Site Assessment Plan (SAP)

Maryland Offshore Wind Project
Lease OCS-A 0490

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1.0 INTRODUCTION

US Wind, Inc (US Wind) submitted its original Site Assessment Plan (SAP) for the installation of a meteorological tower on November 23, 2015 and the SAP was approved on March 22, 2018. US Wind has decided to utilize a metocean buoy in the near term and reserve the possible installation of the meteorological tower for a later date. Accordingly, US Wind is submitting this SAP for the deployment, operation and decommissioning of a metocean buoy. Much of the information contained in the original SAP has been retained and updated where needed along with new information specific to the metocean buoy and its deployment and operation.

1.1 Project Information (30 CFR § 585.610(a))

This section describes basic project information.

1.1.1 Contact Information (§ 585.610(a)(1))

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1.1.2 Site Assessment Concept (§ 585.610(a)(2))

The general concept is to deploy, operate and maintain one (1) meteorological and oceanographic buoy, hereafter referred to as the metocean buoy, within the Maryland Lease Area (Lease Area) of the Atlantic Ocean, as designated by the Bureau of Ocean Energy Management (BOEM) and leased to US Wind.

The device to be deployed is a floating Light Detection and Ranging (LiDAR) metocean buoy which will float on the surface and be moored to the seafloor. The proposed location for the metocean buoy is the same as the original meteorological tower and is shown in Figure 1.1.2.

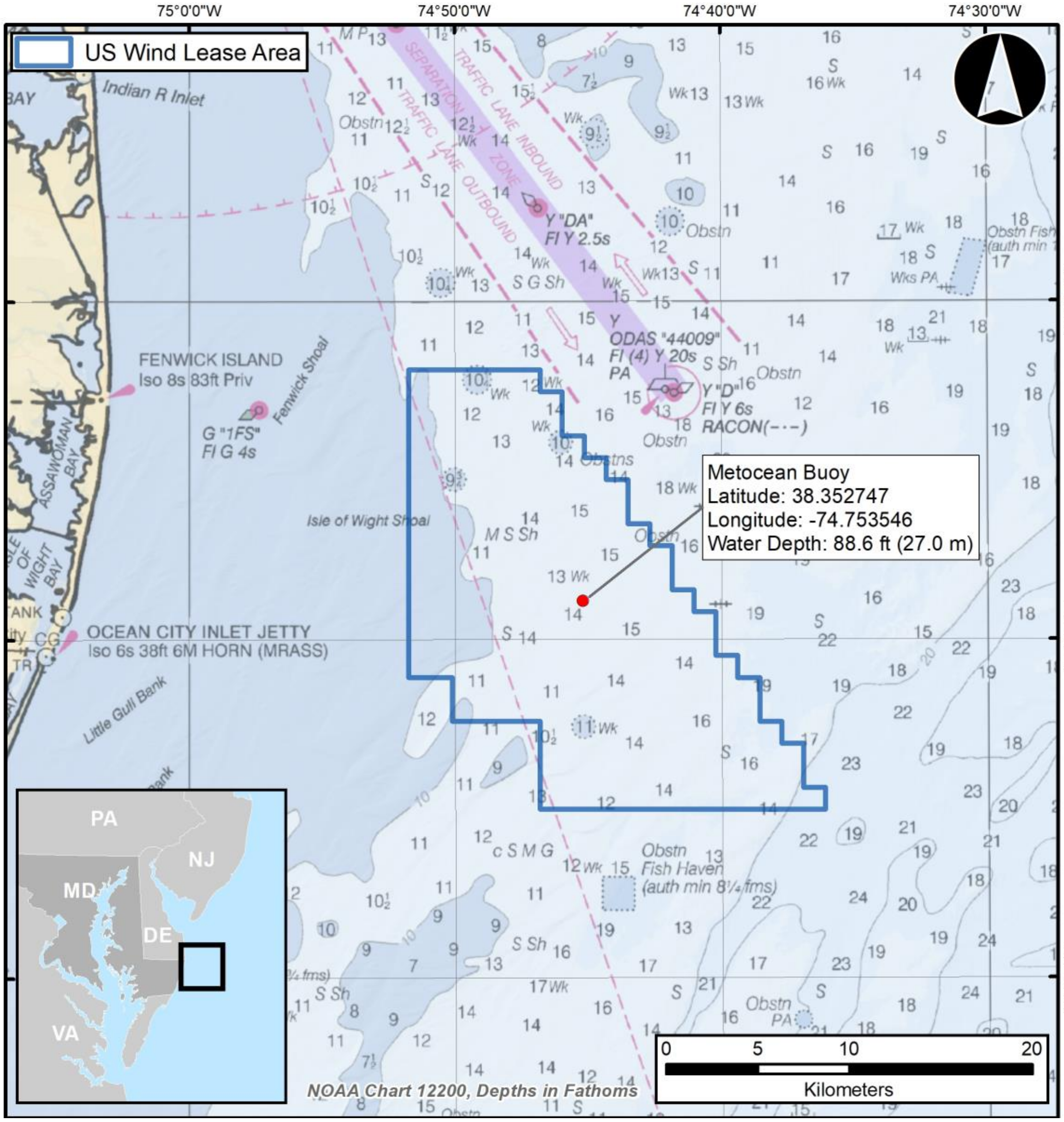


Figure 1.1.2. *Location Plat showing location of SAP Area (§ 585.610(a)(5))*

Location Plat, coordinates and water depth are:

E: 521533.96
N: 4244982.95
Latitude: 38° 21' 9.889" N
Longitude: 74° 45' 12.766" W
NAD83, UTM 18N, Meters [EPSG 26918]
Depth: 27.0 meters (88.6 feet, 14.8 fathoms)

The information collected from the metocean buoy will be used in addition to any existing metocean data available in the Maryland Lease Area and vicinity during pre-installation, installation, construction and operations of the US Wind proposed offshore wind project.

Deployment of the metocean buoy is planned for April 2021 . The deployment process is expected to take less than one week, from arrival of the work platform in the port of operations to the time the buoy enters the water and mooring weight is placed on the seafloor. The total duration of the metocean buoy deployment for data collection is anticipated to be approximately two (2) years.

The buoy is considered a non-complex ocean buoy as it is a proven and widely used technology, the buoy uses standard materials, and it has a minimal seabed footprint as a result of the mooring placement. The deployment, operation, and decommissioning of the buoy will have negligible or less than negligible impacts on the affected environment.

The following table (Table 1.1.2) summarizes the potential environmental impacts due to the Site Assessment Plan (SAP) activities; this impact assessment factors in the implementation of mitigation measures proposed in Section 3.3. Summaries of environmental resources within the SAP area may be found in Section 3.0.

Table 1.1.2. Summary of Impacts

Project Activity	Geologic Resources	Coastal Habitats & Terrestrial Mammals	Water Quality	Benthic Resources	Fisheries & Essential Fish Habitat	Marine Mammals & Sea Turtles	Coastal & Marine Birds & Bats	Air Quality	Archaeological Resources	Visual Resources	Navigation, Transportation & Military Activities	Commercial & Recreational Fishing	Socioeconomics
Deployment													
Vessels	NA	N	NA	NA	NA	N	NA	N	NA	NA	N	NA	NA
Anchor Deployment	N	NA	NA	N	N	NA	NA	NA	NA	NA	N	NA	NA
Operation													
Service Vessels	NA	N	NA	NA	NA	N	NA	N	NA	NA	N	NA	NA
Buoy (incl. anchor & chain sweep)	N	NA	NA	N	N	N	NA	NA	NA	NA	N	NA	NA
Lighting	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N	NA	NA
Decommissioning													
Vessels	NA	N	NA	NA	NA	N	NA	N	NA	NA	N	NA	NA
Anchor Removal	N	NA	NA	N	N	NA	NA	NA	NA	NA	N	NA	NA

N = Negligible
NA = Not applicable or less than negligible

1.1.3 Designation of Operator (§ 585.610(a)(3))

US Wind intends to be the sole operator of the metocean buoy in compliance with the stipulations stated in the Lease and described in Section 1.1.4, as they relate to the SAP and SAP activities.

1.1.4 Lease Stipulations and Compliance (§ 585.610(a)(4))

A copy of the lease issued to US Wind for the Maryland Wind Energy Area is posted on the BOEM website at: https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/MD/SIGNED-Fully-Executed-Lease-Amendment-OCS-A-0490.pdf. US Wind has and will continue to comply with the stipulations in these leases as they relate to the development and approval of this Site Assessment Plan (SAP) and SAP activities.

US Wind completed SAP survey activities as described in Section 2.0 in accordance with a pre-survey meeting and SAP Survey Plan approved by BOEM in support of the proposed meteorological tower installation. US Wind also conducted a tribal pre-survey meeting, as specified in the leases prior to conducting SAP survey activities, and consulted with United States Fleet Forces (USFF) N46 and the Fleet Forces Atlantic Exercise Coordination Center (FFAECC), which coordinates all regional military/other agency activities (both sea and air) for the Virginia Capes operating area (VACAPES OPAREA) and ensures events are de-conflicted.

SAP activities will be conducted in a manner that conforms to US Wind's responsibilities pursuant to 30 CFR § § 585.105(a) and 606. US Wind will conduct the activities described in this SAP only as approved by BOEM and in accordance with its lease stipulations. US Wind proposes to conduct SAP activities in a manner that will not unreasonably interfere with or endanger other approved activities, will not cause any undue harm or damage to the environment, will not create hazardous or unsafe conditions, and will not adversely affect resources of historic, cultural or archeological significance. Measures that will be implemented to avoid, minimize, and/or mitigate potential impacts associated with SAP activities, as required by the leases, are described in Section 3.0 of the SAP.

US Wind will comply with the Federal regulations and associated SAP guidelines regarding the items listed in Table 1.1.4 below, as stated in the table and outlined in this SAP.

Table 1.1.4. Compliance with Regulations

Regulation	Description	Compliance Statement
585.105(a)	Design your project and conduct all activities in a manner that ensures safety,	US Wind will comply with the requirements specified under 585.105(a). Project design standards and company health and safety policies are in place to ensure safe working conditions for people, *in situ* equipment, and all activities occurring within the Lease Area and for the project.
	and will not cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components to the extent practicable;	US Wind's activities has been designed to minimize or avoid impacts to the environment. See Section 3.3 (Mitigation Measures) for further details of specific environmental resources.
	and take measures to prevent unauthorized discharge of pollutants including marine trash and debris into the offshore environment.	US Wind will enforce operational rules and safeguards against discharge from vessels working on the project, in the Lease Area, and within surrounding waterways connecting to the port.
585.606(a)	(1) Conforms to all applicable laws, regulations, and lease provisions of your commercial lease	US Wind will comply with the requirements specified under 585.606(a). US Wind will follow applicable laws, regulations, and provisions specified in Lease OCS-A-0490. Standard Operating Conditions are addressed in Section 3.3 (Mitigation Measures).
	(2) Is safe	US Wind has planned and is prepared to conduct all SAP activities in a safe manner following company's US Wind's and subcontractor's health and safety policies.
	(3) Does not unreasonably interfere with other uses of the OCS, including those involved with National security or defense	SAP activities will not interfere with other uses of the Outer Continental Shelf (OCS) and Lease Area. US Wind and its contractors will continue to communicate with USCG, appropriate entities, and other users of the OCS; and obtain approval from Navy Fleet Forces Atlantic that the OCS is clear for SAP activities. See Section 3.1.10.
	(4) Does not cause undue harm or damage to natural resources; life (including human and wildlife); property; the marine, coastal, or human environment; or sites, structures, or objects of historical or archaeological significance	US Wind has and will continue to conduct due diligence efforts to protect the environment during offshore and upland project activities, as well as any cultural resources identified within the Project Area. See Section 3.0 and Appendix J for analysis of site characteristics, potential impacts, and avoidance and mitigation measures.

Regulation	Description	Compliance Statement
	(5) Uses best available and safest technology	Metocean buoy equipment and associated mooring hardware are widely used, standard technologies that are used for other offshore wind SAP monitoring and represent the best available and safest technologies for the environment at the time of this submittal.
	(6) Uses best management practices	US Wind will continue to use best management practices (BMPs) regarding all project tasks. Some of the BMPs specific to the SAP activities include, but are not limited to; • avoidance of impacts to benthic and nektonic habitats, • avoidance of impacts to marine mammals and sea turtles, • deployment activities only during approved months to avoid impacts to fisheries and marine mammals, • avoid any bottom disturbance during deployment except the weight for the mooring itself, • use of approved USCG lighting and marking of metocean buoys to avoid impacts to the commercial fishing industry, • design of the buoy to minimize avian perching, • design of the mooring to avoid entanglement by marine mammals and sea turtles, • routine inspection of the moorings to ensure structural integrity and minimal seabed disturbance, • combine vessel trips for inspection and , maintenance to minimize environmental impact where feasible, • prepare and execute an oil spill response plan, • exercise responsible and safe behavior during all site activities.
	(7) Uses properly trained personnel	US Wind will ensure that suitably experienced personnel will be employed for all SAP activities, meeting company and health and safety standards for the work to be performed.

1.2 Proposed Activity

1.2.1 General Structure and Project Design, Fabrication, and Installation (§ 585.610(a)(6))

As outlined in Section 1.1.2, one floating metocean buoy (EOLOS FLS200 LiDAR Buoy, FLS200) moored to the bottom is proposed to be deployed within the Maryland Lease Area during the development and installation period of the wind farm. The device will be deployed at Latitude: 38° 21' 9.889'' N Longitude: 74° 45' 12.766'' W in approximately 27 meters (88.6 feet) of water (see location Figure 1.1.2, (585.610(a)(5))). Deployment duration for the buoy will be approximately two (2) years from the date of deployment, anticipated from approximately April 15, 2021 to April 14, 2023 as shown in Table 1.2.1-1 below. This instrument is an off-the-shelf product and is widely applied in the offshore industry. The measurement device and its components are briefly described in Table 1.2.1-2. Components of the buoy include the gravity-based anchor and the chain that affixes the buoy to the anchor, as further described below. A report describing the approach to modelling wave and current conditions in the deployment area, the design of the mooring system and detailed technical information about the FLS200 is provided in Appendix A.

Table 1.2.1-1. LiDAR Buoy Proposed Schedule

2 Year Campaign	Estimated Dates
Contract Execution	30-Oct-2020
System Build, Ex-works	4-Jan-2015-Jun-20
Validation	18-Jan-21 to 8-Mar-21
Transport to USA	29-Mar-21
Deployment	15-Apr-21
Data Collection Start	15Apr-21
End Year 1 Campaign	14-Apr-22
End Year 2 Campaign	14-Apr-23

The FLS200 will be mounted to the seafloor using a steel chain mooring connected to a gravity-based anchor weight (Figure 1.2.1). The FLS200 mooring components would comprise 26 mm and 38 mm chain, certified terminations, shackles and other consumables. All strops and terminations would be weight-tested and prepared in accordance with the industry standards. All shackles and other mooring components would be Safe Working Load (SWL) certified and galvanized. Any mixed metal contacts would be insulated to prevent electrolytic corrosion. The FLS200 anchor weight would consist of a custom-made 5,000 kg oval shaped cast iron/steel sinker. The mooring design and materials will be site specific, and take the following factors into consideration:

Water Depth	Wind
Current Speeds	Type of deployment vessel and equipment available on board
Tides	Desired length of life of the mooring
Waves	Vessel traffic in the vicinity of the mooring

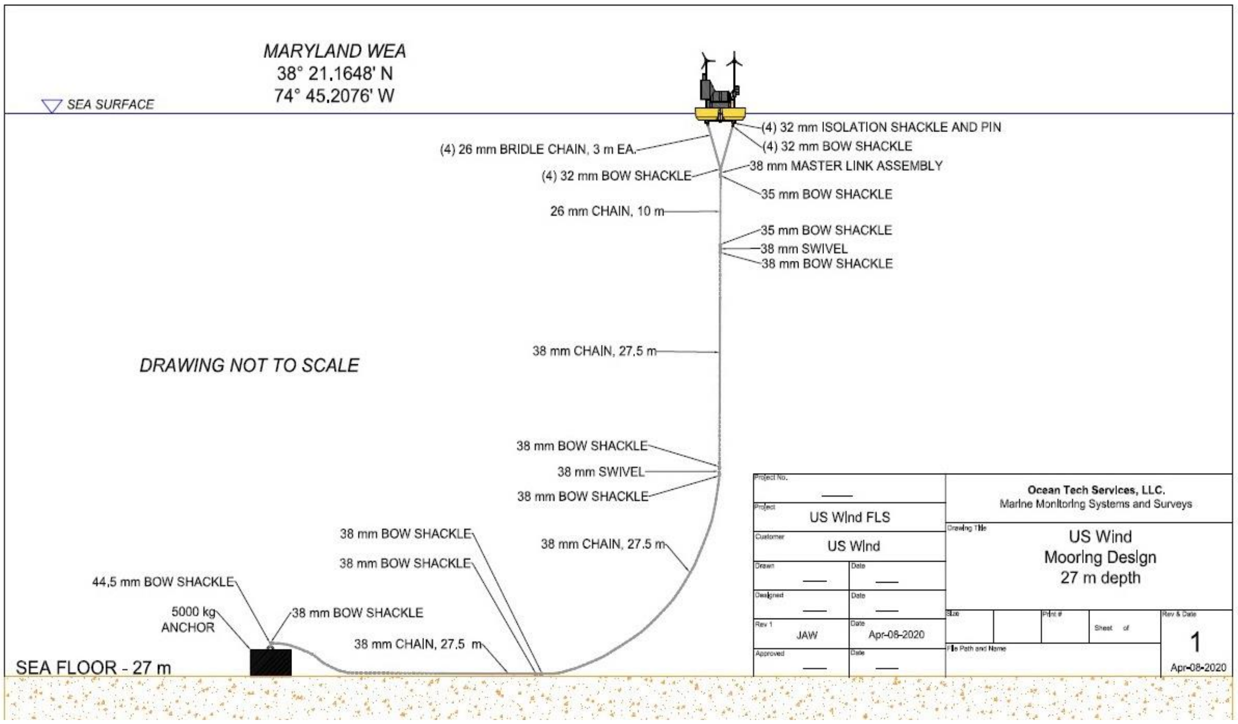
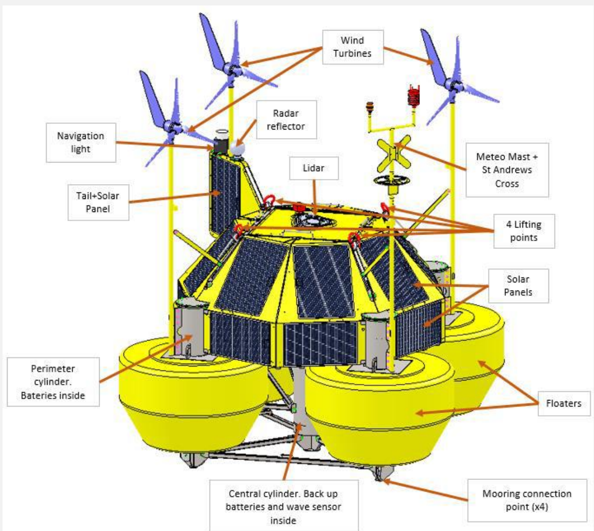


Figure 1.2.1. *FLS200 Buoy Mooring System*

The buoy will be equipped with the proper safety lighting, markings and signal equipment per United States Coast Guard (USCG) Private Aids to Navigation (PATON) requirements

Table 1.2.1-2. Summary Description of Measuring Device for Deployment

<table>
<tr><th colspan="2">EOLOS FLS200 LiDAR Buoy</th></tr>
<tr><td>
</td><td>The EOLOS FLS200 LiDAR Buoy (FLS200)is a fully-equipped and autonomous wind, wave, and current measuring system specifically suited for marine conditions.

The FLS200 is equipped with ZX 300M LiDAR SYSTEM, which provides remote wind measurements at ten user-defined heights from 10 m to 200 m (32.8 ft to 656 ft) above sea level. Additionally, the system can measure wind speed and direction at approximately 3.1 m (10.2 ft) above sea level using the weather transmitter mounted to the mast of the buoy. Buoy systems also measure sea state characteristics (wave direction, wave height, current velocity and direction, water temperature) and meteorological parameters (air temperature/humidity, air pressure, precipitation). The buoy will also be equipped with the following biological sensors including: avian acoustic recorder, bat ultrasonic recorder, marine mammal hydrophone, and bird and fish nanotag detectors.

The EOLOS FLS200 buoy has the following characteristics:
Dimensions: 4 m (13.1 ft) length and width, approximately 3.1 m (10.2 ft) above sea level
Weight 4,062 kg (4.5 tons)
Mounting: A single 5,000 kg (5.5 tons) anchor with approximately 92 m (302 ft) of 38mm and 26mm anchor chain
Mooring chain sweep: 65 m (213 ft) radius around anchor</td></tr>
</table>

In addition to the meteorological and oceanographic sensors, the buoy will also be outfitted with the following monitoring equipment. Specification sheets are provided in Appendix A.

1. Vemco VR2W Fish nanotag receiver. Will be housed within the Mooring Systems, Inc. General Purpose Trawl Resistant Bottom Mount (TRBM).
2. Loggerhead Instruments LS1X acoustic recorder for dolphins. To be housed within the TRBM.
3. Chelonia F-Pod acoustic recorder for porpoises. To be housed in suitable position within the TRBM.
4. Wildlife Acoustics SM-4 Avian Acoustic Recorder (sunrise to sunset and night operation during Spring/Fall migrations).
5. Wildlife Acoustics SM4BAT Bat Ultrasonic Recorder (dusk to dawn operation).
6. Cellular Tracking Technologies (CTT) Sensor Station. Next generation nanotag system that can track both Lotek and CTT tagged birds.

1.2.2 Deployment Activities (§ 585.610 (a)(7))

The instrument will be mobilized from Avalon, NJ. Once prepared, the buoy would be transported to the installation site on the deck of the deployment vessel. All gear will be firmly secured to the deck with chain binders to appropriately rated pad eyes and hold points before transport to the deployment site. Once on site, the vessel will deploy the system using the “anchor last” method, in which the FLS200 is deployed over the stern while the vessel maintains slow speed ahead. At 1 nm distance from the site the buoy will be lifted to the water behind the vessel. Approximately 50m of chain will be slowly released from the vessel to serve as a tow line for the buoy. The vessel will then slowly approach the site while towing the buoy behind. Once on position the crew will increase the amount of chain out by releasing sections in a controlled manner. This process will continue until all chain is overboard and the anchor remains on deck. The anchor will be slowly lowered to the seabed utilizing the mooring chain once confirmation of positioning has been obtained. All equipment will be deployed in a highly controlled manner; at no time during the operation are chain or the anchor permitted to “free-fall”. The mooring system will be secured to the vessel at a minimum of two points at all times, to mitigate runaway hardware in the case of a component failure. Specifications of potential deployment vessels are provided in Appendix B.

Ten-minute averages of non-biological data collected by buoy sensors will be transmitted via satellite link during the deployment period. Biological data and raw data from non-biological sensors will be collected during routine visits to the buoy. The FLS200 will require planned in-water inspection and data acquisition visits on an approximately quarterly basis, and annual maintenance during which the buoy and mooring system would be recovered to the deck of a vessel with all required buoy maintenance conducted on the vessel. All mooring components would be inspected and replaced as needed, and the buoy redeployed. This service trip could take up to two days. There should be no need to return to port or deploy a marker buoy. If the device suffers from malfunction or collision, it will be replaced with a similar device.

1.2.3 Mitigation Measures (§ 585.610 (a)(8))

The Project will implement best practices and comply with all applicable regulations and lease stipulations to avoid, minimize, reduce, eliminate, and monitor environmental impacts during buoy deployment, operation, and decommissioning. US Wind will comply with 30 Part 585 Subpart H. This will include measures to avoid and prevent accidental events such as fuel spills. There will be no vessel discharges. These measures will ensure that any unavoidable impacts are negligible. Mitigation and monitoring measures are described in detail in Section 3.3.

1.2.4 CVA nomination (§ 585.610 (a)(9))

The operation, and decommissioning of a standard metocean buoy does not qualify as a complex or significant activity; therefore, nomination of a Certified Verification Agent (CVA) is not required.

1.2.5 Reference Information ((§ 585.610 (a)(10))

A list of all documents and published sources referenced throughout this SAP is included in Section 4.0 at the end of this document.

1.2.6 Decommissioning and Site Clearance Procedures (§ 585.610 (a)(11))

Decommissioning and site clearance procedures will be conducted pursuant to the applicable sections of 30 CFR Part 585, Subpart I. In general, device recovery will be undertaken by vessels similar to those used during commissioning. During decommissioning operations, the mooring chain and anchor will be recovered to the deck of the vessel, leaving no materials on the seafloor. The buoy will then be connected to a tow line for transit to the Ocean Tech Services (OTS) facility in Avalon, NJ. Vessel speed during return transit with buoy under tow will be limited to 5 knots. If a vessel with sufficient deck space and an adequately sized A-frame or crane is used for the recovery operation, the buoy will instead be lifted onto the deck of the vessel and secured for return transit to the OTS facility, rather than being towed.

After the conclusion of the campaign, the buoy will be moved to shore and decommissioned. As part of the decommissioning process, local authorities (Coast Guard, maritime authorities) will be advised of the removal of the device from the area.

1.2.7 Air Quality Information (§§ 585.610(a)(12) and 585.659)

Given the minimal air emissions associated with SAP activities, an Outer Continental Shelf Air Permit is not required for SAP activities. Potential impacts associated with SAP activities are expected to be negligible. See Section 3.3.7 for air quality mitigation measures.

1.3 Regulatory Framework (§ 585.610(a)(13))

1.3.1 List of Permits/Authorizations

US Wind will apply for approvals and/or authorizations as shown in Table 1.3.1 to conduct site assessments activities (metocean buoy deployment, operation, and decommissioning):

Table 1.3.1. US Wind SAP Permitting Plan

Agency	Permit / Approval	Statutory Basis	Regulations	Expected Filing Date
Bureau of Offshore Energy Management (BOEM)	Site Assessment Plan (SAP) • National Environmental Policy Act (NEPA) • National Historic Preservation Act Review & State Historic Preservation Act Consultation	NHPA 16 U.S.C. 470	36 CFR Part 60, Part 800	Submitted May 2020
US Army Corps of Engineers (USACE)	Nationwide Permit 5 – Scientific Collection Device	Clean Water Act 33 U.S.C. 134	33 CFR 320 *et seq.*	Expected Fall 2020
US Coast Guard (USCG)	Private Aid to Navigation Local Notice to Mariners	14 U.S.C.81	33 CFR Part 66	Expected Fall 2020

1.3.2 Completed and Anticipated Agency Correspondence (§ 585.610(a)(14))

US Wind has conducted or will conduct outreach with the following local, State, and Federal agencies via meetings and/or correspondence. This outreach will address planned site assessment and development activities for the US Wind Offshore Wind Project, including the proposed metocean buoy. These agencies include:

- BOEM
- National Marine Fisheries Service (NMFS)
- USACE
- US Navy – VA Capes Command (VACAPES)
- USCG, District Commander
- National Oceanic and Atmospheric Administration (NOAA)

US Wind will continue to provide notifications as may be required during deployment and operation of the metocean buoy, and prior to decommissioning.

1.4 Financial Assurance Information (§ 585.610(a)(15))

In compliance with BOEM regulations (30 CFR 585.610(a)(15)), before the commencement of the deployment of any devices, US Wind, Inc. will provide a Surety Bond, issued by a primary financial institution, or other approved security, as required in 30 CFR 585.515 and 30 CFR 585.516 in order to guarantee the commissioning obligation.

1.5 Other Information (§ 585.610(a)(16)) – *As requested by BOEM*

No other information has been requested by BOEM at this time relative to the proposed site assessment activities.

2.0 SURVEY RESULTS (§ 585.610(b))

US Wind completed a geophysical and geotechnical survey of the metocean buoy site in the June/July 2015 time frame. These surveys were based on the BOEM approval of the US Wind Survey in June 2015 Plan (Appendix C) for the meteorological tower proposed at the same location. The results of the 2015 SAP Survey are directly applicable to the metocean buoy installation. The surveys were conducted to provide information for the Site Assessment Plan (SAP), for the meteorological tower engineering and design, and for permitting and regulatory purposes. The marine surveys covered a 300-meter radial area extending from the meteorological tower location and the area encompassed in the Area of Potential Effect (APE) where bottom disturbance could occur during geotechnical drilling operations and meteorological tower installation.

Bathymetric and geophysical data were collected using a multibeam echosounder, side-scan sonar, shallow penetration sub-bottom profiler and a marine magnetometer. A geotechnical borehole was advanced at the meteorological tower site which included combined drilling and CPT pushing, and also included acquisition of samples for physical description and laboratory testing. Grab samples and underwater video/photography were also performed in the meteorological tower area and in a baseline area approximately 1 km north of the site. These combined data sets provided seafloor and sub-surface characterization needed to determine site suitability.

The meteorological tower is not planned to be installed at this time and instead, a metocean buoy will be installed. It has a significantly smaller footprint and much less complex installation (i.e. a bottom weight instead of driven piles). It will be installed at the same location as the meteorological tower and therefore the data from the 2015 SAP Survey is directly applicable for use to assess the metocean buoy installation.

Alpine prepared a location summary based on the 2015 data in a specific area where the original survey was undertaken considering the installation of a metocean buoy instead of the originally planned meteorological tower. The report "Alpine Metocean 2015 G&G Survey Buoy Area Summary Letter" is provided in Appendix K.

2.1 Geotechnical Survey (§ 585.610(b)(1))

See Appendix D "Geotechnical Results Report".

2.2 Geological Survey and Shallow Hazards (§§ 585.610(b)(4) and 585.610(b)(2))

See attached Appendix E "Marine G&G Survey Report for Site Assessment Plan" and Appendix F "Data Integration and Engineering Report" and also Appendix K. Appendix E provides the results of the survey conducted for the installation of a meteorological tower which includes information on shallow faults, gas, sediment slumps, hydrates and ice scour. This data is summarized in section 3.1.1.1 below and remains relevant for the installation of the metocean buoy which is a less complex installation requiring only a weight to hold it to the bottom versus a pile foundation as in the case of the meteorological tower.

Appendix F provides an analysis of the meteorological tower location where one composite borehole comprising of CPTU, sample and PS Logging was completed down to a depth of 64.94m to determine the geotechnical properties of the underlying soils in order to perform an engineering analysis in connection with conceptual foundation design. The installation of the metocean buoy consists of a simple weight that will be lowered to the ocean floor in contrast to the pile foundation required for the meteorological tower. Although the information provided to the deeper depths is not required for the metocean buoy, the more surficial sediment and bottom information from this survey is very relevant to the installation of the buoy and is described below in section 3.1 and in the geological setting described in section 3.1.1.

Note: Digital geotechnical and geophysical (G&G) survey data was provided to BOEM via USB flash drive in conjunction with the meteorological tower SAP. This digital data included Sub-Bottom Profiler data from the Maryland MEA G&G Survey conducted in 2013 for the US Wind metocean buoy site. The Data Integration and Engineering Report (shallow hazards information, Appendix F) is included in the G&G survey report but is called out here separately for clarity.

2.3 Archeological Resources (§ 585.610(b)(3))

R. Christopher Goodwin & Associates, Inc. (RCG&A) conducted a Phase I archaeological assessment to identify potential archaeological resources within the meteorological tower area of potential effect (APE) for the original meteorological tower SAP. This work was performed to assist the US Wind and BOEM in compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended, and its implementing regulations 36 Code of Federal Regulations (CFR) 800, entitled Protection of Historic Properties.

See Appendix G for the Confidential "Marine Archaeological Resources Assessment".

RCG&A assessed the meteorological tower APE that encompassed any bottom disturbing activity that would occur with installation, operation, maintenance and decommissioning of the proposed tower, as well as with the foundation of the tower itself. The APE is a 300 meter radius centered on the proposed tower location; with a 65 m vertical depth established to accommodate all potential impacts of the development based on engineering details. Analyses considered all portions of the seafloor within the area of impact where bottom disturbing activities are likely to occur. RCG&A analyzed bathymetric data, side scan sonar data, CHIRP sub-bottom data, and magnetometer data. No side scan sonar anomalies were identified during review. Thirteen magnetic anomalies were recorded within the vicinity of the APE, but none exhibit the characteristics of significant cultural resources and no relict landforms were identified during review of the sub-bottom profiler data within the meteorological tower APE. RCG&A analysis found no potential cultural resources were identified within the APE and RCG&A concluded that no potential archeological resources will be affected by the proposed meteorological tower installation, operation and decommissioning activities and a determination of “No historic properties affected” (36 CFR 800.4) was recommended.

The metocean buoy is to be installed at the same coordinates and within the same APE evaluated by RCG&A and so the information in Appendix G is directly applicable to the metocean buoy. In fact the footprint is substantially less and includes 1 m^2 (10.8 ft^2) anchor footprint versus a pile foundation and a maximum mooring chain sweep of 65 m (213 ft) around the anchor which is all within the 300m radius APE evaluated for the meteorological tower.

RCG&A conducted a review of previous archaeological assessment of the HRG survey data collected by Alpine in 2015 associated with the proposed metocean buoy APE. The review identified no side scan sonar contacts and no magnetic anomalies that may represent submerged cultural resources. The seismic data indicated that no paleo landforms are present that may preserve inundated archaeological sites within the APE. RCG&A concluded that no potential submerged archaeological resources or paleo landscape features will be affected by the proposed metocean buoy installation, operation and decommissioning activities within the APE and recommended a determination of “No historic properties affected” (36 CFR 800.4). Concurrence with this recommendation is sought from BOEM. RCG&A’s Site Assessment Plan Amendment letter is provided in Appendix L.

2.4 Biological Survey (§ 585.610(b)(5))

See Appendix H “Benthic Assessment Report” and Appendix I “Final PSO Report”.

Note: Appendix I is composed of two separate reports, one from each survey vessel used during the G&G investigation. This report also answers questions that BOEM requested after receiving the Protected Species Observer (PSO) Interim Report.

3.0 AFFECTED ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATION MEASURES (§ 585.611(b))

3.1 Environmental Baseline

BOEM has previously conducted evaluations of similar types of activities and environmental effects on the Maryland Wind Energy Area (WEA), and therefore, it is US Wind’s position that the proposed activities and effects described in its SAP are well within the scope of BOEM’s prior Maryland WEA analyses (e.g., the lease sale NEPA document) and are not significantly different. US Wind has included a summary-level discussion of the types of information contained in 585.611(b)(1) through (10) to facilitate BOEM’s review. More detailed information about existing environmental conditions is included as Appendices E, F, G, H, and I.

In order to characterize seabed conditions at the metocean buoy position and within the adjacent APE, empirical G&G data was gathered in the June/July 2015 timeframe. This data included the results of Bathymetry, Side Scan Sonar, Chirp, and Magnetometer surveys. A basic description of the sea floor environment at the proposed metocean buoy site based on review of this data follows. Details are provided in Appendices E, F, and G.

Bathymetry data in the metocean buoy area show the seafloor to be characterized by limited relief, with water depths ranging between 26.3-27.1 m (86.3-88.9 ft). Surface sediments in the area are composed of fine to coarse-grained sand, with trace amounts of gravel. Small sand ripples are present throughout the area, with average wavelengths of less than 1 m (3.2 ft), and crest heights less than 0.5 m (1.6 ft). Shallow sub-surface sediments are dominated by sands, with occasional interlayers of clay and gravel. A shallow reflector was observed throughout the area, occurring 0.5-1.5 m (1.6 – 4.9 ft) below the seafloor and is interpreted to represent an erosional surface remnant from the last sea level transgression. This surface is interpreted as the boundary between late Pleistocene and early Holocene sediments. Three main sub-surface units were identified. Unit 1 represents recent Holocene sandy sediments ranging in thickness between 0.5 m (1.6 ft) and 2.5 m (8.2 ft) across the SAP area. Unit 2 represents a channel complex directly underlying Unit 1. Unit 3 represents a thick sequence of subparallel layered sediments dominated by silt and clay.

3.1.1 Geologic Setting

The Maryland Lease lies offshore from the Delmarva Peninsula, which is part of the Atlantic Coastal Plain Province of the eastern United States. The Atlantic coast is a passive margin and therefore a tectonically quiet area with dominant processes related to weathering and erosion. This creates a low relief landscape with thick accumulations of sedimentary deposits. The peninsula overlies a seaward thickening wedge of unconsolidated sediments dating back to Cretaceous time (> 65 million years ago), which are over 2,400 m (7,874 ft) thick near Ocean City, Maryland. Tertiary age (Paleocene-Eocene, 34 – 65 million year ago) marine sediments overlie the Cretaceous deposits (Hobbs, Krantz, and Wikel 2008, Andreasen et al. 2016). A disconformity is present between the Eocene sediments and overlying marine Miocene sands, silts and clays. The top of the Miocene (5 million years old) generally lies between 27 – 43 m (89 – 141 ft) below the Maryland coast.

The Tertiary aged sediments of the Delmarva Peninsula and coastal areas are disconformably overlain by younger Quaternary aged sediments consisting of fluvial sands and gravels, littoral and shallow marine clay, silt, and sand. Fluvial deposits comprise the majority of the Pleistocene age sediments (10,000 - 1.8 million years ago), with upper Pleistocene deposits consisting of barrier, back-barrier and foreshelf origin.

Holocene sediments are typically fine to coarse-grained sands ranging in thickness from less than 1 to 10 m (3.2 to 32.8 ft), are generally deposited in coastal and marsh environments, and are similar to the Pleistocene littoral and shallow marine sediments.

3.1.1.1 Hazard Assessment (§ 585.611(b)(1))

The data sets were reviewed for the presence of any natural or man-made hazards which could impact development of the site. Upon review of the shallow penetration and medium penetration sub-surface data, there was no evidence of (i) Shallow faults; (ii) Gas seeps or shallow gas; (iii) Slump blocks or slump sediments; (iv) Hydrates; or (v) Ice scour of seabed.

No man-made hazards were identified and no sonar contacts were observed. Nine (9) small magnetic anomalies were detected with none exceeding 21 nT in amplitude and are not expected to impact deployment or operation of the metocean buoy.

Shallow faults, gas, sediment slumps, hydrates and ice scour are not a common feature in the Quaternary and upper Tertiary (Coastal Plain) sediments on the Outer Continental Shelf offshore

Maryland. Typically, if present, these features would be recognizable in the medium penetration seismic data, and other high resolution geophysical (HRG) data.

Shallow faults are identified as sharp vertical offsets, or steps, in the detected seismic reflectors, however no such features were identified in the medium or shallow penetration seismic data in the SAP area. The episode of faulting along the Atlantic margin dates back to Cretaceous time during continental rifting and the opening of the Atlantic Ocean.

Shallow gas is seen in the seismic record where the upper surface of gas-rich sediments inhibits acoustic wave propagation into the subsurface, thereby preventing the ability to resolve deeper reflectors. Shallow gas is more commonly found in river deltas, estuaries, harbors, but can be found in deeper water continental shelf areas characterized by rapidly deposited muddy sediment with high organic content. Shallow gas was not identified in the SAP area and gas seeps were not observed and are known to occur in deeper waters, similar to hydrates as discussed below.

Sediment slumps or slump blocks are slope failures and can be identified on seismic records by slump scars and downslope rotated blocks, typically occurring where significant bottom slopes occur. Slumps were not observed, as bottom slopes are very minimal in the SAP area (< 0.5˚). Sediment slumps in the surficial sands and gravels would not be expected in this area, but if they were to occur it would be in over-steepened areas (i.e. edges of significant sand ridges).

Hydrates are known to form at temperature and pressure conditions found in much deeper waters than occurs in the Lease Area, typically in waters deeper than 500m (1,640 ft) and were not observed in the data sets.

Ice scouring typically occurs in polar oceans near calving glaciers and large masses of floating sea ice. This is not the current environment of the Maryland continental shelf. Ice scouring may have occurred during the last glacial maximum when the continental ice sheets extended further into mid-latitudes, however it is not expected to represent a hazard to the SAP area in modern time.

The data from the original survey was reviewed by Alpine with respect to the deployment of a metocean buoy and reported in Appendix K.

No significant impacts to local geology are anticipated as a result of the metocean buoy deployment. The seabed conditions are suitable for proposed activity and there are no naturally occurring shallow hazards that would impact the buoy deployment or operation.

3.1.2 Coastal Habitats

The mid-Atlantic coastline adjacent to the Project is characterized by a nearly continuous line of barrier islands and beaches and two large embayments – the Delaware and Chesapeake Bay estuaries. The main barrier islands off the eastern coast of Maryland are Fenwick and Assateague. Tidal exchange with the back bays behind these islands and beaches is limited to the inlet at Ocean City, dividing Fenwick and Assateague Islands, and another inlet in Virginia, south of Chincoteague Island (Maryland Department of Natural Resources 2004). To the north along the coast of Delaware are Bethany Beach, Dewey Beach, and Rehoboth Beach with an inlet at Indian River. The closest shoreline is approximately 27 km (16.8 miles) away from the metocean buoy location.

Coastal habitats types found along these shorelines include beaches, tidal flats, salt and brackish water marshes, swamps, and scrub-shrub wetlands. Coastal habitats provide food, shelter, and nesting resources for birds and terrestrial mammals. They also serve as an important habitat to migratory shorebirds and serve as a recreational destination for locals and tourists.

3.1.3 Water Quality (§ 585.611(b)(2))

The affected environment is divided into coastal and marine waters for the purposes of the following discussion. Coastal waters include all the ports/harbors, rivers, bays and estuaries that could be affected by Project activities (e.g., traversed by vessels during metocean buoy deployment, operation, decommissioning; and/or non-routine events). Marine waters include waters of the OCS, in which the Lease Area is located, as well as waters offshore that are state territory (within three nm of shore) and those of the OCS in the path to and from the Lease from shore.

Water quality is controlled primarily by the anthropogenic inputs of land runoff, land point source discharges, and atmospheric deposition. With increasing distance from shore, oceanic circulation patterns play an increasingly larger role in dispersing and diluting anthropogenic contaminants and determining water quality.

The condition of mid-Atlantic estuaries and coastal waters is fair to good in most locations, as measured by the National Coastal Condition Assessment water quality index (USEPA 2016). Among the water quality analytes examined, phosphorus and chlorophyll (algal productivity) were more likely to be rated as fair, while nitrogen, dissolved oxygen, and water clarity were predominantly rated as good. Coastal waters in the mid-Atlantic region have improved with regard to overall water quality since 2001 (USEPA 2016). The most consistent gains were observed in dissolved oxygen and water clarity.

Offshore water quality in the mid-Atlantic region is generally good, as the region standardly exhibits low water column stratification, low nutrient concentrations (both nitrogen and phosphorus concentrations), low chlorophyll populations, and good water quality measurements (USEPA 1998, 2001). The 2006 mid-Atlantic Bight assessment found no major indications of poor sediment or water quality and that the dissolved oxygen, sediment contaminants, and sediment Total Organic Carbon (TOC) component indicators were rated good throughout the survey area (USEPA 2012).

Concentrations of suspended matter (turbidity) are typically low in mid-Atlantic marine waters, though they increase naturally during storm events and vary locally between surface and bottom waters, between seasons, and in different areas due to variability in runoff sources and sediment grain sizes. Detailed studies of total suspended matter concentrations in surface waters of the mid-Atlantic have shown general concentrations of less than 1 milligram/liter (mg/L) throughout the region (Louis Berger Group Inc. 1999).

The Maryland Lease is characterized by sand ridges and troughs that are oriented along a generally southwest to northeast axis (CB&I 2014, Conkwright, Van Ryswick, and Sylvia 2015). The sand ridges have a complex morphology that is superimposed with smaller scale bedforms (sand waves). This is suggestive of active sediment transport with frequent sediment mobilization, resuspension, and deposition occurring due to tides, currents, and storm activity. Wave action may also affect sediment transport in water depths shallower than approximately 20 m (65.6 ft). During these periods of naturally induced sediment transport, short-term increases in turbidity affecting water quality may occur. In the

SAP APE, evidence of naturally occurring sediment transport events is present in the form of sand ripples.

Based on data collected from within the Maryland Lease, including Northeast Fisheries Science Center (NEFSC) historical data (NOAA NEFSC 2014) from numerous survey and research cruises taken over the past ten years: 1) Bottom water was quite uniform throughout its spatial extent in any given season; 2) Summer bottom temperatures were the most consistent during and across years; 3) Turnover events in September appeared to result in a sudden rise in bottom temperature, and winter bottom temperatures were usually substantially colder than summer and fall bottom temperatures; 4) Surface temperatures were similar to bottom temperatures in winter, indicating a consistent well-mixed water column condition; 5) Salinities varied little throughout the year, particularly on the bottom (<0.3 psu variation); and 6) Surface to bottom salinity gradients were consistently small (<2 psu) throughout all seasons (Table 3.3-1).

Table 3.1.3-1 Ten Years (2003 – 2012) of NEFSC CTD Data from the Maryland Lease Area Summarized by Seasonal Periods

Period	Layer	Temperature (deg C)			Salinity (psu)		
		Median	Min	Max	Median	Min	Max
Jun 1 – Aug 31	Surface	21.99	17.04	24.24	31.17	29.49	32.01
	Bottom	10.92	9.39	17.88	32.73	31.72	32.90
Sep 1 – Oct 31	Surface	22.01	20.35	23.72	31.21	30.14	32.06
	Bottom	19.76	11.57	23.42	21.58	30.19	32.76
Jan 1 – Mar 31	Surface	5.27	3.41	10.12	31.81	30.05	32.25
	Bottom	5.03	3.40	10.38	31.91	31.00	32.47

Data source: NOAA, NEFSC 2014.

Additional conductivity, temperature and depth (CTD) data were collected during benthic surveys conducted within the Maryland Lease in July 2013. The results from these surveys found there is a strongly-stratified water column with warm (>21° C) water in a thin surface layer, underlain by a strong thermocline and a thick bottom layer of cool water (~10° C) with a salinity about 1.5 psu higher than the surface. The decline in temperature from the surface to the bottom water layers was paralleled by a decline in dissolved oxygen (DO) from supersaturated (>100% saturation) at the surface layer to ~80% saturation in the bottom layer. There was little difference in bottom temperature, salinity, and DO from place to place, showing no evidence of horizontal frontal structures. There were, however, north to south differences in the depths of the layers, which is indicative of sloping surfaces of water masses that generate currents (Guida et al. 2017).

Physical oceanographic conditions vary only minimally over the Lease with no strong lateral gradients or fronts observed (Guida et al. 2017). Seasonal variations in bottom water temperature are consistent across the Lease with warmest conditions occurring during autumn turnover, when temperatures may approach or exceed 20°C (68°F). Thermal stratification is strongest in summer, with surface temperatures more than 10°C (18°F) higher than bottom temperatures. Although the Lease is entirely euhaline, with salinity typically higher than 30 practical salinity units (psu), vertical salinity gradients are observable in summer when surface salinity is up to 2 psu lower than bottom salinity. A vertically mixed thermal and salinity profile persists from fall through winter.

3.1.4 Benthic Resources (§ 585.611(b)(3-5))

Benthic habitat in the Maryland Lease is generally characterized by sandy substrates on gentle slopes with evidence of at least moderate levels of mobility (Guida et al. 2017). Shell hash frequently accompanies mineral substrates in the Lease and the resultant variations in sediment type and slope are minor. Sand dominates sediment type, but gravel is common as a minor component, particularly to the north. Muddy sands are also present in areas protected from strong currents, such as portions of the central Lease. Gravel- and cobble-dominated substrates are rare in the Lease while bedrock, boulder, and live-bottom benthic habitats have not been documented. Submerged aquatic vegetation (SAV) beds have also not been documented in the Lease. A review of data collected during geophysical surveys of the SAP APE and data from benthic field surveys (see discussion below) indicated no evidence of potentially sensitive or unique benthic habitat types, such as hard bottom, live bottom, and SAV, in the SAP area.

The benthic community in the Lease appears to be dominated by polychaetes, which were the most abundant taxonomic group observed during benthic sampling conducted within the Lease by the NOAA NMFS NEFSC in 2013 (Guida et al. 2017). Polychaetes representing 26 distinct taxonomic families contributed more than 50 percent of the total macroinvertebrate abundance. Oligochaete worms were the second-most abundant group observed, followed (in descending order) by mollusks, crustaceans, and other organisms.

Recent video surveys and survey trawls of the Lease suggest that the primary benthic epifaunal taxa include common sand dollar (*Echinarachnius parma*), hermit crab (*Pagurus* spp.), rock crab (*Cancer irroratus*), moon snails (Naticidae), nassa snails (*Ilyanassa* [*Nassarius*] spp.), and sea stars (*Asterias* spp.) (Guida et al. 2017). Penaeid shrimp (Penaeidae), sand shrimp (*Crangon septemspinosa*) and horseshoe crab (*Limulus polyphemus*) were also occasionally recorded in survey trawl data.

Benthic Field Survey

A site-specific field survey of benthic resources was conducted on July 25, 2015. The benthic field survey was composed of two elements, including 1) collection of still images and video of the seafloor and 2) collection of benthic grab samples for laboratory analysis of taxonomic composition. To obtain site-specific information on the benthic community, the benthic field survey focused on three locations near the site of the proposed metocean buoy (Appendix H). Three additional benthic samples were collected from an area of comparable habitat located 1,000 m (3,281 ft) north of the SAP area (reference area). Water depth, seabed slope and substrate type in the reference area, as described in Guida et al. (Guida et al. 2017), are similar to that encountered near the proposed metocean buoy. The reference area was selected to represent background conditions as it is well outside the area of anticipated impact from the deployment, operation, and removal of the proposed metocean buoy.

Qualitative analysis of the benthic imagery obtained indicated the presence of at least seven (7) macrofaunal taxa overall, including six (6) in the SAP area (Appendix H). Hermit crabs and sand dollars were the most frequently observed taxa, and most taxa were primarily epifaunal species.

Overall, nineteen (19) species of benthic fauna were observed from the six (6) grab samples. The taxa richness, density, and community composition of the samples collected from the SAP area were very similar to the reference area (Table 3.1.4-2). Polychaete worms were the most taxonomically rich group, contributing as much as 50 percent of the taxa richness in the study area. Mollusks were less taxonomically rich, with just a handful of taxa encountered. Crustaceans, oligochaete worms, and other taxonomic groups contributed one or two taxa each. Nematode worms were the most abundant organism encountered in the site-specific benthic grab sampling program, although they made up a larger portion of the benthic community near the metocean buoy location than in the reference area. Polychaete worms were the second-most abundant benthic organism observed, followed by oligochaete worms, crustaceans, and mollusks.

Table 3.1.4-2 Summary of Key Statistics from the Benthic Community Study

Statistic	SAP Area	Reference Area
Number of Samples	3	3
Mean Density per Square Meter (±1 SD)	3,567 ± 666	3,300 ± 361
Mean Taxa Richness (±1 SD)	9 ± 1	9 ± 2
Total Number of Taxa	16	14
Number of Taxa Observed by Taxonomic Group		
Mollusks	4	3
Oligochaetes	1	1
Polychaetes	8	6
Crustaceans	1	2
Other	2	1
Percent of Total Abundance by Taxonomic Group		
Mollusks	4.7	3.0
Oligochaetes	8.4	11.1
Polychaetes	33.6	37.4
Crustaceans	6.5	12.1
Other	46.7	36.4

Most of the benthic macrofaunal taxa observed in the site-specific benthic grab samples were small burrowing or tube-building taxa. The most commonly observed polychaete taxa include *Polygordius* sp. and *Lumbrinerides acuta* (both typical of sandy shelf habitats (Solis-Weiss et al. 1995, Ramey 2008). The most abundant crustacean (the tanaid *Tanaissus psammophilus*) and mollusk (the razor clam [*Ensis directus*]) are also shallow burrowers (Weiss 1995). Although not abundant, surf clam (*Spisula solidissima*) juveniles were present in samples collected from stations G3 (SAP area) and G6 (reference area). No other shellfish of commercial importance were observed in the site-specific benthic grab samples.

Larger nematode worms (longer than 500 microns) were included in the site-specific data analysis. However, nematodes are often treated entirely as meiofauna and not included in analyses of the benthic macroinvertebrate community (e.g., (Guida et al. 2017). When nematodes are removed from the site-specific dataset, polychaete worms become the dominant taxonomic group, contributing 54.5 percent and 58.7 percent of the total benthic abundance at the SAP site and reference site, respectively. These community composition results are consistent with previous grab sampling of the benthic community near the proposed metocean buoy (Site F in (Guida et al. 2017).

See Appendix H for more detailed results of the benthic field survey, and a taxonomic classification of benthic habitat in the SAP area.

3.1.5 Fisheries and Essential Fish Habitat (§ 585.611(b)(3-5))

The Maryland Lease is located in the mid-Atlantic Bight (MAB) of the Northeast Continental Shelf Large Marine Ecosystem. The MAB has very diverse and abundant fishery resources, consisting of both northern (temperate) and southern (tropical-subtropical) species that undergo extensive migrations as they follow temperature isotherms (Olney and Bilkovic 1998). In an Ocean/Wind Power Ecological Baseline Study conducted from 2008 through 2009, over 250 species of fish were identified in the mid-Atlantic, with 15% identified as temperate species and 75% as tropical-subtropical species (NJDEP 2010).

Many habitat and spatial factors affect the distribution of fish within the waters of the MAB (Helfman et al. 2009), including temperature, salinity, pH, currents, and physical habitat. Fish assemblages along the Atlantic Coast are generally categorized according to life habits or preferred habitat associations, such as pelagic, demersal, and highly migratory. NEFSC bottom trawl survey results from within the Maryland Lease demonstrate a large seasonal shift in benthic/demersal species. Larger catches were made in fall (September – October) than in spring (March), both in terms of numbers of individuals caught (mean fall catch = 1,709 per trawl vs. 76 per trawl in spring) and numbers of species (39 in fall vs. 15 in spring) ((Guida et al. 2017). Fall catches were dominated by seasonally migratory species such as Atlantic croaker, weakfish, spot, and northern sea robin, whereas the smaller spring catches were dominated by little skate, smallmouth flounder, and spotted hake. It was also noted that the spring catch species represent a year-round resident fauna.

