Appendix A
Geophysical Survey Report

FINAL REPORT

GEOPHYSICAL INVESTIGATION
DUNDALK MARINE TERMINAL

BALTIMORE HARBOR, MD

OSI Project No. 06ES101

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1.0 INTRODUCTION

During the period 13 December to 20 December 2006, Ocean Surveys, Inc. (OSI) conducted an integrated hydrographic and geophysical survey in Baltimore Harbor adjacent to the Dundalk Marine Terminal (DMT) in Baltimore, MD. These investigations were subcontracted to OSI by CH2M Hill (CH2M) working under contract to Honeywell International Inc. and represent the first and second tasks of a multi-task program designed to characterize the adjacent Patapsco River and Colgate Creek prior to the proposed surface water and sediment sampling.

2.0 PROJECT SUMMARY

2.1 Survey Background and Objectives

DMT is a major marine terminal operated by the Maryland Port Administration and located approximately 5 miles southeast of Baltimore's Inner Harbor (Figure 1). The DMT encompasses approximately 560 acres of land and includes thirteen piers along three pier faces. The facility's northwest piers face Colgate Creek and the Seagirt Marine Terminal while the southern piers face the Patapsco River. Residential property abuts the southeastern corner of the DMT.

During construction in the late 1950's, approximately 120 acres of the marine terminal was constructed on fill composed primarily of COPR. It has been reported that deteriorated storm drains on the property may provide a path for impacted groundwater to be transported into the river from selected storm drains. CH2M has been tasked with conducting investigations to characterize the extent of COPR beneath and surrounding the DMT.

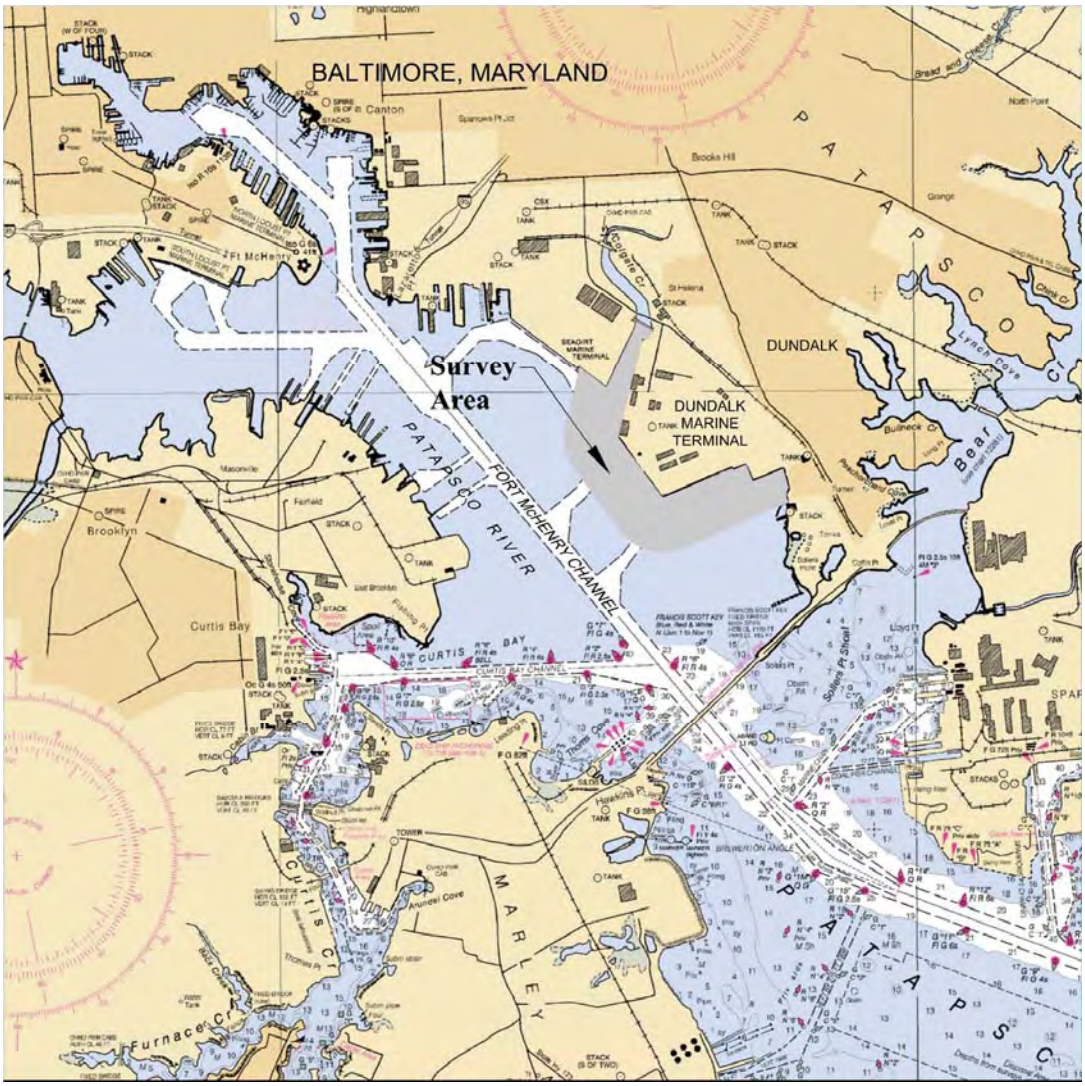


Figure 1: Site Location map of DMT and survey area. (taken from NOAA Chart No. 12281 entitled "Baltimore Harbor", (Nov. 2004).

The purpose of Tasks 1 and 2 (described herein) was to document existing hydrographic and subbottom conditions in the harbor surrounding the DMT to a distance of approximately 2,000 feet offshore of the facility as illustrated in Figure 2. OSI Tasks 3 and 4 will focus on acquiring water and sediment samples along nine transects laid out by CH2M (shown in red in Figure 2). These samples will be used to characterize the near surface benthic habitats surrounding the DMT.

Figure 2: Location map showing the planned Task 1 and 2 survey lines (green) and pre-defined CH2M sampling transects (red).

2.2 Summary of Field Survey and Equipment

Prior to the start of the field program, a survey trackline design was constructed as illustrated in Figure 2. The survey plan included the acquisition of hydrographic and subbottom profile data along a series of 50-foot spaced tracks oriented parallel to the DMT terminal faces. The survey plan also included the acquisition of data along the nine sampling transect lines provided by CH2M (herein referred to as T1-T9) and four "tielines". The tielines were oriented perpendicular to the navigation channels as part of the QA/QC plan for the hydrographic data. In total, approximately 80 nautical miles (nm) of tracklines were planned

for investigation. Hydrographic and subbottom data were collected simultaneously along all tracklines where safe and practical.

Upon arrival on-site for the field investigation, the OSI field team met with the CH2M representative and on-site project coordinator, Mr. McCarthy and discussed field investigation strategies and the survey trackline layout. Mr. McCarthy remained with the OSI field team during the course of the survey investigation to provide project direction and logistical support.

2.2.1 Horizontal and Vertical Control

Positioning of the survey vessel was accomplished using a differential global positioning system (DGPS) installed on the vessel. Prior to commencement of the field investigation, the DGPS system accuracy was verified by occupying a survey control monument provided by CH2M (see below for coordinates). Once system accuracy was verified, a second point was established at the marina for a daily navigation check conducted at the beginning and end of each field day. Project horizontal coordinates are referenced in feet to the Maryland State Plane Coordinate System (1900), NAD83.

SURVEY CONTROL MONUMENT

Designation	Easting*	Northing*	Vertical (NAVD88)
PT-709	1444618.19	573046.89	7.36 feet

* Coordinates are in feet and referenced to the Maryland State Plane Coordinate System (1900), NAD83

The OSI field team installed two electronic water level recorders (a primary and secondary recorder for backup and quality control) on-site to continuously document tidal variation during the investigation. The water level recorders were referenced to North American Vertical Datum (NAVD 1988) and provided a means to adjust water depth data to the datum.

2.2.2 Survey Vessel and Equipment

Survey operations were conducted by a 40-hour trained and certified (in accordance with OSHA CFR 1910.120) field team consisting of a geologist/geophysical specialist and a navigator/support technician onboard OSI's customized survey vessel, R/V Willing II. Specific equipment installed on the survey vessel and used to complete the investigation include a DGPS positioning system, a precision survey-grade depth sounder, and a subbottom profiling system. The table below summarizes the primary instrumentation used for this survey and briefly describes the operation of each system. A complete discussion of this equipment, along with the operational procedures for data collection, can be found in Appendix 1. Equipment specification sheets are included in Appendix 2.

Equipment System	Function
Coastal Leasing, Inc. water level recorder	Digital data logger which measures and records changes in pressure and temperature over time (directly related to fluctuations in water level above the instrument). Instrument is deployed to correct sounding data for tidal variation.
Trimble 4000 Differential Global Positioning System (DGPS) and beacon reciever	Satellite positioning system that tracks up to eight satellites at a time and applies position correction factors relayed to it via radio link from a nearby DGPS Coast Guard Beacon to provide reliable, precision (+/-3 feet) positioning. The Trimble system outputs position fixes at a rate of 1 per second.
HYPACK MAX navigation and data logging software package	Navigation software operating on a data logging computer that provides real time trackline control (helmsman steerage for survey lines), digital data recording, and position interfaces for all equipment systems. This package allows the simultaneous acquisition of data from multiple systems correlating all by vessel position and time.
TSS-DMS2-05i motion sensor	An inertial sensor designed to provide real-time heave, pitch, and roll measurements to survey grade depth sounders and data logging programs allowing depth data to be compensated for boat motion in rough sea conditions
KVH AutoComp 1000 digital fluxgate heading sensor	An electronic fluxgate compass with better than 0.5 degree accuracy and an automated compensation system. The compass provides means for digital data output to the motion sensor and data logging platform to aid in post processing.
Innerspace Model 448 single beam echosounder	Microprocessor controlled, high resolution, survey-grade depth sounder with a 200 kilohertz, 8° beam transducer. The Model 448 recorder provides precise, high-resolution depth records using a solid-state thermal printer and digital data output, which allows integration with the navigation software..

Equipment System	Function
EdgeTech XStar "chirp" subbottom profiler equipped with a SB216 tow vehicle	Subsurface profiler that generates an intense, short duration acoustic pulse in the water column in the range of 2 to 16 kilohertz. The high acoustic frequencies used by this system are intended for increased resolution of layers in the nearsurface. The "chirp" system generates a profile view of seismic reflectors below the bottom, which is then interpreted to develop a geologic cross section under the trackline surveyed.

Figure 3 shows the basic equipment configuration onboard the survey vessel ~~the vessel~~. Both the hydrographic and subbottom equipment sensors were aligned on the starboard side of the vessel, as close to the DGPS receiver as possible, in order to ensure that both sensors collected data as close to the planned tracklines as possible. ~~highat~~

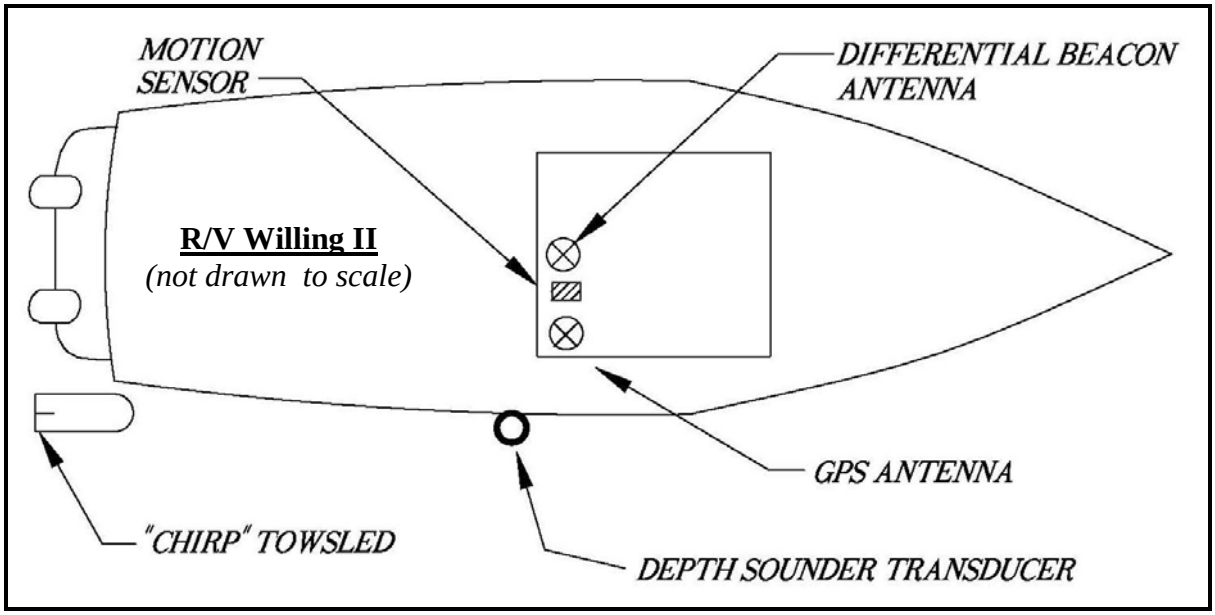


Figure 2. Schematic of instrument configuration during onsite operations.

Shallow site conditions (water depths less than 20 feet) in some regions of the survey area allowed the onboard geologist to perform push probes while the survey vessel was on-line acquiring data to characterize the nearsurface sediments. These probes were accomplished by pushing (by hand) a 1-inch diameter, thick-walled aluminum pipe into the bottom and interpreting the "feel" of the sediments through the probe. By advancing the probe into the riverbed, the scientist was able to gain information about the near-surface sediments (i.e. degree of compaction, presence of sand, silt, clay, etc.). During each attempt, position

information, texture classification, and description of the "feel" was logged. The texture classification adheres to the following scheme: 1 = soft material, 2 = Mixture of sand and mud, 3 = Soft material over a hard impenetrable material, 4 = Sand over a hard impenetrable material, 5 = hard impenetrable material.

3.0 PROCESSING, REVIEW, and DATA PRODUCTS

Following completion of the field investigation, all survey records were brought back to OSI's Old Saybrook, CT office for processing and interpretation. Appendix 3 details the processing methods for each data set. Results are presented on two plan view drawings at a horizontal scale of 1 inch = 400 feet. A third drawing includes representative profiles that provide an overview of subbottom data throughout the site. The plan view drawings are referenced to the project horizontal datum, Maryland State Plane (1900), NAD83 and provided at the back of this volume. The hydrographic data are referenced to NAVD88. The following table summarizes the final products generated for this project.

Drawing	Description
1	Hydrographic contour map with 2 foot interval (1 inch = 400 feet)
2	Representative subbottom profiles illustrate the variation in records collected across the site. (vertical exaggeration 16:1)
3	Subbottom data summary including survey tracklines, location of push probes, and a classification based on subbottom penetration. (1 inch = 400 feet)

Several appendices are also included with this report to present project data and provide a more detailed discussion of the equipment and procedures used for this investigation. The following table summarizes the data presented in each appendix. All paper records generated during the course of the investigation have been annotated and will be archived at OSI along with all digital files. The subbottom profiles for all nine sampling transects are provided in Appendix 5 to aid the planning of sediment core sampling.

Appendix	Data Presentation
1	Equipment Operations and Procedures
2	Equipment Specification Sheets
3	Data Processing and Analysis Summary
4	Push Probe Results
5	Subbottom Profiles along CH2M Hill Sampling Transects

4.0 DATA ANALYSIS AND DISCUSSION

The following sections present a summary of findings based on an integrated hydrographic and geophysical survey performed during December 2006. Water depths discussed in the hydrographic data section are below NAVD88, while depths presented in the subbottom data section are measured below the riverbed. It should be noted that seasonal variations, storm events and/or man's influence since this investigation may alter the conditions reported herein. Refer to OSI Project Drawings 1-3 presented with this report while reviewing the subsequent sections.

4.1 Hydrographic Data

Hydrographic data acquired during the course of the investigation provided sufficient information to document water depth within the project limits. Figure 4 and OSI Drawing 1 present a shaded relief bathymetric image using color to denote depth. The data document a network of steep sided navigation channels that allow shipping access to the DMT from the Fort McHenry navigation channel and the Seagirt Marine Terminal. The channels encompass nearly half of the area surveyed and are a minimum of 39 feet deep, although some spots are as deep as 48 feet. The channel bottom is variable, a likely artifact of past dredging operations. The shoalest region of the channel network, appears to be an area encompassing approximately 10.5 acres with an average depth of 42 feet, approximately 4 feet less that the surrounding channel.

