PORTSMOUTH HARBOR AND PISCATAQUA RIVER
NEW HAMPSHIRE AND MAINE
NAVIGATION IMPROVEMENT STUDY
FEASIBILITY REPORT

APPENDIX F
GEOTECHNICAL INVESTIGATIONS

PORTSMOUTH HARBOR AND PISCATAQUA RIVER
GEOTECHNICAL INVESTIGATIONS

Project

The purpose of this project is to dredge the existing channel and modify the existing Federal navigation project on the Piscataqua River in Portsmouth, New Hampshire to increase the width of the upper turning basin to a 1200 foot radius. The authorized depth of the Federal Channel is 35 feet below MLLW and the target maximum dredge depth is 39 feet below MLLW.

Location of Project

Portsmouth Harbor is located at the mouth of the Piscataqua River, about 45 miles northeast of Boston Harbor, Massachusetts. The river forms the boundary between the states of New Hampshire and Maine. The existing Federal project includes a 35-foot deep channel, 400 feet wide, extending from deep water in Portsmouth Harbor (river mile 2.6) upstream to river mile 8.8. The project includes widening the bends at Henderson Point, Gangway Rock, Badgers Island, the Maine-New Hampshire interstate Bridge, and Boiling Rock, a 950-foot wide turning basin upstream of Boiling Rock, and an 850-foot wide turning basin near the upstream end of the Federal channel. The turning basin is located between the Nannie Island Fault to the Southeast and the General Sullivan Fault to the Northwest. The Nannie Island Fault is a strike slip fault while the General Sullivan Fault is a ductile shear zone.

Previous Explorations

On 21-22 December 2006, Ocean Surveys, Inc. (OSI) conducted a geophysical survey of the project site. The materials encountered appeared to provide several interfaces that may be changes in material type or changes in density. Unfortunately, the soils at the site are dense and therefore difficult to evaluate with the equipment that was used. In September 2007, eight test borings and three probes were drilled to measure the soil parameters at the site and to field verify the OSI results. The borings were terminated at approximately elevation -40 feet MLLW. The probes were advanced to refusal assumed to be bedrock. Rock was only encountered in test boring B-6 at elevation -27 feet. The rock was penetrated for 18 feet. The rock encountered may be bedrock or a very large erratic boulder. Either way, it is a hard fine grained rock which will likely require blasting prior to excavation. The soil boring locations are shown on Figure 1. Logs for borings B-1 through B-8 and Probes P-1 through P-3 are included later in this Appendix. Ten representative samples of the soils were tested for grain size and one Atterberg Limit test was conducted on the clay material obtained from boring B-5. The laboratory results are presented later in this Appendix. It should be noted that borings B-1 and B-3 are both outside of the proposed turning basin.

Figure 1 - Location of Borings and Probes in Upper Turning Basin Expansion Area

Overburden Materials

Along the Piscataqua River, surficial geologic material consists of marine regressive deposits (PMRS generally composed of sand, gravel, and silt) and drumlinoid deposits of surficial materials that strike northwest-southeast.

The mud line varies from elevation -2 to -19 ft MLLW. The materials at the mud line are silty fine sand and sub-angular gravel. They appear to be outwash deposits which were deposited during medium to high flow conditions within the river banks. The silt tends to thicken towards the north and east to approximately 10 feet at B-5. The thick deposit was determined to be a low plasticity clay with a liquid limit of 35 and a plastic limit of 17. The remaining overburden material is generally sand and gravel that appears to have been washed clean of fine grained soils. The quantity of gravel determines the density of the material. Typically, “N” values were between 7 and 13 within the fine sand, between 10 to 29 in medium sand, and coarse sand and gravel between 27 and 62. The “N” value is the number of blows required to drive a standard 2-inch spoon one foot with a 140 pound hammer dropped 30 inches. The coarse material is not suitable for measurement using a standard split spoon, typically resulting “N” values that are artificially high. The sampling spoon was only plugged with a rock on two occasions, which suggests that there is little coarse gravel or larger stones in the formation. However, many of the samples from borings B-5, B-7 and B-8 had little or no recovery. When the recovery was insufficient, a three-inch spoon was driven with a 300 pound hammer to collect a representative sample. The three inch spoon was driven approximately one foot. The material collected was likely scraped from the side of the boring and is not necessarily representative of the foundation within that interval. The soil boring logs indicated that the roller bit encountered significant amounts of gravel in layers between samples. It is therefore concluded that most of the gravel encountered during the sampling process was pushed aside. The foundation materials appear to become denser at or just above the bedrock surface.

The probes were driven through the overburden to refusal without sampling. Casing blows were recorded for the first probe. From 19 feet to 58 feet, the blows ranged between 21 and 29 per foot, and the blows between 53 feet and the bottom of the hole ranged from 34 to 56 per foot. This suggests that the material encountered was consistently deposited. The data for material encountered in the uppermost 7 feet of boring B-5 was fine sand and silt which might not be suitable for beach nourishment The top 4 inches of material was black.

On 2 June 2009, USACE conducted 22 Van Veen grab samples from a 75 foot grid north of boring B-6 to supplement the data from sediment cores collected in 2007 to ensure that there are not areas of fine grained sediments not suitable for beach nourishment. Sediments in the sample area consisted of poorly sorted sand, gravel, cobble, and shell with scattered pockets of fine sand and silt. Six locations where no sample was obtained were attributed to a rocky bottom or coarse material preventing the grab from closing. Three of these adjacent to the existing dredged channel may be bedrock at approximate elevation -15 feet. Only two probes encountered fine sand and silt. They are located adjacent to boring B-5 and at grab location 21 which is 75 feet further north. None of the samples had any organic odor. Based on this sampling, all the overburden material is classified suitable for placement on beaches.

Bedrock

The rock core recovered from geotechnical boring B-6 appears to be gray phyllite, rather than gneiss as noted in the boring log. Riverbed geomorphology and stratigraphic framework in the Piscataqua River at the site consists of the Eliot Formation of the Merrimack Group. The bedrock is generally thin bedded gray calcareous and ankeritic quartz-biotite-chlorite phyllite and metasiltstone, and dark gray biotie-chlorite-muscovite phyllite. The Elliot formation ranges from metamorphosed to more metamorphosed argillaceous, sedimentary rocks that are Precambrian in age. In the least metamorphosed portions of the formation, predominantly easily-weathered quartzose and calcareous slates, gray on fresh surface , turn buff-colored when normally exposed. With an increase in the grade of metamorphism, biotite begins to form and the fresh rocks become purplish-brown biotie schist, the more quartose become quartz-mica schist and the calcareous rocks become biotite-actinolite schist and green-gray actinolite granulite. The uppermost section of the Eliot formation consists of the Calef member which is primarily recognized as a black phyllite with some green quartz-chlorite phyllite. Outcrops of the Eliot formation consist of a mix of the rock types described above in alternating beds a few inches to a few feet thick. The Elliot Formation strikes northeast and dips steeply southeast (70 degrees). Compositional layering in the metamorphic rock of the Elliot Formation has been documented in the area of the General Sullivan Fault. A diabase dike outcrops on the south bank of the Piscataqua River and strikes northeast with a near vertical dip.

See the OSI report for the regional geology attached at the end of this appendix. The report indicates that the seismic reflection survey was unable to differentiate between acoustic basement composed of bedrock or of glacial till. The surface of the acoustic basement exhibits significant relief as shown in the cross-sections.

The bedrock encountered in test boring B-6 located nearest the channel towards the northwestern end of the turning basin was encountered at the depth of the acoustic basement reflector recorded in the seismic reflection survey. Therefore, the northwestern portion of the seismic survey appears to be composed of bedrock. The top of rock as determined by the refusal depth of the geotechnical probes does not correspond with the acoustic basement. The acoustic basement is assumed to be either composed of glacial till or bedrock. Probes P-1 and P-3 extended beyond the depth of the acoustic basement, while P-2 encountered refusal shallower than acoustic basement. P-1 and P-3 are both located in the vicinity of B-5 to the north of B-6. Refusal of probe P-2 may be due to a boulder or a bedrock pinnacle. An acoustic basement high is located in the southeast portion of the seismic reflection survey area. No borings or probes have been conducted in this area. The basement high is located along strike of the onshore biabase dike, which may suggest that the high is composed of bedrock.

The boring logs indicate the bedrock is a metamorphosed granitic rock with similar banding and properties to the Eliot formation. It is a slightly weathered fine grained rock with two joints in the ten feet cored. The joints were at 19.9 and 23.6 foot depths dipping 50 and 60 degrees from the horizontal. The rock drilled at a rate of three to four minutes per foot produced 100 percent recovery with an RQD of between 92 and 94 percent. The uppermost 6 feet of bedrock was not cored. The weathering at the surface of the bedrock is unknown, but is likely slight to moderate based on the way it drilled with a roller bit. The wash water was cloudy gray, and tailings appeared to be crushed rock. The section of the cored rock between 18 and 19 feet contained pitted voids.

Construction Concerns

The overburden is rounded or sub-angular and should be removable with a mechanical dredge. The borings are spaced at approximately 100 yards so there is a high degree of uncertainty about the amount of bedrock which will be encountered. The side scan sonar may have indicated some boulders near the surface. Additional probes and test borings are recommended to further identify the extent of the rock. There was no evidence of other large erratic boulders. The rock encountered in boring B-6 is hard, intact, and apparently only slightly fractured. Removal of ten feet of this rock, including 2 feet of over-dredging, will require blasting.

The cut for the turning basin will be approximately 20 feet high and the side slope can be cut to 1V to 3H. It is thought that steeper slopes may be stable, but the prop wash from tug boats in the basin would erode the side slopes resulting in sloughing and possible need for more frequent dredging.

A total of 74 magnetic anomalies indicate that there may be man-made debris on the bottom. None of the anomalies indicated that they were too large to be excavated.

FINAL REPORT

MARINE GEOPHYSICAL INVESTIGATION
NAVIGATION CHANNEL IMPROVEMENT PROJECT
PISCATAQUA RIVER
PORTSMOUTH, NEW HAMPSHIRE

OSI REPORT NO. 06ES102-NH

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17 September 2008

TABLE OF CONTENTS

FIGURES

FINAL REPORT

Marine Geophysical Investigation
Navigation Channel Improvement Project
Piscataqua River
Portsmouth, New Hampshire

1.0 INTRODUCTION

Ocean Surveys, Inc. (OSI) conducted a marine geophysical investigation in the Piscataqua River in Portsmouth Harbor, New Hampshire on 21 and 22 December 2006 (Figure 1) in support of the United States Army Corps of Engineers (USACE), New England District, proposed navigation channel improvement project. The project site is specifically located at the northernmost end of the federally maintained navigation channel, immediately northwest of Frankfort Island and Mast Cove. The site actually borders Eliot, Maine to the northeast and Newington, New Hampshire to the southwest. The project proposes to dredge a turning basin on the east side of the channel between red nun buoys #10 and #12 to increase the area available for commercial vessel maneuverability off from the Sprague Energy Terminal.

This investigation was designed to provide information both for a marine archaeological assessment of the riverbed and an evaluation of geologic conditions in the project depth of interest. A proposed maximum dredging depth of 45 feet below MLLW (mean lower low water) was noted in the final scope of work (SOW) dated 6 November 2006. The study was performed under contract with The Public Archaeology Laboratory, Inc. (PAL) who are responsible for the marine archaeology portion of the project.

In support of the marine archaeological and geological site assessments, the primary objectives of the marine geophysical investigation thus included (1) the identification of natural and man made objects on and below the bottom and (2) high resolution seismic data acquisition down to 52 feet MLLW and an overall assessment of subsurface conditions to 70 feet MLLW.

The intent of objective no. 2 was to identify the presence of coarse glacial till (cobbles, boulders) and bedrock that may adversely affect dredging operations within the depth of interest. The subbottom profile data were also reviewed to provide information on any seismic facies suggestive of paleo-environments, such as buried channels and shorelines, that might represent potential pre-historic cultural sites.

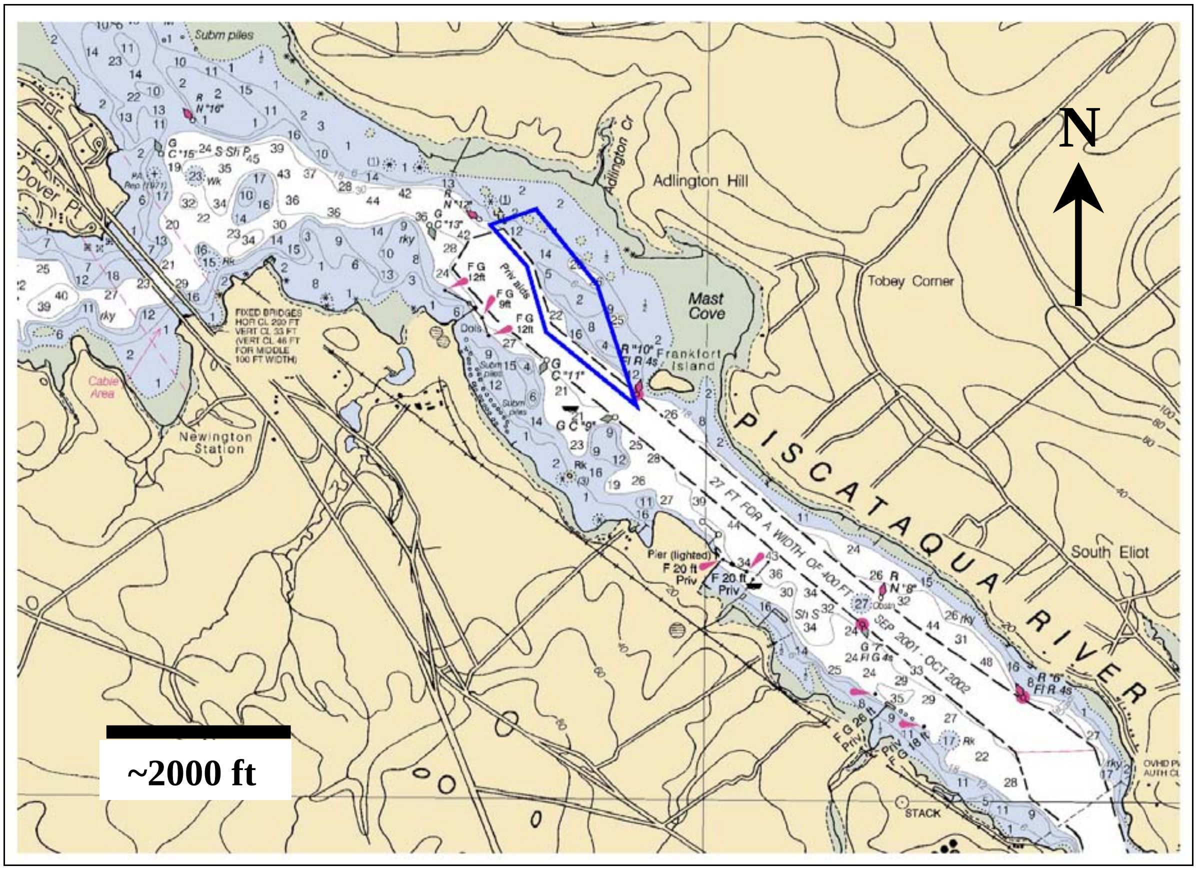

Figure 1. Location of the area investigated for this project (site limits in blue). Nautical chart no. 13285 in background.

1.1 Project Tasks

To accomplish the goals and objectives discussed above, the following survey tasks were completed in support of the proposed channel improvement project in the Piscataqua River:

- **Side scan sonar survey** to identify coarse materials as well as natural and man-made acoustic targets on the bottom
- **Magnetic intensity survey** to identify objects composed of ferrous materials on and below the bottom
- **Subbottom profile survey** to map subsurface stratigraphy and possible large buried obstructions to the depth of interest

At the request of the USACE, no hydrographic survey work was performed during this investigation. Original depth to acoustic basement calculations, completed for the earlier draft of this report, were based on historical hydrographic data provided by the USACE. In April 2008, the USACE provided depth data from an August 2007 hydrographic survey (multibeam) conducted by the USACE as well as geotechnical data acquired in September 2007 for correlation with seismic profiles. Revision of the June 2007 OSI draft report has resulted in this final report which presents the results of the analysis and correlation of updated USACE data sets with the OSI geophysical interpretations, generating new depth to primary acoustic basement calculations.

2.0 GEOLOGIC SETTING

Riverbed geomorphology and stratigraphic framework in the Piscataqua River near Mask Cove and Frankfort Island consists primarily of rocks of the 'Merrimack Group', specifically the Eliot Formation (Billings, 1980). The Merrimack Group generally covers southeastern New Hampshire and the southern tip of Maine. The rocks of the Eliot Formation ("Sze" on the bedrock geology map; Anderson, 1985) range from somewhat metamorphosed to more metamorphosed, argillaceous, sedimentary rocks (green schist facies) that are Silurian-PreCambrian in age. In the least metamorphosed portions of the formation, predominantly easily-weathered, quartzose and calcareous slates, gray on fresh surfaces, turn buff-colored when normally exposed. With an increase in the grade of metamorphism, biotite begins to form and the fresh rocks become purplish-brown biotite schist, the more quartzose become quartz-mica schist, and the calcaleous rocks become brown biotite-actinolite schist and green-gray actinolite granulite (Billings, 1980). Quartzites are estimated to constitute approximately 15% of the formation (Freedman, 1950).

The uppermost section of the Eliot formation consists of the Calef Member which is primarily recognized as a black phyllite with some green quartz-chlorite phyllite. Maximum thickness of the Calef Member is estimated at 800 feet while the entire formation in this region is believed to extend up to 6,500 feet deep (Freedman, 1950). Outcrops of the Eliot Formation consist of a mix of the rock types described above in alternating beds a few inches to a few feet thick.

The Piscataqua River bottom in the site is comprised of an extremely wide range of materials from fine grained sediments (such as silt nearshore, outside the stronger current flows in the channel), to coarse glacial till (including gravel, cobbles, and possibly boulders). The extreme tidal range in this area generates high velocity currents which can inhibit the deposition of most finer materials, leaving only coarser deposits on the riverbed.

3.0 SURVEY AREA AND TRACKLINES

The project site covers an approximate 900 foot by 2,600 foot shoal area east of the Piscataqua River federal navigation channel between red nun buoys #10 and #12. The site is offshore from Adlington Creek and Mast Cove, and extends approximately 100 feet out into the federal channel (Figure 2). The table below lists the corner coordinates of the survey area. Due to the absence of water in the site during low tide, all survey work had to be completed around high tide, with the exception of a few lines along the edge of the channel.

Piscataqua River Survey Area Limits

Point	Easting (feet) *	Northing (feet) *
1	2781542.5	105206.7
2	2782299.3	104257.0

Point	Easting (feet) *	Northing (feet) *
3	2782784.7	102743.9
4	2781666.7	103670.2
5	2781430.9	104492.0
6	2780980.4	105009.4

*Note: Site limit coordinates referenced to the Maine State Plane Coordinate System, West Zone 1802, NAD 83.

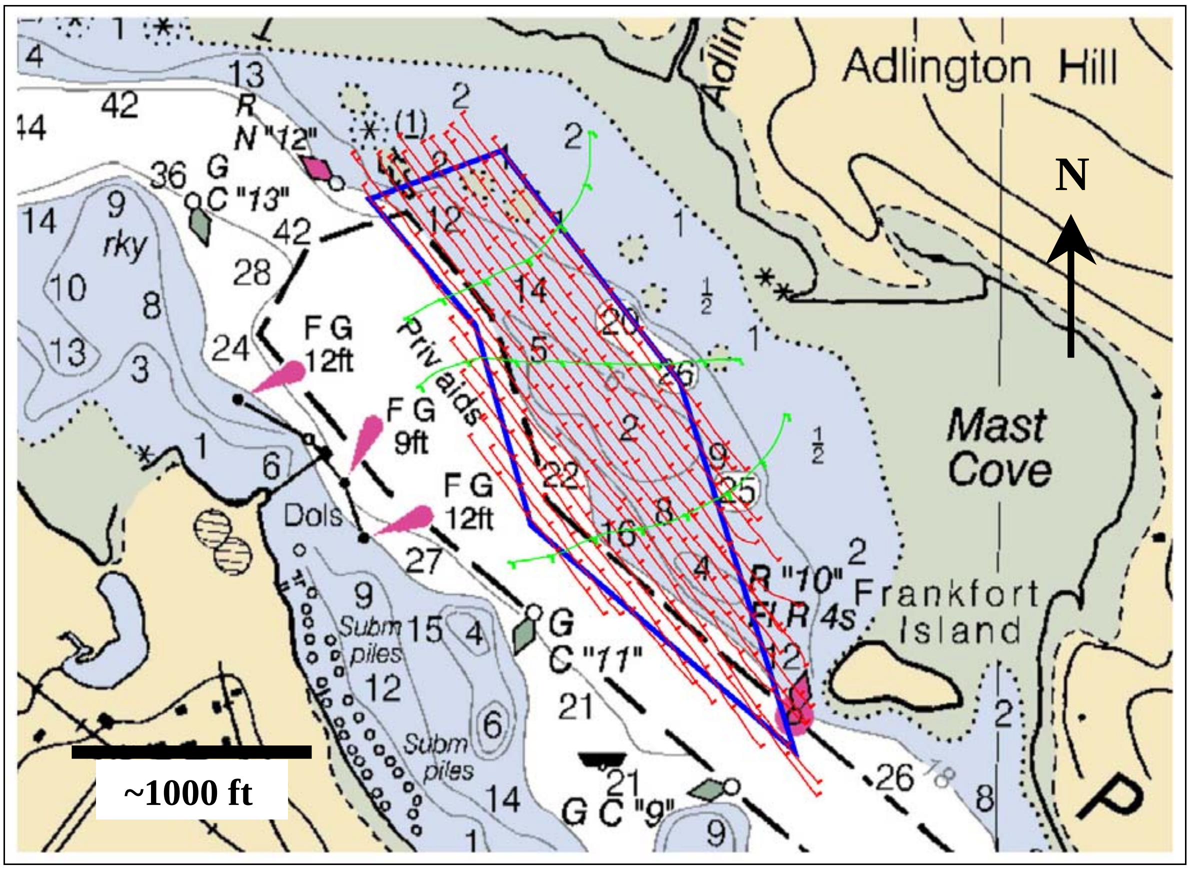

Figure 2. Primary survey tracklines (red) and tielines (green) in the project site (outline in blue), overlaying chart no. 13285.

Primary survey tracklines were spaced 50 feet apart throughout the entire survey area and were oriented generally parallel to the main axis of the channel (see Figure 2). Magnetic intensity measurements were collected on every primary line, while side scan sonar imagery and subbottom profiles were recorded on every third line at a minimum. This included Lines 1, 4, 7, 10, 12, 15, and 18. Tielines were surveyed through the site (Lines 19, 20, 21) and oriented generally perpendicular to the primary survey lines, based on the preliminary field review of subsurface data. Only subbottom profile data were collected along the tielines.

4.0 SURVEY EQUIPMENT OVERVIEW

The major equipment systems mobilized to the Piscataqua River for this investigation, and a brief description of their operation, are listed below. A complete discussion of this equipment along with the operational procedures employed to collect the data for this project can be found in Appendix E. Specification sheets for all the equipment used can be found in Appendix F.

Synopsis of Survey Equipment Operations

Equipment System	Description
Trimble 4000RS DGPS Receiver	Global positioning system receiver capable of tracking up to 9 satellites simultaneously; interfaced with Trimble ProBeacon receiver and HYPACK® navigation computer.
Trimble ProBeacon USCG Beacon Receiver	Beacon receiver which receives USCG differential corrections that are input to the Trimble 4000 receiver, increasing the overall system accuracy.
HYPACK® navigation software and data logging computer	HYPACK® software runs on a Pentium notebook computer providing real time trackline control, digital data logging, and many survey utility functions; this package allows for efficient simultaneous acquisition of digital data from multiple systems.
Klein 3000 Dual Frequency Side Scan Sonar System	Side scan sonar system providing acoustic imagery of the bottom out to either side of the survey trackline; dual frequency technology allows the acquisition of high resolution images (500 kHz) and extended sweep ranges (100 kHz).
Geometrics G-882 Marine Cesium Magnetometer	Marine cesium magnetometer used to detect ferrous metal on and below the bottom to a 0.1 gamma accuracy. Measurements collected at a rate of 10 times per second.
Applied Acoustics Engineering “Boomer” Subbottom Profiling System	Powerful low frequency 0.5-8 kHz “Boomer” system used to try and penetrate coarse glacial till and adverse geologic conditions to resolve subsurface layering and lithologic structures in the stratigraphic column.

The side scan sonar towfish and magnetometer sensor were deployed off the sides of the vessel and each towed off a davit and winch to allow modificiation of sensor height along tracklines. The side scan sonar system utilized a 164 foot (50 meter) sweep range to provide high resolution imagery. Over 200% coverage of the bottom, as data were collected on parallel lines spaced 150 feet apart. The side scan sonar towfish was maintained at an altitude of 10-15% of the sweep range where possible (shallow water does not permit this). Similarly, the magnetic sensor was towed at a nominal height of 20 feet but was actually much closer in shallow water nearshore.

The subbottom profiler sound source (catamaran with transducer plate) and receiver (hydrophone array or “eel”) were towed off the vessel’s stern outside the boat propeller wash to minimize acoustic noise. The “boomer” subbottom profiler used a 100 millisecond scan rate to record a total depth profile (water and stratigraphic column) of approximately 250 feet (assumes 5,000 feet per second sound velocity in sediments). The system collects raw seismic signals in the 500-8,000 hertz range, with filtered frequencies of 800-4,000 hertz used for final display and interpretation. Laybacks and offsets to sensors were recorded in the field for application during post-survey processing.

5.0 SUMMARY OF FIELD INVESTIGATION

The marine geophysical investigation took place on 20 and 21 December 2006 under favorable weather conditions for the time of year. Calm sea states were encountered the afternoon of 20 December and morning of 21 December followed by windy, choppy conditions in the afternoon of 21 December. The field survey successfully navigated around the shoal and timed the operations perfectly around high tide. The following OSI personnel comprised the field crew for this project.

Geophysical Survey Crew:

Jeffrey D. Gardner	Geophysical Project Manager
Gregory L. Schulmeister	Geophysical Technician

The R/V Ready II (26 foot Parker Sport with dual 150 Hp outboard engines) was outfitted with the necessary geophysical equipment and support gear to complete the field investigation and transited directly from Searsport, Maine where a similar geophysical program was conducted during the seven days prior. The vessel is outfitted with an enclosed cabin and full suite of electronic navigation devices to ensure safe operations under a wide range of weather conditions. David Robinson from PAL was onboard the vessel for the duration of the field program.

5.1 Horizontal Control

Horizontal positioning of the survey vessel was accomplished by utilizing a Trimble 4000 Differential Global Positioning System (DGPS via interface to Trimble ProBeacon Reciever) which calculates geodetic coordinates referenced to the WGS-84 datum (World Geodetic System established in 1984), and equivalent to NAD 83 (North American Datum established in 1983). Differential corrections were received from the U.S. Coast Guard reference beacon at Portsmouth, New Hampshire (288 kilohertz at a transmission rate of 100 bps) with good reliability and signal strength. This DGPS configuration typically provides better than a 3 foot (sub-meter) repeatable position accuracy, as stated by the manufacturer.

The HYPACK® computer navigation software utilized aboard the survey vessel converts the geodetic coordinates (latitude-longitude) to state plane coordinates (easting-northing) for navigation while logging these position data at 1 second intervals along survey tracklines. The survey was conducted in the Maine State Plane Coordinate System (West Zone 1802), referenced to NAD 83 with all coordinates in feet. The table below lists information for the horizontal check point established at the marina dock with the DGPS system. Navigation checks were performed over this point at the beginning and end of each field day to ensure the positioning system was functioning properly and delivering the horizontal position accuracy required for the project.

Point ID	Position *	Description
Great Bay Marine Slip A1	N 103845 E 2774061	Point marked by PK nail with pink survey flagging flush with the dock. Point is positioned midway along the southeast edge of outermost dock, next to center cleat, Slip A1

*Note: Coordinates referenced to the Maine State Plane Coordinate System, West Zone 1802, NAD 83.

6.0 DATA PROCESSING AND DELIVERABLES

Data processing techniques and the methods used for analysis of the side scan sonar, magnetic intensity, and subbottom profile data are described in Appendix G. The following list details the data products generated for this project. Final drawings have been provided separately in hard copy (24x36 inch, D sheets) and digital (AutoCAD 2000) formats. Drawings have been constructed at a horizontal scale of 200 feet per inch in a plan view format. All data have been referenced to the Maine State Plane Coordinate System (West Zone 1802), NAD 83 in feet, in the horizontal plane. Vertical reference datum for the project is Mean Lower Low Water (MLLW) as dictated by the USACE April 2008 hydrographic data.