A list of major fish and shellfish species potentially occurring in the Project Area is presented in Appendix J. Important managed shellfish on the mid-Atlantic continental shelf include scallops, horseshoe crabs, surf clams, and ocean quahogs. Of these, surf clams were the only managed shellfish species directly observed in the SAP APE. The economic importance of managed shellfish species in the Maryland Lease is further discussed in Section 3.1.9.2, Commercial and Recreational Fisheries.

Pelagic Fishes

Pelagic species spend most of their lives swimming in the water column, rather than occurring on or near the bottom. Some coastal pelagic species in the Atlantic region, including important schooling forage fish such as menhaden (*Brevoortia tyrannus*) and predatory species such as red drum (*Sciaenops ocellatus*), are found primarily in shallower waters. Many coastal pelagic species rely on coastal wetlands, seagrass habitats, and estuaries to provide habitat for specific life stages and many of these species migrate north and south along the Atlantic Coast during some periods of the year. Some pelagic species are distributed from the shore to the continental shelf edge. A number of these species are schooling fish that are sought by both recreational and commercial fisheries. Included in this assemblage are smaller forage species, such as Atlantic herring (*Clupea harengus*), and larger predatory fishes, including bluefish (*Pomatomus saltatrix*). In general, these fish use the highly productive coastal waters within the Atlantic region during the summer months and migrate to deeper and/or more distant waters during the rest of the year.

Demersal Fishes

Demersal fish (groundfish) are those fish that spend at least a portion of their life cycle in association with the ocean bottom. Demersal fish are often found in mixed species aggregations that differ depending upon the specific area and time of year. Many demersal fish species have pelagic eggs or larvae that are sometimes carried long distances by oceanic surface currents. Common demersal species in the MAB include the following: Family *Pleronectidae* (flounder), Family *Gadidae* (hake), and Family *Serranidae* (sea basses and groupers).

Highly Migratory Fishes

Highly migratory fish often migrate from southern portions of the South Atlantic to as far north as the Gulf of Maine. Examples of these species include Atlantic bluefin tuna (*Thunnus thynnus*), albacore (*Thunnus alalunga*), and yellowfin tuna (*Thunnus albacares*). Other than some tuna species (family *Scombridae*), which exhibit schooling behavior, many of the highly migratory species occur either singly or in pairs.

A wide variety of highly migratory pelagic shark species also occur in waters of the Atlantic region. Many of these are also sought by commercial and recreational anglers. Examples of such sharks include thresher shark (*Alopias vulpinus*), porbeagle (*Lamna nasus*), and shortfin mako (*Isurus oxyrinchus*).

Ichthyoplankton

Fish eggs and larvae found in the MAB come from warm temperate, cold temperate, and boreal regions and are generally distributed in an onshore/offshore pattern (Doyle, Morse, and Kendall 1993, Hare, Fahay, and Cowen 2001). In general, the most abundant fish eggs and larvae found during winter months are those of cold temperate species originating in more northerly waters. During spring, summer, and fall months, ichthyoplankton is dominated by warm temperate species originating from more southerly waters.

3.1.5.1 Threatened and Endangered Fish

There are two fish species that are Federally listed as threatened or endangered that may occur in the Project Area: the shortnose sturgeon (*Acipenser brevirostrum*), and the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (Table 3.1.5). Both are anadromous species, meaning they spawn in rivers and spend their adult lives in the open ocean. Profiles of these species are included in Appendix J. Additional species that have been petitioned for endangered or threatened status and not yet deemed candidates—or are currently candidates for listing and the status determination has not been made yet—are considered as Federal “species of concern” and are included in Table 3.1.5.

Table 3.1.5 List of Threatened and Endangered Fish Species and Species of Special Concern

Species (Scientific Name)	Relative Occurrence in Lease Area	ESA Status
Shortnose sturgeon (*Acipenser brevirostrum*)	Rare	Endangered
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*)	Likely	Endangered
Porbeagle shark (*Lamna nasus*)	Likely	Species of Concern
Sand tiger shark (*Carcharias taurus*)	Likely	Species of Concern
Alewife (*Alosa pseudoharengus*)	Unlikely	Species of Concern
Blueback herring (*Alosa aestivalis*)	Unlikely	Species of Concern
Atlantic Bluefin (*Thunnus thynnus*)	Likely	Species of Concern
Rainbow smelt (*Osmerus mordax*)	Unlikely	Species of Concern

3.1.5.2 Commercially and Recreationally Important Fish

Many of the fish species found in the MAB are important due to their value as commercial and/or recreational fisheries. Commercial fishing in the Project Area occurs primarily offshore in both Maryland and Delaware. U.S. fisheries landings data from 2013 to 2017 indicate that the following species were the top valued commercial fisheries (by revenue) in Delaware: blue crab, striped bass, eastern oyster, knobbed whelk, and horseshoe crab (NMFS 2019a). These species accounted for 88.8% of the commercial fishing revenue in Delaware from 2013 to 2017. Top valued fisheries in Maryland were similar, with the top valued fisheries being blue crab, eastern oyster, striped bass, sea scallop, and channel catfish (NMFS 2019a). These species accounted for 87.2% of the commercial fishing revenue in Maryland from 2013 to 2017. In both states, blue crab accounted for at least 59% of revenues over this period (NMFS 2019a).

In Delaware, top species by catch include Atlantic croaker, summer flounder, bluefish, black sea bass, and white perch. For each of the top twelve species by catch, over 80% of the catch occurred in inland waters for all species except summer flounder, bluefish, black sea bass, and smooth dogfish (NMFS 2019b). The vast majority of recreational fishing in Maryland also occurs in inland waters. In Maryland, top species by catch include white perch, striped bass, spot, and Atlantic croaker. For each of the top twelve species by catch, over 90% of the catch occurred in inland waters for all species except black sea bass (NMFS 2019b).

The most important offshore fishing ground in the vicinity of the Project Area is located offshore of Delaware. This area, known for its rocky bottom and corals, is referred to as the “Old Grounds.” The Old Grounds is heavily used for recreational and for-hire charter fishing, primarily targeting winter flounder, summer flounder, black sea bass, tautog, and red hake.

A detailed description of fishing activities and the economic value of fisheries is provided in Section 3.1.9.2, Commercial and Recreational Fisheries.

3.1.5.3 Essential Fish Habitat (EFH)

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires fishery management councils to: (1) describe and identify EFH in their respective regions; (2) specify actions to conserve and enhance that EFH; and (3) minimize the adverse effects of fishing on EFH. The Magnuson-Stevens Act requires Federal agencies to consult on activities that may adversely affect EFH designated in fishery management plans. Additionally, fishery management councils identify habitat areas of particular concern (HAPCs) within fishery management plans. HAPCs are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation. There is no HAPC identified for any listed finfish species within the Maryland Lease.

EFH has been designated for the following species for one or more life stages near the Project Area (see Appendix J for details).

New England Fishery Management Plan Species

- Atlantic herring
- Atlantic cod
- Clearnose skate
- Little skate
- Red hake
- Winter skate
- Yellowtail flounder
- Windowpane flounder
- Winter flounder
- Witch flounder
- Monkfish
- Silver hake

Mid-Atlantic Fishery Management Plan Species

- Atlantic mackerel
- Black sea bass
- Bluefish
- Atlantic Butterfish
- Scup
- Surf clam
- Spiny dogfish
- Summer flounder
- Longfin inshore squid

Atlantic Highly Migratory Species Fishery Management Plan Species

- Albacore tuna
- Atlantic angel shark
- Atlantic bluefin tuna
- Atlantic skipjack
- Atlantic yellowfin tuna
- Dusky shark
- Sand tiger shark
- Sandbar shark
- Shortfin mako
- Common Thresher shark
- Tiger shark
- Smoothhound shark
- Blue shark
- Atlantic sharpnose shark

3.1.6 Marine Mammals and Sea Turtles (§ 585.611(b)(3-5))

3.1.6.1 Marine Mammals

There are approximately 41 species of marine mammal known to occur in the waters of the Atlantic OCS (USDOI and BOEM 2013, 2014). All of these species are protected under the Marine Mammal Protection Act (MMPA), and several are listed as endangered under the Endangered Species Act (ESA). A total of five (5) sea turtles could occur in Northwestern Atlantic OCS waters, all of which are protected under the ESA. The following describes those species that have the potential to be impacted by SAP activities.

The marine mammal species that are most likely to be in the region and may be impacted by SAP activities include:

- North Atlantic right whale
- fin whale
- humpback whale
- minke whale
- sei whale
- Atlantic white-sided dolphin
- bottlenose dolphin
- long-finned pilot whales
- Risso's dolphins
- short-beaked common dolphin
- sperm whale
- harbor porpoise
- harbor seal
- gray seal

Of the fourteen (14) species listed above, five (5) are baleen whales, seven (7) are toothed whales, and two (2) are seals. A table summarizing the status, distribution, and density of these species is included in Appendix J. See Appendix J for detailed information about the abundance, distribution, and habitat use patterns for the North Atlantic right whale, fin whale, sei whale, and sperm whale. Refer to BOEM (2012) and (USDOI and BOEM 2014) for detailed information on other marine mammal species.

3.1.6.2 Sea Turtles

Of the five (5) species of sea turtles that may occur in the Northwest Atlantic OCS, only four species are likely to be encountered in the Maryland Lease. These species include the loggerhead, green, Kemp's ridley, and leatherback. The hawksbill is not likely to occur in the vicinity of the Project Area and is therefore not addressed further (USDOI and BOEM 2013). See Appendix J for detailed information about the abundance, distribution, and habitat use patterns for loggerhead, leatherback, Kemp's ridley, and green sea turtles.

3.1.7 Coastal and Marine Birds and Bats (585.611(b)(3-5))

Numerous marine and coastal bird species are known to occur in the Maryland Lease, many of which are protected under the Migratory Bird Treaty Act of 1918 (MBTA) (16 U.S.C. 703–712). Four of these species are also protected under the ESA. ESA-listed species that may be present within the SAP Area include piping plover (*Charadrius melodus*), bermuda petrel (*Pterodroma cahow*), red knot (*Calidris canutus rufa*), and roseate tern (*Sterna dougallii*). Coastal and marine birds that may be impacted by SAP activities are described in Appendix J.

Twelve bat species are known to occur in Maryland. Only three of these species, none of which are protected under the ESA, have the potential to occur in waters of the Maryland Lease. The silver-haired bat (*Lasionycteris noctivagans)*, eastern red bat (*Lasiurus borealis)*, and hoary bat (*Lasiurus cinereus)* may migrate or forage near the Project Area.

3.1.8 Archaeological Resources (§ 585.611(b)(6))

R. Christopher Goodwin & Associates, Inc. (RCG&A) conducted a Phase I archaeological assessment to identify potential archeological resources within the meteorological tower APE for the original SAP.

This work was performed to assist US Wind and BOEM in compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended, and its implementing regulations 36 Code of Federal Regulations (CFR) 800, entitled Protection of Historic Properties. All work was performed in accordance with the NHPA of 1966, as amended; the National Environmental Policy Act of 1969, as amended, and its implementing regulations (36 CFR Part 800); and the Archaeological Resources Protection Act of 1979. RCG&A's report, titled *Marine Archaeological Resources Assessment for the US Wind Offshore Energy Project*, is provided in Appendix G.

The direct APE based on buoy specifications and deployment plans is defined to include the proposed 1 m^2 (10.8 ft^2) anchor footprint plus a maximum mooring chain sweep of 65 m (213 ft) around the anchor. As previous sampling has indicated that sediments at the deployment location are dense sand and some gravel, no penetration of the anchor into the seabed is anticipated. This area falls within the 300 m (984 ft) radius meteorological tower APE.

RCG&A conducted a detailed analysis of all HRG survey data that was acquired in the meteorological tower APE in accordance with the BOEM, Office of Renewable Energy Programs' Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585 (BOEM 2012). Archival research for the Project provided relevant and focused prehistoric and historic maritime contexts for the Project Area and identified potentially significant submerged cultural resources within the study area.

No potential cultural resources were identified by RCG&A within the meteorological tower APE. Therefore, RCG&A concluded that no potential archaeological resources will be affected by the proposed meteorological tower installation, operation, and decommissioning activities and recommended a determination of "No historic properties affected" (36 CFR 800.4). Given that the deployment of the metocean buoy is a non-complex installation, will have substantially less impacts in all areas and is temporary, this original assessment and the findings are directly applicable to the metocean buoy.

RCG&A also conducted a review of previous archaeological assessment of the HRG survey data collected by Alpine in 2015 (Schmidt et al. 2016) associated with the proposed metocean buoy APE and the letter report is provided in Appendix L. RCG&A concluded that no potential submerged archaeological resources or paleolandscape features that may preserve inundated archaeological sites will be affected by the proposed metocean buoy installation, operation and decommissioning activities within the APE and recommended a determination of "No historic properties affected" (36 CFR 800.4) and concurrence from BOEM.

3.1.9 Social and Economic Resources (§ 585.611(b)(7))

Maryland's economy continues to outperform the country as a whole. The leading forces behind Maryland's economic growth are information technology, telecommunications, and aerospace and defense (Maryland Manual On-Line 2020). Maryland's unemployment was 3.5% in December 2019, the same as the national average (Maryland DOL 2020, BLS 2020). Maryland's workforce was more than 3.2 million in 2019 and is among the best educated in the nation (Maryland Workforce Exchange 2020).

Between 2014 and 2018, the median household income in Worcester County was $61,145, lower than median household income in the State of Maryland, at $81,868 (USCB 2020d). Per capita income from

2015 to 2018 exhibits the same trend, at $35,666 in Worcester County and $40,517 in Maryland (USCB 2020c). Five-year average median household income and per capita income (2015 – 2018) in both Worcester County and Maryland exceeded nationwide values ($60,293 and $32,621, respectively) (USCB 2020c).

As of 2018, more than 4.8 million Maryland residents were employed, and approximately 43,674 Worcester County residents are employed (USCB 2020b). Average unemployment rates from 2015 to 2018 were 5.3% and 5.6%, in Worcester County and Maryland, respectively (USCB 2020b). During this time period, national average unemployment was 5.9% (USCB 2020b).

3.1.9.1 Coastal Industries & Employment

The ocean economy of Worcester County has grown significantly since 2007 (NOEP 2020). Total GDP of all ocean sector businesses in Worcester County was over 378 million in 2016, a greater than 15% increase compared to 2006 (NOEP 2020). Tourism and recreation dominate the ocean economy, these industries employed more than 7,738 people and produced a GDP exceeding $428.8 million in 2016 (NOEP 2020). Information about the transportation, minerals, and shipbuilding industries in Worcester County are not available due to disclosure issues (NOEP 2020).

3.1.9.2 Commercial & Recreational Fisheries

US Wind contracted Sea Risk Solutions to conduct a study of fisheries and fishing activities in the Lease Area (Sea Risk Solutions 2015). The most common gear types used in the vicinity of the Lease are crab pots and traps, lines trot with baits, pound nets, gill nets, and clam dredges, ranked in order by value landed (Sea Risk Solutions 2015). Commercial fisheries target pelagic fish species using gears, such as trawls, longlines, and purse seines. Demersal fish are usually taken by using trawling gear, although a great number are also caught with other gear such as gill nets, traps, and longlines.

There are a number of fishery management plans in place for regulating and managing pelagic fisheries in the Atlantic region, including plans for Atlantic salmon, Atlantic herring, bluefish, dolphin, and wahoo. Fisheries for demersal fishes in the Atlantic region are managed by multispecies groundfish fishery management plans as well as a number of single-species management plans.

A summary of the study results is presented below.

America Lobster Trap/Pot

The commercial fishing season for the American lobster (*Homarus americanus*) peaks from July to September. Pots are set individually or along strings, typically on grounds 12-60 nm offshore Ocean City, MD. Fewer than twelve (12) commercial vessels with lobster licenses operate out of Ocean City. Fishing areas shift frequently, but it appears unlikely that a substantial concentration of lobster traps would be fished in the Lease Area.

Black Sea Bass

Black sea bass (*Centropristis striata*) is fished via pots, bottom trawling, and with hook and line often near rocks or reefs mainly at depths of 70-80 m. Due to the typical water depth range for this fishery, it is unlikely that large concentrations of sea bass pots would be placed in the Lease Area.

Conch Trap/Pot

Conch (channeled whelk *Busycotypus canaliculatus* and knobbed whelk *Busycon carica*) is targeted using pots but can also be landed as bycatch from the black sea bass pot fishery and the trawl fishery. Dedicated conch pots are set within a depth range of 5-33 m. This fishery has been expanding quickly in recent years and pots are now reported to be set in large numbers over broad areas, which may include the Lease Area.

Horseshoe Crab

Horseshoe crabs (*Limulus polyphemus*) are used for baiting fish and crustacean pots and for blood collection associated with a copper containing protein called hemocyanin. They have been harvested mainly by trawl, dredge, and by hand at the shoreline. Approximately 50% of the allowable catch is landed in state waters (1-3 nm from shore) and the rest in federal waters as a bycatch of trawl fisheries. The bycatch allowance is open from July through November. It is likely that some trawling occurs in the Lease Area.

Atlantic Deep-Sea Red Crab Trap/Pot

The Atlantic deep sea red crab (*Chaceon quinquedens*) fishery sets strings of traps from New England through the Mid-Atlantic, but the fishery is actively pursued only by 4-6 vessels based in New Bedford, Massachusetts, in depths of 400-600 m, well offshore of the Lease Area.

Hard Clam Dredge

Surf clams (*Spisula solidissima*) may be targeted by dredges near the Lease. Vessels targeting clams off Maryland typically fish one or two dredges at a time and operate at speeds near two knots. Ocean quahogs (*Artica islandica*) are generally targeted offshore in deeper water. One or two clam vessels were recently reported to work the general area of the Lease or slightly deeper.

Gillnets

Some gillnet fishing is likely to occur in the Project Area on a seasonal basis, notably in winter and early spring. Within Maryland state waters, there is limited effort for striped bass (*Morone saxatilis*). In federal waters, there is a seasonal fishery for monkfish (*Lophius americanus*) and other species, which has moved beyond the Lease at the present time.

Longline

There is a longline demersal fishery for tilefish (*Lopholatilus chamaeleonticeps*) that occurs in waters much deeper than those in the Lease. A pelagic (midwater) longlining fishery targets swordfish (*Xiphias gladius*) and various tuna species, but the lines are drifted much farther from the coast. It is unlikely that any substantial concentration of longline fishing occurs in the Project Area.

Trawling

It is likely that occasional trawling occurs in the Project Area.

Sea Scallop Dredge

In recent years the Atlantic sea scallop (*Placopecten magellanicus*) fishery has been closely managed and profitable. The important Delmarva and Elephant Trunk Access Areas fishing grounds are offshore of the Lease. Scallop dredging could occur in the Project Area, but most scallop dredging is likely to be concentrated farther offshore in deeper waters of 65-90 m.

Recreational Fisheries

Recreational fishing is very substantial in the Project Area.

Artificial Reefs

Artificial reefs have been established offshore Ocean City to provide substrate that encourages growth of marine invertebrates and provides protection for crustaceans and fish. They also provide recreational fishing opportunities. None are located within the Lease.

A recent BOEM study (Kirkpatrick et al. 2017) assessed existing commercial and recreational fisheries-related activities in the Maryland Lease for exposure to wind energy development. It also assessed exposure of shoreside dependents, which include businesses that directly support (e.g. gas stations, bait and ice dealers, transportation, etc.) and/or use the landings of commercial and recreational fisheries (e.g. first point of sale dealers, etc.). Exposed activities and stakeholders have the potential to be affected by Lease development. Impacts associated with exposure are varied and depend on factors such as the extent of the Lease developed, type of development, and the fishery exposed. Overall, the report finds the Maryland Lease is best characterized as being lightly fished commercially. The report concludes that generally, neither commercial and recreational fisheries nor their shoreside dependents, are highly exposed to development of the Maryland Lease (Kirkpatrick et al. 2017).

3.9.1.3 Recreational Use

Maryland's coastline and beach recreation areas attract many local citizens, as well as out of state visitors. Popular recreational activities include swimming, boating, fishing, and sunbathing. There are 68 beaches along the coast in the coastal counties of Anne Arundel, Baltimore, Calvert, Cecil, Kent, Queen Anne's, Somerset, St. Mary's, and Worcester (BOEM 2012).

Delaware's Sussex County has 26 miles of Atlantic Ocean coastline. Shorefronts in this area include 21 beaches, and a diversity of natural and developed landscapes that host substantial recreation, particularly in connection with marine fishing and beach-related activities (BOEM 2012).

Recreational boating activity occurs primarily inshore of the Lease Area except for that associated with recreational fishing

3.1.9.4 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 FR 7629 (February 11, 1994)), requires Federal agencies to incorporate environmental justice as part of their missions. Specifically, it directs them to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations. The Maryland Department of the Environment (MDE) is also legally obligated to enforce these requirements (MDE 2020).

Low-income and minority communities are most vulnerable to Environmental Justice issues. Often these communities do not have an organized community group that can serve as a point of contact. Additionally, these communities may house a disproportionate amount of polluting facilities putting residents at a much higher risk for health problems from environmental exposures (MDE 2020).

The average poverty rate (2015 – 2018) in Worcester County was 9.3, slightly lower than the state poverty rate of 9.4%, and lower than the national poverty rate of 14.1% (USCB 2020e). Seventeen percent of the population of Worcester County represented minority groups between 2015 and 2018; notably less than the state-wide percentage of 43.8% (USCB 2020a).

3.1.9.5 Visual Resources

The metocean buoy will be approximately 3.1 m (10.2 ft) tall. As the metocean buoy will be more than 28 km (15 nm) from the closest land near Ocean City and Berlin, Maryland, it will not be visible from shore. Although there are several historic and culturally significant resources in the vicinity of Ocean City and Berlin, the presence of a buoy more than 27 km (15 nm) away will not create any visual impact. Boaters and tourists traveling offshore may be able to see the buoy; however, due to the existing conditions (presence of other buoys, boaters, ships, etc.), it is unlikely that the presence of a relatively small buoy will significantly alter or diminish the visual aesthetic. Furthermore, because boats/ships are generally moving, close-up views of the buoy, and any associated impacts, would be brief (BOEM 2014).

3.1.10 Coastal and Marine Uses (§ 585.611(b)(8))

The Atlantic OCS in the vicinity of the Maryland Lease supports a variety of coastal and marine uses. Aside from commercial and recreational fishing, which is described in Section 3.1.9 (Social and Economic Resources), uses include shipping and marine transportation, air traffic and airports, and military activities.

3.1.10.1 Shipping and Marine Transportation

Commercial vessel traffic typically concentrates at the entrances of large bays, such as the Chesapeake and Delaware Bays. The Lease Area is located offshore between these two waterways approximately 176 km (95 nm) from the entrance to the Chesapeake and approximately 46 km (25 nm) from the entrance to Delaware Bay. These two bays provide access to several major U.S. east coast ports, including Baltimore, Maryland; Philadelphia, Pennsylvania; Wilmington, Delaware; and the Hampton Roads area of Virginia. Large commercial vessels (cargo ships, tankers, and container ships) use these ports to access upland rail and road routes to transport goods throughout the U.S. Other vessels using these ports include military vessels, commercial business craft (tug boats, fishing vessels, and ferries), commercial recreational craft (cruise ships and fishing/sight-seeing/diving charters), research vessels, and personal craft (fishing boats, house boats, yachts and sailboats, and other pleasure craft) (BOEM 2012).

The U.S. Coast Guard (USCG) designates shipping fairways and establishes traffic separation schemes (TSSs) that control the movement of vessels as they approach major ports. A non-mandatory TSS has been defined by the USCG near the mouths of both the Chesapeake and Delaware Bays (BOEM 2012). The Delaware Bay TSS consists of two approaches (SE and NE). Each approach has an inbound and outbound lane.

The Lease Area is located outside of the TSS for Delaware Bay, approximately 1.8 km (1 nm) from the southern approach. The metocean buoy location is approximately 11.1 km (6 nm) from the TSS. The placement of any metocean buoy within a TSS is prohibited (see 33 U.S.C. Section 1223).

Vessel traffic in the vicinity of Delaware Bay and the Lease Area generally follows the TSS routes however, vessels may also follow routes not designated on charts. These routes may be determined by factors such as vessel destination, depth requirements, and weather conditions. In the vicinity of the Lease Area and metocean buoy, the highest density of vessel traffic leaving the Bay is concentrated in the TSS areas. Further offshore the routes become more dispersed as vessels begin to transit south, some through the Lease Area to the east of the metocean buoy location, or even further east out to sea. The USCG Atlantic Coast Port Access Route Study (PARS) Interim Report also shows a smaller volume of tug and barge traffic transiting inshore of the Maryland Lease.

3.1.10.2 Airports

The airport closest to the Project site is the Ocean City Municipal Airport. This airport is more than 31.4 km (17 nm) from the metocean buoy location.

3.1.10.3 Military Activities

Military range complexes and civilian space program use areas, including restricted areas and danger zones, are established in areas off U.S. coastlines to allow military forces to conduct training and testing activities. The Lease Area is located in a naval operating area (OPAREA), Virginia Capes (VACAPES), where the Navy conducts surface, subsurface, and air-to-surface exercises training exercises. The VACAPES OPAREA extends along the coastlines of Delaware, Maryland, and North Carolina (BOEM 2012).

Within VACAPES, the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center's Wallops Flight Facility (WFF) is located approximately 77.8 km (42 nm) from the metocean buoy. NASA conducts science, technology, and educational flight projects from WFF aboard rockets, balloons, and UAV's, using the Atlantic waters for operations on almost a daily basis (BOEM 2012).

A small portion of the northwest corner of the Lease Area is located within the range of a U.S. Navy radar facility located at WFF. The metocean buoy is located to the east of this area. This radar facility is used to track launch and flight activities conducted by NASA and its partners. The radar may be used to track air-to-air, air-to-surface, surface-to-air, and surface-to-surface missile exercises, gunnery exercises, aircraft flights and rocket launches. When the Wallops Island radar is not in use for range support activities it may be released to the FAA (BOEM 2012).

3.1.11 Consistency Certification (§ 585.611(b)(9))

BOEM has performed a consistency review and issued a Regional Consistency Determination (CD) finding that SAP activities anticipated for the Maryland WEAs, including the installation, operation and decommissioning of meteorological towers and buoys, are consistent with the provisions of the Coastal Management Program of Maryland (USDOI and BOEM 2013). The State of Maryland concurred in a letter to BOEM on September 23, 2011. The SAP activities proposed by US Wind are consistent with the activities anticipated in the BOEM consistency review; therefore, no further consistency review certification should be required.

3.1.12 Air Quality

Air quality is characterized by comparing the ambient air concentrations of criteria pollutants to the National Ambient Air Quality Standards (NAAQS), which have been established by the EPA to be protective of human health and welfare. The Clean Air Act (CAA) establishes two types of national air quality standards: (1) primary standards, which set limits to protect public health, including the health of "sensitive" populations (e.g., asthmatics, children, and the elderly); and (2) secondary standards, which set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (NAAQS 2019). The NAAQS have been established in 40 CFR Part 50 for each of the seven criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$, particulate matter with a diameter less than or equal to 10 and 2.5 µm, respectively), and lead (Pb) (NAAQS 2019).

Ambient air quality concentrations of criteria pollutants are determined using data collected by monitoring stations that are mainly operated by the states. These monitoring sites provide long-term assessment of pollutant levels by measuring the quantity and types of certain pollutants in the surrounding, outdoor air. When the monitored pollutant levels in an area exceed the NAAQS for any pollutant, the area is classified as “nonattainment” for that pollutant. The State of Maryland is presently “in attainment” (or compliant with) with the NAAQS, except for the Baltimore and Washington D.C. metropolitan areas. These densely populated urban core areas are presently in nonattainment with the ozone NAAQS, as are most large east coast population centers.

The FLS200 power system is fully redundant and autonomous, using three independent sources of charging power including solar panels, wind generators, and an EFOY Pro fuel cell. GEL batteries provide power storage. The back-up fuel cell system has the capacity to power the entire buoy for approximately 30 days.

There is no discharge from the solar panels, wind generators, and batteries into the environment.

It is anticipated that the fuel cell power system operating hours will be minimal and that the exhaust gases produced during the operation of the fuel cell will consist of carbon dioxide and water. Methanol concentration in the exhaust fluid is expected to be 1.3 grams per liter of fluid.

3.2 Potential Impacts

To assess the SAP activities described in Section 1.0, impacts have been classified into one of four levels – negligible, minor, moderate, or major, according the MMS Programmatic Environmental Impact State for Alternative Energy as described below (USDOI and MMS 2007).

The impact levels are defined as follows:

- Negligible: No measurable impacts.
- Minor: Most impacts to the affected resource could be avoided with proper mitigation. If impacts occur, the affected resource will recover completely without any mitigation once the impacting agent is eliminated.
- Moderate: Impacts to the affected resource are unavoidable. The viability of the affected resource is not threatened although some impacts may be irreversible, OR The affected resource would recover completely if proper mitigation is applied during the life of the project or proper remedial action is taken once the impacting agent is eliminated.
- Major: Impacts to the affected resource are unavoidable. The viability of the affected resource may be threatened, AND The affected resource would not fully recover even if proper mitigation is applied during the life of the project or remedial action is taken once the impacting agent is eliminated.

3.2.1 Vessel Related Potential Impacts

The vessel activities necessary to deploy, operate, and remove a metocean buoy have the potential to affect coastal habitats and terrestrial animals, marine mammals and sea turtles, air quality, and navigation, transportation, and military operations. Potential impacts to these resources are described below.

Although other resources (i.e., commercial and recreational fishing, water quality, birds) could experience minor side effects from vessel related activities, due to the very limited number of vessels and vessel trips associated with the SAP activities, those effects are expected to be less than negligible; and therefore, will not be described further.

Certain non-routine events associated with vessel activities, although unlikely, include collisions and spills. Vessels associated with deployment, operation, and decommissioning could collide with other vessels and experience accidental capsizing or result in a diesel spill. Collisions are considered unlikely since vessel traffic is controlled by multiple routing measures, such as safety fairways, Traffic Separation Schemes, and anchorages. These higher traffic areas were excluded from the Lease Area, as described in (BOEM 2012). A diesel spill could also occur as a result of accidents or natural events. Vessels are expected to comply with USCG requirements relating to prevention and control of oil spills.

3.2.1.1 Coastal Habitats and Terrestrial Mammals

Increased minimal vessel traffic associated with SAP activities could impact coastal habitats and terrestrial mammals due to wake erosion and associated sediment disturbance. However, given the existing volume and commercial/industrial nature of existing vessel traffic in the SAP Area, only a negligible increase, if any, to wake-induced erosion may occur around smaller, non-armored, waterways used by project vessels. Therefore, potential impacts are expected to be negligible, if any.

3.2.1.2 Marine Mammals and Sea Turtles

Increased vessel traffic associated with SAP activities could impact marine mammals and sea turtles due to the noise from work boats. Vessel noise is primarily composed of low-frequency components caused by propeller cavitation, though rotational and reciprocal machinery movement, and hydrodynamic water movement over the boat hull also contribute to sound generation (Hildebrand 2009). As the intensity of vessel noise is largely related to ship size and speed (Hildebrand 2009), exposure of marine mammals and sea turtles to noise from deployment vessels would be variable. Reactions of marine mammals may include apparent indifference, cessation of vocalizations or feeding activity, and evasive behavior (e.g., turns, diving) to avoid approaching vessels (Richardson et al. 1995, Nowacek and Wells 2001). Recent research has indicated that porpoises can exhibit behavioral response to low levels of high frequency sound present in vessel noise (Dyndo et al. 2015), and North Atlantic right whale (NARW) are vulnerable to communication masking due to low frequency vessel traffic (Hatch et al. 2012). Similarly, high levels of vessel traffic (e.g. from whale watching operations) have been noted to cause behavior changes in many cetacean species (reviewed in Parsons 2012). However, because the SAP Area and adjacent waters are well-traveled and host active fishing (recreational and commercial) and commercial shipping industries, marine mammals and sea turtles in the area are likely habituated to these existing conditions. Increases in vessel noise in the area due to SAP activities are expected to be insignificant. Any impacts to marine mammals or sea turtles would be temporary, with behavior rapidly returning to normal following passage of a vessel, and it is unlikely that such short-term effects would result in long-term population-level impacts.

Vessels associated with the SAP activities could collide with marine mammals or sea turtles during transit. Vessel collisions with marine mammals can cause serious injury or death and are a leading cause of mortality for certain species. Baleen whales are most at risk from ship strikes, and species including fin whale, NARW, humpback whale, and sperm whale are particularly vulnerable (Laist et al. 2001). Most ship strikes resulting in severe injury or death occur from ships traveling at 14 knots or faster, and strikes from larger vessels (>80 m) are more likely to result in mortality (Laist et al. 2001).

The highly endangered NARW experiences the most numerous per capita vessel strikes (Vanderlaan and Taggart 2007) and is especially vulnerable because it primarily utilizes busy coastal areas, swims slowly, and congregates at or just below the water surface (NOAA Fisheries 2018). This species also shows no avoidance response when exposed to approaching vessels (Nowacek, Johnson, and Tyack 2003), perhaps indicating habituation to ubiquitous vessel noise in its habitat. However, vessel speed restrictions are very effective in decreasing NARW ship strikes; vessel speed limits of 10 knots have been shown to reduce ship strike mortality risk by 80-90% (Conn and Silber 2013). All SAP vessels will follow NOAA NMFS collision avoidance guidance, including vessel speed restrictions to minimize the risks to NARW and other marine mammals. Due to the implementation of vessel strike avoidance measures, and the limited intermittent nature of SAP activities, impacts to marine mammals from vessel strikes are expected to be negligible.

3.2.1.3 Air Quality

There are no emissions from the solar panels and batteries that power the buoy, and emissions from the fuel cell are comprised almost exclusively of water and carbon dioxide. Due to the short duration and low level of additional vessel traffic in the SAP Area over the course of the deployment, operation and removal of the metocean buoy, the existing air quality in the area, and the mitigation measures described in Section 3.3, the potential impacts to ambient air quality are expected to be negligible.

3.2.1.4 Navigation, Transportation, and Military Operations

There will be a very limited increase in vessel traffic associated with SAP activities, and only limited potential for impacts to navigation, transportation, and military activities. SAP activities, in accordance with the Lease, are subject to restrictions imposed by military and NASA needs, rules, and regulations. To address the requirements of its Lease and avoid such interference, coordination between the Department of Defense (DoD) and vessel operators and contractors will be required, as needed throughout SAP activities, to ensure there are not conflicts with and/or adverse impacts to military activities in the SAP Area. Thus, potential impacts to navigation, transportation, and military operations are expected to be negligible, if any.

3.2.2 Buoy-Related Potential Impacts

The presence of a metocean buoy, and its components, have the potential to affect geologic resources, benthic resources, fisheries and essential fish habitat, marine mammals and sea turtles, navigation, transportation, and military operations. Potential impacts to these resources are described below.

Although other resources could experience minor effects from the metocean buoy deployment, operation, and retrieval, those effects are expected to be less than negligible due to the very small size and temporary deployment of the buoy and are not described further.

3.2.2.1 Geologic Resources

It is anticipated that deployment of the metocean buoy would impact a small area of seafloor. Disturbance would be limited to the 1 m^2 (10.8 ft^2) anchor footprint plus a maximum mooring chain sweep of 65 m (213 ft) around the anchor. Thus, potential impacts to geologic resources are expected to be negligible, if any.

3.2.2.2 Water Quality

Buoy deployment will influence turbidity in the immediate vicinity of the anchor location. As the metocean buoy is bottom-moored, there will be a localized and temporary turbidity increase as sediments are disturbed due to initial contact of the anchor with the seafloor. Surficial sediments that may be disturbed are primarily composed of fine- to coarse-grained sand, with trace amounts of gravel (Section 3.1.1) and are expected to settle quickly.

Deployment of the metocean buoy is not anticipated to have any impact on water temperature or salinity levels.

3.2.2.2 Benthic Resources

Slow-moving or sessile organisms inhabiting benthic sediments in areas directly within the footprint of the anchor and chain sweep area will suffer mortality from crushing or burial. Although motile organisms, including crabs, lobsters, and sea scallops, may be able to vacate this area and avoid direct mortality, these organisms could be displaced by deployment and operation activities. Though benthic communities will experience localized mortality and habitat disturbance during deployment and operation, these impacts are expected to be temporary and spatially limited (chain sweep is expected to disturb an area with a radius of 65 m (213 feet) around the weight).

Habitat alteration will be associated with the introduction of hard substrate (cast iron/steel anchor and chains) in an area currently consisting of unconsolidated sands. Fouling organisms, including tunicates, sponges, bryozoans, algae, mussels, barnacles, and hydroids, are anticipated to colonize the new areas of hard substrate created by the buoy anchoring system. Removal of the buoy will result in mortality of these organisms. However, as the area of hard substrate associated with buoy structures is small, impacts on local benthic resources are expected to be negligible.

Indirect impacts from suspended sediments and sediment deposition resulting from buoy deployment and operation are possible, but expected to be extremely limited, due to the small size and temporary nature of the metocean buoy and anchoring system.

The area disturbed by buoy deployment activities will constitute a very small percentage of benthic habitats in the region, and organisms are expected to rapidly recolonize these locations from surrounding undisturbed habitats once the buoy has been removed. Examinations of monitoring results from the Block Island Wind Farm indicate that areas of seafloor disturbance associated with turbine installation, primarily caused by contact with lift boat spud legs and anchors, are likely to physically recover over a short time period; approximately 46% of disturbance areas had completely healed within one year of construction activities (HDR 2018). Physical seafloor recovery was more rapid in areas of fine-grained sand than in areas of medium to coarse grained sand (HDR 2018). Benthic communities in mobile sand habitats, like those of the Maryland Lease, have also been observed to recover from natural sediment movement in less than a year (Lindholm, Auster, and Valentine 2004), though the rate of recovery can vary due to local species diversity and organism density. Studies examining dredging impacts have suggested benthic recovery times ranging from 3 months to 2.5 years (Brooks et al. 2006), 1.5 to 2.5 years (Wilber and Clarke 2007), and up to 3.0 years (Wilber and Clarke 2007). Recovery times are impacted by the size of the disturbed areas and the composition of the benthic community in surrounding habitats (Wilber and Clarke 2007), but community composition may not return to baseline conditions until three or more years after the disturbance event (BOEM 2016). As the area of seafloor that will be disturbed by the metocean buoy anchor and chain sweep is very small, the estimated recovery rates presented above are likely conservative. Thus, impacts to benthic resources from SAP activities are anticipated to be negligible.

3.2.2.3 Fisheries and Essential Fish Habitat

The presence of the metocean buoy would result in loss of a very small amount of fish habitat and would cause some temporary and localized increases in suspended sediment, due to anchor placement and chain sweep. Suspended sediments are expected to rapidly settle out onto the surrounding seafloor. Due to the small footprint of disturbance relative to the overall available fisheries habitat, the temporary nature of the buoy deployment, and the availability of similar habitat adjacent to the SAP Area, the buoy is expected to have negligible, if any, effects on fish resources.

3.2.2.4 Marine Mammals and Sea Turtles

Deployment of the metocean buoy would result in the disturbance of small areas of the seafloor and the addition of a small amount of man-made structure to the marine habitat. This activity could conceivably impact marine mammals and sea turtles by removing a small amount of forage area that would otherwise be available to these species. However, the metocean buoy will not physically restrict marine mammal movement. Due to the small footprint of disturbance, the temporary nature of the action, and the availability of similar benthic habitats adjacent to the SAP Area, any impacts on marine mammals and sea turtles. are expected to be negligible.

3.2.2.5 Navigation, Transportation and Military Operations

The presence of a metocean buoy has the potential to interfere with existing vessel traffic and military operations. The mitigation measures described in Section 3.3 will significantly reduce any potential impacts to navigation, transportation and military operations. Thus, potential impacts to navigation, transportation and military operations, if any, are expected to be negligible.

3.3 Mitigation Measures

In accordance with the Lease and BOEM's 2012 Environmental Assessment, the following subsections describe the Standard Operating Conditions (SOCs) pertinent to the deployment, operation, and removal of a temporary metocean buoy.

BOEM has developed several measures, called SOCs, to minimize or eliminate impacts on protected species. These SOCs were developed through consultation with other Federal and State agencies. The following mitigation measures are derived from BOEM's SOCs and supplemented with additional measures to ensure protection to the affected resources.

For cultural resources and biologically sensitive habitats, the primary mitigation strategy is avoidance. The location of the metocean buoy was selected to avoid adverse effects to offshore cultural resources or biologically sensitive habitats.

3.3.1 Vessel Strike Avoidance Measures

The measures in this section are quoted directly from the Lease and are applicable to the preparation of a SAP and a Construction and Operations Plan (COP). These measures are not applicable to approved SAP activities, although the measures used in the activities described herein are expected to be similar.

4.1.1. <u>Vessel Strike Avoidance Measures</u>. The Lessee must ensure that all vessels conducting activities in support of plan (i.e., SAP and COP) submittal, including those transiting to and from local ports and the lease area, comply with the vessel strike avoidance measures specified in stipulations 4.1.1 through 4.1.1.9 in the amendment to Lease OCS-A 0490, issued in January 2018, except under extraordinary circumstances when complying with these requirements would put the safety of the vessel or crew at risk

4.1.1.1. The Lessee must ensure that vessel operators and crews maintain a vigilant watch for cetaceans, pinnipeds, and sea turtles and slow down or stop their vessel to avoid striking these protected species.

4.1.1.2. The Lessee must ensure that vessels 19.8 meters (m) (65 feet [ft]) in length or greater that operate between November 1 through April 30, operate at speeds of 10 knots (11.5 miles per hour [mph]) or less.

4.1.1.3. The Lessee must ensure that from November 1 through April 30, vessel operators monitor NMFS North Atlantic Right Whale reporting systems (e.g., the Early Warning System, Sighting Advisory System, and Mandatory Ship Reporting System) for the presence of NARWs.

4.1.1.4. The Lessee must ensure that all vessel operators comply with 10 knot (18.5 kilometers per hour [km/hr]) speed restrictions in any DMA.

4.1.1.5. <u>North Atlantic Right Whales:</u>

4.1.1.5.1. The Lessee must ensure all vessels maintain a separation distance of 500 m (1,640 ft) or greater from any sighted North Atlantic right whale.

4.1.1.5.2. The Lessee must ensure that the following avoidance measures are taken if a vessel comes within 500 m (1,640 ft) of any North Atlantic right whale:

4.1.1.5.2.1. If underway, any vessel must steer a course away from any North Atlantic right whale at 10 knots (18.5 km/h) or less until the 500 m (1,640 ft) minimum separation distance has been established (except as provided in 4.1.1.5.2.2)

4.1.1.5.2.2. If a North Atlantic right whale is sighted within 100 m (328 ft) to an underway vessel, the vessel operator must immediately reduce speed and promptly shift the engine to neutral. The vessel operator must not engage the engines until the North Atlantic right whale has moved beyond 100 m (328 ft), at which point the Lessee must comply with 4.1.1.5.2.1 above.

4.1.1.5.2.3. If a vessel is stationary, the vessel must not engage engines until the North Atlantic right whale has moved beyond 100 m (328 ft), at which point the Lessee must comply with 4.1.1.5.2.1.

4.1.1.6. <u>Non-Delphinoid cetaceans other than the North Atlantic Right Whale</u>.

4.1.1.6.1. The Lessee must ensure all vessels maintain a separation distance of 100 m (328 ft) or greater from any sighted non-delphinoid cetacean.

4.1.1.6.2. The Lessee must ensure that the following avoidance measures are taken if a vessel comes within 100 m (328 ft) of any non-delphinoid cetacean:

4.1.1.6.2.1. If underway, the vessel must reduce speed and sift the engine to neutral and must not engage the engines until the non-delphinoid cetacean has moved beyond 100 m (328 ft).

4.1.1.6.2.2. If stationary, the vessel must not engage engines until the non-delphinoid cetacean has moved beyond 100 m (328 ft).

4.1.1.7. <u>Delphinoid cetaceans and Pinnipeds (dolphins, porpoises and seals).</u>

4.1.1.7.1. The Lessee must ensure that all vessels underway do not divert to approach any delphinoid cetacean and/or pinniped.

4.1.1.7.2. The Lessee must ensure that all vessels maintain a separation distance of 50 meters (164 ft) or greater from any sighted delphinoid cetacean or pinniped, except if the delphinoid cetacean and/or pinniped approaches the vessel, in which case, the Lessee must follow 4.1.1.7.3 below.

4.1.1.7.3. If a delphinoid cetacean and/or pinniped approaches any vessel underway, the vessel underway must avoid excessive speed or abrupt changes in direction to avoid injury to the delphinoid cetacean and/or pinniped

4.1.1.8. <u>Sea Turtles.</u>

4.1.1.8.1. The Lessee must ensure all vessels maintain a separation distance of 50 meters (164 feet) or greater from any sighted sea turtle.

4.1.1.9. <u>Vessel Operator Briefing.</u> The Lessees must ensure that all vessel operators are briefed to ensure they are familiar with the requirements specified in 4.1.1.

<u>3.3.2 Marine Trash and Debris Prevention</u>

The measures in this section are quoted directly from Lease OCS-A 0490.

The Lessee must ensure that vessel operators, employees, and contractors actively engaged in activity in support of plan (i.e., SAP and COP) submittal are briefed on marine trash and debris awareness and elimination, as described in the BSEE NTL No. 2012-GOI ("Marine Trash and Debris Awareness and Elimination") or any NTL that supersedes this NTL, except that the Lessor will not require the Lessee, vessel operators, employees, and contractors to undergo formal training or post placards. The Lessee must ensure that these vessel operator employees and contractors are made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment. The above-referenced NTL provides information the Lessee may use for this awareness training.

<u>3.3.3. Fisheries Communications Plan (FCP) and Fisheries Liaison</u>

During planning for the Project, US Wind met with commercial and recreational fishing stakeholders to inform fishermen and shoreside dependents about the Project and identify stakeholder concerns. US Wind will continue to communicate with fishermen and fishing interests through these stakeholder groups during the metocean buoy deployment, operation, and decommissioning phases of the Project.

<u>3.3.4 Entanglement Avoidance</u>

Entanglement avoidance requirements are not provided in the Lease. However, US Wind plans to implement the following measures to minimize entanglement risks during SAP activities.

- structures or devices attached to the seafloor for continuous periods greater than 24 hours will use the best available mooring systems for minimizing the risk of entanglement or entrainment of marine mammals, manta rays and sea turtles, while still ensuring the safety and integrity of the structure or device. The best available mooring system may include, but is not limited to, vertical lines (chains, cables, or coated rope systems), swivels, shackles, and anchor designs.

- All mooring lines and ancillary attachment lines must use one or more of the following measures to reduce entanglement risk: shortest practicable line length, rubber sleeves, weak-links, chains, cables or similar equipment types that prevent lines from looping or wrapping around animals or entrapping protected species.

3.3.5 Buoy Markings and Lighting

Navigation lights for the buoy will comply with USCG requirements. In addition, support vessels will be used only when necessary and vessel lighting will be hooded and directed downward, when possible, to reduce upward illumination and illumination of adjacent waters.

3.3.6 Buoy Notifications

US Wind will submit a Local Notice to Mariners (LNTM) for the proposed work in planned survey areas and expected timing to the US Coast Guard. The schedule of activities and an outline of the survey area will also be submitted to U.S. Navy Fleet Forces. US Wind will communicate the exact Global Positioning System (GPS) location of the buoy with the USCG, DoD, BOEM, and all other pertinent agencies.

3.3.7 Air Quality Control Measures

Given the minimal air emissions associated with SAP activities, the appropriate mitigation measures are consistent with industry standard, area-wide measures for marine vessels. This includes existing fleet wide requirements for engine certifications (for 40 CFR Part 89, Tier 3 or 4 engines typical), emissions control equipment, and regular maintenance along with the use of ultra-low sulfur diesel fuel.

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Appendix A

Metocean Buoy and Sensor Specifications

Ocean Tech Services, LLC
MARINE MONITORING SYSTEMS AND SURVEYS

21 July, 2020

Summary of Mooring Design and Modelling Approach, Environmental Data Inputs
US Wind Maryland, Floating Lidar Buoy

Ocean waves and currents are the two main drivers of buoy motions, and consequently of forces on the moorings. The reaction of the mooring to forces on the buoy are modeling using a software program Proteus DS, a well-known marine engineering simulation package that represents accurately the effects of waves, currents, and winds on structures (buoys, moorings) in the ocean.

Typically, models are run for various conditions: extreme and mean conditions. To obtain these data, we rely on U.S. governmental sources: in particular, the **U.S. Army Corps of Engineers Wave Information Service (WIS)**, and the **National Oceanographic and Atmospheric Administration's National Data Buoy Center**. These two sources represent decades of measurements and or advanced modeling results describing ocean wave conditions.

For the **USACE WIS** study, we rely on station 63165 (Maryland) and stations adjacent to it. For the period of 1980 to 2014 (35 years), simulations are run of ocean wave conditions, capturing the most energetic waves for that period. In this case, the 100-year storm event significant wave height is approximately 8.2m, with a peak spectral period of 12 seconds. The dominant direction is from the east.

For the **NOAA NDBC** study, we analyse NDBC station 44009, which has measured waves for approximately 22 years (1986 to 2008), within the period of the WIS studies. The highest significant wave height during that period was 7.6m, with a dominant wave mean period of up to 16 seconds.

For the mooring modeling, we would use a significant wave height of 8.2m with a peak spectral period of about 15 seconds, as the extreme event. For normal conditions, we would use 1.5 m waves at 8 seconds dominant period. Dominant direction is from the east.

For currents, the NOAA NDBC presents current data derived from high frequency surface radar. Extreme currents are close to 50 cm/sec, varying in direction. For current modeling, we use 50cm/sec as an extreme current, and 25 cm/sec as a normal current. As for direction, the worst case mooring tension occurs when waves are collinear with currents, so in the modeling we force the currents to be co-linear with the waves.

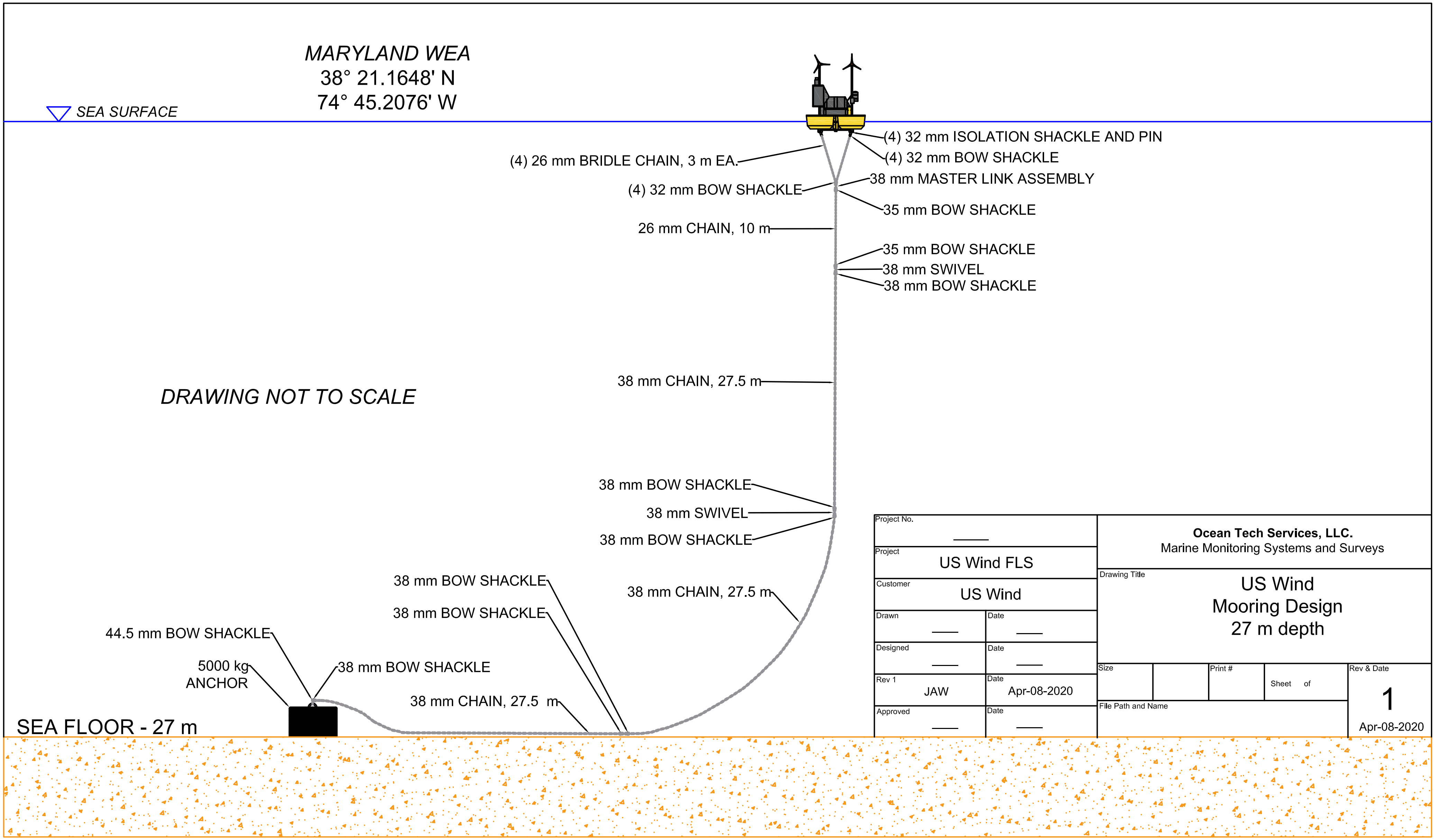
Site Environmental Conditions - US Wind Maryland Inputs to Mooring Design and Modelling				
Waves				
	Return Period	**Spectral Period**	**Dominant Direction**	**Data Sources**
Normal Conditions	1.5m	15 sec	East	USACE Wave Info Service (WIS), NOAA National Data Buoy Ctr
100 Yr RP	8.2m	8 sec	East	
Currents				
	Velocity	**Direction**		
Normal Conditions	25 cm/s	co-linear w waves		
Extreme	50 cm/sec	co-linear w waves		

Results from the analysis process will demonstrate that the proposed mooring system is adequate to withstand extreme environmental conditions corresponding to the 10-year ARP.