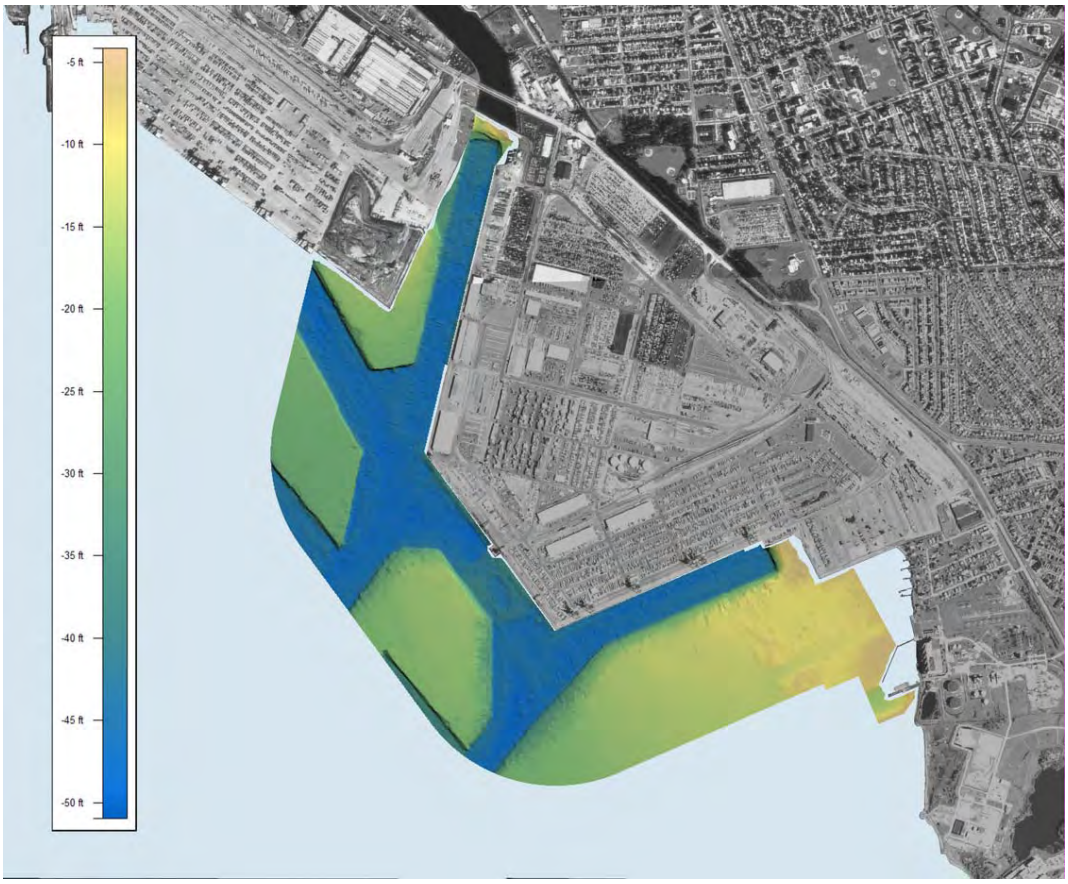


Figure 4: Hydrographic data presented in plan view using color to represent depth (vertical datum: NAVD88).

Water depths measured outside the channels were generally less than 20 feet. Four prominent shallow water areas were identified. The only major bottom feature detected outside the navigation channels was an approximate 1,500-foot elongate depression (1-3 feet deep). This feature was detected in the southeastern sector of the survey area approximately 1,500 feet south of the DMT's southeastern pier face. The bottom topography in these shallow areas appears less variable than the channel topography.

4.2 Subbottom Data

Chirp data acquisition achieved limited penetration and was generally restricted to the upper 10 feet. In some areas no penetration was achieved, while elsewhere reflectors were observed to depths as great as 50 feet. The observation of reflectors at depth indicates that

the subbottom profiling system was functioning properly but that site conditions played a significant role in the ability of the system to achieve penetration. OSI project Drawing 2, Sheets 1-3 provide examples of the subbottom data collected and illustrate the variation in subbottom reflections.

The limited penetration across much of the site is believed to be a result of several factors, including the presence of gaseous sediments in the near-subsurface sediments and the disturbance of the surficial sediments during past dredging activity in the area. Gases produced by the decomposition of naturally occurring organic material in the sediment, impede acoustic propagation and thus prevent imagery of subbottom reflectors deeper than the layer containing the gases. The high reflection coefficient of the sediment/gas interface causes a strong signal to be reflected back toward the surface then off the water/air interface producing "multiple" reflections on the subbottom record. Gaseous sediments are often encountered in upland rivers, bays, and estuaries just as irregular riverbeds are often encountered in dredging areas. Irregular morphology can disperse acoustic energy and prevent it from penetrating the riverbed, thereby producing subbottom records with a diffuse appearance. Consequently, the limited subbottom penetration achieved throughout the survey area is expected.

After analyzing the subbottom profiler records and reviewing the data along with the push probe results, subbottom data have been delineated into five categories to better understand their distribution throughout the project area. This classification is defined primarily based on the characteristics of subbottom reflectors detected and the depth of penetration achieved. The five categories are summarized in the following table along with the color hatch pattern used to represent them on project Drawing 2 and 3. Figures 5-7 provide examples for each of the categories.

Table of Subbottom Data Classification

Type	Description	Color/Hatch Pattern Used
1	No subbottom penetration achieved below the riverbed. Generally associated with the navigation channels. Due to depth limitations – no push probes were conducted in these areas.	
2	Limited subbottom penetration achieved. Subbottom reflectors are observed in the upper 10 feet of the riverbed and terminate abruptly. Reflectors are generally horizontal and closely spaced approximately 1 foot apart. The one push probe (p01) conducted in this type area encountered a mix of sand and mud.	
3	Shallow subbottom penetration achieved. Continuous subbottom reflector detected several feet below riverbed. Subbottom reflector detected appears to be related to the upper surface of a gaseous sediment horizon. Sediments overlying the detected reflector appear acoustically transparent suggesting that they may have a high water content. Probes conducted in these areas primarily encountered soft sediments.	
4	Shallow subbottom penetration achieved. Minimum of one subbottom reflectors detected within approximately ten feet of the riverbed. Subbottom reflectors may be discontinuous but at least one of them appears to be related to the upper surface of a gaseous sediment horizon. Probes in these areas encountered soft sediments as well as mud intermixed with sand.	
5	Deep subbottom penetration achieved. Several continuous subbottom reflectors detected to a depth of as much as 50 feet below the riverbed. Probes in these areas encountered a wide variety of sediment types from soft mud to coarse sand and gravel.	

In general, the delineation of the five acoustic classes seems to be correlated to their geographic distribution. For example, Type 1 and Type 2 data are encountered mainly within the dredged navigation channels, while Type 3 data are typically associated with the three distinct shallow water areas located on the north and west sides of the DMT. Type 4 and Type 5 data are associated with the shallow areas south and southeast of the DMT. Figure 8 and OSI Project Drawing 3 provide an overview of the distribution of acoustic characteristics identified in the project site.

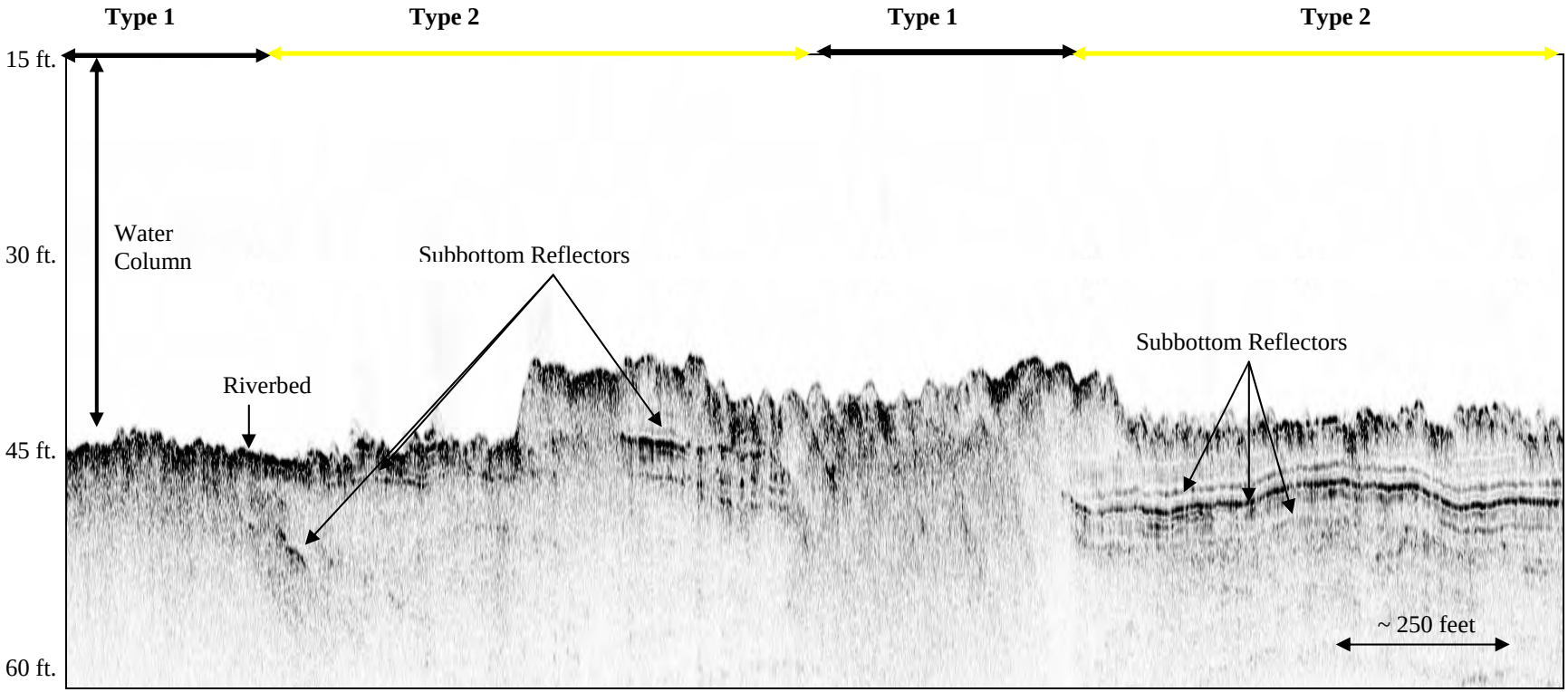


Figure 5: Reproduced section of chirp profile record depicting subbottom data classification Types 1 and 2. These profile categories are representative of the shipping channels. Type 1 refers to areas where no subbottom penetration was observed. Type 2 refers to areas of generally horizontal and closely spaced reflectors that terminate abruptly.

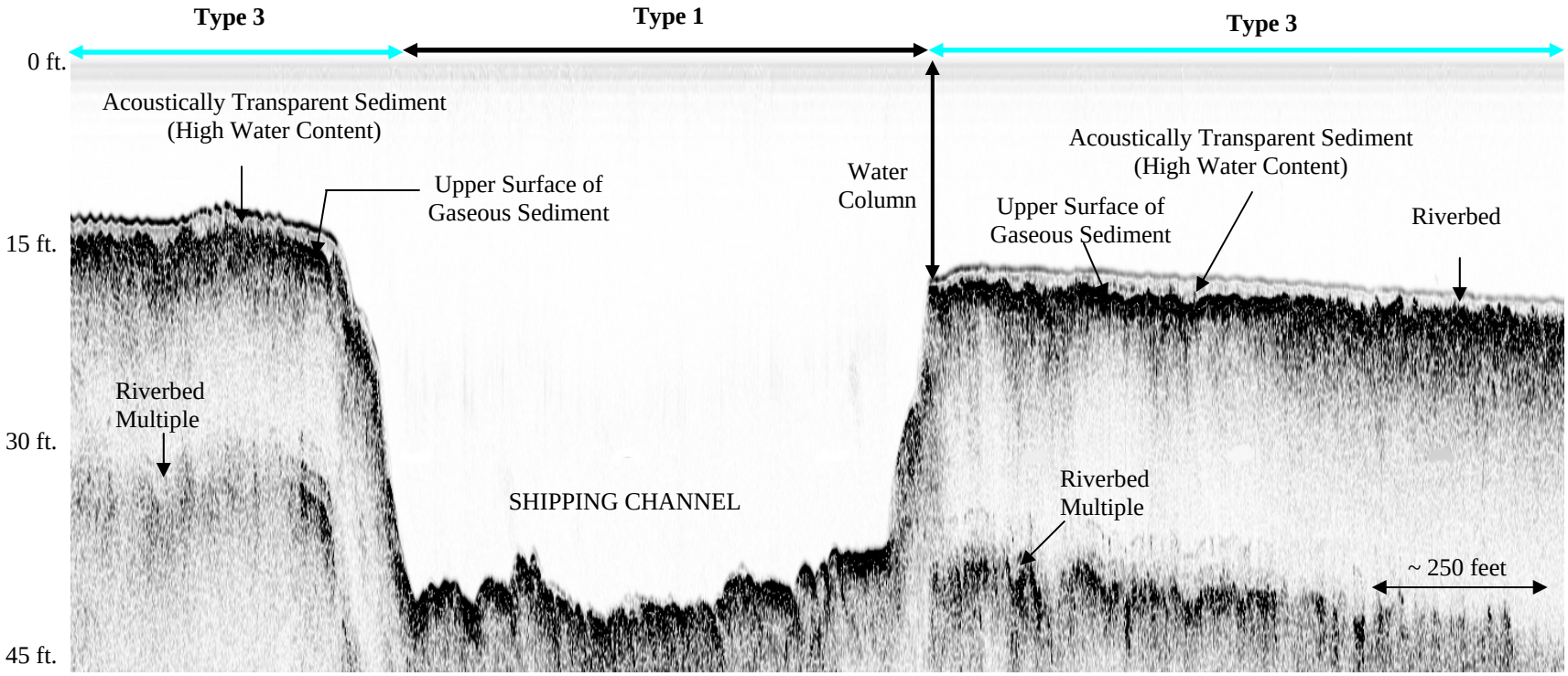


Figure 6: Reproduced section of chirp profile record depicting subbottom data classification Types 1 and 3. Note the thin layer (~2-3') of acoustically transparent sediments that blanket the riverbed in Type 3 areas. The acoustically transparent sediments are generally associated with highly aqueous silts.