Product	Scale/Format	Description
As Appendices at End of Report		
Sonar Target List	NA Excel spreadsheet	Table of acoustic targets interpreted from the side scan sonar imagery, included in Appendix A
Magnetic Anomaly List	NA Excel spreadsheet	Table of magnetic anomalies interpreted from the total earth's magnetic field intensity data, included in Appendix B

Product	Scale/Format	Description
Geologic Cross Sections	(as shown) PDF format	Interpretation of selected subbottom profiles used to determine depth to coarse glacial till or bedrock, included in Appendix C

Product	Scale/Format	Description
Hard Copy and Digital Full Size Drawings, Separate Deliverable		
Drawing V-1	1 inch = 200 feet	Water depth contours at a 1 foot interval developed from August 1007 USACE hydrographic survey
Drawing V-2	1 inch = 200 feet	Geophysical data results; side scan sonar targets and magnetic anomaly locations as well as areas of coarse surficial material
Drawing V-3	1 inch = 200 feet	Contour map of the primary acoustic basement reflector, contour interval 1 foot

On April 24, 2008 USACE provided to OSI, an XYZ ASCII file titled "Portsmouth proposed channel aug16+17+2007 03 avg.xyz". This file contains a 3 foot by 3 foot cell matrix of soundings, referenced to MLLW (1983-2001 Tidal Epoch) based on average depth selection and is considered the full resolution data set by the USACE. Figure 3 is a plan view illustration of the hydrographic data coverage (gray) in relation to the subbottom profile transects (red) surveyed by OSI. Note that there were some gaps in the hydrographic data (greater than 3 foot by 3 foot spacing between soundings) especially in the shallow areas, in the northern corner of the survey area. A digital surface model of the multibeam hydrographic data was generated using QuickSurf DTM software to determine water depths along the subbottom profiler tracklines. Reflector depths below the bottom were measured and exported out of ReflexW seismic processing software and referenced to MLLW using the multibeam hydrographic surface.

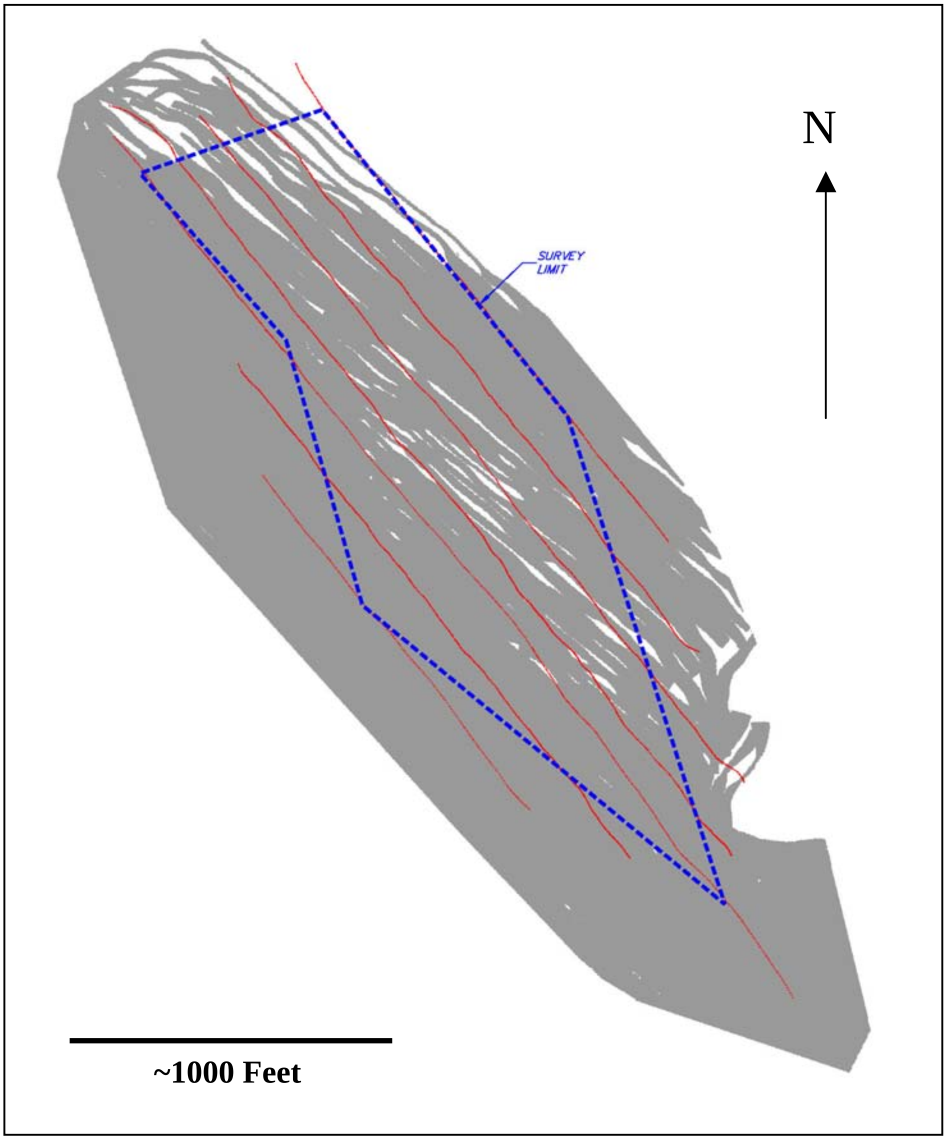

Figure 3. Illustration of the OSI 2006 subbottom data points (red) and site boundary (blue) in relation to the hydrographic data "Portsmouth proposed channel aug16+17+2007 03 avg.xyz"provided by the USACE (gray). Note, white spaces indicate holidays in hydrographic data (greater than 3 feet by 3 feet spacing between points).

7.0 SURVEY RESULTS

The following discussion of survey results references the project drawings listed above. All water depths discussed in the text are referenced to MLLW, while subsurface reflector or lithology depths may be relative to MLLW or depth below the bottom, as specified in the text. Subsurface results were developed from interpretation of the OSI geophysical data (collected December 2006) and correlated to geotechnical data (probes and borings collected in September 2007) provided by the USACE in October 2007 and June 2008. Geotechnical logs provided by the USACE for the eight borings and three probes are included in Appendix D.

7.1 Side Scan Sonar Imagery

Review and interpretation of the side scan sonar imagery reveals acoustic reflectivity representative of different sediment types and bottom features. Stronger reflectivity on the records can be related to coarser material (sand, gravel, rocks), submerged aquatic vegetation, and/or variations in bottom morphology, whereas weaker acoustic returns are typically associated with finer grained sediments (silt-clay). It is important to remember the side scan sonar system is a surface mapping tool only and does not provide information on subsurface conditions.

Based on interpretation of the sonar images, coarse glacial till (gravel, cobbles, boulders) is apparent over some portions of the site (Figure 4). Sand and gravel are suspected to dominate the remainder of the riverbed and cover a majority of the navigation channel slope. Some silt may exist closer to the Maine river bank in slightly deeper, quiescent waters infilling depressions in the bedrock surface. The shoal that covers the central portion of the site, parallel to the top of the channel slope, is at least partially comprised of coarse glacial till.

A total of 80 acoustic targets have been identified in the site from review of the side scan sonar images. Most appear as isolated, linear or oblong targets or debris fields inclusive of numerous targets. Many of the targets could be boulder-sized material (greater than 12 inches diameter) associated with the coarse glacial till in some portions of the site. In many cases, it is difficult to determine from acoustical properties only whether a target is a natural feature or man made. Non-linear targets average approximately 3 feet by 6 feet in size. Ten of the sonar targets have correlating magnetic anomalies within close proximity, suggesting the targets may be generated by nearby ferrous objects.

7.2 Magnetic Intensity Data

Measurements of the earth's total magnetic field allowed the identification of local deviations in the field due to the presence of ferrous objects on or below the riverbed. A magnetic anomaly with no associated sonar target at the same location indicates the ferrous object may be buried below the bottom. The magnetic intensity data were analyzed in order to map isolated anomalies in the site potentially generated by man made debris. Significant variation in the magnetic intensity readings exists due to shallow metamorphic bedrock and boulders in the area. The abundance of ferrous minerals in the rocks affect the total measured magnetic field, resulting in more pronounced background variations. Fluctuations in the background magnetic field generated by subsurface geology were not included in the anomaly list. A total of 74 magnetic anomalies have been identified within the limits of the designated survey area (Appendix B). Man made debris is common in harbors such as this where heavy commercial traffic has existed for years.

It is important to remember that anomalies are always measured at the sensor position along each trackline. The magnetic sensor cannot determine distance from an object which may rest at some distance offline, at the surface, or buried in the riverbed. Thus the anomaly location does not necessarily represent the exact position of the ferrous object. In some cases, the anomaly may be associated with a nearby sonar target identified from the side scan sonar imagery.

7.3 Subbottom Profile Data

The subbottom profiling method achieved subsurface penetration over a majority of the survey area where surficial materials allowed. Little to no organic-rich, gaseous deposits were evident, while apparent coarse material deposits on and below the riverbed did limit signal penetration in a number of places. It is possible these accumulations of material could be outcroppings of coarse glacial till (boulders, cobbles, gravel), piles of man made debris, or side castings of coarse dredged materials from the channel. Please refer to the interpreted subbottom profiles in Appendix C (Lines 1, 4, 7, 10, 12, 15, 18) for the following discussion.

An acoustic basement reflector was mapped from interpretation of the “boomer” subbottom profiles and correlated to the geotechnical data set. This reflector may represent either the top of coarse glacial till (mix of gravel, cobbles, and boulders with a sand matrix) or the bedrock surface underlying the site. The acoustic basement reflector is relatively weak and discontinuous in nature and the mapped surface is based primarily on the geotechnical information. This is typical in areas where a high concentration of coarse material inhibits the seismic signal penetration down to the top of rock.

The USACE borings and probes suggest bedrock is generally deeper than 40 feet MLLW except in the vicinity of Boring B6 which encountered metamorphic rock at a depth of 15 feet below the riverbed (30 feet MLLW). Although correlation of Boring B6 is indirect due to its position between geophysical tracklines, interpretation of adjacent seismic profiles #7 and #10 indicates the acoustic basement reflector slopes up closer to the bottom in this area. Figure 4 illustrates the areas where the acoustic basement has been mapped shallower than 45 feet MLLW based on interpretation of the seismic profiles. Full scale OSI Drawing 3 presents contours of the acoustic basement reflector depth below MLLW at a 1 foot interval.

In the remainder of the site, the primary acoustic basement reflector was apparent at depths of 10-20 feet below the bottom in the channel (Line 18) and along the toe of the slope (Lines 12 and 15). The interpreted top of the coarse glacial till/bedrock surface slopes up slightly to the east-northeast toward the top of the channel slope. Geotechnical results suggest bedrock is generally deeper than 40 feet MLLW in the southeastern two-thirds of the site as only one station, P2, penetrated deeper to 52 feet MLLW. None of the borings or probes indicate hard refusal was encountered. The shoal evident in the central portion of the site, particularly on Lines 7, 10, and 12, is believed to be primarily comprised of sand with coarse material (gravel, cobbles, boulders), mainly gravel according to the borings.

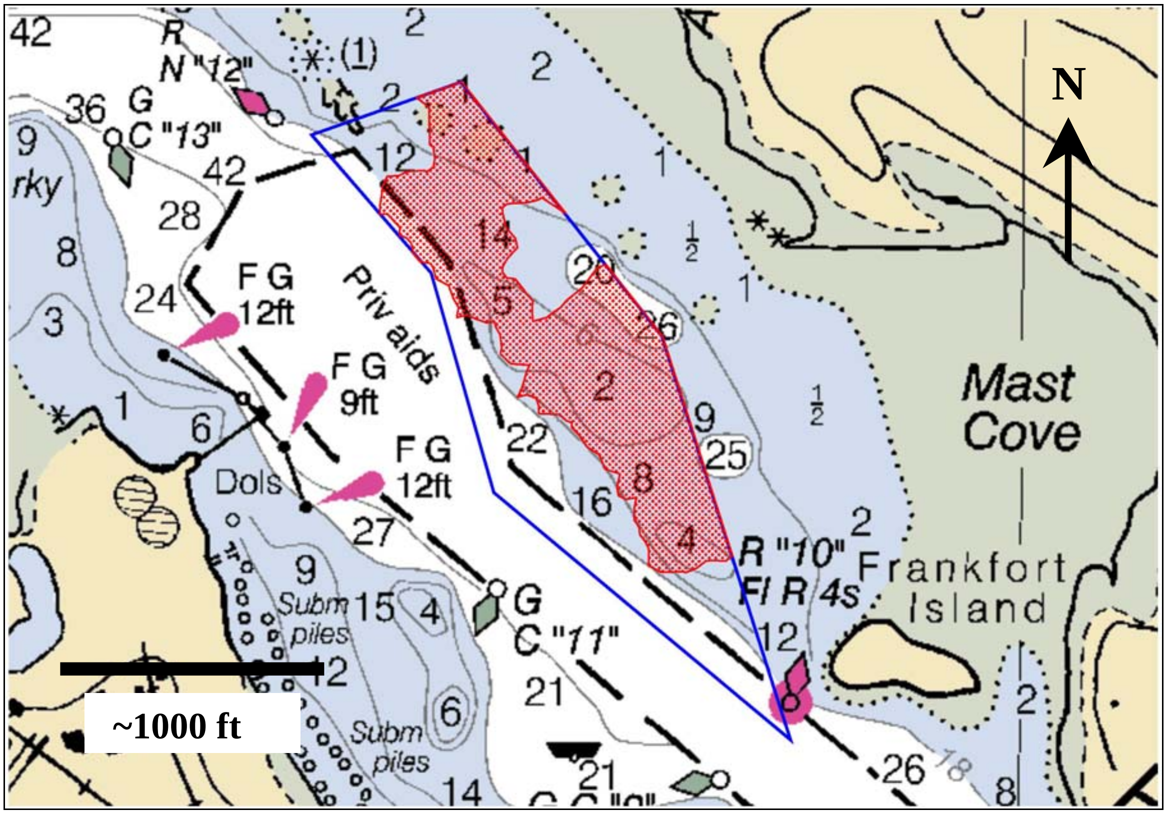

Figure 4. Map showing the areas within the site (blue outline) where the acoustic basement has been interpreted from the seismic reflection profiles and identified at Boring B6 shallower than 45 feet MLLW (red hatch).

One anomalous area of the site is evident from review of the data sets. Despite the findings of Probe P1 along Line 1 that indicate 59 feet of unconsolidated sediments, the seismic profile reveals a strong acoustic basement reflector quite shallower, closer to 20-30 feet below the riverbed (see Line 1 profile in Appendix C) where it has been mapped. It is possible that this reflection is a partial side echo from a mound of coarse till or bedrock high spot located just off the trackline.

An average acoustic velocity of 5,000 feet per second was used to calculate sediment thickness, a potentially conservative estimate of sound speed for dominantly coarse material overburden. For example, an increase in the assumed average velocity from 5,000 feet per second (representative of finer grained, saturated marine sediments such as silt to medium sand) up to 6,000 feet per second (more typical of coarser grained, saturated marine sediments such as gravel and cobbles) would result in an increase of 20% in the estimated reflector depths. Given the shallow nature of the acoustic basement reflector at this site, this velocity variation would have minimal affect on the interpreted sediment thickness and resulting depth to acoustic basement contoured surface.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The detailed marine geophysical investigation conducted in the Piscataqua River on 21-22 December 2006 has provided valuable information for riverbed and subsurface characterization of site geology. Geophysical data sets acquired have also allowed the mapping of natural and man made objects on and possibly below the bottom. A total of 80 side scan sonar targets and 73 magnetic anomalies have been identified from interpretation of the geophysical data sets, as well as bottom areas where sonar reflectivity suggests the presence of coarse material. Such objects and features observed on the side scan sonar and magnetic intensity data may represent obstructions to future dredging operations. All data products generated as a result of this investigation have been delivered to PAL for their archaeological assessment of the site, a determination of the presence of potentially significant cultural resources.

Regarding the subsurface geologic conditions, coarse glacial till and bedrock are present shallower than 45 feet MLLW in the vicinity of Boring B6 and may exist above this project depth of interest in other portions of the site, as suggested by seismic interpretation (see Figure 4). Due to the abundance of coarser deposits (coarse sand, gravel, cobbles) in the nearsurface, it is difficult to determine from the seismic profiles whether the origin of the acoustic basement reflector is coarse glacial till or bedrock. There is not much acoustic signal left to resolve the bedrock surface at depth after being reflected proportionally by the overlying coarse materials. Interpretation of the seismic profiles does suggest significant relief may exist in the acoustic basement reflector that could represent locally abrupt changes in elevation. The acoustic basement is apparent just below the bottom of the navigation channel (5-10 feet), suggesting coarse till and rock may have been dredged from the channel previously (this is the point where the channel widens toward the turning basin at its northwest end).

The difficult nature of the site conditions on the seismic reflection profiling technique, causing reduced penetration and resolution of the acoustic basement, indicates geotechnical investigations may provide the most absolute findings. If further delineation of the bedrock surface and coarse glacial till deposits are necessary, additional borings (Figure 5) are recommended to fill in the remainder of the site with geotechnical information and supplement geophysical data acquisition and its interpetation.

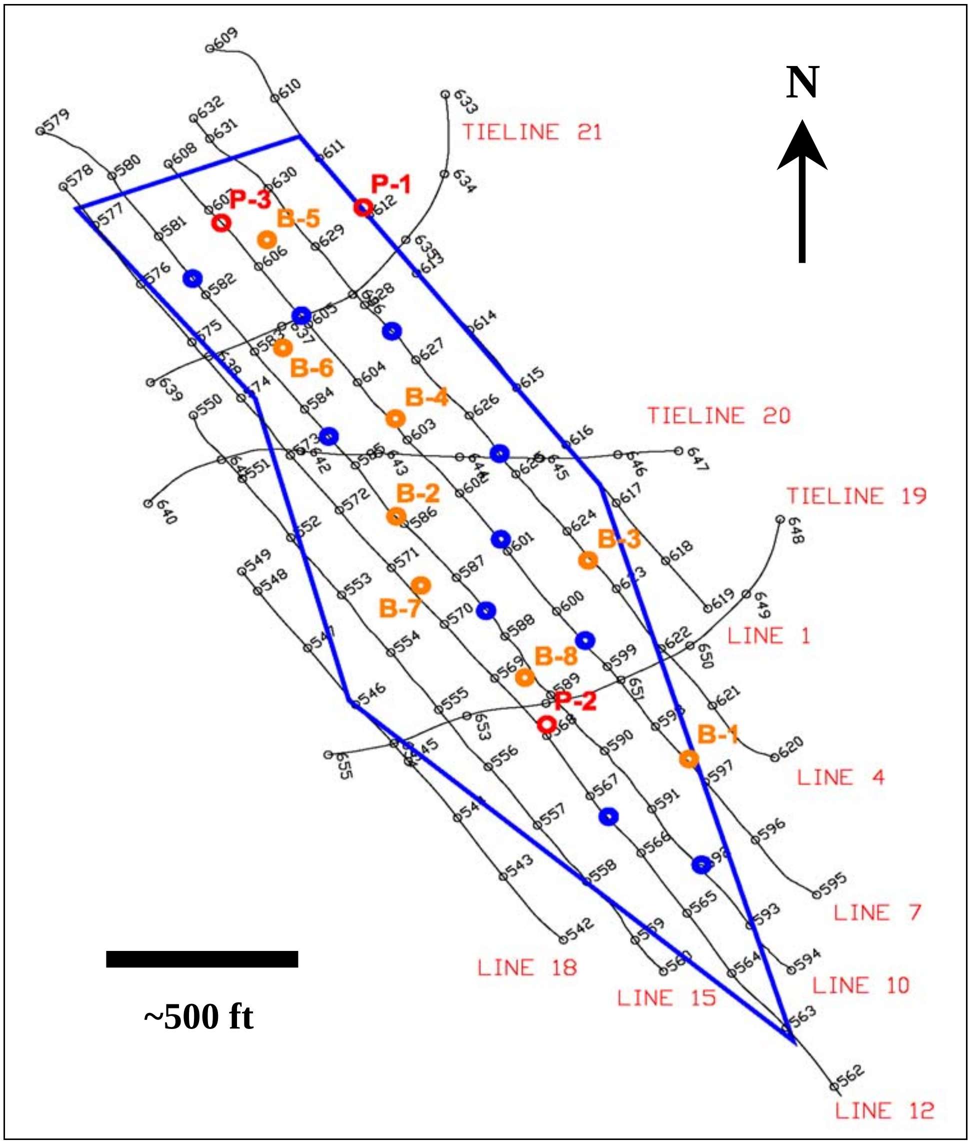

Figure 5. Recommended additional geotechnical stations in the site (blue), if further delineation of subsurface geologic conditions is deemed necessary.

9.0 REFERENCES

Anderson, W.A., 1985. Bedrock Geologic Map of Maine, Maine Geological Survey / Department of Conservation, 1:500,000 scale.

Billings, M.P., 1980. The Geology of New Hampshire, Part II: Bedrock Geology, New Hampshire Department of Resources and Economic Development, p. 38-43.

Freedman, J., 1950. Stratigraphy and Structure of the MT. Pawtuckaway Quadrangle, Southeastern New Hampshire. Geological Society of America Bulletin: Vol. 61, No. 5, p. 449–492.

NOTES

1. GRID SYSTEM IS IN FEET AND IS THE MAINE STATE PLANE COORDINATE SYSTEM WEST ZONE 1802, (NAD 83).

2. DEPTHS ARE IN FEET AND REFERENCED TO MEAN LOWER LOW WATER (MLLW). CONTOURS ARE BASED ON DEPTHS PROVIDED BY USACE IN FILE "portsmouth proposed channel aug16+17+2007 03 avg.xyz".

3. CONTOUR INTERVAL IS 1 FOOT. CONTOURS WERE COMPUTER GENERATED USING "QUICKSURF" VERSION 5.1 (SCHREIBER INSTRUMENTS, INC.) OPERATING WITHIN "AUTOCAD" VERSION 2000 (AUTODESK).

4. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).

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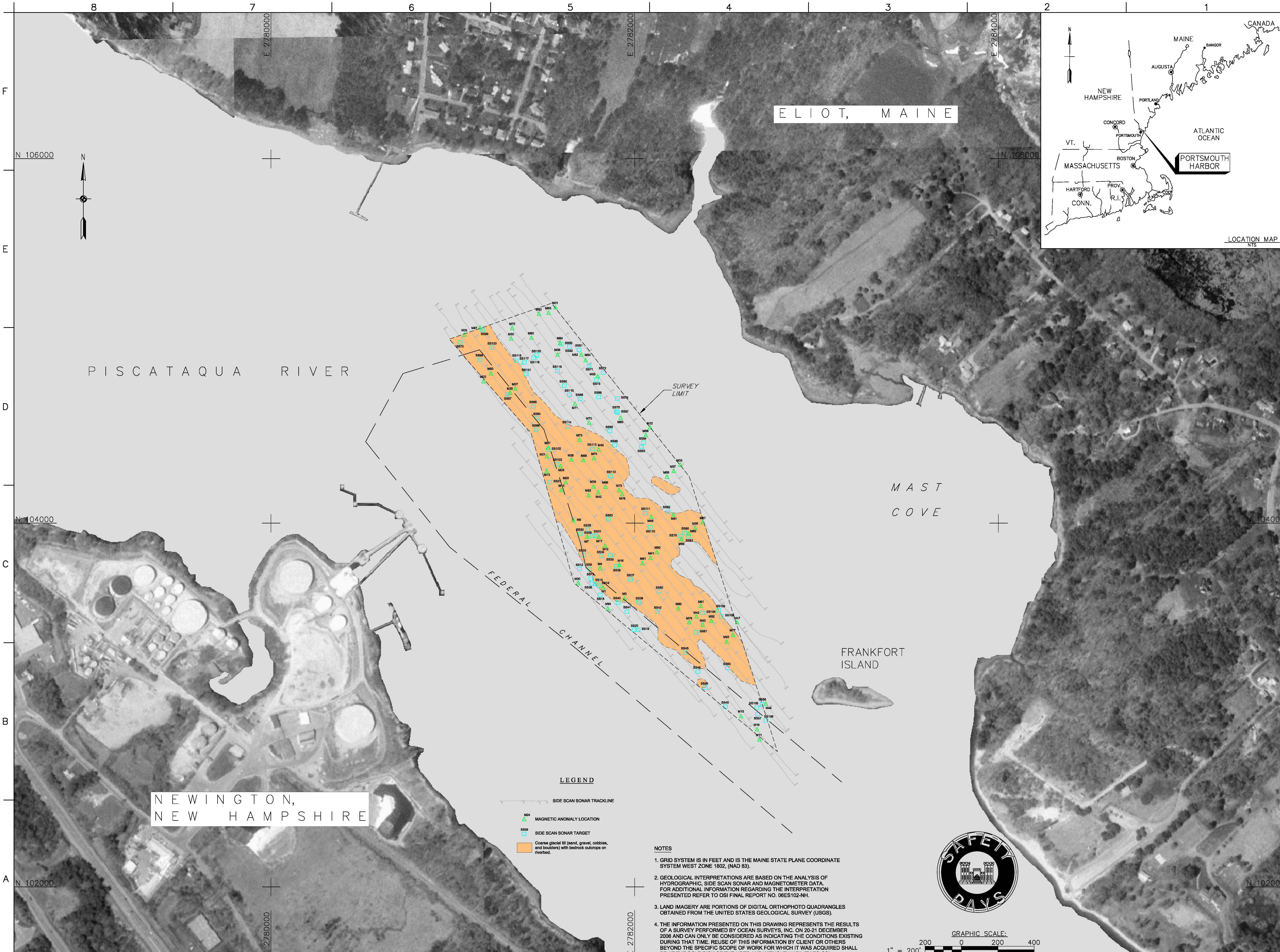
Design file:
Drawing code: 2625
File name: 06ES102_PH01
Plot date: 09/15/08
Plot scale: 1" = 200'
Rev.

PISCATAQUA RIVER
PORTSMOUTH, NEW HAMPSHIRE
HYDROGRAPHIC CONTOURS

Reference number:
V-1
Sheet 1 of 1



NOTES

1. GRID SYSTEM IS IN FEET AND IS THE MAINE STATE PLANE COORDINATE SYSTEM WEST ZONE 1802, (NAD 83).
2. GEOLOGICAL INTERPRETATIONS ARE BASED ON THE ANALYSIS OF HYDROGRAPHIC, SIDE SCAN SONAR AND MAGNETOMETER DATA. FOR ADDITIONAL INFORMATION REGARDING THE INTERPRETATION PRESENTED REFER TO OSI FINAL REPORT NO. 06ES102-NH.
3. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
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Plotted By: P.J. LACKEY	Design file:	
Asst. Chief, Survey Section	Drawing code: 2625	
Chief, Survey Section	File name: 06ES102_PS01 Plot date: 09/15/08 Plot scale: 1" = 200'	

PISCATAQUA RIVER
PORTSMOUTH, NEW HAMPSHIRE
SIDE SCAN SONAR TARGETS,
MAGNETIC ANOMALIES &
SURFICIAL FEATURES

Reference number:
V-2
Sheet 1 of 1

NOTES

1. GRID SYSTEM IS IN FEET AND IS THE MAINE STATE PLANE COORDINATE SYSTEM WEST ZONE 1802, (NAD 83).

2. DEPTH TO ACOUSTIC BASEMENT WAS DETERMINED BY ADDING THE INTERPRETED THICKNESS OF THE OVERBURDEN (BASED ON SUBBOTTOM DATA ANALYSIS) TO THE WATER DEPTHS, REFERENCED TO MLLW PROVIDED BY USACE IN FILE "portsmouth proposed channel aug16+17+2007 03 avg.xyz". ACOUSTIC VELOCITY USED FOR DETERMINING OVERBURDEN THICKNESS IS 5,000 FEET/SEC. FOR ADDITIONAL INFORMATION REGARDING THE INTERPRETATION PRESENTED REFER TO OSI FINAL REPORT NO. 06ES102-NH.

3. CONTOUR INTERVAL IS 1 FOOT. CONTOURS ARE BASED ON A GRIDDED SURFACE MODEL GENERATED WITHIN "QUICKSURF" VERSION 5.1 (SCHREIBER INSTRUMENTS, INC.) OPERATING WITHIN "AUTOCAD" VERSION 2000 (AUTODESK).

4. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).

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Symbol	Description	Date	Appr.

Symbol	Description	Date	Appr.

