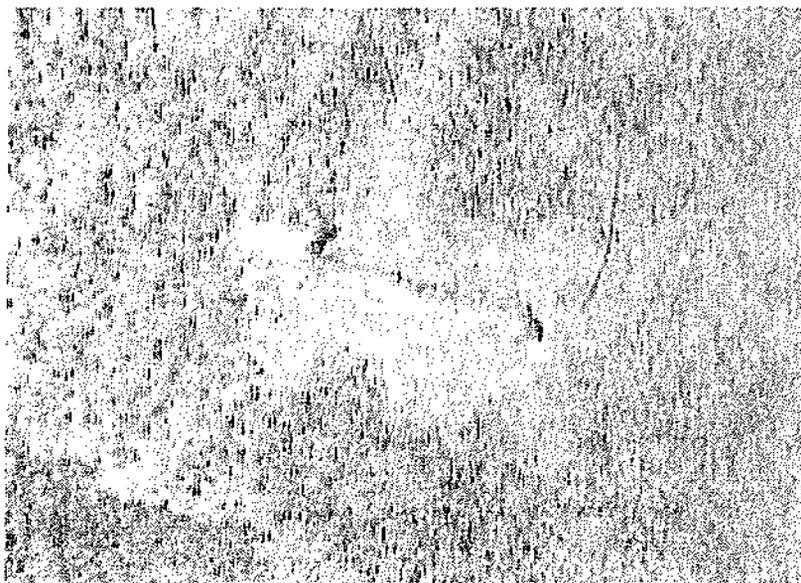
Target # P24-2

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\24popes-BAC.CMN
First Target Ping Num: 2188 at 10/23/2002 14:58:27
Target Location: 41° 38.5723' N 070° 54.6404' W



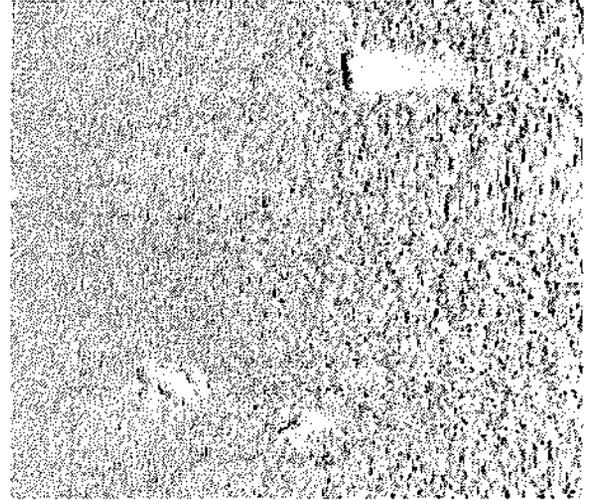
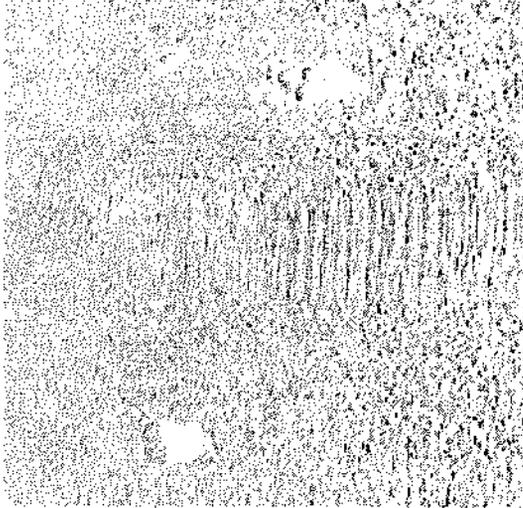
Target # P26-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\26rpopes-BAC.CMN
First Target Ping Num: 4406 at 10/23/2002 14:49:43
Target Location: 41° 38.7815' N 070° 54.8469' W