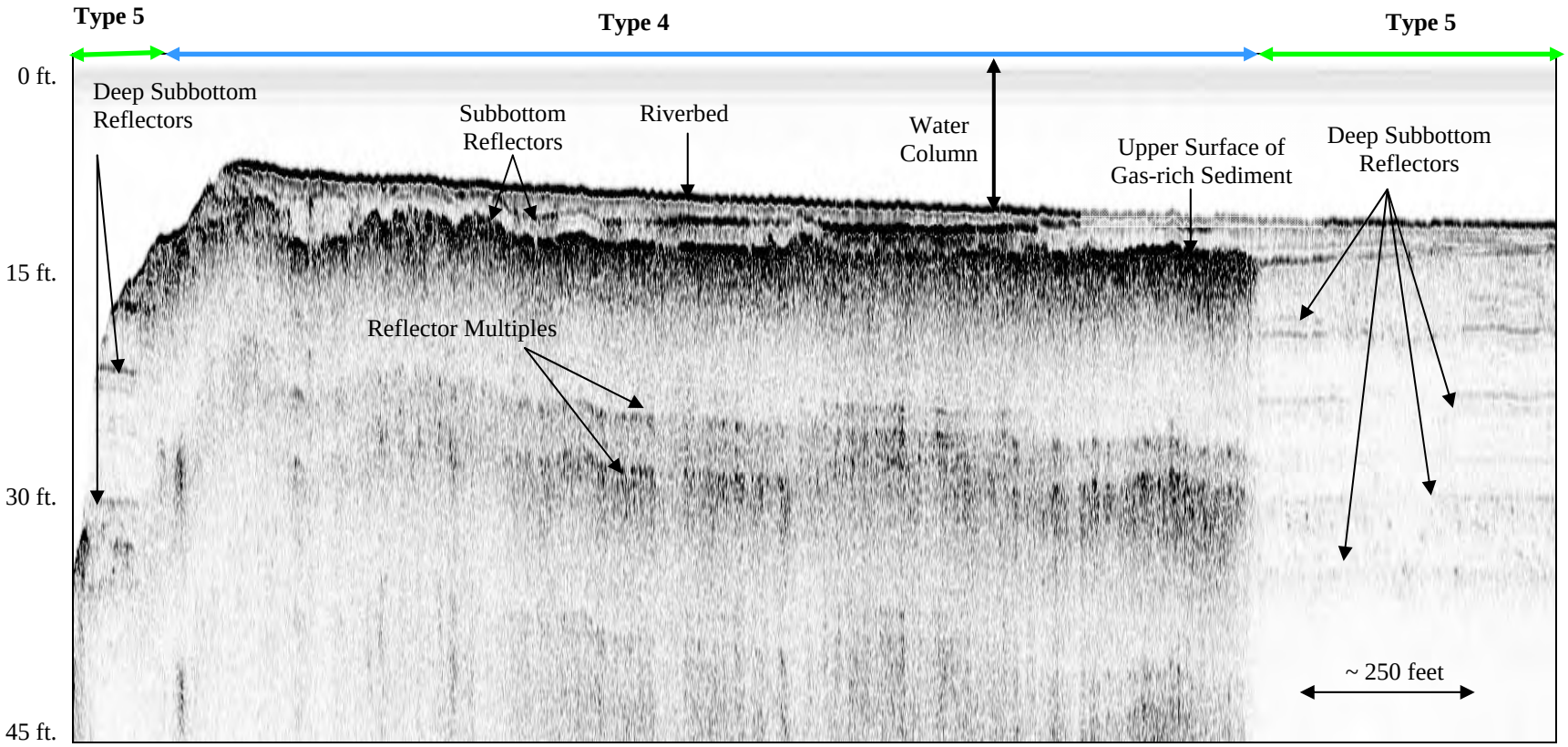


Figure 7: Reproduced section of chirp profile record depicting subbottom classification Types 4 and 5. Type 4 is characterized by a minimum of one subbottom reflector, which generally overlies a gas-rich sediment horizon. Type 5 is associated with deep subbottom penetration and the detection of multiple subbottom reflectors. Note the abrupt transition from Type 4 to Type 5 and the lack of deep subbottom reflectors in the Type 4 data.

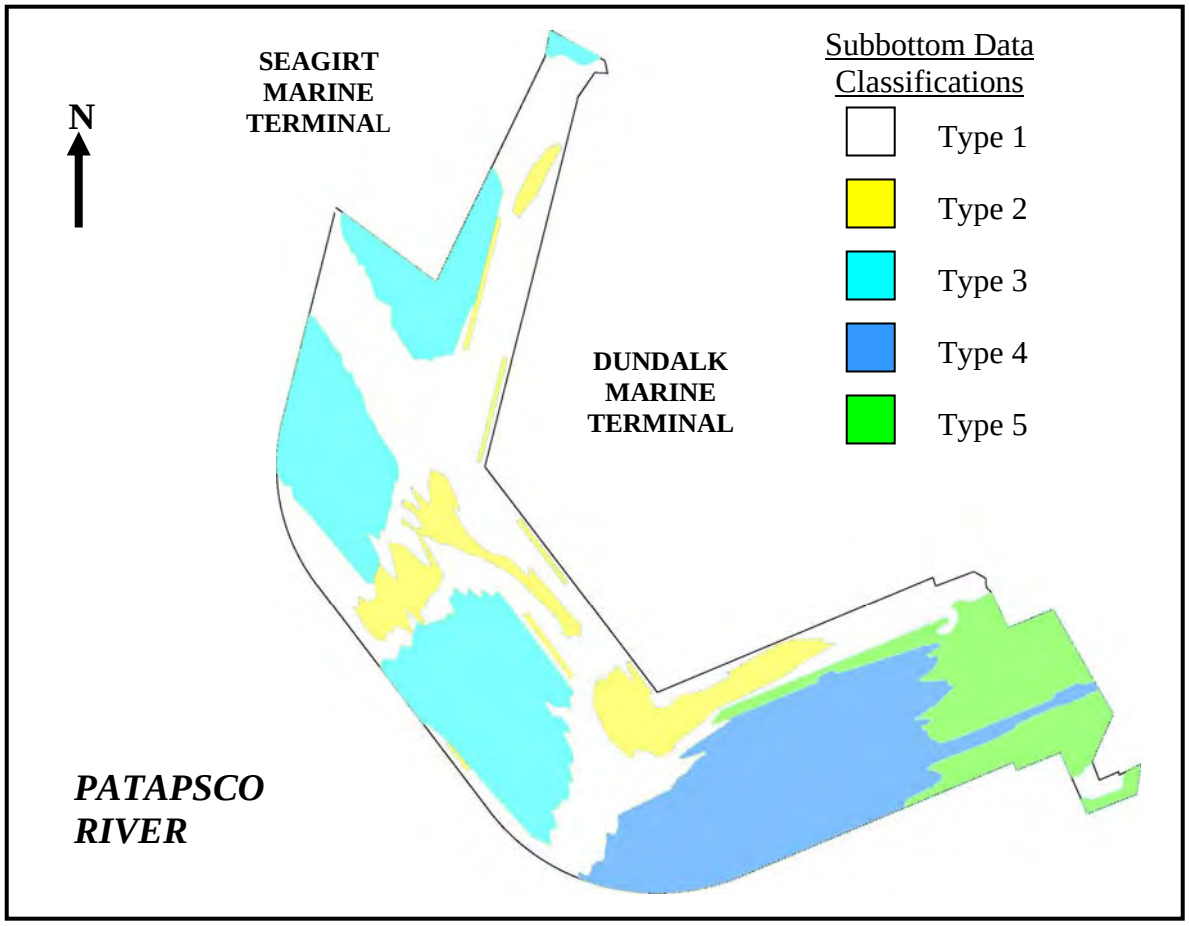


Figure 8: Overview of subbottom data classification types identified throughout the project site.

The diversity of acoustic response throughout the survey area is an indication of the variation in surficial sediments present. The water depths across much of the survey area were too deep to conduct push probe investigations while underway, although additional information may be obtained in a later phase of the investigation. The uniformity of subbottom data within Types 1-4 suggest that near-surface sediments may not change dramatically within each area. While we can only speculate about sediment types across much of the deep regions of the site, an abundance of push probe data is available in the Type 5 region. A variety of hard (impenetrable) materials were encountered in this area ranging from compact clay to coarse sand and gravel. In most cases, a layer of softer material typically less than 3 feet thick was "felt" above the hard bottom.

The elongate depression previously described in the hydrographic section is clearly evident on several of the subbottom profiles collected along CH2M defined sampling transects (provided in Appendix 5 – Specifically T1 - T4). The acoustic data associated with the depression are characterized as Type 4. Push probes performed in the feature suggest it is in-filled with soft sediments, while probes performed directly adjacent to the depression encountered sand. The stark contrast in sediment type, subbottom data, and the unusual morphology of the depression suggest that the feature may be of man-made origin and could be an artifact of dredge operations.

The deep subbottom penetration attained within the Type 5 area; mapped in the southeastern region of the site, allowed for the detection of a series of steeply dipping reflectors as illustrated by the two intersecting profiles presented in Figure 9. The deepest reflector identified in the profiles (at least 50 feet below the riverbed) appears to form a subsurface mound. Based upon a review of subbottom data, it is unclear what the mound is composed of. Push Probe #61 was performed at the intersection of the two representative profiles shown in Figure 9, where the subsurface mound is exposed on the riverbed. This probe encountered a mix of sand and mud. Several overlying reflectors indicate on-lapping sediments, which appear to thicken away from the apex of the mound.

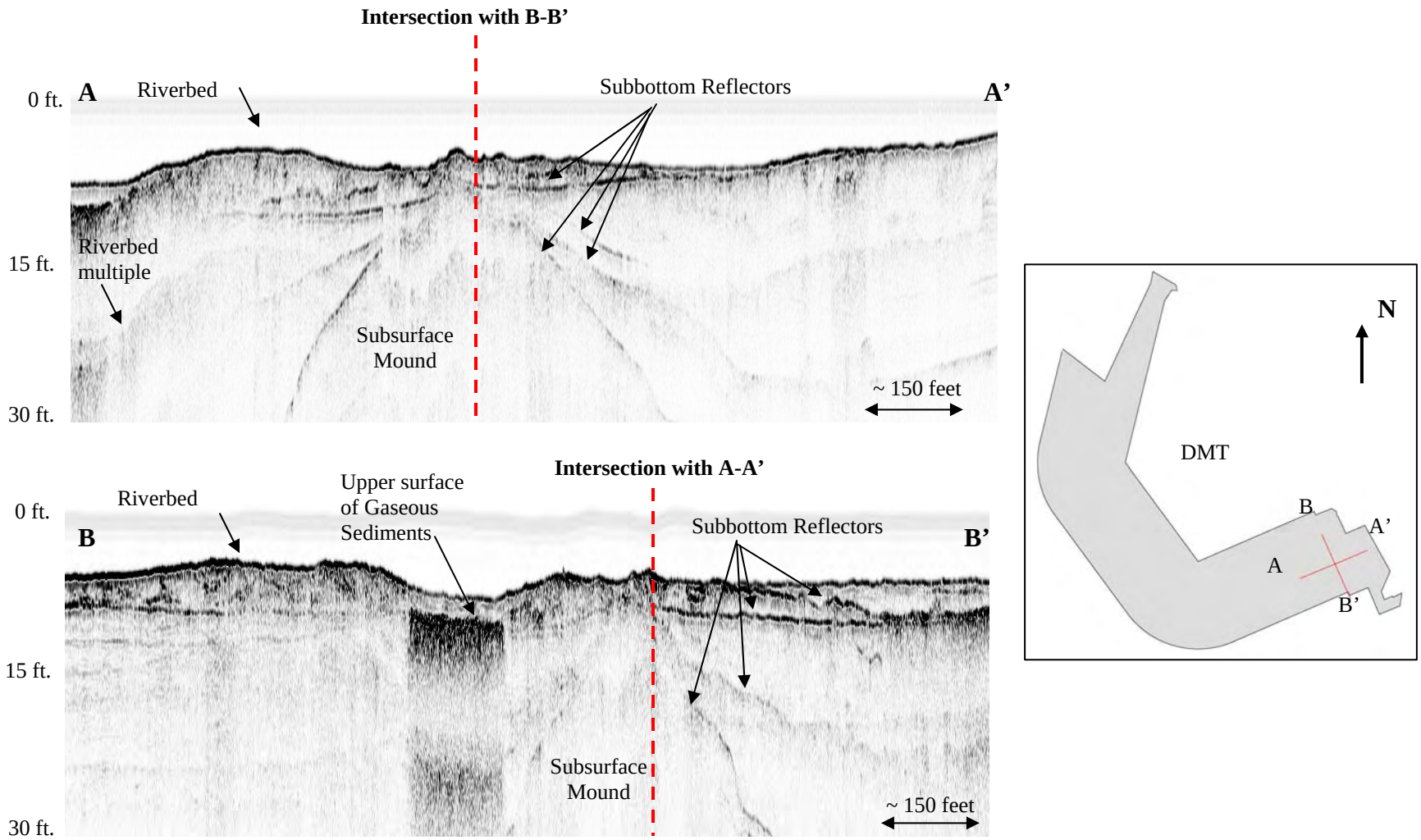


Figure 9: Reproduced sections of chirp subbottom profile records depicting unusual subsurface mound identified in the southeastern margin of site. Sections of two orthogonal profiles intersecting at the apex of several steeply dipping subbottom reflectors illustrate the asymmetry of an unusual subbottom feature. Location map illustrates the position of each profile in the survey area. The images have an approximate vertical exaggeration of 16:1.

5.0 CONCLUSIONS AND RECOMMENDATIONS

An integrated hydrographic/geophysical survey was completed in Baltimore Harbor in the waters immediately adjacent to the DMT. This survey, conducted by OSI for CH2M, represents the first and second task of a multi-task program designed to characterize the water and sediments surrounding the DMT to a distance of approximately 2,000 feet offshore of the facility.

Completed simultaneously, the specific purpose of the Task 1 and 2 surveys (described herein) was to document existing hydrographic and subbottom conditions in the project area. Upcoming OSI investigations will focus on acquiring water and sediment samples in the project area under the direction of CH2Ml representatives.

Hydrographic data clearly document a network of steep sided navigation channels traversing the project area that allow shipping access to the DMT from the Fort McHenry navigation channel and the Seagirt Marine Terminal. The channel system varies from 39 to 48 feet below NAVD88. Four prominent shallow water areas were identified within the project area outside the shipping channels. Depths in these areas generally average less than 25 feet below NAVD88. The most northern of the shallow water areas, situated adjacent to the Seagirt Marine Terminal, is identified as a 'Spoil Area" on the NOAA chart.

Subbottom profiling coupled with push probing observations made during the course of the survey investigation provided data to characterize the surficial sediments and shallow subsurface stratigraphy underlying the project area. In general, the acquired data sets indicate variability in the surface and subsurface sediments in the site, both horizontally and vertically. To better understand this variability, subbottom returns were characterized into five classes (referred to as Types 1-5), which were mapped throughout the project area. This characterization scheme is primarily based on the depth of penetration attained by the subbottom profiler and the characteristic of the subbottom reflectors observed on the records.

Acoustic Types 1-4 characterize the majority of the area investigated and are generally associated with near surface deposits of soft, often aqueous sediment varying in thickness but generally greater than 1-foot thick. Type 5 data were isolated to a small shallow area in the southeastern corner of the survey site and are associated with a wide variety of surficial sediments varying from muds to coarse sands and gravel.

Subbottom imagery can be greatly affected by the acoustical properties of near-surface material. As a result, overlying layers can mask subbottom layers that would otherwise be represented by acoustic reflectors.

One of the primary goals of this investigation was to provide CH2M with data to aid in designing a strategy for sampling that will be followed during upcoming tasks. Currently, CH2M plans to acquire samples along nine transects located around the DMT within the survey area (designated T1-T9). During the current investigation, subbottom data were acquired along these transects. Annotated subbottom profile records for each of the nine transects are included in Appendix 5 of this report and should be reviewed to identify sampling locations. In general, sediment sampling performed along transects T1 to T4 will recover a wide variety of surficial sediment types, where as sediment samples acquired along transects T5 to T9 will most likely encounter soft, often highly aqueous, sediment types intermixed with sand. Upcoming sediment sampling investigations should consider variations in sampling methodologies to recover these varying sediment types. With regard to sediment sampling the following general recommendations are provided:

- Collect sediment samples within each of the different acoustic classification areas to better understand the data and the distribution of sediments within the survey area.
- Collect sediment at survey line grid nodes (intersection of survey lines); to compare with subbottom data acquired along two survey profiles.
- Collect several sediment samples in the vicinity of the subsurface mound feature identified in the southeastern region of the survey site to better understand the nature and composition of the mound.

Existing riverbed conditions were documented during this investigation and can be used as a baseline for future studies and comparative analyses. Mapping programs in the future should consider the use of side scan sonar imagery. Side scan sonar is a surface mapping tool and can provide a comprehensive map of the textural changes existing throughout the survey area, which are typically associated with variations in sediment type and benthic habitats. In addition, side scan sonar imagery can be used to identify features present within the site that could potentially impact the project and might otherwise have gone undetected utilizing the current instrumentation. Future investigation might also consider the acquisition of marine magnetometer data within the project site. Magnetometer data could provide information about the presence of undetected ferrous objects present in the site.

APPENDICES

APPENDIX 1

EQUIPMENT OPERATIONS AND PROCEDURES

Coastal Leasing Micro-Tide Recorder
Trimble 4000 GPS with Differential Probeacon Receiver
HYPACK MAX Navigation Software
TSS-DMS2-05i Motion Sensore
KVH AutoComp 1000 Digital Fluxgate Heading Sensor
Innerspace Model 448 Single Beam Echosounder
EdgeTech XStar “chirp” Subbottom Profiler

EQUIPMENT OPERATIONS AND PROCEDURES

Coastal Leasing Micro-Tide Recorder

Continuous water level measurements were recorded during the survey by installing a Coastal Leasing Micro-Tide recorder in the vicinity of the survey area. The Micro-Tide recorder contains an advanced microprocessor capable of the sampling, averaging, and internal storage of pressure data as well as providing options for telemetry or networking. The tide recorder/gauge is a self-contained, fully submersible instrument with a cylindrical stainless steel housing less than 13 inches long, 5.5 inches in diameter, and weighs under 20 pounds. The unit is typically mounted to the end of a wood board which is attached to the backside of a piling away from heavy vessel traffic and preferably in a protected basin or other calm area. The tide recorder was referenced to the temporary bench mark previously established for this project as provided by the client. The instrument may be set to record pressure/tidal height readings at 0.5-60 minute intervals.