For this US Wind location, environmental conditions and water depth, it is anticipated that the overall layout will be comprised of a single 1" – 1-1/2" catenary chain, approximately 95m in length, yielding a 3.5:1 mooring length to water depth ratio. Associated hardware will include shackles, links and swivels. The anchor will be a single cast iron weight of 11,000 #.

A preliminary Mooring Design Diagram is Attached.

Individual hardware components will be sized and selected in accordance with anticipated loading derived from modelling. All mooring chain sections are to be of high-quality steel. All hardware (links, shackles, swivels) will be of high grade galvanized US steel.


MARYLAND WEA
38° 21.1648' N
74° 45.2076' W
SEA SURFACE
DRAWING NOT TO SCALE
(4) 32 mm ISOLATION SHACKLE AND PIN
(4) 32 mm BOW SHACKLE
(4) 26 mm BRIDLE CHAIN, 3 m EA.
38 mm MASTER LINK ASSEMBLY
(4) 32 mm BOW SHACKLE
35 mm BOW SHACKLE
26 mm CHAIN, 10 m
35 mm BOW SHACKLE
38 mm SWIVEL
38 mm BOW SHACKLE
38 mm CHAIN, 27.5 m
38 mm BOW SHACKLE
38 mm SWIVEL
38 mm BOW SHACKLE
38 mm BOW SHACKLE
38 mm CHAIN, 27.5 m
38 mm BOW SHACKLE
44.5 mm BOW SHACKLE
5000 kg
ANCHOR
38 mm BOW SHACKLE
38 mm CHAIN, 27.5 m
SEA FLOOR - 27 m
Project No.
Project
US Wind FLS
Customer
US Wind
Drawn
Date
Designed
Date
Rev 1
JAW
Date
Apr-08-2020
Approved
Date
Ocean Tech Services, LLC.
Marine Monitoring Systems and Surveys
Drawing Title
US Wind
Mooring Design
27 m depth
Size
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The EOLOS FLS0200 LiDAR Buoy is a fully-equipped and autonomous wind, wave and current measuring system based on market leader ZX Lidars technology accompanied by oceanographic instrumentation, which allows for the collection of wind measurements at heights of more than 200m over the sea level at much lower costs than conventional bottom-fixed offshore met masts.

The EOLOS FLS200 is a marine buoy type of the following form:

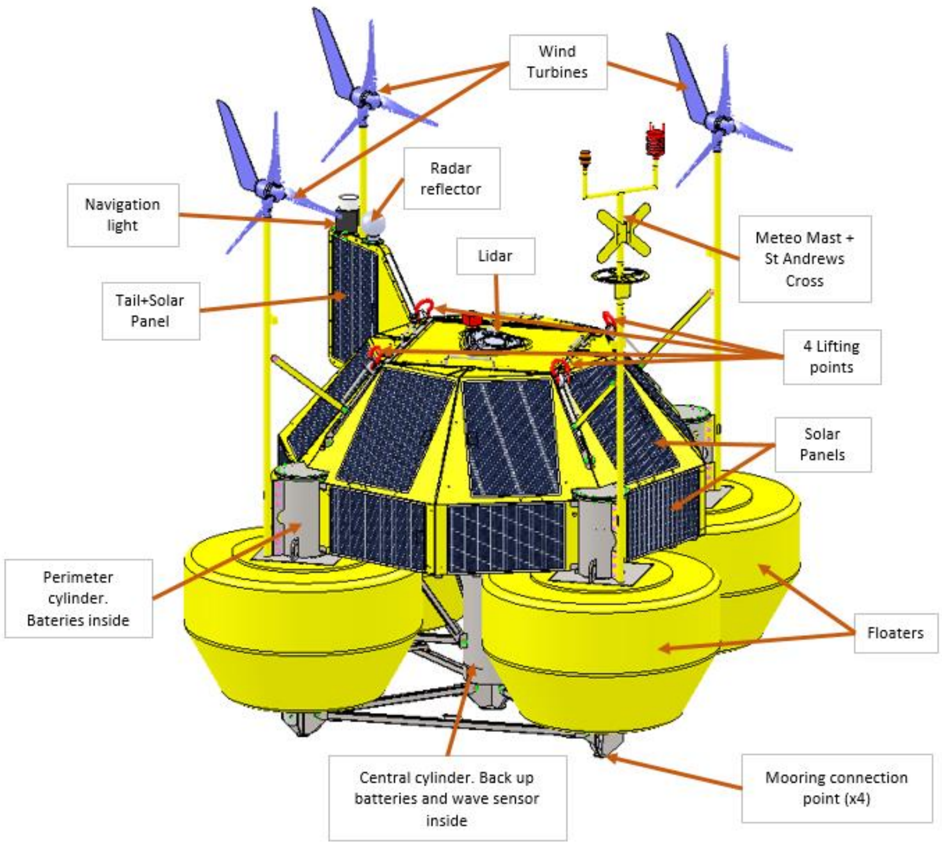


Figure 1: FLS200 Buoy description scheme

The EOLOS FLS200 power system is fully redundant and autonomous, using 3 independent sources of power, minimizing the risk of a power shortage in any weather circumstance or unforeseen event (such as failure of one of the power systems). There is no diesel generator on-board.

Table 1: Painting protection and AToN characteristics of the different elements of the FLS200

Floaters	Polyurethane based paint RAL 1023
Fiberglass	Topcoat for polyester RAL 1023
Stainless steel	Yellow RAL 1023
Underwater stainless steel	Antifouling

Wind resource measurements

- Lidar Type: ZX Lidars 300M
- Speed
- Altitude
- Direction

Ocean measurements

- Wave height
- Wave periodicity
- Current flow
- Water and air temperatures
- Other meteorological attributes
- Customisable data capture such as avian surveys

Data communication

- Satellite / 4G / WiFi Via Eolos Connect

Marine approvals

- RAL 1023 Yellow
- Fully compliant with IALA
- Radar reflector
- Marine Lantern
- Redundant GPS Location
- Drift alarm

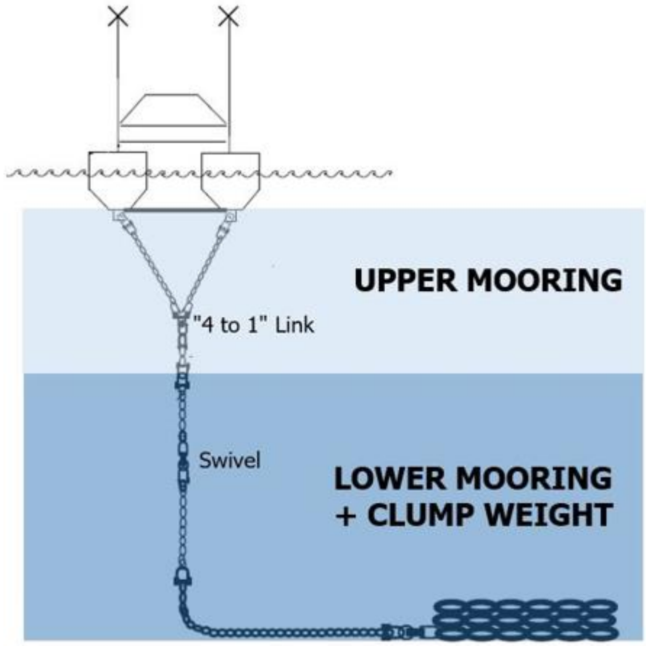
Obstruction Light
A Carmanah M701 self-contained LED obstruction lamp is installed on the Buoy.

Radar reflector
A passive radar reflector giving a homogeneous response inside a wide angle.

St. Andrew cross
The FLS200 Buoy is provided with a yellow St. Andrew cross as a special mark according to the IALA regulations for Aids to Navigation (AToN) for an ODAS Buoy.

Automatic Identification System (AIS)
EOLOS can equip its unit with an AIS system upon request according to local requirements.

Positioning alarm system
In event of a catastrophic failure of mooring or tethering, the Buoy is provided with a real time GPS and Iridium satellite communication system.


UPPER MOORING
"4 to 1" Link
Swivel
LOWER MOORING
+ CLUMP WEIGHT

Lotek

AVIAN TERRESTRIAL MARINE FRESHWATER

SRX800

Technology: **Radio**

Product: **Receiver**

The original Smart Receiver

Lotek SRX receivers have been assisting fisheries and wildlife researches answer questions regarding the behavior of animals in their natural environment since the SRX400 was first introduced in 1991. Inspired by the belief that in order to provide effective tools to assist researchers, those tools must be readily adaptable to evolving research requirements.

As radio telemetry evolved from tracking small numbers of tagged animals by boat, plane, car or on foot, to a standard research tool in large-scale research projects, monitoring behavior and migratory patterns of thousands of animals over hundreds of miles, the SRX receiver likewise evolved to become the standard by which radio telemetry receivers are measured. Performance and reliability are synonymous with their use.

The SRX800 is designed to meet the demands of today's research and is available in a feature-rich suite of readily scalable receiver models. The researcher can thus select the model that best meets immediate application needs and budgets constraints, with assurance their investment will continue to support evolving telemetry requirements.

Features:

Versatile:
Autonomous data-logging or mobile tracking capability

Superior Range:
Enhanced sensitivity

Coded Capability:
Supporting up to 728 unique IDs per channel

Extended Antenna Coverage:
Supporting up to 8 individual antennas

Product Applications

Species migration patterns, presence/absence monitoring, survival studies, passage/guidance efficiency, critical habitat use, species interactions.

SRX800 Model	M1	M2	D1	D2	D3	MD2	MD3	MD4
Keypad & display	Yes	Yes	-	-	-	Yes	Yes	Yes
Mobile tracking	Yes	Yes	-	-	-	Yes	Yes	Yes
Padded carry case	-	Yes	-	-	-	Yes	Yes	Yes
Pelican™ Case	-	-	Yes	Yes	Yes	-	-	-
Operating bandwidth	8 MHz	8 MHz	8 MHz	8 MHz	8 MHz	8 MHz	8 MHz	26 MHz
Sensor support [1]	-	Yes	-	Yes	Yes	Yes	Yes	Yes
Autonomous datalogging	-	-	Yes	Yes	Yes	Yes	Yes	Yes
Max # of antennas	1	1	4	4	4	8	8	8
Max coded frequencies	7	128	1	7	128	7	64	128
Max beeper frequencies	20	128	20	64	128	64	64	128
Memory [3]	-	1 MB	4 MB	4 MB	16 MB	4 MB	4 MB	16 MB
Max event capacity	-	250K	1M	1M	4M	1M	1M	4M
GPS clock & position	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Code ID & channel filter [2]	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes
Monitor mode [3]	-	Yes	-	-	-	-	-	-
CRTO [4]	-	-	Yes	Yes	Yes	Yes	Yes	Yes
AGC [5]	-	-	Yes	Yes	Yes	Yes	Yes	Yes
TOA [6]	-	-	Yes	Yes	Yes	Yes	Yes	Yes
ON/OFF scheduler [7]	-	-	-	Yes	Yes	-	-	-
Remote terminal control [8]	-	-	-	-	-	-	-	Yes

The SRX800 supports a wide variety of user-selectable features and options to best meet application-specific needs. Among them:

1. Sensor Support: Supports coded multi-sensor tags including temperature, pressure, activity and EMG. Depending on tag model selected, temperature, pressure and activity data may be logged directly on the tag, as well as be transmitted for detection by receiver. A bi-modal (active/inactive) motion tag option is also available.

2. Code ID & Channel Filter: Supports the ability to accept or reject specific coded tag IDs or combinations (up to 100 individual entries). The feature is beneficial in both manual and data logging operations, as it allows user to monitor specific tags of interest.

3. Memory Capacity/Monitor Mode: 1MB applies to use of the Monitor Mode feature, that allows users to manually log detected events, including date and time tag ID, sensor data, signal strength and GPS position for user-specified durations during mobile tracking sessions.

4. CRTO (Continuous Record on Time-out): A flexible option to conserve memory by providing summary detections over a user-specified time period.

5. AGC (Adaptive Gain Control): User-selectable feature that enables the receiver to dynamically adjust gain to compensate for prevailing local ambient noise conditions.

6. TOA (Time-out on Acquisition): With TOA enabled, the receiver monitors each frequency and antenna combination specified in its active configuration only until the first valid detection is logged. Total scan cycle time is reduced accordingly.

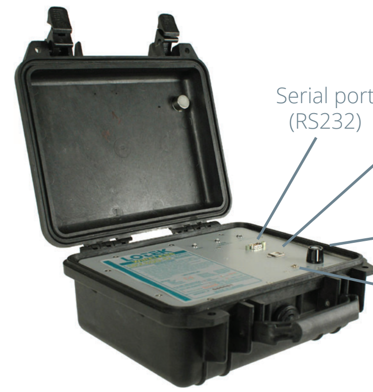
7. ON/OFF Scheduler: The Wake Up Sleep utility defines scanning and logging periods based on a user-defined time window within a 24 hour period, thereby conserving both storage capacity and energy budget for externally powered datalogging stations.

8. Remote control: Supports remote data download and the ability to upload a new configuration to the receiver via modem connection (modem not included).

Lotek

SRX800

SRX800 D1, D2, D3:



SRX800 M1, M2, MD2, MD3, MD4:

Technical specifications:
Operating temperature range: -20° C to +55° C
LCD: from -5° C (SRX800 M1, M2, MD2, MD3, MD4)
Operating voltage range: 8-10V DC (nominal 9V) (SRX800 M1, M2, MD3, MD4)
Operating voltage range: 9-16V DC (nominal 12V) (SRX800 D1, D2, D3)
Operating frequency range: 138 to 176 MHz
Channel spacing: 1 KHz
Sensitivity: -150 dBm (minimum discernible audio level)
-135 dBm (minimum discernible software)
Gain control range: 90 dB
I/O: RS232 and USB
Antennas: 1- 8 (SRX800 M1, M2, MD3, MD4)
Antennas: 1- 4 (SRX800 D1, D2, D3)

Warranty

SRX800 receivers are warrantied to be free of defects in materials and workmanship under Normal Use for a duration of 24 months from time of sale.
For Warranty terms and conditions, please review our Warranty Statement.

Accessories

SRX800 D1, D2, D3 models require an external power supply.
All models require antennas.

LS1/LS1X

Applications
- Noise monitoring
- Seismic and pile driving
- Marine mammal monitoring
- Fish monitoring

Loggerhead Instruments is the industry leader in underwater passive acoustics recording with over 10 years of experience. Loggerhead recorders are in use throughout the world's oceans.

Features
- Includes everything needed to make recordings
- Sample rates: 8, 16, 32, 44.1, 48, 96 kHz
- Wav files saved to removable microSD
- Up to 4 microSD cards for huge storage
- Continuous or duty cycle recording

- Hydrophone easily removable for travel
- Hydrophone status LED
- Interchangeable hydrophones with custom gain settings

- Alkaline batteries (12 D-cell) make transportation easy

- LS1X model has twice the battery capacity

- Housings
  - LS1 PVC (17 x 4.5"): 300 m
  - LS1X PVC (25 x 4.5"): 300 m
  - Aluminum (25 x4.5"): 3000 m

Hydrophone Options: HTI-96-min, HTI-99-HF, HTI-99-UHF
Standard sensitivity: -170 dBV re:1µPa (US, Europe)
Standard export (max 1000m): -180 dBV re:1µPa (China)
Intense sound: -210 dBV re:1µPa (worldwide)

Example Deployment Times

Scenario	Record Duration (s)	Sleep (s)	Power Duration (days)	GB
Continuous (5 minute files)	300	0	50	381
5 minutes every 10 minutes	300	300	95	362
1 minute every 10 minutes	60	540	344	263
10 seconds every 10 minutes	10	590	760	96

Mounting
Optional MB-2 mounting brackets make it easy to attach the DSG-ST to an underwater mooring, bottom mount, or a subsurface line.
Optional 3 m tether allows you to position the hydrophone away from the housing.

VR2W Single Channel Receiver

With *Bluetooth*® Wireless Technology for Fast Data Offloads Bluetooth®

Receivers

The VR2W was designed using the same proven and reliable technology you've come to know and trust in all VEMCO receiving equipment. Affordable, compact, easy to use, long-lasting and flexible, the VR2W is ideal for research projects ranging from small river monitoring to freshwater lake studies to multi-researcher, multi-tracking operations in large oceanic systems.

VR2W Key Features

- Rapid upload speed using Bluetooth® wireless technology - after retrieving your VR2Ws, offload data quickly (100,000 bytes in ~8 seconds or roughly 10,000 detections) and from up to 7 receivers simultaneously
- Substantial data storage capacity - 16 MBytes (~1.6-million detections)
- Field upgradable design allows the VR2W unit to be upgraded in the field with future coding scheme enhancements
- Safe, robust data storage capability - the VR2W always retains every detection in non-volatile memory so all data is saved even if the unit unexpectedly fails

Simple to Use. The VR2W records the identification number and time stamp from acoustic transmitters as a tagged animal travels within receiver range. Depth, temperature and other sensor data can also be collected. After removing your VR2Ws from the water, data is downloaded quickly and easily in the field without opening the case by using your PC with Bluetooth® wireless technology. The VR2W system uses VUE software that is compatible with Windows XP SP2, VISTA or Windows 7 operating systems.

The VR2W operates with VUE PC software

The VEMCO User Environment (VUE) PC Software for initialization, configuration and data upload from VEMCO receivers allows users to combine data from multiple receivers of varying types into a single integrated database. Studies using 69 kHz and 180 kHz tags can also be combined into one VUE database.

The VEMCO Bluetooth Communications Package includes everything you need to talk to your VR2W:

- VUE Software
- Software Manual
- Two Magnetic Activator Probes
- Adapter for USB to Bluetooth®

VUE requires Windows XP SP3, VISTA, Windows 7, 8 and 10 operating systems. See VEMCO's website for more details on VUE Software.

Receivers | Transmitters | Accessories | Data Loggers

Tel: (902) 450-1700
Fax: (902) 450-1704

www.vemco.com

The VR2W from VEMCO is a flexible, cost effective receiver for remote monitoring

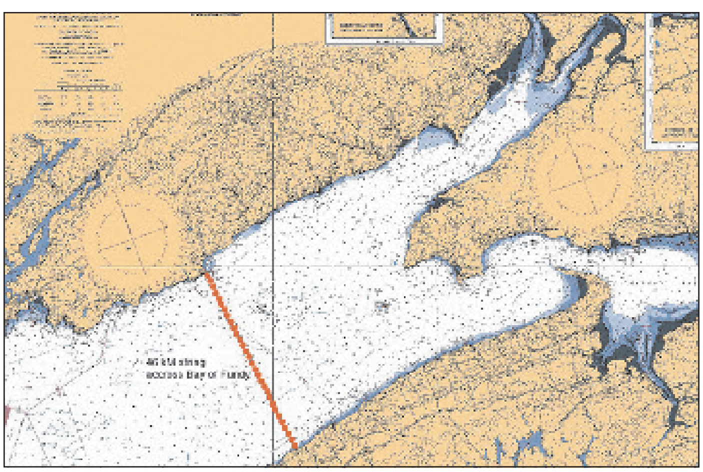
The VR2W is capable of identifying all VEMCO coded transmitters and provides marine biologists with a flexible and reliable means of recording fish telemetry data.

Compact. The VR2W consists of a hydrophone, receiver, ID detector, data logging memory, and battery all housed in a submersible case. The VR2W receiver's plastic high pressure case is lightweight and has a depth rating of 500 meters. The VR2W is easily moored or hidden underwater by a diver and can also be set up with an acoustic release system for highly inaccessible locations.

Proven Technology. The device has been used successfully in several studies including:

- The Pacific Ocean Shelf Tracking Project (POST) monitors the movement of marine animals through an array of listening stations set along the west coast of North America.
- Network of 250 receivers in the Bay of Fundy tracking the migratory patterns of several salmon groups.
- Ocean cod tracking off Nova Scotia using an array of 70 receivers.
- Fish passage monitoring at Tees River Barrage, UK.
- Endangered Giant Sea Bass monitoring off California.
- Lingcod site residency monitoring off Alaska.
- Monitoring of sturgeon, sharks and grouper species.

Flexible. The VR2W is ideal for acoustic telemetry projects ranging from small river monitoring to multi-researcher, multi-species tracking operations in large coastal areas. The receiver is effective at detecting all VEMCO 69 kHz tags including miniature and medium sized tags enabling a researcher to track a wide variety of fish species with the same receiver array.



VR2W Specifications	
Dimensions	308 mm long x 73 mm diameter
Weight	1190 g in air, 50 g in water
Power supply	1 - 3.6 V Lithium D cell battery
Battery life	Approximately 15 months
Maximum depth	500 metres
Receive frequency	69 kHz standard
Storage	16 MBytes non-volatile flash memory (~1.6-million detections)
Attachment	Standard: Cable ties
Firmware	Field upgradeable receiver firmware
Software	Compatible with VEMCO User Environment (VUE) software
Transmitters	Logs and decodes ALL VEMCO coded transmitters
Code Maps	Support for all current and planned VEMCO Code Maps

Long Field Life. The low current draw VR2W will last up to 15 months on a Lithium D battery. Because non-volatile memory is used, the data remains intact even with the loss of battery power. Coded transmitters used with the VR2W enable researchers to conduct longer term studies. Many transmitters last several years giving the researcher the benefit of collecting many years of behavioural data from the same animal.

Global Compatibility. The global proliferation of VR2Ws along with the ability to decode all VEMCO tags (including Global tags introduced in 2010), allows researchers to collaborate by sharing receiver network arrays and infrastructure the world over.

For more information on the specific applications of VR2W technology or for technical details, contact VEMCO.

vemco

EdgeTech
The Leader in Underwater Technology

PORT LF-SD

PUSH OFF RELEASE TRANSPONDER LOW FREQUENCY (SMALL DIAMETER)

FEATURES

- All Aluminum components
- Simple and easy maintenance
- Small lightweight package
- Medium load acoustic release
- Full transponder capability
- 1.25 years on alkaline batteries
- Reliable and secure command coding including Enable, Disable and Release commands
- Purge Port
- Auto Disable
- Tilt & Release indication

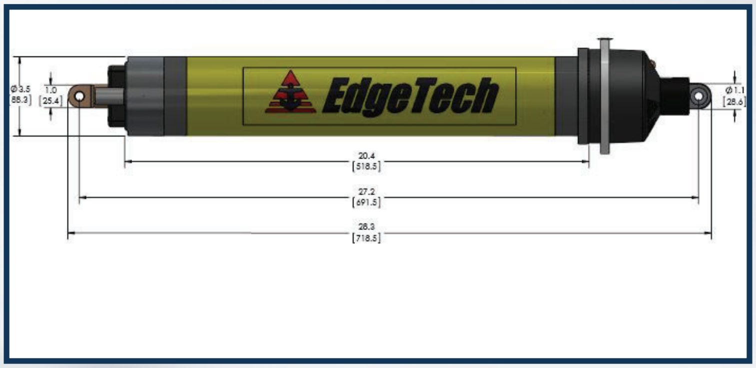
The PORT Push Off Release Transponder is ideal for deployments in coastal environments. The mechanical drive off system is the best choice for deployments where mechanisms can experience growth or sediment build up. The low frequency acoustic command structure is proven to be very reliable and is unsurpassed in multi-path environments.

PORT LF-SD

PUSH OFF RELEASE TRANSPONDER LOW FREQUENCY (SMALL DIAMETER)

KEY SPECIFICATIONS

MECHANICAL	
Release mechanism	High Torque Motor driven push off mechanism
Release load rating	250 kg (550 lbs)
Lifting load rating	750 kg (1650 lbs)
Depth rating	3500 meters (11400 ft) (crush depth 4700 meters)
Length	71.8 cm (28 in)
Diameter	8.9 cm (3.5 in)
Weight in air	7.0 kg (15.4 lbs)
Weight in water	3.0 kg (6.7 lbs)
Exposed materials	Hard Coated Aluminum, Plastic Buna –N (O-rings) Ultem and Nylon (isolation hardware)
ELECTRICAL	
Command frequencies	9.3 kHz to 10.7 kHz
Command codes	BACS commands (ORE Offshore)
Transmit Source Level	192 dB re 1 uPascal-meter
Receiver sensitivity	-78 dB re 1 uPascal-meter
Battery life Alkaline	1.25 Years & 10,000 replies



CELLULAR TRACKING TECHNOLOGIES

Internet of Wildlife™ Products

SensorStation™

A complete, all-in-one Motus compatible receiver for VHF and UHF radio tags.

SensorStation is a complete all-in-one Motus solution that is compatible with SensorGnome software. It features an integrated Raspberry Pi Compute Module 3+ with 16GB of storage, 7 FunCube compatible USB ports, 5 LifeTag receiving channels, and cellular connectivity. **The SensorStation future-proofs your radio telemetry installation**, and gives you the peace of mind to focus on your research, rather than worrying about your hardware.

The Future is Wide Open with SensorStation

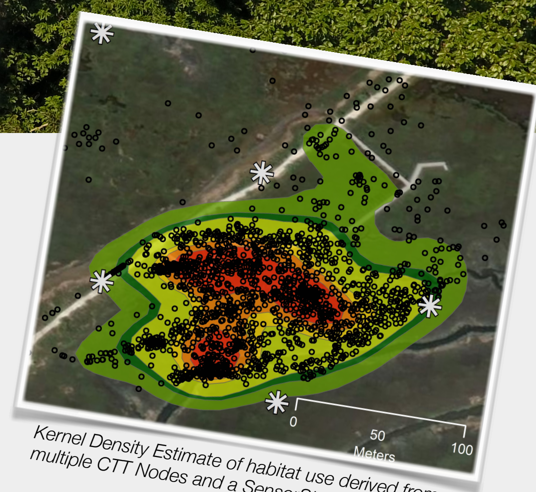
The SensorStation was built for today, with an eye on tomorrow. Being “tag-agnostic”, it works great with transmitters from multiple manufacturers. 434MHz and 166MHz are just the tip of the iceberg, as the SensorStation is ready for expansion across a full range of frequencies and technologies. **SensorStation is Open Source Software as well as Open Hardware,** so go forth and design your own sensors too…in fact we hope you do!

Internet of Wildlife

CTT SensorStation as the Backbone of a Fully Integrated Study Grid

Your five 434MHz SensorStation channels can be assigned to detecting tags, or to receive data from CTT Nodes™. By adding an array of CTT Nodes to your SensorStation network, you can collect high-resolution locational and movement data on tagged animals like never before! Home range, stopover habitat usage, and many other questions can now be answered on tiny species without needing to recover a tag!

CTT Node



Kernel Density Estimate of habitat use derived from multiple CTT Nodes and a SensorStation.

Optional Accessories and Services

- Outdoor readable display
- Waterproof case with latches and optional pre-drilled and installed antenna and power ports
- World band GPRS-GSM radio with non-removable, soldered eSIM to prevent data theft. Upgradable to 3G or 4G LTE via Mini PCI-e
- Best data rates available, due to our 1000s of registered SIMs, with two cellular data plan options (see below)
- Various plug in sensors, such as altimeter, pollutant monitoring, lightning, and more
- Argos USB adapter
- Other radio technologies: ULR, LoRa, LoRaWAN, FSK, GFSK, GMSK, and OOK from 142 - 1000MHz and 2.4GHz
- HopeRF compatible footprints for a wide variety of castellated radio receivers

CTT Data Plans

Health Reports Only Plan ($5/month)

- Remote system health reports
- Ability to remotely configure the five 434MHz radios

Health + Tag Data Plan ($5/month + Data) - All above plus:

- Data automatically sent to the Motus servers
- Access to the CTT interface for viewing, downloading and analyzing data

SensorStation Specifications

- USB 2.0 multi translator highspeed backplane
- 6 Widely Spaced, High power USB ports (for FunCube, RTL-SDR, etc.)
- 5 built in LifeTag receiver channels, all CTT Node compatible
- LifeTag receiver channels feature a smart radio design, allowing for optional technologies such as ULR
- Navigation buttons, data download buttons for USB thumb drives
- GSM radio can be configured to send tag data in real time, batched, or monitor health
- Integrated multi-GNSS GPS receiver with time pulse (PPS) wired to Raspberry Pi
- DS3231 extremely accurate real-time clock with battery backup
- Deep cycle battery and solar panel monitor ports
- 3 expansion ports for additional I2C sensors
- USB ports can be used for quick downloads of base station data, WiFi connectivity, and more
- Optional network connectivity for monitoring station health, data storage levels, and tag statistics
- Vertical SMA connectors
- 40 Pin Raspberry Pi interface for displays and other accessories
- Composite video out for external monitor
- LED indicator lights to show connectivity & download status
- Solar and 12v battery or A/C (120v/240v) compatible

CELLULAR TRACKING TECHNOLOGIES

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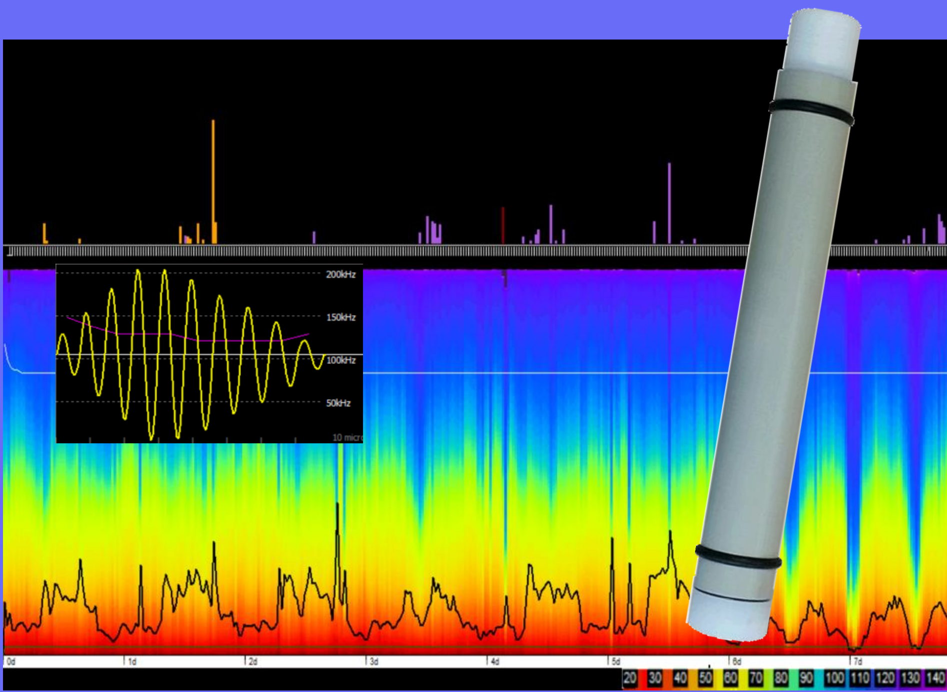
www.CellTrackTech.com Email: sales@celltracktech.com
+1-866-582-8707

Chelonia Limited
Wildlife Acoustic Monitoring

F-POD
New Features



WWW.CHELONIA.CO.UK

20 January 2020

The F-POD uses new electronics and software to capture more information and this has made starting and stopping the POD easier.

All other deployment procedures are the same as for the C-POD.

Major improvements

The F-POD:

- stores more information of higher quality on each click to enable improved train detection and species classification, so the need for visual validation is reduced.
- has on-board train detection that selects clicks in trains so that some representative full waveforms can be saved.
- detects short dolphin clicks more efficiently.
- can capture up to 21 cycles of a click and construct its waveform, providing new insights into the frequency slopes of NBHF.
- has automated adaptation to noise so that it does not often max out even in severe conditions.
- writes normal files to any SD card, up to 32GB, without any special formatting.
- runs two independent sonar detectors that detect and filter out boat sonars. A record is kept of sonar detections.
- has much reduced 'drop-out' of porpoise clicks.
- has an improved hydrophone with less Z-plane variation.
- has a real-time clock which you can set, e.g. to local time rather than UTC.
- takes lithium batteries without any modification giving longer deployment times than alkaline batteries.
- runs with reduced power consumption when conditions are quiet.
- has a deep-sleep mode which enables the POD to run for years, sampling every *n*th minute.
- can be set to start at a later date.
- can be set to switch on and off at different angles to the vertical.

Main differences between using the C-POD and F-POD

The main differences between the operation of the C-POD and F-POD are:

- Two SD cards are supplied with each F-POD. However, the F-POD can use any standard SD card up to 32GB. No special formatting is required.
- The F-POD has a real-time clock and so it is no longer necessary to record start and stop times. The correct UTC time is set during manufacture, but you can also set the clock time very simply, to local time for example, by using an SD card and the cpod.exe app.
- A new version of the POD app has been developed for use with the F-POD. The new app can also be used to compare C-POD and F-POD data.
- You can also change various operational settings for the POD, via the SD card and app.
- The POD starts automatically when an SD card is inserted.
- The POD has two multicolour LEDs.

Setup options

The F-POD app allows you change the following setup options:

- different types of battery
- continuous or intermittent logging
- boat sonar filtering
- automatic amplitude threshold control
- POD settings for different environments
- POD start time and date
- ON/OFF angle to vertical range
- real-time clock settings, e.g. use local time rather than UTC.

Chelonia Limited
Wildlife Acoustic Monitoring

The Barkhouse, North Cliff, Mousehole,
Penzance, TR19 6PH, UK
Tel: +44 (0)1736 732462
Email: team@chelonia.co.uk
Web: www.chelonia.co.uk
Company Registered in UK, no. 5472768

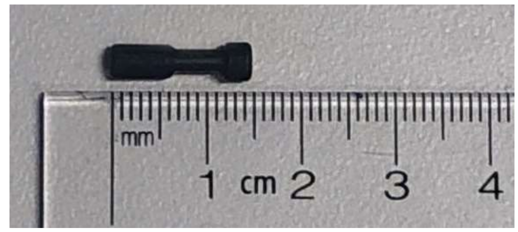
HR3 High Residence Receiver

vemco
innovasea

Receivers

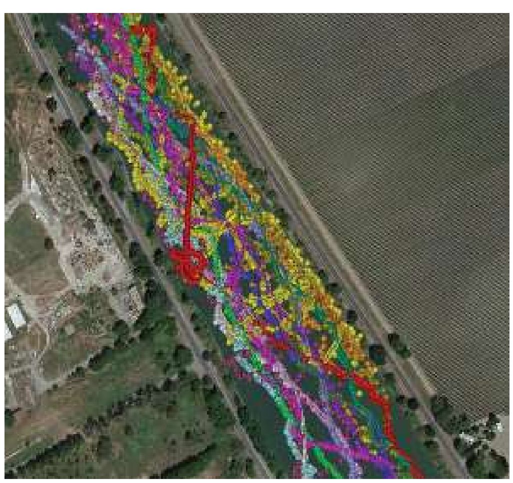
Track more small fish in less time and with more accuracy than ever before

The HR3 High Residence Receiver is an excellent choice for tracking many fish with higher accuracy than ever before using our 307 kHz V3 transmitter. The HR3 receiver and HR telemetry system was designed specifically to allow researchers to monitor or position many tagged animals with sub-meter accuracy.



The HR3 is capable of decoding two different methods of transmitting IDs to satisfy different study design objectives: HR Mode(High Residency),and HTI Mode. HR represents a more aggressive transmission system that offers the ability to detect many more tagged animals at once than our traditional PPM coding. Each HR ID code is embedded in every short ping transmitted by the tag. The HTI coding structure provides researchers with high performance in noisy and reflective environments. To provide collaboration/equipment efficiencies, the HR3 receivers can detect tags transmitting our traditional HR signal, or transmissions from HTI 307kHz tags. This means that the HR3 can be used with existing HTI 307 kHz transmitters.

Remotely monitor mooring integrity, lost receivers, or if fish have passed HR3 receivers, using a VR-100 surface receiver and a VHTx 307kHz transponding hydrophone (both sold separately). Query a moored HR3 for tilt, temperature, noise and number of detections, or program the on-board sync tag and then move on to the next receiver. If an HR3 shifts its mooring position or drifts away in the tide, locate it by setting up two-way communication between the HR3 receiver and VR100, and measure the precise distance between you and your HR3.



VEMCO Positioning System (VPS)

The HR3 has a built-in sync tag for receiver synchronization in 2D/3D positioning studies. When setting up a VPS study, use the HR3's transponding features to quickly verify if receiver spacing is appropriate to provide high accuracy positioning.

Real-time Monitoring

The HR3 supports real-time monitoring. Connect a cable to the bottom of the HR3 to communicate directly with the receiver via PC, or through a data logger or cellular modem to an IP address. Through the data port, offload detections, view data in real time, and check the health of the receiver.

Receivers | Transmitters | Accessories | Data Loggers

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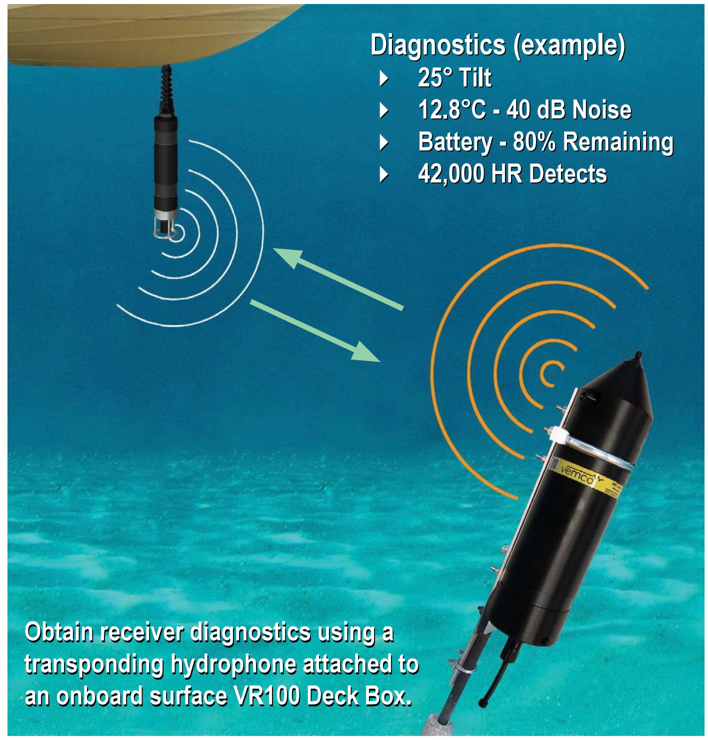
Transponding

Rather than employing a diver to check receivers, communicate with HR3s remotely from the surface to learn about their status (i.e. tilt, battery level, number of detections). Having transponding capability adds tremendous value in numerous scenarios including 2D/3D positioning studies, range testing, and knowing if any fish have passed a receiver gate.



HR3 307 kHz Applications

- High residence studies of hundreds of tagged animals
- Frequent and precise positioning of fish (i.e. sub-meter every second depending on tag transmission rate)
- Monitor migration survival
- Monitor predator and prey behavior
- Multi-mode: the HR3 can be set to detect HR Mode or HTI Mode to support high residence studies
- Small tags: detects VEMCO's smallest tag, highest frequency tags (weighing 0.3g) making it ideal for very small fish
- Real-time data access and precise positioning (standalone or cabled)

General Specifications	
Weight	2.93 kg (Lithium battery); 3.21 kg (Alkaline battery)
Dimensions	Length 40 cm (15.75 inches); Diameter 10 cm (3.9 inches)
Battery Life	6 months (Lithium); 2 months (Alkaline)
Power	Internal Lithium or Alkaline battery pack and optional external power supply: 10-30 VDC
Temperature Limit	-5°C to +40°C (Water must not freeze)
Depth	300m (440 psi)
Frequency	307 kHz
PC Software	fathom™
Data Capacity and Type	160,000,000 HR detections or 100,000,000 HTI detections
Diagnostics	Received signal strength, receiver noise, tilt, temperature, battery capacity, etc.
Transponding	2 way acoustic communications between the HR3 and the researcher at the surface (requires a VR100 Deck Box and 307 kHz transponding hydrophone, both sold separately)

VR100 Deck Box

307 kHz Transponding Hydrophone

LS1/LS1X

Features

- Includes everything needed to make recordings
- Sample rates: 8, 16, 32, 44.1, 48, 96 kHz
- Wav files saved to removable microSD
- Up to 4 microSD cards for huge storage
- Continuous or duty cycle recording

- Hydrophone easily removable for travel
- Hydrophone status LED
- Interchangeable hydrophones with custom gain settings

- Alkaline batteries (12 D-cell) make transportation easy

- LS1X model has twice the battery capacity

- Housings
  - LS1 PVC (17 x 4.5”): 300 m
  - LS1X PVC (25 x 4.5”): 300 m
  - Aluminum (25 x4.5”): 3000 m

Hydrophone Options: HTI-96-min, HTI-99-HF, HTI-99-UHF
Standard sensitivity: -170 dBV re:1µPa (US, Europe)
Standard export (max 1000m): -180 dBV re:1µPa (China)
Intense sound: -210 dBV re:1µPa (worldwide)

Applications

- Noise monitoring
- Seismic and pile driving
- Marine mammal monitoring
- Fish monitoring

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Mounting

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Optional 3 m tether allows you to position the hydrophone away from the housing.

6576 Palmer Park Circle
Sarasota, FL 34238 USA P 941.923.8855

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ARROW, Tsunami Detection System
Surface Buoys
Bottom Mounts (TRBM)
ADCP Buoys & Floats
Instrument Frames
Pier Mounted Installations
3 x 19 Wire Rope
Sediment Coring
Rigging & Hardware
Pop-up Buoys

BOTTOM MOUNT SYSTEMS FOR ADCPS

Mooring Systems, Inc. manufactures Trawl Resistant Bottom Mounts designed for protecting oceanographic instrumentation from fishing gear and aluminum tri-pods for applications where fishing activities are not a concern but compact size for transportation is.

These instrument deployment platforms are ideally suited for use with up-ward looking ADCPs and provide space for extra battery housings, and other instrumentation.

Our extensive product line with its many optional configurations provide the necessary tools for deployment and recovery of instruments in many locations and environmental conditions.

Above: General Purpose GP-TRBM system manufactured by MSI

GP-TRBM Mechanical Specifications:

Model	GP-TRBM
Cover Material	3/8" (9.5 mm) Urethane
Base Material	1" (25.4 mm) Fiberglass
Gimbaled Mount	Molded Urethane Ring
Fasteners	316 Stainless
Length	70" (1775 mm)
Width	50" (1270 mm)
Height (Outside)	22" (558 mm)
Height (Inside)	19" (480 mm)
Weight In Air	132 lbs. (60 kg) empty
Weight In Water	50 lbs. (23 kg) empty

Song Meter SM4

A dual-channel, weatherproof, bioacoustics recording and analysis system.

Longest deployment time available

Easy-to-use scheduling features

Weatherproof and securable enclosure

Two channels for more recording flexibility

Record using low-noise built-in microphones

wildlife ACOUSTICS
BIOACOUSTICS MONITORING SYSTEMS

Learn more at WildlifeAcoustics.com

The Song Meter SM4 combines 13 years of field-proven technology. With over 30,000 Song Meters deployed on every continent, biologists rely on the SM4 for species inventory, presence monitoring, repertoires analysis, ecoacoustics studies and a variety of projects.

The longest deployment times available

The SM4 features very low power consumption which enables up to 400 hours of record time. In Sleep Mode, between scheduled recordings, the SM4 uses almost no power, allowing it to remain idle for months – meaning longer deployments, and fewer trips into the field.

Easy-to-use scheduling features

The SM4 includes out-of-the box Quick Start recording programs; including daytime, nighttime, and continuous recording schedules. Simply choose the schedule and press the Start button. For more complex projects, easily create custom recordings with the SM4 Advanced Scheduler to suit your exact needs.

Two channels for more recording flexibility

Record in stereo or mono using built-in microphones, or connect one or two cabled microphones for more project design flexibility. Add a hydrophone to simultaneously record underwater sounds. Microphones and hydrophones can be extended up to 100m with additional cables.

High quality recordings

The SM4 records in 16 bit standard .wav files with sample rate choices for a variety of recording needs. Featuring professional-grade microphones and low noise electronics, the SM4 produces best-in class field audio recordings.

A must have analysis tool – Kaleidoscope Pro software

The SM4 can capture terabytes of recordings and Kaleidoscope can quickly sort and organize the data.

Use the **FREE Kaleidoscope Viewer** to listen to recordings or scan spectrograms. **Kaleidoscope Pro** features Cluster Analysis to group similar sounds and create species-specific classifiers.

Song Meter SM4

A dual-channel, weatherproof, bioacoustics recording and analysis system.

Specifications:

Recording Technology:
- Two-channel, 16 bit .wav

Recording Bandwidth:
- 20Hz – 48kHz

Sample Rates (one or two channels):
- 8 kHz, 12 kHz, 16 kHz, 22.05 kHz, 24 kHz, 32 kHz, 44 kHz, 48 kHz , 96 kHz

Built-in Microphones (2):
- Omni-Directional
- Sensitivity: -33 dB +/- 3 dB at 1 kHz (0 dB=1 V/Pa)
- Signal to Noise Ratio: 80 dB Typ. at 1kHz (1 Pa, A weighted network)
- Max Input Sound Level: 122 dB S.P.L. Typ.

Run-Time (using internal batteries):
- Up to 400 hours of record time spread over weeks or months

Power Options:
- Internal power using 4 D-size alkaline or NiHM batteries
- External power via optional SM3/SM4 Power Cable

Storage:
- Two SDXC/SDHC flash card slots (Class 4 or greater)
- More than 1 terabyte total capacity using two 512GB SDXC cards

Dimensions:
- Height: 8.6" / 21.8 cm
- Width: 5.9" / 15.0 cm
- Depth: 2.8" / 7.1 cm

Weight:
- 1.6 lbs / .73 kg without batteries
- 2.9 lbs / 1.3 kg with batteries

Enclosure Material:
- Polycarbonate

Operating Temperature:
- -4°F to +185°F or -20°C to 85°C

Warranty:
- 3 years

The cabled **SMM-A2 acoustic microphone** is optional when the project requires one or both microphones to be mounted away from the recorder. It is completely weather-proof and can be deployed using multiple lengths of additional cable.

The SM4 recorder can also be used with the optional **SM3/SM4-H1 hydrophone** to allow underwater recording. The hydrophone ships on a 20 meter cable and attaches to the same connectors as the cabled microphones.

When deploying multiple SM4 recorders, a single **GPS accessory** can automatically set the date, time and location settings of all recorders.*

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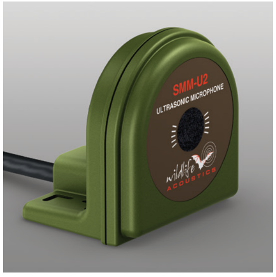
Learn more at WildlifeAcoustics.com

YouTube Watch the SM4 videos on our YouTube channel

 *The SM4 is not suitable for triangulation for localization

Song Meter SM4BAT

Compact, lightweight, single-channel bat recorders.



SMM-U2 Ultrasonic Microphone

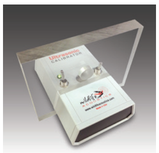
The new SMM-U2 microphone's low noise and superior sensitivity results in recording bat calls at greater distances.

The enclosure's innovative weatherproof design includes a built-in mounting bracket that allows for a wide range of mounting options.

The microphone includes a 5 meter cable, and can use up to 100 meters of cable with no adverse effect on recording quality.

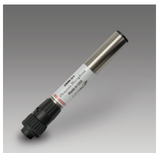
GPS Option

When deploying multiple SM4BAT recorders, a single GPS accessory can automatically set the date, time and location settings of all recorders. For transects, GPS logs recording location and path.*



Ultrasonic Calibrator

The Ultrasonic Calibrator is designed to verify the sensitivity of SMM-U1 microphones. It also verifies overall system performance.



SMM-U1 Ultrasonic Microphone

The SMM-U1 microphone is designed for recording bats up to 190 kHz. Extend using up to 100 meters of cable with no adverse effect on recording quality.

Directional Horn for SMM-U1 Microphone

The SMM-U1 is omni directional to maximize recording coverage. In applications requiring more directionality, the microphone can be adapted for directional sensitivity with the available horn.

Kaleidoscope Pro Analysis Software

Efficiently find what you are looking for.

- **Free Kaleidoscope Viewer** to listen to recordings or view spectrograms.
- **Kaleidoscope Pro** includes integrated bat Auto-ID to identify most likely species, and verify gigabytes of files in minutes.
- **Kaleidoscope Pro** also includes Cluster analysis for regions where Auto-ID is not provided, or for sorting similar bat passes by similarity to facilitate manual vetting. In addition, labeled Clusters can be used to create bat species classifiers.

Specifications:

Recording Technology:
- SM4BAT FS: single channel 16-bit .wav at 192kHz, 256kHz, 384kHz, or 500kHz sample rate
- SM4BAT ZC: single channel zero-crossing

Run-Time (using internal batteries):
- SM4BAT FS: up to 45 nights
- SM4BAT ZC: up to 70 nights

Power Options:
- Internal power using 4 D-size alkaline or NiHM batteries
- External power via optional SM3/SM4 Power Cable

Storage:
- Two SDHC/SDXC flash card slots (Class 4 or greater)
- More than 1 terabyte total capacity using two 512GB SDXC cards

Dimensions:
- Height: 8.6" / 218 mm
- Width: 6.0" / 152 mm
- Depth: 3.1" / 78 mm

Weight:
- 1.6 lbs./.73kg without batteries
- 2.9 lbs./1.3kg with batteries

Enclosure Material:
- Polycarbonate

Enclosure Environmental Protection:
- Fully weatherproof

Operating Temperature:
- -4°F to +185°F or -20°C to 85°C

Warranty:
- 3 years

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BIOACOUSTICS MONITORING SYSTEMS

Learn more at WildlifeAcoustics.com

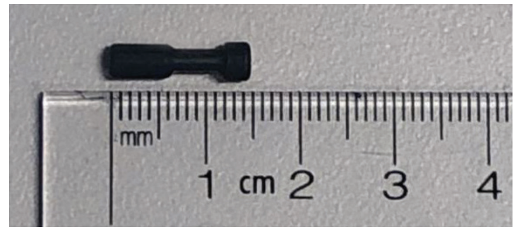
 *The SM4BAT is not suitable for triangulation of bat echolocation calls.

V3 307 kHz Coded Transmitter

VEMCO's miniature coded transmitters open up a new world for small fresh and salt water species research

Smaller Fish, More Species

Weighing just under 0.3 grams and measuring 15 mm in length, the V3 tag is the smallest of VEMCO's line of miniature coded transmitters. The V3 enables researchers to track and monitor smaller fish and a broader range of species than ever before!



Why a Higher Frequency?

The V3, operating at 307 kHz, is designed to work well in fresh water. This frequency enabled VEMCO to develop a lightweight tag that allows researchers to track a large number of fish in a small space. Researchers can now tag and release many more fish simultaneously due to the detection capabilities of our new tag transmission sytems.

Compatible Receivers

The V3 works with VEMCO's new High Residence HR3 Receiver, as well as HTI 290-Series Receivers and 395 Data Loggers. The HR3 can be deployed remotely, or cabled for real-time detections, and can be programmed to detect either HR or HTI coding schemes, or both schemes alternating.

High Residence (HR)

HR represents a more aggressive transmission system that offers the ability to detect many more tagged animals at once. Each HR ID code is embedded in each short ping transmitted by the tag. This allows the HR3 receiver to detect many IDs in a short period of time.

Benefits of HTI Coding

The HTI coding structure provides researchers with high performance in noisy and reflective environments. Alternating HTI and HR coding schemes provide researchers with interesting study possibilities that previously weren't possible, in a tag designed for very small fish. The HTI coding (i.e. the ability to vary pulse widths and signal types, etc.) in the V3 tag also allows for cross-compatibility with HTI equipment.

Physical Specifications

Frequency (kHz)	307
Diameter (mm)	4
Length (mm)	15
Weight in air (g)	< 0.3
Power Output (dB re 1uPa @1m)	141
Battery	Lithium Micro
Trigger Time (hrs)	3-5*

** Temperature dependent*

vemco

innovasea

Transmitters

High Residence (HR) and HTI transmission systems offer new ways of detecting your tagged animals!

Receivers | Transmitters | Accessories | Data Loggers

Tel: (902) 450-1700
Fax: (902) 450-1704

vemco.com

HR3 Receiver

The new HR3 receiver is capable of very precise signal timing, which makes it ideal for anyone interested in accurate spatial 2D/3D positioning with sub-meter resolution. Many tagged animals can be tracked in a short period of or have their movements tracked as they move quickly through acoustic gates (i.e. river survival study). Using a VR100 and VHTx-307 hydrophone, HR3 receivers can be communicated with, to query things such as tilt, temperature, battery usage, memory used, and detection count.

Advantages of VEMCO's 307 kHz Product Line

- Two transmission systems (HR and HTI) in one tag provides flexibility for study designs and research objectives
- Real time monitoring of HR and HTI tags (HR3s and HTI 290-series receivers)
- HR and HTI transmission systems available in all 307 kHz tag models
- Able to transmit HR, HTI, or both signals alternating

Programmable ON/OFF

The V3, as with all VEMCO transmitters, is available with programming options that allow users to take greater advantage of fish behaviour over the life of their tags. In order to control the characteristics of their tags, users have the option of using up to four programming steps to define the tags transmission: Status (ON/OFF), time interval, nominal delay, and transmission type (HR / HTI / Alternating).