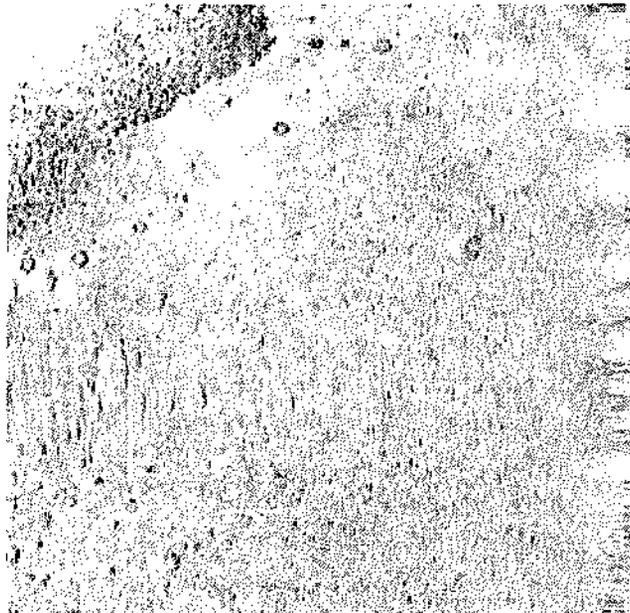
Target # P28-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\28popesd-BAC.CMN
First Target Ping Num: 4679 at 10/23/2002 14:36:39
Target Location: 41° 38.6508' N 070° 54.6768' W



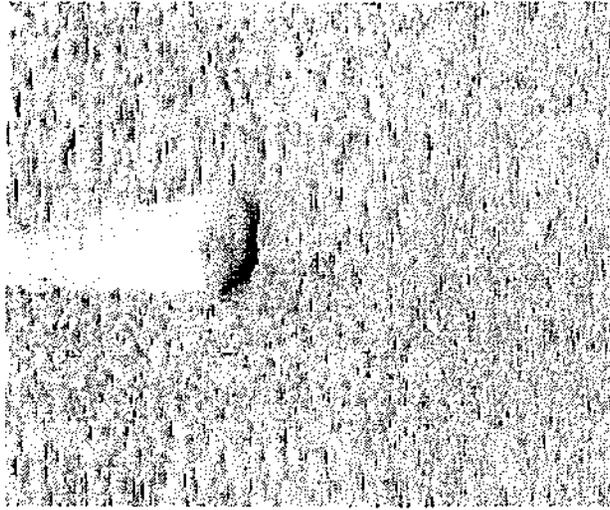
Target # P28-2

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\28popesd-BAC.CMN
First Target Ping Num: 11022 at 10/23/2002 14:40:37
Target Location: 41° 38.7876' N 070° 54.8212' W