The Micro-Tide recorder contains two pressure sensors, such that one can be submerged to collect pressure or height of water above the sensor while the second sensor can be mounted in air directly above the instrument to collect barometric pressure data. The recorder automatically makes the adjustment for barometric pressure to generate a corrected, real time tide curve.

Trimble 4000 Global Positioning System Interfaced with a ProBeacon U.S. Coast Guard Differential Receiver

The Trimble 4000 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 ProBeacon Coast Guard receiver. The ProBeacon receiver consists of a small control unit, a volute antenna and cable, and RS232 interface to the Trimble 4000 unit. In this system configuration a position accuracy of ± 1-2 meters is reported by the manufacturer, although experience suggests it can provide consistent +/-1 meter reliability.

Fully automated, the Trimble 4000 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 beacon receiver which continuously receives differential satellite correction factors via radio link from one of the DGPS United States Coast Guard beacons (1 second update rate). The Trimble 4000 accepts the correction factors and applies the differential corrections to obtain continuous, high accuracy, real time position updates. The Trimble 4000 system is interfaced to the OSI navigation system running HYPACK MAX® software for trackline control.

HYPACK MAX Navigation Software

Survey vessel trackline control and position fixing were obtained by utilizing an OSI computer-based data logging package running HYPACK MAX navigation software. The HYPACK navigation system processes the geodetic position data into the correct grid system, which is then 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. Digitized shoreline and the locations of existing structures, buoys, and control points can also be displayed on the monitor in relation to the vessel position. The OSI computer logging system, combined with the HYPACK MAX 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.

VT TSS DMS-05 Dynamic Motion Sensor

Vessel heave, pitch and roll information was measured and logged utilizing a VT TSS's DMS-05 Dynamic Motion Sensor. Incorporating an enhanced external velocity and heading aiding algorithm for improved accuracy during dynamic maneuvers, the solid-state angular sensor offers reliability and the highest performance of any VT TSS produced vertical reference unit. The DMS-05 motion sensor was designed for use with multibeam echosounders and incorporates advanced processing techniques and high grade inertial sensing elements to attain heave, pitch, and roll measurements with high dynamic accuracy and immunity to vessel turns and speed changes. The DMS-05 allows full utilization of all echosounder beams and survey capabilities to IHO standards. The DMS-05 has a dynamic

roll and pitch accuracy to 0.05° over a 30° range and dynamic heave accuracy to 5 centimeters or 5% (whichever is greater). The unit can output digital data at a rate up to 200 hertz and accepts a standard NMEA-0183 message string. Digital data are logged by the HYPACK® navigation computer. The DMS-05 permits survey operations to continue through degrading weather conditions, increasing project productivity and efficiency.

KVH AutoComp 1000 Fluxgate Compass

The KVH AutoComp 1000 fluxgate compass was used to measure magnetic compass headings along survey tracklines. The AutoComp 1000 incorporates next generation electronic fluxgate technology to provide 0.5 degrees accuracy and an automatic compensation system that automatically corrects for compass deviation on the vessel, without a compass adjuster. The system automatically calibrates itself after installation by steering the survey vessel in a circle so the microprocessor-controlled unit can measure, process, and compensate for the magnetic field. The unit corrects for B, C, D, E coefficient errors, while standard NMEA 0183 output provides easy interfacing with other equipment. The digital data are logged on the HYPACK® navigation computer.

Innerspace Technology 448, 200 kHz Digital Depth Sounder

Precision single beam water depth measurements were obtained by employing an Innerspace Model 448 digital depth sounder with a 200 kHz, 3° beam width transducer. The Model 448 recorder provides precise, high-resolution depth records using a solid-state thermal printer as well as digital data output which allows integration with the OSI computer-based navigation system. The Model 448 also incorporates both tide and draft corrections plus a calibration capability for local water mass sound speed.

Sound speed calibrations were accomplished by performing "bar checks". The bar check procedure consists of lowering an acoustic target, typically a 20 pound lead disk, on a measured sounding line, to the specified project depth. The speed of sound control is adjusted such that the reflection from the disk is printed on the recorder precisely at this

known depth. The acoustic target is then raised to successively shallower depths and calibration readings at these depths are recorded. Variations which exist in the indicated depth at these calibration points are incorporated in the sounding data processing to produce maximum accuracy in the resulting depth measurements. Bar checks were performed at the beginning of each day to check the surface water mass sound speed in comparison with the CTD profiler.

EdgeTech XStar "Chirp" Subbottom Profiler

Information concerning subsurface stratigraphy was explored through use of an EdgeTech XStar "Chirp" Subbottom Profiler system operating at frequencies of 2 to 16 kilohertz. The subbottom profiler consists of three components: the deck unit (Xstar topside computer, amplifier, monitor, keyboard, and trackball), an underwater cable, and a Model SB216 towed vehicle housing the transducers. Data is displayed on a VGA monitor and EPC 1086 thermal printer while saved digitally on the topside control computer.

The XStar "chirp" profiler is a versatile subbottom system that generates cross-sectional images and collects normal incidence reflection data over many frequency ranges. The system transmits and receives an FM pulse signal generated via a streamlined towed vehicle (subsurface transducer array). The outgoing FM pulse is linearly swept over a full spectrum range of 2 to 16 kilohertz for a period of approximately 20 milliseconds. The acoustic return received at the hydrophone array is cross-correlated with the outgoing FM pulse and sent to the deck unit for display and archiving, generating a high resolution image of the subbottom stratigraphy. Because the FM pulse is generated by a converter with a wide dynamic range and a transmitter with linear components, the energy, amplitude, and phase characteristics of the acoustic pulse can be precisely controlled and enhanced.

The "chirp" subbottom profiler is designed for acquiring high resolution subsurface data from upper portions of the stratigraphic column (5 to 25 meters depending on site conditions). The higher end frequencies allow good resolution of subbottom layering while the lower end acoustic frequencies provide moderate penetration. This particular system is

capable of providing excellent acoustic imagery of the subsurface in a wide variety of marine environments.

Operationally, a seismic source is used to create a swept frequency pulse or signal in the water column. This signal propagates downward to the bottom 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 characteristics of the materials 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 is correlated with the outgoing pulse and the resultant trace. 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.

APPENDIX 2

EQUIPMENT SPECIFICATION SHEETS

www.coastal-usa.com

Coastal's MacroTide

Description:	Coastal's MacroTide and MacroTide+ record pressure levels in aquatic environments for tidal measurements using either an ICS Strain Gauge Pressure Sensor or a high-precision Paroscientific Digiquartz Sensor.
Capacity:	200K standard Optional (Compact Flash Cards): 8MB, 16MB, etc.
Housing:	**Diameter** – 5.5 in. **Length** – 14 in. (including handle) **Weight** – 15 lbs. in air **Material** – Stainless steel and UHMW plastic housing MacroTide+ length is 15.5 in., weight is 17 lbs. in air
Power:	User replaceable standard alkaline D cells
Interface:	*Wizard* IBM PC compatible software ASCII data files in engineering units User controlled sampling parameters and sensor functions
Clock:	Solid state real time, accuracy one minute per year
Standard:	**Pressure, Standard** – ICS Strain Gauge **Temperature, Internal** – YSI Thermister
Optional: Standard, MacroTide+	**Pressure, High Precision** – Paroscientific Digiquartz
Optional:	**Temperature, External –** YSI Thermister **Additional External Pressure** – ICS Strain Gauge

Coastal MacroTide
Exterior(above), Interior(below)

Function	Sensor (*optional)	Range	Accuracy	Resolution	Units
Pressure, Standard	IC Sensors Strain Gauge, piezoresistive	30, 50, 100, 250	0.1%	12 bit	psia
Temperature	Internal YSI Thermister	-5° to 35°	0.1°	.02 typ	°C
Pressure, High Precision	*Paroscientific Digiquartz	900<	0.015%	16 bit	psia

Coastal Leasing, Inc. 179 Sidney Street Cambridge MA 02139-4238
p 617.497.1122 f 617.497.1188 coastal@coastal-usa.com

IMPROVED!

4000RSi & 4000DSi

DGPS Reference Surveyor and Differential Surveyor

The world's best real-time sub-meter DGPS receivers are now twice as good!

The 4000RSi Reference Surveyor™ and 4000DSi Differential Surveyor™ now 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 and 4000DSi incorporate Trimble's Super-trak™ technology. Super-trak enhances low power satellite signal acquisition, improves signal tracking capabilities under less than ideal conditions, and provides increased immunity to signal jamming resulting from radio frequency interference. These further improvements are derived from integrating complex RF circuitry onto a single chip and using state-of-the-art surface acoustic wave (SAW) filter technology.

Super-trak increases productivity and facilitates continual operations in demanding environments, such as ports, harbors, along river banks, and near sources of high radio frequency that may interfere with satellite signals.

The 4000RSi and 4000DSi also incorporate Trimble's latest advance in multipath rejection through enhanced signal processing: the patented EVEREST™ 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 4000RSi and 4000DSi 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 light-weight, rugged, weatherproof housing; and low power consumption for extending field operation time from batteries.

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

The 4000DSi is designed to use DGPS corrections in the RTCM SC-104 standard format broadcast by the 4000RSi. 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.

During operation, the 4000RSi and 4000DSi can output binary and ASCII data for archiving or post-mission analysis. In addition, the 4000RSi can operate as a mobile receiver with the same features, functionality and options as the 4000DSi. 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.

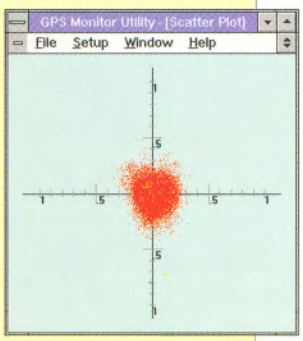
System Integration Components

Data Communications Systems

Trimble offers optimized telemetry systems. The real-time DGPS data communication systems include short-range "license-free" telemetry for line-of-sight environments such as ports, rivers, and coastal regions. For mid-range applications, there are proven HF, VHF and UHF systems for various conditions and licensing requirements. For long-ranges (up to 500 km), Trimble offers MF ground-wave systems. All telemetry components and accessories are tested to ensure system reliability.

GPS Monitor Utility™

The performance of the new 4000RSi/DSi with EVEREST Multipath Rejection Technology is graphically displayed using the GPS Monitor Utility software program (included with the 4000RSi and 4000DSi and available separately also). DGPS accuracy has never looked so good!



QA/QC Real-time Quality Assurance

The QA/QC firmware option enables the user to verify the positioning integrity in real-time. QA/QC includes real-time position quality assurance displays, a position quality alarm with definable levels, and data output of quality related information. It provides unprecedented real-time assurances of the receiver's position accuracy so that the operator knows whether the required position quality is being met. If the accuracy falls below acceptable levels, an audible alarm notifies the operator.

Universal Reference Station™

The Universal Reference Station (URS™) is a PC-based software system that works as a dedicated, programmable DGPS reference station for broadcasting corrections to an unlimited number of users. URS collects data from all satellites in view, including pseudo ranges, carrier phase and ephemeris data, and outputs the data and corrections for transmission to mobile receivers that are being used anywhere in range. URS also can also be programmed to collect data for post-processed applications.

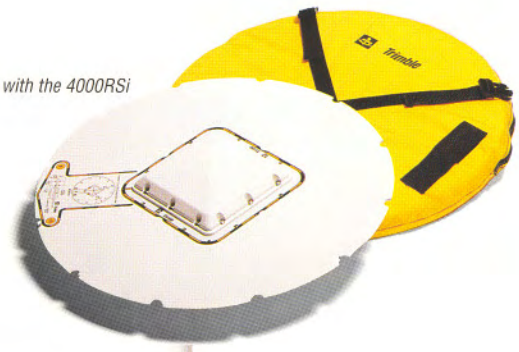
Standard Configuration

a. Series 4000 GPS receiver (4000DSi)
b. Compact dome antenna
c. 30m antenna cable
d. Operating manual
e. Lemo to dual BNC cable
f. 5 pin Lemo to DB9 cable
g. 7 pin Lemo to DB9 cable
h. Dual power input cable

Geodetic Antenna Option

a. Ground plane geodetic antenna
b. Soft case carrying case

The Geodetic Antenna Option is standard with the 4000RSi and is optional for the 4000DSi.



TRIMTALK Series Radio Link Options

TRIMTALK radios are available in various application-specific configurations for reference site, repeater and mobile use. Frequency options are tailored to operation worldwide, including *license-free* in many countries.

ProBeacon Option

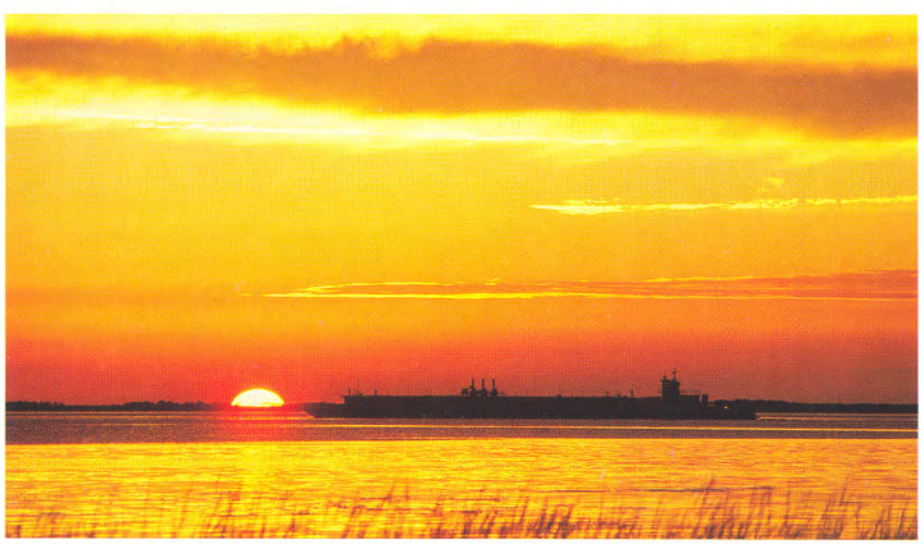
The ProBeacon is designed specifically to receive the differential GPS correction broadcasts from DGPS/MSK radio beacons. Availability of these differential correction broadcasts is increasing rapidly worldwide.

For information about additional options, contact your Trimble sales representative.

Applications:
Precision GPS Positioning on the ground, at sea and in the air.

HYDRO/DGPS Trimble's HYDRO software provides a totally integrated field-to-finish product that combines your DGPS position with other survey sensors such as echosounders, compasses, sidescan sonar, tide gauges and acoustic positioning equipment. HYDRO also provides navigation and has post-processing capabilities to produce high-quality plots. Additional modules include contouring, profiles, volumes and digitizing. HYDROseismic and HYDRORig have specialized features for the exploration industry's requirements for surveying and rig positioning.

Airborne Applications Traditionally, aerial applications have required multiple pilots as well as numerous human flaggers and associated ground crews. Using TRIMFLIGHT™, a precise DGPS airborne navigation and mapping system, crops can be sprayed effectively and consistently—without flaggers or ground assistance, providing the pilot with graphical proof of where he has sprayed. The system can also be used for a wide variety of other aerial applications, such as geophysical exploration, photogrammetry, GIS data capture and search & rescue.



Tracking Trimble's Barge Monitoring System has taken DGPS one step further by using two-way radio communications. While DGPS corrections are transmitted to vessels for navigation, positions and other status information are reported back to the reference site for display. The system is being used for environmental policing to ensure that the barges dump the material in legal dump sites. If a dump occurs outside these sites, the system will warn the controller.

4000RSi & 4000DSi

DGPS Reference Surveyor and Differential Surveyor

4000 RSi Features

Autonomous operation; filtered and carrier-smoothed RTCM differential corrections (versions 1.0 and 2.X); 0.5 second measurement rate; data integrity provision; data link flow control on RTCM port; triple DC input; L1 geodetic antenna; 30m antenna cable; automatic mode restoration after power-off; dual RS-232 I/O ports for data recording; low power; lightweight; portable; environmentally protected; 1 PPS output; NMEA-0183 outputs; RTCM input and output; 1-year warranty.