PISCATAQUA RIVER
PORTSMOUTH, NEW HAMPSHIRE
ACOUSTIC BASEMENT
CONTOURS

Reference number:
V-3
Sheet 1 of 1

APPENDICES

A Side Scan Sonar Target Listing
B Magnetic Anomaly Listing
C Seismic Reflection Profiles
D Geotechnical Logsheets (provided by the USACE)
E Equipment Operations and Procedures
F Equipment Specification Sheets
G Data Processing and Analysis Methods

APPENDIX A

Side Scan Sonar Target Listing

Piscataqua River / Navigation Channel Improvement Project											
Side Scan Sonar Targets											
Date	***Run***	***Line***	***Event***	***Target ID #***	***Easting***	***Northing***	***Length***	***Width***	***Height or Relief***	***Comment***	***Associated Magnetic Anomaly***
					feet	feet	feet	feet	feet		
21-Dec	2	18	419.8	SS8	2781753	103748	3.6	1.6	1.3	curved	
			420.3	SS10	2781783	103665	3.0	2.3	1.0	rectangular, possible lobster pot	
			419.6	SS12	2781697	103749	40.0	0.3	<0.5	linear	
			420.1	SS13	2781759	103695	2.0	1.6	1.6	triangular	
			420.3	SS14	2781803	103656	35.4	2.3	1.0	broken linear	M1
			420.5	SS15	2781810	103605	4.9	3.6	1.3	rounded	
			422.0	SS19	2782018	103413	n/a	0.3	<0.5	long linear end	
			421.9	SS20	2781998	103413	2.3	1.0	0.7	small	
21-Dec	4	15	435.1	SS27	2781534	104225	13.1	6.6	5.2	possible angular, at edge of boulder field	
			436.7	SS28	2781741	103965	3.0	1.3	0.7	oval	
			436.9	SS29	2781769	103930	2.6	0.7	0.7	rectangular	
			436.7	SS30	2781701	103941	n/a	0.3	<0.5	long linear begin	
			437.0	SS31	2781784	103933	n/a	0.3	<0.5	long linear2 begin	
			437.3	SS33	2781717	103826	2.3	2.0	1.3	curved	
			437.6	SS34	2781818	103820	3.0	1.6	1.6	curved object	
			437.7	SS35	2781867	103823	n/a	0.3	<0.5	long linear2 end	
			438.0	SS36	2781900	103763	n/a	0.3	<0.5	begin long linear4	M16
			438.6	SS37	2781977	103691	13.1	2.0	0.3	wide linear	
			438.0	SS38	2781765	103667	5.6	3.9	0.7	curved	
			439.2	SS39	2782023	103565	4.6	3.0	3.9	angled, alonglong linear4 object	
			438.8	SS40	2781909	103563	5.9	0.7	0.7	2 linear approimately same size	
			439.2	SS41	2781958	103513	n/a	0.3	<0.5	approximate end of long linear3	
			439.7	SS42	2782126	103515	4.6	1.3	1.6	2 parallel rectangular	
			441.1	SS45	2782281	103289	7.2	4.6	1.3	rectangular	
			441.7	SS46	2782347	103184	1.3	1.0	1.0	small	
			447.7	SS49	2782498	102991	n/a	0.7	<0.5	end long linear4	
21-Dec	5	12	447.0	SS57	2782676	102950	n/a	0.3	<0.5	approximate beginning long linear	
			447.2	SS58	2782700	103003	5.6	1.0	1.0	2 objects, one oblong, one oval	M44

Piscataqua River / Navigation Channel Improvement Project											
Side Scan Sonar Targets											
Date	***Run***	***Line***	***Event***	***Target ID #***	***Easting***	***Northing***	***Length***	***Width***	***Height or Relief***	***Comment***	***Associated Magnetic Anomaly***
					feet	feet	feet	feet	feet		
			448.4	SS59	2782388	103096	8.5	0.7	0.3	linear	
			448.5	SS60	2782510	103203	3.3	1.3	1.3	small	
			449.8	SS61	2782338	103400	7.2	4.6	0.7	rectangular	
			451.3	SS62	2782135	103625	4.3	3.3	2.3	rounded	
			453.7	SS63	2781855	104021	n/a	0.7	<0.5	approximate end long linear	
			457.2	SS64	2781464	104578	6.2	4.6	5.2	angular, in boulder field	
			457.5	SS65	2781442	104642	5.6	7.5	<0.5	angular, in boulder field	
			456.9	SS66	2781458	104513	12.8	3.0	2.6	possible angular, in boulder field	
			458.2	SS67	2781301	104707	5.2	6.2	6.2	curved angular	M26
			459.4	SS68	2781148	104898	5.2	2.3	<0.5	rectangular	
			460.3	SS70	2781040	104992	4.9	2.6	5.9	oval	
21-Dec	24	1	663.4	SS71	2781750	104865	4.6	2.0	0.7	rectangular	
			663.7	SS72	2781827	104828	6.2	2.3	1.0	2 adjacent curved	
			663.7	SS73	2781789	104788	11.5	4.3	0.7	possible partially buried rectangular object	M55
			664.6	SS74	2781904	104685	17.4	<0.5	<0.5	linear depression	
			664.8	SS75	2781899	104613	5.2	2.0	1.0	3 oblong shapes	
21-Dec	25	4	674.0	SS79	2782249	103930	3.0	2.3	1.0	roughly rectangular	M69
			674.0	SS80	2782275	103946	3.9	3.9	1.0	square	M60
			673.8	SS81	2782298	103926	4.6	3.0	1.3	curved/round	
			674.7	SS82	2782181	104063	4.9	2.3	1.6	curved-angular	
			676.6	SS83	2782038	104420	3.3	2.6	1.0	oval	
			676.7	SS84	2782050	104443	3.9	1.6	1.0	linear	
			677.1	SS85	2781890	104429	4.9	1.3	0.7	2 objects approximate same size, oblong	
			677.5	SS86	2781864	104507	4.3	3.6	1.6	1 linear, 1 oblong	
			677.7	SS87	2781905	104608	8.2	5.6	3.3	curved	
			678.7	SS88	2781700	104682	4.6	3.6	1.0	angled	
			678.4	SS89	2781802	104694	12.1	3.0	1.0	curved angluar	
			679.3	SS90	2781613	104756	18.0	3.3	0.3	somewhat pointed	
			679.8	SS91	2781694	104951	18.4	3.6	<0.5	2 parallel linear	
			680.0	SS92	2781641	104968	3.6	4.6	0.7	rounded	
			680.2	SS93	2781596	104983	35.4	2.0	1.0	partially buried linear	M64
21-Dec	26	10	685.0	SS99	2781164	105060	6.2	0.3	<0.5	possible linear object	M87
			685.5	SS100	2781214	104964	4.3	1.0	1.3	curved next to round	

Piscataqua River / Navigation Channel Improvement Project											
Side Scan Sonar Targets											
Date	***Run***	***Line***	***Event***	***Target ID #***	***Easting***	***Northing***	***Length***	***Width***	***Height or Relief***	***Comment***	***Associated Magnetic Anomaly***
					feet	feet	feet	feet	feet		
			686.7	SS101	2781403	104821	8.5	1.3	1.3	possible curved-linear	
			688.7	SS102	2781524	104404	n/a	0.7	<0.5	begin linear	M27
			689.2	SS103	2781572	104324	n/a	0.7	<0.5	end linear	
			694.8	SS104	2782375	103507	5.6	2.6	1.3	oblong	
			697.8	SS105	2782672	102984	11.2	8.5	<0.5	area with curved and linear features	
			698.4	SS106	2782722	102915	<0.5	<0.5	<0.5	approximately 20m long striations with one rounded target	
21-Dec	28	7	706.7	SS108	2782477	103488	12.5	3.9	1.0	possibly partially buried object	
			706.9	SS109	2782462	103521	3.9	1.6	2.3	oblong	
			709.9	SS110	2782085	103978	17.4	27.2	3.6	oblong and curved-angular objects	
			710.3	SS111	2782058	104055	6.6	1.3	2.3	wide linear	
			711.7	SS112	2781867	104259	4.6	0.7	2.0	linear	
			712.6	SS113	2781769	104408	5.6	3.0	4.3	oval	
			713.5	SS114	2781631	104531	8.9	3.0	3.6	crescent-shape	
			714.2	SS115	2781641	104706	21.7	3.6	1.3	somewhat linear	
			714.8	SS116	2781575	104837	13.5	6.6	3.3	roughly rectangular	
			715.7	SS117	2781393	104883	5.9	2.6	1.0	oblong	
			715.8	SS118	2781347	104893	35.8	3.0	2.3	linear, possible partially buried object	
			715.6	SS119	2781445	104908	8.5	1.6	1.3	curved and linear	
			715.6	SS120	2781462	104922	8.9	2.0	3.0	possibly partially buried object	

NOTES:

1. Coordinates are referenced to the Maine State Plane system, West Zone 1802, NAD83, in feet.
2. Target sizes and dimensions are based on acoustic measurements only and have not been verified directly.
3. The side scan sonar method only identifies features located on (not below) the bottom.
4. Only targets evident on more than one side scan sonar image / trackline were mapped; targets located outside the survey areas were not mapped.
5. Target identification numbers are not sequential, as mutliple targets on overlapping images were removed from the data set.

APPENDIX B

Magnetic Anomaly Listing

Piscataqua River / Navigation Channel Improvement Project Magnetic Anomalies													
Date	***Run***	***Line***	***Event***	***Anomaly ID#***	***Easting***	***Northing***	***Size***	***Type***	***Duration***	***Sensor Altitude***	***Dipolar ferrous mass (lbs)***	***Monopolar ferrous mass (lbs)***	***Associated Side Scan Target***
					feet	feet	gammas		feet	feet	pounds	pounds	
21-Dec	7	16	472.0	M1	2781826	103643	12	D	67	45.7	1189.3	26.0	SS014
21-Dec	8	15	481.0	M3	2781944	103583	10	M+	25	45.5	978.2	21.5	
			482.0	M4	2781810	103750	15	M+	100	51.7	2152.5	41.6	
21-Dec	9	14	494.4	M7	2781739	103923	200	M+	60	29.9	5551.6	185.7	
			494.9	M8	2781662	104013	250	M-	25	35.6	11712.9	329.0	
21-Dec	10	13	500.4	M11	2782686	102808	110	M+	150	50.5	14710.9	291.3	
			507.3	M12	2781836	103874	190	M+	67	35.0	24514.8	491.3	
			509.9	M13	2781516	104283	50	M+	133	44.6	4606.3	103.3	
			509.3	M14	2781597	104180	20	M+	100	42.4	1583.1	37.3	
			501.3	M15	2782585	102936	18	M+	67	49.9	2322.5	46.5	
			506.6	M16	2781916	103768	20	M+	133	32.3	699.9	21.7	SS036
			507.6	M17	2781803	103921	20	M+	50	34.0	816.3	24.0	
21-Dec	11	12	514.5	M19	2782673	102864	150	D	225	47.8	17011.7	355.9	
			523.2	M20	2781621	104222	150	D	67	47.7	16905.2	354.4	
			524.0	M21	2781517	104365	40	M-	150	43.8	3490.2	79.7	
			526.8	M22	2781169	104777	140g	M+	133	47.7	15778.2	330.8	
21-Dec	38	11	825.4	M25	2781063	105032	8g	M-	40	27.1	165.3	6.1	
			827.4	M26	2781315	104715	75g	M+	200	39.8	4910.0	123.4	SS067
			829.2	M27	2781524	104412	10g	M+	33	42.9	819.9	19.1	SS102
			829.8	M28	2781593	104311	53g	D	100	38.9	3239.7	83.3	
20-Dec	1	18	413.3	M30	2781690	103669	100g	M+	225	18.6	668.2	35.9	
21-Dec	24	1	661.7	M31	2781565	105182	32g	D	133	7.3	12.9	1.8	
			665.8	M32	2782085	104524	20g	M-	133	26.0	365.0	14.0	
			667.2	M33	2782250	104319	35g	M+	133	28.4	832.5	29.3	
21-Dec	25	4	674.1	M35	2782332	103973	75g	M+	200	18.3	477.3	26.1	
			680.2	M36	2781576	104922	10g	M+	15	11.4	15.4	1.3	
21-Dec	26	10	686.9	M37	2781343	104738	40g	M+	200	21.5	412.8	19.2	
			689.4	M38	2781652	104348	5g	M+	18	10.1	5.3	0.5	
			690.4	M39	2781774	104199	12g	M+	29	6.8	4.8	0.7	
			690.6	M40	2781800	104167	10g	M+	33	7.3	4.0	0.6	
			692.9	M41	2782087	103807	30	M+	133	18.0	181.7	10.1	
			694.9	M42	2782339	103484	5	M+	67	8.6	3.3	0.4	
			695.3	M43	2782374	103439	15	M+	67	8.6	9.9	1.2	

Piscataqua River / Navigation Channel Improvement Project													
Magnetic Anomalies													
Date	***Run***	***Line***	***Event***	***Anomaly ID#***	***Easting***	***Northing***	***Size***	***Type***	***Duration***	***Sensor Altitude***	***Dipolar ferrous mass (lbs)***	***Monopolar ferrous mass (lbs)***	***Associated Side Scan Target***
					feet	feet	gammas		feet	feet	pounds	pounds	
			633.7	M44	879695	285016	33.9	M+	50	15.37	127.8	8.3	SS171
21-Dec	28	7	706.5	M47	2782563	103453	38	D	225	17.2	200.8	11.7	
			710.3	M48	2782091	104033	8	D	13	6.6	2.4	0.4	
			712.6	M49	2781802	104402	8	M+	33	5.9	1.7	0.3	
			716.5	M50	2781321	105012	15	D	100	30.2	429.0	14.2	
21-Dec	31	2	730.8	M52	2781707	104922	5	M+	20	6.6	1.5	0.2	
			729.3	M53	2781527	105153	10	M+	67	8.1	5.5	0.7	
			731.0	M54	2781730	104894	4	M+	20	6.8	1.3	0.2	
			731.6	M55	2781797	104806	20	M+	200	15.1	71.5	4.7	SS073
			733.7	M56	2782062	104482	30	M-	171	23.1	384.0	16.6	
			734.9	M57	2782215	104285	30	M+	133	24.0	430.7	17.9	
21-Dec	32	5	741.5	M60	2782297	103941	50	M+	200	24.8	792.0	31.9	SS080
			742.2	M61	2782213	104044	10	M+	67	14.4	31.0	2.2	
			748.4	M62	2781432	105016	18	M+	100	6.7	5.6	0.8	
21-Dec	33	3	752.3	M63	2781474	105146	35	M+	50	7.8	17.2	2.2	
			753.3	M64	2781590	104986	5	M+	17	6.8	1.6	0.2	SS093
			755.8	M65	2781923	104577	12	M+	100	22.7	145.8	6.4	
			757.9	M66	2782178	104252	15	M+	100	20.3	130.3	6.4	
			759.5	M67	2782375	104003	80	M+	175	11.0	110.6	10.1	
21-Dec	34	6	767.2	M69	2782256	103910	25	M+	200	21.9	272.7	12.5	SS079
			771.3	M70	2781749	104550	12	M+	150	19.9	98.2	4.9	
			771.8	M71	2781672	104655	25	M+	50	14.7	82.5	5.6	
			774.6	M72	2781327	105068	20	M-	125	6.3	5.2	0.8	
21-Dec	35	8	781.8	M73	2781696	104457	10	M+	50	7.4	4.2	0.6	
			782.5	M74	2781777	104355	5	M+	50	9.0	3.8	0.4	
			783.5	M75	2781914	104178	3	M+	25	7.3	1.2	0.2	
			783.7	M76	2781931	104157	5	M+	25	6.8	1.6	0.2	
			788.6	M77	2782541	103383	25	M+	200	14.8	84.2	5.7	
21-Dec	36	11	796.2	M79	2782300	103453	10	D	50	11.7	16.6	1.4	
			796.6	M80	2782240	103528	10	M+	67	12.4	19.8	1.6	
			798.2	M81	2782042	103778	20	M+	175	20.4	176.3	8.6	
			800.6	M82	2781748	104151	100	M-	50	6.1	23.6	3.9	
			804.9	M83	2781209	104821	50	M-	100	34.0	2040.7	60.0	
21-Dec	37	9	809.8	M87	2781149	105071	20	M+	50	6.1	4.7	0.8	SS099

Piscataqua River / Navigation Channel Improvement Project Magnetic Anomalies													
Date	***Run***	***Line***	***Event***	***Anomaly ID#***	***Easting***	***Northing***	***Size***	***Type***	***Duration***	***Sensor Altitude***	***Dipolar ferrous mass (lbs)***	***Monopolar ferrous mass (lbs)***	***Associated Side Scan Target***
					feet	feet	gammas		feet	feet	pounds	pounds	
			814.4	M88	2781717	104345	2	M+	7	8.4	1.2	0.1	
			815.4	M89	2781840	104197	15	M+	40	5.7	2.9	0.5	
			817.7	M90	2782122	103838	30	M+	100	12.5	60.8	4.9	
			819.5	M91	2782363	103543	10	M+	50	12.7	21.3	1.7	
			820.0	M92	2782422	103461	25	D	100	8.4	15.4	1.8	
			820.8	M93	2782506	103346	30	M+	175	11.3	45.0	4.0	
21-Dec	6	17	464.7	M94	2781852	103528	8	M+	29	20.2	68.5	3.4	

NOTES

1. Positions are referenced to the Maine State Plane Coordinate System, West Zone 1802, NAD83, in feet.
2. Estimated ferrous masses calculated using the following formulas:

   $W = T\ r^2 / 963$ for monopoles

   $W = T\ r^3 / 963$ for dipoles

   where W = weight of ferrous object, T = anomaly amplitude, r = distance between magnetic sensor and object

   *Magnetic moment is assumed at a median value of 963, but may vary by an order of magnitude between 175 and 1750.
3. Anomaly types: M+ = positive monopole, M- = negative monopole, D = dipole, CD = complex dipole
4. Anomaly identification numbers are not sequential, as those positioned outside the site limits were removed from the listing.

APPENDIX C

Seismic Reflection Profiles

Lines 1, 4, 7, 10, 12, 15, 18
and TieLines 19, 20, 21

NOTES ON SEISMIC PROFILES:

1. Assumed seismic velocity of 5,000 feet per second used to correct the raw time sections to geologic profiles.

2. Profiles have been referenced to MLLW based on predicted tide values for Dover Point, New Hampshire, the nearest NOAA tide station.

3. ReflexW Seismic Processing Software used to pick acoustic reflectors and export x,y,z values for contouring.

4. Event numbers (black) across the top of each profile are spaced 200 feet apart. Green line numbers with vertical mark represent the intersection points of crossing tracklines.

5. Primary survey lines labeled L1, L4, L7, L10, L12, L15, and L18. Tielines labeled T19, T20, and T21.

6. Reflector color codes are:
   blue = interpreted acoustic basement reflector (top of coarse glacial till or bedrock)

7. Geotechnical stations positioned slightly off the geophysical tracklines were projected onto adjacent profiles. Due to highly variable bottom topography, some stations could not be realistically projected.

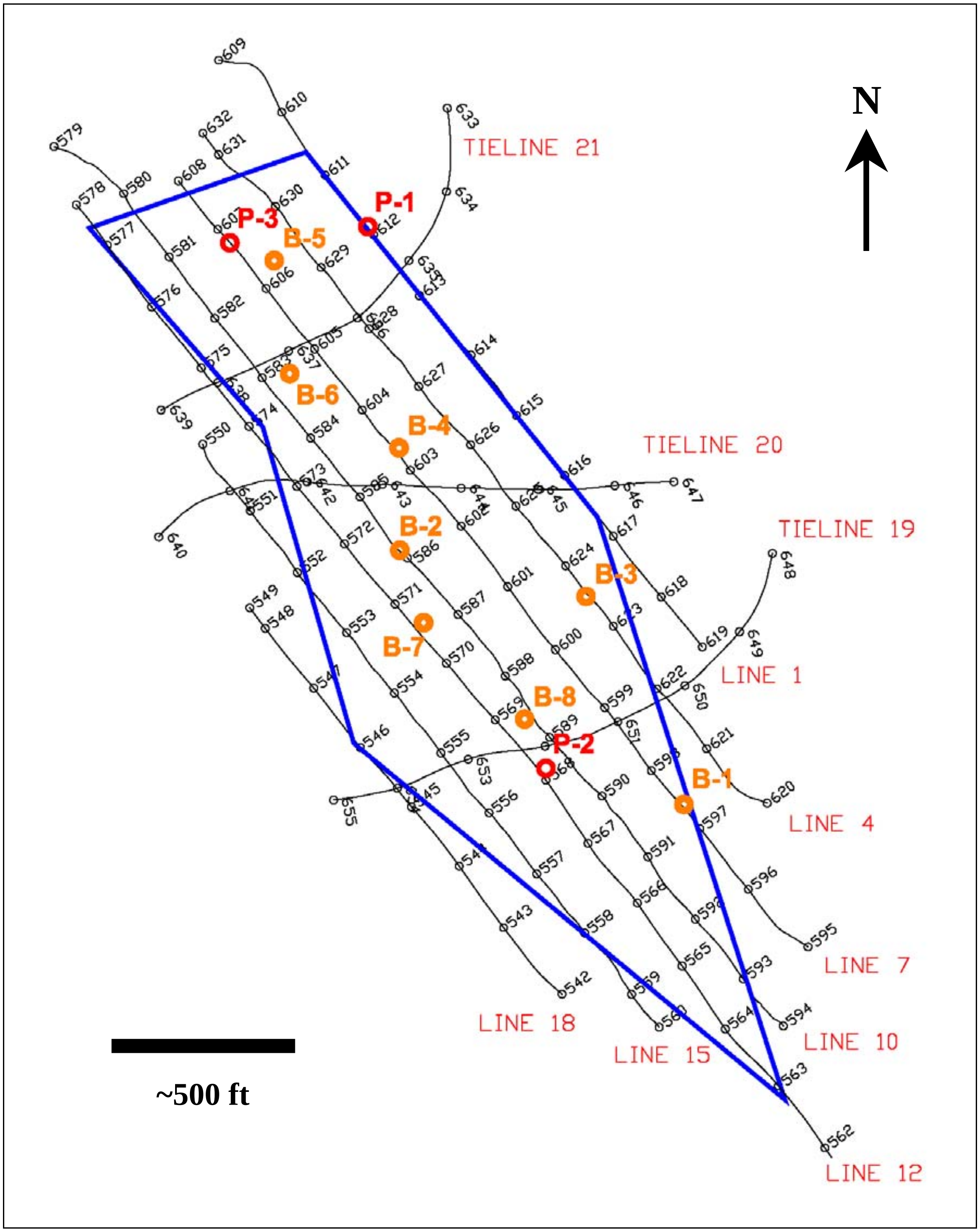
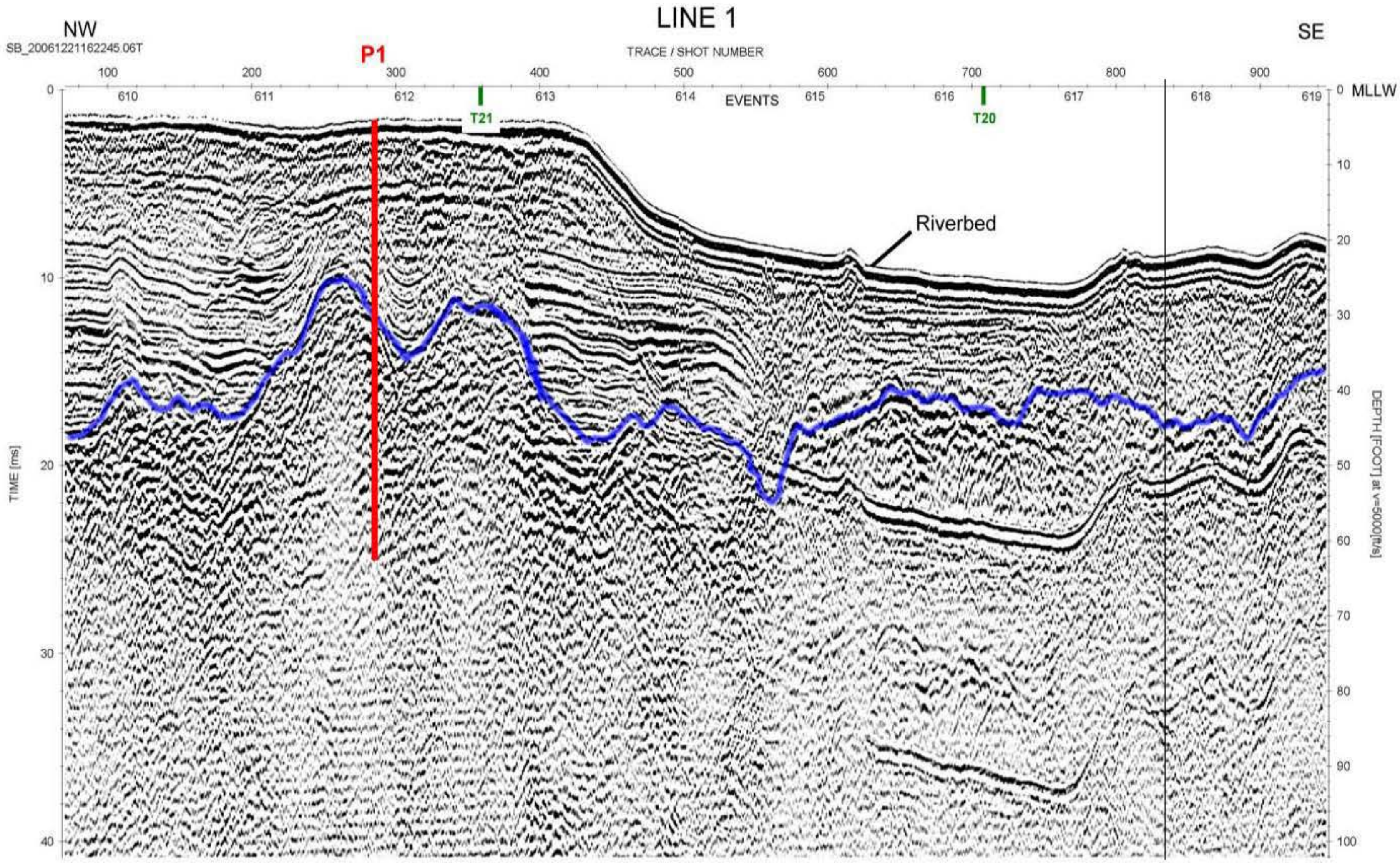
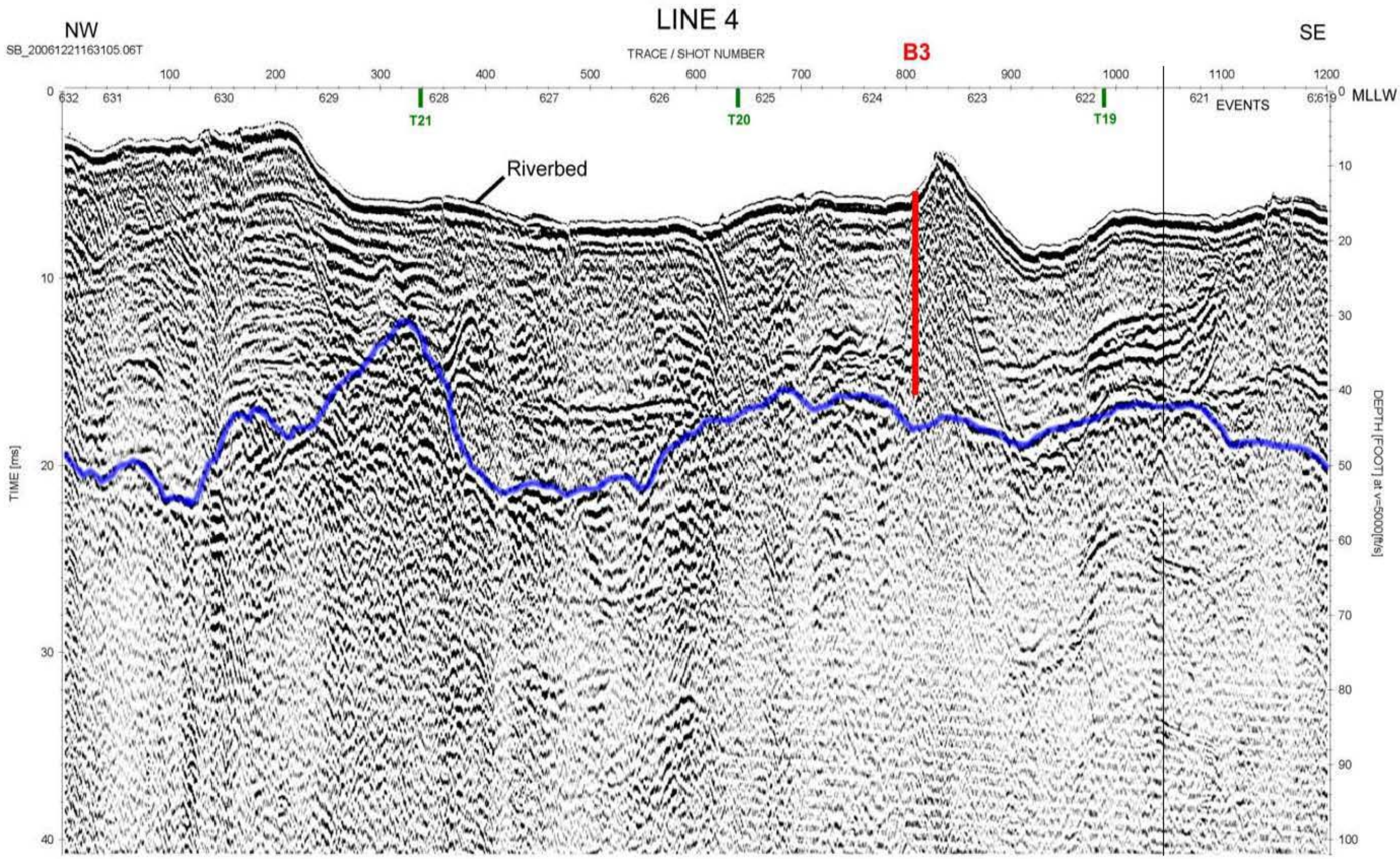
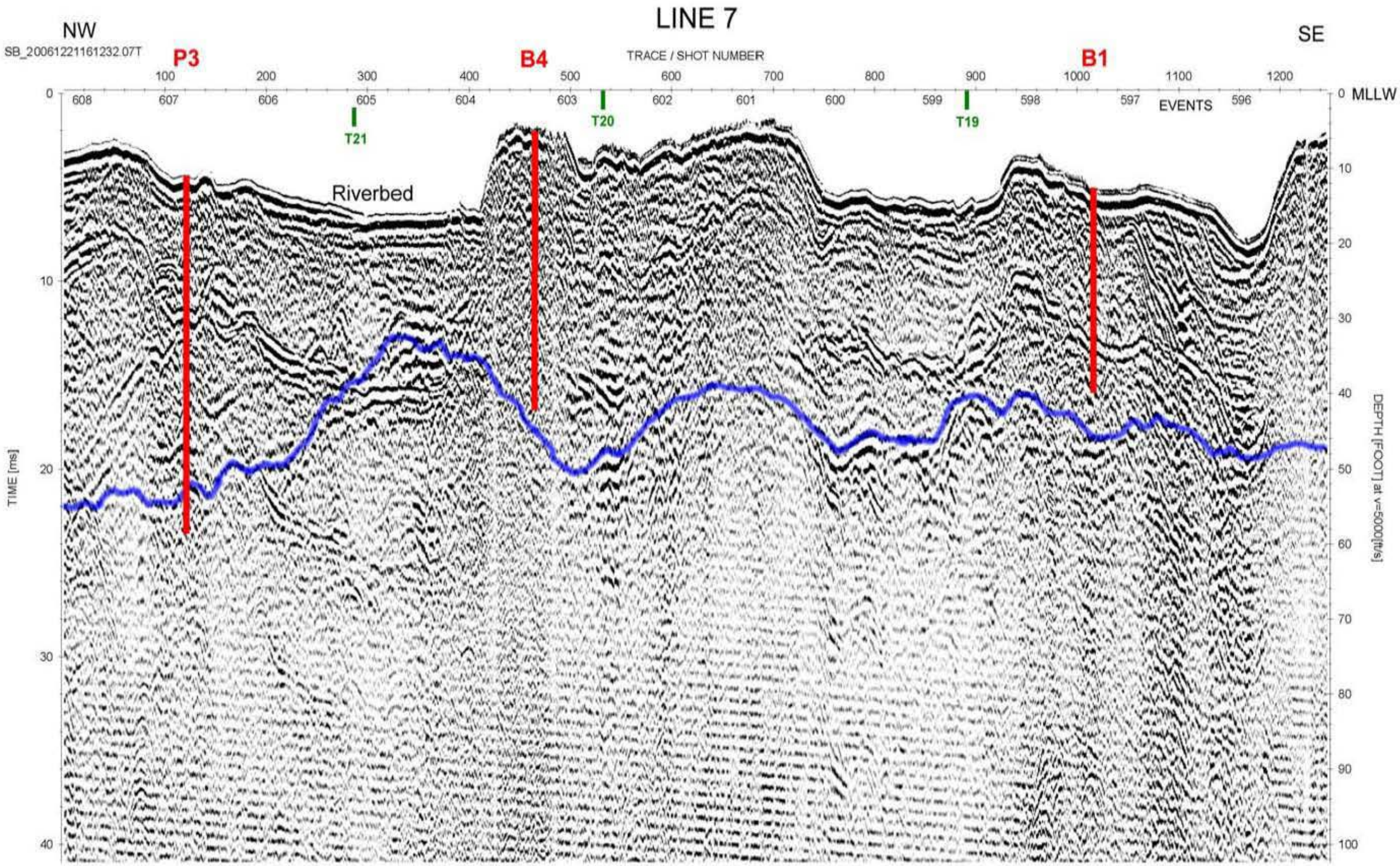
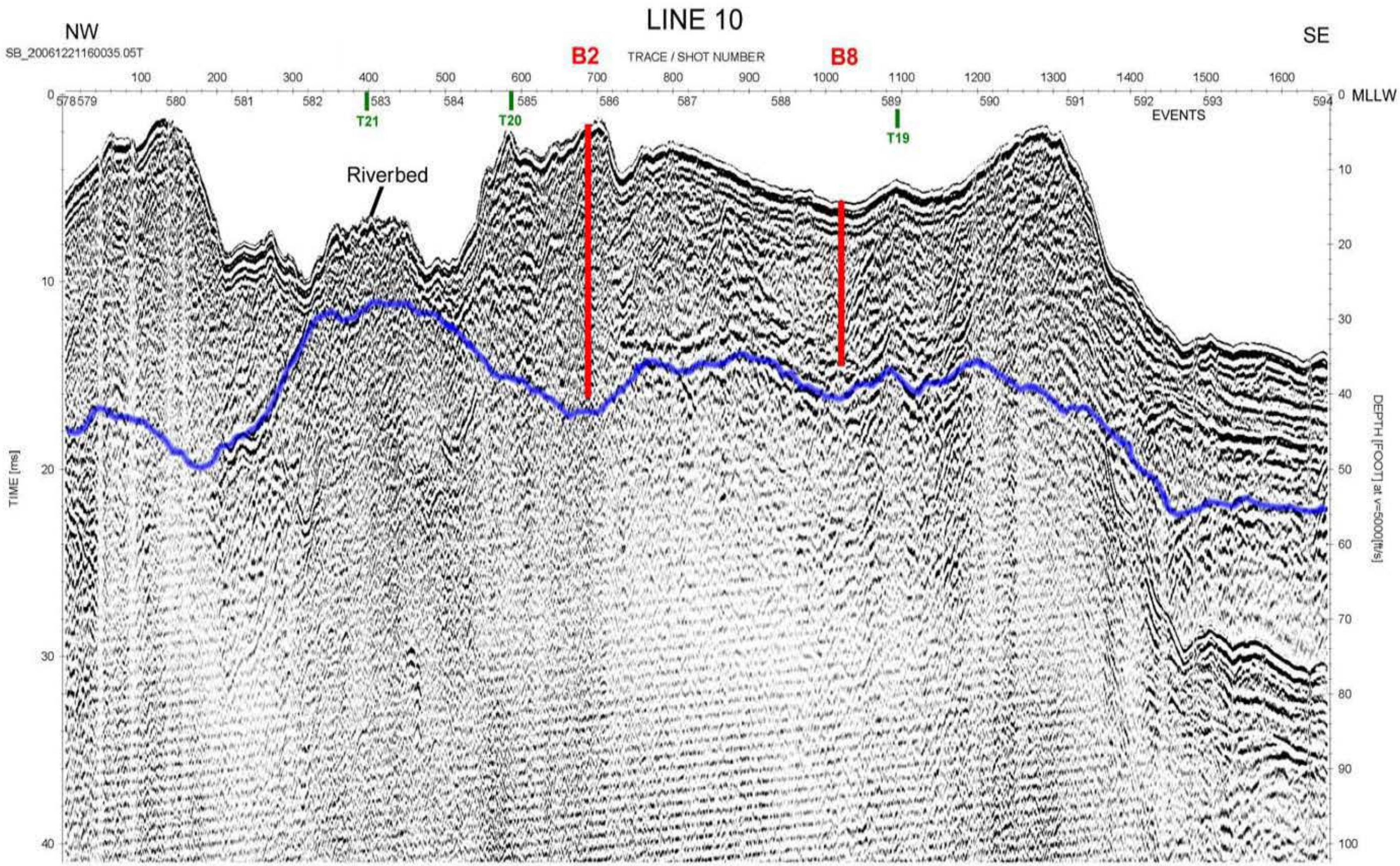