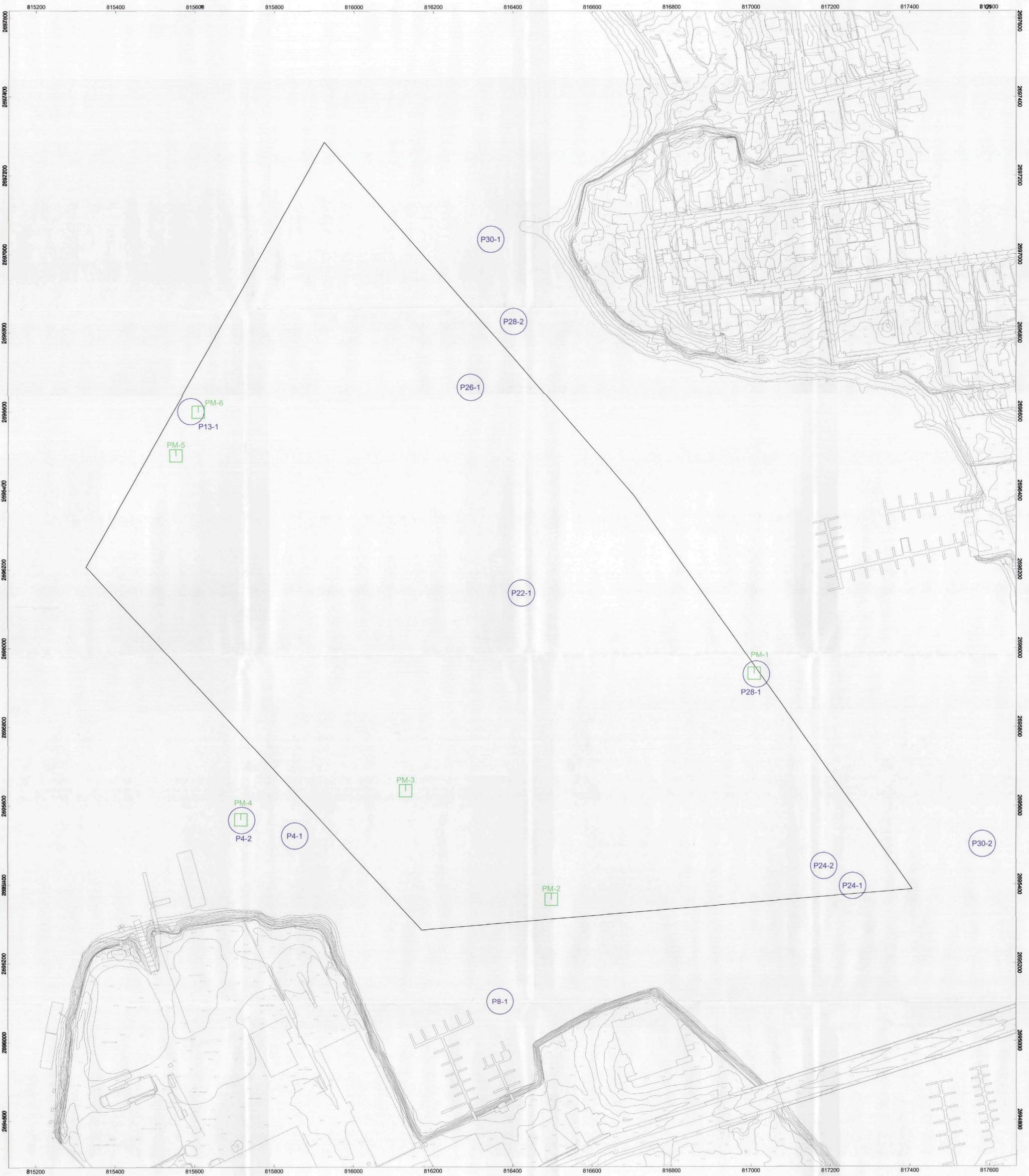
Target # P30-1

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\30popes-BAC.CMN
First Target Ping Num: 3634 at 10/23/2002 14:25:16
Target Location: 41° 38.8340' N 070° 54.8502' W



Target # P30-2

Sonar Filename: C:\Program Files\Chesapeake Technology,
Inc\SonarWeb\popes\SlantRangeCorrected\30popes-BAC.CMN
First Target Ping Num: 14724 at 10/23/2002 14:32:12
Target Location: 41° 38.5810' N 070° 54.5852' W



NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using a Geometrics G-881 Cesium magnetometer float on the water surface. Planned line spacing of 50 feet.

LEGEND:

	AREA OF INTEREST TARGET
	NON-INTEREST TARGET
	SIDE SCAN SONAR ANOMALY



REV.	DESCRIPTION	BY:	DATE:

HAZARDS & CULTURAL IDENTIFICATION - SUMMARY

**POPE ISLAND NORTH AREA
NEW BEDFORD HARBOR, MA**

INTERPRETED TARGETS

 80 Congress St
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=100'
DATE: 12/20/02

DRAWN BY: TM	DESIGN BY: TM	CHECKED BY: JAB	PROJECT: 0510.002	
			SHEET 8 OF 8	