4000 DSi Features

Better than 0.5 meter accuracy with Trimble 4000RSi including EVEREST technology; real-time operation; 0.5 second measurement rate; data integrity provision; triple DC input; compact dome antenna; 30m antenna cable; automatic mode restoration after power off; extra RS-232 I/O port for data recording; low power; portable; environmentally protected; 1 PPS output; navigation firmware; NMEA-0183 outputs; weighted least-squares solution; RTCM input; 1-year warranty.

Options

- Firmware update service—1 and 4 years
- L1 carrier phase
- 12 channels
- Rack mount
- Event marker
- QA/QC firmware
- Internal memory for datalogging
- Extended hardware warranty
- 4 serial I/O ports

Accessories

- L1 Geodetic antenna
- 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

Physical Characteristics

Size:	9.8"W x 11.0"D x 4.0"H (standard receiver) (24.8cm x 28.0cm x 10.2cm) 16.8"W x 16"D x 5.25"H (rack-mount receiver) (42.7cm x 40.6cm x 13.3cm)
Weight:	6 lbs. (2.7kg) standard receiver 15lbs. (6.8kg) rack-mount receiver 0.5 lbs. (0.2kg) compact dome antenna 5.7 lbs. (2.6kg) L1 geodetic antenna
Power:	Nominal 10.5 to 35 VDC, 7 watts
Operating temp:	-20°C to +55°C
Storage temp:	-30° to +75°C
Humidity:	100%, fully sealed, buoyant (standard receiver) 95% non-condensing (rack-mount receiver)

Technical Specifications

4000 RSi

Compatibility:	Corrections may be applied to all differential-equipped RTCM compatible GPS receivers

4000 DSi

Accuracy:	Typically better than 0.5m RMS: assumes at least 5 satellites and PDOP less than 4.
Compatibility:	Accepts RTCM SC-104 corrections Version 1.0 or 2.X

4000 RSi and 4000 DSi

Tracking:	9 channels of L1 C/A
Signal Processing:	Multibit Super-trak; Maxwell architecture with EVEREST Multipath Rejection Technology; very low-noise C/A code processing
Start-up time:	Less than 2 minutes from power-on to tracking
Antenna:	External antenna with 30m RG213 cable
RS-232 data link rates:	50-57.6K baud
RTCM message output:	Types 1, 2, 3, 6, 9, 16
NMEA-0183:	ALM, BWC, GGA, GLL, GSA, GSV, RMB, RMC, VTG, WPL, XTE, ZDA
Ports:	Dual serial; Triple power inputs; Antenna; and 1PPS output
Display:	Backlit LCD with four lines of forty alphanumeric characters; Large, easy-to-read characters—2.8mm x 4.9mm; Total viewing area: 32cm2; Adjustable backlight and viewing angle
Keyboard:	Alphanumeric, function, and softkey entry

Specifications and descriptions subject to change without notice.

Trimble

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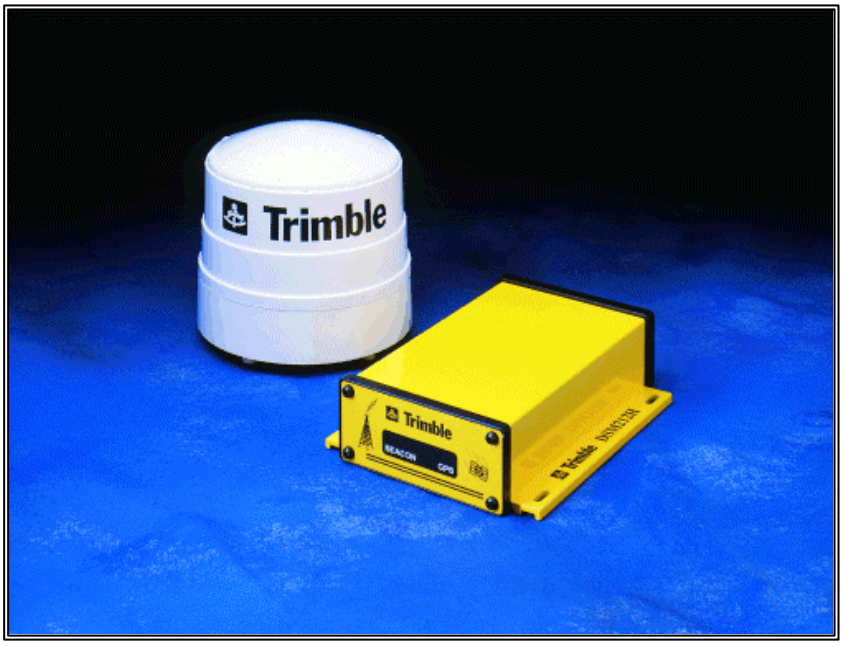
TRIMBLE DSMPRO

INTEGRATED DGPS/MSK RECEIVER



GENERAL DESCRIPTION

The DSM*Pro* offers the DGPS user a fully integrated DGPS/MSK receiver based upon leading technology in both Differential GPS and MSK receivers.

FEATURES

- 8 Channel GPS Receiver
- Combined L1 GPS and MSK H field loop antenna
- Sub-meter accuracy
- Real time processing
- 10 Hz maximum position and velocity update rate
- Positioning based on carrier-phase filtered L1 pseudo-ranges.
- Two RS-422 serial ports
- NMEA-0183 output
- TSIP interface protocol I/O
- RS-232 MSK control port
- 1PPS Output
- DSM Software toolkit
- Operation manual
- 15m antenna cable
- L1 C/A code and instantaneous carrier-phase outputs

TRIMBLE DSMPRO

INTEGRATED DGPS/MSK RECEIVER

TECHNICAL SPECIFICATIONS

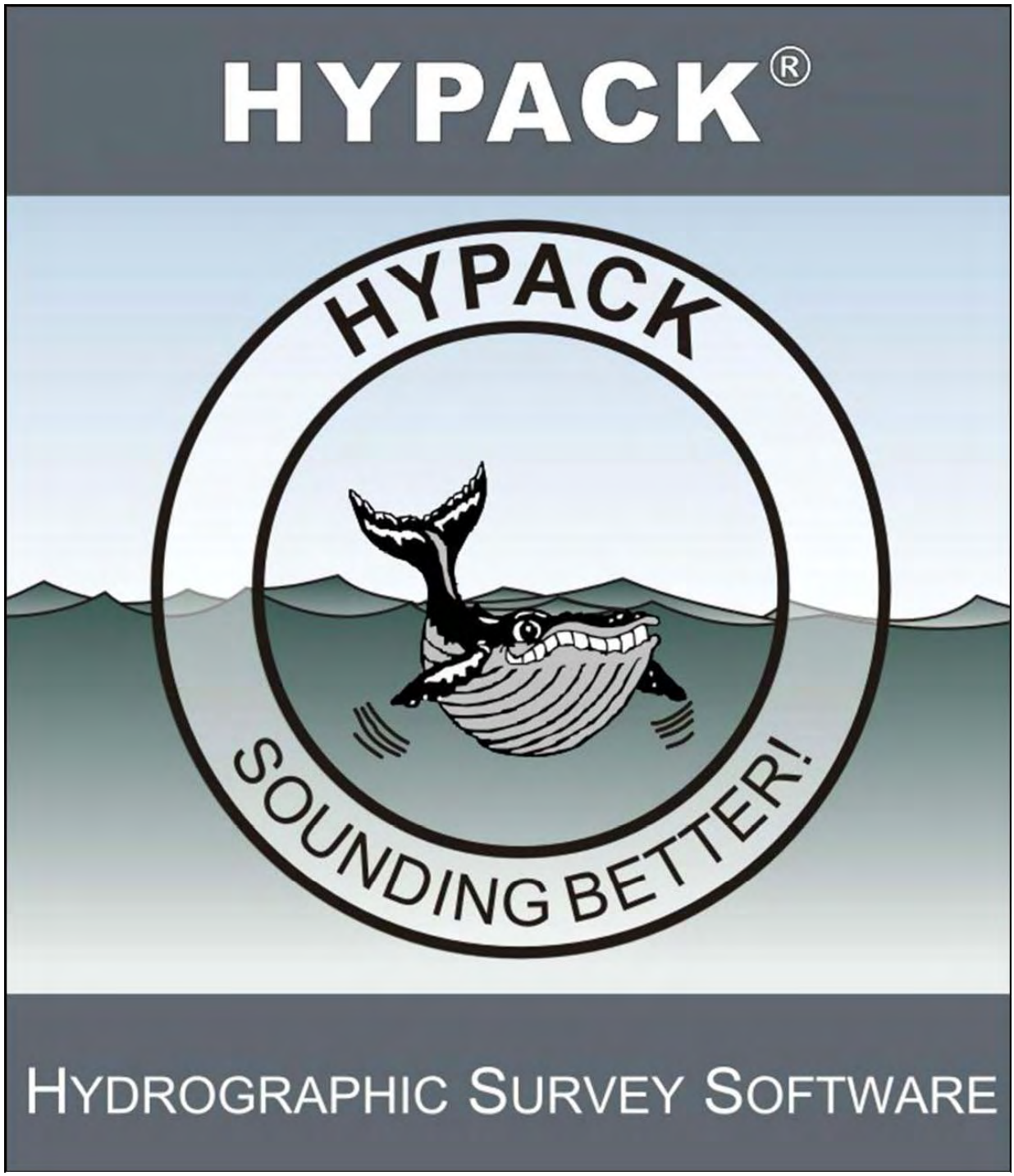
GPS Receiver

General	8 Channel, parallel tracking, L1 C/A code with carrier phase filtering and instantaneous carrier phase measurements.
Update Rate	10Hz Maximum (Maximum 8 satellites tracked for a update rate of greater than 5Hz.)
Accuracy	Typically less than 1m RMS; Assumes at least 5 satellites, PDOP<4 and RTCM SC-104 standard format broadcast from a Trimble DSM Reference station, 4000RS or equivalent reference station.
Time to first fix	<30 seconds, typical
NMEA messages	ALM, GGA, GLL, GSA, GSV, VTG, ZDA.

MSK Receiver

Frequency Range	283.5 kHz to 325.0 kHz.
Channel Spacing	500Hz
MSK Modulation	25, 50, 100 & 200 bits/second
Signal Strength	10 µV/meter minimum
Dynamic Range	100dB
Channel Selectivity	60dB @ 500 Hz offset
Frequency Offset	10ppm maximum (200 bits/ second) 40ppm maximum (100, 50 & 25 b/s)
3rd Order Intercept	+15dB @ RF input (min. AGC setting)
Power	7.5 watts typical, 10 to 32VDC
Operating Temperature	-20° to +60°C (Combined Antenna -30° to +65°C)
Humidity	95% non-condensing (Combined Antenna 100% fully sealed)

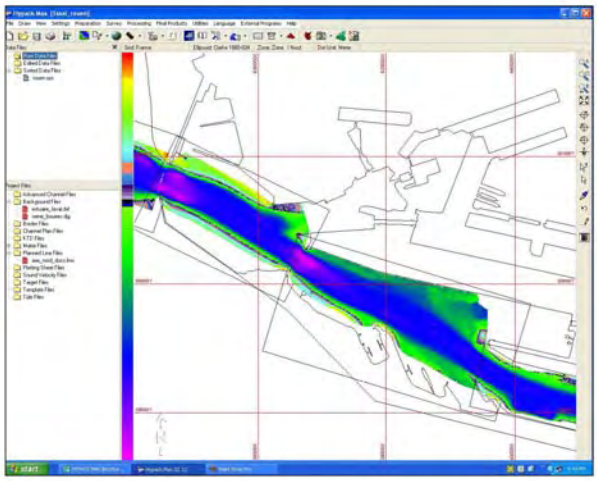
WEIGHTS	DIMENSIONS
GPS/MSK Receiver 4.0lbs (1.8Kg) with mounting plate Combined Antenna 2.15lbs 15cm Dia. x 15.5cm H	17cm x 9cm x 25.5cm



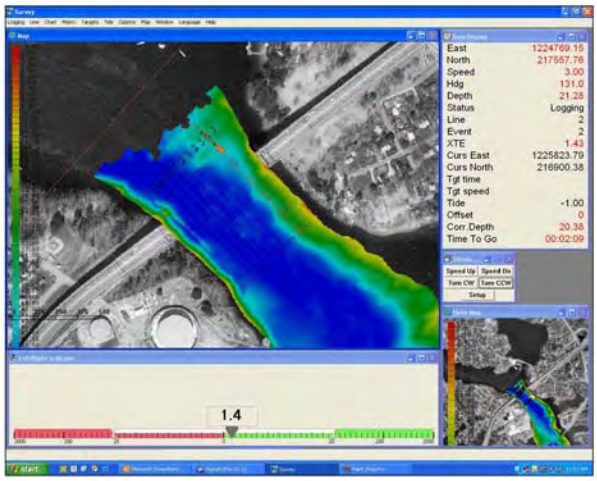
HYPACK, Inc.
56 Bradley St.
Middletown, CT 06457
Phone: 860-635-1500
Web: www.hypack.com Sales: sales@hypack.com

HYPACK®

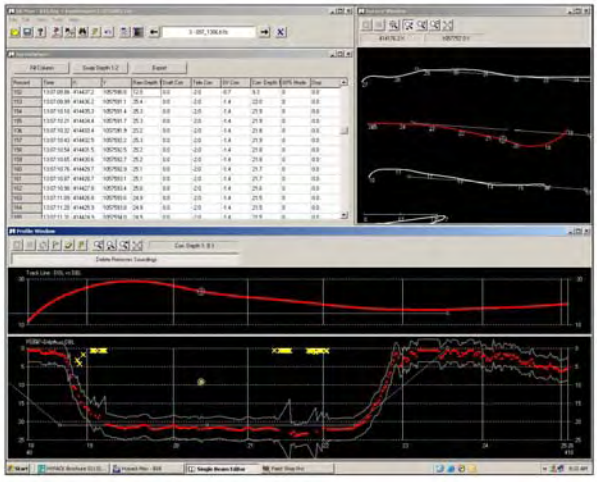
HYPACK® is one of the most widely used hydrographic surveying packages in the world, with over 3,000 users. It provides the surveyor with all of the tools needed to design their survey, collect data, process it, reduce it, and generate final products. Whether you are collecting hydrographic survey data 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.



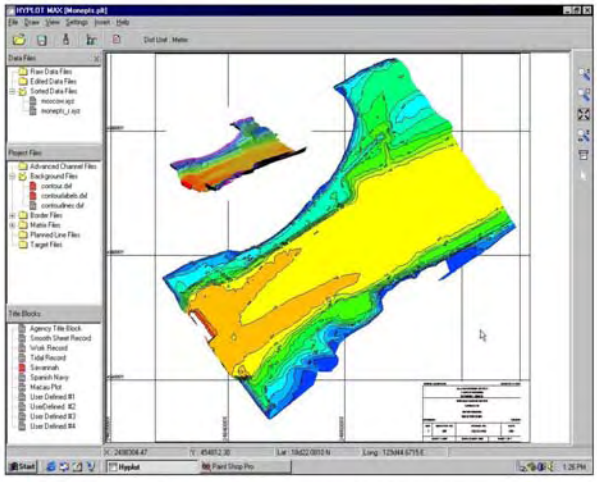
SURVEY DESIGN: HYPACK® allows you to create a 'Project' that contains all of your survey information for each job. You can easily define your geodetic basis, selecting from existing national grids or defining your own projection or local grid. HYPACK® also allows you to import background files in a variety 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.



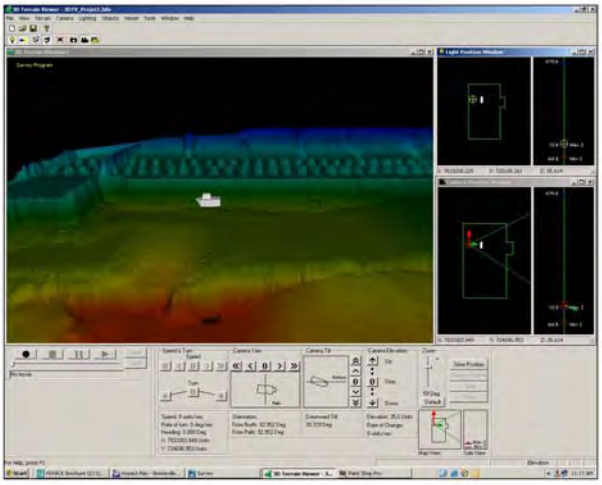
EDITING: The SINGLE BEAM EDITOR program is used to quickly review your survey data and to automatically and/or manually remove outliers. Sounding data is simultaneously displayed in plan, spreadsheet, and profile views with the channel design info drawn in the backgrounds. Routines developed by **HYPACK®** 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.