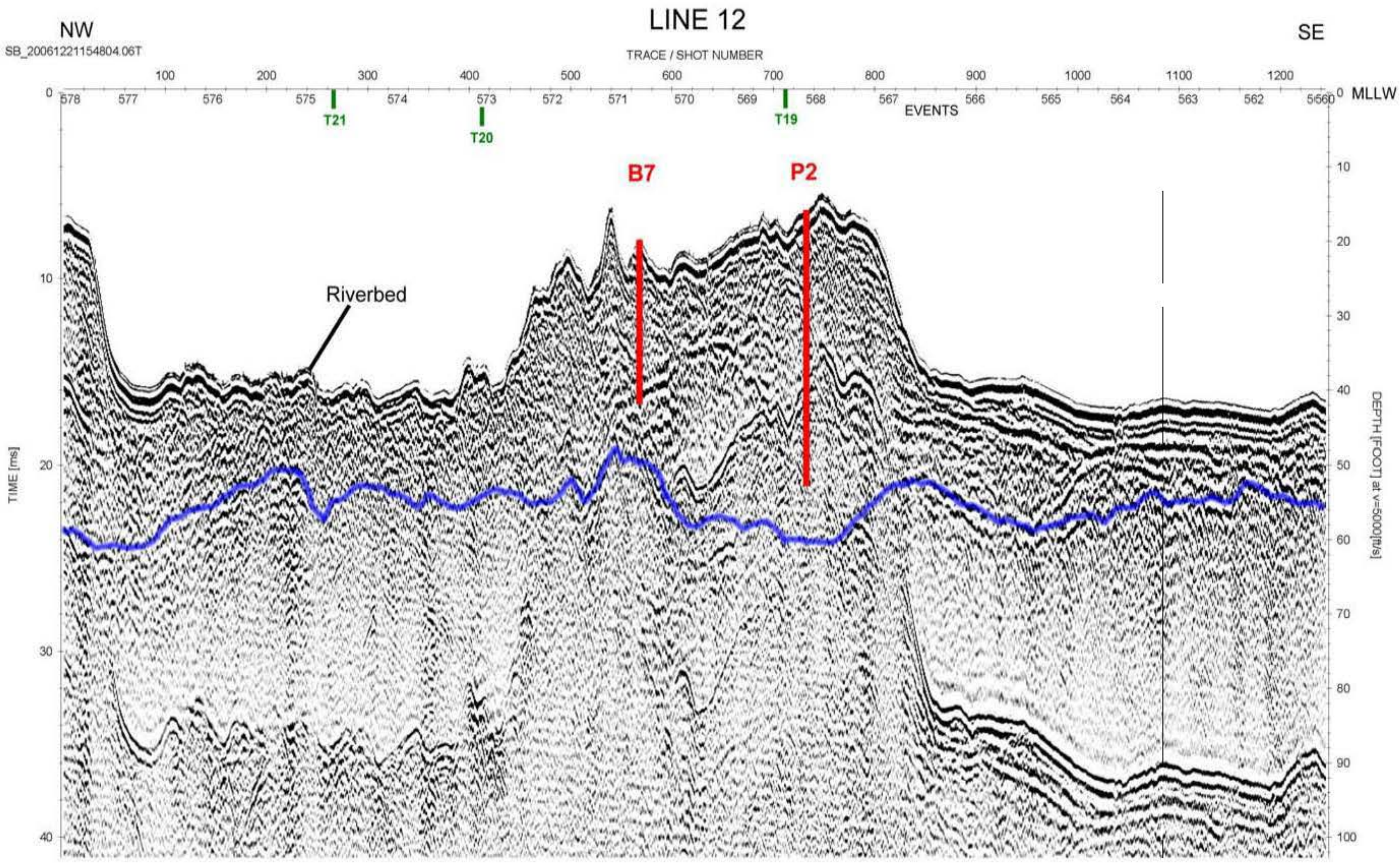
Figure showing the location of subbottom "boomer" profile lines and borings in the site.


LINE 1
NW
SE
SB_20061221162245.06T
P1
TRACE / SHOT NUMBER
100
200
300
400
500
600
700
800
900
610
611
612
613
614
615
616
617
618
619
EVENTS
T21
T20
0 MLLW
Riverbed
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]
0
10
20
30
40
10
20
30
40
50
60
70
80
90
100

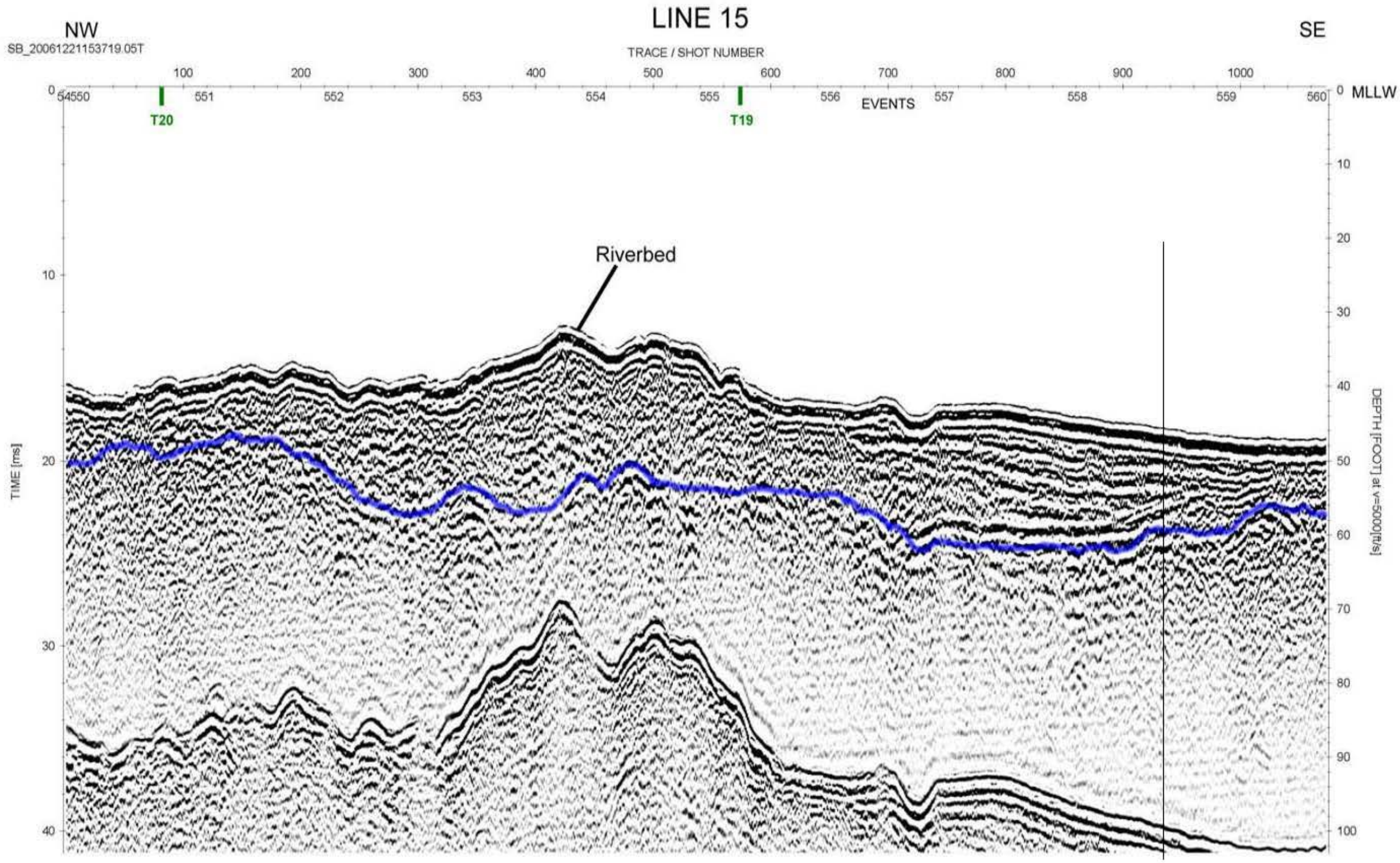

LINE 4
NW
SE
SB_20061221163105.06T
TRACE / SHOT NUMBER
B3
100
200
300
400
500
600
700
800
900
1000
1100
1200
632
631
630
629
628
627
626
625
624
623
622
621
EVENTS
619
0 MLLW
T21
T20
T19
Riverbed
TIME [ms]
0
10
20
30
40
DEPTH [FOOT] at v=5000[ft/s]
10
20
30
40
50
60
70
80
90
100

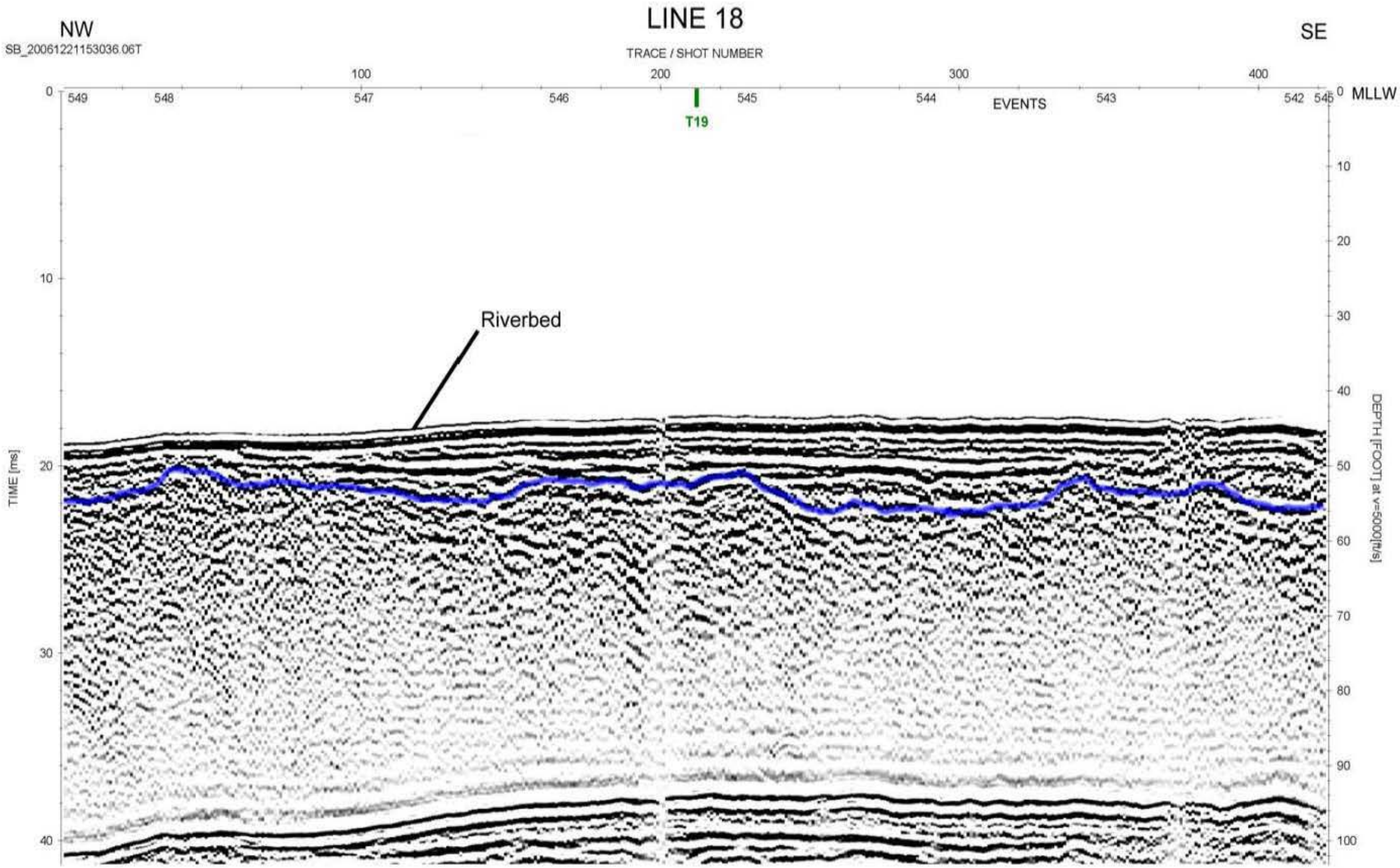

LINE 7
NW
SE
SB_20061221161232.07T
P3
B4
B1
TRACE / SHOT NUMBER
100
200
300
400
500
600
700
800
900
1000
1100
1200
608
607
606
605
604
603
602
601
600
599
598
597
596
EVENTS
T21
T20
T19
Riverbed
0 MLLW
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]
0
10
20
30
40
50
60
70
80
90
100

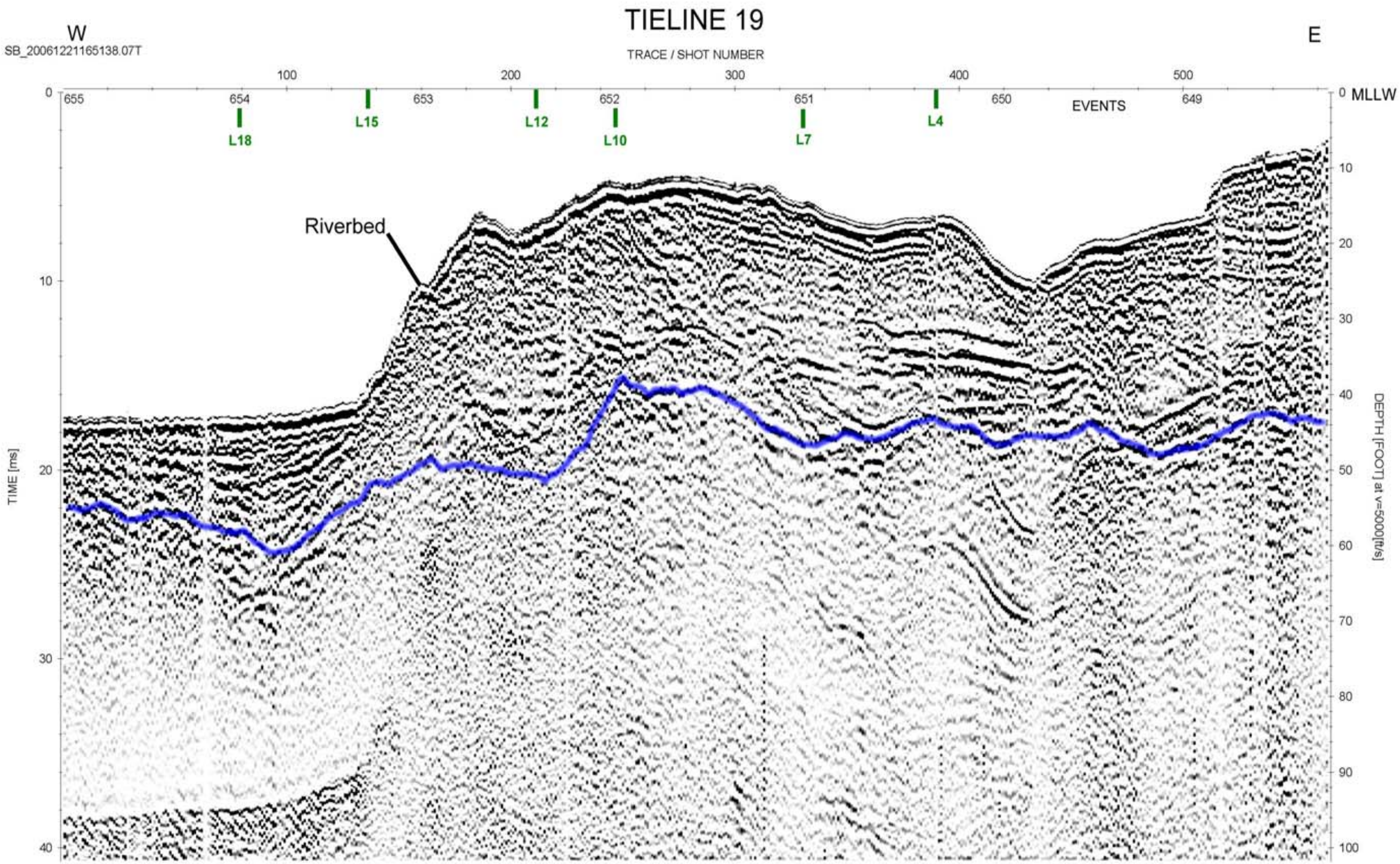

LINE 10
NW
SE
SB_20061221160035.05T
B2
TRACE / SHOT NUMBER
B8
T21
T20
T19
Riverbed
0 MLLW
EVENTS
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]

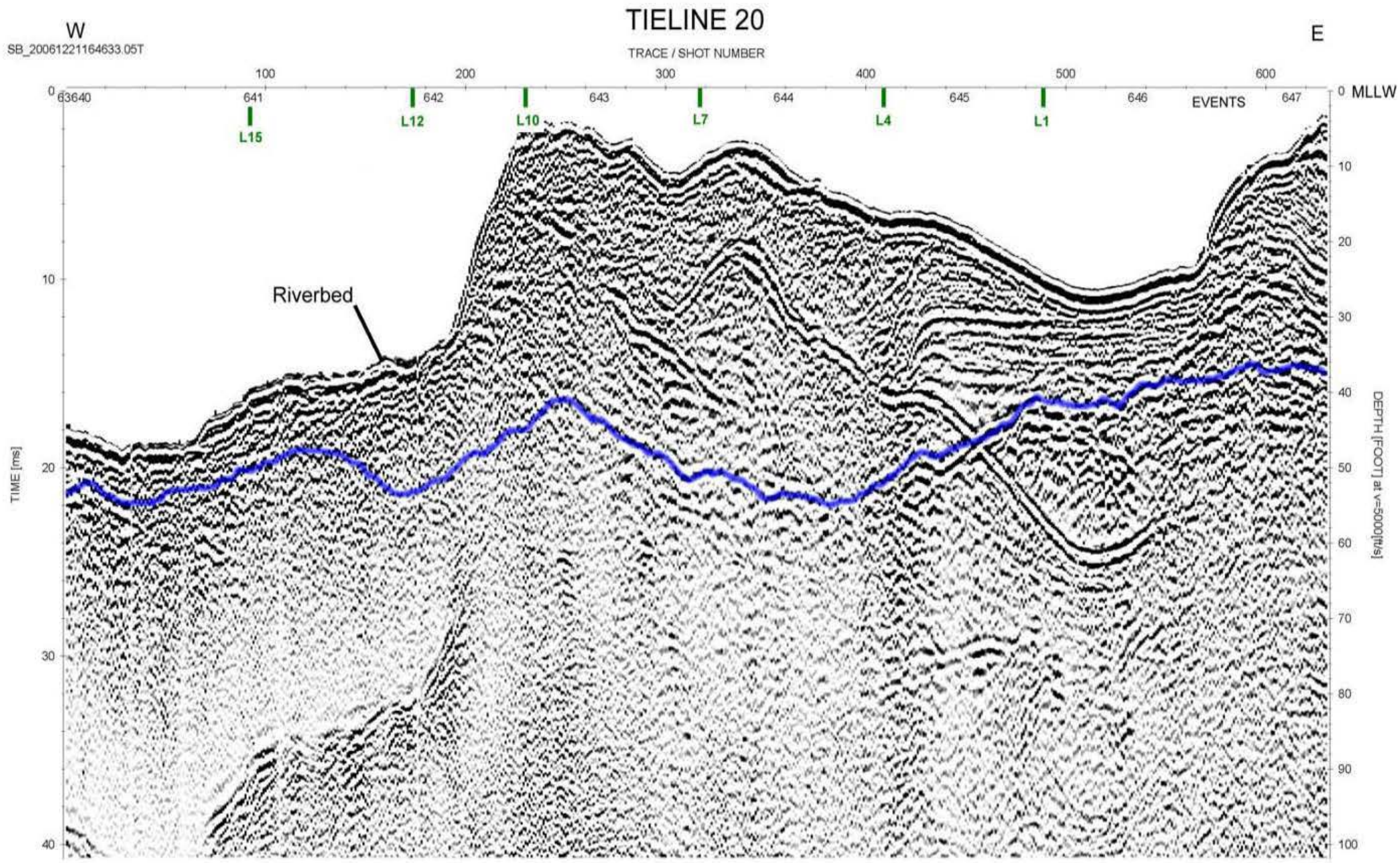


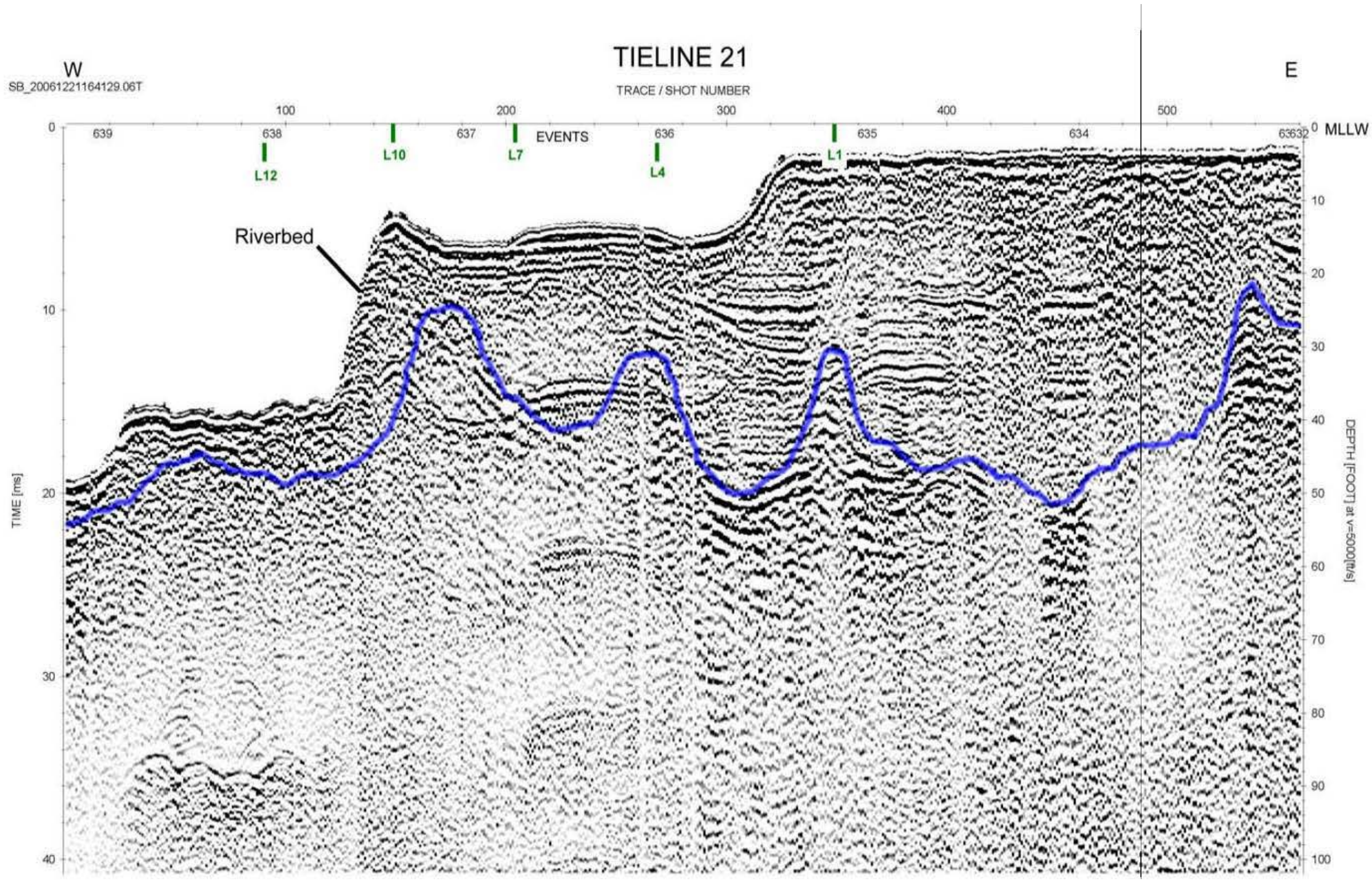
LINE 12
NW
SE
SB_20061221154804.06T
TRACE / SHOT NUMBER
EVENTS
0 MLLW
T21
T20
T19
B7
P2
Riverbed
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]