This is an example of how V3 tag programming options can be utilized to provide a staged release tag behaviour.

Interval	Status	Time	Power (H)	Nominal Delay (sec)
Step 1	ON	1 hour	H	30
Step 2	OFF	7 days		
Step 3	ON	70 days	H	10

When finished, LOOP back to Step 3.

Step 1: The tag is programmed to start with a nominal delay setting of 30 seconds for a period of 1 hour. This allows a researcher to activate a tag and have it transmit during the surgical implantation phase of the study.

Step 2: The tag is programmed to turn OFF for a period of 7 days, in order to conserve battery life while the animals recover from surgery. The tags are switched to the OFF status since the location of the animals is known.

Step 3: The tag is programmed to stay ON with a nominal delay setting of 10 seconds for a period of 70 days. This allows a researcher the ability to monitor the animals during what might be a more residency type setting. Note the Loop control setting is set to Step 3, thus keeping the tag in the ON status until the tag reaches its battery end of life.

VEMCO Tag Activator (VTA)

The VTA is a handheld device that enables users to quickly and easily activate 307 kHz transmitters.

Contact Us!

Please consult with VEMCO if you are considering 307 kHz products. We can help you fine tune your study design and programming options!

Appendix B

Deployment and O&M Vessels

The Commander

240' Offshore Supply Vessel

REGISTRATION: Hull #162 | Vessel Type: Offshore Supply Vessel | Year Built: 1 997, North American Fabricators

	U.S. MEASUREMENTS	METRIC EQUIVALENTS
DIMENSIONS	240' x 56' x 18.9'	73.15 mX 17 m X5.72 m
Draft (Loadline):	15.55'	4.74 m
Draft (Lightship):	6.56'	2
Clear Deck:	165' 46'	50.29 m x 14.02 m
Clear Deck Area:	7,590 sq. ft.	705.5 m^2
Deck Cargo Capacity:	1 ,300 LT @ 3' VCG	1 ,320.86 MT @ 3' VCG
Deadweight Tonnage:	2,669 LT	2,712 MT

CAPACITIES

Fuel Oil:	169,956 gals.	643.35 m^3
Ballast:	432,607 gals.	1 ,637.60 m^3
Potable Water:	36,696 gals.	138.91 m3
Dry Bulk:	6,320 cu. ft. @ 80 psi	178.96 @ 5.5 bars
Liquid Mud:	6,593 barrels	1 ,048.20 m^3

MACHINERY

Main Engines:	Two (2) 3516 CAT
Bow Thrusters:	One (l) 340 HP CP Tunnel
	One (1) I ,200 HP Retractable Azimuthing
Propulsion:	Two (2) Ulstein 1 ,350 HP Retractable Azimuthing
Speed:	14.2 knots
Generators:	Two (2) x 300 kW, One (1) x 99 kW

SPECIAL FEATURES

Ship Motion:	Two (2) Passive Type Anti-Roll Tanks, Bilge Keels
Positioning:	DP2
Tuggers:	Two (2) x 10 Tons

CLASSIFICATION

ABS	Star All Oceans-Unrestricted
ABS	Circle E
USCG	Subchapter L (OSV)

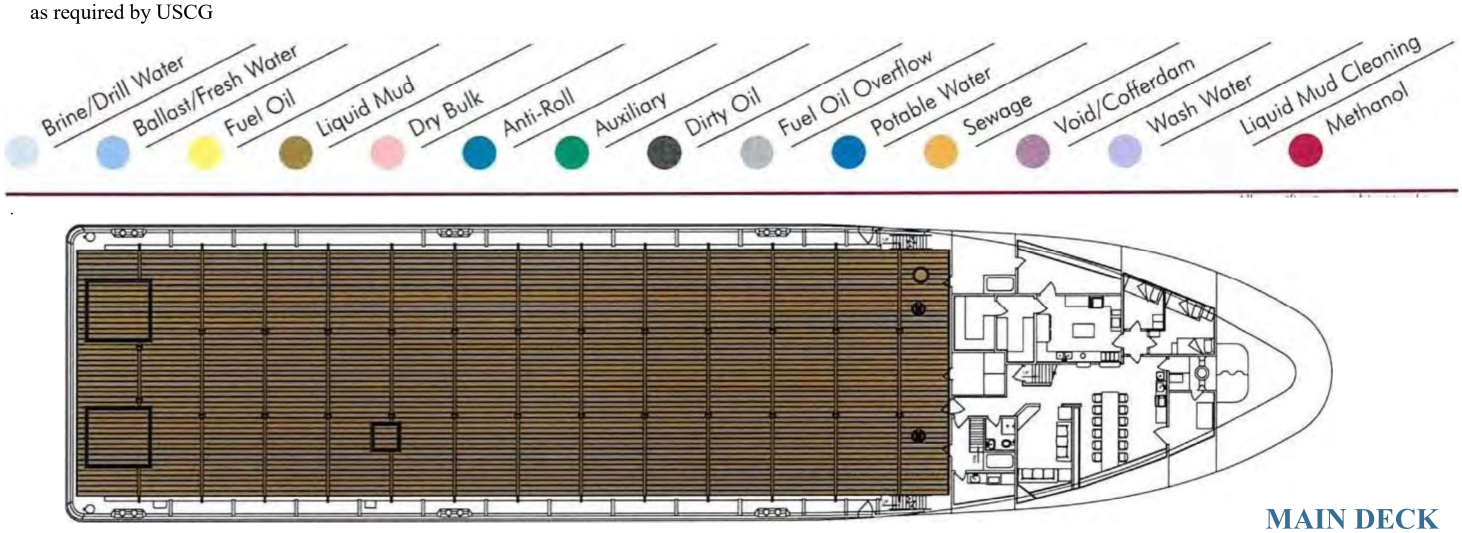
LIFESAVING EQUIPMENT

Four (4) x 20-Man Inflatable Life Rafts Other gear as required by USCG

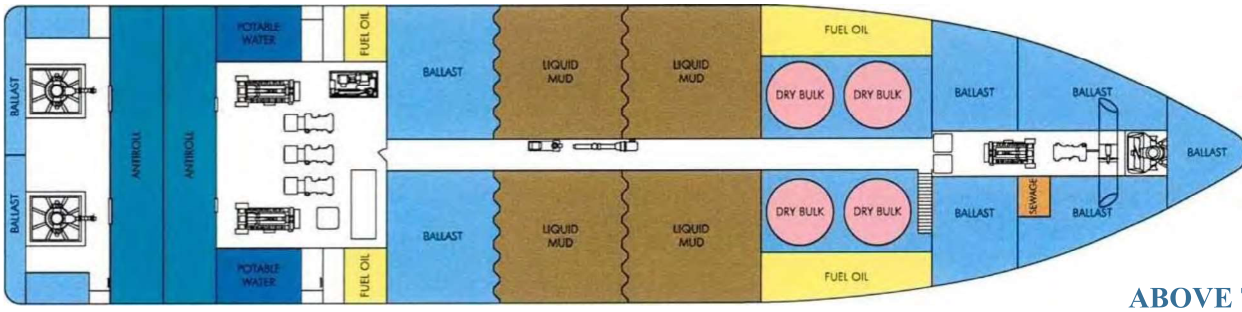
ACCOMMODATIONS: 31

ELECTRONICS

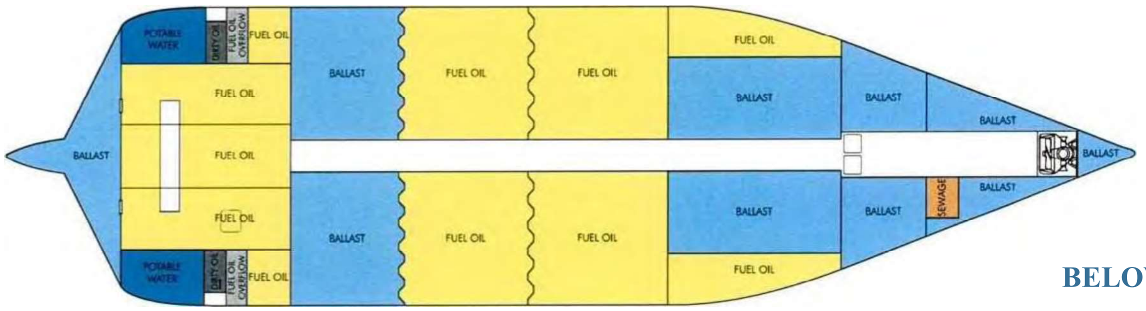
Sea 7156 VHF
Sea 7100 VHF DSC Controller
Sea 330 SSB (Single Sideband Radio)
JRC JUE-75C Inmarsat
Seawatch 7001 MF/HF Receiver
Necode DSC 1000
Furuno 1510 Mark-2 Radar
Furuno FE 6001 Sounder
Seator 3000 GMDSS
Two (2) R.M. Young Wind Sensors
Two (2) DGPS Navigation Systems
MDL Fanbeam
Two (2) Meridian Gyro Repeaters
Iridium Satellite Phone
Marine Technologies Bridge Mate DP 2 System
VSAT
AIS
Two (2) MRU



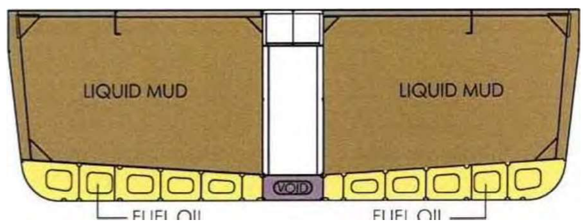
MAIN DECK



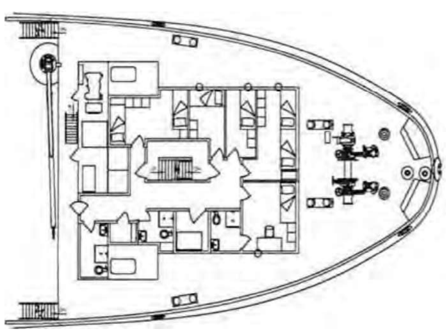
ABOVE TANK TOP



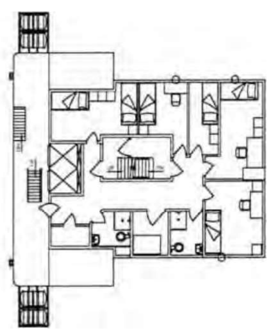
BELOW TANK TOP



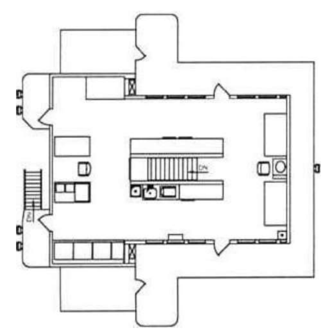
CROSS SECTION



DECK 01



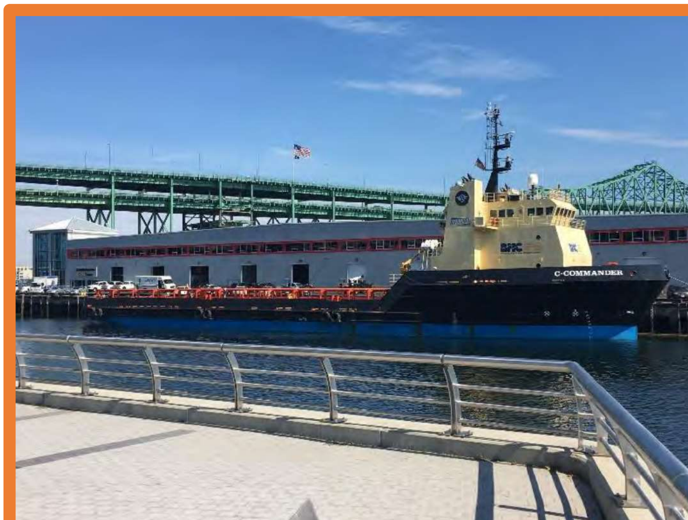
DECK 02

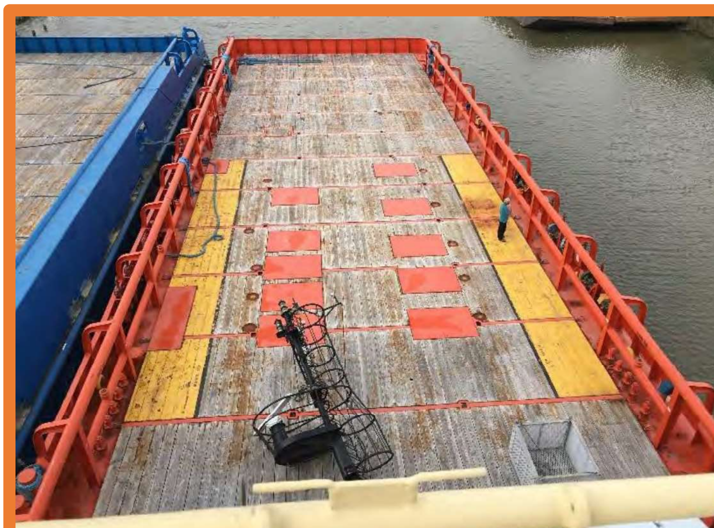


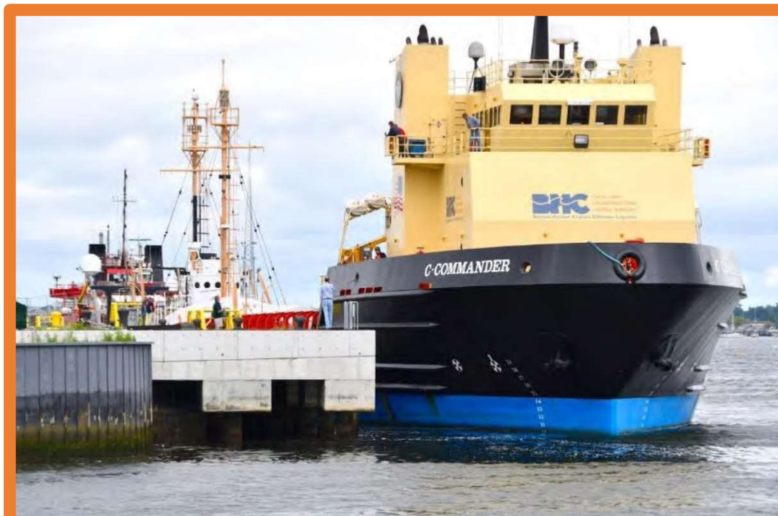
DECK 03


C COMMANDER
BOSTON, MA


C-COMMANDER


C-COMMANDER

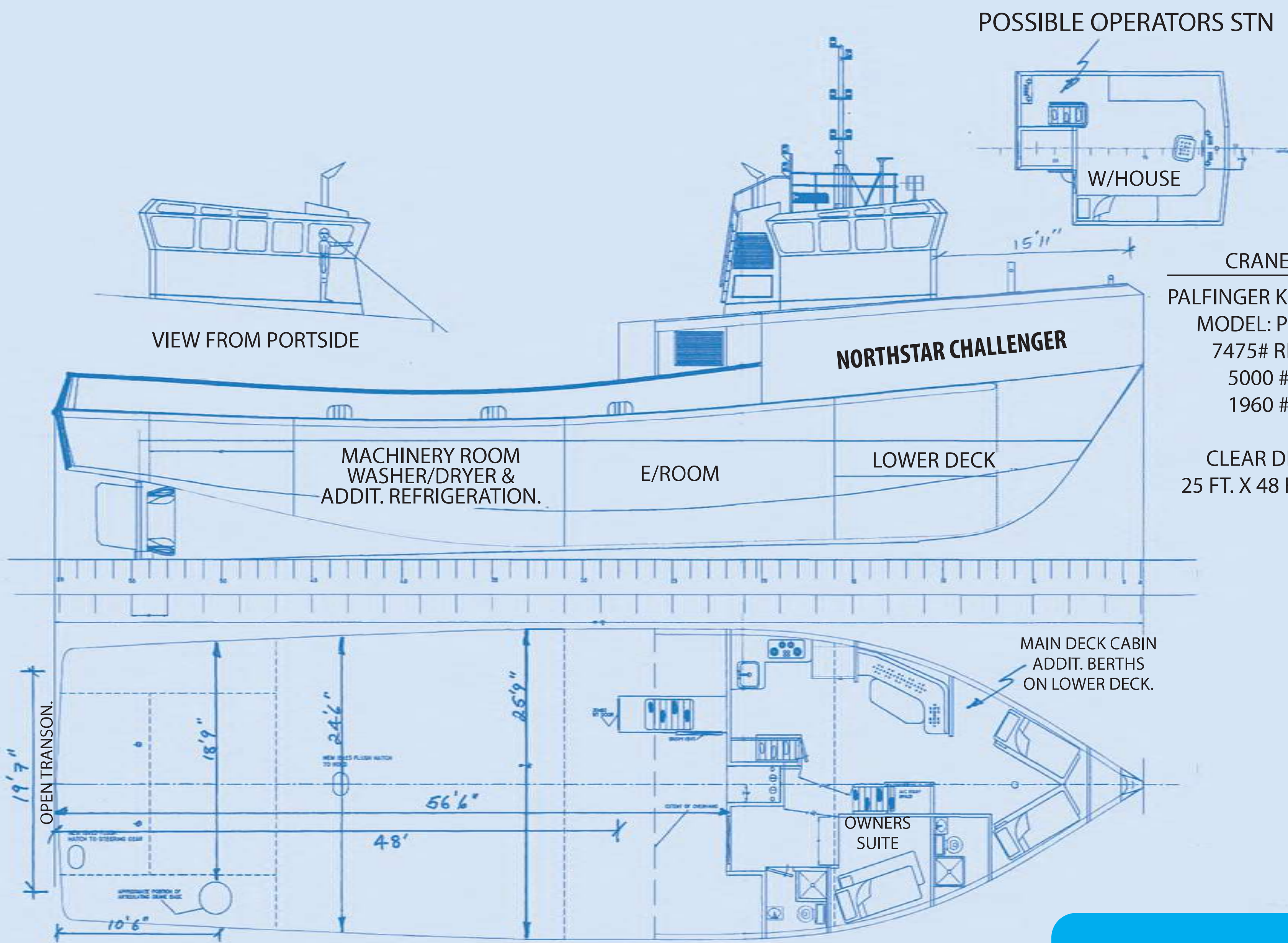



C-COMMANDER

Northstar Challenger

92' Offshore Supply Vessel

northstarmarineinc.com



CRANE DETAILS

PALFINGER KNUCKLE BOOM
MODEL: PK 18080 MD
7475# RETRACTED
5000 # @ 20 FT.
1960 # @ 48 FT.

CLEAR DECK SPACE:
25 FT. X 48 FT. = 1200 FT.²

Appendix C

BOEM Approval of US Wind Met Tower SAP Survey Plan

From:	Bennett, James
To:	a.toto@totospa.it
Cc:	w.wall@uswindmaryland.com; s.vitale@renexia.it; Erin Trager
Subject:	U.S. Wind SAP Survey Plan
Date:	Wednesday, June 03, 2015 4:45:04 PM

Mr. Toto:

This message is being sent to your attention in response to US Wind Inc.'s (the Lessee's) SAP Survey Plan and alternative monitoring plan, which were submitted to the Bureau of Ocean Energy Management (BOEM) pursuant to your commercial wind leases offshore Maryland.

Commercial leases OCS-A 0489 and OCS-A 0490 went into effect December 1, 2014. The Lessee submitted an alternative monitoring plan pursuant to stipulation 4.3.3 of Addendum "C" of the Maryland leases on January 12, 2015, with subsequent revisions submitted on April 15 and May 19. It has since been further revised and incorporated into the SAP Survey Plan.

The Lessee submitted the SAP Survey Plan pursuant to stipulation 2.1.1.1 of Addendum "C" of the Maryland leases on January 30, 2015, with subsequent revisions submitted on March 4, May 27, and June 3.

BOEM has completed its review of the final version of the SAP Survey Plan and its component alternative monitoring plan, both dated June 3, 2015. BOEM has determined that the Lessee has satisfactorily modified the SAP Survey Plan to address the Lessor's comments on the contents of the SAP Survey Plan.

BOEM has also decided to allow the Lessee to conduct the geological and geophysical (G&G) surveys proposed in the SAP Survey Plan at night or when visual observation is otherwise impaired using the proposed alternative monitoring methodology provided in Appendix E of the SAP Survey Plan dated June 3, 2015.

Should you have any questions or concerns, please contact Erin Trager at 703-787-1713 or erin.trager@boem.gov.

Jim Bennett

James F. Bennett
Chief, Office of Renewable Energy Programs
Bureau of Ocean Energy Management
United States Department of the Interior
45600 Woodland Road VAM-OREP
Sterling, Virginia 20166
Office: 703-787-1660
Cell: 571-230-9280
e-mail: jfbennett@boem.gov

Appendix D

Geotechnical Results Report

Geotechnical Report for
US Wind Inc.

Project:
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area (MET Tower)

Description:
Volume 2: Geotechnical Results Report

Survey Date:
22 June 2015 – 07 July 2015

Project Number:
10451

Client Reference:
REF11449

Report Status:
Final

REPORT AUTHORISATION AND DISTRIBUTION

Report Status	Volume 2: Geotechnical Results Report	Final
Compilation	Civil Engineer	…………………………………… Oliver Jones
QC Approval	Civil Engineer	…………………………………… Simon McDowell
Authorisation	GeoConsultancy Manager	…………………………………… Roi Santos

Revision	Date	Title	Report Ref
0	25 Sept 2015	Volume II: Geotechnical Results Report	10451 (Draft)
1	23 Feb 2015	Volume II: Geotechnical Results Report	10451 (Final)

Distribution

1 copy

US Wind Inc.
155 Federal Street
Boston
Massachusetts
02110

Attention: Bill Wall

SERVICE WARRANTY

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REPORT STRUCTURE

VOLUME 1: OPERATIONAL REPORT (BS EN ISO 19901)	VOLUME 2: GEOTECHNICAL RESULTS REPORT (BS EN ISO 19901)	VOLUME 3: DATA INTEGRATION AND ENGINEERING REPORT (BS EN ISO 19901-8)
Executive Summary 1. Scope of Project 2. Offshore Activities 3. Drilling Operations 4. InSitu testing-CPTU 5. InSitu testing-PS Logging 6. Sampling Operations 7. Field Laboratory 8. Preliminary Geotechnical logs and Soil profiles 9. Classification Laboratory results 10. CPTU Analysis 11. Laboratory Testing Procedures 12. Geodetic Information and Water Depths 13. Health Safety and Environment 14. References	Executive Summary 1. Scope of Project 2. Soil Description and Profiles 3. Triaxial Laboratory Test Results 4. Chemical Results 5. Laboratory Testing Procedures 6. CPTU Analysis 7. In Situ Testing - PS Logging 8. List of Symbols and Abbreviations 9. References	Executive Summary 1. Scope of Project 2. Summary of Soil Conditions 3. Assessment of Data 4. Ground Model 5. Representative Soil Parameters 6. List of Symbols and Abbreviations 7. References

EXECUTIVE SUMMARY

This report presents the combined sampling and CPTU borehole log and laboratory test results for the Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area, focusing solely on the MET Tower Location. The site is located in the North Atlantic Ocean, approximately 10km off the coast of Maryland. Detailed locations are shown in Appendix 1.1.

The objective of the investigation was to collect suitable geotechnical data in order to assess and select suitable foundations for the development of the wind farm. The borehole is comprised of combined undisturbed soil sampling, downhole CPTU data acquisition and PS Logging data acquisition..

BH-MET Tower reached a maximum penetration of 64.94m.

Table 1 provides a summary of fieldwork; including the number of boreholes completed, fieldwork dates and vessel details. The water depth at the proposed Maryland Wind Energy Area ranged from 12.20m to 42.00m. The water depth at BH-MET Tower was 27.70m. Section 6 in the Field Operations report provides more detail regarding water depth and tidal measurements.

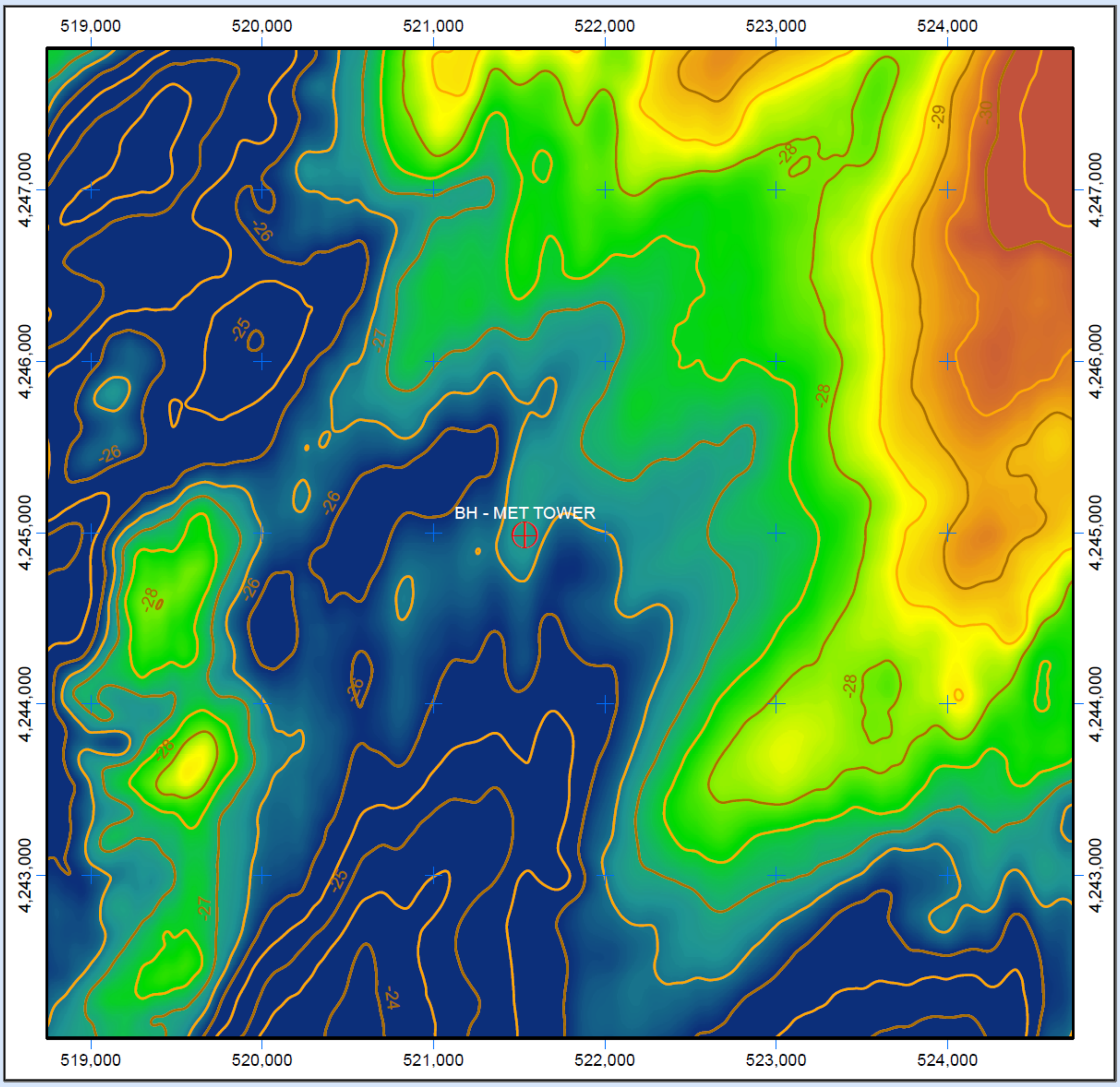
Table 1 Fieldwork Summary

Fieldwork Summary	
Survey Vessel	M.V. Ocean Discovery
Fieldwork dates	22 June 2015 – 07 July 2015
Composite CPTU & sample Borehole	7
PS logging locations	4

This report contains the results from all acquired samples and laboratory testing for BH-MET Tower.

The investigation allowed the soil stratigraphy to 64.94m to be established. The soils encountered are discussed in further detail in Section 2.1.

Figure 1 Location of the Maryland Wind Energy site



Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Overview Map

Legend & Map Scale (A4)

Combined Borehole (CPTU/Sampling) & PS Logging
1.0m Contours
0.5m Contours
Bathymetry
-26.0m
-30.0m

Kilometers
0 0.4 0.8 1.2 1.6 2
1:35,000

Coordinate Reference System	
Datum	NAD 83
Ellipsoid	GRS 80
Projection	UTM Zone 18N (75W)
Overview Data	ESRI

Contract Information	
Gardline Job	10451
Client	US Wind Inc.
Client Ref	REF11449
Vessel	MV Ocean Discovery

Gardline Geosciences Ltd, Hewett Park, Hewett Road, Great Yarmouth, Norfolk. United Kingdom. NR31 0NN.

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VOLUME II: GEOTECHNICAL RESULTS

1. Scope of Project

1.1 General

This report presents the geotechnical results of BH-MET Tower for the Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area for obtained between 22 June 2015 and 07 July 2015 (see Figure 1).

Seven boreholes were drilled at representative locations at the Maryland Wind Farm site. This report focuses on the borehole location BH-MET Tower. The purpose was to collect suitable geotechnical data in order to assess and select suitable foundations for the development of the wind farm. Boreholes comprised of combined undisturbed soil sampling, downhole CPTU data acquisition and PS Logging data acquisition.

2. Soil Description and Profiles

2.1 General

This section presents the borehole logs with the laboratory test results being discussed in subsequent sections.

A location map for BH-MET Tower is shown in Appendix 1.1.

2.2 Soil Layering

The borehole logs include the soil logging, laboratory results and interpreted borehole results (Appendix 2.1). Table 2.1 details the parameters presented on the logs.

Table 2.1 Dataset presented on logs

Data Type	Symbol	Data Units
Soil Description	-	-
Undrained Shear Strength	S_u	kPa
Natural Moisture Content	-	%
Atterberg Limits	-	%
Density	-	Mg/m^3
Relative Density	D_r	%
Corrected Cone Resistance	q_t	MPa
Sleeve Friction	f_s	MPa
Pore Pressure	U_2	kPa
Ambient Pore Pressure	-	kPa

Layer boundaries have been chosen based the soil descriptions, classification tests and shear strength measurements from laboratory testing.

Results from the samples indicate there are nine distinct soil layers as detailed in Table 2.3.

Table 2.3 General Description of Soil Layers

Soil Layer	Description
I	Poorly graded SAND with gravel. Sand is angular, coarse, light brown with mostly shell. Shell is fine gravel size.
II	Poorly graded SAND with silt. Sand is angular to subangular. Fine to medium grained. Dense to compact. Light grey becoming dark grey. Few stratifications of GRAVEL, gravel is angular and fine. Few pockets of clayey SAND. Few laminations of black organic staining. Micaceous. Strong HCL reaction.
III	Poorly graded SAND. Sand is fine to medium grained, very dense to compact. Light grey and moist. Few laminations of black organic staining. Micaceous. No HCL reaction.
IV	Sandy SILT. Medium dense to dense locally loose.
V	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt. Micaceous. No HCL reaction.
VI	Sandy CLAY. Sand is fine. Very hard to hard, very dark grey, dry. Little fine to coarse gravel size (<30mm) shell. Some laminations and lenses of sand and silt. Sand is fine grained. Micaceous with trace organics. Weak HCL reaction.
VII	Poorly graded SAND with silt. Sand is fine grained, grey, compact and wet. No HCL reaction.
VIII	Sandy CLAY. Sand is fine. Hard, grey, moist. No HCL reaction.
IX	Clayey SAND becoming SAND with silt. Sand is fine to medium grained, grey and moist.

3. Classification Test Results

3.1 General

This section presents the results of the offshore laboratory testing performed. Information on the laboratory testing procedures can be found in Section 9.

Offshore laboratory testing was scheduled by the geotechnical team onboard and conducted alongside drilling operations. Representative samples were extruded offshore and tested according to ASTM D2488-93 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

The geotechnical testing offshore consisted of the following tests:

- Soil description and classification
- Photography of extruded samples
- Moisture content and density determination with the use of cylindrical density rings
- Index shear strength tests: Torvane, Pocket Penetrometer and Motorised Laboratory Vane
- Unconsolidated Undrained Triaxial
- Hydrochloric acid (HCL 10%)

Classification tests were performed within the designated offshore laboratory in order to obtain basic soil characteristics on all recovered samples. All extruded samples were photographed and then visually classified. Sample suitability was then assessed for onshore testing and preserved as either undisturbed samples (referenced as sample type “U” or “Q”), or double bagging as disturbed samples (referenced as sample type “B”).

Further onshore laboratory testing was scheduled by the client and the samples were subjected to further onshore testing at Gardline’s onshore geotechnical testing laboratory.

Geotechnical and chemical testing onshore consisted of the following:

- Soil Description and classification
- Photography of extruded samples
- Index shear strength tests: Fallcones
- Unconsolidated Undrained Triaxial testing
- Advanced shear strength testing: Consolidated Anisotropic Undrained Compression Triaxials (CAUC)
- Chemical: Carbonate contents

All individual test results are presented in the BH-MET Tower combined log in Appendix 2.1. A summary of the laboratory results is presented in Appendix 3.

3.2 Moisture Content

Moisture contents were taken at various depths within each extruded sample. Where soil characteristics changed additional moistures were taken to incorporate this.

The moisture content values presented in this report are measured values and no corrections have been applied.

Moisture content values are consistent throughout the borehole. Results are considered of good quality and repeatability.

Moisture content results are presented in Appendix 3.1 as well as on the borehole log in Appendix 2.1.

3.3 Density

Density tests were generally undertaken at the same depths as moisture contents where a measured volume of undisturbed sample could be taken.

The bulk and dry density values presented in this report are measured values and no corrections have been applied.

Density values are consistent across the site. Results are considered of good quality and repeatability.

Density results are presented in Appendix 3.1 as well as on the borehole logs in Appendix 2.1.

3.4 Particle Density

Particle Density tests were undertaken within core samples. Three particle density tests were conducted throughout the borehole.

Particle Density values are consistent across the site. Results are considered of good quality and repeatability.

Particle density results are presented in Appendix 3.1 as well as on the borehole logs in Appendix 2.1.

3.5 Particle Size Distribution (PSD)

Five PSD with hydrometer tests were conducted within the borehole.

Eleven Determination of the Amount of Material In Soils Finer Than No. 200 (75µm) Sieve tests were undertaken.

PSD and Amount of Material In Soils Finer Than 75µm Sieve tests are considered to be of good quality and achieved repeatable results. They confirmed the soil type and behavioural characteristics noted during the logging phase.

Particle size distribution plots are presented in Appendix 3.3 and the boundary data is presented in the Classification Summary in 3.2.
Amount of Material In Soils Finer Than No. 200 (75µm) Sieve test results are presented in Appendix 3.4.

3.6 Plasticity

Plasticity tests were undertaken within every suitable identified soil unit where possible. Seven plasticity tests were conducted within the borehole.

Plasticity tests were consistent within the clay units. Plasticity tests are considered to be of good quality and achieved repeatable results.

The results of the plasticity testing are presented on the Classification Summary in Appendix 3.2, the borehole logs (Appendix 2.1) and on Plasticity Charts in Appendix 3.5.

3.7 Index Shear Strength Testing

Index shear strength tests were conducted using Pocket Penetrometers, Torvane, Fallcone and Motorised Laboratory Vane. The shear strength results were concurrent with consistency tests and CPTU data and were consistent within each soil unit.

A single Motorised Lab Vane (MLV) was conducted and offered good results. The MLV result was slightly higher than other surrounding index shear strength tests. The higher value is likely attributed to local variances within the soil unit, including laminations and lenses of sand and silt. All other index shear strengths were performed on identified CLAY units, MLV tests are performed before extrusion and thus sediment composition would not be known.

Index shear strength results are presented in Appendix 3.6 as well as on the borehole logs in Appendix 2.1.

4. Triaxial Laboratory Test Results

4.1 General

This section presents the results of the triaxial laboratory testing. Information on the testing procedures can be found in Section 9. Results were used in conjunction with other shear strength results to run an N_{kt} assessment in order to accurately correlate CPTU and laboratory results.

UUT and CAUC plots are presented in Appendix 3.8 and Appendix 3.8 respectively and summarised in Appendix 3.7, as well as on the borehole logs in Appendix 2.1.

4.2 Undrained Unconsolidated Triaxial (UUT)

In general, shear strength values from UUT tests were consistent within a particular soil layer, and were comparable with the index shear strength testing undertaken. Results are considered of good quality and repeatability and any deviation from the general trend is considered to be as a result of fissures, laminations and shear planes within the sample.

UUT plots are presented in Appendix 3.8 with the results plotted on the borehole logs in Appendix 2.1.

4.3 Consolidated Anisotropic Undrained Triaxial Test (CAUC)

In general, CAUC results are considered of good quality and repeatability. The results correlate with other strength testing conducted.

Five CAUC tests were conducted within the samples acquired.

CAUC plots are presented in Appendix 3.9 with the results plotted on the borehole logs in Appendix 2.1.

5. Chemical Laboratory Test Results

5.1 General

This section presents the results of the chemical laboratory testing. Information on the testing procedures can be found in Section 9.

5.2 Carbonate Content

Carbonate content tests were conducted on a selection of appropriate samples within the borehole.

Carbonate content tests are considered to be of good quality and achieved repeatable results.

Ten carbonate tests were conducted within the borehole.

Carbonate content results are presented in Appendix 3.10.

6. Laboratory Testing Procedures

6.1 General

The objective of the laboratory test program was to evaluate the pertinent physical and mechanical characteristics of the soils encountered during sampling at the site.

This section of the report discusses the laboratory testing program performed. Tests were performed in accordance with ASTM where possible.

6.2 Soil Description

Descriptive terms are based on ASTM D2488-09A – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

The basic soil types as defined by particle size analysis are as follows:

GRAVEL	Coarse	19.0mm to 75.0mm
	Fine	4.75mm to 19mm
SAND	Coarse	2.00mm to 4.75mm
	Medium	0.425mm to 2.00mm
	Fine	0.075mm to 0.425mm

SILT Soil that is less than 0.075mm that is non plastic or very slightly plastic and that exhibits little or no dry strength when air dry.

CLAY Soil that is less that 0.075mm that can be made to exhibit plasticity within a range of water contents and that exhibits considerable strength when air dry.

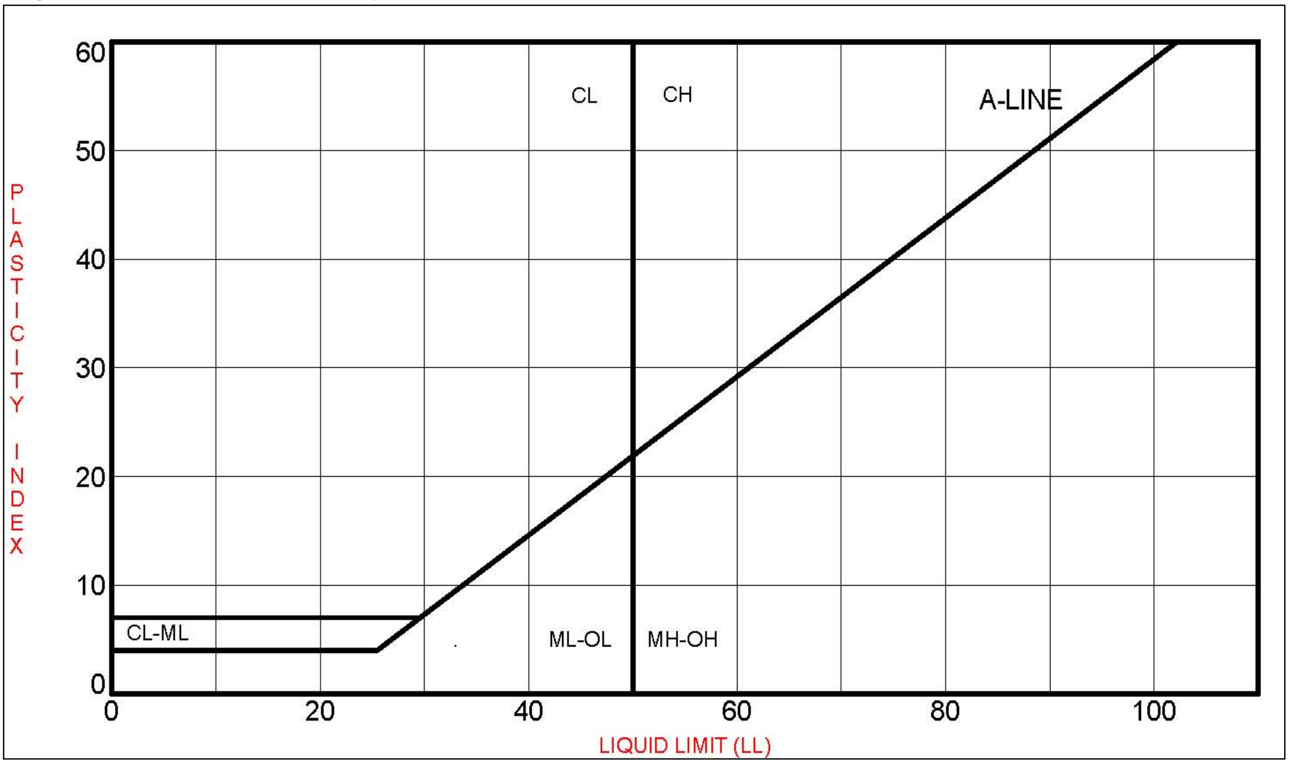
The principal soil type is based on particle size distribution of the coarse fraction and of the fine fraction as determined by a series of specified hand tests supplemented by soil classification tests.

6.2.1 Fine Grained Soils

The identification and description of fine grained soils is based both on a set of hand tests and the measurement of the particle size grading. These hand tests include: dry strength, plasticity and dilatancy.

In general terms, a soil lying above the A-line (Figure 5.1) would be identified as a CLAY and a soil below the A-line as a SILT, however it must be recognized that a soil above the A-line may be comprised of particles of non CLAY minerals (less than 2µm size such as rock flour); equally soils that fall below the A-line may be comprised of the clay minerals halloysite, kaolinite and chlorite.

Figure 5.1 Soil Plasticity Chart



A fine soil is also described according to its consistency shown below in Table 5.1 and shear strength shown in Table 5.2.

Table 5.1 Soil Consistency Classification Parameters

Descriptor	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25mm)
Soft	Thumb will penetrate soil about 1 inch (25mm)
Firm	Thumb will indent soil about ¼ inch (6mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumb will not indent soil

Table 5.2 Soil Strength (ASTM D-5578-07 (2007))

Undrained shear strength of clays	Undrained shear strength (kPa)
Very Soft	<12.5
Soft	12.5 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	>200

Table 5.3 Soil Dilatancy Classification Parameters

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

Table 5.4 Soil Plasticity Classification Parameters

Description	Criteria
Non-plastic	A ⅛ inch (3mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

Secondary constituents within a fine soil are classified as summarised in Table 5.5.

Table 5.5 Secondary Constituent Classification (Fine Soils)

Group Symbol	Classification Steps			Group Name
CL	< 30% plus 75µm	<15% plus 75µm 15-25% plus 75µm	% sand > % gravel %sand < % gravel	Lean clay Lean clay with sand Lean clay with gravel
	> 30% plus 75µm	% sand > % gravel %sand < % gravel	< 15% gravel > 15% gravel < 15% sand > 15% sand	Sandy lean clay Sandy lean clay with gravel Gravelly lean clay Gravelly lean clay with sand
ML	< 30% plus 75µm	<15% plus 75µm 15-25% plus 75µm	% sand > % gravel %sand < % gravel	Silt Silt with sand Silt with gravel
	> 30% plus 75µm	% sand > % gravel %sand < % gravel	< 15% gravel > 15% gravel < 15% sand > 15% sand	Sandy silt Sandy silt with gravel Gravelly silt Gravelly silt with sand
CH	< 30% plus 75µm	<15% plus 75µm 15-25% plus 75µm	% sand > % gravel %sand < % gravel	Fat clay Fat clay with sand Fat clay with gravel
	> 30% plus 75µm	% sand > % gravel %sand < % gravel	< 15% gravel > 15% gravel < 15% sand > 15% sand	Sandy fat clay Sandy fat clay with gravel Gravelly fat clay Gravelly fat clay with sand
MH	< 30% plus 75µm	<15% plus 75µm 15-25% plus 75µm	% sand > % gravel %sand < % gravel	Elastic silt Elastic silt with sand Elastic silt with gravel
	> 30% plus 75µm	% sand > % gravel %sand < % gravel	< 15% gravel > 15% gravel < 15% sand > 15% sand	Sandy elastic silt Sandy elastic silt with gravel Gravelly elastic silt Gravelly elastic silt with sand

6.2.2 Coarse Grained Soils

The description of coarse soils (SAND and GRAVELS) is primarily performed by visual observation. There are two problems with the description of coarse soils. First, one must consider the visual differences observed between volume and weight percentages of a sample; and second, is the correct application of the 4.75mm grain size between SAND and GRAVEL. The correct visual description is in accordance with the “weight percentage”, and can be verified by a laboratory particle size distribution test.

Secondary constituents within a coarse soil are classified as summarised in Table 5.6.

Table 5.6 Secondary Constituent Classification (Coarse Soils)

			Group Symbol		Group Name
< 5% fines	Well-graded		GW	< 15% sand	Well-graded gravel
				> 15% sand	Well-graded gravel with sand
	Poorly graded		GP	< 15% sand	Poorly graded gravel
				> 15% sand	Poorly graded gravel with sand
10% fines	Well-graded	Fines = ML or MH	GW-GM	< 15% sand	Well-graded gravel with silt
				> 15% sand	Well-graded gravel with silt and sand
		Fines = CL or CH	GW-GC	< 15% sand	Well-graded gravel with clay
				> 15% sand	Well-graded gravel with clay and sand
	Poorly graded	Fines = ML or MH	GP-GM	< 15% sand	Poorly graded gravel with silt
				> 15% sand	Poorly graded gravel with silt and sand
		Fines = CL or CH	GP-GC	< 15% sand	Poorly graded gravel with clay
				> 15% sand	Poorly graded gravel with clay and sand
> 15% fines		Fines = ML or MH	GM	< 15% sand	Silty gravel
				> 15% sand	Silty gravel with sand
		Fines = CL or CH	GC	< 15% sand	Clayey gravel
				> 15% sand	Clayey gravel with sand
< 5% fines	Well-graded		SW	< 15% gravel	Well-graded sand
				> 15% gravel	Well-graded sand with gravel
	Poorly graded		SP	< 15% gravel	Poorly graded sand
				> 15% gravel	Poorly graded sand with gravel
10% fines	Well-graded	Fines = ML or MH	SW-SM	< 15% gravel	Well-graded sand with silt
				> 15% gravel	Well-graded sand with silt and gravel
		Fines = CL or CH	SW-SC	< 15% gravel	Well-graded sand with clay
				> 15% gravel	Well-graded sand with clay and gravel
	Poorly graded	Fines = ML or MH	SP-SM	< 15% gravel	Poorly graded sand with silt
				> 15% gravel	Poorly graded sand with silt and gravel
		Fines = CL or CH	SP-SC	< 15% gravel	Poorly graded sand with clay
				> 15% gravel	Poorly graded sand with clay and gravel
> 15% fines		Fines = ML or MH	SM	< 15% gravel	Silty sand
				> 15% gravel	Silty sand with gravel
		Fines = CL or CH	SC	< 15% gravel	Clayey sand
				> 15% gravel	Clayey sand with gravel

All soil types are described in the following order:

- Group Name
- Group Symbol
- Percent of cobbles / boulders by volume
- Particle size range
- Particle angularity
- Particle shape
- Maximum particle size / dimension
- Plasticity of fines
- Dry strength
- Dilations
- Toughness
- Colour
- Odour
- Moisture
- Reaction with HCl
- Consistency
- Structure
- Cementation
- Additional information

6.3 Soil Classification

Classification tests were performed to identify the index properties of the soils encountered at the site. The offshore and onshore laboratories conducted moisture content, wet and dry density, visual identification and consistency tests.

6.3.1 Natural Moisture Content and Bulk and Dry Density

Bulk densities of soil samples were measured by weighing samples of known volume immediately following sample extrusion; the dry density was then calculated from the measured wet density and the associated moisture content value.

Testing was carried out in accordance with ASTM D2488

6.3.2 Atterberg Limits

Natural moisture content (w) and the Plastic Limit (P_L) and Liquid Limits (L_L) were determined for cohesive samples to provide classification information. In each case the liquid limit test was performed by the casagrande method.

Values of the plasticity index (I_P) and the liquidity index (LI) have been calculated for all fine grained soils. The LI is an index property that relates the natural moisture content of a fine grained soil to its respective liquid and plastic limits and is expressed as:

$$LI = \underline{w-P_L}$$

I_P

Testing was carried out in accordance with ASTM D4318-10.

6.3.3 Particle Size Distribution (PSD)

A soil consists of discrete particles of varying shapes and sizes. The purpose of a particle size analysis is to group these particles into separate size ranges, and so determine the relative proportions, by dry weight, of each size range. Two separate and different procedures are used to assess the range of particle sizes for the sediments encountered along the route and over the mooring area. These are wet sieving, which is used to assess the coarse grained particle sizes of sand, and sedimentation by hydrometer, for the finer silt and clay particle sizes.

During sedimentation by hydrometer, a reagent of sodium hexametaphospate solution is used following the procedure set out in ASTM D421.

For the clays with some sand content encountered in the borehole, composite tests using both sieving and sedimentation by hydrometer were necessary to provide a full particle size distribution.

Testing was carried out in accordance with ASTM D422-63.

6.3.4 Determination of the Amount of Material in Soils Finer Than No.200 (75µm) Sieve

The purpose of the test is to determine the amount of soil that is finer than the No. 200 sieve (75µm). Two methods are used depending on the amount of coarse material within the sample, for sand samples the soil is soaked for at least ten minutes in water and then passed through 0.075mm and 0.425mm sieves. For clay samples, the material is soaked for a minimum of two hours in a deflocculating solution consisting of sodium hexametaphosphate and distilled water. The soil solution is then passed through the sieves mentioned. The percentage passing the 0.075mm sieve is calculated and reported giving an approximate fines content value.

Testing was carried out in accordance with ASTM D1140-14.

6.3.5 Particle Density

The soil particle density is the ratio between the mass of dry mineral particles and the mass of distilled water displaced by the dry mineral particles. The Pyknometer method was used for all particle density tests.

Testing was carried out in accordance with ASTM D854-10.

6.4 Undrained Shear Strength

Undrained shear strength of cohesive samples were obtained from Torvane, Motorised Laboratory Vane, Pocket Penetrometer and triaxial tests offshore. Additional Fallcone, Triaxial, Shearbox and compressibility tests were undertaken in the onshore laboratory.

6.4.1 Pocket Penetrometer

The Pocket Penetrometer is a small hand held device consisting of a flat faced plunger and spring located in a cylindrical housing. The plunger is forced to penetrate the soil sample until a punching-type bearing failure occurs. The compression of the pocket penetrometer spring is directly calibrated to indicate the undrained shear strength of the soil, S_u.

The Pocket Penetrometer has a working limit of 300kPa; if this maximum limit is reached during testing it has been reported as 300+kPa on the summary tables. At higher strengths the most accurate method of measuring the undrained shear strength is the unconsolidated undrained triaxial test.

Testing was carried out in accordance with manufacturer's manual of operation.

6.4.2 Fallcone

The Fall Cone uses a cone with a specified weight and angle (10g and 60g with an angle of 60º and 100g and 400g with an angle of 30º) to measure the penetration into the sample from a controlled height. The weight of the cone is dependent on the strength of the sample. Soft samples require a lighter cone and stiff samples a heavier one. The cone is released from the magnetic cone holder by a release button on the back of the apparatus. The depth of penetration is indicated on the penetration scale which has an optical magnifier for accuracy. The depth of cone penetration is an indicator of the strength of the sample. For remoulded tests the sample is mixed into a homogeneous paste and placed in the remoulding cup for testing.

Testing was carried out in accordance with ISO 17892-6 (2004).

6.4.3 Torvane Test

The Torvane is a small hand-operated device consisting of a plastic disc with thin, radial vanes projecting from one face. The Torvane is pressed against a flat surface of the soil until the vanes are fully embedded and is rotated through a torsion spring until the soil is sheared. The device is calibrated to indicate shear strength of the soil directly from the rotation of the torsion spring.

Testing was carried out in accordance with manufacturer's manual of operation.

6.4.4 Motorised Laboratory Vane

A Motorised Laboratory Vane setup comprises a four bladed cruciform vane mounted on a rod, the assembly being of stainless or plated steel and hard soldered. Typical blade dimensions are 12.7mm wide and 12.7mm long, but larger vanes may be used for measuring very low shear strengths. Rotation of the vane is provided by a motor applying torque via a worm and pinion drive with a suitable scale graduated in 1^o intervals for measuring angular rotation of the vane relative to the soil in which it is placed. A calibrated open coil torsion spring is used to increase torque with rotation. Shear is determined by the degree of rotation achieved after sufficient torque has been acquired to shear the vane within the sample.

6.4.5 *Unconsolidated Undrained Triaxial Test (UUT)*

In the unconsolidated undrained triaxial test the test specimen is encapsulated in a latex rubber membrane and subjected to a confining pressure as specified by sample depth. The soil specimen is then loaded axially in a load frame at a constant rate of strain; typically in the order of 1% per minute until the specimen fails. No drainage is allowed at any stage of the test. The undrained shear strength of the soil, S_u is half of the deviator stress at failure:

$$S_u = \frac{\sigma_1 - \sigma_3}{2}$$

Where σ_1-σ_3 is the maximum deviator stress (kN/m^2).

Testing was carried out in accordance with ASTM D2850-03a.

6.4.6 *Consolidated Anisotropic Undrained Compression Triaxial Test (CAUC)*

Consolidated Isotropic Undrained triaxial effective stress testing with the measurement of base pore water pressure was performed to complement and add value to offshore strength testing and provide additional data to be used for design.