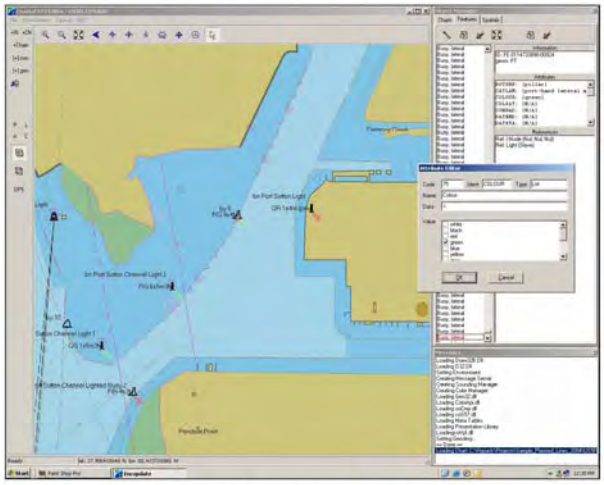
FINAL PRODUCTS: The ability to create the final products you need separates **HYPACK®** from the rest. The plotting program generates professional smooth sheets with soundings, grids, graphics and contours in a WYSIWYG display. The VOLUMES program is the de facto standard of the U.S. Army Corps of Engineers 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®

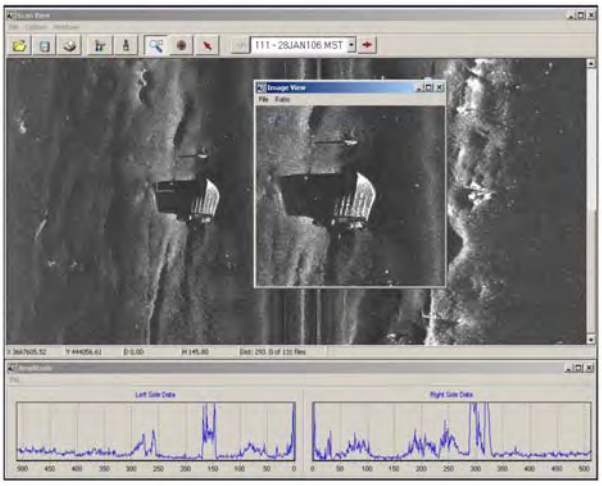
Support: An important factor in the purchase of any hydrographic survey system is the support provided to the end-user. **HYPACK®** prides itself on taking good care of our users. A trained, professional staff is on-call to answer your questions, develop custom device drivers or modify programs to meet 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.



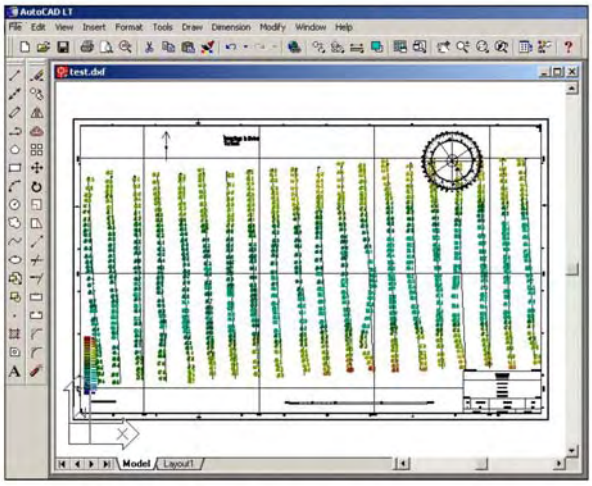
DATA VISUALIZATION: The TIN MODEL and 3D TERRAIN VIEWER (3DTV) programs of **HYPACK®** provide fantastic tools to view and present your data. 3DTV allows you to fly a 'camera' across your edited XYZ surface and display the results or save them to a AVI file for distribution to your clients. 3DTV also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

DMS

MARINE MOTION SENSORS

DYNAMIC ATTITUDE PLATFORMS FOR MARINE APPLICATIONS

- New solid state angular rate gyro elements
- Enables survey to Class 1 IHO standard
- High dynamic accuracy during vessel turns
- Dynamic roll & pitch accuracy to 0.05°
- Depth rated to 3000m
- Surface versions available
- Plug & play installation
- DMSView intuitive Windows™ control software
- Enhanced aiding algorithm maintains accuracy across wider dynamic spectrum
- Compact size and lightweight
- Flexible orientation
- EMC and CE rated
- User configurable output formats
- Real-time digital & analogue outputs

- Multibeam echo-sounders
- Singlebeam echo-sounders
- Acoustic positioning
- Dynamic positioning
- ROV / AUV attitude measurement
- Helideck monitoring
- Vessel monitoring and control
- ADCP
- Platform monitoring

Building on achievement - the fourth generation of the world's most successful motion sensor

TSS DMS Now in its fourth generation the new DMS leads the world in performance and reliability.

The DMS is designed specifically for the motion measurement needs of the marine industry. Whether it is achieving IHO standard survey from any size of vessel or providing safety critical monitoring of offshore platforms, large vessels, helidecks, cranes and positioning systems. The new DMS provides accurate motion measurement in all sea conditions, incorporating an enhanced external velocity and heading aiding algorithm for improved accuracy during dynamic maneuvers.

All-new solid state angular rate sensors offer high reliability and a revised complementary blending algorithm has proven that the new DMS is the highest performance vertical reference unit ever produced by TSS.

TSS' unique heave algorithm is respected and acknowledged as the world's most accurate. By maintaining a more accurate vertical reference across a wider dynamic spectrum our heave accuracy is taken to a new level of performance.

DMSView is an intuitive Windows™-based operating program that enables installation, set-up, and integrity checking and monitoring of the sensor. The user can select from a series of frequently used data protocols or configure a bespoke output from a selection of variables.

Despite its compact size the unit is depth rated to 3000m, alternatively surface-mount versions are available. The new unit can also be supplied in various configurations for integration with towed vehicles and other bespoke applications.

As with all TSS systems the DMS is certified to meet all current and anticipated European legislation for electromagnetic compatibility and electronic emissions.

Backed by the largest global support network of any manufacturer, TSS has complete repair, test and calibration facilities in the UK and the USA aided by factory trained service engineers on every continent.

TSS TECHNOLOGY IN MOTION

MARINE MOTION SENSORS

Technical Specifications

Technical Specifications		Heave	Roll & Pitch	
Accuracy (preliminary)	Model	All	DMS-05	DMS-10
	Static	5cm or 5% whichever is greater	0.025°	0.05°
	Dynamic	Period - 0 to 20s	0.03° for a ±5° amplitude 0.05° for a ±30° amplitude	0.10°
Range		±10m	±60° roll and pitch	
Resolution		1cm	Digital - 0.01° Analogue - 12 bit	
Bandwith		0.05 to > 30 Hz	0 to > 30 Hz	
Data Output Rate		Digital - Up to 200 Hz Analogue - 500 Hz		
Available Output Parameters		Adjustable data packet output rate down to 1hz Heave; roll; pitch; remote heave; angular rate X,Y,Z - acceleration X,Y,Z (body frame); angular rate east, north, up - acceleration east, north, up (geographical frame); IMU temperature; surge; sway; sensor status; external speed; external heading; UTC time;		
Dimensions		210mm by 110 diameter (excluding connector and mounting plate)		
Weight		< 5kg (In water @ 2kg)		
Temperature Range		0° to 55°C operating -20° to 70°C storage		
Power Requirement		10 - 36V , maximum 14W		
Velocity input packet formats		NMEA0183 (requires VTG & GLL or GGA); TSIP; Doppler Speed Log		
Heading input packet formats		NMEA 0183; SGB; Robertson; Sperry LR 40/60		
Depth rating		3000m standard; 6000m & Surface-mount available as bespoke items		
Environmental		Shock (survival) - 30g peak 40ms half-sine; Vibration (operating) 30mm/s² or 0.2mm, 7-300 Hz		
Available output formats		USER CONFIGURABLE via DMSView operating software, in addition to many bespoke manufacturers interfaces. TSS can configure specific data packets as required by clients in addition to the standard TSS and other manufactures specifications		
Interface		Digital; RS232 or RS422 (software selectable) Analogue; Configurable		
Deliverables		DMS motion sensor, transit case, 5m umbilical cable, manual, DMSView CD-ROM, calibration certificate; vertical and horizontal mounting plates		
Options		Umbilical Cable - 5 to 1000m, Remote Repeater (digital and analogue outputs, external heading and GPS inputs)		
Other Data		MTBF (computed) - 50,000hr		

Represented by:

TSS (UK) Ltd:
New Mill, New Mill Lane, Witney, Oxfordshire OX29 9SN UK
Tel +44 (0)1993 777700 Fax +44 (0)1993 777701 E-mail: tssmail@tssuk.co.uk

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KVH's NEW AutoComp 1000™
Digital Fluxgate Heading Sensor-

The Next Generation of Fluxgate Compass Technology has Arrived!

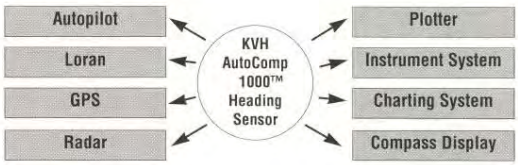
The *new* KVH ***AutoComp 1000*** uses next generation electronic fluxgate compass technology to provide unsurpassed 0.5° accuracy and an automatic compensation system that automatically corrects for deviation on a vessel - without a compass adjuster! The *AutoComp 1000* is available with standard NMEA 0183 output and has the capability of utilizing KVH's new *Universal Interface Card* which provides simultaneous heading data to most leading brands of autopilots, lorans, GPS, radars, electronic charts, and instrument systems. The *AutoComp 1000* sensor is found at the heart of KVH's new ***AC*** line of *Sailcomp* and *Azimuth* compass systems.

Automatic Self-Compensation for Unequalled Real World Accuracy

With the ***AutoComp 1000's*** continuous automatic compensation, you can quickly compensate your compass to ±0.5° accuracy anywhere in the world - without a compass adjuster! Utilizing the very latest in electronic fluxgate compass technology, the *AutoComp 1000* continously measures the magnetic deviation of a vessel and will automatically recompensate itself for unsurpassed accuracy! Install the *AutoComp 1000* on a vessel and steer in a circle. That's it! The sensor is fully compensated to ±0.5° accuracy without adjusting any dials, taking any measurements or installing compensating magnets! If something ever significantly alters the vessel's magnetic deviation, the *AutoComp 1000* will automatically gather new data as the vessel turns and recompensate itself to assure accuracy for the new conditions. And if you ever want to intentionally recompensate for peace of mind before or during a long passage, simply steer in a circle and in a few minutes, wherever you are, it's done. It's that simple, and it will even work on steel vessels!

New Universal Interface Card Provides Outputs to many other Instruments

The accuracy and functionality of many navigational instruments are directly dependent on the accuracy of the heading information they receive. This is why many leading manufacturers of marine navigational instruments offer KVH Heading Sensors with their products. The ***AutoComp 1000*** is specifically designed to be the perfect sensor to provide heading input to many other instruments on a vessel, improving their performance and saving money by eliminating the need for multiple heading sensors. It communicates with these other electronic devices through its standard NMEA 0183 output or through one of the many outputs available on KVH's new *Universal Interface Card* - the industry's first truly universal interface!



KVH

Display Options for Power or Sail Boats - Choose Azimuth or Sailcomp

The ***AutoComp 1000*** heading sensor is at the heart of KVH's new ***AC*** line of Azimuth and Sailcomp Digital Compasses. ***Azimuth*** (for powerboats) and ***Sailcomp*** (for sailboats) offer a variety of bold digital and graphic displays. Contact KVH for more information on these products.

Azimuth 314*AC* Compass

Sailcomp 103*AC* Compass

Rugged and Reliable

Designed to military quality standards, the ***AutoComp 1000*** utilizes a free floating toroidal fluxgate sensor coil and the latest in electronic technology making it extremely rugged and reliable. Add a 3 Year Protection Plan and backing by one of the finest customer assistance departments in the industry and you can be assured of great performance for years to come.

Built by the Worldwide Leader in Electronic Compass Technology

The ***AutoComp 1000*** is built in the U.S.A. by KVH Industries, the recognized leader in modern electronic compass technology. In 1982, KVH developed the first digital electronic compass for the marine industry, and since that time has built more sophisticated electronic compasses than any other company in the world. KVH markets the *Azimuth*, *Sailcomp* and *DataScope* product lines in the marine industry, and is also a leading supplier of highly advanced electronic compass systems for all branches of the U.S. Armed Forces. Many of the *AutoComp 1000's* sophisticated features result from the extensive research and development that KVH has conducted over the past 5 years to create electronic compass systems for the military's vehicles, jet fighters, and sophisticated weaponry systems. No other company in the world can match KVH's experience in producing high quality electronic compasses.

Get the benefits of the AutoComp 1000 as a stand-alone sensor or as part of a Sailcomp or Azimuth Digital Compass System.

Technical Specifications

Performance	
Accuracy	±0.5° *after AutoCompensation*
Temperature / Humidity Range	0°C to +70° C / 0% to 100%
Field Strength Sensitivity	6.5 to 65μ Tesla
Range Horizontal Component	Up to 80° Magnetic Inclination or Dip
Gimbal Range	±25° (±45° gimballed "**Sail**" version also available)
Voltage	12V DC Nominal
Current Drain	60 mA (80 mA with Universal Interface Card)
Deviation Compensation	
Method	*Automatic Continuous Compensation.* After installation, microprocessor continually reviews magnetic field information, updating the compensation when magnetic field changes require it. Corrects B, C, D & E Coeff. Errors.
Interface Capabilities	
Standard Output	NMEA 0183 (Serial Data Stream)
Optional Interfaces	*Universal Interface Card* outputs N+1, Sin/Cos, Differential Sin/Cos, & RS232 simultaneously. Furuno, Linear Analog, RS422, & Custom Outputs also available. Contact KVH or your Dealer for specific interfacing info.
Dimensions/Weight/Cabling	
Sensor Housing	4.75" cylinder x 4" Height (12 cm x 10 cm)
Sensor Weight	17 oz. (482 g)
Cable Length	15' (4.6 m)

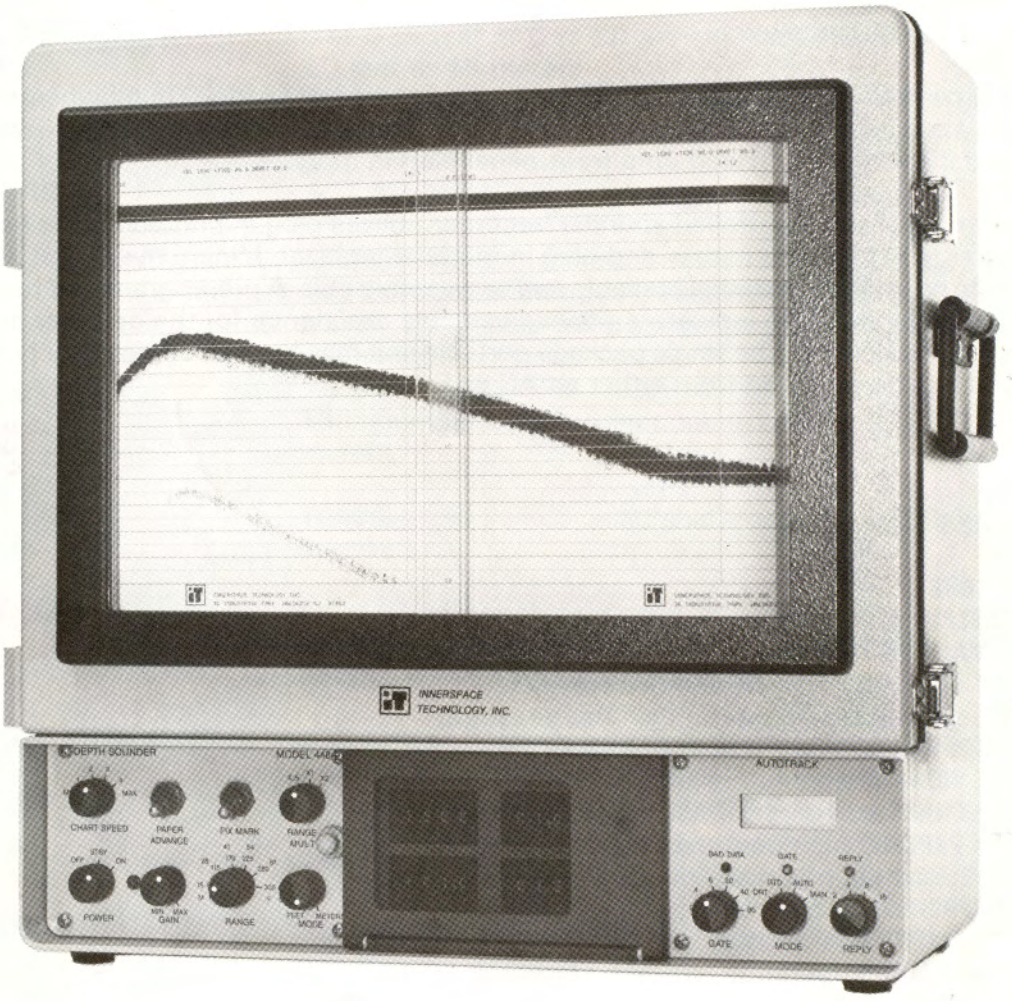
KVH

KVH Industries, Inc. 110 Enterprise Center, Middletown, RI 02840 U.S.A. Tel.: (401) 847-3327 Fax: (401) 849-0045

MADE IN U.S.A.