LINE 15
NW
SE
SB_20061221153719.05T
TRACE / SHOT NUMBER
100
200
300
400
500
600
700
800
900
1000
0
54550
551
552
553
554
555
556
557
558
559
560
EVENTS
T20
T19
0 MLLW
10
20
30
40
50
60
70
80
90
100
DEPTH [FOOT] at v=5000[ft/s]
TIME [ms]
10
20
30
40
Riverbed


LINE 18
NW
SE
SB_20061221153036.06T
TRACE / SHOT NUMBER
EVENTS
T19
Riverbed
MLLW
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]


TIELINE 19
W
E
SB_20061221165138.07T
TRACE / SHOT NUMBER
100
200
300
400
500
655
654
653
652
651
650
649
EVENTS
L18
L15
L12
L10
L7
L4
0 MLLW
Riverbed
TIME [ms]
0
10
20
30
40
DEPTH [FOOT] at v=5000[ft/s]
10
20
30
40
50
60
70
80
90
100


TIELINE 20
W
E
SB_20061221164633.05T
TRACE / SHOT NUMBER
100
200
300
400
500
600
63640
641
642
643
644
645
646
647
EVENTS
L15
L12
L10
L7
L4
L1
0 MLLW
Riverbed
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]


TIELINE 21
W
E
SB_20061221164129.06T
TRACE / SHOT NUMBER
100
200
300
400
500
639
638
637
636
635
634
6363
EVENTS
L12
L10
L7
L4
L1
0 MLLW
Riverbed
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]
0
10
20
30
40
50
60
70
80
90
100

APPENDIX D

Geotechnical Logsheets
(provided by the USACE)

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT: FS for Navigational Improvement, Portsmouth, NH
2. BORING LOCATION (Coordinates or Station): N 103,511.5 E 2,782,522.9
3. DRILLING AGENCY: New Hampshire Boring
4. NAME OF DRILLER: Manlea "Bub" Thompson
5. NAME OF INSPECTOR: Maria Orosz
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 27.00 ft
8. DEPTH DRILLED INTO ROCK: ft
9. TOTAL DEPTH OF HOLE: 27.00 ft
10. SIZE AND TYPE OF BIT: 4" roller bit
11a. VERTICAL DATUM: MLLW
11b. HORIZONTAL DATUM: State Plane, NAD 83 Maine West
12. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED 0
14. TOTAL # OF ROCK SAMPLES: 0
15. ELEVATION GROUND WATER: ft (▽ ft; ▽ ft; ▼ ft)
16. DATE/TIME: STARTED 9/10/07 0945; COMPLETED 9/10/07 1200
17. ELEVATION TOP OF HOLE: -13.00 ft
18. TOTAL ROCK CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: *Maria Orosz*

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/AB/CR	BLOWS / 0.5 ft	PP/TOR	Length REC.	% REC.	RQD	Length RQD
-13.00 / -15.00	0.00 / 2.00		0.0-2.0 Silty fine, SAND and gravel, wet, brown	J-1	SPT	2-2-17-21		0.7	35%		
-18.00	5.00		2.0-5.0 ROLLERBITTED.								
-20.00	7.00		5.0-7.0 Medium to coarse, SAND and gravel, wet, brown	J-2	SPT	16-11-11-11		0.5	25%		
-23.00	10.00		7.0-10.0 ROLLERBITTED.								
-25.00	12.00		10.0-12.0 Medium to coarse, SAND and gravel, wet, brown, with one larger angular piece of gravel.	J-3	SPT	13-14-13-8		0.3	15%		
-28.00	15.00		12.0-15.0 ROLLERBITTED.								
-30.00	17.00		15.0-17.0 Medium to coarse, SAND and gravel, wet, brown, with one larger piece of gravel.	J-4	SPT	5-7-8-8		0.4	20%		
-33.00	20.00		17.0-20.0 ROLLERBITTED.								

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: -13.00 ft

Hole No. B-1

PROJECT: FS for Navigational Improvement

INSTALLATION: Baltimore District

SHEET 2 OF 2 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-35.00	22.00		20.0-22.0 Fine, SAND little gravel, wet, brown		J-5	SPT	3-3-7-9		1	50%		
-38.00	25.00		22.0-25.0 ROLLERBITTED.									
-40.00	27.00		25.0-27.0 Fine, SAND some gravel, wet, brown BOTTOM OF HOLE		J-6	SPT	4-5-8-14		0.9	45%		

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven manually by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 16.5'
4. Drill rods periodically ran rough for short periods of time during drilling, especially while drilling through sands and gravels.
5. The majority of SPT samples did not have sample in shoe, most likely due to wash out.
6. Boring were advanced using 4" casing and 4" rollerbit.
7. Roundness of gravel was subangular.
8. GPS coordinates were determined through data processing.

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 3 SHEETS

1. PROJECT FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT 4" roller bit
2. BORING LOCATION (Coordinates or Station) N 104,172.3 E 2,781,786.4	11a. VERTICAL DATUM MLLW; 11b. HORIZONTAL DATUM State Plane, NAD 83 Maine West
3. DRILLING AGENCY New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL Detrich D-50
4. NAME OF DRILLER Manlea "Bub" Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 8; UNDISTURBED 0
5. NAME OF INSPECTOR Maria Orosz	14. TOTAL # OF ROCK SAMPLES 0
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER ft (▽ ft; ▼ ft; ▼ ft)
	16. DATE/TIME STARTED 9/10/07 1322; COMPLETED 9/11/07 0855
7. THICKNESS OF OVERBURDEN 37.00 ft	17. ELEVATION TOP OF HOLE -3.00 ft
8. DEPTH DRILLED INTO ROCK ft	18. TOTAL ROCK CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 37.00 ft	19. SIGNATURE OF INSPECTOR *Maria Orosz*

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-3.00 / -5.00	0.00 / 2.00		0.0-2.0 Medium to coarse, SAND and gravel, wet, brown	J-1	SPT	9-11-5-2		0.5	25%		
-5.00 / -8.00	2.00 / 5.00		2.0-5.0 ROLLERBITTED.								
-8.00 / -10.00	5.00 / 7.00		5.0-7.0 Medium, SAND little gravel, wet, brown	J-2	SPT	6-5-4-5		0.6	30%		
-10.00 / -13.00	7.00 / 10.00		7.0-10.0 ROLLERBITTED.								
-13.00 / -15.00	10.00 / 12.00		10.0-12.0 Fine to medium, SAND little gravel, wet, brown	J-3	SPT	4-4-6-8		1	50%		
-15.00 / -18.00	12.00 / 15.00		12.0-15.0 ROLLERBITTED.								
-18.00 / -20.00	15.00 / 17.00		15.0-17.0 Fine to medium, SAND little gravel, wet, brown, Bottom 0.3 medium to coarse sand and gravel.	J-4	SPT	4-8-12-12		0.8	40%		
-20.00 / -23.00	17.00 / 20.00		17.0-20.0 ROLLERBITTED.								

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: -3.00 ft

Hole No. B-2

PROJECT: FS for Navigational Improvement

INSTALLATION: Baltimore District

SHEET 2 OF 3 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-25.00	22.00		20.0-22.0 Medium to coarse, SAND and gravel, wet, brown		J-5	SPT	9-12-17-17		0.6	30%		
-28.00	25.00		22.0-25.0 ROLLERBITTED.									
-30.00	27.00		25.0-27.0 Medium to coarse, SAND and gravel, wet, brown		J-6	SPT	6-8-11-14		0.7	35%		
-33.00	30.00		27.0-30.0 ROLLERBITTED									
-35.00	32.00		30.0-32.0 Medium to coarse, SAND and gravel, wet, brown		J-7	SPT	11-12-14-18		0.8	40%		
-38.00	35.00		32.0-35.0 ROLLERBITTED									
-40.00	37.00		35.0-37.0 GRAVEL with medium to coarse sand, wet, brown, In tip of SPT the color changed to gray BOTTOM OF HOLE		J-8	SPT	7-31-30-27		0.8	40%		

<u>Notes:</u>

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven manually by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 9.0'
4. Drill rods running rough between 20.0' - 27.0'.
5. Drill rods periodically ran rough for short periods of time during drilling, especially while drilling through sands and gravels.
6. The majority of SPT samples did not have sample in shoe, most likely due to wash out.
7. Boring were advanced using 4" casing and 4" rollerbit.
8. Roundness of gravel was subangular.

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
			9. GPS coordinates were determined through data processing.									

Hole No. B-3

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT: FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT: 4" roller bit
2. BORING LOCATION (Coordinates or Station): N 104,052.6 E 2,782,268.9	11a. VERTICAL DATUM: MLLW; 11b. HORIZONTAL DATUM: State Plane, NAD 83 Maine West
3. DRILLING AGENCY: New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50
4. NAME OF DRILLER: Manlea "Bub" Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED 0
5. NAME OF INSPECTOR: Maria Orosz	14. TOTAL # OF ROCK SAMPLES: 0
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: ft (During drilling: ft; At completion: ft; After drilling: ft)
7. THICKNESS OF OVERBURDEN: 27.00 ft	16. DATE/TIME: STARTED 9/11/07 1000; COMPLETED 9/11/07 1310
8. DEPTH DRILLED INTO ROCK: ft	17. ELEVATION TOP OF HOLE: -15.00 ft
9. TOTAL DEPTH OF HOLE: 27.00 ft	18. TOTAL ROCK CORE RECOVERY FOR BORING: %
	19. SIGNATURE OF INSPECTOR: *Maria Orosz*

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/AB/CR	BLOWS / 0.5 ft	PP/TOR	Length REC.	% REC.	RQD	Length RQD
-15.00 / -17.00	0.00 / 2.00		0.0-2.0 Fine to medium, SAND contains shells, little gravel, wet, black and brown	J-1	SPT	3-3-3-2		0.4	20%		
-17.00 / -20.00	2.00 / 5.00		2.0-5.0 ROLLERBITTED.								
-20.00 / -20.60	5.00 / 5.60		5.0-5.6 Fine to medium, SAND little gravel, wet, brown	J-2	SPT	31-120/0.1		0.6	100%		
-20.60 / -25.00	5.60 / 10.00		7.0-10.0 ROLLERBITTED.								
-25.00 / -27.00	10.00 / 12.00		10.0-12.0 Sandy fine, SILT with gravel, wet, brown	J-3	SPT	2-5-22-37		1.2	60%		
-27.00 / -30.00	12.00 / 15.00		12.0-15.0 ROLLERBITTED.								
-30.00 / -32.00	15.00 / 17.00		15.0-17.0 Fine, SAND with two interbedded silt layers, wet, brown	J-4	SPT	4-5-5-6		0.7	35%		
-32.00 / -35.00	17.00 / 20.00		17.0-20.0 ROLLERBITTED.								

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-37.00	22.00		20.0-22.0 Fine, SAND wet, brown		J-5	SPT	8-2-6-8		0.4	20%		
-40.00	25.00		22.0-25.0 ROLLERBITTED.									
-42.00	27.00		25.0-27.0 Fine to medium, SAND wet, brown BOTTOM OF HOLE		J-6	SPT	8-6-4-6		0.9	45%		

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven manually by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 18.5'
4. Casing dropped 0.5' while setting up to sample J-2, potentially due to washed out sand and gravel.
5. Drill rods running rough between 5.6' to 10.0' - sounded like grinding on gravel.
6. Drilling for B-3 was rougher for longer periods of time than B-1 and B-2.
7. The majority of SPT samples did not have sample in shoe, most likely due to wash out.
8. Boring were advanced using 4" casing and 4" rollerbit.
9. Roundness of gravel was subangular.
10. GPS coordinates were determined through data processing.

Hole No. B-4

DRILLING LOG	DIVISION: North Atlantic Division	INSTALLATION: Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT: FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT: 4" roller bit
2. BORING LOCATION (Coordinates or Station): N 104,438.4 E 2,781,783.8	11a. VERTICAL DATUM: MLLW; 11b. HORIZONTAL DATUM: State Plane, NAD 83 Maine West
3. DRILLING AGENCY: New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50
4. NAME OF DRILLER: Manlea "Bub" Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 5; UNDISTURBED 0
5. NAME OF INSPECTOR: Maria Orosz	14. TOTAL # OF ROCK SAMPLES: 0
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: ft (▽ ft; ▽ ft; ▼ ft)
	16. DATE/TIME: STARTED 9/13/07 1230; COMPLETED 9/13/07 1230
7. THICKNESS OF OVERBURDEN: 37.00 ft	17. ELEVATION TOP OF HOLE: -3.00 ft
8. DEPTH DRILLED INTO ROCK: ft	18. TOTAL ROCK CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 37.00 ft	19. SIGNATURE OF INSPECTOR: *Maria Orosz*

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/AB/CR	BLOWS / 0.5 ft	PP/TOR	Length REC.	% REC.	RQD	Length RQD
-3.00 / -5.00	0.00 / 2.00		0.0-2.0 Silty medium to coarse, SAND and gravel, wet, brown, rock stuck in tip of SPT	J-1	SPT	8-12-21-18		0.6	30%		
-5.00 / -8.00	2.00 / 5.00		2.0-5.0 ROLLERBITTED.								
-8.00 / -10.00	5.00 / 7.00		5.0-7.0 Fine to medium, SAND little gravel, wet, brown	J-2	SPT	4-6-9-11		0.9	45%		
-10.00 / -18.00	7.00 / 15.00		7.0-15.0 ROLLERBITTED.								
-18.00 / -20.00	15.00 / 17.00		15.0-17.0 Fine to medium, SAND little gravel, wet, brown, Bottom 0.2 fine sandy silt	J-3	SPT	4-6-10-12		1.3	65%		
-20.00	17.00		17.0-25.0 ROLLERBITTED.								

DRILLING LOG (Cont. Sheet) | ELEVATION TOP OF HOLE -3.00 ft | **Hole No. B-4**

PROJECT: FS for Navigational Improvement | INSTALLATION: Baltimore District | SHEET 2 OF 2 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-28.00	25.00										
-30.00	27.00		25.0-27.0 Fine to medium, SAND little gravel, wet, brown	J-4	SPT	7-13-30-42		1.1	55%		
-38.00	35.00		27.0-35.0 ROLLERBITTED.								
-40.00	37.00		35.0-37.0 Fine to medium, SAND wet, brown BOTTOM OF HOLE	J-5	SPT	10-12-38-81		1.4	70%		

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven manually by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 8.0'
4. Drill rods running rough between 2.0' to 5.0', 7.0' to 10.0', and 25.0' to 37.0'.
5. The majority of SPT samples did not have sample in shoe, most likely due to wash out.
6. Boring was advanced using 4" casing and 4" rollerbit.
7. Roundness of gravel was subangular.
8. GPS coordinates were not processed and the raw utilized.

Hole No. B-5

DRILLING LOG	DIVISION: North Atlantic Division	INSTALLATION: Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT: FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT: 4" roller bit
2. BORING LOCATION (Coordinates or Station): N 104,925.0 E 2,781,460.3	11a. VERTICAL DATUM: MLLW / 11b. HORIZONTAL DATUM: State Plane, NAD 83 Maine West
3. DRILLING AGENCY: New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50
4. NAME OF DRILLER: Dave Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 6 / UNDISTURBED 0
5. NAME OF INSPECTOR: Maria Orosz	14. TOTAL # OF ROCK SAMPLES: 0
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: ft (During drilling: ft; At completion: ft; After drilling: ft)
	16. DATE/TIME: STARTED 11/27/07 0945 / COMPLETED 11/27/07 1245
	17. ELEVATION TOP OF HOLE: -14.50 ft
7. THICKNESS OF OVERBURDEN: 27.00 ft	18. TOTAL ROCK CORE RECOVERY FOR BORING: %
8. DEPTH DRILLED INTO ROCK: ft	19. SIGNATURE OF INSPECTOR: *Maria Orosz*
9. TOTAL DEPTH OF HOLE: 27.00 ft	

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/AB/CR	BLOWS / 0.5 ft	PP/TOR	Length REC.	% REC.	RQD	Length RQD
-14.50 / -16.50	0.00 / 2.00		0.0-2.0 Sandy fine, SILT wet, brown, Upper 0.3 black fine sand with shells	J-1	SPT	1-1-3-3		1.4	70%		
-19.50	5.00		2.0-5.0 ROLLERBITTED.								
-21.50	7.00		5.0-7.0 Sandy fine, SILT wet, brown	J-2	SPT	3-3-5-5		0.6	30%		
-24.50	10.00		7.0-10.0 ROLLERBITTED.								
-26.30	11.80		10.0-11.8 Silty fine, SAND with gravel, wet, brown, One large piece of gravel approx 0.1'	J-3	SPT	30-50-96-100/0.3		1.2	67%		
-29.50	15.00		11.8-15.0 ROLLERBITTED.								
-31.50	17.00		15.0-17.0 Fine, SAND wet, brown, Bottom 0.2 gravel and coarse sand.	J-4	SPT	20-17-18-21		1.1	55%		
-34.50	20.00		17.0-20.0 ROLLERBITTED.								

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: -14.50 ft

Hole No. B-5

PROJECT: FS for Navigational Improvement

INSTALLATION: Baltimore District

SHEET 2 OF 2 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-36.50	22.00		20.0-22.0 Fine, SAND little gravel, wet, brown		J-5	SPT	9-20-21-24		1.2	60%		
-39.50	25.00		22.0-25.0 ROLLERBITTED.									
-41.50	27.00		25.0-27.0 Fine to medium, SAND little gravel, wet, brown BOTTOM OF HOLE		J-6	SPT	12-29-40-48		1.3	65%		

<u>Notes:</u>

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven manually by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 23.5'
4. Boring was advanced using 4" casing and 4" rollerbit.
5. Roundness of gravel was subangular.
6. Drill rods running rough between 7.0' to 15.0'.
7. GPS coordinates were not processed and the raw utilized.

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT 4" roller bit
2. BORING LOCATION (Coordinates or Station) N 104,631.0 E 2,781,500.2	11a. VERTICAL DATUM MLLW; 11b. HORIZONTAL DATUM State Plane, NAD 83 Maine West
3. DRILLING AGENCY New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL Detrich D-50
4. NAME OF DRILLER Dave Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 3; UNDISTURBED 0
5. NAME OF INSPECTOR Maria Orosz	14. TOTAL # OF ROCK SAMPLES 2
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER ft (▽ ft, ▼ ft, ▼ ft)
	16. DATE/TIME STARTED 11/28/07 0800; COMPLETED 11/28/07 1305
	17. ELEVATION TOP OF HOLE -15.00 ft
7. THICKNESS OF OVERBURDEN 12.00 ft	18. TOTAL ROCK CORE RECOVERY FOR BORING 100 %
8. DEPTH DRILLED INTO ROCK 10.00 ft	19. SIGNATURE OF INSPECTOR *Maria Orosz*
9. TOTAL DEPTH OF HOLE 28.00 ft	

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-15.00 / -17.00	0.00 / 2.00		0.0-2.0 Fine to medium, SAND with gravel, wet, brown	J-1	SPT	7-8-9-10		0.6	30%		
-20.00	5.00		2.0-5.0 ROLLERBITTED.								
-22.00	7.00		5.0-7.0 Silty fine, SAND with gravel, wet, brown	J-2	SPT	18-28-40-43		0.5	25%		
-25.00	10.00		7.0-10.0 ROLLERBITTED.								
-27.00	12.00		10.0-12.0 Silty fine, SAMD with gravel, wet, brown, Upper 0.2 black gravel and coarse sand	J-3	SPT	76-88-63-72		1	50%		
-33.00	18.00		12.0-15.0 ROLLERBITTED. 15.0-18.0 SPT refusal @ 15' (0.0/100). ROLLERBITTED to 18.0'. Wash water from tailings was cloudy gray, and tailings appeared to be crushed rock. Began coring at 18.0.'								
			18.0-23.0 Gneiss gray, slightly weathered, fine, medium hard, Rock contained pitted voids from 18.0 to 19.0'. One apparent fracture at 19.9'. Fracture was slightly stained, rough, narrow, dipping at approx 50 degrees								

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-38.00	23.00		Mechanical breaks occurred at 18.2', 18.9', 20.1', 20.5' and 22.2'.		CR Run 1			5	100%	0.92	55.2
-43.00	28.00		23.0-28.0 Gneiss gray, slightly weathered, fine, medium hard, One apparent fracture at 23.7'. Fracture was slightly stained, rough, narrow, dipping at approx 60 degrees. Mechanical breaks occurred at 24.6', 25.3', 25.7', and 26.5'. Mechanical break angles ranged from 40 to 70 degrees. BOTTOM OF HOLE		CR Run 2			5	100%	0.94	56.4

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven manually by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 15.0'
4. Boring was advanced using 4" casing and 4" rollerbit.
5. Roundness of gravel was subangular.
6. Run Times (ft/min) for Run #1: 3-4-4-4-4, and Run#2: 4-3-3-3-3.
7. Poor recovery for J-2 due to rock in catcher.
8. Drill rods running rough between 7.0' to 10.0'.
9. GPS coordinates were determined through data processing.

Hole No. B-7

DRILLING LOG	DIVISION: North Atlantic Division	INSTALLATION: Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT: FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT: 4" roller bit
2. BORING LOCATION (Coordinates or Station): N 103,983.5 E 2,781,847.7	11a. VERTICAL DATUM: MLLW; 11b. HORIZONTAL DATUM: State Plane, NAD 83 Maine West
3. DRILLING AGENCY: New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50
4. NAME OF DRILLER: Dave Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 5; UNDISTURBED 0
5. NAME OF INSPECTOR: Maria Orosz	14. TOTAL # OF ROCK SAMPLES: 0
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: ft
	16. DATE/TIME: STARTED 11/29/07 0830; COMPLETED 11/28/07 1100
	▽ ft; ▽ ft; ▼ ft
7. THICKNESS OF OVERBURDEN: 22.00 ft	17. ELEVATION TOP OF HOLE: -19.00 ft
8. DEPTH DRILLED INTO ROCK: ft	18. TOTAL ROCK CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 22.00 ft	19. SIGNATURE OF INSPECTOR: *Maria Orosz*

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/AB/CR	BLOWS / 0.5 ft	PP/TOR	Length REC.	% REC.	RQD	Length RQD
-19.00 / -21.00	0.00 / 2.00		0.0-2.0 Fine, SAND little gravel, wet, brown	J-1	SPT	11-4-3-2		1	50%		
-24.00	5.00		2.0-5.0 ROLLERBITTED.								
-26.00	7.00		5.0-7.0 Fine to medium, SAND little gravel, wet, brown	J-2	SPT	5-5-3-5		1.3	65%		
-29.00	10.00		7.0-10.0 ROLLERBITTED.								
-31.00	12.00		10.0-12.0 Fine to coarse, SAND with gravel, wet, brown	J-3	SPT	4-4-4-6		1.2	60%		
-34.00	15.00		12.0-15.0 ROLLERBITTED.								
-36.00	17.00		15.0-17.0 Medium to coarse, SAND with gravel, wet, brown	J-4	SPT	7-8-12-31		0.9	45%		
-39.00	20.00		17.0-20.0 ROLLERBITTED.								

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: -19.00 ft

Hole No. B-7

PROJECT: FS for Navigational Improvement

INSTALLATION: Baltimore District

SHEET 2 OF 2 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
			20.0-22.0 Medium to coarse, SAND with gravel, wet, brown		J-5	SPT	13-78-39-26		1.4	70%		
-41.00	22.00		BOTTOM OF HOLE									

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven manually by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 25.0'
4. Boring was advanced using 4" casing and 4" rollerbit.
5. Roundness of gravel was subangular.
6. Drill rods running rough between 17.0' to 20.0'.
7. The current was very strong in this location.
8. For samples J-1, J-3, and J-5, the 3" spoon was used to retrieve a greater amount of sample.
9. GPS coordinates were determined through data processing.

DRILLING LOG	DIVISION: North Atlantic Division	INSTALLATION: Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT: FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT: 4" roller bit
2. BORING LOCATION (Coordinates or Station): N 103,732.7 E 2,782,109.8	11a. VERTICAL DATUM: MLLW; 11b. HORIZONTAL DATUM: State Plane, NAD 83 Maine West
3. DRILLING AGENCY: New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50
4. NAME OF DRILLER: Dave Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 5; UNDISTURBED 0
5. NAME OF INSPECTOR: Maria Orosz	14. TOTAL # OF ROCK SAMPLES: 0
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: ft (▽ ft, ▽ ft, ▼ ft)
	16. DATE/TIME: STARTED 11/29/07 1237; COMPLETED 11/30/07 1000
7. THICKNESS OF OVERBURDEN: 22.00 ft	17. ELEVATION TOP OF HOLE: -18.00 ft
8. DEPTH DRILLED INTO ROCK: ft	18. TOTAL ROCK CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 22.00 ft	19. SIGNATURE OF INSPECTOR: *Maria Orosz*

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SAMPLE	SPT/AB/CR	BLOWS / 0.5 ft	PP/TOR	Length REC.	% REC.	RQD	Length RQD
-18.00 to -20.00	0.00 to 2.00		0.0-2.0 Fine to medium, SAND wet, brown, One large piece of gravel approx 0.3'	J-1	SPT	19-6-2-2		0.7	35%		
-20.00 to -23.00	2.00 to 5.00		2.0-5.0 ROLLERBITTED.								
-23.00 to -25.00	5.00 to 7.00		5.0-7.0 Coarse, SAND AND GRAVEL wet, brown	J-2	SPT	5-5-7-9		1	50%		
-25.00 to -28.00	7.00 to 10.00		7.0-10.0 ROLLERBITTED.								
-28.00 to -30.00	10.00 to 12.00		10.0-12.0 Fine to medium, SAND AND GRAVEL little gravel, wet, brown	J-3	SPT	14-19-23-30		0.9	45%		
-30.00 to -33.00	12.00 to 15.00		12.0-15.0 ROLLERBITTED.								
-33.00 to -35.00	15.00 to 17.00		15.0-17.0 Medium to coarse, SAND AND GRAVEL wet, brown	J-4	SPT	12-30-31-40		2	100%		
-35.00 to -38.00	17.00 to 20.00		17.0-20.0 ROLLERBITTED.								

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE -18.00 ft	**Hole No. B-8**

PROJECT	INSTALLATION	SHEET
FS for Navigational Improvement	Baltimore District	2 OF 2 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
			20.0-22.0 Coarse, SAND AND GRAVEL wet, brown		J-5	SPT	13-15-17-14		1	50%		
-40.00	22.00		BOTTOM OF HOLE									

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven manually by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 25.0'
4. Boring was advanced using 4" casing and 4" rollerbit.
5. Roundness of gravel was subangular.
6. For samples J-1, J-2, J-4, and J-5, the 3" spoon was used to retrieve a greater amount of sample.
7. GPS coordinates were determined through data processing.

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 3 SHEETS

1. PROJECT FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT
2. BORING LOCATION (Coordinates or Station) N 105,013.1 E 2,781,703.1	11a. VERTICAL DATUM MLLW / 11b. HORIZONTAL DATUM State Plane, NAD 83 Maine West
3. DRILLING AGENCY New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL Detrich D-50
4. NAME OF DRILLER Manlea "Bub" Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF INSPECTOR Maria Orosz	14. TOTAL # OF ROCK SAMPLES 0
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER ft (▽ ft; ▼ ft; ▼ ft)
	16. DATE/TIME: STARTED 9/13/07 0740; COMPLETED 9/13/07 0915
7. THICKNESS OF OVERBURDEN 58.90 ft	17. ELEVATION TOP OF HOLE -2.00 ft
8. DEPTH DRILLED INTO ROCK ft	18. TOTAL ROCK CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 58.90 ft	19. SIGNATURE OF INSPECTOR *Maria Orosz*

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-2.00	0.00		0.0-58.9									
			19.0-24.0 Casing blows per foot: 26-24-22-24-21									

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG (Cont. Sheet) ELEVATION TOP OF HOLE -2.00 ft **Hole No. P-1**

PROJECT: FS for Navigational Improvement | INSTALLATION: Baltimore District | SHEET 2 OF 3 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
			24.0-29.0 Casing blows per foot: 23-21-22-21-21									
			29.0-34.0 Casing blows per foot: 21-21-20-21-22									
			34.0-39.0 Casing blows per foot: 26-25-25-22-20									
			39.0-44.0 Casing blows per foot: 23-27-24-23-22									
			44.0-49.0 Casing blows per foot: 21-21-18-21-27									

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE -2.00 ft	Hole No. P-1
PROJECT FS for Navigational Improvement	INSTALLATION Baltimore District	SHEET 3 OF 3 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
			49.0-54.0 Casing blows per foot: 26-26-29-34-42									
			54.0-58.9 Casing blows per foot: 40-42-48-56-49									
-60.90	58.90		BOTTOM OF HOLE									

Notes:

1. Water depth at start of drilling from top of water to mudline was 2.5'
2. Probe holes were advanced using a 300 lb hammer to pound NW rods into the sediment. An A-rod center plug that was ground into a 60 degree point was used to advance the NW rods.
3. Top of rock was determined by a bouncing refusal.
4. Casing blows were only recorded for P-1.
5. GPS coordinates were determined through data processing.