Anisotropically consolidated undrained triaxial tests (CAUC) were performed on selected samples of cohesive soil.

Testing was carried out in accordance with ASTM D4767.

6.5 Chemical Tests

Chemical tests were performed to determine the carbonate, organic and sulphate content within the samples. Testing was also carried out to ascertain the samples pH values.

6.5.1 Carbonate Content

The test procedure is a gasometric method that utilises a simple portable apparatus. The carbonate content of soil is determined by treating a dried soil specimen with hydrochloric acid (HCl) in an enclosed reaction cylinder (reactor). Carbon dioxide (CO_2) gas is exsolved during the reaction between the acid and carbonate fraction of the specimen. The resulting pressure generated in the closed reactor is proportional to the calcite equivalent of the specimen. This pressure is measured with a suitable pressure gauge, or equivalent pressure-measuring device, that is pre-calibrated with reagent-grade calcium carbonate.

It should be noted that the results of this test are calcite equivalent as different carbonate species will result in percentages greater than 100%. This test does not distinguish between the carbonate species and such determination must be made using quantitative chemical analysis methods such as atomic absorption (ASTM D 4373-02).

The calcium carbonate of all selected test specimens was determined in accordance with the ASTM D 4373-02 standard test method.

7. CPTU Analysis

7.1 General

Downhole CPTU operations were carried out in accordance with ISO 22476-1:2012 Geotechnical Investigation and Testing - Field Testing. Part I. All CPTUs carried out were within accuracy class 1 or 2, as set out by ISO 22476-1:2012. All testing was completed using 10cm^2 piezocones at the BH-MET Tower location. The CPTU's were carried out using Wireline downhole CPTU. The data from these CPTU tests were processed using Gardline's TerraFusion software. The measured and derived plots for each test can be seen in Appendix 4.1.

Thirty five CPTUs were completed at BH-MET Tower; details of these tests can be seen in Appendix 4.1. Corrected cone resistance, sleeve friction, pore pressure, undrained shear strength and relative density are shown on the borehole log in Appendix 2.1.

Following an N_{kt} assessment using laboratory shear strength results an N_{kt} range of 15 – 20 was chosen for all CPTU tests.

For information relating to CPTU Presentation and CPTU Interpretation refer to Appendix 4.1.

7.2 Discussion of Results

The CPTUs conducted were within accuracy Class 1 or 2 as set out by ISO 22476-1:2012. Any sensory drifts out of class 1 can be attributed to the ground conditions encountered at the borehole. Cone offsets were monitored by Gardline's CPTU operators and Geotechnical Engineers after each test. All cones where assessed for stability during mobilisation and any cones deemed unstable were removed from usage.

The zero reading offsets were consistent before and after testing and there is no evidence of sensor drift effects. In addition, the tip resistance pore pressure and sleeve friction measurements showed excellent responsiveness to layer changes and to the presence of any laminations, stratifications or coarse grained materials within fines. This is an indication of good sensor response and sensitivity. The zero readings of the tests were taken on deck before and after the test and on the seabed before and after each test.

8. PS Logging Analysis

8.1 General

The method is used for the in situ determination of compression (P) and shear (S) wave seismic velocities. The equipment, manufactured by OYO Corporation, comprises a directional seismic source and a pair of directional seismic detectors mounted together with associated power, switching and data transmission electronics, in a 7 m long wireline sonde (Figure 7.1 and 7.2). It is deployed in a fluid filled uncased borehole from a logging winch (Figure 7.3) fitted with depth encoder. Operation is controlled using Robertson Geologging Ltd (RGL) software running a RGL Micrologger 2 logging interface unit.

Figure 7.1 and 7.2 Sonde Component

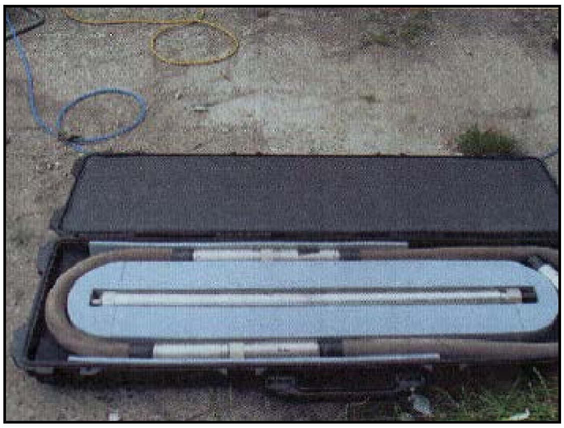
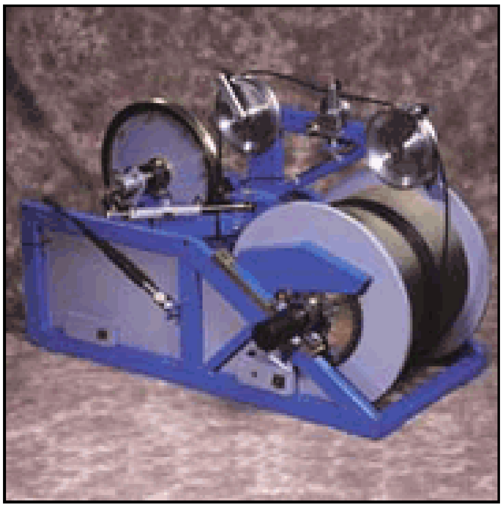


Figure 7.3 PS Logging Winch



8.2 Summary of PS Logging Operations

In operation the seismic source in the sonde is activated to produce a sequence of seismic pulses which excite ‘flexural’ waves. Depending on the direction of impulse the seismic waves which are generated travel at the P- and S-wave velocities of the formation and are detected by the seismic receivers which are 1 m apart. The difference in arrival time at the lower and upper receivers can be measured from the displayed waveforms and the seismic velocities can then be calculated.

It is necessary for the operator to control the system settings to ensure that the data recorded are of sufficient quality for the arrival time measurements to be carried out. Measurements are usually made from the bottom up at 1m intervals and a raw data file is stored for each record.

Once specified depths have been measured the data is then processed. From the resulting wave formation plots, the first arrival times from both the compression (P) and shear (S) wave velocities are picked. The seismic velocities are then determined and used along with other geotechnical data such as densities to aide in characterisation of the basic material properties and determination of G_0.

PS Logging results are presented in Appendix 5.1.

9. CPTU Analysis List of Symbols and Abbreviations

SYMBOLS

α	Cone area ratio
A_c	Projected area of the cone
A_n	Cross-sectional area of the load cell or shaft
B_q	Pore pressure ratio
D_r	Relative density / Equivalent Relative Density
f_s	Local side friction
K_o	Coefficient of lateral earth pressure
N_{kt}	Cone factor
q_c	Measured cone tip resistance
q_n	Net cone tip resistance
q_t	Corrected cone tip resistance
R_f	Friction ratio
u_2	Pore water pressure measure behind the tip
σ_{vo}	Total overburden stress
e	Voids ratio
σ_1-σ_3	Deviator stress
S_u	Undrained shear strength
S_r	Remoulded shear strength

ABBREVIATIONS

BPP	Borehole Progression Plan
CPT	Cone penetration test
CPTU	Cone penetration test with pore pressure measurement
SBF	Seabed Frame
UTM	Universal Transverse Mercator
UUT	Undrained Unconsolidated Triaxial
w	Natural Moisture Content

10. References

ASTM International Designation: D 2488-09A: 2009, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). *American Society for Testing and Materials,* Pennsylvania.

ASTM International Designation: D 4186-06: 2006, Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading. *American Society for Testing and Materials,* Pennsylvania.

ASTM International Designation: D 4422-63: 2007, Standard Test Method for Particle-Size Analysis of Soils. *American Society for Testing and Materials,* Pennsylvania.

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ASTM International Designation: D4373-02:2007, Standard Test Method for Rapid Determination of Carbonate Content of Soils. *American Society for Testing and Materials,* Pennsylvania.

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ASTM-3213-91, ASTM International Designation: D 3213 -97, Standard Practices for Handling, Storing and Preparing Soft Undisturbed Marine Soil

ASTM D6528-07:2013. Standard Test Method for Consolidated Undrained Direct Simple Shear Testing of cohesive Soils. *American Society for Testing and Materials,* Pennsylvania.

BS EN ISO 19901-8, 2013. Petroleum and Natural Gas Industries – Specific requirements for offshore structures, Part 8: Marine Soil Investigations

DD CEN ISO 17892-6: 2004. Geotechnical investigation and testing – Laboratory testing of soils– Part 6 Fall cone test. *British Standards Institute,* London

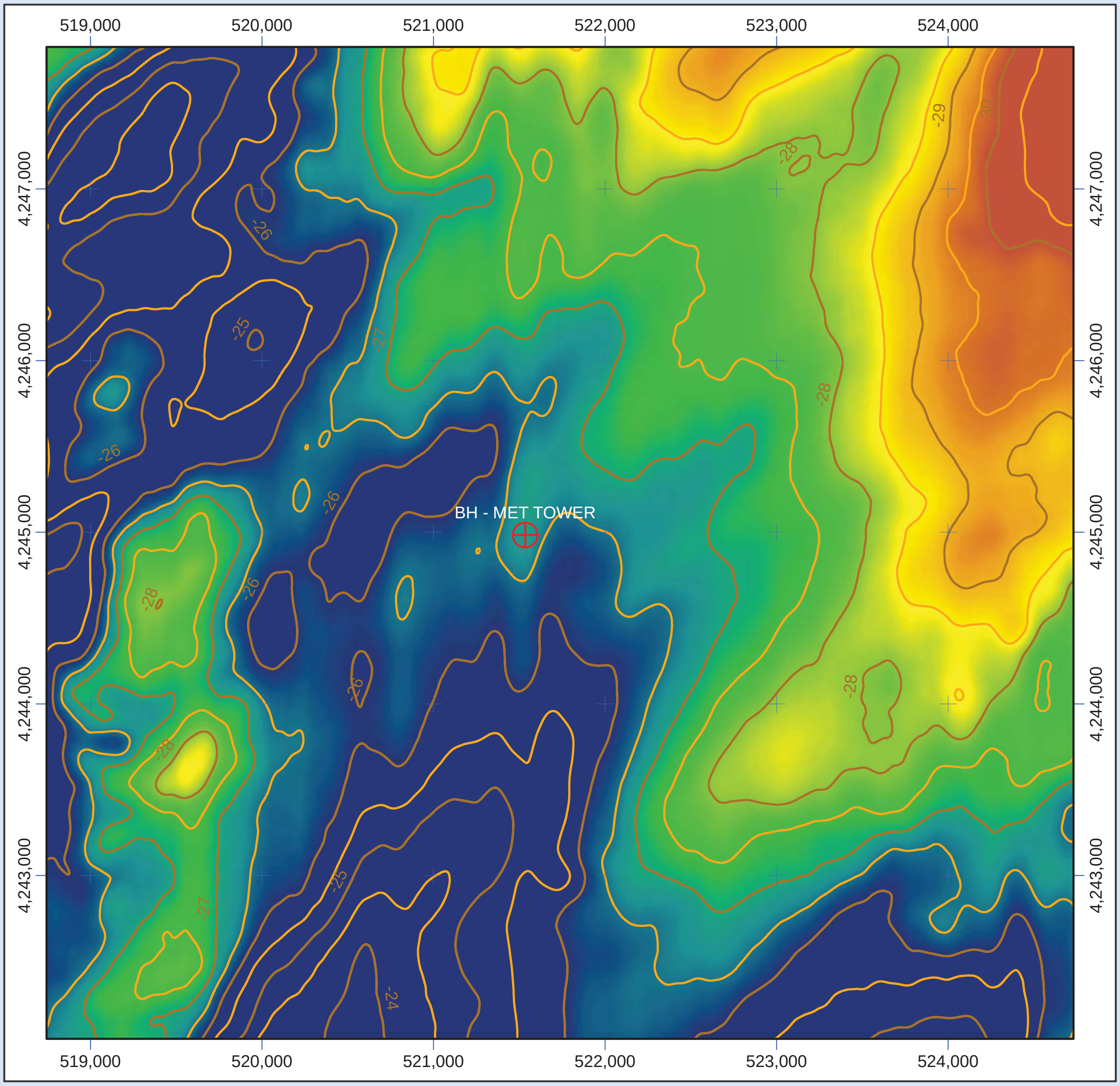
BS1377- 7, 1990 Methods of test for Soils for civil engineering purposes Incorporating Amendment No. 1. *British Standards Institute,* London

APPENDIX 1

1.1 Location Details

1.2 Location Summary

1.1 Location Map



Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Overview Map

Legend & Map Scale (A4)

Combined Borehole (CPTU/Sampling) & PS Logging

1.0m Contours

0.5m Contours

Bathymetry

-26.0m

-30.0m

Kilometers

0 0.4 0.8 1.2 1.6 2

1:35,000

Coordinate Reference System

Datum	NAD 83
Ellipsoid	GRS 80
Projection	UTM Zone 18N (75W)
Overview Data	ESRI

Contract Information

Gardline Job	10451
Client	US Wind Inc.
Client Ref	REF11449
Vessel	MV Ocean Discovery

Gardline Geosciences Ltd, Hewett Park, Hewett Road, Great Yarmouth, Norfolk. United Kingdom. NR31 0NN.

1.2 Location Summary

Gardline

10451 - Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

US Wind sea energy inc

Borehole	Latitude/ Easting (m)	Longitude/ Northing (m)	Water Depth (m)	Penetration (m)	Date of Test	Comments
BH - MET TOWER	38.352750/ 521533.9	74.753547/ 4244983.3	27.7	64.90	25/06/2015 - 26/06/2015	Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa

BOREHOLE LOCATION SUMMARY

GRS 80 UTM ZONE 18 N (75 W)

APPENDIX 2

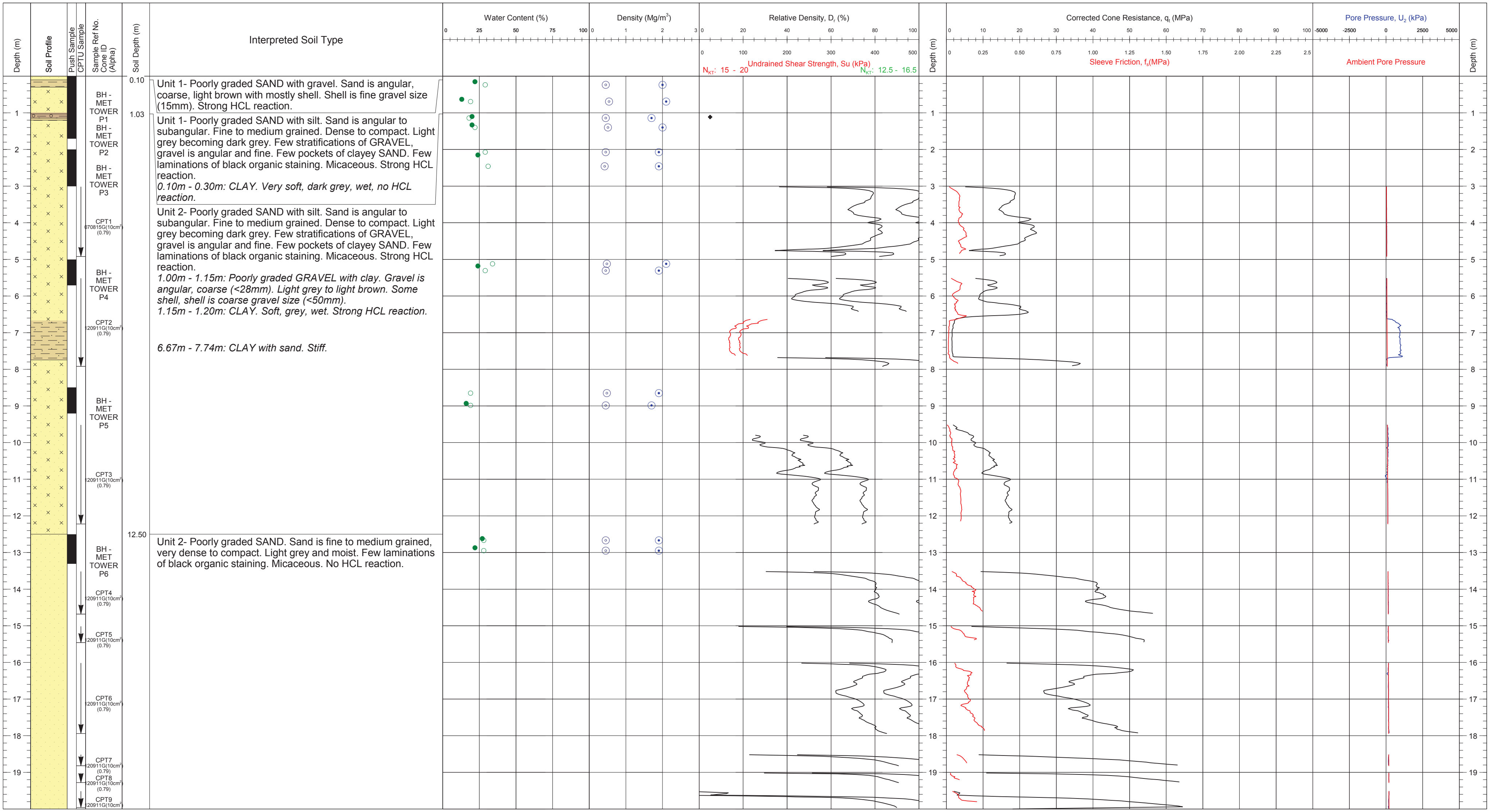
2.1 Interpreted Borehole Logs

2.2 Sample Photographs

2.1 Interpreted Borehole Logs

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

BOREHOLE LOG, LABORATORY TEST RESULTS AND INSITU CPTU TESTING



KEY TO SOIL PROFILE

SILT, CLAY, CHALK, PEAT, SAND, GRAVEL, COBBLES, Mixed Soil

Area	Maryland USA	Coordinates	521533.9E	4244983.3N	CRS: GRS 80 UTM ZONE 18 N (75 W)
Contract	10451	Latitude/ Longitude	38.352750	74.753547	Comments: Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa
Client Name/Ref	US Wind Inc./REF11449	Water Depth (mMSL)	27.7		
Vessel	MV Ocean Discovery	Date of Test (Start-End)	25/06/2015 - 26/06/2015		
Method	Wison	Final Borehole Depth	64.90m		

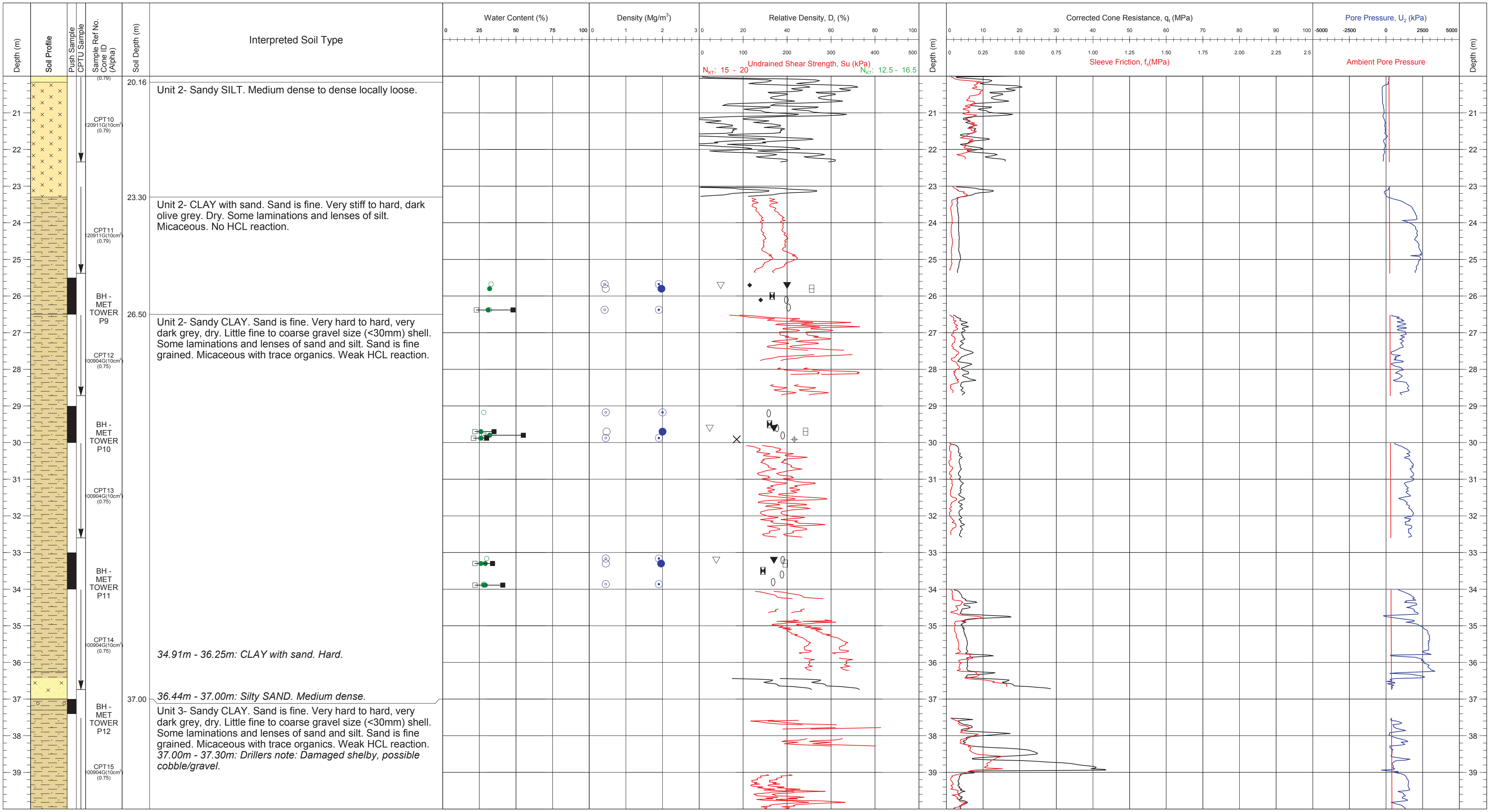
QC Status		
Preliminary	Draft	Final
NV-S (27/06/2015)	SMc (23/09/2015)	

Sample Name

BH - MET TOWER

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

BOREHOLE LOG, LABORATORY TEST RESULTS AND INSITU CPTU TESTING



KEY TO SOIL PROFILE

SILT	CLAY	CHALK	PEAT
SAND	GRAVEL	COBBLES	Mixed Soil

Area	Maryland USA	Coordinates	521533.9E	4244983.3N	CRS: GRS 80 UTM ZONE 18 N (75 W)
Contract	10451	Latitude/ Longitude	38.352750	74.753547	Comments: Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa
Client Name/Ref	US Wind Inc./REF11449	Water Depth (mMSL)	27.7		
Vessel	MV Ocean Discovery	Date of Test (Start-End)	25/06/2015 - 26/06/2015		
Method	Wison	Final Borehole Depth	64.90m		

QC Status		
Preliminary	Draft	Final
NV-S (27/06/2015)	SMc (23/09/2015)	

Sample Name: BH - MET TOWER

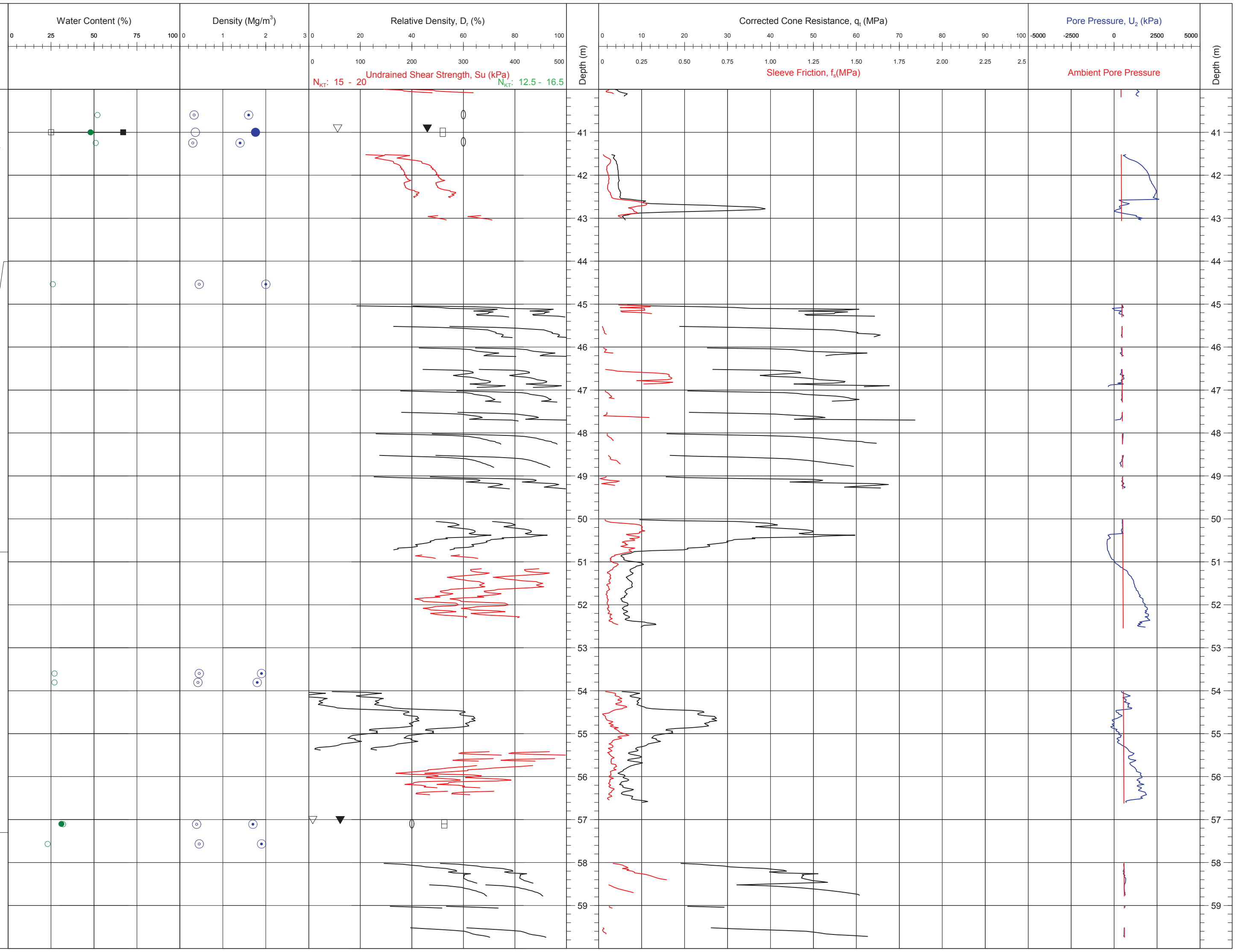
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

BOREHOLE LOG, LABORATORY TEST RESULTS AND INSITU CPTU TESTING

Gardline | US Wind

Soil Depth (m)	Interpreted Soil Type
	Unit 3- Sandy CLAY. Sand is fine. Very hard to hard, very dark grey, dry. Little fine to coarse gravel size (<30mm) shell. Some laminations and lenses of sand and silt. Sand is fine grained. Micaceous with trace organics. Weak HCL reaction. *40.50m - 41.53m: Elastic SILT. Firm, olive grey, moist, mostly laminated with sandy clay. Sand is fine. No HCL reaction.* *42.60m - 42.93m: Silty SAND. Dense.*
44.01	Unit 3- Poorly graded SAND with silt. Sand is fine grained, grey, compact and wet. No HCL reaction. *44.50m - 44.69m: Drillers note: Damaged shelby, possible cobble/gravel*
50.77	Unit 3- Sandy CLAY. Sand is fine. Hard, grey, moist. No HCL reaction. *53.50m - 55.30m: Silty SAND. Medium dense to dense.*
57.30	Unit 3- Clayey SAND becoming SAND with silt. Sand is fine to medium grained, grey and moist.

Sample Ref No. / Cone ID (Alpha): BH - MET TOWER P13; CPT16 100904G(10cm²) (0.79); BH - MET TOWER P14; CPT17 120911G(10cm²) (0.79); CPT18 100904G(10cm²) (0.79); BH - MET TOWER P14A; CPT19 100904G(10cm²) (0.79); CPT20 100904G(10cm²) (0.79); CPT21 100904G(10cm²) (0.79); CPT22 100904G(10cm²) (0.79); CPT23 100904G(10cm²) (0.79); CPT24 120911G(10cm²) (0.79); CPT25 120911G(10cm²) (0.79); CPT26 120911G(10cm²) (0.79); CPT27 120911G(10cm²) (0.79); BH - MET TOWER P16A; CPT28 120911G(10cm²) (0.79); BH - MET TOWER P17; CPT29 120911G(10cm²) (0.79); CPT30 120911G(10cm²) (0.79); CPT31 120911G(10cm²) (0.79); CPT32 120911G(10cm²) (0.79)



KEY TO SOIL PROFILE

SILT, CLAY, CHALK, PEAT, SAND, GRAVEL, COBBLES, Mixed Soil

Area	Maryland USA	Coordinates	521533.9E	4244983.3N
Contract	10451	Latitude/ Longitude	38.352750	74.753547
Client Name/Ref	US Wind Inc./REF11449	Water Depth (mMSL)	27.7	
Vessel	MV Ocean Discovery	Date of Test (Start-End)	25/06/2015 - 26/06/2015	
Method	Wison	Final Borehole Depth	64.90m	

CRS: **GRS 80 UTM ZONE 18 N (75 W)**

Comments:
Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa

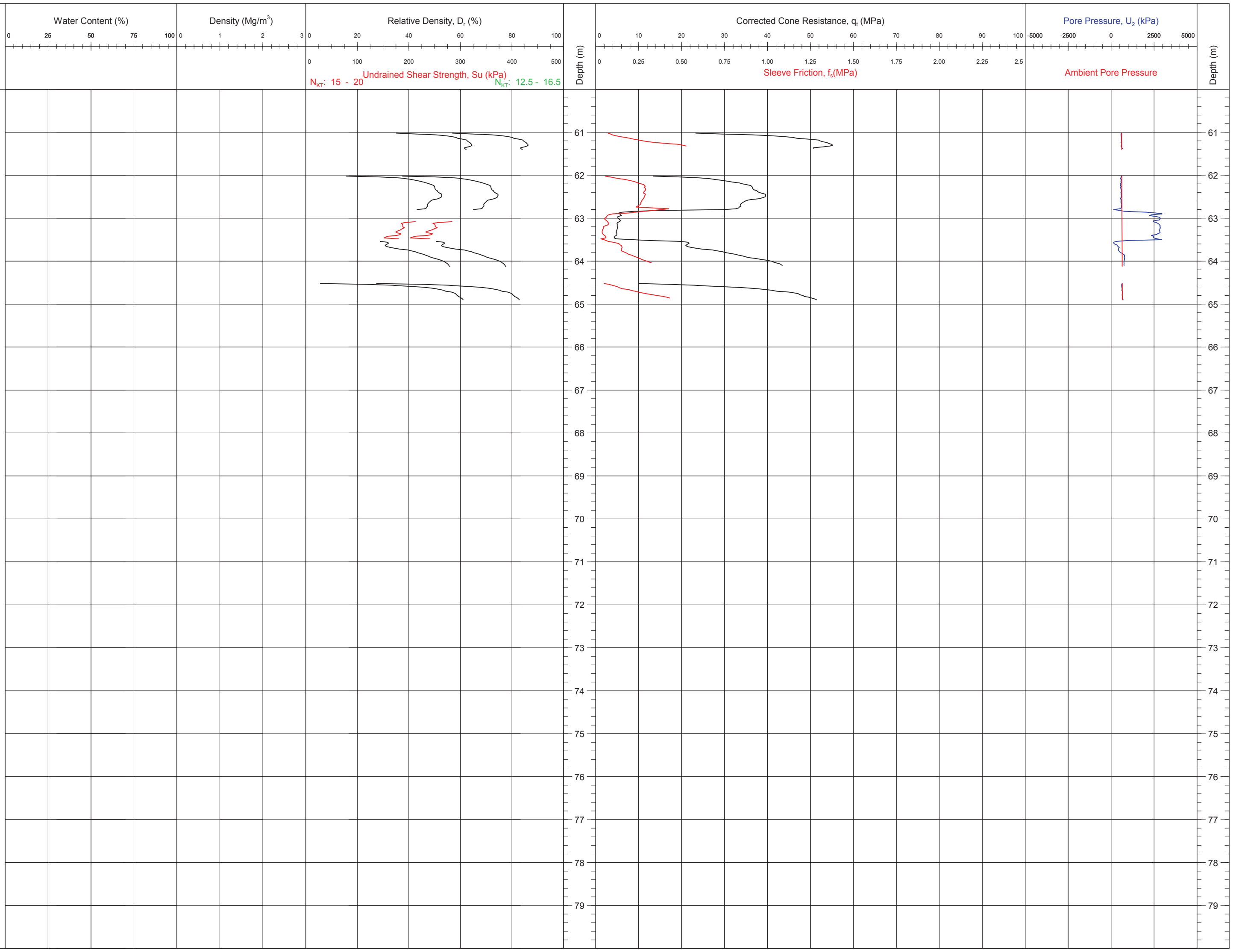
QC Status		
Preliminary	Draft	Final
NV-S (27/06/2015)	SMc (23/09/2015)	

Sample Name: **BH - MET TOWER**

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

BOREHOLE LOG, LABORATORY TEST RESULTS AND INSITU CPTU TESTING

Depth (m)	Sample Ref No. Cone ID (Alpha)	Interpreted Soil Type
60.0 – 64.90	CPT33 120911G(10cm²) (0.79); CPT34 120911G(10cm²) (0.79); CPT35 120911G(10cm²) (0.79)	Unit 3- Clayey SAND becoming SAND with silt. Sand is fine to medium grained, grey and moist.
63.09 – 63.51		*63.09m - 63.51m: Sandy CLAY. Hard.*
64.90		End of borehole at 64.90m



KEY TO SOIL PROFILE

SILT, CLAY, CHALK, PEAT, SAND, GRAVEL, COBBLES, Mixed Soil

Area	Maryland USA	Coordinates	521533.9E	4244983.3N
Contract	10451	Latitude/ Longitude	38.352750	74.753547
Client Name/Ref	US Wind Inc./REF11449	Water Depth (mMSL)	27.7	
Vessel	MV Ocean Discovery	Date of Test (Start-End)	25/06/2015 - 26/06/2015	
Method	Wison	Final Borehole Depth	64.90m	

CRS: **GRS 80 UTM ZONE 18 N (75 W)**

Comments:
Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa

QC Status		
Preliminary	Draft	Final
NV-S (27/06/2015)	SMc (23/09/2015)	

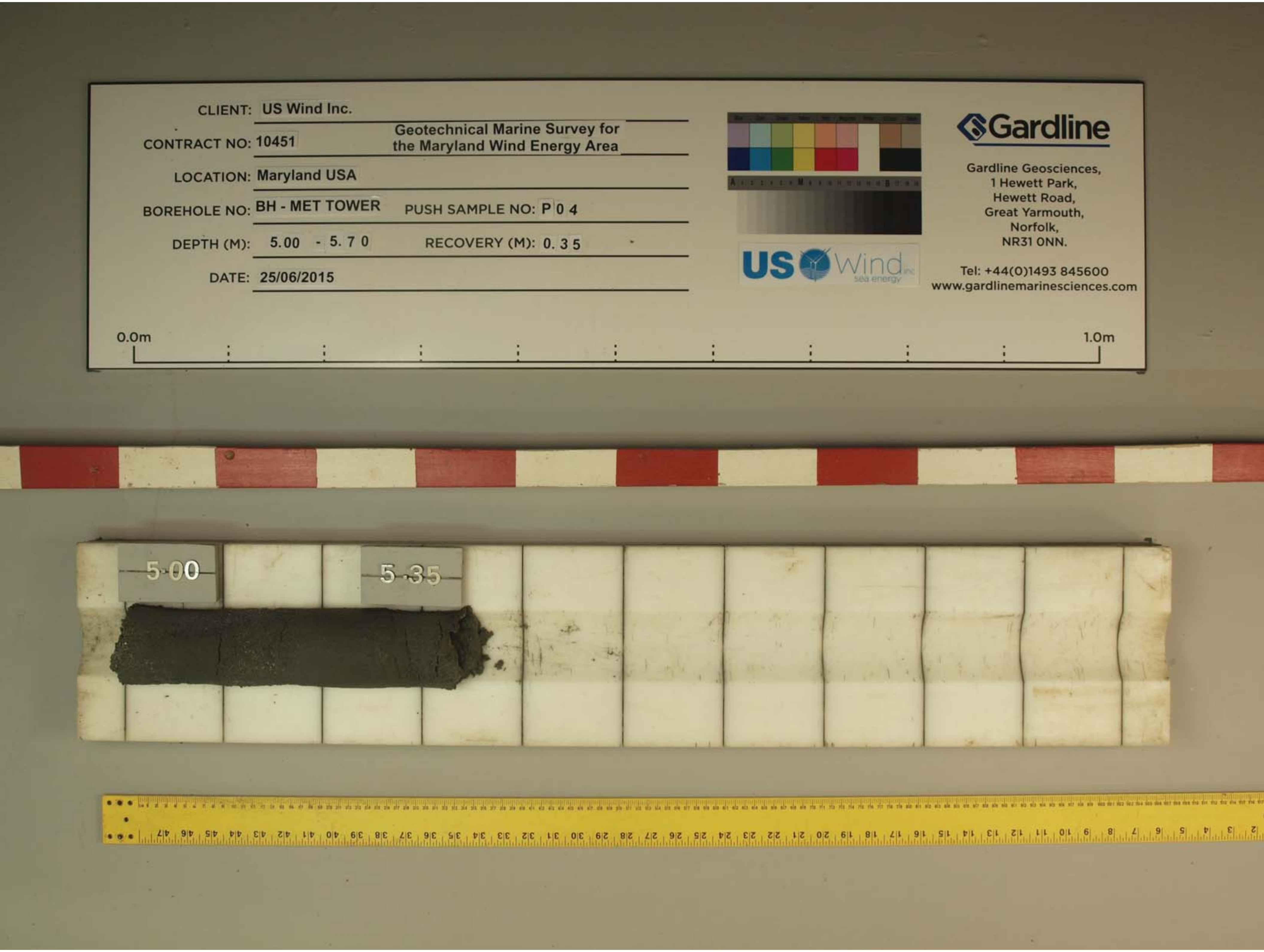
Sample Name: **BH - MET TOWER**

2.2 Sample Photographs


CLIENT: US Wind Inc.
CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 0 1
DEPTH (M): 0. 00 - 1. 00
RECOVERY (M): 0. 7 5
DATE: 25/06/2015
Gardline
Gardline Geosciences,
1 Hewett Park,
Hewett Road,
Great Yarmouth,
Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
www.gardlinemarinesciences.com
US Wind
sea energy
0.0m
1.0m
0.00
0.75


CLIENT: US Wind Inc.
CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 0 2
DEPTH (M): 1. 00 - 2. 00
RECOVERY (M): 0. 4 5
DATE: 25/06/2015
Gardline
Gardline Geosciences,
1 Hewett Park,
Hewett Road,
Great Yarmouth,
Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
www.gardlinemarinesciences.com
US Wind
sea energy
0.0m
1.0m
1·00
1·45


CLIENT: US Wind Inc.
CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 0 3
DEPTH (M): 2. 00 - 3. 00
RECOVERY (M): 0. 6 0
DATE: 25/06/2015
Gardline
Gardline Geosciences,
1 Hewett Park,
Hewett Road,
Great Yarmouth,
Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
www.gardlinemarinesciences.com
US Wind
0.0m
1.0m
2.00
2.60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CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 0 4
DEPTH (M): 5.00 - 5. 7 0
RECOVERY (M): 0. 3 5
DATE: 25/06/2015
Gardline
Gardline Geosciences,
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Hewett Road,
Great Yarmouth,
Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
www.gardlinemarinesciences.com
US Wind
sea energy
0.0m
1.0m
5·00
5·35


CLIENT: US Wind Inc.
CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 0 5
DEPTH (M): 8. 50 - 9. 20
RECOVERY (M): 0. 55
DATE: 25/06/2015
Gardline
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Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
www.gardlinemarinesciences.com
US Wind inc
sea energy
0.0m
1.0m
8·50
9·05

CLIENT: US Wind Inc.

CONTRACT NO: 10451 Geotechnical Marine Survey for the Maryland Wind Energy Area

LOCATION: Maryland USA

BOREHOLE NO: BH - MET TOWER PUSH SAMPLE NO: P06

DEPTH (M): 12.50 - 13.30 RECOVERY (M): 0.50

DATE: 25/06/2015

0.0m 1.0m

Gardline

US Wind inc sea energy

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Tel: +44(0)1493 845600
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CLIENT: US Wind Inc.

CONTRACT NO: 10451 Geotechnical Marine Survey for the Maryland Wind Energy Area

LOCATION: Maryland USA

BOREHOLE NO: BH - MET TOWER PUSH SAMPLE NO: P 0 9

DEPTH (M): 2 5. 50 - 2 6. 50 RECOVERY (M): 0. 9 5

DATE: 26/06/2015

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Norfolk,
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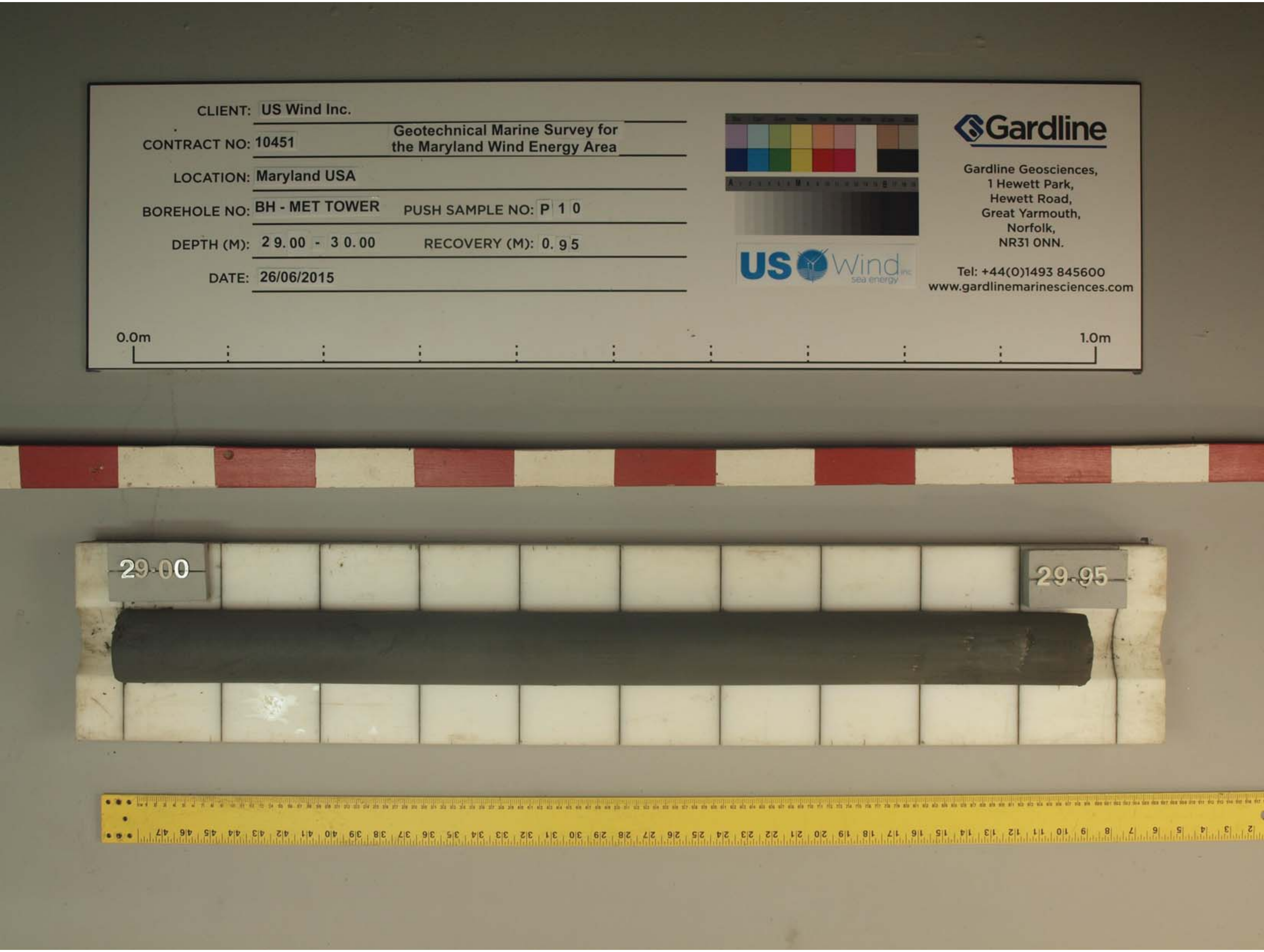
0.0m 1.0m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CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 1 0
DEPTH (M): 2 9.00 - 3 0.00
RECOVERY (M): 0. 9 5
DATE: 26/06/2015
Gardline
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Norfolk,
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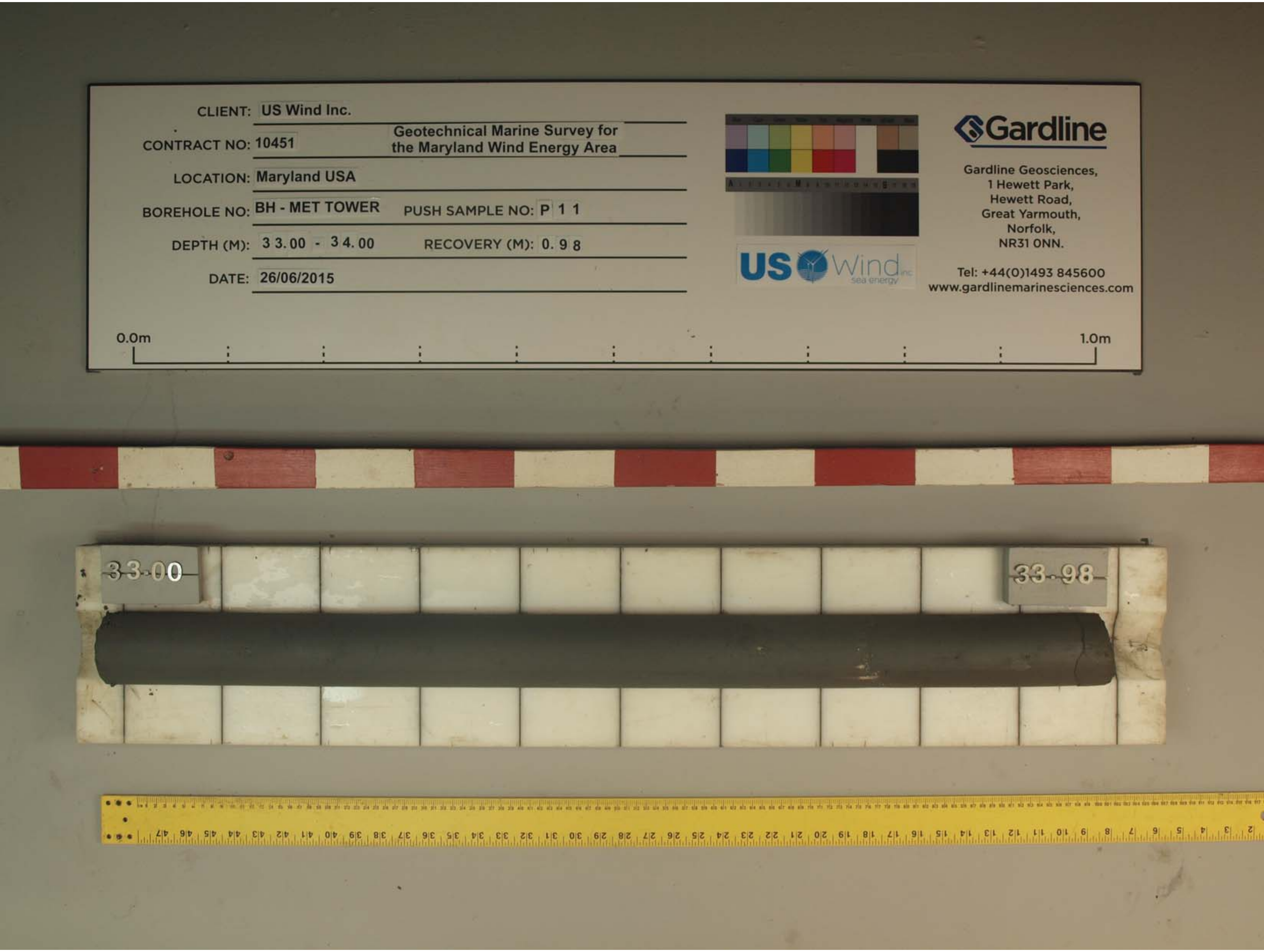
US Wind
sea energy
0.0m
1.0m
29.00
29.95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Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 1 1
DEPTH (M): 33.00 - 34.00
RECOVERY (M): 0.98
DATE: 26/06/2015
Gardline
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Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
www.gardlinemarinesciences.com
US Wind
0.0m
1.0m
33.00
33.98


CLIENT: US Wind Inc.
CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 1 2
DEPTH (M): 37. 00 - 37. 40
RECOVERY (M): 0. 30
DATE: 26/06/2015
Gardline
Gardline Geosciences,
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Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
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US Wind
0.0m
1.0m
37.00
37.30

CLIENT: US Wind Inc.