INNERSPACE

THERMAL DEPTH SOUNDER RECORDER
MODEL 448



DESCRIPTION

The Innerspace Technology Model 448 Thermal Depth Sounder Recorder provides survey precision, high resolution depth recordings using SOLID STATE THERMAL PRINTING. The lightweight, portable unit is designed for use in small boat surveying as required for nautical chart production, engineering surveys, harbor and channel maintenance, pre and post dredge surveys, etc. The Model 448 TDSR uses a thermal printing technique pioneered by Innerspace for depth sounding which provides the high resolution and accuracy required by groups such as the U.S. Army Corps of Engineers, dredging companies, survey companies, port administrations, etc. The state of the art design allows integration into portable hydrographic survey systems.

INNERSPACE TECHNOLOGY, INC.

36 INDUSTRIAL PARK, WALDWICK, NJ 07463 (201) 447-0398 FAX (201) 447-1919

OPERATION

The Model 448 TDSR utilizes the highest resolution, solid state, fixed thermal print head available for depth sounding. Blank white, high contrast thermal paper is used to print the selected range scale along with the depth. The depth is always read directly from the scale printed, thereby avoiding the possible confusion encountered when examining outmoded, preprinted, multi-scaled charts. Built-in chart annotation is standard and includes printing of numerical values for Speed of Sound, Tide and Draft. Time and event marks are numerically annotated and the chart is automatically labeled FEET or METERS as determined by the MODE switch.

Operator controls are provided on a gasketed, splashproof front panel. Thumbwheel switch settings are behind a splashproof access cover on the front panel, and the digitizer controls and display are provided on a front panel plug in module.

The microprocessor controlled sounder/recorder utilizes plug in printed circuit boards, a modular plug in power supply and plug in modular digitizer. Minimum wiring connections help provide an extremely reliable and serviceable unit. A preprogrammed test routine and diagnostic LED indicators provide valuable assistance for the operator and/or electronics technician. The single package portable unit may be used vertically or horizontally and can be powered from either an AC or DC source.

FEATURES

- **LOW COST**
- **RELIABLE**
- **THERMAL PRINTING** fixed head—no stylus to replace
- **CLEAN** operation—no carbon dust residue
- **QUIET** operation—no rotating stylus, no arcing
- **ODORLESS** operation—no burned paper
- **LARGE VIEWING** area with sliding window
- **LARGE CHART** standard format—high resolution
- **BLANK PAPER** is high contrast black on white and low in cost
- **PORTABLE** and lightweight for small boat operation
- **MICROPROCESSOR** controlled
- **SCALE SELECTED** is the only one printed
- **FEET or METERS** operation—switch selectable
- **THUMBWHEEL SETTINGS** for speed of sound, tide and draft
- **ANNOTATION** of all parameters appear on recordings in chart margin Speed of Sound, Tide, Draft, Event, Time and Mode of Operation
- **TVG** (time varied gain) minimizes gain adjustments
- **INTERNAL** micro controlled depth digitizer
- **EXTERNAL** depth digitizer connector on rear panel
- **NO ADJUSTMENTS** for zero line or call line are required

OPTIONS

CUSTOM LOGO—Programs recorder to repetitively print, in the lower chart margin, customer specified information such as user's logo, name, address, etc.

FREQUENCY—Choice of either 208 kHz or 125 kHz

POWER—Allows operation from either 110/120, 220/240 VAC or (not including) 12,

SPECIFICATIONS—SINGLE FREQUENCY TDSR MODEL 448

PRINTING	Thermal solid state fixed head thick film
CHART PAPER	8-¾ inches x 200 feet
PAPER SPEEDS	.5,1,2,4 or 8 inches/min. (Depends on scale selected)
DEPTH RANGES	0 to 335 feet or 0 to 80 meters. 6 overlapping phases of 60 feet or 15 meters A x 2 SWITCH multiplies each range by a factor of 2 and A x .5 SWITCH multiplies each range by a factor of .5
ACCURACY	± .1 foot or meter timing and printing resolution
SPEED OF SOUND	Thumbwheel switch selectable 4550 to 5050 feet/sec. or 1350 to 1550 meters/sec. Precision crystal referenced frequency synthesizer using a phase locked loop provides exact calibration.
TIDE	Thumbwheel switch selectable from 0 to ± 25.0 feet or meters
DRAFT	Thumbwheel switch selectable from 0 to + 99.9 feet or meters
EVENT MARK	Front panel switch or remote, increments internal counter
TIME	Internal clock with battery backup
SOUNDER FREQUENCY	208 kHz or 125 kHz standard or others optional
TRANSDUCERS	208 kHz 8 degree beamwidth at—3db 208 kHz 3 degree beamwidth at —3db (optional) 125 kHz 14 degree beamwidth at —3db (optional)
PULSE LENGTH	.15 to .6 ms. Automatically determined by frequency and depth range selected
PULSE POWER	250 watts RMS
SOUNDING RATE	1,200 soundings per minute max
TIME VARIED GAIN (TVG)	Automatically compensates for spreading loss and attenuation over depth range
GAIN CONTROL	Provides manual gain adjustment
STANDBY MODE	Allows transceiver and digitizer (if used) to operate without running chart paper
OUT OF PAPER SENSOR	Indicated by blinking front panel light. Paper motion stops, but sounding continues.
RAPID PAPER ADVANCE	Front panel switch allows for the rapid advance of blank paper
ANNOTATION	The numerical value of Speed of Sound, Tide, Draft, Time and Event are permanently recorded above the chart record periodically

DIGITIZER OUTPUT	In addition to the built in depth digitizer, Start/Stop pulses are available for use with external digitizers such as Innerspace Models 410, 412 and 445.
POWER	Either 12, 24 V DC or 120, 240 V AC (Must be specified AC or DC)
DIMENSIONS	17 in. W x 17¼ in. H x 9¼ in. D
WEIGHT	45 pounds
ENCLOSURE	Coated aluminum, corrosion resistant and splashproof. Sliding window for chart access and settings door for easy access to thumbwheel switches.

SPECIFICATIONS—INTERNAL MICROPROCESSOR DIGITIZER

OPERATING MODES	Either a DIRECT, GATED, AUTO or MANUAL mode may be chosen DIRECT — No gate present GATED — Gate width doubles, then quadruples automatically to reacquire the bottom reply AUTO — Gate width doubles, quadruples then goes to non-gated automatically to reacquire the bottom reply MANUAL — Fixed gate as preset on initial depth thumbwheel
GATE WIDTH	Selectable 2, 4, 8, 20, 40 or 80 via rotary switch. Gate width in feet or meters, determined by the recorder MODE switch setting
MISSED REPLIES	REPLY switch selects 2, 4, 8 or 16 missed replies, before reacquisition of bottom reply, in AUTO mode.
DISPLAY	Four digit LCD 7 segment. Resolution to 0.1 feet or meters, determined by the recorder MODE switch setting.
INDICATORS	Three LED's representing BAD DATA, REPLY and depth GATE
INITIAL DEPTH	Three station thumbwheel switch allows entry of an initial depth gate position
ALARM	A switched audible alarm indicates loss of track
OUTPUTS	BCD—8421 TTL compatible 5V positive logic. Buffered outputs with data hold, inhibit, strobe and flag lines. IEEE488 GPIB—4 digits with proper protocol and selectable address switches (optional) EIA RS232C—4 digits with selectable baud rates (optional). A bad data flag is available and can optionally set the output number to all zeros.

INNERSPACE TECHNOLOGY, INC.

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FULL SPECTRUM™
SUB-BOTTOM PROFILER

X-STAR

Sub-Bottom Profiler
Shallow Tow System

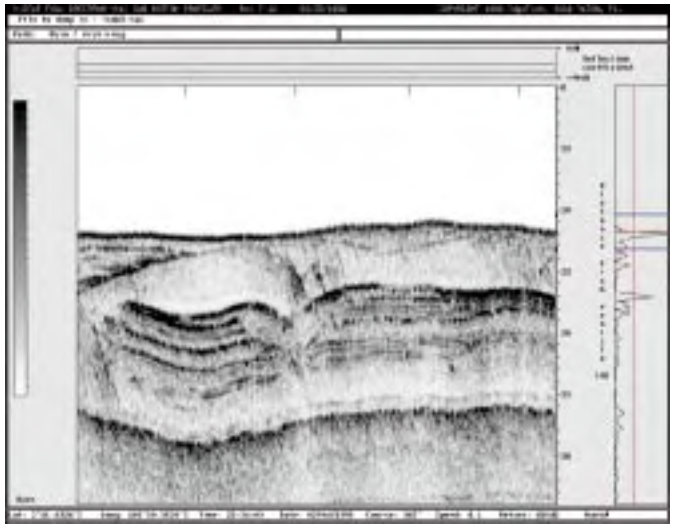
X-STAR is a high resolution wideband Frequency Modulated (FM) sub-bottom profiler utilizing EdgeTech's proprietary FULL SPECTRUM™ CHIRP technology. The system transmits a FM pulse that is linearly swept over a full spectrum frequency range (for example 2-16 kHz for 20 milliseconds.) The acoustic return received at the hydrophones is passed through a pulse compression filter, generating high resolution images of the sub-bottom stratigraphy in oceans, lakes, and rivers.

Because the FM pulse is generated by a digital to analog converter with a wide dynamic range and a transmitter with linear components, the energy, amplitude, and phase characteristics of the acoustic pulse are precisely controlled. This precision results in high repeatability and signal definition required for sediment classification.

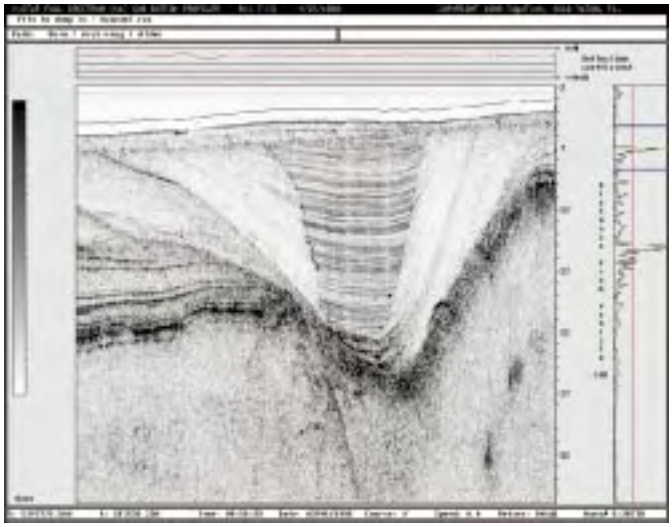
Several stable, low drag tow vehicles are available that contain wide band transmitter arrays and sensitive line array receivers that can operate in water depths up to 300 meters. The selection of tow vehicle depends on the sub-bottom characteristics and resolution required.

Full Spectrum Benefits

FM pulses have been used in radar for over 30 years and are sometimes called chirp or swept frequency pulses. Its application in sonar systems has come with the availability of high speed Digital Signal Processors (DSP).



Unequalled images that combine good penetration and high resolution. 20-30 dB improved SNR over conventional systems by using Full Spectrum (FM) Pulses.



• EEZ resource development • Geo-technical surveys • Hazard surveys • Environmental site investigations • Geological studies • Sediment classification • Buried object location • Search and recovery • Locate and map buried pipelines and cables • Mining and dredging surveys • Bridge and shoreline scour surveys

EdgeTech®
THE SOUND SOLUTION

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E-mail: sales@edgetech.com • Website: www.edgetech.com

XSTAR

FULL SPECTRUM™
SUB-BOTTOM PROFILER

Full Spectrum signal processing technology uses a proprietary matched filter to process wideband signals. This matched filter uses special amplitude and phase weighting functions for the transmitted pulse and a pulse compression filter that maximizes the Signal to Noise Ration (SNR) of the acoustic images over a wide band of operating frequencies. These X-STAR signal processing features provide a significant SNR improvement in the acoustic image generated by other impulse and chirp sonars with band limiting components that are limited in dynamic range.

One of the outstanding aspects of Full Spectrum signal processing is the use of a broad bandwidth transmitting pulse that sweeps out over a range of frequencies. This generates a great deal of acoustic energy in the water. Instead of trying to operate with one very sharp acoustic peak pulse, like conventional CW systems, the Full Spectrum sonar spreads the transmission out over a long time duration. In addition, to the resolution improvement, the process of correlation processing achieves a signal processing gain over the background noise. To equal the typical performance of the Full Spectrum sonar pulse, conventional pulsed sonar would have to operate at a peak pulse power 100 times higher than the Full Spectrum pulse.

Normally, when using long pulses the resolution of the seabed is lost. Resolution of the seabed is regained after correlation processing the received signal. This is because the output of the correlation is a very sharp wavelet that has duration of the order of the inverse of the sweep bandwidth. Thus, the more bandwidth used, the sharper this pulse will become.

Another important feature, which enhances the ability of the Full Spectrum Sub-bottom Profiler system to classify sediments, is realized by the built-in de-convolution of the system response from the output pulse. The sonar's system impulse response is measured at the factory and is used to design a unique output pulse that will prevent the source from ringing. In addition to this, the Full Spectrum wavelet is weighted in the frequency domain to have a Gaussian like shape. As the Gaussian shaped spectrum is attenuated by the sediment, energy is lost but its bandwidth is preserved. Thus, even after being attenuated by 20 meters of sand, the Full Spectrum pulse has approximately the same resolution as a non-attenuated pulse.

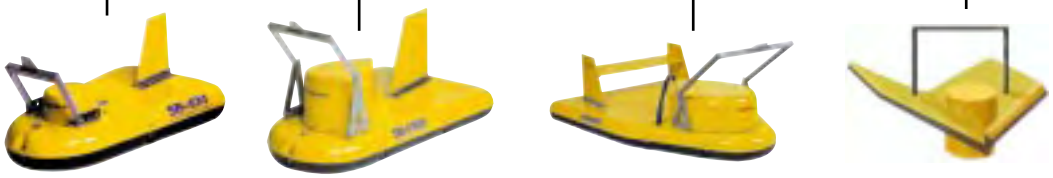
The Full Spectrum Sonar side lobes are greatly reduced in the effective transducer aperture. The wide bandwidth of the sweep frequency smears the side lobes of the transducer and thus achieving a beam pattern with virtually no side lobes. The effective spatial beam width obtained after processing the Full Spectrum sub-bottom pulse is typically 20 degrees measured to the -3db points. This feature is clear when inspecting the Full Spectrum records. Since the transmitted pulse is highly repeatable and its peak amplitude is precisely known, the sediment reflective values can be estimated from the peak pulse amplitude measurements of the bottom returns.

Use different tow vehicles for desired penetration and resolution. The topside portion remains the same. The FM pulse is user selected based on the sub-bottom conditions at the survey site and the type of sub-bottom features that need to be imaged.