Hole No. P-2

DRILLING LOG	DIVISION: North Atlantic Division	INSTALLATION: Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT: FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT
2. BORING LOCATION (Coordinates or Station): N 103,605.5 E 2,782,165.0	11a. VERTICAL DATUM: MLLW; 11b. HORIZONTAL DATUM: State Plane, NAD 83 Maine West
3. DRILLING AGENCY: New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50
4. NAME OF DRILLER: Manlea "Bub" Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF INSPECTOR: Maria Orosz	14. TOTAL # OF ROCK SAMPLES: 0
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: ft (▽ ft; ▼ ft; ▼ ft)
	16. DATE/TIME: STARTED 9/12/07 0130; COMPLETED 9/12/07 1453
7. THICKNESS OF OVERBURDEN: 37.00 ft	17. ELEVATION TOP OF HOLE: -15.50 ft
8. DEPTH DRILLED INTO ROCK: ft	18. TOTAL ROCK CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 37.00 ft	19. SIGNATURE OF INSPECTOR: Maria Orosz

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-15.50	0.00		0.0-37.0									

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: -15.50 ft

Hole No. P-2

PROJECT: FS for Navigational Improvement

INSTALLATION: Baltimore District

SHEET 2 OF 2 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-52.50	37.00		BOTTOM OF HOLE									

Notes:

1. Water depth at start of drilling from top of water to mudline was 15.5'
2. Hard driving rods near bottom of probe hole.
3. At completion of probe hole, the final rod that was pulled was bent.
4. Probe holes were advanced using a 300 lb hammer to pound NW rods into the sediment. An A-rod center plug that was ground into a 60 degree point was used to advance the NW rods.
5. Top of rock was determined by a bouncing refusal.
6. GPS coordinates were not processed and the raw utilized.

DRILLING LOG

DRILLING LOG	DIVISION: North Atlantic Division	INSTALLATION: Baltimore District	SHEET 1 OF 3 SHEETS

1. PROJECT: FS for Navigational Improvement, Portsmouth, NH	10. SIZE AND TYPE OF BIT
2. BORING LOCATION (Coordinates or Station): N 104,971.2 E 2,781,345.4	11a. VERTICAL DATUM: MLLW; 11b. HORIZONTAL DATUM: State Plane, NAD 83 Maine West
3. DRILLING AGENCY: New Hampshire Boring	12. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50
4. NAME OF DRILLER: Manlea "Bub" Thompson	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF INSPECTOR: Maria Orosz	14. TOTAL # OF ROCK SAMPLES: 0
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: ft (During drilling: ft; At completion: ft; After drilling: ft)
	16. DATE/TIME: STARTED 9/12/07 0840; COMPLETED 9/12/07 1132
7. THICKNESS OF OVERBURDEN: 49.00 ft	17. ELEVATION TOP OF HOLE: -12.00 ft
8. DEPTH DRILLED INTO ROCK: ft	18. TOTAL ROCK CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 49.00 ft	19. SIGNATURE OF INSPECTOR: *Maria Orosz*

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-12.00	0.00		0.0-49.0									

NAB 1836 LETTER PORTSMOUTH_NAB_ALL_BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE
-12.00 ft

Hole No. P-3

PROJECT	INSTALLATION	SHEET
FS for Navigational Improvement	Baltimore District	2 OF 3 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD

NAB 1836 LETTER PORTSMOUTH NAB ALL BORINGS.GPJ USACE BALTIMORE.GDT 12/7/07

PROJECT	INSTALLATION	SHEET 3
FS for Navigational Improvement	Baltimore District	OF 3 SHEETS

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)		SAMPLE	SPT/ AB/ CR	BLOWS / 0.5 ft	PP/ TOR	Length REC.	% REC.	RQD	Length RQD
-61.00	49.00		BOTTOM OF HOLE									

Notes:

1. Water depth at start of drilling from top of water to mudline was 11.5'
2. Probe holes were advanced using a 300 lb hammer to pound NW rods into the sediment. An A-rod center plug that was ground into a 60 degree point was used to advance the NW rods.
3. Top of rock was determined by a bouncing refusal.
4. GPS coordinates were determined through data processing.

APPENDIX E

Equipment Operations and Procedures

Trimble 4000RS and ProBeacon Differential GPS
HYPACK® Navigation Software
Klein 3000 Dual Frequency Side Scan Sonar System
Geometrics G-882 Marine Cesium Magnetometer
Applied Acoustics Engineering “Boomer” Seismic Reflection System

EQUIPMENT OPERATIONS AND PROCEDURES

Trimble 4000RS and ProBeacon Differential GPS

The Trimble 4000RS satellite positioning system provides reliable, high-precision positioning and navigation for a wide variety of operations and environments. The system consists of a GPS receiver, a GPS volute antenna and cable, RS232 output data cables, and a secondary reference station receiver, in this case a Trimble ProBeacon receiver. The beacon receiver consists of a small control unit, a volute antenna and cable, and RS232 interface to the Trimble GPS unit.

Fully automated, the Trimble 4000RS provides means for 9 channel simultaneous satellite tracking with real time display of geodetic position, time, date, and boat track if desired. The Trimble unit is mounted on the survey vessel with the ProBeacon receiver which continuously receives differential satellite correction factors via radio link from one of the DGPS United States Coast Guard beacons. The Trimble 4000RS accepts the correction factors via the ProBeacon interface and applies the differential corrections to obtain continuous, high accuracy, real time position updates. The Trimble 4000 system is interfaced to the OSI data logging computer and HYPACK® navigation software for trackline control. The output data string from the Trimble receiver can be modified to send all or part of the data parameters to the computer for logging.

The Coast Guard beacon located at Portsmouth Harbor, New Hampshire (frequency of 288 kHz, @ 100 bps) was used during this project with good reliability and signal strength.

HYPACK® Navigation Software

Survey vessel trackline control and position fixing were obtained by utilizing an OSI computer-based data logging package running HYPACK® navigation software. The Pentium computer is interfaced with the Trimble 4000 DGPS system onboard the survey vessel. Vessel position data from the Trimble 4000RS were updated at 1.0 second intervals and input to the HYPACK® navigation system which processes the geodetic positions into State Plane coordinates used to guide the survey vessel accurately along preselected tracklines. The incoming data are logged on disk and processed in real time allowing the vessel position to be displayed on a video monitor and compared to each preplotted trackline as the survey progresses. A nautical chart background shows the shoreline, general water depths, and locations of existing structures, buoys, and control points on the monitor in relation to the vessel position. The OSI computer logging system combined with the HYPACK® software thus provide an accurate visual representation of survey vessel location in real time, combined with highly efficient data logging capability and post-survey data processing and plotting routines.

Klein 3000 Dual Frequency Side Scan Sonar System

Side scan sonar images of the bottom were collected using a Klein 3000 dual frequency, high resolution sonar system operating at frequencies of 100 and 500 kilohertz. The system consists of a topside notebook computer, external monitor, keyboard, mouse, an EPC1086NT dual channel thermal graphic recorder, a Kevlar tow cable and sonar towfish. The system contains an integrated navigational plotter which accepts standard NMEA 0183 input from a GPS system. This allows vessel position and sonar sweep to be displayed on the monitor and speed information to be used for controlling the sonar ping rate.

All sonar images are stored digitally and can be enhanced real-time or post-survey by numerous mathematical filters available in the program software. Other software functions that are available during data acquisition include; changing range scale and delay, display color, automatic or manual gain, speed over bottom, multiple enlargement zoom, target length, height, and area measurements, logging and saving of target images, and annotation frequency and content. The power of this system is its real-time processing capability for determining precise dimensions of targets and areas on the bottom.

As with many other marine geophysical instruments, the side scan sonar derives its information from reflected acoustic energy. A set of transducers mounted in a compact towfish generate the short duration acoustic pulses required for extremely high resolution. The pulses are emitted in a thin, fan-shaped pattern that spreads downward to either side of the fish in a plane perpendicular to its path. As the fish progresses along the trackline, the acoustic beam is capable of scanning the bottom from a point beneath the fish, outward as far as 200 meters on each side of the survey trackline, depending on towfish height above the seabed.

Acoustic energy reflected from any bottom discontinuities is received by the set of transducers in the towfish, amplified and transmitted to the survey vessel via the tow cable where it is further amplified, processed, and converted to a graphic record by the side scan recorder. The sequence of reflections from the series of pulses is displayed on the dual-channel graphic recorder on which paper is incrementally advanced prior to printing each acoustic pulse. The resulting output is essentially analogous to a high angle oblique "photograph" providing detailed representation of the bottom features and characteristics.

Geometrics G-882 Marine Cesium Magnetometer

Total magnetic field intensity measurements were acquired along the survey tracklines using an Geometrics G-882 cesium magnetometer which has an instrument sensitivity of 0.1 gamma. The G-882 magnetometer system includes the sensor head with a coil and optical component tube, a sensor electronics package which houses the AC signal generator and mini-counter that converts the Larmor signal into a magnetic anomaly value in gammas, and a RS-232 data cable for transmitting digital measurements to a data logging system. The cesium-based method of magnetic detection allows the sensor to be towed off the side of the survey vessel, simultaneously with other remote sensing equipment, while maintaining high quality, quiet magnetic data with ambient fluctuations of less than 1 gamma. The G-882 features an altimeter that provides digital height above the bottom in real time thus allowing the sensor height to be precisely maintained along line. The altimeter and magnetic intensity data were recorded at a 10 hertz sampling rate on the OSI data logging computer by HYPACK®.

The G-882 magnetometer acquires information on the ambient magnetic field strength by measuring the variation in cesium electron energy states. The presence of only one electron in the cesium atom’s outermost electron shell (known as alkali metals) makes cesium ideal for optical pumping and magentometry.

In operation, a beam of infrared light is passed through a cesium vapor chamber producing a Larmor frequency output in the form of a continuous sine wave. This radio frequency field is generated by an H1 coil wound around a tube containing the optical components (lamp oscillator, optical filters and lenses, split-circular polarizer, and infrared photo detector). The

Larmor frequency is directly proportional to the ambient magnetic intensity measurements, and is exactly 3.49872 times the ambient magnetic field measured in gammas or nano-Teslas. Changes in the ambient magnetic field cause different degrees of atomic excitation in the cesium vapor which in turn allows variable amounts of infrared light to pass, resulting in fluctuations in the Larmor frequency.

Although the earth's magnetic field does change with both time and distance, over short periods and distances the earth's field can be viewed as relatively constant. The presence of magnetic material and/or magnetic minerals, however, can add to or subtract from the earth's magnetic field creating a magnetic anomaly. Rapid changes in total magnetic field intensity which are not associated with normal background fluctuations mark the locations of these anomalies.

Determination of the location of an object producing a magnetic anomaly depends on whether or not the magnetometer sensor passed directly over the object and if the anomaly is an apparent monopole or dipole. A magnetic dipole can be thought of simply as a common bar magnet having a positive and negative end or pole. A monopole arises when the magnetometer senses only one end of a dipole as it passes over the object. This situation occurs mainly when the distance between opposite poles of a dipole is much greater than the distance between the magnetometer and the sensed pole, or when a dipole is oriented nearly perpendicular to the ambient field thus shielding one pole from detection. For dipolar anomalies, the location of the object is at the point of maximum gradient between the two poles. In the case of a monopole, the object associated with the anomaly is located below the maximum or minimum magnetic value.

Applied Acoustics Engineering "Boomer" Seismic Reflection System

Subbottom information from deeper below the seafloor was gathered using an Applied Acoustics Engineering seismic reflection system. The AAE "boomer" system consists of a variable 100-300 joule power supply, a catamaran boomer plate for sound source, a 10 element hydrophone array (eel) as receiver, and a graphic recorder for printing the acoustic returns. For this project, an Octopus Model 760 Marine Seismic Processor with universal amplifier and filter was used inline with the system, which includes TVG (time varied gain) with bottom tracking, automatic gain control, and a swell filter. A Kronhite Model 3200 analog filter was also used to band pass the signals for unwanted electrical and tow noise. The entire system was interfaced with an EPC Model 1086NT thermal recorder for displaying the seismic profiles.

The Octopus 760 seismic processor adds significant power and versatility to the system. Besides the typical amplification and filtering options (band pass filter, time varied gain (TVG), it also includes a number of time varied filtering (TVF) features such as signal stacking and swell filtering which help minimze noise in the horizontal plane. The system has the ability to save data in a variety of digital formats.

Operationally, a seismic source is used to create an intense, short duration acoustic pulse or signal in the water column. This signal propagates downward to the seafloor where it is partially reflected at the sediment-water interface, while the rest of the signal continues into the subbottom. As the downward propagating signal encounters successive interfaces between layers of different material, similar partial reflections occur. The types of sediment which cause acoustic signals to behave in such a manner are defined primarily by the cross-product of the bulk density and the compressional wave velocity of each material, a quantity known as the acoustic impedance. As a first approximation, the percentage of an acoustic signal which is reflected from an interface is directly proportional to the change in acoustic impedance across that interface.

The return signal consists of a continuous sequence of reflected energy which has a series of "peaks" correlative in intensity with the magnitude of the change in acoustic impedance of the materials on either side of the interface. These return signals received by the transducer array are subsequently converted to electrical voltages which are proportional to the intensity of the return and hence dictate how strongly the return is printed by the graphic recorder. Ambient noise is filtered out and the signal is then amplified with overall gain and/or TVG and displayed trace-by-trace iteratively on the recorder to yield a continuous display somewhat analogous to a geologic cross section. The lower frequency and increased band width of the boomer waveform is designed to achieve greater penetration into the subsurface for resolution of deeper stratigraphy.

APPENDIX F

Equipment Specification Sheets

4000RSi & 4000DSi

DGPS Reference Surveyor and Differential Surveyor

Key features and benefits

- **Sub 0.5 meter accuracy**
- **Real time QA/QC**
- **Everest Multipath Rejection Technology**
- **Super-trak Signal Processing Technology**

The 4000RSi™ Reference Surveyor receiver and 4000DSi™ Differential Surveyor receiver incorporate the latest in GPS technology, offering true, real-time positioning accuracy better than 0.5 meter. Based on Trimble's advanced Maxwell processing technology, these DGPS receivers provide the highest level of accuracy even when operating in the most challenging conditions.

The 4000RSi receiver operates as an autonomous reference station, generating DGPS corrections in the RTCM SC-104 standard format for transmission to mobile GPS receivers.

The 4000DSi receiver is designed to use DGPS corrections in the RTCM SC-104 standard format broadcast by the 4000RSi receiver. The 4000DSi's standard NMEA-0183 messages, navigation firmware, data, and 1PPS outputs allow for optimal flexibility for system integration and interfacing with other instruments.

The signal processing of the two reeivers incorporates Trimble's Super-trak™ technology. This technology enhances low power satellite signal acquisition, improves signal tracking capabilities under less than ideal conditions and provides increased immunity to signal jamming from radio frequency interference (RFI). These improvements are derived from integrating complex RF circuitry onto a single chip and by using state-of-the-art Surface Acoustic Wave filter technology.

Super-trak technology increases productivity and facilitates continual operations in demanding environments, such as ports, harbors, along riverbanks and near RFI sources that would normally interfere with satellite signals.

The 4000RSi and 4000DSi receivers also incorporate Trimble's latest advance in multipath rejection through enhanced signal processing: the patented EVEREST™ Multipath Rejection Technology. This technology eliminates multipath error before the receiver calculates GPS measurements. When combined with Trimble's advanced carrier-aided filtering and smoothing techniques applied to exceptionally low noise C/A code measurements, the result is real-time positioning accuracy on the order of a few decimeters.

The two receivers are ideal for hydrographic and navigation systems, vessel tracking, dynamic positioning systems, dredging, and other dynamic positioning and navigation applications. Both receivers feature nine channels of continuous satellite tracking (12 channels optional); a lightweight, rugged, weatherproof housing; and low power consumption for extending the field operation time from batteries.

During operation, both receivers can output binary and ASCII data for archiving or post-mission analysis. In addition, the 4000RSi receiver can operate as a mobile receiver with the same features, functionality and options as the 4000DSi receiver. For optimum DGPS performance, combine the receivers with any of Trimble's data communication systems and QA/QC firmware to ensure the integrity of positioning accuracy.

4000RSi & 4000DSi

DGPS Reference Surveyor and Differential Surveyor

4000 RSI FEATURES

- RTCM Input
- RTCM Output; filtered and carrier-smoothed RTCM differential corrections (version 1.0 and 2.X) (4000RSi)
- EVEREST Multipath Rejection Technology
- Super-trak Signal Processing Technology
- Better than 0.5 meter DGPS accuracy using 4000RSi receiver corrections
- 0.5 second measurement rate
- Weighted-least squares solution
- Autonomous operation - automatic mode restoration after power-cycle
- Data integrity provision
- 2 RS-232 I/O ports with flow control for data recording and data link (4 RS-232/422 on rack mount)
- Triple DC input
- Low power; lightweight; portable; environmentally protected
- 1 PPS output; NMEA-0183 outputs
- L1 geodetic antenna; 30m antenna cable (4000RSi)
- Compact Dome antenna; 30m antenna cable (4000Dsi)
- 1-year warranty
- Firmware upgrades via serial port

OPTIONS AND ACCESSORIES

- Firmware update service - 1 and 4 year
- Extended hardware warranty
- L1 Carrier Phase
- 12 L1 channels
- L1/L2 Carrier Phase (rackmount)
- 12 L1/L2 channels (rackmount)
- Internal Memory for datalogging
- Event Marker input (requires memory option)
- QA/QC feature
- Rackmount Version
- 4 serial I/O ports (standard on rackmount)
- L1 and Ll/L2 Geodetic antennas
- 30m antenna cable extension, with in-line amplifier
- Office Support Module: OSM II (CE Marked)
- Receiver transport case
- TRIMTALK™ Series radio links
- ProBeacon™ MSK receiver
- LEMO to dual BNC sockets adapter

PHYSICAL CHARACTERISTICS

Receiver

Size	9.8" W x 11.0" D x 4.0" H (portable) (24.8cm X 28.0cm x 10.2cm) 16.8" W x 16.0" D x 5.25" H (rackmount) (42.7cm x 40.6cm x 13.3cm)
Weight	6 lbs (2.7kg) (portable), 15 lbs. (6.8kg) (rackmount) 0.5 lbs (0.2kg) compact dome antenna 5.7 lbs (2.6kg) L1 geodetic antenna
Power	Nominal 10.5-35 VDC, 7 Watts (portable) 100, 120, 220, 240 VAC, 40 Watts (rack mount) DC: 10-36 Volts, 30 Watts
Operating temperature	-20°C to +55°C (portable), 0°C to +50°C (rack mount)
Storage temperature	-30°C to +75°C (portable) -20°C to +60°C (rack mount)
Humidity	100%, fully sealed, buoyant (portable) 95%, non-condensing (rack mount)

Geodetic Antenna

Size	16" D x 3.5" H
Weight	5.7 lbs.
Operating temperature	-40°C to +65°C
Storage temperature	-55°C to +75°C
Humidity	100%, fully sealed

Interface

Keyboard	Alphanumeric, function and softkey entry
Display	Backlit LCD, four lines of forty alphanumeric characters; Large, easy-to-read– 2.8mm x 4.9mm; Viewing area: 32 cm²; adjustable backlight and viewing angle
Serial Ports	Port 1 and 3: up to 57600 bps, software flow control Port 2 and 4: up to 57600 bps, hardware/software flow control RS-232 / RS-422 user configurable (rack mount)
Data recording	RTCM and GPS data available via serial port
Remote control	Trimble Data Collector Interface
Antenna	External, LEMO socket connector (portable), N-Type Socket connector (rack mount)
RTCM Messages	Types 1, 2, 3, 6, 9, 16; Version 1.0 and 2.X
1 PPS	LEMO 7-pin, adapter to BNC available (portable) BNC socket (rack mount)
Event Marker	LEMO 7-pin, adapter to BNC available (portable) BNC socket (rack mount)
NMEA-0183	ALM, BWC, GGA, GLL, GRS, GSA, GST, GSV, RMB, RMC, VTG, WPL, ZDA

PERFORMANCE CHARACTERISTICS

Signal Processing	Multibit Super-trak technology; Maxwell architecture with EVEREST Multipath Rejection Technology; very low noise C/A code processing
Tracking (Standard)	9 channels L1 C/A code and carrier
(Optional)	12 L1, 12 L1 + 12 L2; C/A, P and/or cross-correlation code and carrier (rack mount)
Startup time	< 2 minutes after cold start
Measurement rate	0.5 second per independent measurement
Accuracy	Typically better than 0.5 m RMS: assumes at least 5 satellites, PDOP less than 4, and using 4000RSi corrections.
RTCM Corrections	4000RSi corrections can be applied to all differential-equipped RTCM compatible GPS receivers.

ORDERING INFORMATION

4000RSi Reference Surveyor	P/N 29443-75
4000RSi Reference Surveyor pair	P/N 29561-00
4000DSi Differential Surveyor	P/N 29443-70
4000RSi Reference Surveyor Rackmount	P/N 26541-80

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ProBeacon

Marine Radiobeacon MSK Receiver

Key features and benefits

- High noise immunity
- Rapid signal aquisition
- Automatic and manual modes
- FFT signal analysis

Differential GPS correction data broadcast from marine radiobeacons provides GPS users with the improved accuracy of DGPS without setting up and maintaining a reference station. Depending on the DGPS receiver being used in conjuction with the ProBeacon™, the combination can provide position and navigation accuracies of less than a meter to land surveyors, dredge operators, resource management agencies, crop dusters, and many others operating on land, offshore or in the air. Anyone within the range of a radiobeacon, whose application requires real-time positions, time, or velocity can benefit from this form of DGPS.

Differential GPS using MSK radiobeacon broadcasts.

RTCM and IALA complaint

The International Association of Lighthouse Authorities (IALA), the U.S. Coast Guard and the Radio Technical Commission for Maritime Services (RTCM) have developed standards for the broadcast of DGPS correction data for public access.

All digital design

Obtaining the highest levels of DGPS performance requires a superior MSK receiver. Trimble's ProBeacon is an all-digital design, proven in independent testing to have the best overall performance, even under conditions of low signal strength and/or high noise levels. This all-digital design facilitates rapid signal acquisition and superior tracking capabilities. In addition, the ProBeacon signal processing is based upon a proprietary (patented) "noise cancellation" technique utilizing multiple channels to further improve data reception by rejecting the "impulsive" type of noise commonly found in this frequency band.

The ProBeacon also utilizes advanced logic, working in conjunction with the DGPS receiver to select the most appropriate beacon. The ProBeacon constantly monitors Message Error Ratio, switching to a different beacon if the signal degrades. By utilizing the broadcast beacon almanacs and receiving the position data from the DGPS receiver, the ProBeacon switches to the nearest beacon to maintain the highest accuracy possible.

H-field loop antenna

These features, combined with an advanced, high sensitivity H-field antenna, ensure that the DGPS user realizes the best performance under all conditions.

ProBeacon

Marine Radiobeacon MSK Receiver

DESCRIPTION

Differential GPS (DGPS) is the most accurate long range form of GPS for surveying, positioning and navigation. GPS receivers that are differential capable use the correction data to counter the effects of Selective Availability, errors induced by the ionosphere and troposphere and other correlated errors that degrade the GPS solution. The ProBeacon is designed to provide this correction data in the RTCM SC-104 standard format to any compatible DGPS receiver, using standard RS-232 and RS-422 serial connections. Accuracy will depend on the type of DGPS receiver utilized. Trimble offers several GPS receivers with DGPS capability designed to meet all types of application requirements.

PERFORMANCE CHARACTERISTICS

General

Frequency range	283.5 kHz to 325.0 kHz
Channel spacing	500 Hz
MSK modulation	25, 50, 100 & 200 bits/second
Signal strength	10 µV/meter minimum
Dynamic range	100 dB
Channel selectivity	60 dB @ 500 Hz offset
Frequency offset	10 ppm maximum (200 bits/second)
	40 ppm maximum (100, 50 & 25 bits/second)
3rd order intercept	+15 dBm @ RF input (min. AGC setting)

PHYSICAL CHARACTERISTICS

Receiver

Size	5.6″ W x 2.7″ H x 7.5″ D
	(14.2 cm x 6.9 cm x 19.0 cm)
Weight	2.5 lbs. (1.1 kg)
Power consumption	3.5 watts
Voltage	10 to 32 volts DC
Operating temperature	–20°C to +60°C
Humidity	95% non-condensing

Antenna

Dimensions	5.8″ D x 4.5″ H (14.7 cm x 11.4 cm)
Weight	1.4 lbs. (0.63 kg)
Operating temp	–30°C to +65°C
Humidity	100% – fully sealed
Cable length	50 ft. (15 meters)

FEATURES

Automatic

The ProBeacon serves as a stand-alone receiver of DGPS correction data. Once on, it automatically selects and tracks the best differential beacon in your area. If you lose reception of a differential beacon, the ProBeacon automatically switches to another beacon for continuous DGPS coverage.

Manual

Manual mode allows the operator to select a specific beacon, to pre-program a list of preferred beacons, and to request signal levels, SNR data, PLL offsets, RTCM message errors, and tracking history.

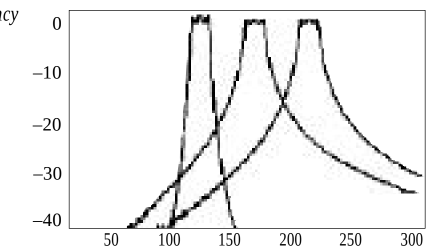
Fast acquisition

The ProBeacon uses a proprietary spectral search algorithm which enables exceptionally fast identification and acquisition of differential beacons under all operating conditions.

Jamming immunity

Only a subset of all marine radiobeacons will be differential beacons. The ProBeacon is able to track a weaker differential beacon signal in the presence of multiple jamming signals from nearby standard radiobeacons.

Normalized Frequency



Integrity monitoring

The ProBeacon continuously monitors the integrity of incoming RTCM messages. If it observes parity errors, the ProBeacon will automatically switch to an adjacent beacon to ensure RTCM data integrity.

Noise immunity

Using advanced digital signal processing, the ProBeacon reliably tracks even in the presence of heavy atmospheric noise (e.g. lightning). Using algorithms based on a proprietary (patented) noise cancellation technique, the ProBeacon realizes improved performance in the presence of impulsive noise. As shown in the above figure, the signal channel plus two additional channels are monitored by the MSK receiver. These two noise-only, or pilot, channels facilitate noise reduction as the output from all the channels is highly correlated. Reduction in noise in the signal channel improves the performance of the ProBeacon in all operating environments.

Almanac monitoring

Each differential beacon broadcasts an almanac message with the identity (frequency, data rate, etc.) for adjacent differential beacons. The ProBeacon uses this message to accelerate the switch between beacons. This minimizes the interruption in DGPS data when you lose reception of a beacon.

Dual serial ports

The ProBeacon offers two bi-directional serial ports and multiple baud rates (1200, 2400, 4800, 9600). Both RS-232 and RS-422 are supported. One port supports modem operation, allowing remote control of the ProBeacon

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THE GPS SOLUTION

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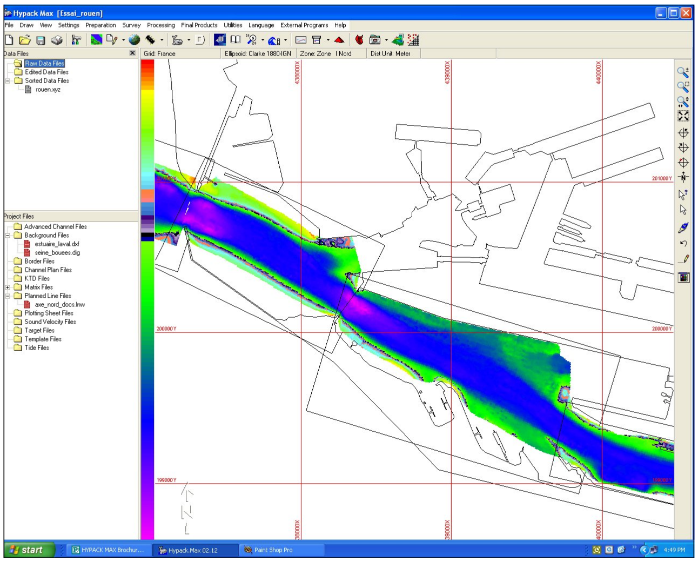
HYPACK®

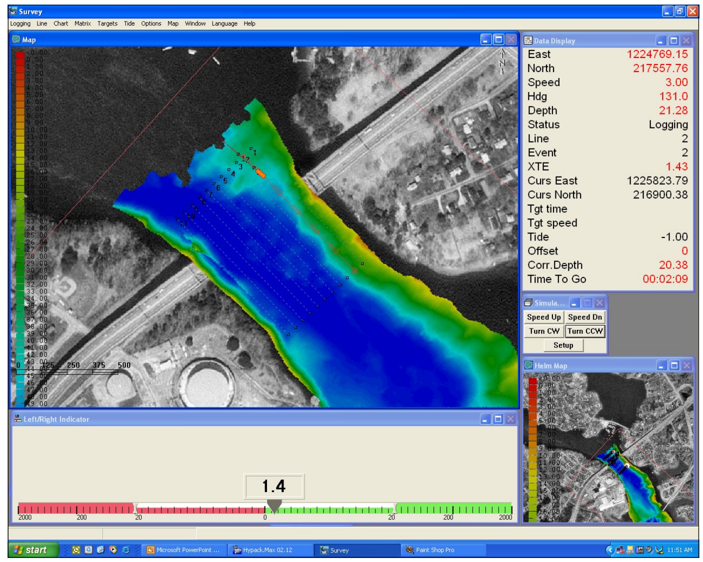
HYDROGRAPHIC SURVEY SOFTWARE

HYPACK®

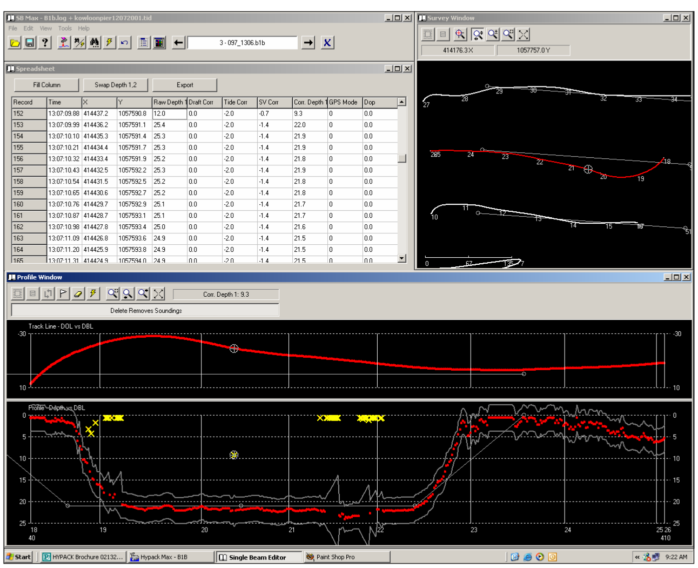
HYPACK® is one of the most widely used hydrographic surveying packages in the world, with over 3,000 users. It provides the surveyor with all of the tools needed to design their survey, collect data, process it, reduce it, and generate final products. Whether you are collecting hydrographic survey data or environmental data, or positioning your vessel in an engineering project, HYPACK® provides the tools needed to complete your job. With users spanning the range from small vessel surveys with just a GPS and single beam echosounder to large survey ships with networked sensors and systems, HYPACK® gives you the power needed to accomplish your task in a system your surveyors can master.