CONTRACT NO: 10451 Geotechnical Marine Survey for the Maryland Wind Energy Area

LOCATION: Maryland USA

BOREHOLE NO: BH - MET TOWER PUSH SAMPLE NO: P 1 3

DEPTH (M): 4 0. 50 - 4 1. 5 0 RECOVERY (M): 0. 9 0

DATE: 26/06/2015

Gardline Geosciences,
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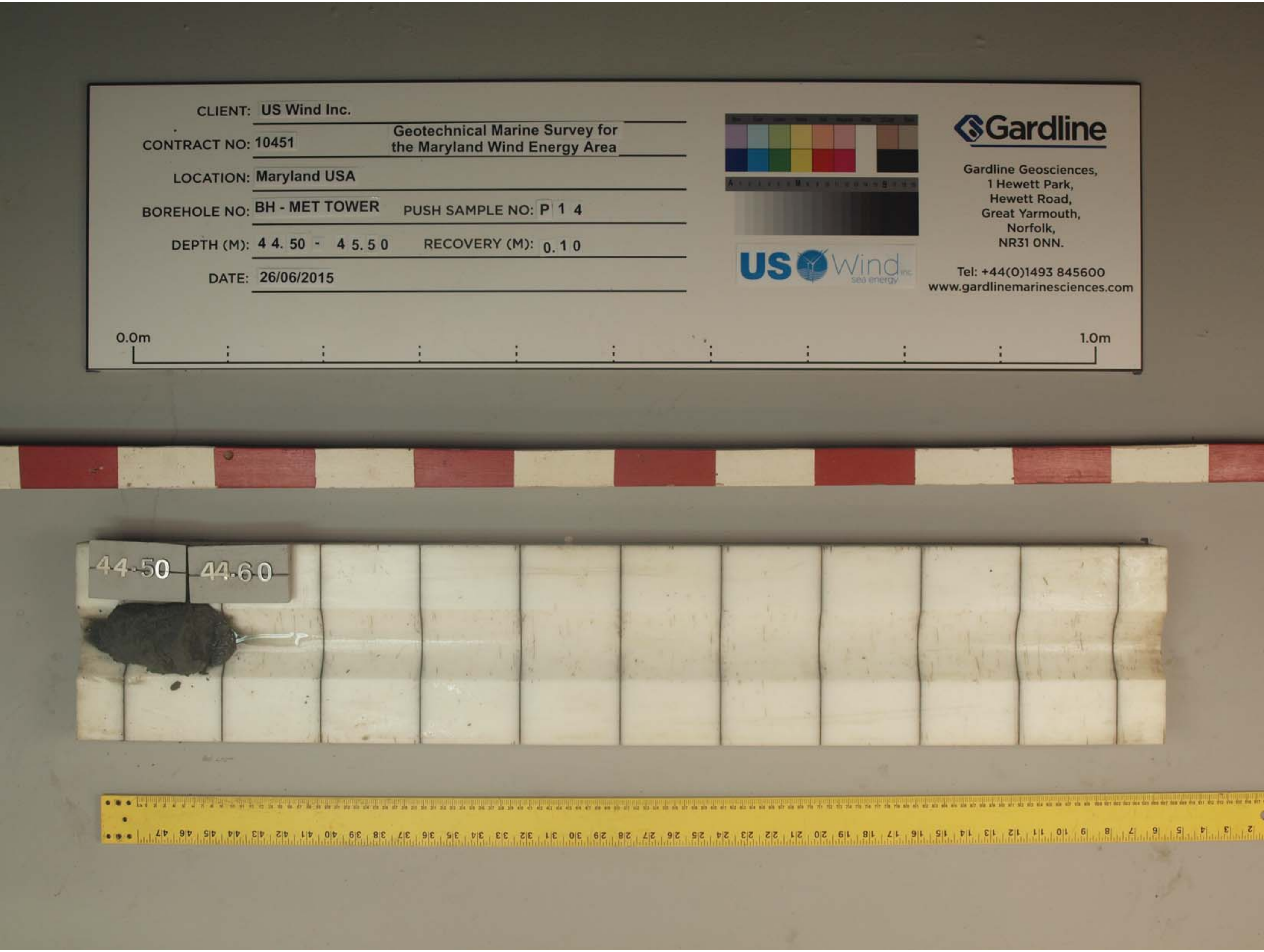
0.0m 1.0m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BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 1 4
DEPTH (M): 4 4. 50 - 4 5. 5 0
RECOVERY (M): 0. 1 0
DATE: 26/06/2015
Gardline
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Hewett Road,
Great Yarmouth,
Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
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US Wind
0.0m
1.0m
44.50
44.60


CLIENT: US Wind Inc.
CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 1 4 A
DEPTH (M): 4 4. 50 - 4 5.00
RECOVERY (M): 0. 3 0
DATE: 26/06/2015
Gardline
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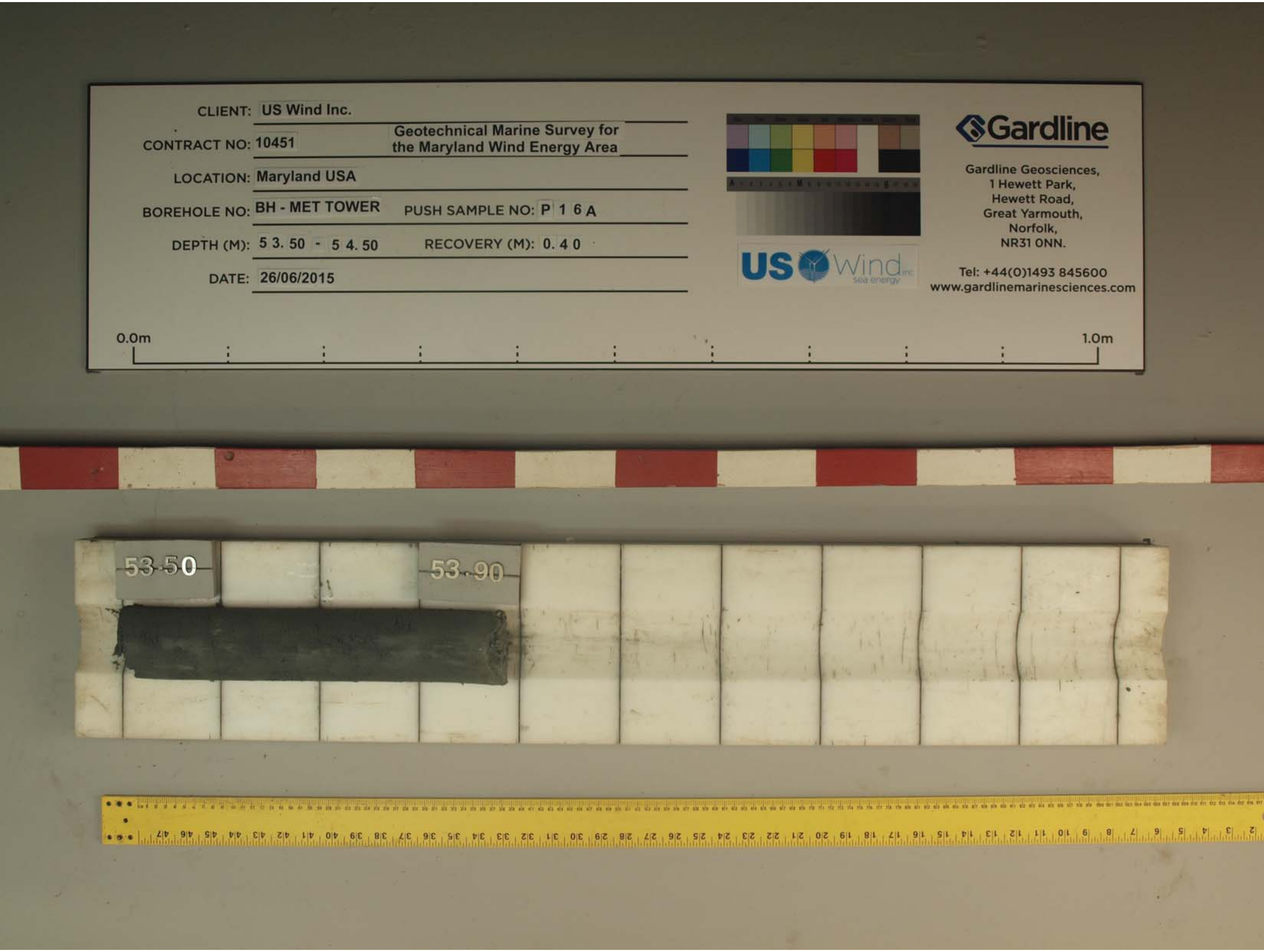
Hewett Road,
Great Yarmouth,
Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
www.gardlinemarinesciences.com
US Wind
0.0m
1.0m
44.50
44.80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CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 1 6 A
DEPTH (M): 5 3. 50 - 5 4. 50
RECOVERY (M): 0. 4 0
DATE: 26/06/2015
Gardline
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Hewett Road,
Great Yarmouth,
Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
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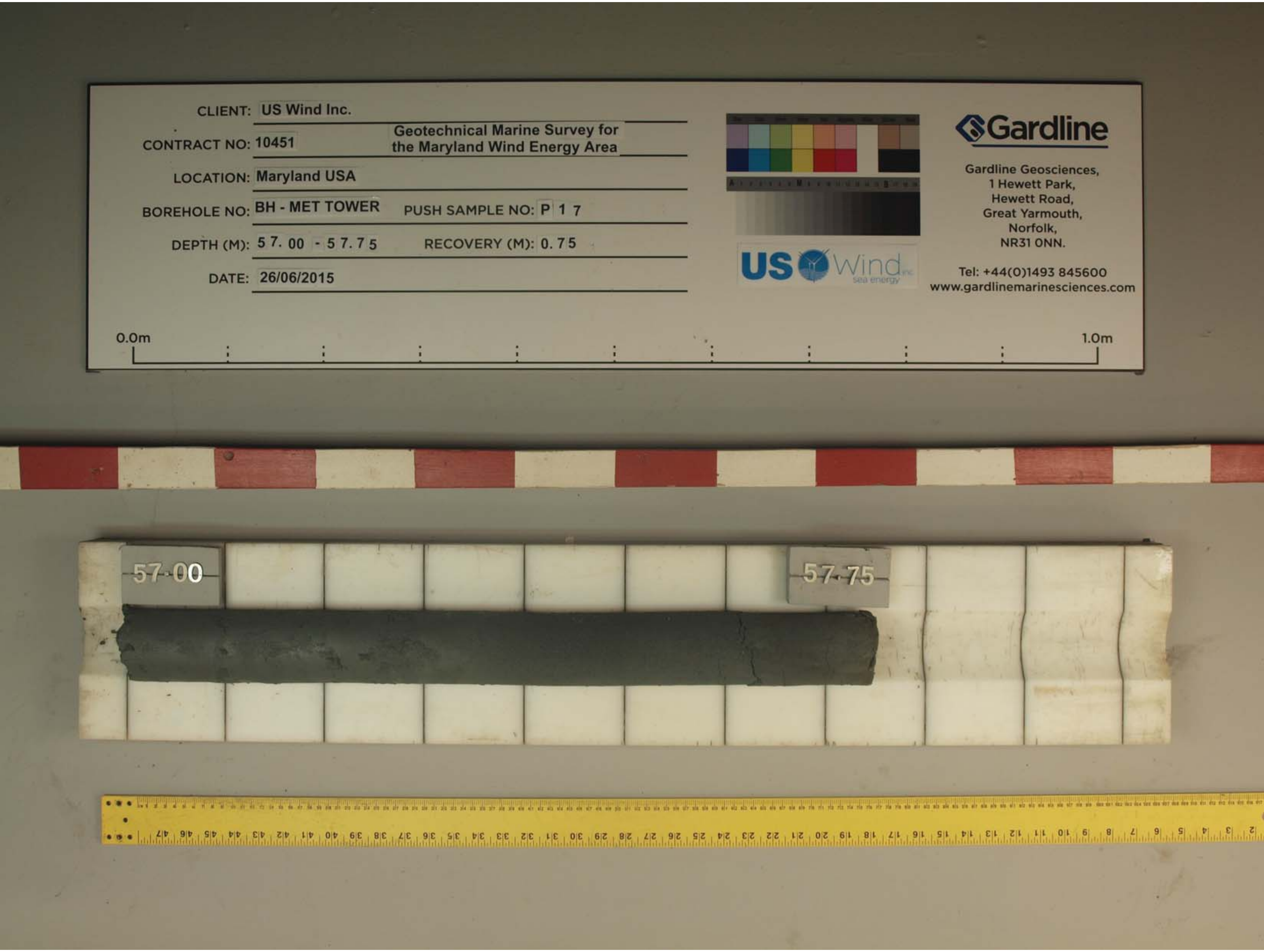
US Wind
sea energy
0.0m
1.0m
53.50
53.90


CLIENT: US Wind Inc.
CONTRACT NO: 10451
Geotechnical Marine Survey for the Maryland Wind Energy Area
LOCATION: Maryland USA
BOREHOLE NO: BH - MET TOWER
PUSH SAMPLE NO: P 17
DEPTH (M): 57.00 - 57.75
RECOVERY (M): 0.75
DATE: 26/06/2015
Gardline
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Norfolk,
NR31 0NN.
Tel: +44(0)1493 845600
www.gardlinemarinesciences.com
US Wind
sea energy
0.0m
1.0m
57.00
57.75

APPENDIX 3

3.1 Moisture Content and Density Results

3.2 Classification Summary

3.3 Particle Size Distribution Results

3.4 Finer than 75µm Report Summary

3.5 Plasticity Results

3.6 Shear Strength Summary

3.7 Triaxial Summary

3.8 Undrained Unconsolidated Triaxial (UU) Results

3.9 Consolidated Anisotropic Undrained Compression Triaxial (CAUC)

3.10 Chemical Laboratory Results

3.1 Moisture Content and Density Results

10451 Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BH-MET Tower

Push Number	Level in core (m)	Natural Moisture Content (%)	Dry Density (Mg/m³)	Bulk Density (Mg/m³)	Density of Intact Core (Mg/m³)	Minimum Dry Density (Mg/m³)	Maximum Dry Density (Mg/m³)	Particle Density (Mg/m³)	Saturated Moisture Content	Void Ratio	Porosity	Unit Weight (kN/m³)	Remarks
P1B1	0.15	22											
P1B1	0.24	29	1.5	2.0								19.62	
P1B3	0.63	13						2.65					
P1B3	0.69	19	1.8	2.1								20.60	
P2B1	1.10	20											
P2B1	1.14	18	1.5	1.7								16.68	
P2B2	1.40	22	1.7	2.0								19.62	
P2B2	1.33	20											
P3B1	2.07	29	1.5	1.9								18.64	
P3B1	2.15	24											
P3B2	2.46	31	1.4	1.9								18.64	
P4B1	5.12	34	1.6	2.1								20.60	
P4B1	5.18	24						2.66					
P4B1	5.31	29	1.5	1.9								18.64	
P5B1	8.65	19	1.6	1.9								18.64	
P5B2	8.93	16											
P5B2	8.99	19	1.5	1.7								16.68	
P6B1	12.62	27						2.66					
P6B1	12.67	28	1.5	1.9								18.64	
P6B2	12.87	22											
P6B2	12.95	28	1.5	1.9								18.64	
P9B1	25.68	33	1.4	1.9								18.64	
P9Q1	25.80	32	1.50	1.97								19.33	
P9Q1	29.80	32											

DETERMINATION OF MOISTURE CONTENT AND DENSITY

ASTM D2216-05

Gardline

10451 Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area BH-MET Tower

US Wind inc sea energy

Push Number	Level in core (m)	Natural Moisture Content (%)	Dry Density (Mg/m^3)	Bulk Density (Mg/m^3)	Density of Intact Core (Mg/m^3)	Minimum Dry Density (Mg/m^3)	Maximum Dry Density (Mg/m^3)	Particle Density (Mg/m^3)	Saturated Moisture Content	Void Ratio	Porosity	Unit Weight (kN/m^3)	Remarks
P9B2	26.38	32	1.4	1.9								18.64	
P9B2	26.38	31						2.77					
P10B1	29.18	28	1.5	2.0								19.62	
P10Q2	29.70	26	1.58	2.00								19.62	
P10B2	29.88	28	1.5	1.9								18.64	
P10B2	29.88	26											
P11B1	33.16	30	1.5	1.9								18.64	
P11Q1	33.30	29	1.51	1.96								19.23	
P11B2	33.86	28	1.5	1.9								18.64	
P11B2	33.89	29											
P13B1	40.60	52	1.1	1.6								15.70	
P13Q2	41.00	48	1.20	1.76								17.27	
P13B2	41.25	51	1.0	1.4								13.73	
P14AB1	44.65							2.69					
P14B1	44.54	26	1.5	2.0								19.62	
P16AB1	53.60	27	1.5	1.9								18.64	
P16AB2	53.80							2.69					
P16AB2	53.81	27	1.4	1.8								17.66	
P17Q1	57.10	31											
P17Q1	57.11	32	1.3	1.7								16.68	
P17B2	57.57	23	1.5	1.9								18.64	

DETERMINATION OF MOISTURE CONTENT AND DENSITY

ASTM D2216-05

3.2 Classification Summary

10451 Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BH-MET Tower

Push Name	Specimen Depth (m)	Particle Size Distribution (%)					Atterberg Limits						Principal Soil Type
		GRAVEL 2mm-63mm	SAND 60µm-2mm	FINES <63µm	SILT 2µm-63µm	CLAY <2µm	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (I_P)	Liquidity Index (I_L)	Moisture Content (%)	Activity	
P1B1	0.15	0	62	38	18	20							Clayey silty SAND
P1B3	0.63	0	89	11	6	5							SAND
P2B1	1.10	0	42	58	28	30							Sandy silty CLAY
P2B2	1.33	0	63	37	22	15							Silty clayey SAND
P9Q1	29.80						55	28	27	14.0	32		CLAY
P9B2	26.38						48	23	25	32.0	31		CLAY
P10Q2	29.70						35	22	13	34.0	26		CLAY
P10B2	29.88						30	21	9	55.0	26		CLAY
P11Q1	33.30						34	22	12	34.0	26		CLAY
P11B2	33.89						41	22	19	33.0	28		CLAY
P13Q2	41.00						67	25	42	54.0	48		CLAY
P14AB1	44.65	11	68	21	13	8							SAND

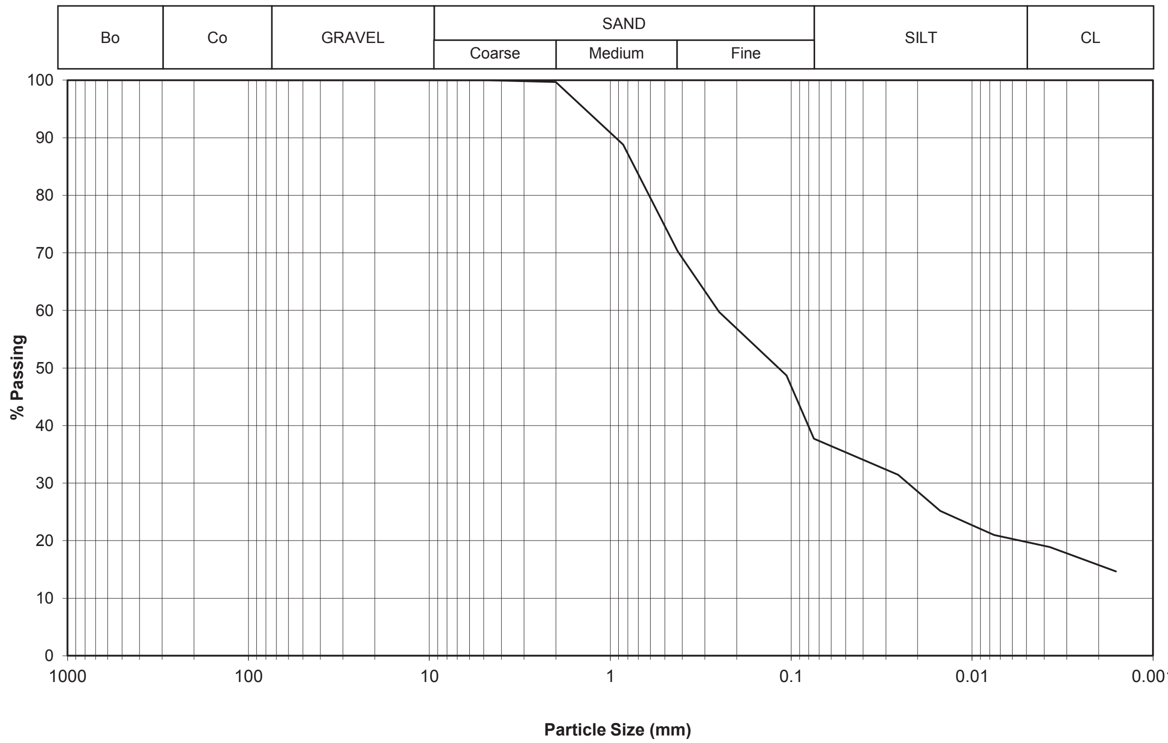
CLASSIFICATION SUMMARY TABLE

ASTM D422-63 (2007) & D4318

3.3 Particle Size Distribution Results

Gardline	**Particle Size Distribution Analysis**	US Wind inc sea energy

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH No.	BH - MET TOWER
Soil Description	Clayey silty SAND. Sand is fine to medium, light brown, wet.	**Sample Ref.**	P1B1
		Depth (m)	0.00 - 0.30



Sieving	
Particle Size (mm)	% Passing
75.0	100
50.0	100
37.5	100
25.0	100
19.0	100
9.5	100
4.750	100
2.000	100
0.850	89
0.425	70
0.250	60
0.106	49
0.075	38

Sedimentation	
Particle Size (μm)	% Finer
25.6	31
15.0	25
10.7	23
7.6	21
3.7	19
1.6	15

Particle Density (ρs) Mg/m3	
2.65	assumed

Soil Categories	
Type	%
Cobbles / Boulders	0
Gravel	0
Sand	62
Silt / Clay	38
Silt	18
Clay	20

Grading Analysis	
D60 (mm)	0.253
D30 (mm)	0.0226
D10 (mm)	
Uniformity Coefficient	
Curvature Coefficient	

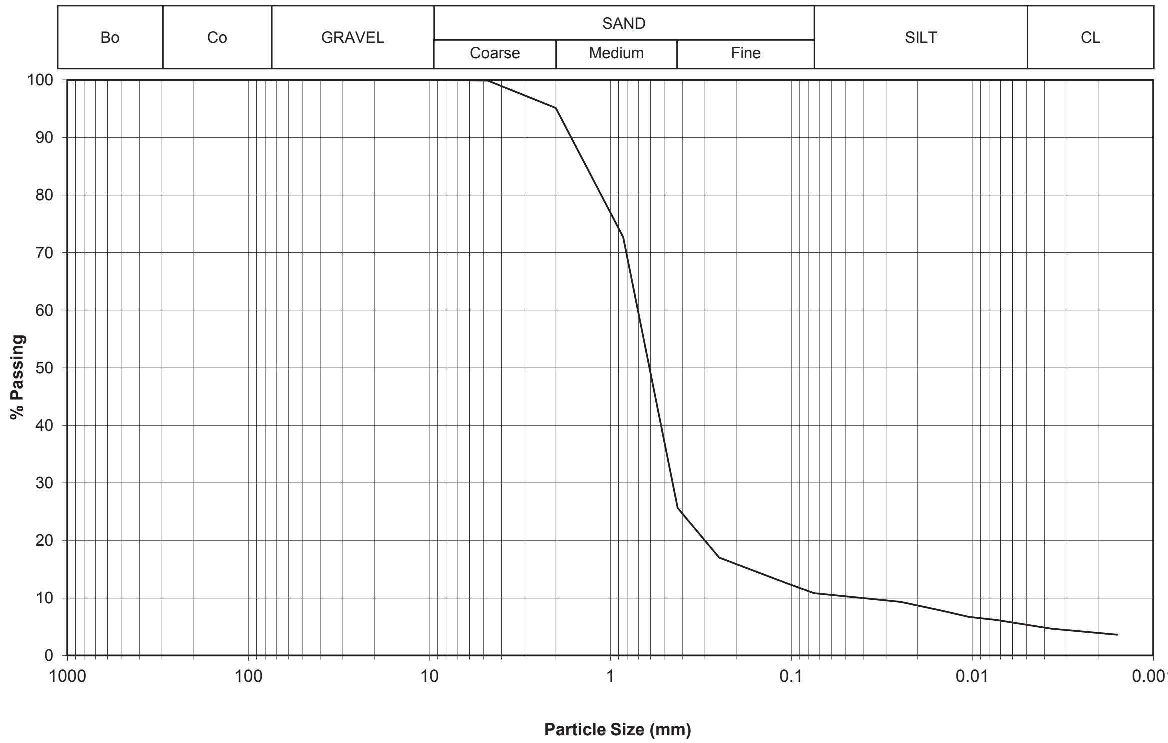
Testing in accordance with
ASTM D422-63 (2007)

Remarks

Checked by	DR
Approved by	AA

Particle Size Distribution Analysis

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH No.	BH - MET TOWER
Soil Description	SAND with silt and clay. Sand is medium to coarse, light grey becoming dark grey, moist.	**Sample Ref.**	P1B3
		Depth (m)	0.50 - 0.75



Sieving	
Particle Size (mm)	% Passing
75.0	100
50.0	100
37.5	100
25.0	100
19.0	100
9.5	100
4.750	100
2.000	95
0.850	73
0.425	26
0.250	17
0.106	13
0.075	11

Sedimentation	
Particle Size (μm)	% Finer
24.9	9
14.6	8
10.4	7
7.4	6
3.7	5
1.6	4

Particle Density (ρs) Mg/m3	
2.65	measured

Soil Categories	
Type	%
Cobbles / Boulders	0
Gravel	0
Sand	89
Silt / Clay	11
Silt	6
Clay	5

Grading Analysis	
D60 (mm)	0.705
D30 (mm)	0.453
D10 (mm)	0.0303
Uniformity Coefficient	23
Curvature Coefficient	9.6

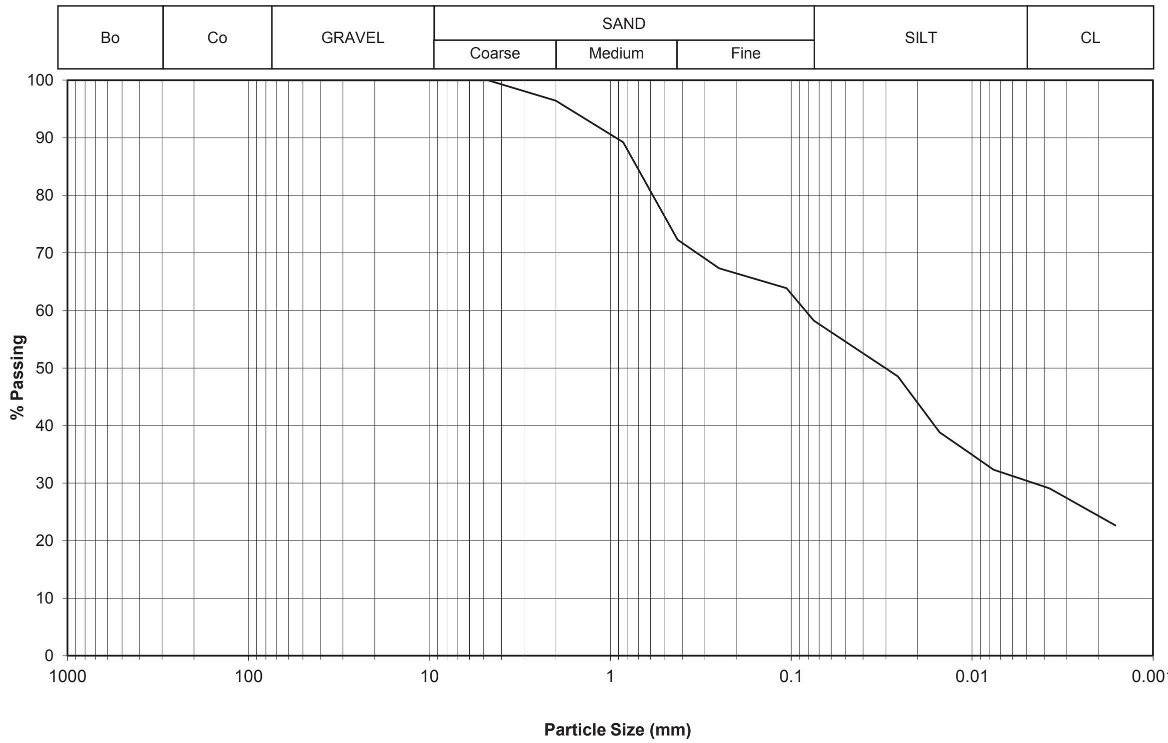
Testing in accordance with
ASTM D422-63 (2007)

Remarks

Checked by	DR
Approved by	AA

Gardline	**Particle Size Distribution Analysis**	US Wind inc sea energy

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH No.	BH - MET TOWER
Soil Description	Sandy Silty CLAY, light grey to light brown. Sand is medium.	**Sample Ref.**	P2B1
		Depth (m)	1.00 - 1.20



Sieving	
Particle Size (mm)	% Passing
75.0	100
50.0	100
37.5	100
25.0	100
19.0	100
9.5	100
4.750	100
2.000	96
0.850	89
0.425	72
0.250	67
0.106	64
0.075	58

Sedimentation	
Particle Size (μm)	% Finer
25.7	49
15.1	39
10.7	36
7.6	32
3.7	29
1.6	23

Particle Density (ρs) Mg/m3	
2.65	assumed

Soil Categories	
Type	%
Cobbles / Boulders	0
Gravel	0
Sand	42
Silt / Clay	58
Silt	28
Clay	30

Grading Analysis	
D60 (mm)	0.0837
D30 (mm)	0.00455
D10 (mm)	
Uniformity Coefficient	
Curvature Coefficient	

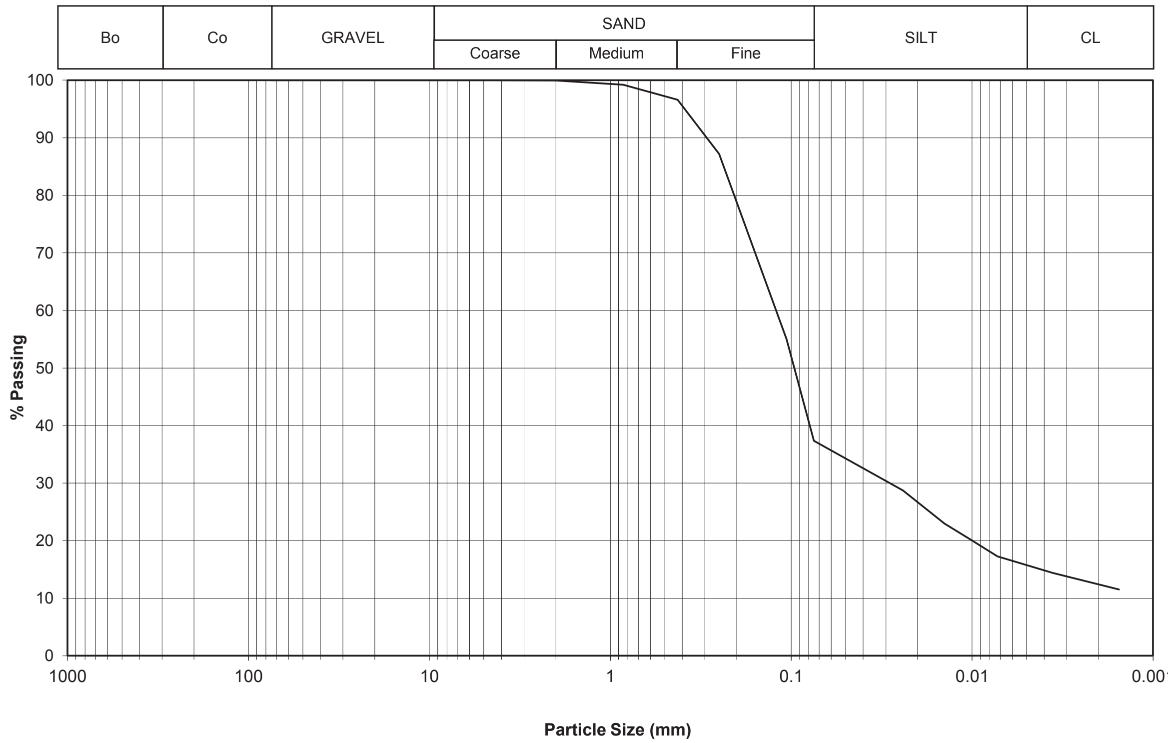
Testing in accordance with
ASTM D422-63 (2007)

Remarks

Checked by	DR
Approved by	AA

Gardline	**Particle Size Distribution Analysis**	US Wind inc sea energy

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH No.	BH - MET TOWER
Soil Description	Silty clayey SAND. Sand is fine, light grey becoming dark grey, moist.	**Sample Ref.**	P2B2
		Depth (m)	1.20 - 1.45



Sieving	
Particle Size (mm)	% Passing
75.0	100
50.0	100
37.5	100
25.0	100
19.0	100
9.5	100
4.750	100
2.000	100
0.850	99
0.425	97
0.250	87
0.106	55
0.075	37

Sedimentation	
Particle Size (µm)	% Finer
24.1	29
14.2	23
10.2	20
7.2	17
3.6	14
1.5	11

Particle Density (ρs) Mg/m3	
2.65	assumed

Soil Categories	
Type	%
Cobbles / Boulders	0
Gravel	0
Sand	63
Silt / Clay	37
Silt	22
Clay	15

Grading Analysis	
D60 (mm)	0.121
D30 (mm)	0.0257
D10 (mm)	
Uniformity Coefficient	
Curvature Coefficient	

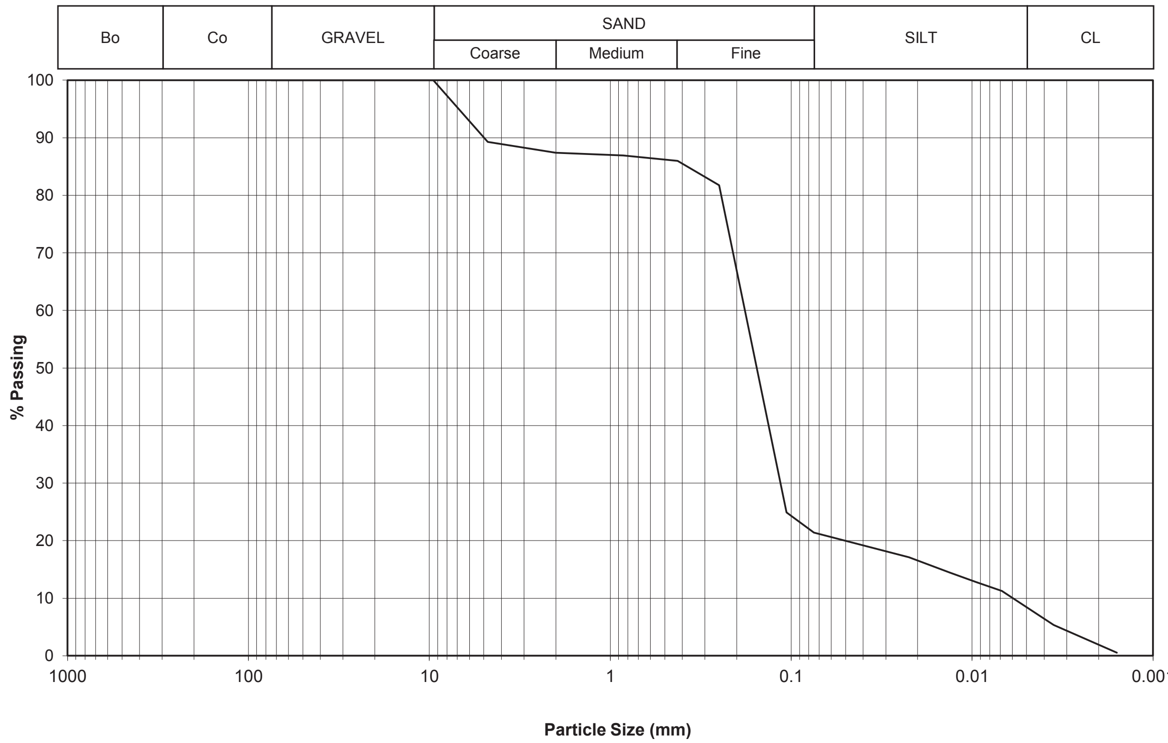
Testing in accordance with
ASTM D422-63 (2007)

Remarks

Checked by	DR
Approved by	AA

Particle Size Distribution Analysis

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH No.	BH - MET TOWER
Soil Description	SAND with gravel, silt and clay. Sand is fine, grey, wet. Gravel is fine to medium.	**Sample Ref.**	P14AB1
		Depth (m)	44.50 - 44.80



Sieving	
Particle Size (mm)	% Passing
75.0	100
50.0	100
37.5	100
25.0	100
19.0	100
9.5	100
4.750	89
2.000	87
0.850	87
0.425	86
0.250	82
0.106	25
0.075	21

Sedimentation	
Particle Size (µm)	% Finer
22.4	17
13.3	14
9.5	13
6.9	11
3.5	5
1.6	1

Particle Density (ρs) Mg/m3	
2.69	measured

Soil Categories	
Type	%
Cobbles / Boulders	0
Gravel	11
Sand	68
Silt / Clay	21
Silt	13
Clay	8

Grading Analysis	
D60 (mm)	0.18
D30 (mm)	0.114
D10 (mm)	0.00597
Uniformity Coefficient	30
Curvature Coefficient	12

Testing in accordance with
ASTM D422-63 (2007)

Remarks

Checked by	DR
Approved by	AA

3.4 Finer than 75μm Report Summary

Determination of the Amount of Material In Soils Finer Than No. 200 (75μm) Sieve

Contract: 10451 | Location: Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Borehole I.D.	Sample Reference	Sample Depth (m)	Description	Dry Mass Determination	Test Method A/B	Soaked/Unsoaked	Amount of Time Soaked	Initial Dry Mass Used	Percentage Finer than 75μm
BH - MET TOWER	P3B1	2.00-2.30	Poorly graded SAND with silt. Sand is angular to subangular. Fine to medium grained, dense to compact, light grey becoming dark grey. Few stratifications of GRAVEL, gravel is angular and fine. Few pockets of clayey SAND. Few laminations of black organic staining.	Direct	A	Soaked	10 minutes	186.91	12.2
BH - MET TOWER	P4B1	5.00-5.35	Poorly graded SAND with silt. Sand is angular to subangular. Fine to medium grained, dense to compact, light grey becoming dark grey. Few stratifications of GRAVEL, gravel is angular and fine. Few pockets of clayey SAND. Few laminations of black organic staining.	Direct	A	Soaked	10 minutes	198	12.1
BH - MET TOWER	P5B1	8.50-8.80	Poorly graded SAND with silt. Sand is angular to subangular. Fine to medium grained, dense to compact, light grey becoming dark grey. Few stratifications of GRAVEL, gravel is angular and fine. Few pockets of clayey SAND. Few laminations of black organic staining.	Direct	A	Soaked	10 minutes	211.83	13.5
BH - MET TOWER	P9Q1	25.70-25.90	CLAY with sand. Very stiff to hard, dark olive grey, dry. Sand is fine. Some laminations and lenses of silt.	Direct	A	Soaked	10 minutes	39.2	91.6
BH - MET TOWER	P9B2	26.30-26.45	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt.	Direct	B	Soaked	2 hours	178.39	61.7
BH - MET TOWER	P10Q2	29.60-29.80	Sandy CLAY. Very hard to hard, very dark grey, dry, Some laminations and lenses of sand and silt. Sand is fine.	Direct	A	Soaked	10 minutes	36.82	52
BH - MET TOWER	P11Q1	33.20-33.40	Sandy CLAY. Very hard to hard, very dark grey, dry. Sand is fine. Little fine to coarse gravel size shell. Lenses of sand and silt.	Direct	A	Soaked	10 minutes	33.24	62.8
BH - MET TOWER	P11B2	33.80-33.98	Sandy CLAY. Sand is fine. Very hard to hard, very dark grey, dry. Little fine to coarse gravel size shell. Some laminations and lenses of sand and silt. Sand is fine grained. Trace organics.	Direct	B	Soaked	2 hours	181.67	60.1
BH - MET TOWER	P13Q2	40.90-41.10	Elastic SILT. Firm, olive grey, moist. Mostly laminated with sandy clay. Sand is fine.	Direct	B	Soaked	2 hours	38.52	82.63
BH - MET TOWER	P16AB2	53.70-53.90	Poorly graded SAND with silt. Sand is fine grained, grey, compact and wet.	Direct	A	Soaked	10 minutes	215.39	20.6
BH - MET TOWER	P17Q1	57.00-57.20	Sandy CLAY. Hard, grey, moist. Sand is fine.	Direct	B	Soaked	2 hours	67.49	43.55

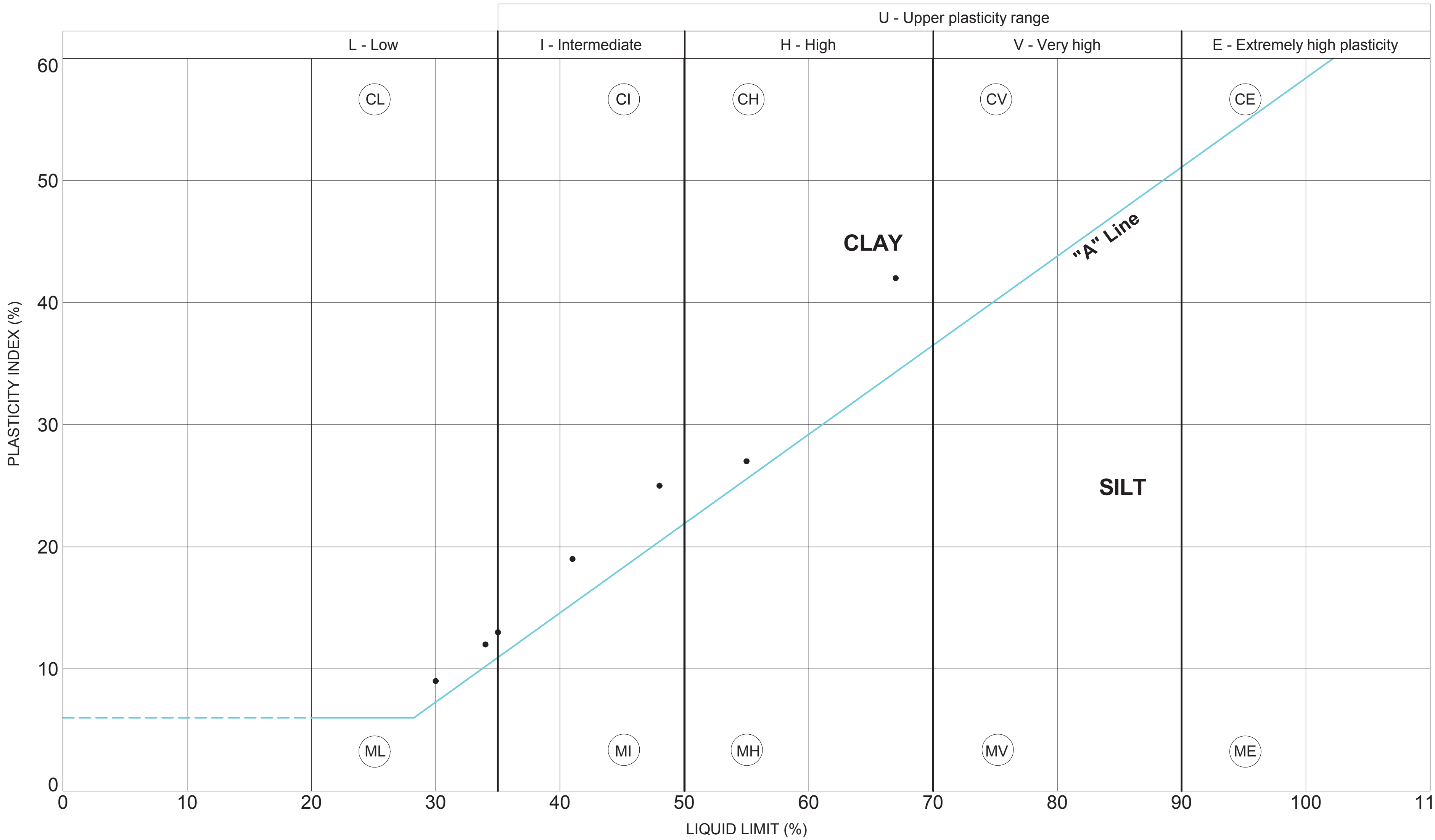
Remarks:

Prepared and Tested in accordance with ASTM D1140-14.

Checked by:	Approved by:
DR	AA

3.5 Plasticity Results

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BH-MET TOWER



3.6 Shear Strength Summary

10451 Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BH-MET TOWER

Push Number	Level in core (m)	INDEX STRENGTH TESTS: PPT S_u (kPa)	Torvane S_u (kPa)	Fall Cone S_u (kPa)	Fall Cone S_r (kPa)	Laboratory Vane S_u (kPa)	Laboratory Vane S_r (kPa)	Hand Shear Vane S_u (kPa)	Hand Shear Vane S_r (kPa)	TRIAXIAL: UU S_u (kPa)	UU S_r (kPa)	CAUC S_u (kPa)	CAUE S_u (kPa)	DSS S_u (kPa)	SENSITIVITY: S_t (Triaxial)	S_t (Fall Cone)	S_t (Lab Vane)
P2B1	1.11		25.0														
P9Q1	25.70		115.0														
P9Q1	25.73			200.0	49.0												
P9Q1	25.80											256.0					
P9U1	26.00									166.0							
P9Q2	26.11	198.3															
P9Q2	26.11		140.0														
P9B2	26.31	203.3															
P10Q1	29.20	158.3															
P10U1	29.50									160.0							
P10Q2	29.60	176.7															
P10Q2	29.63			170.0	24.0												
P10Q2	29.70											242.0					
P10B2	29.81	190.0															
P10B2	29.91					216.5	85.4										
P11Q1	33.20	190.0															
P11Q1	33.23			170.0	39.0												
P11Q1	33.30											196.0					
P11U1	33.50									145.0							
P11Q2	33.60	188.3															
P11B2	33.81	168.3															
P13B1	40.59	300.0															
P13Q2	40.93			230.0	56.0												
P13Q2	41.00											260.0					

DETERMINATION OF UNDRAINED SHEAR STRENGTHS

ISO/TS 17892-6:2003

10451 Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BH-MET TOWER

Push Number	Level in core (m)	INDEX STRENGTH TESTS								TRIAXIAL				DSS	SENSITIVITY		
		PPT	Torvane	Fall Cone		Laboratory Vane		Hand Shear Vane		UU		CAUC	CAUE				
		S_u (kPa)	S_u (kPa)	S_u (kPa)	S_r (kPa)	S_u (kPa)	S_r (kPa)	S_u (kPa)	S_r (kPa)	S_u (kPa)	S_r (kPa)	S_u (kPa)	S_u (kPa)	S_u (kPa)	S_t (Triaxial)	S_t (Fall Cone)	S_t (Lab Vane)
P13B2	41.22	300.0															
P17Q1	57.03			61.0	7.8												
P17Q1	57.10	200.0															
P17Q1	57.10											263.0					

DETERMINATION OF UNDRAINED SHEAR STRENGTHS

ISO/TS 17892-6:2003

3.7 Triaxial Summary

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Push Number	Level in core (m)	Undrained Shear Strength (kPa)		Specimen Diameter	Total Cell Pressure	Initial Moisture	Dev. Stress at Failure	Sample Length	Bulk Density	Dry Density	Strain at Failure	Mode of Failure
		C_u	C_r	mm	kN/m²	%	kN/m²	mm	Mg/m³	Mg/m³	%	
BH - MET TOWERP9U1	25.90	166		72	798	42	331	144	1.88	1.33	10.3	Shear
BH - MET TOWERP10U1	29.40	160		72.2	901	27	321	143.8	1.98	1.56	15.1	Barrelling
BH - MET TOWERP11U1	33.40	145		72.2	965	28	289	142.5	1.94	1.52	9.7	Shear

DETERMINATION OF THE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

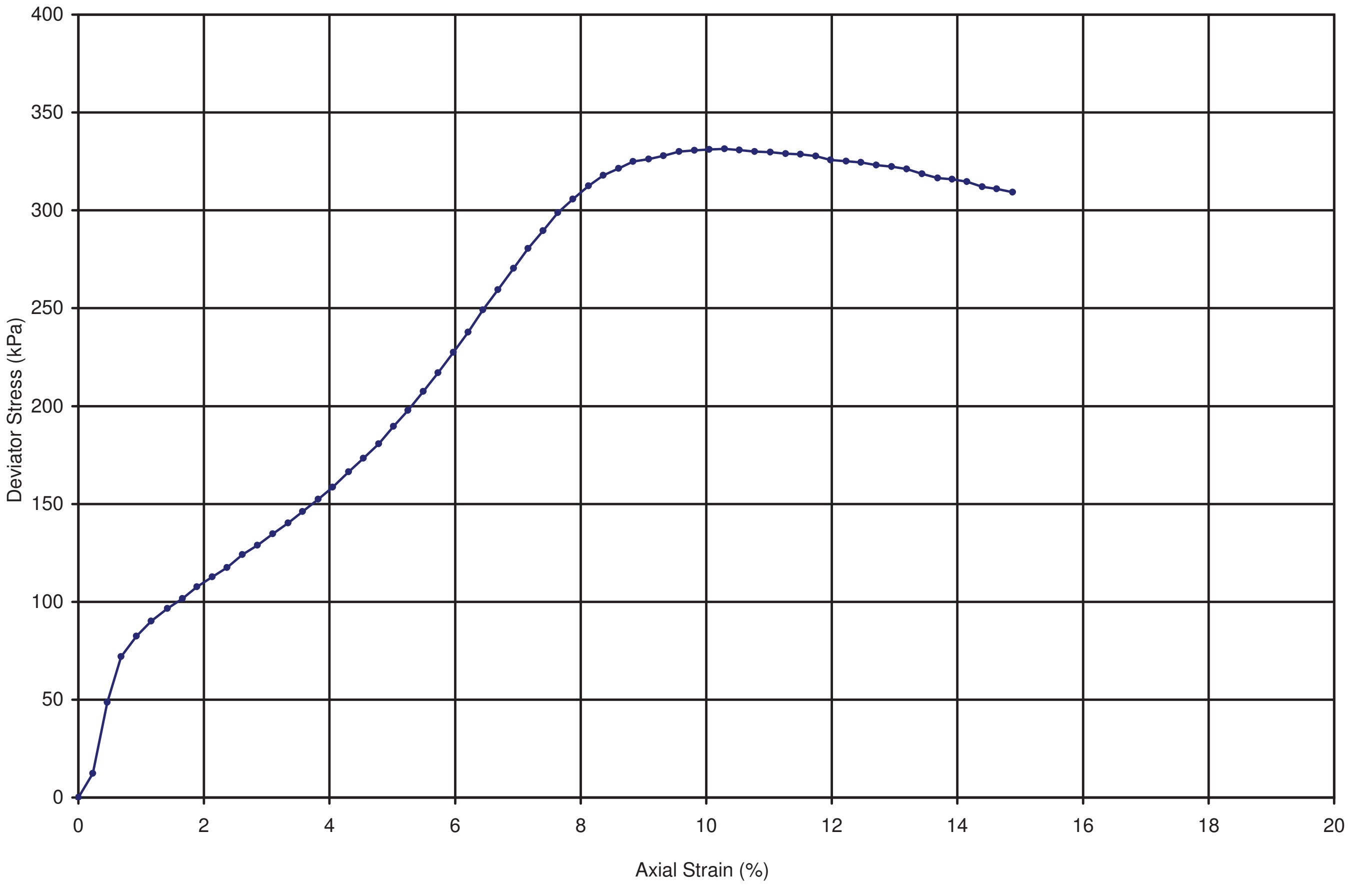
ASTM D 2850 - 03a

3.8 Undrained Unconsolidated Triaxial (UU) Test Results

Gardline	**Determination of the Undrained Shear Strength in Triaxial Compression**	US Wind inc sea energy

Location	**Geotechnical Marine Survey For the Maryland Wind Energy Area**	Contract No.	10451
		Borehole/Pit No.	Met Tower
Soil description	**CLAY**	Sample No./Type	P09 _ U1
Tested and prepared in accordance with	**ASTM D 2850 - 03a**	Depth (m)	25.9-26.1m

STRESS / STRAIN CURVE



RESULTS

Moisture Content	%	42
Bulk Density ρ	Mg/m3	1.88
Dry Density ρδ	Mg/m3	1.33
Initial Height of the Specimen	mm	144.0
Initial Diameter of the Specimen	mm	72.0
Cell Pressure σ_3	kPa	798
Corrected Deviator Stress $(\sigma_1 - \sigma_3)_f$	kPa	331
Failure Strain e	%	10.3
Undrained Cohesion c_u $\frac{1}{2}(\sigma_1 - \sigma_3)_f$	kPa	166

PREPARATION DETAILS

Sample Type Undisturbed

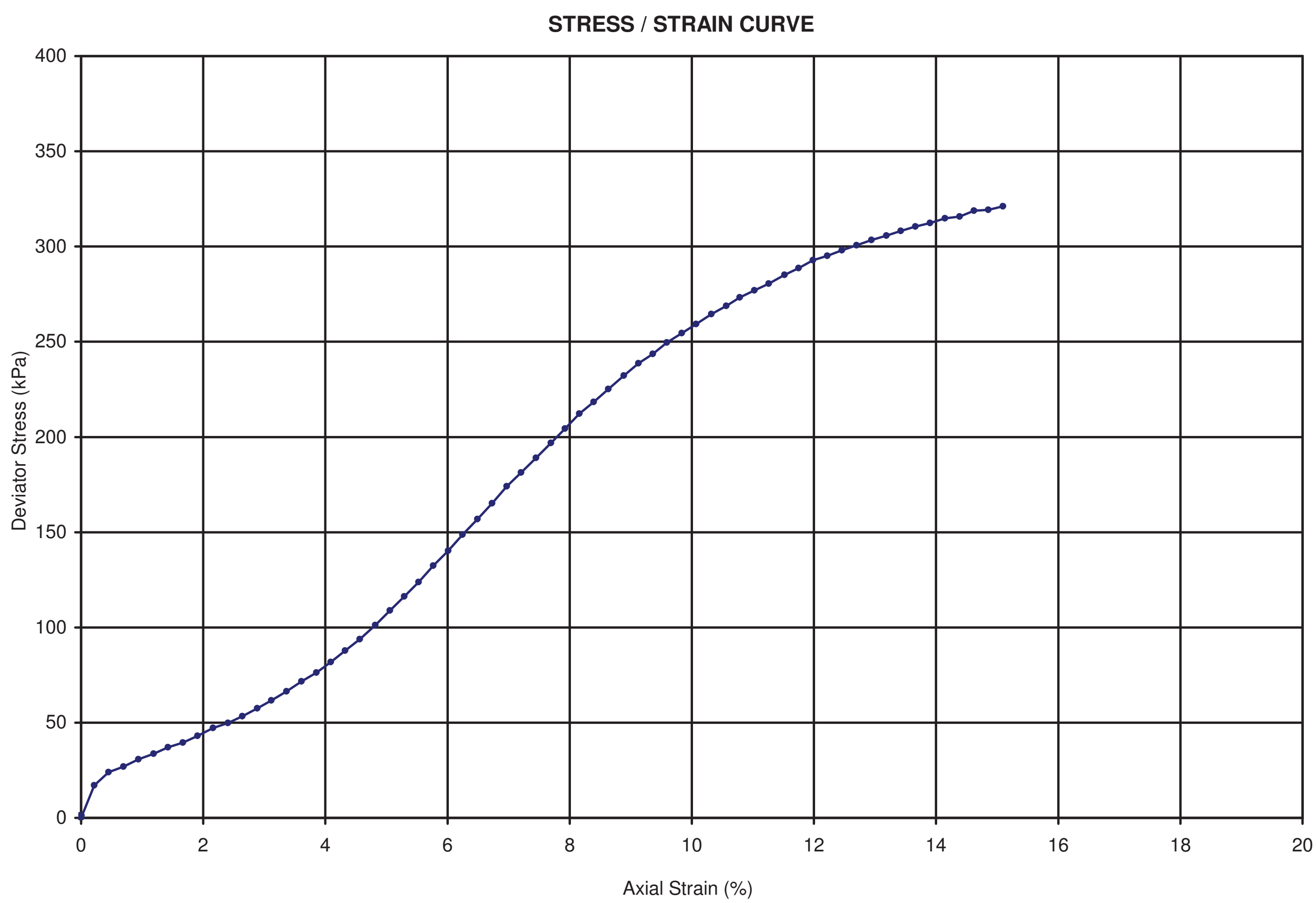
FAILURE MODE

Shear (brittle)

Remarks: Membrane thickness: 38-50mm 0.2mm, 70-100mm 0.4mm Sample sheared at a strain rate of 1 %min	Tested by: **JA**	Checked by: **NH**	Approved by:

Revision: 1.0

Gardline	Determination of the Undrained Shear Strength in Triaxial Compression	US Wind inc sea energy	
Location	**Geotechnical Marine Survey For the Maryland Wind Energy Area**	Contract No.	10451
		Borehole/Pit No.	Met Tower
Soil description	**CLAY**	Sample No./Type	P10 _ U1
Tested and prepared in accordance with	**ASTM D 2850 - 03a**	Depth (m)	29.4-29.6



RESULTS

Moisture Content	%	27
Bulk Density ρ	Mg/m3	1.98
Dry Density $\rho\delta$	Mg/m3	1.56
Initial Height of the Specimen	mm	143.8
Initial Diameter of the Specimen	mm	72.2
Cell Pressure σ_3	kPa	901
Corrected Deviator Stress $(\sigma_1 - \sigma_3)_f$	kPa	321
Failure Strain e	%	15.1
Undrained Cohesion c_u $^1/_2(\sigma_1 - \sigma_3)_f$	kPa	160