FULL SPECTRUM™
SUB-BOTTOM PROFILER

Topside Processor

FS-SB Full Spectrum
Signal Processor



Towfish Model	SB-424	SB-216S	SB-0512	SB-0408
Frequency Range	4-24 kHz	2 - 16 kHz	500 Hz - 12 kHz	400 Hz - 8 kHz
Pulse Type	FM	FM	FM	FM
Standard Pulse Bandwidths / Length (other custom pulses available)	3-24 kHz / 10 ms 4-24 kHz / 10 ms 4-20 kHz / 10 ms 4-16 kHz / 10 ms	2-15 kHz / 20 ms 2-12 kHz / 20 ms 2-10 kHz / 20 ms	2-12 kHz / 20 ms 2-10 kHz / 20 ms 2-8 kHz / 40 ms 1.5-7.5 kHz / 40 ms 1-6 kHz / 40 ms 1-5 kHz / 40 ms 0.5-5 kHz / 40 ms	1.5-10 kHz / 20 ms 1-7 kHz / 40ms 1-6 kHz / 40 ms 0.7-4.5 kHz / 40 ms 0.6-3.0 kHz / 40 ms 0.4-2.4 kHz / 40 ms
Vertical Resolution	4 cm / 4-24 kHz 6 cm / 4-20 kHz 8 cm / 4-16 kHz	6 cm / 2-15 kHz 8 cm / 2-12 kHz 10 cm / 2-10 kHz	8 cm / 2-12 kHz 12 cm / 1.5–7.5 kHz 19 cm / 1- 5 kHz	9 cm / 1.5 kHz-10 kHz 15 cm / 1-6 kHz 37 cm / 0.4-2.4 kHz
Penetration (typical) **in coarse calcareous sand** **in clay**	 2 40	 6 80	 20 200	 40 300
Beam Width (depends on center frequency)	16° / 4-24 kHz 19° / 4-20 kHz 23° / 4-16 kHz	17° / 2-15 kHz 20° / 2-12 kHz 24° / 2-10 kHz	16° / 2-12 kHz 24° / 1.5–7.5 kHz 32° / 1- 6 kHz	10° / 1.5 kHz-10 kHz 14° / 1-7 kHz 37° / 0.4-2.4 kHz
Transmitters	1	1	4	2
Receive Arrays	2	2	4	8
Size (centimeters)	77L x 50W x 34H	105L x 67W x 46H	210L x 134W x 46H	249 L x 214W x 91
Weight (kilograms)	22	44	186	364
Shipping weight (kg.) **dimension** (cm.)	82 L89 x W64 x H54	122 L115 x W79 x H59	288 L172 x W137 x H58	consult factory
Cable Requirements	3 shielded twisted pairs (5 used)	same	same	3 shielded twisted pairs (all used)
Max Depth (meters)	300	300	300	300
GeoStar Interface	Yes	Yes	No	No

Other System Specifications

Tow Speed	3-5 knots optimal, 7 knots maximum safe operational
MaximumTow Fish Operating Depth	300 meters (1,000 feet)
Optimum tow height	3 to 5 meters above seafloor
Calibration	Each system is acoustic tank tested to calibrate for reflection coefficient measurements

FULL SPECTRUM™
SUB-BOTTOM PROFILER

FS-SB Full Spectrum Processor

Main Processor	Intel CPU with high speed PCI bus
Digital Signal Processor	TMS320
Memory	32 MB RAM
Storage	Hard drive, CD-ROM, floppy disk
Operating System	Windows® 98
I/O to Topside Processor	Ethernet
A/D	Analog Input, 16 bit resolution, 200 kHz max. sampling rate
D/A	Analog Output,16 bit resolution, 200 kHz max. sampling rate
Pulse Type	Full Spectrum (Frequency Modulated with amplitude and phase weighting)
Pulse Trigger	Internal or External
Pulse Repetition	0.5 to 12 Hz
Trigger In	TTL negative edge triggered (Middle BNC)
Trigger Out	TTL negative edge triggered. Minimum 5ms long pulse (Lower BNC)
Sampling Rate	Typically 20, 25, 40, or 50 kHz depending on the pulse upper frequency
Acoustic Power	212 dB ref 1μPa peak at center frequency of system
Input Power	120 or 220 VAC Auto Sensing
Power Amplifier	Type: Two channel, Gain: 33dB per channel, Power output: 2000 Watts peak, Power input: 110-120V/60Hz or 220-240 V/50Hz Manually Switchable
Topside Display Processors w/ Support	EdgeTech, CODA Technologies Ltd., Sea Corp., TEI Inc.
Environment	Temperature: 0 to 40ºC, Humidity: 5% to 95% relative, Vibration: Normal ship environment
Enclosure	Portable steel case suitable for transit. Unit can be removed from case and mounted in a 19" rack. Size: 50W x 60D x 33H cm. (19.5x23.5x13 in), Weight: 46 kg (102 lbs.)
Shipping Containers	Size: 109L x 79W x 71H cm. (43x31x28 in), Weight: 150 kg (330 lbs.) Material: Sealed high impact polyurethane case
Options	Diagnostics Kit (Video Display, Keyboard, Mouse), Spare Parts Kit, Optional Pulses

EdgeTech Topside Display Processor

Main processor	SPARC Workstation
Operating System	UNIX
Display	17" Color Monitor
Operator Controls	A/D Gain, Two Stage TVG, Bottom Tracking, Digital Gain, Preamplifier Gain, Horizontal and Vertical Zoom, Direct Path Suppression, Swell Filter, Annotation
Video Displays	Bottom Tracking, Reflection Coefficient, Signal Amplitude, Navigation Map, Scale Lines, Track Lines
Navigation	NMEA 0183, X/Y, N/E, Navigation I/O Utility, Track lines, Event/Fix Marks, Sediment Classification Color vs. Echo Strength
Annotation	Keyboard, RS232 Port
Event Mark	Via Keyboard, Switch Closure, RS232 Port
Printer Support	EPC Models 9800, 8300, 1086, HSP-100, ODECO Model 850 & 1200F, Alden Model 9315 CTP, Ultra Model 183/200
Mass Storage	DAT
I/O Ports	Ethernet, Serial, SCSI, Parallel, Event Mark, Keyboard, Trackball, External Trigger In, Trigger Out, Heave Compensation Input
Power	105-125VAC or 210-250VAC, selectable, 47-63 Hz
Enclosure	Portable steel case suitable for transit. May be removed from cases and installed in 19-inch rack. Size: 50.3W x 50.3D x 15.3H cm. (19.8 x 19.8 x 6 in.), Weight: 32 kg (71 lbs.)
Environment	Temperature: Operating 5ºC to 40ºC Non-operating -40ºC to 45ºC. Humidity: Operating 20% to 80% relative humidity, non-condensing. Non-operating 5%-95%. Vibration: Normal ship environment.
Options	Spare Parts Kit, Replay Software, Ethernet Output of Data, Dual Mass Storage, Software Services Agreement

Specifications subject to change without notice.

EdgeTech®
THE SOUND SOLUTION

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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 LABORATORIES INC., 42A Cherry Hill Drive, Danvers, MA 01923 USA PHONE: (978) 777-1996
FAX: (978) 777-3955 EMAIL: sales@epclabs.com WEB: http://www.epclabs.com

APPENDIX 3

DATA PROCESSING AND ANALYSIS SUMMARY

Navigation and Hydrographic Data

Subbottom Profile Data

DATA PROCESSING AND ANALYSIS SUMMARY

Navigation and Hydrographic Data

During the field investigation, vessel navigation files were continuously processed and entered into AutoCAD drawings to verify survey coverage and assist with the onsite interpretation of geophysical data. Tracklines with position fixes allow preliminary positioning of large obstructions or subbottom features for distribution to the project team, if necessary.

Upon completion of the field work, the depth sounding data was processed using the HYPACK MAX single beam editor. The depth data were referenced to project datum by correcting for tidal levels measured and logged at a known benchmark throughout the survey. Tidal levels were measured using digital pressure gauges mounted near the benchmark. The height of water above or below the project datum was subtracted from the depth measurements to reference elevations. The digital depth data were checked against the graphic sounding records for verification of depth quality. Erroneous digital depths caused by floating and drifting debris, air bubbles from passing ship's wake, or fish in the water column were filtered out of the data. The digital files containing vessel position and hydrographic data were then processed to correct for field calibrations and adjust the sounding data to the required vertical datum.

The processed x, y, z data for the survey area was then contoured at an appropriate interval and presented in a final drawing format. QuickSurf digital terrain modeling (DTM) software was used to generate the depth contours and surfaces using the TIN-GRID method. QuickSurf imports processed survey data points into an AutoCad format drawing and generates surface models from these data. A number of contouring methods are available for different data applications and site specific conditions. A suite of sophisticated tools allows the user to manipulate modeled surfaces into high quality finished maps and perform a variety of engineering computations.

Subbottom Profile Data

Digital files were collected and processed using the Edgetech Discover 3.35 software package. Digital files were converted to JPEG format after the completion of the field operation. Based on review of the subbottom records, a classification scheme was devised to highlight the diversity of acoustic penetration observed across the survey area. Classifications were based on the depth of the deepest reflector and the number of reflectors observed. The spatial extent of each category was mapped using the event marks generated during data collection. The overview map of subbottom types was constructed using AutoCAD 2004.

APPENDIX 4

PUSH PROBE RESULTS

Probe #	Easting[1]	Northing[1]	Group[2]	Field Comment/description
p01	1442486.4	575171.3	2	Soft Mud - Pole penetrates seabed with relative ease - There may be a sand layer ~1' beneath - Two sediment colors identified on pole when brought to surface. Green and black sediment. Green is coarser than black - both are silt with fine grained sand.
p02				No Probe
p03	1444434.1	570867.9	1	Black mud. No evidence of reflector observed in the sub bottom record. Strong odor when probe came to surface.
p04	1448614.0	572382.9	5	Hard Packed - Can't Penetrate
p05	1448669.8	572245.2	2	Silty Sand
p06	1448757.1	572073.8	2	Black mud with fine sand
p07	1449231.3	572287.2	3	Thin layer of mud (~6 inches) over a coarse - hard packed layer. Beach has coarse gravel.
p08	1448803.7	572047.2	1	Soft Mud - Pole penetrates seabed with relative ease
p09	1448747.0	571969.8	3	Thin layer of mud (~1 foot) over a coarse - hard packed layer. Beach has coarse gravel.
p10	1448552.2	571781.0	5	Dense packed bottom. No penetration with probe.
p11	1448573.1	572587.0	2	Silty Sand
p12	1447850.5	572279.1	5	Gravel
p13	1446840.0	571835.0	1	Black mud
p14	1448387.8	572709.4	4	Coarse sand over compact sand
p15	1446577.5	573305.9	2	Thin sand layer (0.5 feet) with mud beneath
p16	1446575.9	573249.4	2	Thin sand layer (0.5 feet) with mud beneath
p17	1447863.3	573815.2	2	Mix of sand and mud
p18	1443130.8	573878.7	2	Sand over mud over sand - all loosely consolidated, sand is fine to medium grained.
p19	1443342.9	573667.4	1	Mud
p20	1448635.7	573914.7	3	Hard packed - ~.3-.5 feet of penetration
p21	1447986.3	573634.2	3	6 inches of soft material over hard packed sand
p22	1445582.2	572542.7	3	6 inches of soft material over hard pack
p23	1445787.4	572529.5	1	Very soft and easy to penetrate
p24	1447096.6	573090.5	4	~6 inches of sand layer on top of soft mud
p25	1448462.3	573678.9	3	6 inches of soft material over hard packed sand
p26	1445120.8	572198.1	2	Thin veneer of sand over mud
p27	1447861.6	573311.7	5	Hard packed
p28	1448060.0	573339.4	3	~2 inches of mud over hard packed
p29	1447819.6	573238.0	3	~6 inches of mud over hard packed
p30	1447422.9	573066.7	4	Sand over coarser sand (penetration changes)

Probe #	Easting[1]	Northing[1]	Group[2]	Field Comment/description
p31	1447172.0	572962.6	5	Hard Packed
p32	1446497.6	572672.7	1	Soft mud at least 3 ft down
p33	1445983.4	572447.5	1	Soft mud at least 3 ft down
p34	1447585.6	572866.9	4	Thin veneer of sand over hard packed layer
p35	1447780.5	572954.3	4	~6 inches of silty sand over hard packed layer which is very clear on the sub bottom record as a reflector that comes up abruptly from deep.
p36	1443664.1	579539.0	1	Very soft and easy to penetrate (black)
p37	1443877.5	579421.6	1	Mud - more stiff than p36
p38	1443935.6	579395.3	5	Hard packed sand
p39	1444006.2	579351.8	5	Hard packed
p40	1442213.8	577029.7	1	Very soft
p41	1443330.8	573140.1	1	Very soft black mud
p42	1446045.4	572098.3	1	Soft mud - easy penetration
p43	1447445.9	572691.6	2	Silty mud harder to penetrate and sticky
p44	1447749.0	572827.0	4	Thin layer of sand above mud above an hard packed layer
p45	1448104.8	572984.8	3	Hard packed layer is ~ 2 feet down
p46	1448338.1	573075.5	3	Hard packed layer ~1 foot down
p47	1447727.1	572589.7	1	Very soft ;gray green color; 3-4 feet thick at least
p48	1447744.3	572501.0	4	Medium grained sand ~6 inches of penetration
p49	1447973.3	572600.3	3	~1 foot of thick silty mud over an hard packed layer
p50	1448597.0	572862.2	4	Fine sand only about 3 inches of penetration
p51	1447941.7	572199.4	4	~6 inches of mix of sand and mud over an hard packed sand layer
p52	1447951.9	572100.4	4	~3 inches of mix of sand and mud over an hard packed sand layer
p53				No Probe
p54	1448031.9	572576.8	4	Fine sand - stiff - over inpentrable layer
p55	1448347.0	573644.0	4	~3 inches of mix of sand and mud over an hard packed sand layer
p56	1447977.7	572596.7	4	~1-2 inches of mix of sand and mud over an hard packed sand layer
p57	1448443.7	572358.5	4	2 inches of mix of sand and mud over an hard packed sand layer
p58	1448713.4	572421.1	3	Dense silty mud ~2-3inches of penetration
p59	1448113.0	572165.3	3	Dense silty mud ~1 foot of penetration
p60	1447843.9	572746.5	1	Black mud easy penetration
p61	1447736.7	572980.7	2	Mix of sand and mud
p62	1447580.5	573331.3	3	Soft mud ~3 feet down to hard packed layer
p63	1447734.3	573726.0	5	Hard packed

Probe #	Easting[1]	Northing[1]	Group[2]	Field Comment/description
p64	1447797.9	573591.5	3	~1 foot of very unconsolidated mud over an hard packed layer
p65	1447874.5	573416.7	1	~3 inches of unconsolidated mud over more dense penetrable mud - layers can be felt
p66	1447975.3	573192.5	4	~3 feet of sand/mud mixture down to impenetrable layer.
p67	1448098.9	572908.6	4	~1-2 feet of sandy mud down to hard packed layer
p68	1448157.2	572767.0	1	Black very soft mud
p69	1448198.1	572668.3	4	Sandy mud ~6 inches down to hard packed layer
p70	1448297.8	572444.1	2	Dense sandy mud - can feel layers.
p71	1447611.4	572682.4	4	~ 2 inches of coarse sand over hard pack
p72	1447319.4	573331.7	2	Sandy mud - max penetration
p73	1446687.9	572928.6	1	Soft mud - max penetration
p74	1446755.8	572744.5	1	Soft mud - max penetration
p75	1447002.3	572202.6	3	~3-4 feet of mud over an impenetrable layer
p76	1447056.9	572047.0	3	~2 feet of soft mud over sticky hard packed layer (might be clay)
p77	1445712.5	572360.1	1	Soft mud easy to penetrate
p78	1443158.5	572300.7	1	At least 15 feet of soft mud - thin sand layer felt near the surface
p79	1444633.1	571382.9	1	At least 15 feet of soft mud

1. Coordinates are in feet and referenced to the Maryland State Plane Coordinate System (1900), NAD83

2. Probes were separated into one of five categories:
   1 = soft sediment
   2 = sand and mud mix
   3 = mud over hard material
   4 = sand over hard material
   5 = hard material

APPENDIX 5

SUBBOTTOM PROFILES ALONG CH2M HILL SAMPLING TRANSECTS

Appendix 5 is available upon request.