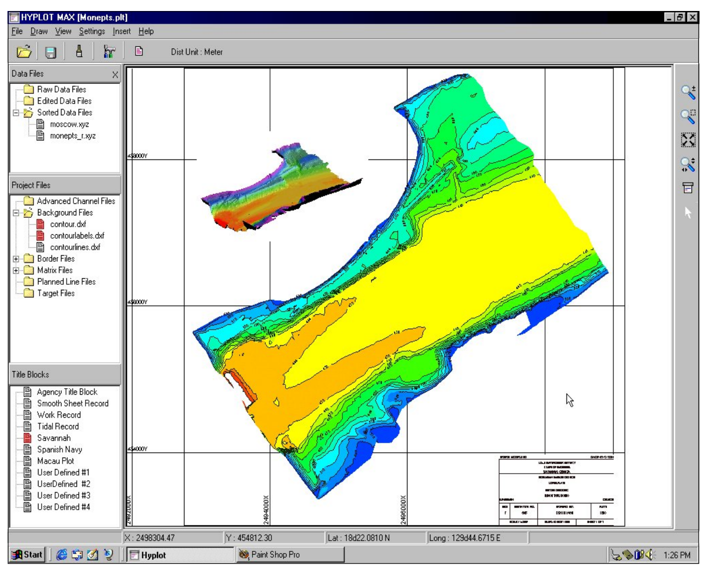
SURVEY DESIGN: HYPACK® allows you to create a 'Project' that contains all of your survey information for each job. You can easily define your geodetic basis, selecting from existing national grids or defining your own projection or local grid. HYPACK® also allows you to import background files in a variety of formats, including S-57, OrthoTif, ARCS, DXF, DGN, BSB and VPF. These files can be displayed while you create your planned lines, survey, edit and plot your results.



SURVEY: HYPACK® contains interface drivers to over 200 devices includings positioning systems, echosounders, heave-pitch-roll sensors, gyros and other types of equipment. SURVEY supports a single vessel or multiple vessels, along with towfish and ROVs. Data is logged with incredible precision (<1mSec). Survey data and windows can be broadcast over a network to any other computer or saved to a file using our Shared Memory Output routines.



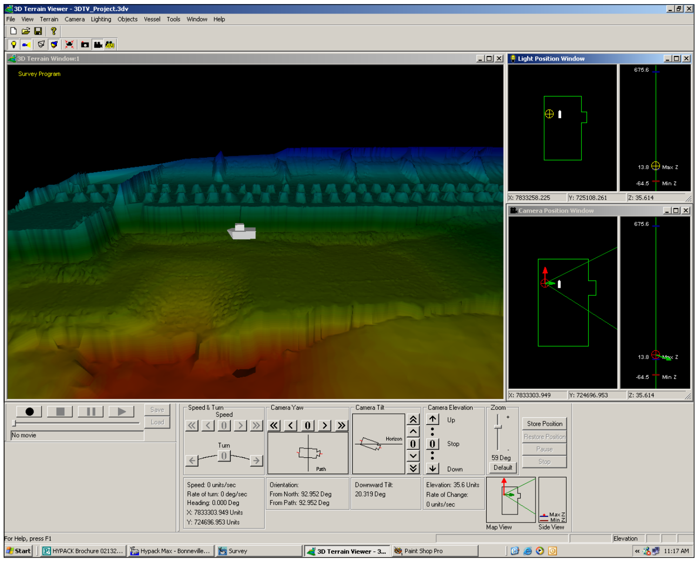
EDITING: The SINGLE BEAM EDITOR program is used to quickly review your survey data and to automatically and/or manually remove outliers. Sounding data is simultaneously displayed in plan, spreadsheet, and profile views with the channel design info drawn in the backgrounds. Routines developed by **HYPACK®** from collaboration with the U.S. Army Corps of Engineers to integrate water level corrections based on RTK GPS elevation info are a standard part of package.



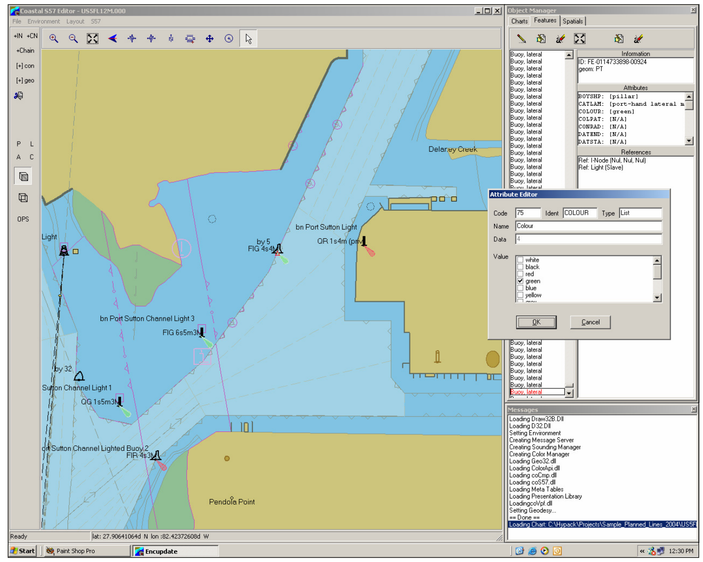
FINAL PRODUCTS: The ability to create the final products you need separates **HYPACK®** from the rest. The plotting program generates professional smooth sheets with soundings, grids, graphics and contours in a WYSIWYG display. The VOLUMES program is the de facto standard of the U.S. Army Corps of Engineers for the computation of quantities in dredging projects. TIN MODEL creates surface models that can be used for contouring, volume computations and surface visualization.

HYPACK®

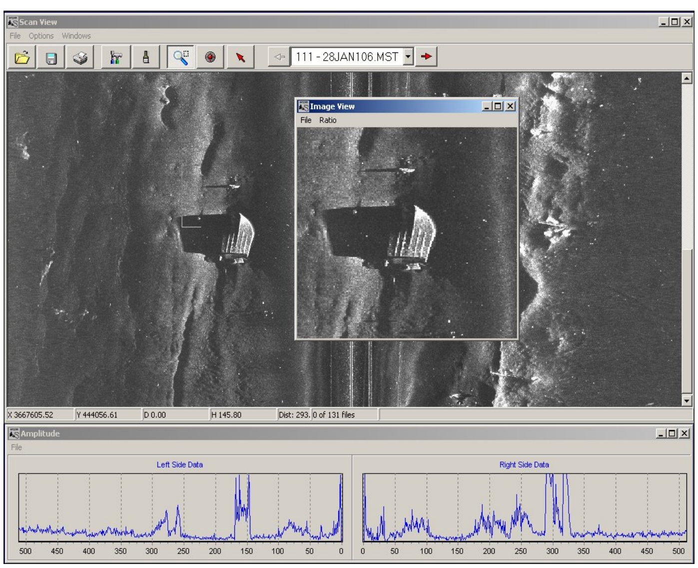
Support: An important factor in the purchase of any hydrographic survey system is the support provided to the end-user. **HYPACK®** prides itself on taking good care of our users. A trained, professional staff is on-call to answer your questions, develop custom device drivers or modify programs to meet your needs. **HYPACK®** training seminars are held annually in many countries to provide you with the latest information. We continue to update our training materials every year to make it easier for you to get the most out of our products. Our latest training material contains PowerPoint presentations with embedded AVI demonstrations on over 100 topics. Our bi-monthly newsletter, 'Sounding Better' is published on our web site (www.hypack.com) and contains technical articles on how to get the most out of your package.



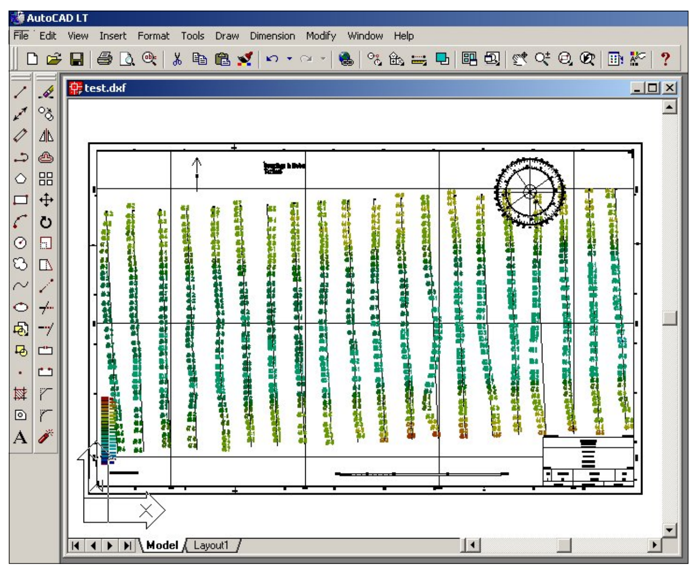
DATA VISUALIZATION: The TIN MODEL and 3D TERRAIN VIEWER (3DTV) programs of **HYPACK®** provide fantastic tools to view and present your data. 3DTV allows you to fly a 'camera' across your edited XYZ surface and display the results or save them to a AVI file for distribution to your clients. 3DTV also allows you to position the camera relative to the actual vessel position, showing the vessel in real time against the bottom surface.



ENCEdit is a new **HYPACK®** module that allows you to create, modify and verify ENC data in S-57 format. ENCEdit provides you with tools to re-attribute, create, move or delete existing features. You can also create new features by manually entering coordinates, by importing data from DXF/DGN, or by transferring targets in real time from SURVEY directly into ENCEdit.



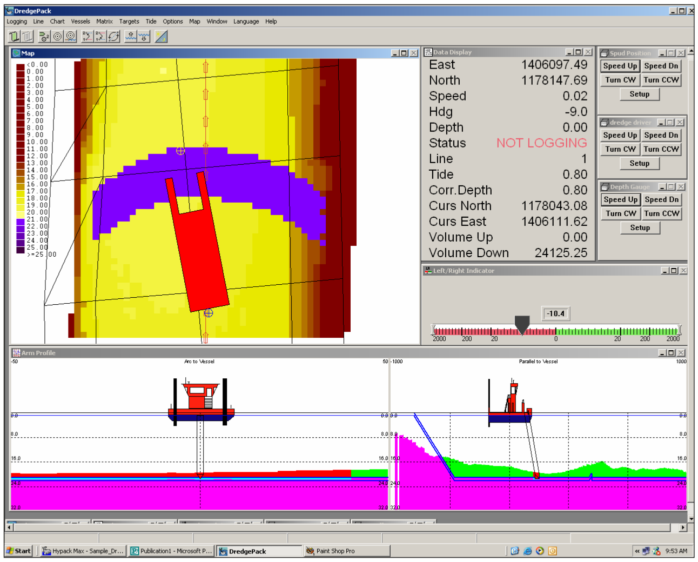
Side Scan Sonar (SSS) Support: **HYPACK®** provides support of SSS systems in its basic package. All analog and several digital side scan systems can be utilized with the SIDE SCAN SURVEY program. Users can display the real time data and perform targeting in real time or post-processing. A program that generates side scan mosaics in GeoTIF format allows you to plot your results in **HYPACK®** or export them to your GIS.



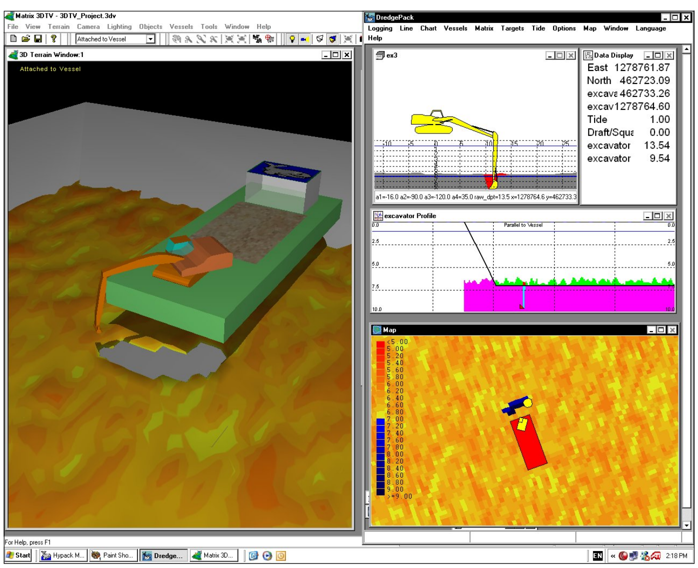
Export to CAD: Many of our users are interested in exporting their survey data into their CAD/GIS package. **HYPACK®** has several tools to import/export via DXF/DGN. The EXPORT TO CAD program takes all of the our files and converts them to DXF and DGN. The plotting sheets and sectional plots can also be exported directly to DXF. Users can create planned lines in their CAD/GIS program and import them into **HYPACK®**.

DREDGEPACK®

DREDGEPACK® is a specially modified version of **HYPACK®** used for providing precise digging information on dredges. It allows you to see exactly where you are digging, how deeply you are digging and how deeply you need to dig. With the ADVANCED CHANNEL DESIGN program, you can create complex dredging plans. Real time cross sections are provided to show you the design profile, the depth of the cutting tool and the material that has to be removed.

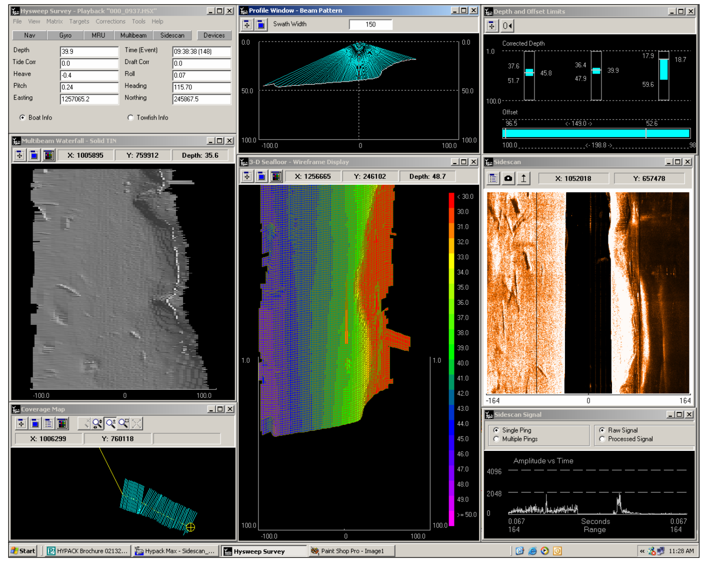


DREDGEPACK® runs on cutter suction, hopper, excavator and bucket-style dredges. It can store a history of the dredge's position, draft, digging tool depth and digging status in order to meet reporting requirements. DREDGEPACK® has been designed to run with a minimum of user intervention. Make sure you are maximizing your dredge's efficiency with DREDGEPACK®

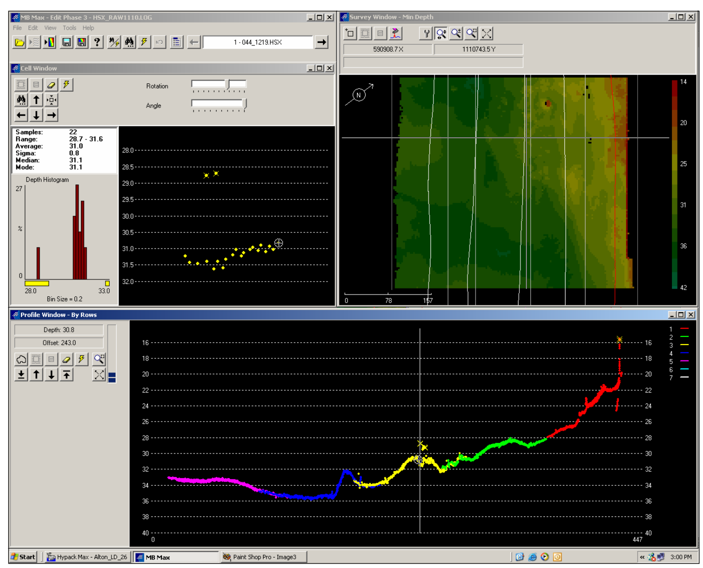


HYSWEEP®

HYSWEEP® is an optional module that integrates the collection and processing of multibeam and multiple transducer sonar systems into **HYPACK®**. Time and again, surveyors switch to HYSWEEP® due to the powerful tools and the ease-of-use of the package. Survey data collected in **HYSWEEP®** is fully integrated with the final products of **HYPACK®**. More surveyors use **HYSWEEP®** for multibeam data collection and processing than any other multibeam software package.



HYSWEEP® SURVEY: The data collection program of **HYSWEEP®** runs simultaneously with the SURVEY program of **HYPACK®**. It provides real time display, QC functions and data logging for most commercially available multibeam systems, including those from Atlas, Odom, Reson, Sea Beam and Simrad. A coverage map lets you examine the bottom coverage in real time, ensuring that you have 100% or 200% coverage before leaving the area.



MULTIBEAM EDITING: Multibeam data editing, sonar alignment calibration and system performance testing are all provided in the powerful MULTIBEAM EDITOR of **HYSWEEP®**. The program performs automatic or manual filtering, using geometric and statistical methods. It also contains the Performance Test that measures the overall performance of your system versus beam angle as required by USACE. **HYSWEEP®** can also use water level corrections created from RTK GPS elevations.

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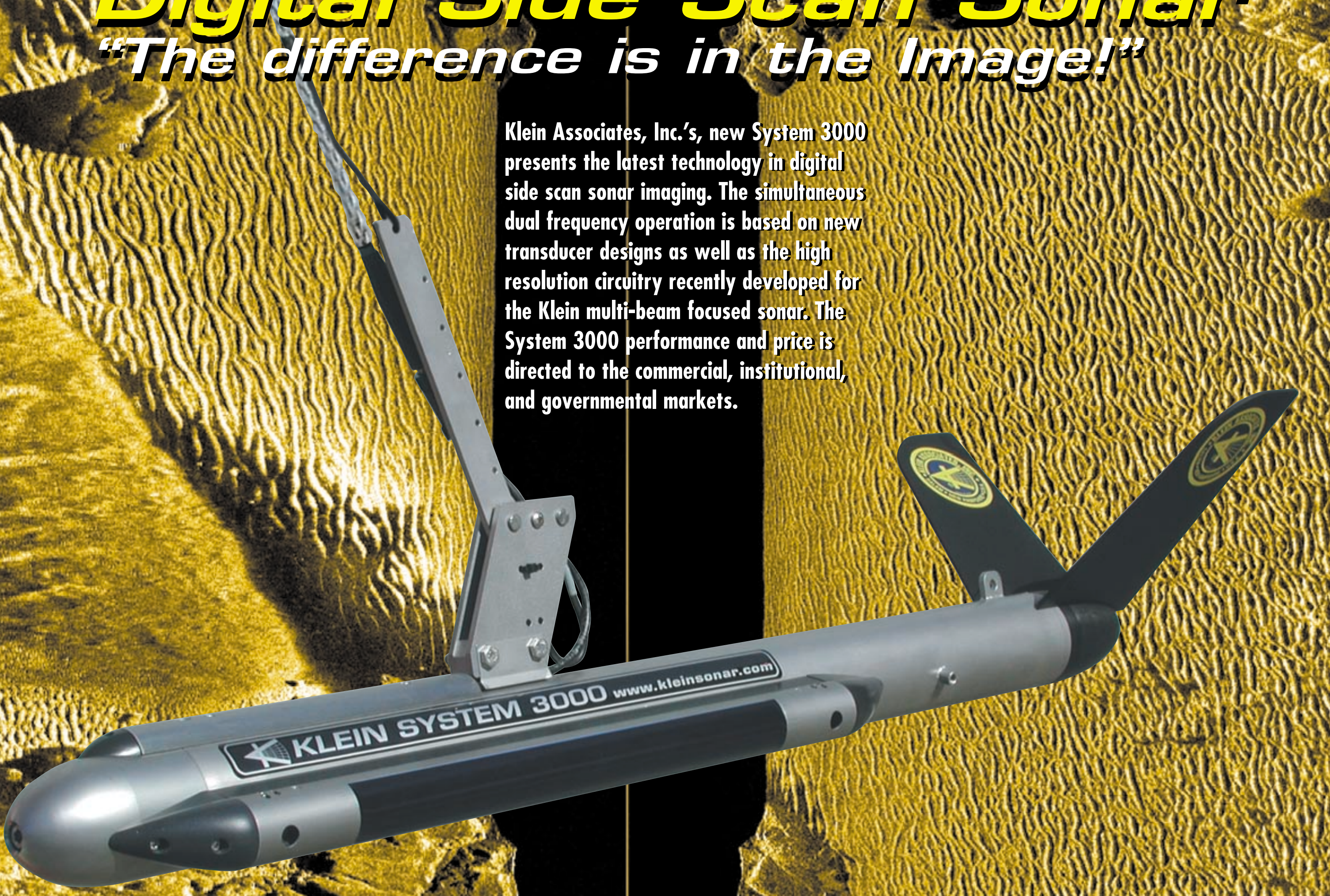
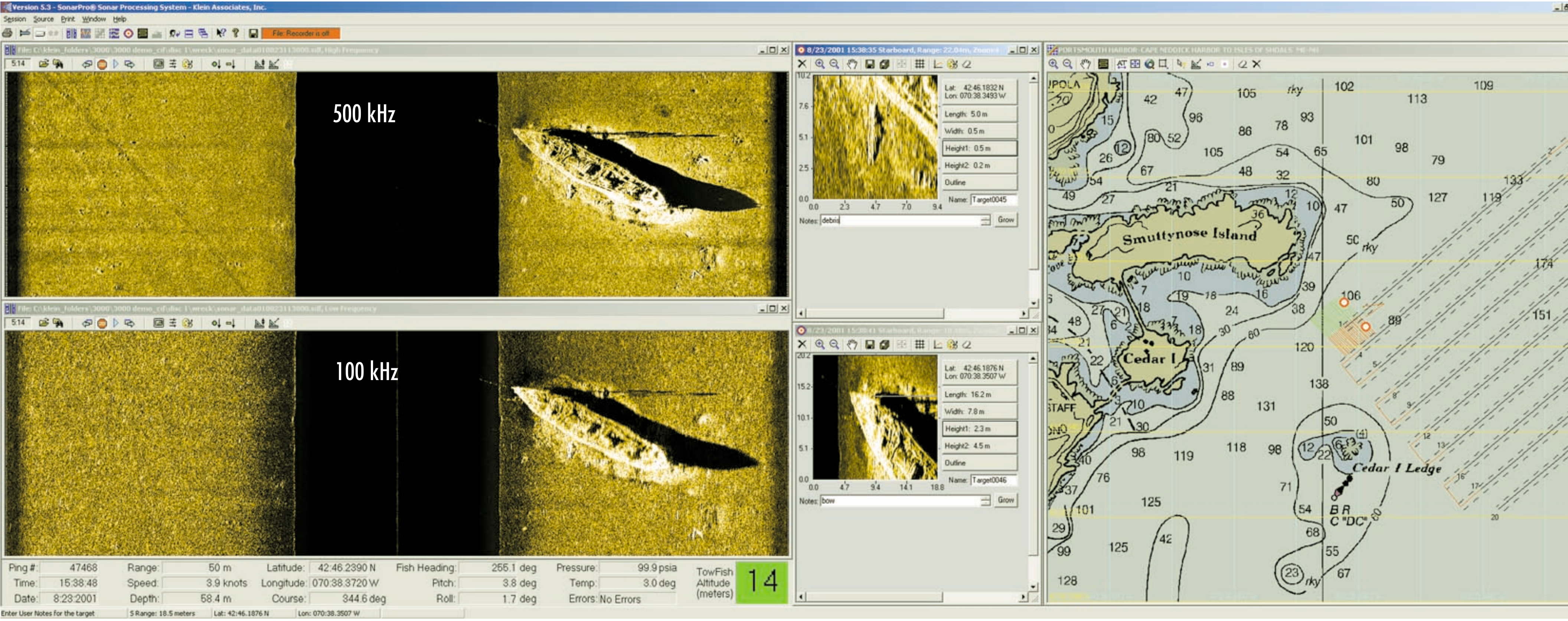
Klein System 3000 Digital Side Scan Sonar

"The difference is in the Image!"

Klein Associates, Inc.'s, new System 3000 presents the latest technology in digital side scan sonar imaging. The simultaneous dual frequency operation is based on new transducer designs as well as the high resolution circuitry recently developed for the Klein multi-beam focused sonar. The System 3000 performance and price is directed to the commercial, institutional, and governmental markets.



- **ADVANCED SIGNAL PROCESSING AND TRANSDUCERS PRODUCE SUPERIOR IMAGERY**
- **COST EFFECTIVE, AFFORDABLE**
- **PC BASED OPERATION WITH SONARPRO® SOFTWARE, DEDICATED TO KLEIN SONARS**
- **SMALL, LIGHTWEIGHT, AND SIMPLE DESIGNS - EASY TO RUN AND MAINTAIN**
- **EASILY ADAPTED TO ROVS, AND CUSTOM TOWFISH**



SPECIFICATIONS

Towfish

Frequencies	100 kHz (132 kHz +/- 1% act.), 500 kHz (445 kHz, +/- 1% act.)
Transmission Pulse	Tone Burst, operator selectable from 25 to 400 μsecs. **Independent pulse controls for each frequency**
Beams	Horizontal - 0.7 deg. @ 100 kHz, 0.21 deg. @ 500 kHz Vertical - 40 deg.
Beam Tilt	5, 10,15, 20, 25 degrees down, adjustable
Range Scales	15 settings - 25 to 1,000 meters
Maximum Range	600 meters @ 100 kHz; 150 meters @ 500 kHz
Depth Rating	1,500 meters standard, other options available
Construction	Stainless Steel
Size	122 cm long, 8.9 cm diameter
Weight	29 kg in air
Standard Sensors	Roll, pitch, heading
Options	Magnetometer Interface, pressure, Acoustic Positioning Responder, and Responder Interface Kits

Transceiver Processor Unit (TPU)

Operating System	vxWorks® with custom application
Basic Hardware	19-inch rack or table mount, VME bus structure
Outputs	100 Base-Tx, Ethernet LAN
Navigation Input	NMEA 0183
Power	120 watts @ 120/240 VAC, 50/60 Hz
Interfacing	Interfaces to all major Sonar Data Processors
Options	Splash proof packaging option available

Klein Sonar Workstation

Basic Operating System	Windows NT®, 2000®, XP® or equiv.
Sonar Software	SonarPro®
Data Format	SDF or XTF or both selectable
Data Storage	Internal hard drive, optional devices available
Hardware	Industrial PC with technically advanced components
Options	Optional waterproof laptops available

Tow Cables

Klein offers a selection of coaxial, Kevlar® reinforced, lightweight cables, double armored steel cables, and interfaces to fiber optic cables. All cables come fully terminated at the towfish end.

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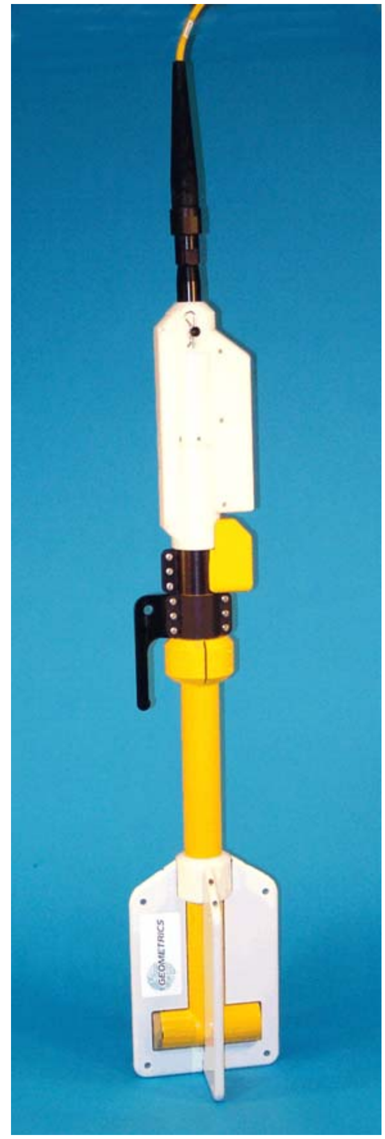
SonarPro® Software

Custom developed software by users and for users of Klein side scan sonar systems operating on Windows NT®, 2000® & XP®. Field proven for many years on Klein's Multi-Beam Focused Sonar Series 5000 Systems and adapted to the System 3000 single-beam system. SonarPro® is a modular package combining ease of use with advanced sonar features.