PREPARATION DETAILS

Sample Type Undisturbed

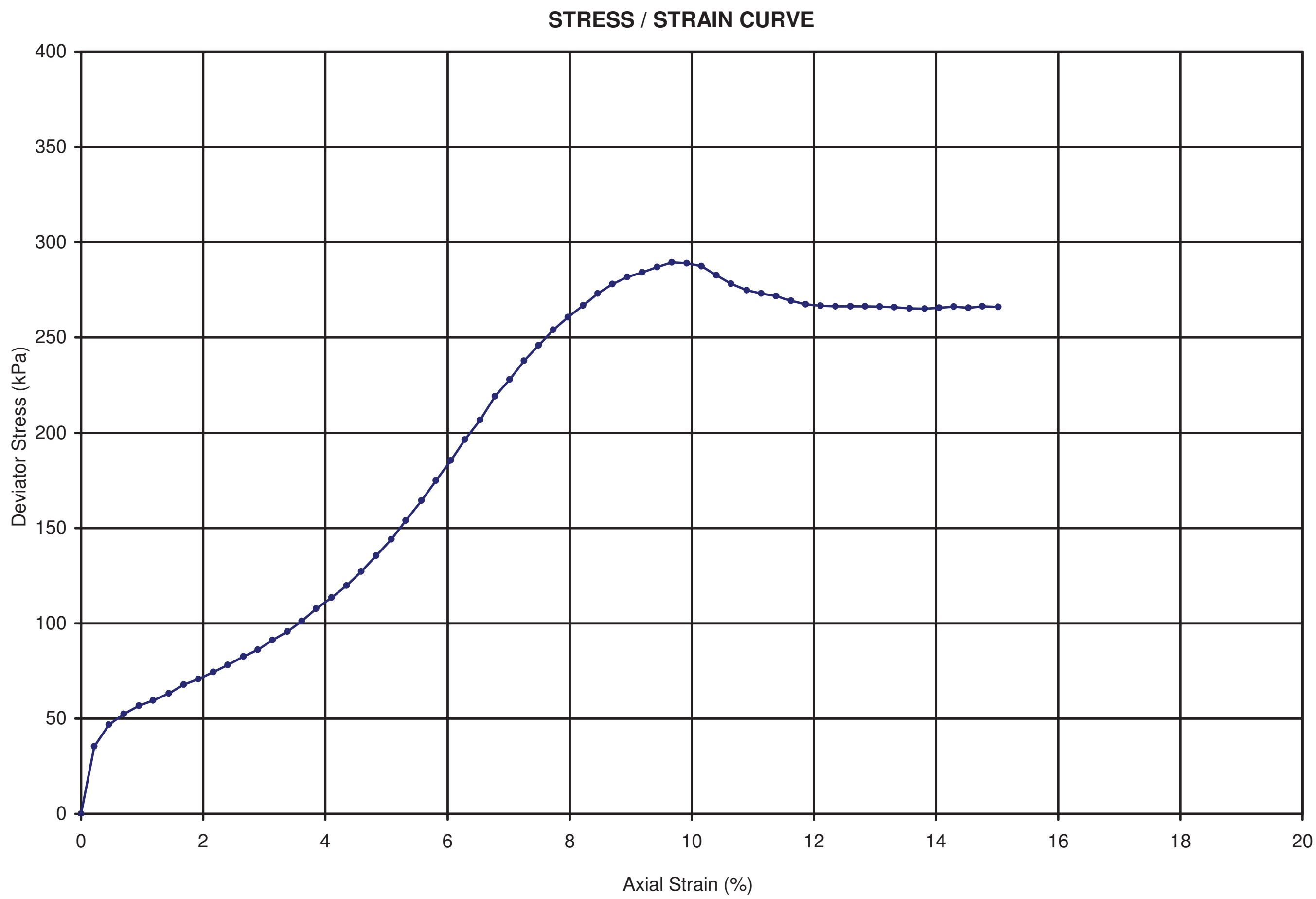
FAILURE MODE

Barrelling (plastic)

Remarks:	Tested by:	Checked by:	Approved by:
Membrane thickness: 38-50mm 0.2mm, 70-100mm 0.4mm	NH	NV-S	
Sample sheared at a strain rate of 1 %min			

Revision: 1.0

Gardline	Determination of the Undrained Shear Strength in Triaxial Compression	US Wind inc sea energy	
Location	**Geotechnical Marine Survey For the Maryland Wind Energy Area**	Contract No.	10451
		Borehole/Pit No.	Met Tower
Soil description	**CLAY**	Sample No./Type	P11 _ U1
Tested and prepared in accordance with	**ASTM D 2850 - 03a**	Depth (m)	33.4-33.6m



RESULTS

Moisture Content	%	28
Bulk Density ρ	Mg/m3	1.94
Dry Density ρδ	Mg/m3	1.52
Initial Height of the Specimen	mm	142.5
Initial Diameter of the Specimen	mm	72.2
Cell Pressure σ_3	kPa	965
Corrected Deviator Stress $(\sigma_1 - \sigma_3)_f$	kPa	289
Failure Strain e	%	9.7
Undrained Cohesion c_u $^1/_2(\sigma_1 - \sigma_3)_f$	kPa	145

PREPARATION DETAILS

Sample Type Undisturbed

FAILURE MODE

Shear (brittle)

Remarks:	Tested by:	Checked by:	Approved by:
Membrane thickness: 38-50mm 0.2mm, 70-100mm 0.4mm Sample sheared at a strain rate of 1 %min	**NH**	**NV-S**	

Revision: 1.0

3.9 Consolidated Anisotropic Undrained Compression Triaxial (CAUC) Results

Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Dark olive grey, dry. Sand is fine. Some laminations and lenses of silt.	**Sample Type/No.**	P09 Q1
		Depth	25.70-25.90
Prepared and tested in accordance with ASTM D4767 and In House method			

Type of Specimen	Undisturbed / Vertical	**Type of test**	Single Stage	**Side Drains Fitted**	Yes	**Drainage Conditions**	One end & radial boundary

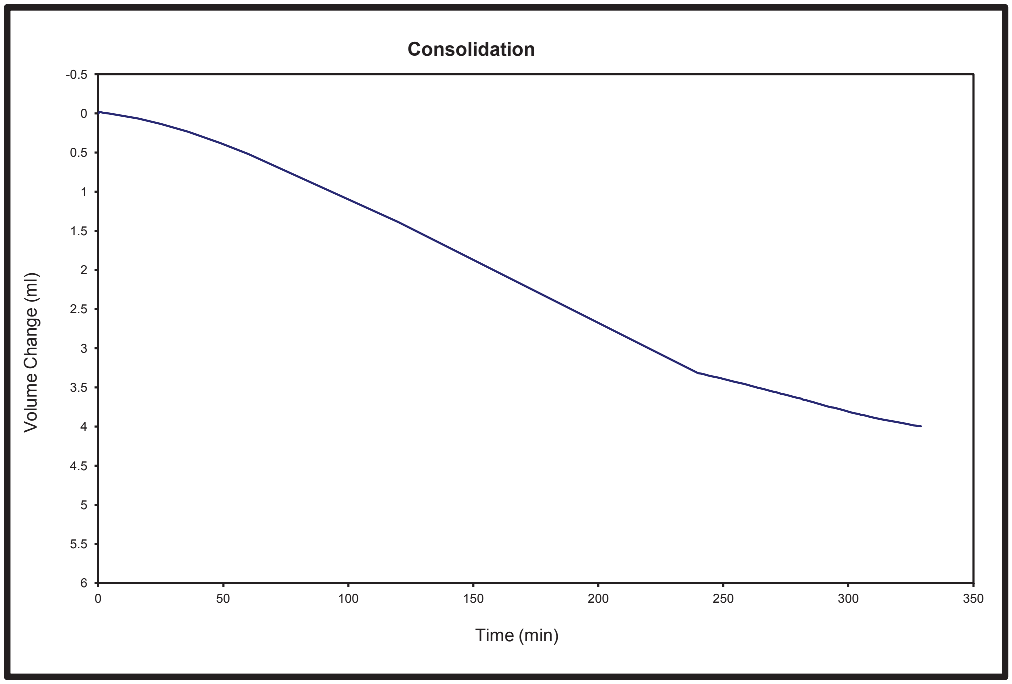
Initial Conditions	Length (mm)	138
	Diameter (mm)	72
	Moisture Content %	32
	Bulk Density (Mg/m3)	1.97
	Dry Density (Mg/m^3)	1.49
Saturation	Initial PWP (kPa)	1
	Saturated PWP (kPa)	426
	Final Cell Pressure (kPa)	500
	B Value	0.96
Consolidation	Cell Pressure (kPa)	645
	Back Pressure (kPa)	426
	Initial PWP (kPa)	426
	Final PWP (kPa)	422
	cv (m^2/yr)	0.41
	mv (m^2/MN)	2.162
	k (calculated value) (m/s)	2.7E-10
Compression	Cell Pressure (kPa)	645
	Back Pressure (kPa)	426
	s3' (kPa)	219
	Rate of Strain (%/hr)	0.9

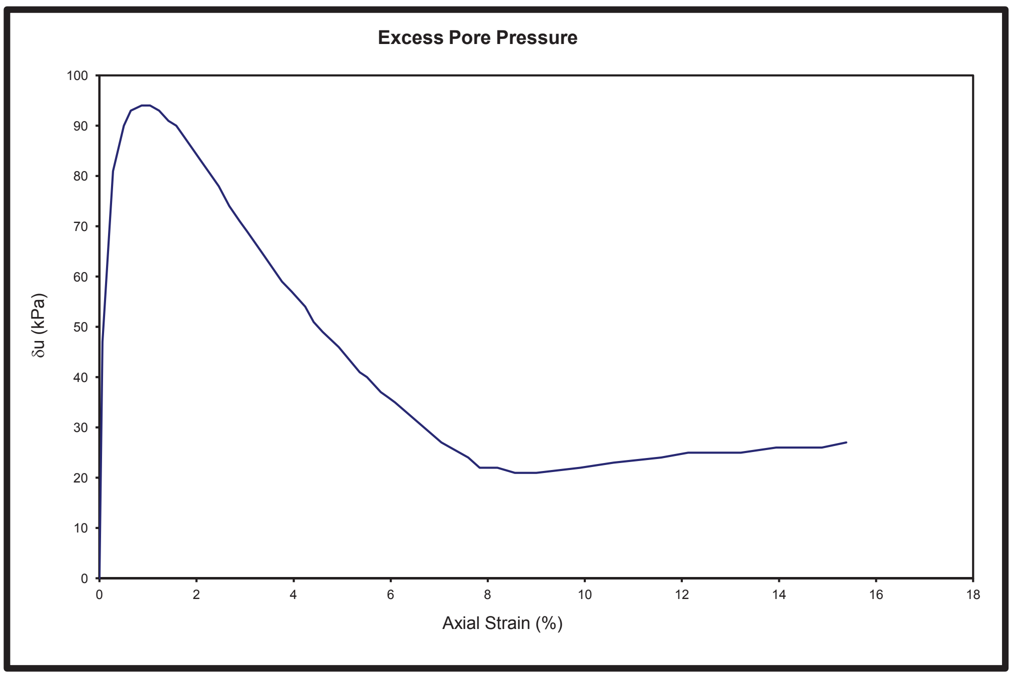
Final Conditions	Moisture Content (%)	33
	Bulk Density (Mg/m3)	1.98
	Dry Density (Mg/m^3)	1.49
Failure Conditions	Strain (e) (%)	5.9
	δu (kPa)	36
	σ_3'f (kPa)	183
	(σ_1' - σ_3')f (kPa)	511

Failure Mode: Shear

Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

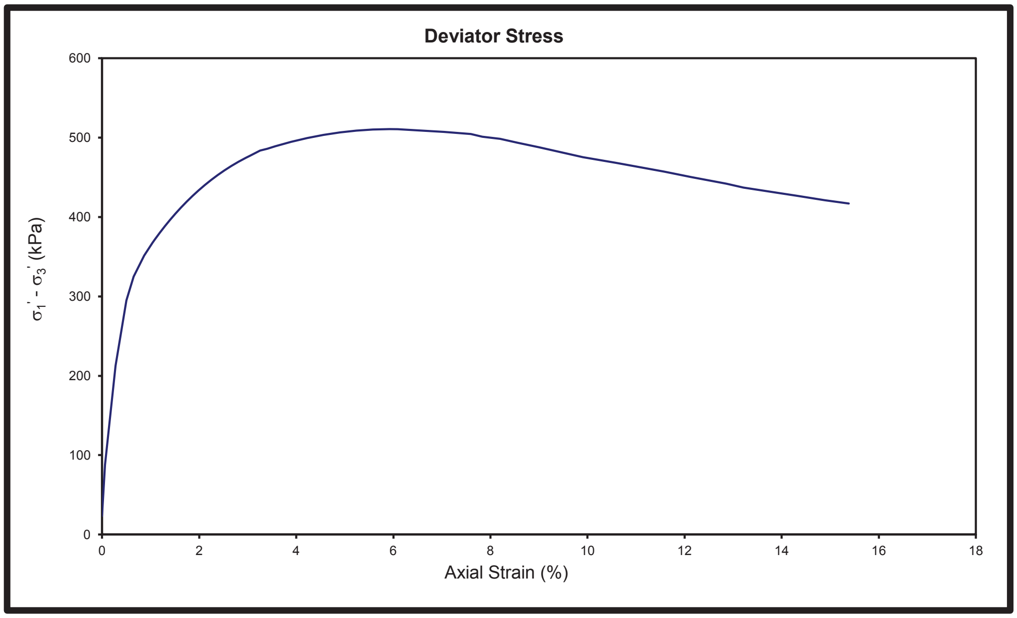
Gardline	**Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure**	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Dark olive grey, dry. Sand is fine. Some laminations and lenses of silt.	**Sample Type/No.**	P09 Q1
		Depth	25.70-25.90
Prepared and tested in accordance with ASTM D4767 and In House method			

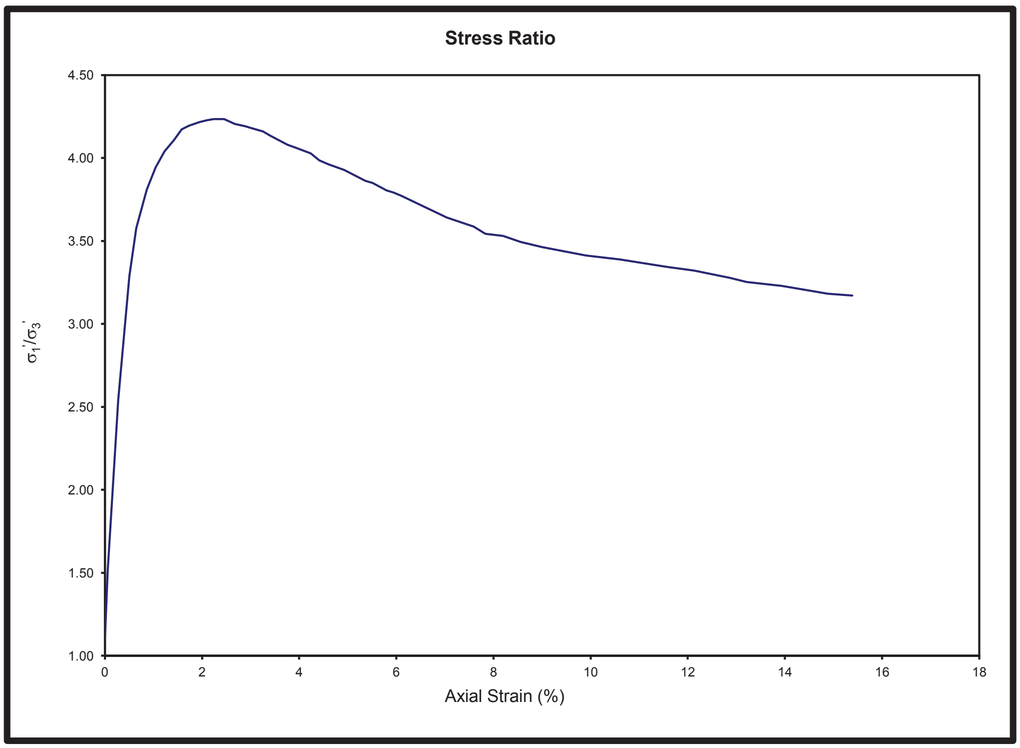




Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

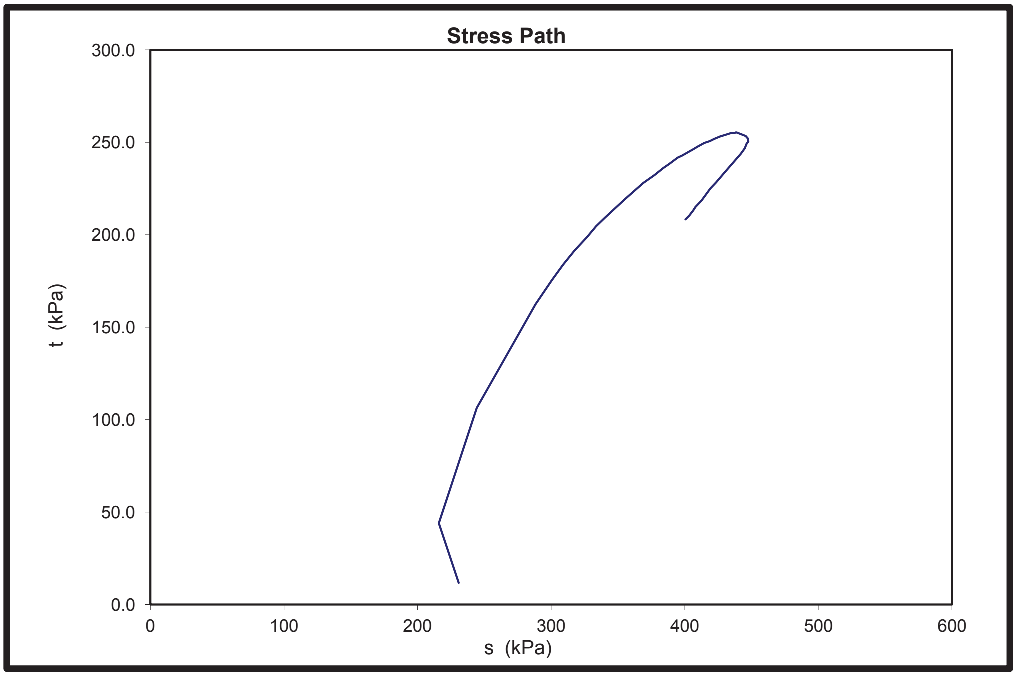
Gardline	Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Dark olive grey, dry. Sand is fine. Some laminations and lenses of silt.	**Sample Type/No.**	P09 Q1
		Depth	25.70-25.90
Prepared and tested in accordance with ASTM D4767 and In House method			

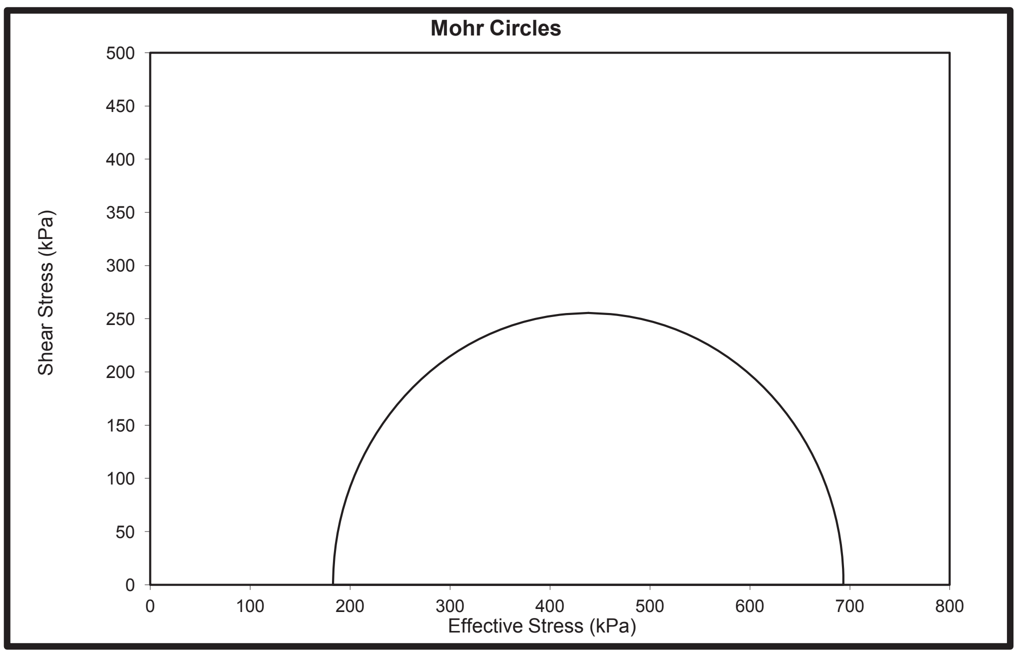




Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Dark olive grey, dry. Sand is fine. Some laminations and lenses of silt.	**Sample Type/No.**	P09 Q1
		Depth	25.70-25.90
Prepared and tested in accordance with ASTM D4767 and In House method			





Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	**Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure**	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Very dark grey, dry, some laminations and lenses of sand and silt. Sand is fine.	**Sample Type/No.**	P10 Q2
		Depth	29.60-29.80
Prepared and tested in accordance with ASTM D4767 and In House method			

Type of Specimen	Undisturbed / Vertical	**Type of test**	Single Stage	**Side Drains Fitted**	Yes	**Drainage Conditions**	One end & radial boundary

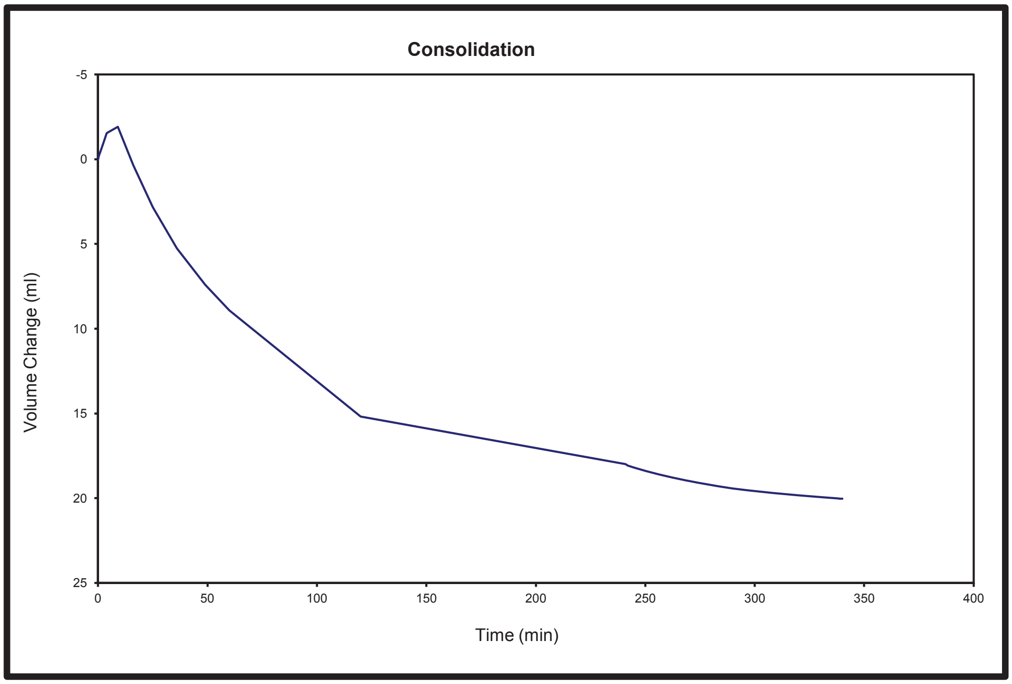
Initial Conditions	Length (mm)	144
	Diameter (mm)	72
	Moisture Content %	27
	Bulk Density (Mg/m3)	2.00
	Dry Density (Mg/m^3)	1.58
Saturation	Initial PWP (kPa)	4
	Saturated PWP (kPa)	499
	Final Cell Pressure (kPa)	500
	B Value	0.99
Consolidation	Cell Pressure (kPa)	751
	Back Pressure (kPa)	499
	Initial PWP (kPa)	500
	Final PWP (kPa)	505
	cv (m^2/yr)	0.57
	mv (m^2/MN)	-9.453
	k (calculated value) (m/s)	-1.7E-09
Compression	Cell Pressure (kPa)	751
	Back Pressure (kPa)	499
	s3' (kPa)	252
	Rate of Strain (%/hr)	0.8

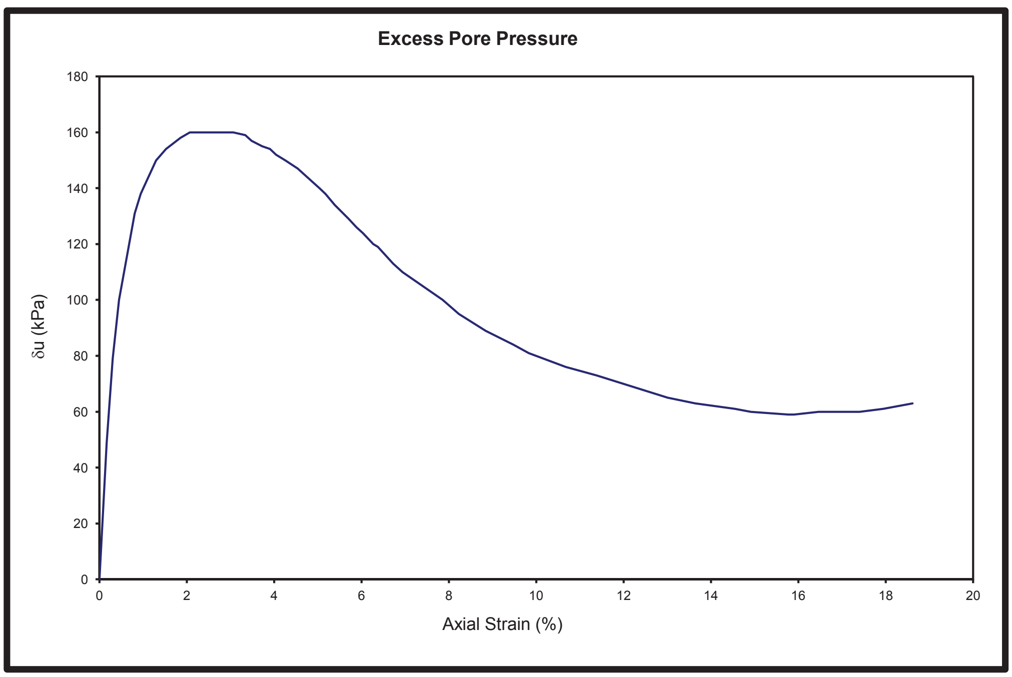
Final Conditions	Moisture Content (%)	28
	Bulk Density (Mg/m3)	2.08
	Dry Density (Mg/m^3)	1.63
Failure Conditions	Strain (e) (%)	13.0
	δu (kPa)	65
	σ_3'f (kPa)	187
	(σ_1' - $\sigma_{3'}$)f (kPa)	484

Failure Mode: Intermediate

Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	**Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure**	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Very dark grey, dry, some laminations and lenses of sand and silt. Sand is fine.	**Sample Type/No.**	P10 Q2
		Depth	29.60-29.80
Prepared and tested in accordance with ASTM D4767 and In House method			

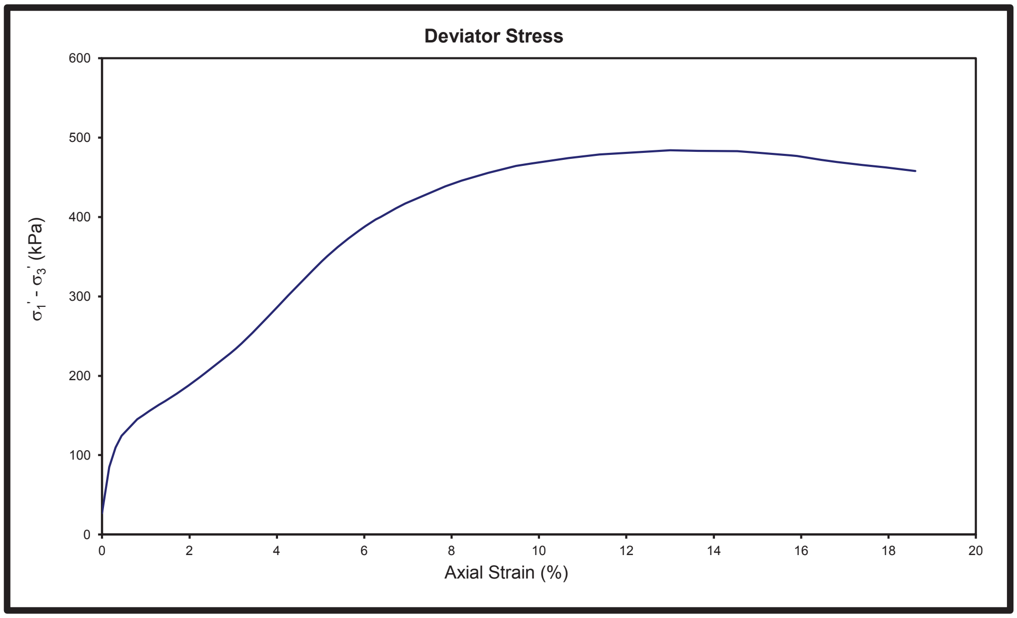


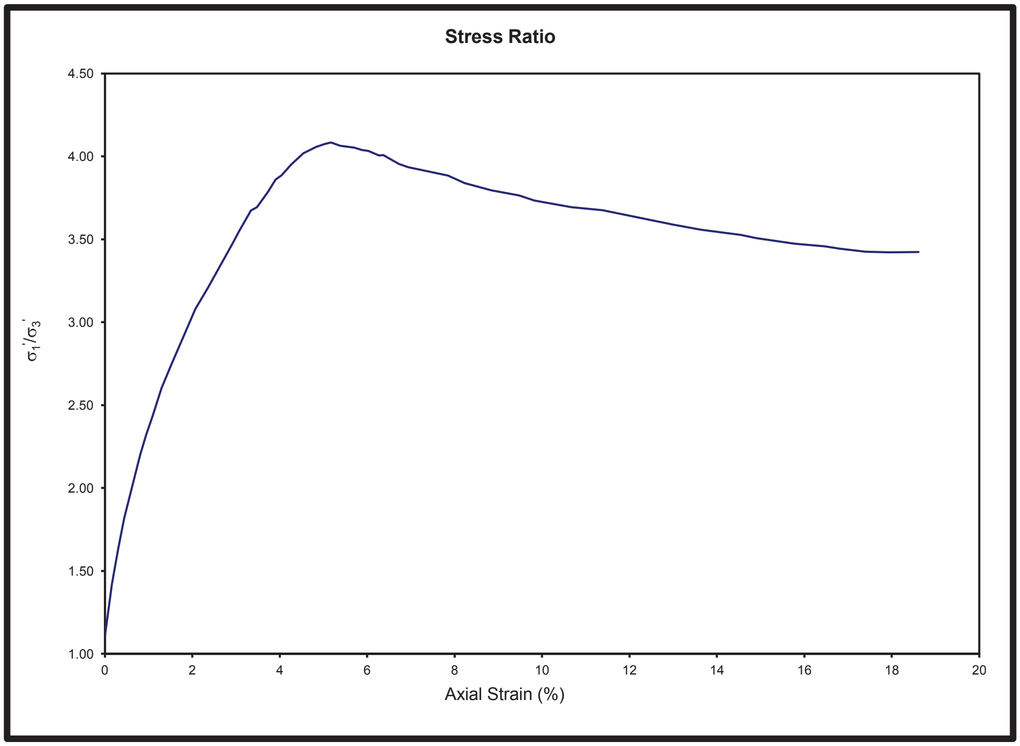


Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Very dark grey, dry, some laminations and lenses of sand and silt. Sand is fine.	**Sample Type/No.**	P10 Q2
		Depth	29.60-29.80

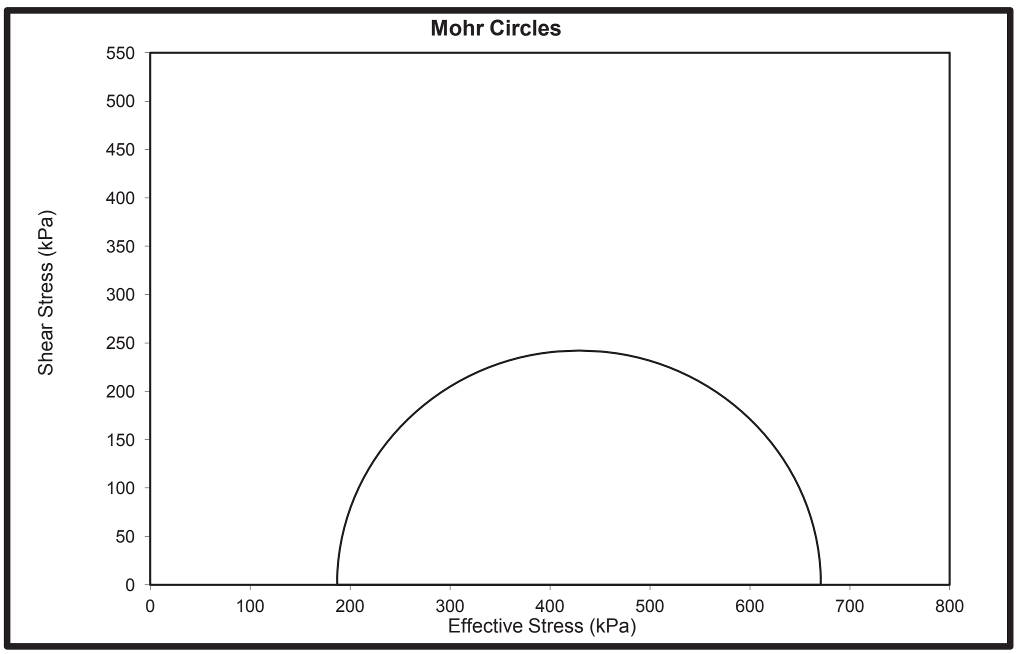
Prepared and tested in accordance with ASTM D4767 and In House method





Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Very dark grey, dry, some laminations and lenses of sand and silt. Sand is fine.	**Sample Type/No.**	P10 Q2
		Depth	29.60-29.80
Prepared and tested in accordance with ASTM D4767 and In House method			



Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Very dark grey, dry. Sand is fine. Little fine to coarse gravel size shell. Lenses of sand and silt.	**Sample Type/No.**	P11 Q1
		Depth	33.20-33.40
Prepared and tested in accordance with ASTM D4767 and In House method			

Type of Specimen	Undisturbed / Vertical	**Type of test**	Single Stage	**Side Drains Fitted**	Yes	**Drainage Conditions**	One end & radial boundary

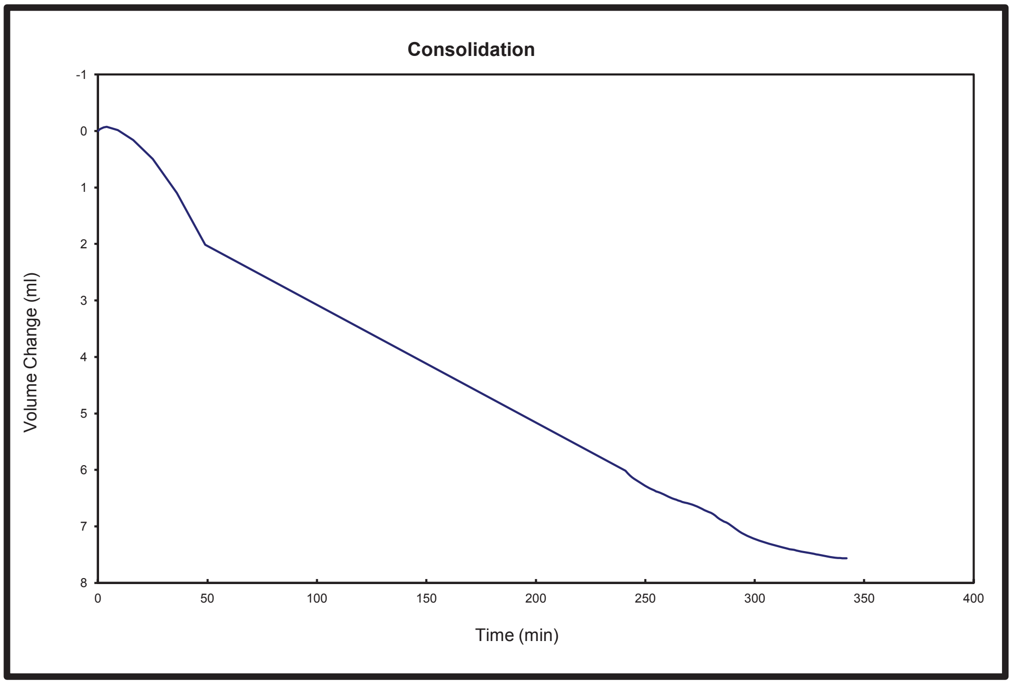
Initial Conditions	Length (mm)	144
	Diameter (mm)	72
	Moisture Content %	29
	Bulk Density (Mg/m3)	1.96
	Dry Density (Mg/m^3)	1.51
Saturation	Initial PWP (kPa)	5
	Saturated PWP (kPa)	511
	Final Cell Pressure (kPa)	550
	B Value	0.98
Consolidation	Cell Pressure (kPa)	799
	Back Pressure (kPa)	516
	Initial PWP (kPa)	523
	Final PWP (kPa)	522
	cv (m^2/yr)	1.53
	mv (m^2/MN)	12.905
	k (calculated value) (m/s)	6.1E-09
Compression	Cell Pressure (kPa)	799
	Back Pressure (kPa)	516
	s3' (kPa)	283
	Rate of Strain (%/hr)	0.8

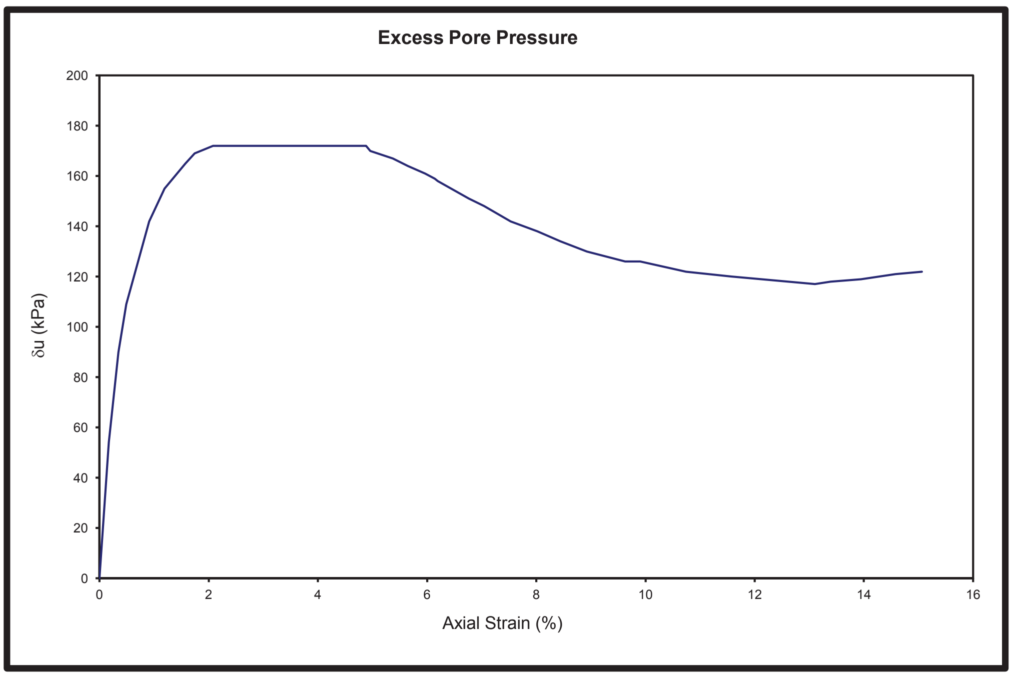
Final Conditions	Moisture Content (%)	29
	Bulk Density (Mg/m3)	1.96
	Dry Density (Mg/m^3)	1.52
Failure Conditions	Strain (e) (%)	10.7
	δu (kPa)	122
	σ_3'f (kPa)	161
	(σ_1' - $\sigma_{3'}$)f (kPa)	392

Failure Mode: Shear

Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

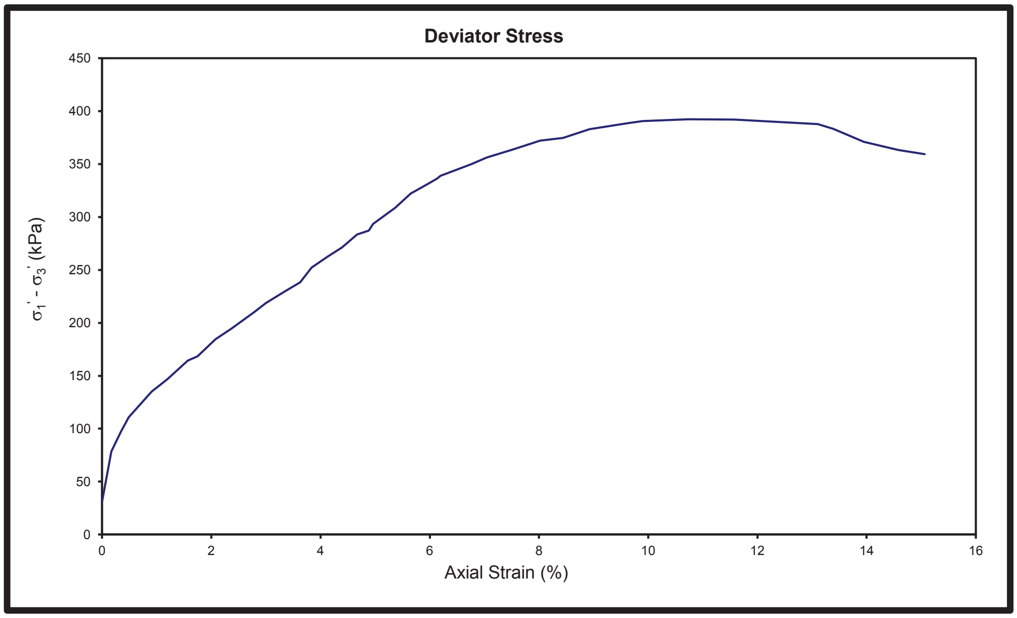
Gardline	Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Very dark grey, dry. Sand is fine. Little fine to coarse gravel size shell. Lenses of sand and silt.	**Sample Type/No.**	P11 Q1
		Depth	33.20-33.40
Prepared and tested in accordance with ASTM D4767 and In House method			

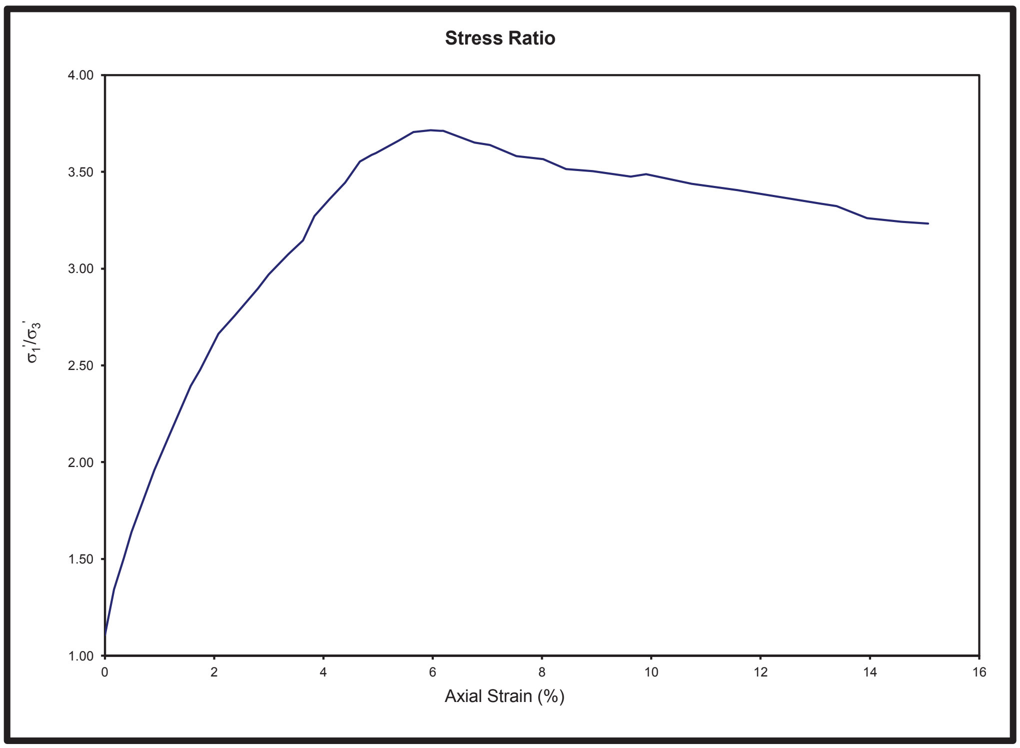




Remarks:	Pore pressure transducer out of calibrated range between 2.08-4.88% axial strain	Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Very dark grey, dry. Sand is fine. Little fine to coarse gravel size shell. Lenses of sand and silt.	**Sample Type/No.**	P11 Q1
		Depth	33.20-33.40
Prepared and tested in accordance with ASTM D4767 and In House method			

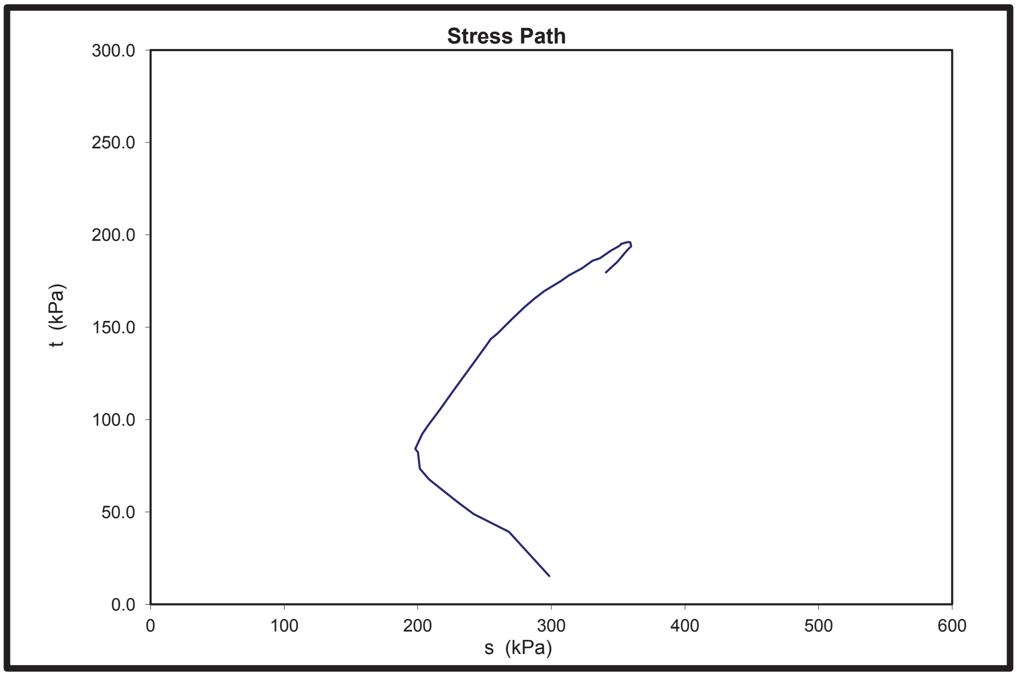


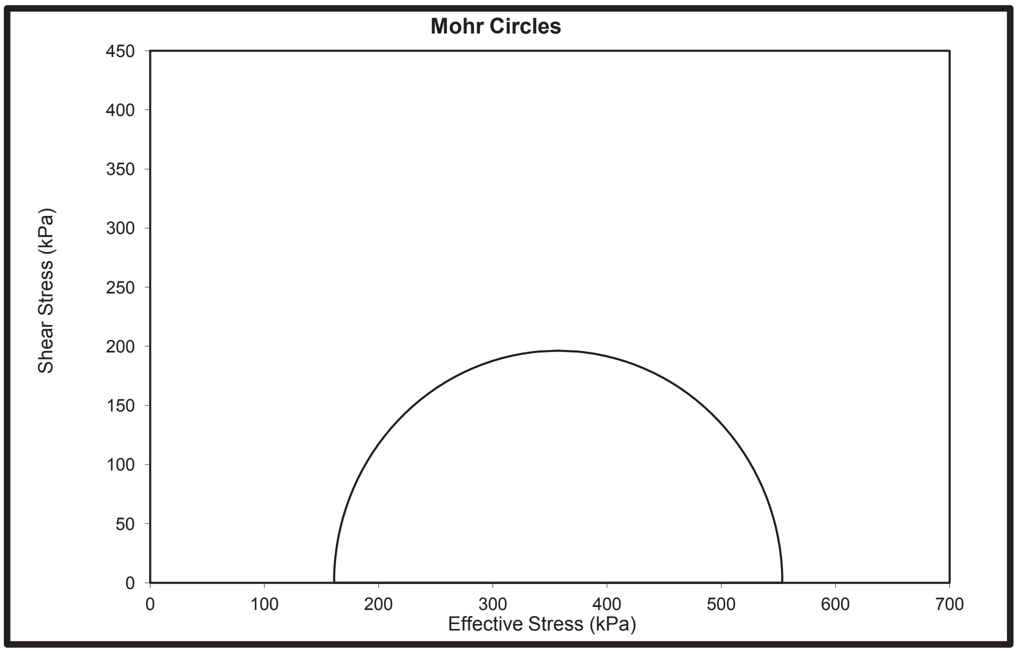


Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	CLAY with sand. Very dark grey, dry. Sand is fine. Little fine to coarse gravel size shell. Lenses of sand and silt.	**Sample Type/No.**	P11 Q1
		Depth	33.20-33.40

Prepared and tested in accordance with ASTM D4767 and In House method





Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	Clayey silty SAND. Olive grey, dry. Sand is fine. Little fine to medium size shell.	**Sample Type/No.**	P13 Q2
		Depth	40.90-41.10
Prepared and tested in accordance with ASTM D4767 and In House method			

Type of Specimen	Undisturbed / Vertical	**Type of test**	Single Stage	**Side Drains Fitted**	Yes	**Drainage Conditions**	One end & radial boundary

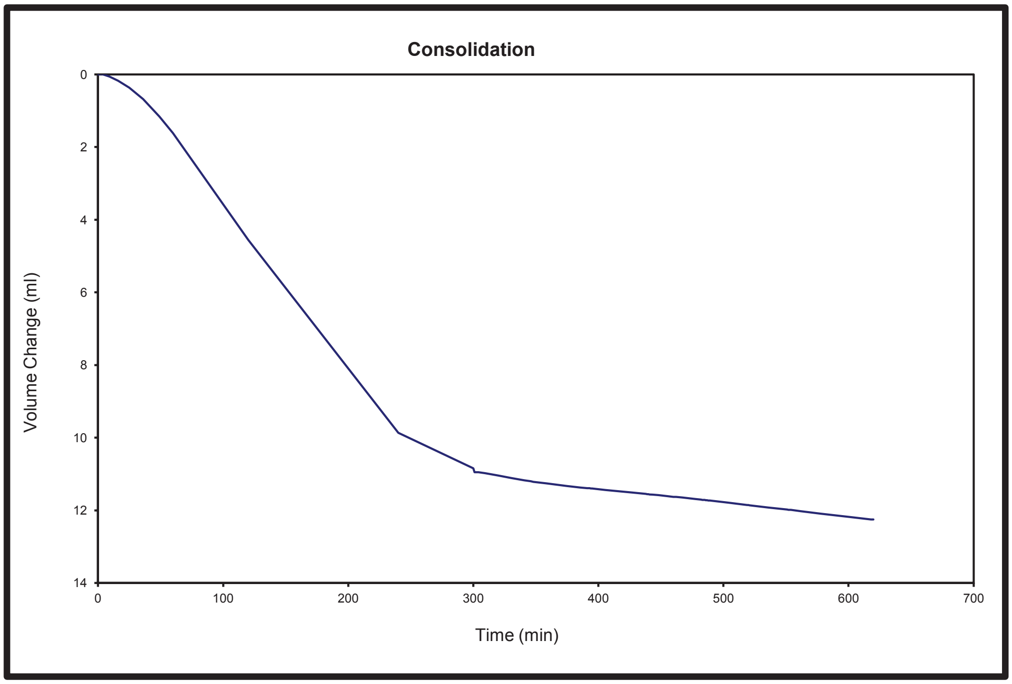
Initial Conditions	Length (mm)	140
	Diameter (mm)	72
	Moisture Content %	48
	Bulk Density (Mg/m3)	1.76
	Dry Density (Mg/m^3)	1.20
Saturation	Initial PWP (kPa)	9
	Saturated PWP (kPa)	423
	Final Cell Pressure (kPa)	550
	B Value	0.96
Consolidation	Cell Pressure (kPa)	773
	Back Pressure (kPa)	424
	Initial PWP (kPa)	420
	Final PWP (kPa)	421
	cv (m^2/yr)	0.43
	mv (m^2/MN)	-21.498
	k (calculated value) (m/s)	-2.9E-09
Compression	Cell Pressure (kPa)	773
	Back Pressure (kPa)	424
	s3' (kPa)	349
	Rate of Strain (%/hr)	0.9