Basic Modules	Main Program, Data Display, Information, Target Management, Navigation, Data Recording & Playing, and Sensor Display.
Multiple Display Windows	Permits multiple windows to view different features as well as targets in real time or in playback modes. Multi-Windows for sonar channels, navigation, sensors, status monitors, targets, etc.
Survey Design	Quick & easy survey set up with ability to change parameters, set tolerances, monitor actual coverage, and store settings.
Target Management	Independent windows permitting mensuration, logging, comparisons, filing, classification, positioning, time & survey target layers, and feature enhancements. Locates target in navigation window.
Sensor Window	Displays all sensors in several formats (includes some alarms) and responder set up to suit many frequencies and ping rates.
Networking	Permits multiple, real time processing workstations via a LAN including "master and slave" configurations.
"Wizards"	To help operator set up various manual and default parameters.
Data Comparisons	Target and route comparisons to historical data.

G-882 MARINE MAGNETOMETER

- ***CESIUM VAPOR HIGH PERFORMANCE – Highest detection range and probability of detecting all sized ferrous targets***
- ***NEW STREAMLINED DESIGN FOR TOW SAFETY – Low probability of fouling in lines or rocks***
- ***NEW QUICK CONVERSION FROM NOSE TOW TO CG TOW – Simply remove an aluminum locking pin, move tow point and reinsert. New built in easy carry handle!***
- ***NEW INTERNAL CM-221 COUNTER MODULE – Provides Flash Memory for storage of default parameters set by user***
- ***NEW ECHOSOUNDER / ALTIMETER OPTION***
- ***NEW DEPTH RATING – 4,000 psi !***
- ***HIGHEST SENSITIVITY IN THE INDUSTRY – 0.004 nT/Hz RMS with the internal CM-221 Mini-Counter***
- ***EASY PORTABILITY & HANDLING – no winch required, single man operation, only 44 lbs with 200 ft cable (without weights)***
- ***COMBINE TWO SYSTEMS FOR INCREASED COVERAGE – Internal CM-221 Mini-Counter provides multi-sensor data concatenation allowing side by side coverage which maximizes detection of small targets and reduces noise***



G-882 with Weight Collar Depth Option & Altimeter

Very high resolution Cesium Vapor performance is now available in a low cost, small size system for professional surveys in shallow or deep water. High sensitivity and sample rates are maintained for all applications. The well proven Cesium sensor is combined with a unique and new CM-221 Larmor counter and ruggedly packaged for small or large boat operation. Use your computer and standard printer with our MagLogLite™ software to log, display and print GPS position and magnetic field data. The G–882 is the lowest priced high performance full range marine magnetometer system ever offered.

The G-882 offers flexibility for operation from small boat, shallow water surveys as well as deep tow applications (4,000 psi rating, telemetry over steel coax available to 10Km). The G-882 also directly interfaces to all major Side Scan manufacturers for tandem tow configurations. Being small and lightweight (44 lbs net, without weights) it is easily deployed and operated by one person. But add several streamlined weight collars and the system can quickly weigh more than 100 lbs. for deep tow applications. Power may be supplied from a 24 to 30 VDC battery power or the included 110/220 VAC power supply. The tow cable employs high strength Kevlar strain member with a standard length of 200 ft (61 m) and optional cable length up to 500m with no telemetry required.
A rugged fiber-wound fiberglass housing is designed for operation is all parts of the world allowing sensor rotation for work in equatorial regions. The shipboard end of the tow cable is attached to an included junction box or optional on-board cable for quick and simple hookup to power and output of data into any Windows 98, ME, NT, 2000 or XP computer equipped with RS-232 serial ports.

The G-882 Cesium magnetometer provides the same operating sensitivity and sample rates as the larger deep tow model G-880. MagLogLite™ Logging Software is offered with each magnetometer and allows recording and display of data and position with Automatic Anomaly Detection and automatic anomaly printing on Windows™ printer! Additional options include: MagMap2000 plotting and contouring software and post acquisition processing software MagPick™ (free from our website.)

The G-882 system is particularly well suited for the detection and mapping of all sizes of ferrous objects. This includes anchors, chains, cables, pipelines, ballast stone and other scattered shipwreck debris, munitions of all sizes (UXO), aircraft, engines and any other object with magnetic expression. Objects as small as a 5 inch screwdriver are readily detected provided that the sensor is close to the seafloor and within practical detection range. (Refer to table at right).

The design of this high sensitivity G-882 marine unit is directed toward the largest number of user needs. It is intended to meet all marine requirements such as shallow survey, deep tow through long cables, integration with Side Scan Sonar systems and monitoring of fish depth and altitude.

Typical Detection Range For Common Objects

Ship 1000 tons	0.5 to 1 nT at 800 ft (244 m)
Anchor 20 tons	0.8 to 1.25 nT at 400 ft (120 m)
Automobile	1 to 2 nT at 100 ft (30 m)
Light Aircraft	0.5 to 2 nT at 40 ft (12 m)
Pipeline (12 inch)	1 to 2 nT at 200 ft (60 m)
Pipeline (6 inch)	1 to 2 nT at 100 ft (30 m)
100 KG of iron	1 to 2 nT at 50 ft (15 m)
100 lbs of iron	0.5 to 1 nT at 30 ft (9 m)
10 lbs of iron	0.5 to 1 nT at 20 ft (6 m)
1 lb of iron	0.5 to 1 nT at 10 ft (3 m)
Screwdriver 5 inch	0.5 to 2 nT at 12 ft (4 m)
1000 lb bomb	1 to 5 nT at 100 ft (30 m)
500 lb bomb	0.5 to 5 nT at 50 ft (16 m)
Grenade	0.5 to 2 nT at 10 ft (3 m)
20 mm shell	0.5 to 2 nT at 5 ft (1.8 m)

MODEL G-882 CESIUM MARINE MAGNETOMETER SYSTEM SPECIFICATIONS

OPERATING PRINCIPLE:	Self-oscillating split-beam Cesium Vapor (non-radioactive)
OPERATING RANGE:	20,000 to 100,000 nT
OPERATING ZONES:	The earth's field vector should be at an angle greater than 6° from the sensor's equator and greater than 6° away from the sensor's long axis. Automatic hemisphere switching.
CM-221 COUNTER SENSITIVITY:	<0.004 nT/ √Hz rms. Up to 20 samples per second
HEADING ERROR:	±1 nT (over entire 360° spin)
ABSOLUTE ACCURACY:	<2 nT throughout range
OUTPUT:	RS-232 at 1,200 to 19,200 Baud
MECHANICAL:	
Sensor Fish:	Body 2.75 in. (7 cm) dia., 4.5 ft (1.37 m) long with fin assembly (11 in. cross width), 40 lbs. (18 kg) Includes Sensor and Electronics and 1 main weight. Additional collar weights are 14lbs (6.4kg) each, total of 5 capable
Tow Cable:	Kevlar Reinforced multiconductor tow cable. Breaking strength 3,600 lbs, 0.48 in OD, 200 ft maximum. Weighs 17 lbs (7.7 kg) with terminations.
OPERATING TEMPERATURE:	-30°F to +122°F (-35°C to +50°C)
STORAGE TEMPERATURE:	-48°F to +158°F (-45°C to +70°C)
ALTITUDE:	Up to 30,000 ft (9,000 m)
WATER TIGHT:	O-Ring sealed for up to 4,000 psi (9000 ft or 2750 m) depth operation
POWER:	24 to 32 VDC, 0.75 amp at turn-on and 0.5 amp thereafter
ACCESSORIES:	
Standard:	View201 Utility Software operation manual and ship kit
Optional:	Telemetry to 10Km coax, gradiometer (longitudinal or transverse), reusable shipping case
MagLog Lite™ Software:	Logs, displays and prints Mag and GPS data at 10 Hz sample rate. Automatic anomaly detection and single sheet Windows printer support

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE ***12/03***

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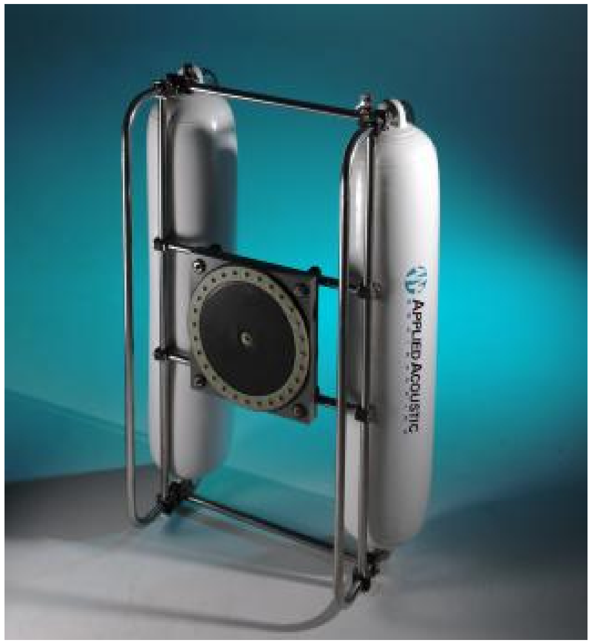
Sub Bottom Profiling

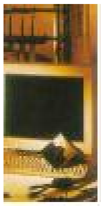
AA200 Boomer Plate and CAT200 catamaran



The Model AA200 is a proven design in boomer plates which encompasses precision moulding techniques to give a rugged design with a stable and repeatable signature. Designed specifically for use with our CSP range of energy sources, (although others can be used) the efficiency of the AA200 transducer ensures high output with an excellent pulse shape.

Designed for ease of use in the real world offshore, we have ensured that the flying lead connectors can be replaced in the field in case of damage. Diaphragm replacement is also straightforward. The lightweight design allows easy transportation. The unit is shown fitted to our 'CAT200' small sized catamaran which has been praised for its towing characteristics. Spectral content information is available.

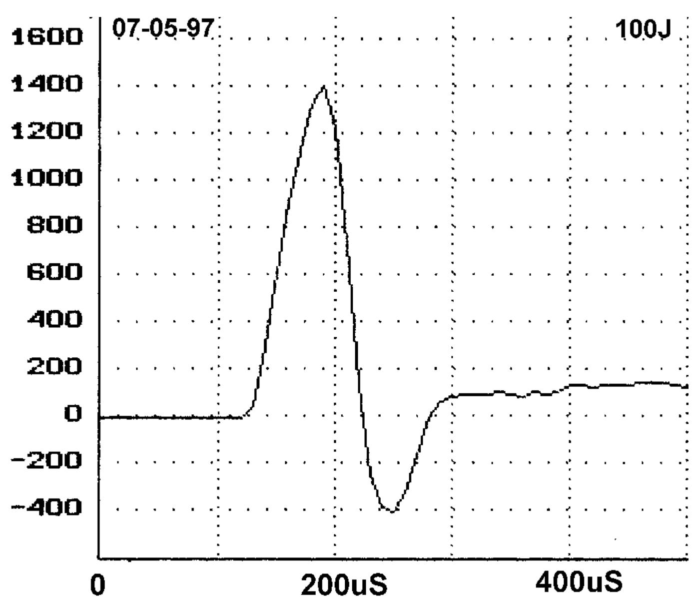
- **Small Size and weight**
- **Repeatable high output pulse**
- **Rugged mechanical design**
- **Proven Performance**



TECHNICAL SPECIFICATION

Size	: 38cm x 38 cm x 5cm thick 9cm including connectors.
Weight in air / water	: 18 / 10 kg.
Fixing centres	: 31.5cm square.
Recommended use	: 100-200J / shot.
Maximum energy input	: 300J / shot.
Source Level	: 215dB re 1uPa @1m at 200J.
Pulse Length	: See graph below.
Reverberation	: <1/10 x initial pulse.
Connector type	: Joy plug male & female.

AA200 Pulse Shape



Part of our integrated Sub-bottom Profiler system. Sample data is available upon request.

December 2001

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760 Geophysical Acquisition System

The simple digital solution for simultaneous sidescan and sub-bottom profiler

The OCTOPUS 760 GEOPHYSICAL ACQUISITION SYSTEM is an all-new multi-channel acquisition package for sidescan sonar and sub-bottom profiler in a single instrument.

Building on the reputation of the industry leading Octopus 360 Sub-Bottom Processor and the 460 Sonar Acquisition Systems, the 760 brings the Octopus geophysical acquisition range right up to date, whilst retaining the simplicity of operation and rugged, reliable design familiar to Octopus users around the world.

Combining Octopus design philosophy focussing on ease of use, with the latest hardware and software and technology, the 760 guarantees compatibility with other systems and peripherals. Incorporating a large high resolution display and the familiar Octopus key-driven user interface in a rugged instrument, the 760 is simple to use in all survey scenarios and is ideally suited to use on small and large vessels alike. Adopting the latest features and familiarity of Windows XP in an instrument package provides all of the benefits with none of the problems. With a simple layout taken from the existing 360 and 460, the 760 combines ease of use with maximum flexibility and performance. Designed and packaged specifically for geophysical acquisition, the 760 is ready to use out-of-the-box and requires minimal training and no special hardware configuration, whilst the optional in-built UPS capability guards against power failure ensuring all data is kept safe. Adding optional internal GPS makes the 760 fully self-contained, for added simplicity.

The Octopus 760 is compatible with all standard sidescan sonars, including the latest digital towfish, and all standard sub-bottom profilers, pingers, boomers, sparkers and chirp, in one compact package.

FEATURES

- 4 channel analogue sidescan acquisition
- 2 channel analogue sub-bottom acquisition
- Analogue output
- Dual SIMULTANEOUS sidescan and sub-bottom acquisition
- Simultaneous display of sidescan and sub-bottom
- Asynchronous sidescan and sub-bottom trigger timing
- Standard formats, XTF, SEGY, CODA, GeoPro
- Internal recording to hard disk and DVD RAM disks
- Simple 7-key interface
- Serial inputs for navigation and standard fix strings
- High resolution 15” screen
- High speed network connectivity
- 19” rack mountable or freestanding
- Supports all standard printers
- In-built UPS

BENEFITS

- Simple to use
- Reduced operating costs
- Reduced hardware
- Minimal user training
- Maximum flexibility
- Fully compatible with all popular post processing systems
- Extends the life of analogue sonars
- Data stored internally is easily and quickly downloaded

OCTOPUS
LeadingGeoSurveySolutions

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760 Geophysical Acquisition System
Technical Specification

INPUTS AND OUTPUTS

	760 Standard - single acquisition card.	**760 Dual Acquisition** - as standard 760 with the following additional features.
	Note: *With single acquisition card, the 760 is user configurable for sub-bottom* ***or*** *sidescan acquisition. With dual acquisition cards, the 760 supports simultaneous sub-bottom* ***and*** *sidescan sonar acquisition.*	
Analogue inputs	4 independent 16 bit channels scalable from 125mV to 5V configurable as 4 x sidescan sonar **OR** 1 x sub-bottom + analogue heave input	2 independent 16 bit channels scalable from 125mV to 5V configured as 1 x sub-bottom + analogue heave input.
Analogue outputs	2 analogue outputs, selectable source, synchronous with trigger out.	1 analogue output, synchronous with trigger out.
Trigger input	Single trigger input with variable threshold, synchronises all channels.	Single trigger input with variable threshold. Can operate asynchronously to main trigger.
Trigger outputs	Internal trigger (5v) user selectable range, 25-1000m. Delayed trigger synced to start of sub-bottom acquisition.	Internal trigger (5v), user selectable range 50 – 1000mS. Delayed trigger synced to start of sub-bottom acquisition.
Navigation & fix data	2 x RS232 serial inputs (9 pin D-type) for NMEA navigation (GGA, GLL, VTG, RMC etc.) or Octopus fix and annotation strings. Additional inputs on request.	
GPS	Optional in-built GPS (with DGPS and/or WASS) for fully self contained operation. Antenna connection at rear. *Available mid 2004*	
Printer interfaces	Centronics (25 way D-type) interface for EPC, Ultra and Isys printers. SCSI interface for Alden/GeoPrinter (SCSI interface optional)	
Network	10/100/1000 $MbitS^{-1}$ Ethernet interface (RJ45).	
Other interfaces	USB x 2 (standard) SCSI II (optional), others available on request.	

DATA RECORDING

Recording devices	Internal 2.5" shock mounted hard disk (60Gb) Single DVD RAM/CD-R drive as standard. Optional second DVD RAM/CD-R. Other devices such as DAT, removable HDD etc. available on request.
Recording formats	Sidescan sonar – XTF, Coda, GeoPro Sub-bottom profiler – SEGY, Coda, XTF All data is recorded raw (without gain or processing applied).

DISPLAY MODES

Sidescan	Up to 4 channels of sidescan in vertical scrolling waterfall display with co-registered oscilloscope. All gain and processing controls on-screen.
Sub-bottom	Single channel sub-bottom profiler display, horizontal scrolling with co-registered oscilloscope display. Pan and zoom functions for optimum data view. All gain and processing controls on-screen.
Dual format	Simultaneous vertically scrolling sidescan AND horizontally scrolling sub-bottom.
Navigation	All navigation, fix, annotation and status information shown on all screens.

CONTROLS

User Interface	Familiar Octopus 7 key interface allowing quick and easy navigation to all functions without the need for a mouse. Arrow keys snap between groups of controls and allow selection of specific functions. Y & N keys allow settings to be saved or cancelled. PAGE key allows rapid selection of display screens.

PROCESSING

Sidescan	Channel-independent gain & TVG. Bottom tracking, slant-range correction.
Sub-bottom	Gain, three stage TVG, high & low pass time varied filters (TVF), time varied stacking, swell compensation (automatic or external heave input).

PHYSICAL

Dimensions	443mm(w) x 355mm(h) x 235mm(d) (19" rack compatible).
Weight	15kg
Power	90-250Vac 47-400Hz, 200Watts. Optional 24Vdc Automatic power management and controlled-shutdown. In-built UPS capability further guards against power loss. *NB. requires optional 24V battery pack in place of second DVD drive*
Construction	Rugged but lightweight aluminium chassis with anodised front panel
Display	High-brightness 15" TFT screen, 1024x768 resolution
Controls	Octopus 7 key user controls for all functions

760ver F-pdf Feb 2004

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OCTOPUS
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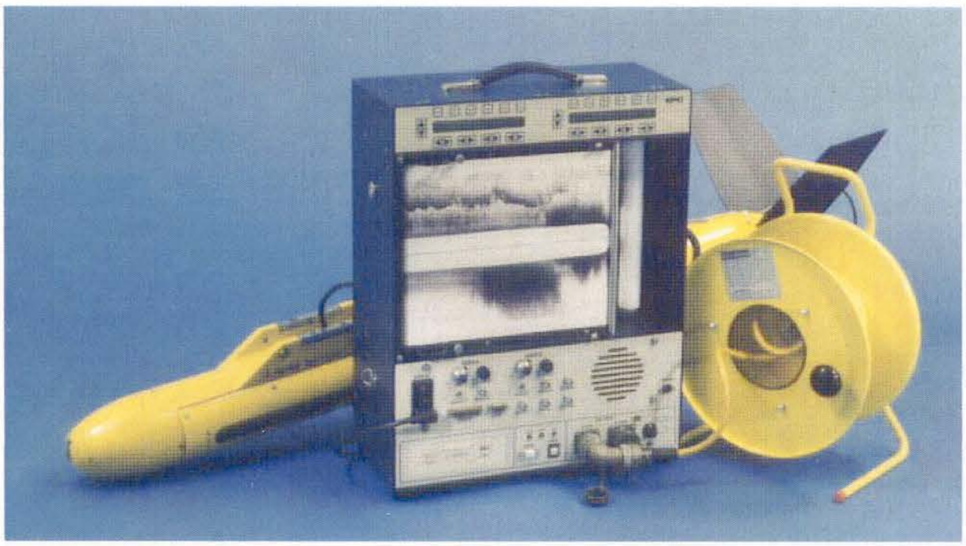
EPC

MODEL MP-1086

Multi-Purpose Recording System



The EPC Model MP-1086 is a multi-purpose recording system that serves as a continuous gray scale printer, analog tow fish interface, mass storage device, and signal processor.

Photographic quality images are produced using the direct thermal printing expertise that has made EPC the industry leader in this field. The analog tow fish interface allows users to connect commonly used side-scan sonars directly to the MP-1086, with no need for external components. Data can be easily logged for post processing directly to the removable disk or sent to a network server for storage.

Real-time acquisition is robust. By incorporating slant range correction, speed correction, TVG, band-pass filtering, and GPS/NMEA decoding, the MP1086 provides a total top-side solution. So, forget about all those extra boxes and cables — the MP1086 Recording System has everything you need.

HARDWARE

CPU Bus
32 Bit PCI/ISA Bus
Control Panel
Sealed membrane type, software defined
Displays
Twin 2x40 LCD displays, LED backlights

POWER

Power Supply
350 Watt, auto-sensing, universal input
84-265 VAC, 50-60 Hz
Power Consumption
80 Watts non-printing
130 Watts Peak

PHYSICAL

Dimensions & Weight
17.6"W x 23.1"H x 8.9"D
55 LBS.
Media
Heat sensitive thermal paper or high grade plastic film - 23dB dynamic range
Paper Length: 150 feet
Film Length: 130 feet
Temperature (non-condensing)
0°C to 65°C - Operating
-28°C to 65°C - Storage

PRINTING

Gray Levels & Resolution
Selectable: 2, 16, 64, 256 Levels
Printhead: 2048 Pixels @ 203 DPI
Maximum Line Speeds (nominal)
@ 2 Shades: 12 ms
@ 16 Shades: 14 ms
@ 64 Shades: 42 ms
@ 256 Shades: 170 ms
Chart Speeds (Lines Per Inch)
Fixed: 80, 100, 120,150, 200, 240, 300
Variable: Preset automatically configured by speed input from gps/nav computer

ANALOG INTERFACE

Dual Signal Input
0V to 10V SIGNAL BNC inputs
(2Kohm Input Impedance)
External Trigger Input (slave)
TTL EXT TRIG BNC with slope-sense
Internal Key Output (master)
TTL KEY OUT BNC with polarity selection
(62.5us pulse width)
Gain, Threshold, Polarity
Independent controls for each channel
Minimum printable signal 150 mV
Time Bases
High B/W A/D with 8 Bit resolution
Scan - 5 ms to 10 secs, 1 ms resolution
Key - 5 ms to 10 secs, 1 ms resolution
Delay - 0 secs to 8 secs, 1 ms resolution

PARALLEL INTERFACE

Interconnect
25 Pin Sub D, metal shell
Data Input (Pins 2-9)
Eight Bit Centronics Compatible
2048 bytes per raster line
Burst Rate Bandwidth: Over 250 kHz
Sustained Bandwidth: Based on gray levels

NETWORK INTERFACE

Interconnect
RJ-45 on front panel
Method
Winsock type Socket Interface for data & commands. High-level programmer's API available

COMMAND INTERFACE

QWERTY Keyboard
Jack for commands and annotation
RS-232 Serial Data Input (DCE)
9 Pin Sub 'D' for commands and GPS
RJ-45 for Socket/Ethernet API

ACCESSORIES

Top Cover Assembly (optional)
Custom mini keyboard
Water proof, Heavy duty keyboard (optional)
Rack mount kit (optional)
Spares kit (optional)

ENHANCED ANALOG FEATURES

Time Varied Gain
255 Logarithmic curves to choose from
Band Pass Filtering
LOW PASS:
1kHz, 1.2kHz, 2kHz, 2.4kHz, 3kHz, 4kHz, 6 kHz, 12 kHz

HIGH PASS:
83Hz, 100Hz, 166Hz, 200Hz, 250Hz, 333Hz, 500Hz, and 1kHz

TOW FISH OUTPUTS

E-type High Voltage
750Vdc short circuit proof indefinately
E-Type Trigger Pulse
100kHz- +12V pulse duration 125us
500kHz- +12V pulse duration 250us
E-Type Compatibility
Edgetech 272T ans 272TD
E-Type Connector
Amp MS3102E20 EG&G 259, 960 & 260

K-Type High Voltage
750Vdc short circuit proof indefinately
K-Type Trigger Pulse
12-15Vdc carrier with riding 12V pulse
Pulse duration 1ms
K-Type Compatibility
Klein 100kHz, 500kHz or dual frequency
K-Type Connector
Amp MS3102E22-19 (Klein 595)

DIGITAL DATA PROCESSING

Slant Range Correction
Controls for bottom tracking algorithm, and fish height alarm.

STORAGE

High Capacity Removable Disk
DVD Ram, IDE hard drive
Storage Format
XTF (standard)
SEGY,RAW (consult EPC)

Warranty: One Year Limited Parts & Labor. Specifications subject to change.

EPC

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APPENDIX G

Data Processing and Analysis Methods

Navigation Files
Side Scan Sonar Imagery
Magnetic Intensity Measurements
Seismic Reflection Profile Data

DATA PROCESSING AND ANALYSIS METHODS

Navigation Files

Upon completion of the field work, the digital files of vessel position were processed using HYPACK® software to facilitate post-survey reconstruction of vessel tracklines to assist data interpretation. Event marks generated by HYPACK® during the field survey are plotted along each track and correlate all data by vessel position and time. These event marks are spaced 200 feet apart and are sequentially numbered throughout the duration of the entire field investigation. Events are stored digitally in the HYPACK® navigation files as well as printed on all hard copy data records.

USACE Depth Data

Processed x, y, z hydrographic data were provided by the USACE from previous surveys in Portsmouth Harbor. Data were provided in a final processed format, having been tide adjusted and refenced to the MLLW datum by the USACE. These data points were input to QuickSurf digital terrain modeling software (Schreiber Instruments, Inc.) operating within the AutoCAD 2004 program to generate depth contours of the harbor floor. The points were first used to develop a bottom surface within QuickSurf then contoured using the TIN-GRID method. Contours were generated at a 1 foot interval and presented in a plan view format on the final drawings.

Side Scan Sonar Imagery

During interpretation of the side scan sonar records, areas on the seabed exhibiting different acoustical properties were identified and mapped. The variation in acoustical characteristics on the bottom represents changes in surficial lithology and/or the presence of benthic communities and foreign material. Areas of large natural seabed features were identified by the increased topographic relief and morphologic variations observed on the records. In particular, areas of different surficial lithology of importance to the project were plotted on the plan view drawings. In general, coarser and harder materials show increased reflectivity whereas finer sediments exhibit weaker reflective characteristics.

Imagery were also reviewed to identify individual acoustic targets representative of natural or man made objects resting on the bottom. An object exhibiting some relief (or height) above the bottom will generate a strong reflection on the sonar image from the side of the object facing the side scan towfish. Shape and textures associated with an object may be interpreted, depending on the acoustic signal angle of incidence, geometry of the object, line orientation with respect to the object, and site conditions at the time of the survey, among other variables.

Files were reviewed and targets picked using the Klein SonarPro software which was also used for acquisition. The SonarPro software files apply the proper sensor layback and ground range correction when positioning a target on the bottom. Individual acoustic targets identified have been compiled and described in detail in an ExCel spreadsheet. These targets are also plotted on a plan view drawing of the site relative to mapped surificial materials and magnetic anomalies.

Magnetic Intensity Measurements

Digital records of the magnetic data were reviewed using HYPACK® software to determine the presence of ferrous material on or below the harbor floor. Anomalous readings above the geologic background gradient were identified. Anomalies are essentially a disturbance in the earth's total magnetic field, created by a more pronounced local field generated by a ferrous object. The object's local, induced field causes a deviation of the earth's total field in its immediate vicinity which is measured by the sensor passing nearby. The magnetic anomalies were then plotted in their proper location on the plan view trackline sheets taking layback of the sensor into account. The magnetic anomalies have been presented on the final drawings in plan view format and also summarized in detail in an ExCel spreadsheet included at the end of this report.

Seismic Reflection Profile Data

The processed navigation data were used to generate a plan view survey trackline sheet as part of the overall review of seismic reflection coverage and subsurface conditions. Digital seismic data was imported to the seismic processing program REFLEXW (Sendmeier Software) Version 2.5 for analysis, interpretation, final data formatting. REFLEXW is a 32 bit software package running in a Windows 2000 environment. Since raw seismic reflection data is measured in time travel of the acoustic signals, a time to distance/depth conversion is required. Acoustic velocities for subsurface layers can be obtained directly from seismic refraction methods or assumed from physical sampling of materials. Historical research shows most marine sediment types and compositions fall into certain velocity ranges. In the absence of geotechnical information, an average acoustic sediment velocity of 5,000 feet per second was used for this project, a typical value for saturated marine sediments tending toward the finer grain sizes.

The seismic reflector depths or sediment thicknesses were exported by the REFLEXW program in a x, y, z format and imported to the QuickSurf digital terrain modeling software. A surface was developed for the sediment thickness "z" value interpreted from the seismic profiles, which was then added to the USACE MLLW depth surface to obtain a final subbottom surface referencing the reflector to the project datum, MLLW. In this manner, depths to the primary acoustic basement reflector were developed relative to the project datum. The final surface was contoured using the TIN-GRID method at a 1 foot interval and presented in plan view on a final drawing.