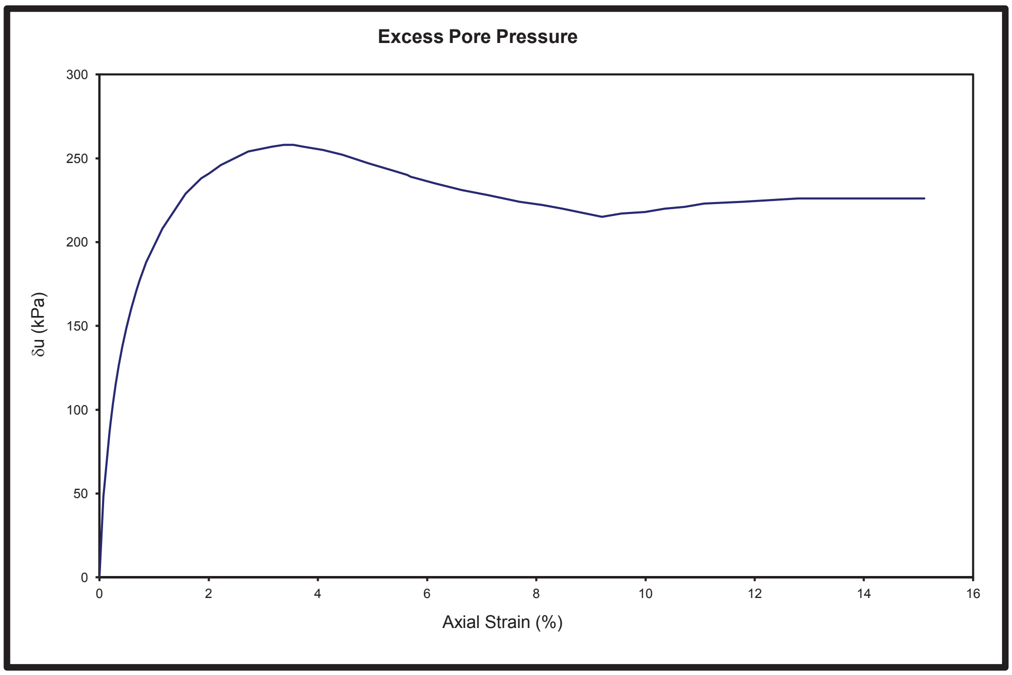
Final Conditions	Moisture Content (%)	44
	Bulk Density (Mg/m3)	1.78
	Dry Density (Mg/m^3)	1.24
Failure Conditions	Strain (e) (%)	7.1
	δu (kPa)	228
	σ_3'f (kPa)	121
	(σ_1' - $\sigma_{3'}$)f (kPa)	520

Failure Mode: Shear

Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

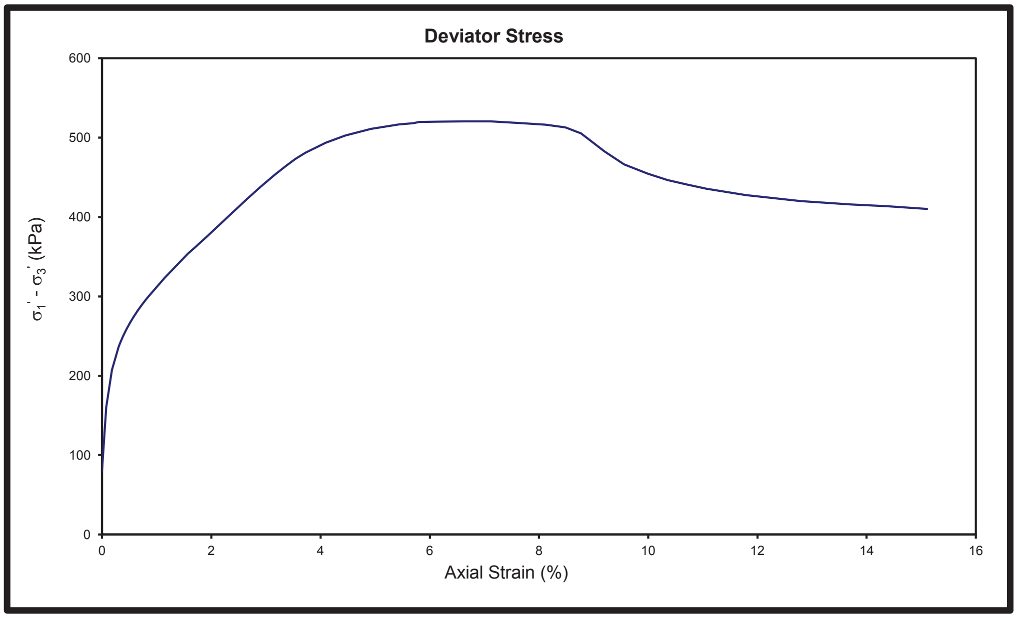
Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	Clayey silty SAND. Olive grey, dry. Sand is fine. Little fine to medium size shell.	**Sample Type/No.**	P13 Q2
		Depth	40.90-41.10
Prepared and tested in accordance with ASTM D4767 and In House method			

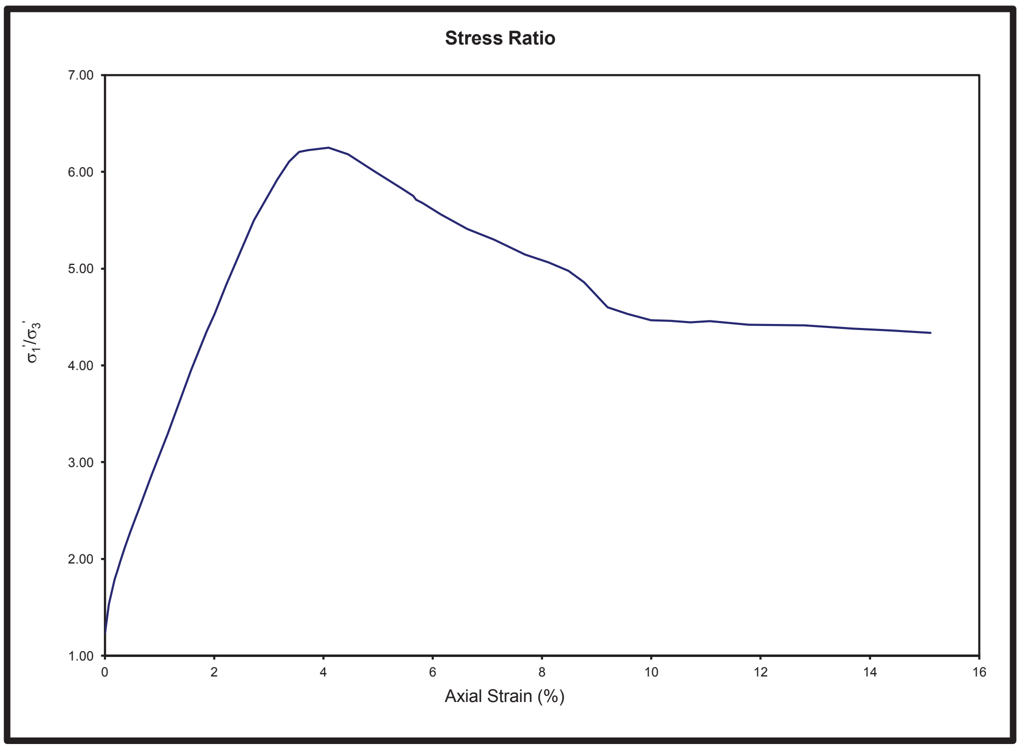




Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	Clayey silty SAND. Olive grey, dry. Sand is fine. Little fine to medium size shell.	**Sample Type/No.**	P13 Q2
		Depth	40.90-41.10
Prepared and tested in accordance with ASTM D4767 and In House method			

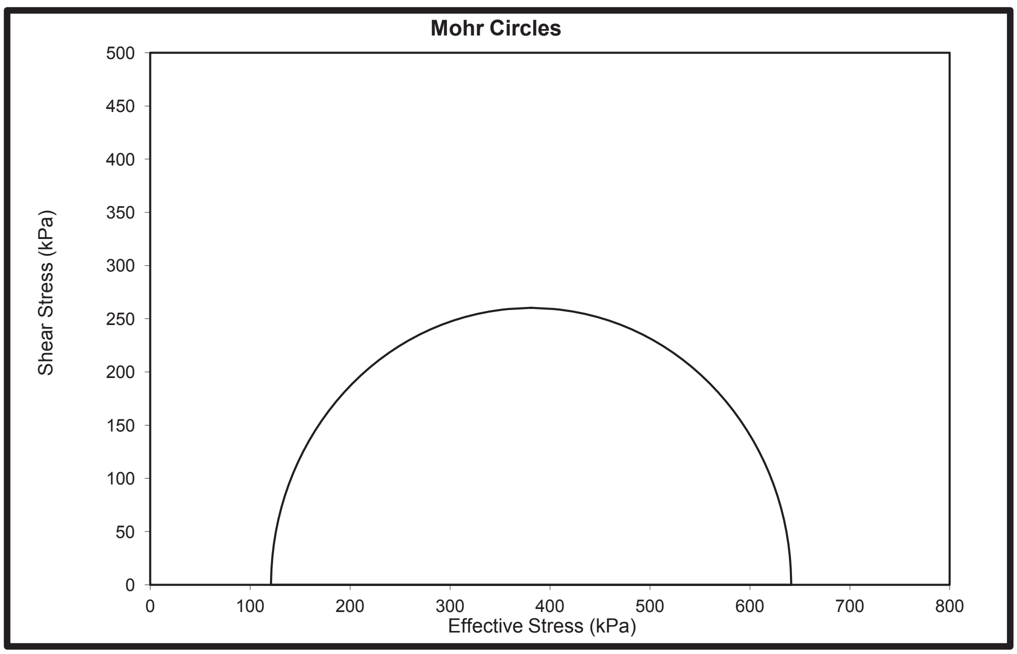




Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	Clayey silty SAND. Olive grey, dry. Sand is fine. Little fine to medium size shell.	**Sample Type/No.**	P13 Q2
		Depth	40.90-41.10

Prepared and tested in accordance with ASTM D4767 and In House method



Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	**Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure**	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	SAND with clay. Very dark greenish grey, moist. Sand is fine to medium.	**Sample Type/No.**	P17 Q1
		Depth	57.00-57.20
Prepared and tested in accordance with ASTM D4767 and In House method			

Type of Specimen	Undisturbed / Vertical	**Type of test**	Single Stage	**Side Drains Fitted**	Yes	**Drainage Conditions**	One end & radial boundary

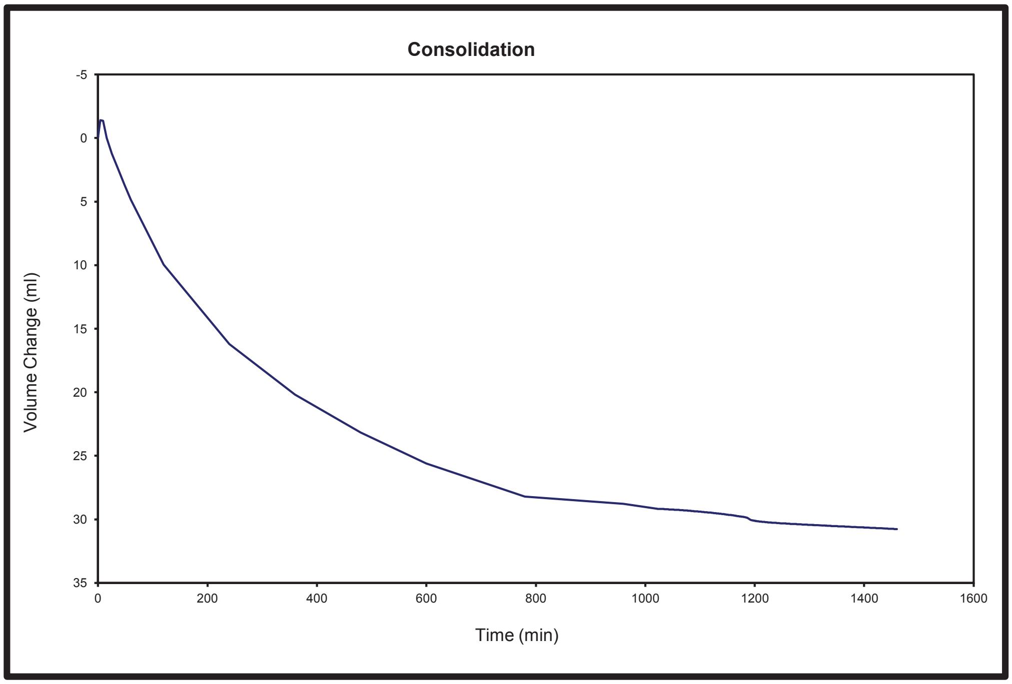
Initial Conditions	Length (mm)	144
	Diameter (mm)	72
	Moisture Content %	31
	Bulk Density (Mg/m3)	1.96
	Dry Density (Mg/m^3)	1.50
Saturation	Initial PWP (kPa)	15
	Saturated PWP (kPa)	547
	Final Cell Pressure (kPa)	550
	B Value	0.97
Consolidation	Cell Pressure (kPa)	1032
	Back Pressure (kPa)	547
	Initial PWP (kPa)	550
	Final PWP (kPa)	555
	cv (m^2/yr)	0.19
	mv (m^2/MN)	-10.495
	k (calculated value) (m/s)	-6.3E-10
Compression	Cell Pressure (kPa)	1032
	Back Pressure (kPa)	547
	s3' (kPa)	485
	Rate of Strain (%/hr)	0.8

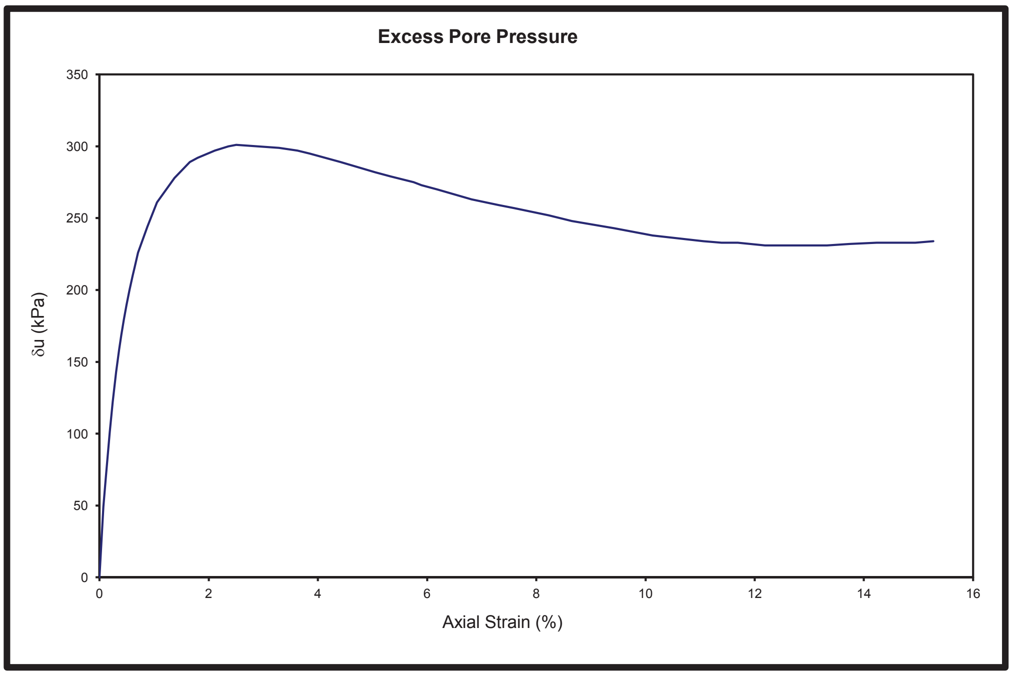
Final Conditions	Moisture Content (%)	24
	Bulk Density (Mg/m3)	2.03
	Dry Density (Mg/m^3)	1.64
Failure Conditions	Strain (e) (%)	10.1
	δu (kPa)	238
	σ_3'f (kPa)	247
	(σ_1' - σ_3')f (kPa)	525

Failure Mode: Shear

Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

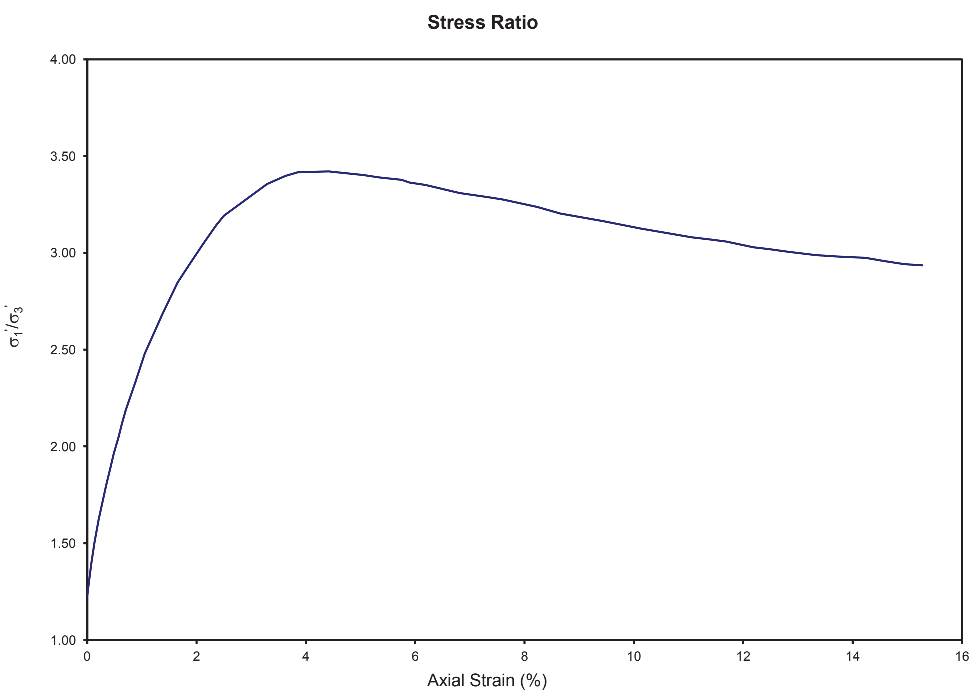
Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	SAND with clay. Very dark greenish grey, moist. Sand is fine to medium.	**Sample Type/No.**	P17 Q1
		Depth	57.00-57.20
Prepared and tested in accordance with ASTM D4767 and In House method			





Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

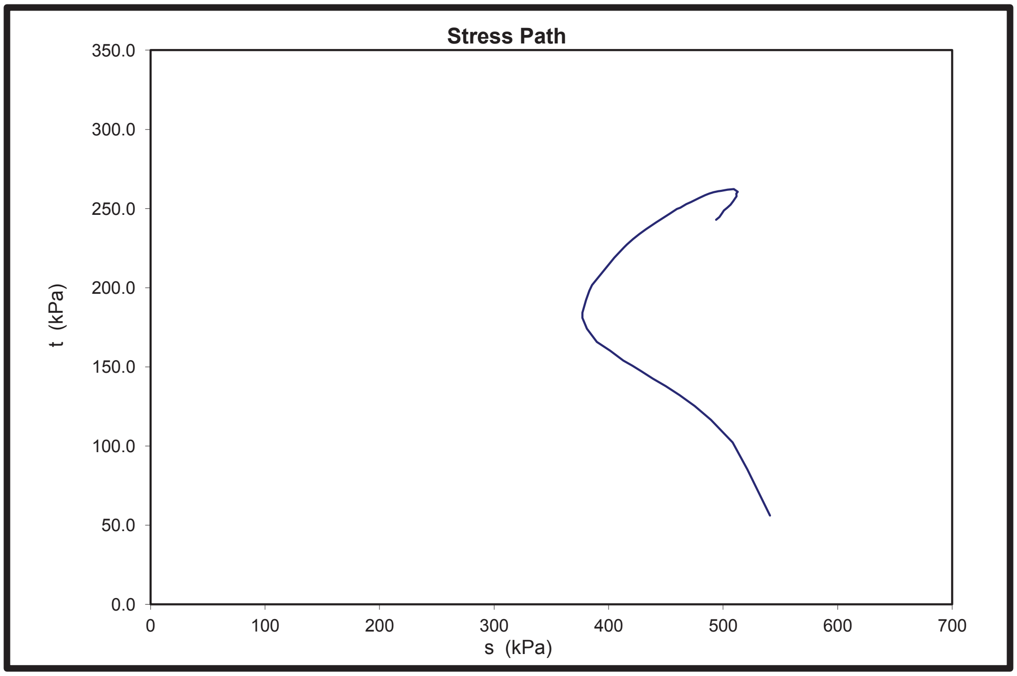
Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy	
Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	SAND with clay. Very dark greenish grey, moist. Sand is fine to medium.	**Sample Type/No.**	P17 Q1
		Depth	57.00-57.20
Prepared and tested in accordance with ASTM D4767 and In House method			

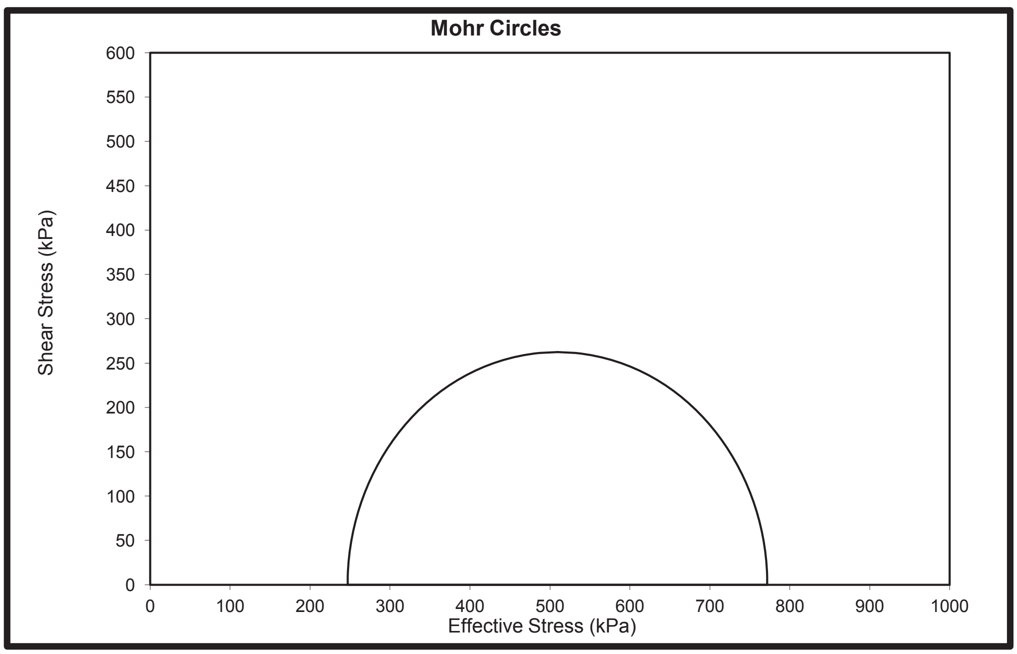


Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

Gardline	Consolidated Anisotropic Undrained Triaxial Test with the Measurement of Pore Water Pressure	US Wind inc sea energy

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	**Contract No.**	10451
		BH/TP No.	BH-MET TOWER
Description	SAND with clay. Very dark greenish grey, moist. Sand is fine to medium.	**Sample Type/No.**	P17 Q1
		Depth	57.00-57.20
Prepared and tested in accordance with ASTM D4767 and In House method			





Remarks:		Prepared by	Tested by	Processed by	Approved by
		LR	LR	LR	AA

3.10 Chemical Laboratory Results

10451 Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area BH-MET Tower

Push Number	Level in core (m)	Carbonate Content (%)	Chalk Content ($CaCO_3$, %)	Organic Matter (%)	pH		Sulphate Content		Principal Soil Type	Remarks
					Detemination in Water	Determination in Calcium Chloride	Water Soluble SO_4 (g/L)	Acid Soluble SO_4 (%)		
P1B1	0.15	3							Clayey silty SAND	
P1B3	0.63	4							SAND	
P2B1	1.10	6							Sandy silty CLAY	
P2B2	1.33	4							Silty clayey SAND	
P3B1	2.15	3							Silty SAND	
P4B1	5.18	3							Silty SAND	
P5B1	8.65	2							Silty SAND	
P6B1	12.62	0							SAND	
P14AB1	44.65	0							SAND	
P16AB2	53.80	0							Silty SAND	

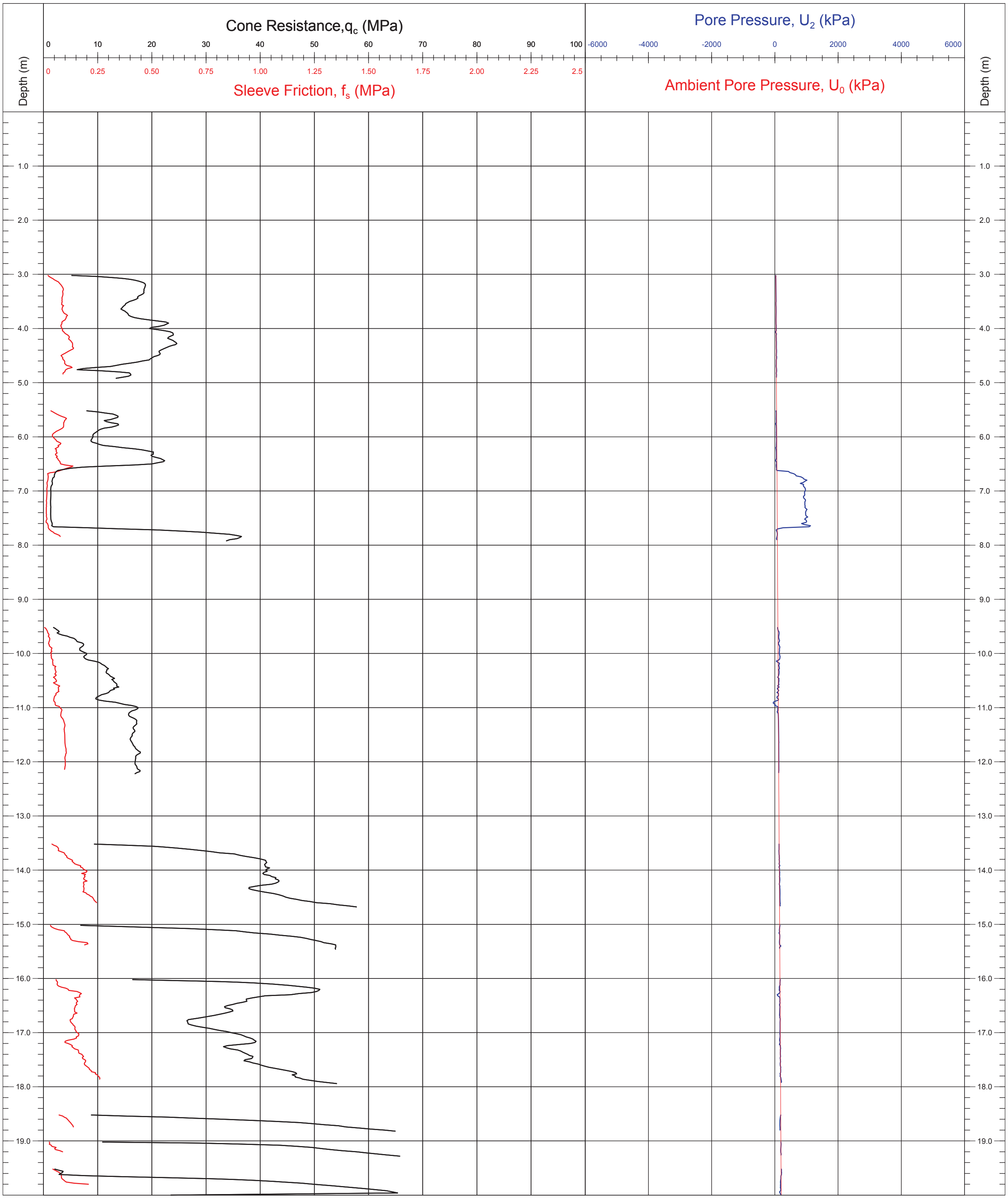
CHEMICAL TESTS - CARBONATE, ORGANIC MATTER, pH, SULPHATE

BS 1377 : Part 3 : 1990 - Section 3.0, 5.0, 6.3, 9.0
ASTM D4373

APPENDIX 4

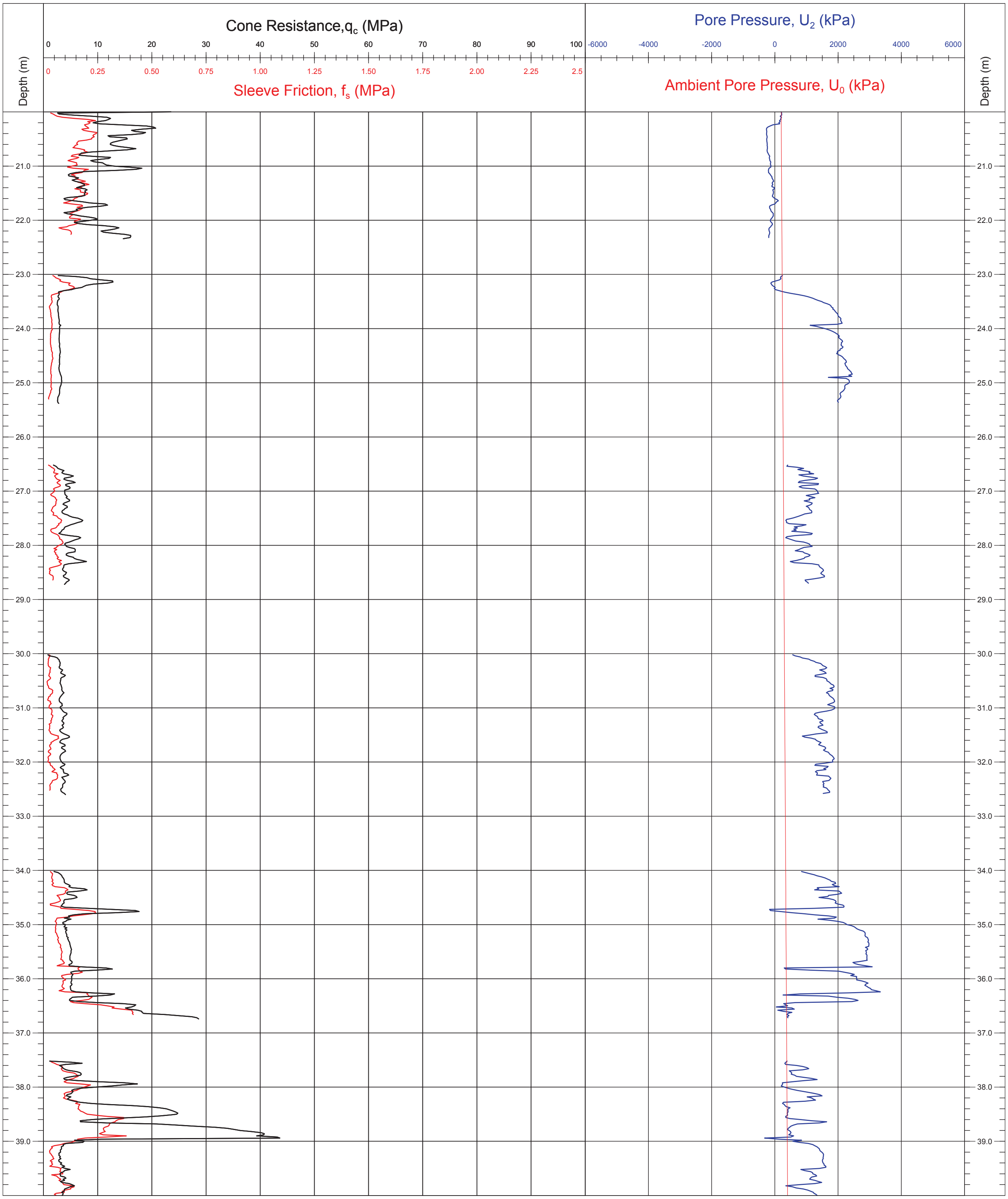
4.1 CPTU Results (Measured and Derived)

Geotechnical Marine Survey
Investigation for the Maryland Wind Energy Area
INSITU CPTU TESTING - MEASURED PARAMETERS



Area	Maryland USA	Coordinates	521533.9E 4244983.3N	CPT Number: BH - MET TOWER
Contract	10451	Latitude/ Longitude	38.352750 74.753547	
Client Name/Ref	US Wind Inc./REF11449	Water Depth (mMSL)	27.7	Page: 1/4
Vessel	MV Ocean Discovery	Date of Test (Start/End)	25/06/2015 to 26/06/2015	QC Status
Comments: Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa		Cone No.(type)/α Factor	070815G (10cm^2) / 0.79	Preliminary: NV-S (27/06/2015)
		Base Inclination	X = 0.0° / Y = 0.0°	Draft: SMc (23/09/2015)
		CRS	GRS 80 UTM ZONE 18 N (75 W)	Final: JG (23/02/2015)

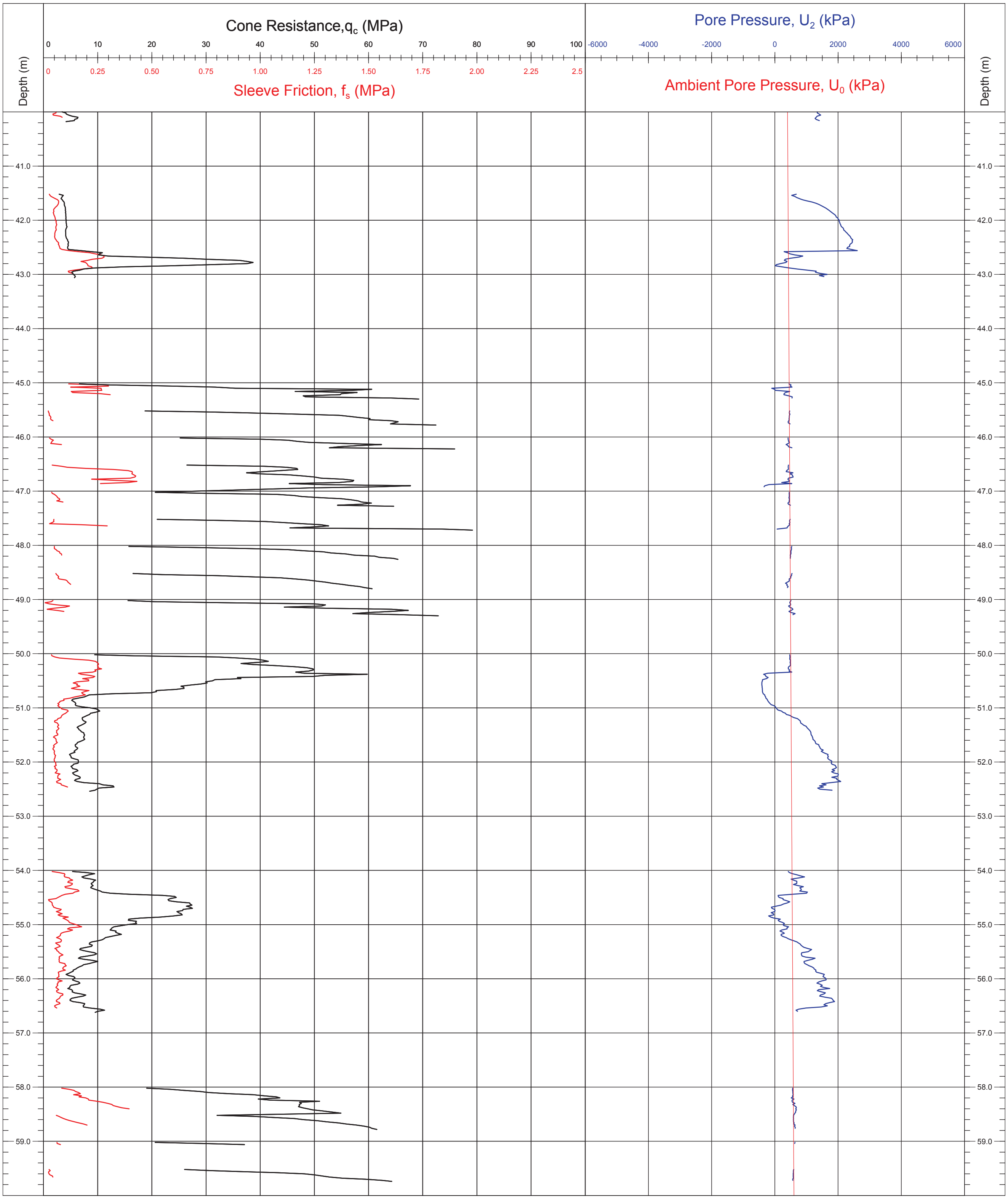
Geotechnical Marine Survey
Investigation for the Maryland Wind Energy Area
INSITU CPTU TESTING - MEASURED PARAMETERS



Area	Maryland USA	Coordinates	521533.9E 4244983.3N	CPT Number
Contract	10451	Latitude/ Longitude	38.352750 74.753547	**BH - MET TOWER**
Client Name/Ref	US Wind Inc./REF11449	Water Depth (mMSL)	27.7	
Vessel	MV Ocean Discovery	Date of Test (Start/End)	25/06/2015 to 26/06/2015	Page: 2/4
Comments: Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa		Cone No.(type)/α Factor	070815G (10cm²) / 0.79	QC Status
		Base Inclination	X = 0.0° / Y = 0.0°	Preliminary: NV-S (27/06/2015); Draft: SMc (23/09/2015); Final: JG (23/02/2015)
		CRS	GRS 80 UTM ZONE 18 N (75 W)	

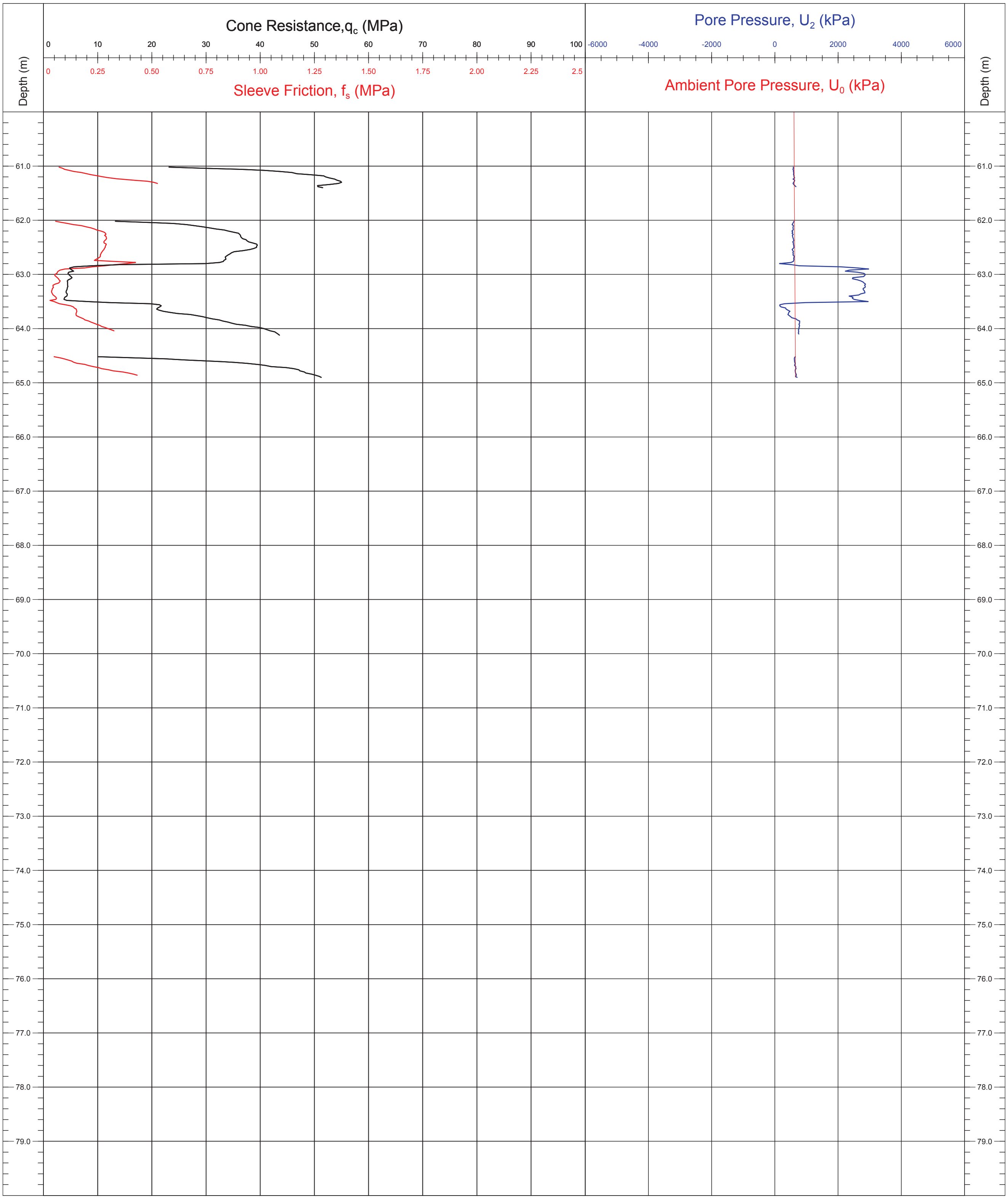
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

INSITU CPTU TESTING - MEASURED PARAMETERS



Area	**Maryland USA**	Coordinates	**521533.9E**	**4244983.3N**	CPT Number
Contract	**10451**	Latitude/ Longitude	**38.352750**	**74.753547**	**BH - MET TOWER**
Client Name/Ref	**US Wind Inc./REF11449**	Water Depth (mMSL)	**27.7**		
Vessel	**MV Ocean Discovery**	Date of Test (Start/End)	**25/06/2015 to 26/06/2015**		Page: 3/4
Comments: Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa		Cone No.(type)/α Factor	**070815G (10cm²) / 0.79**		QC Status
		Base Inclination	**X = 0.0° / Y = 0.0°**		Preliminary: **NV-S** (27/06/2015); Draft: **SMc** (23/09/2015); Final: **JG** (23/02/2015)
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**		

Geotechnical Marine Survey
Investigation for the Maryland Wind Energy Area
INSITU CPTU TESTING - MEASURED PARAMETERS



Area	Maryland USA	Coordinates	521533.9E	4244983.3N	CPT Number
Contract	10451	Latitude/ Longitude	38.352750	74.753547	**BH - MET TOWER**
Client Name/Ref	US Wind Inc./REF11449	Water Depth (mMSL)	27.7		
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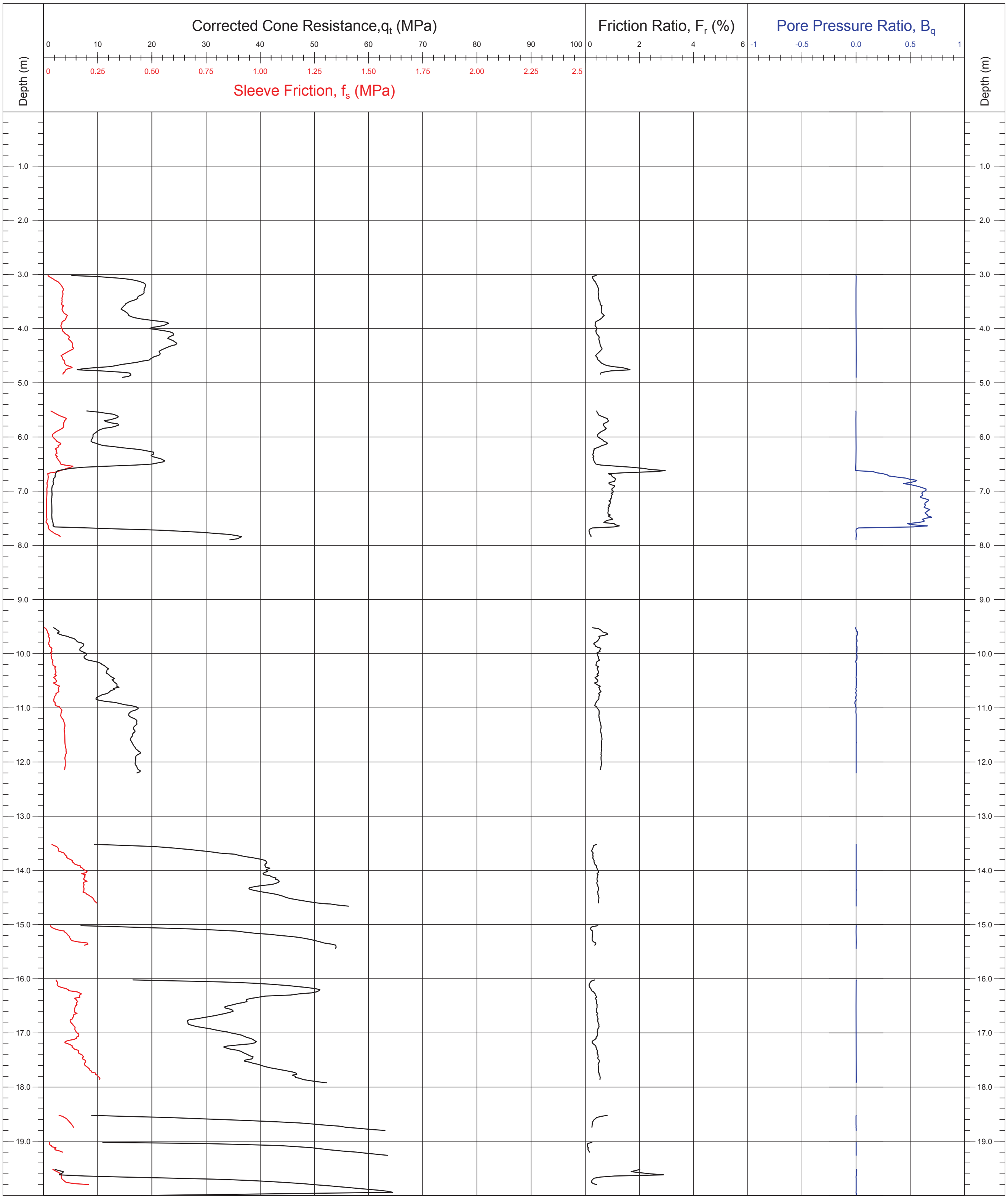
		Base Inclination	X = 0.0° / Y = 0.0°		Preliminary / Draft / Final
		CRS	GRS 80 UTM ZONE 18 N (75 W)		NV-S (27/06/2015) / SMc (23/09/2015) / JG (23/02/2015)

Geotechnical Marine Survey
Investigation for the Maryland Wind Energy Area
INSITU CPTU TESTING - DERIVED PARAMETERS



Area	Maryland USA	Coordinates	521533.9E	4244983.3N	CPT Number
Contract	10451	Latitude/ Longitude	38.352750	74.753547	**BH - MET TOWER**
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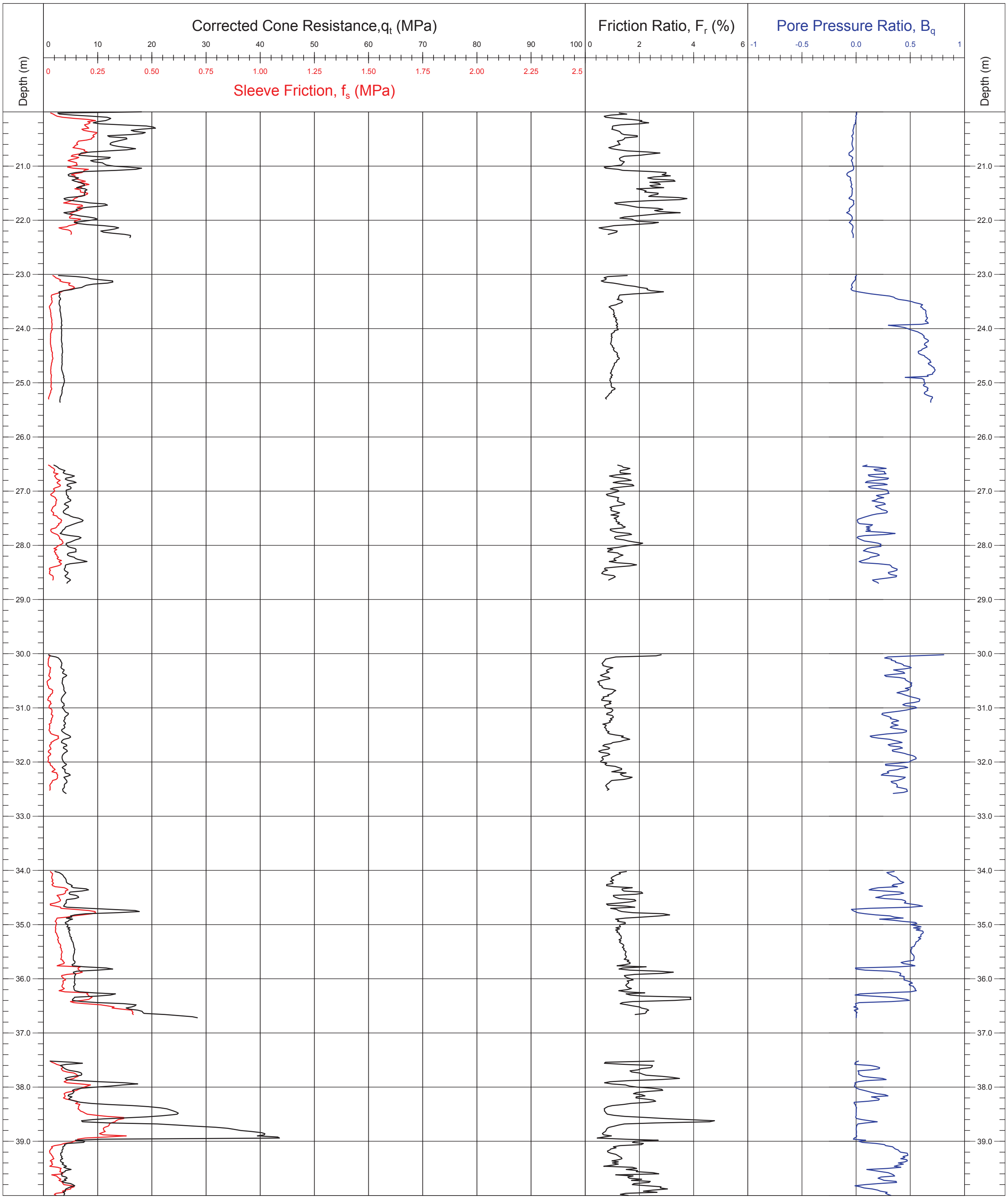
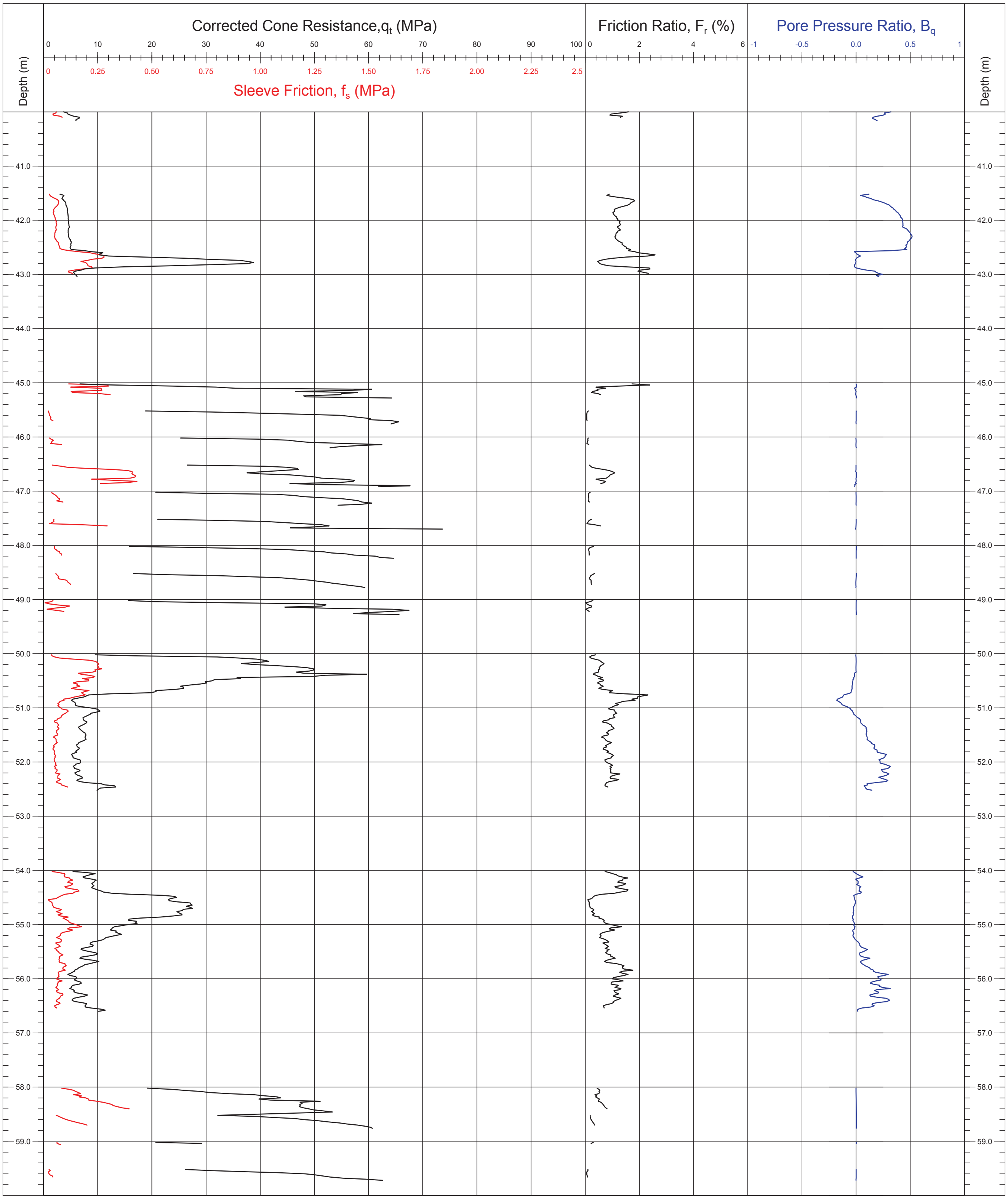
Investigation for the Maryland Wind Energy Area
INSITU CPTU TESTING - DERIVED PARAMETERS



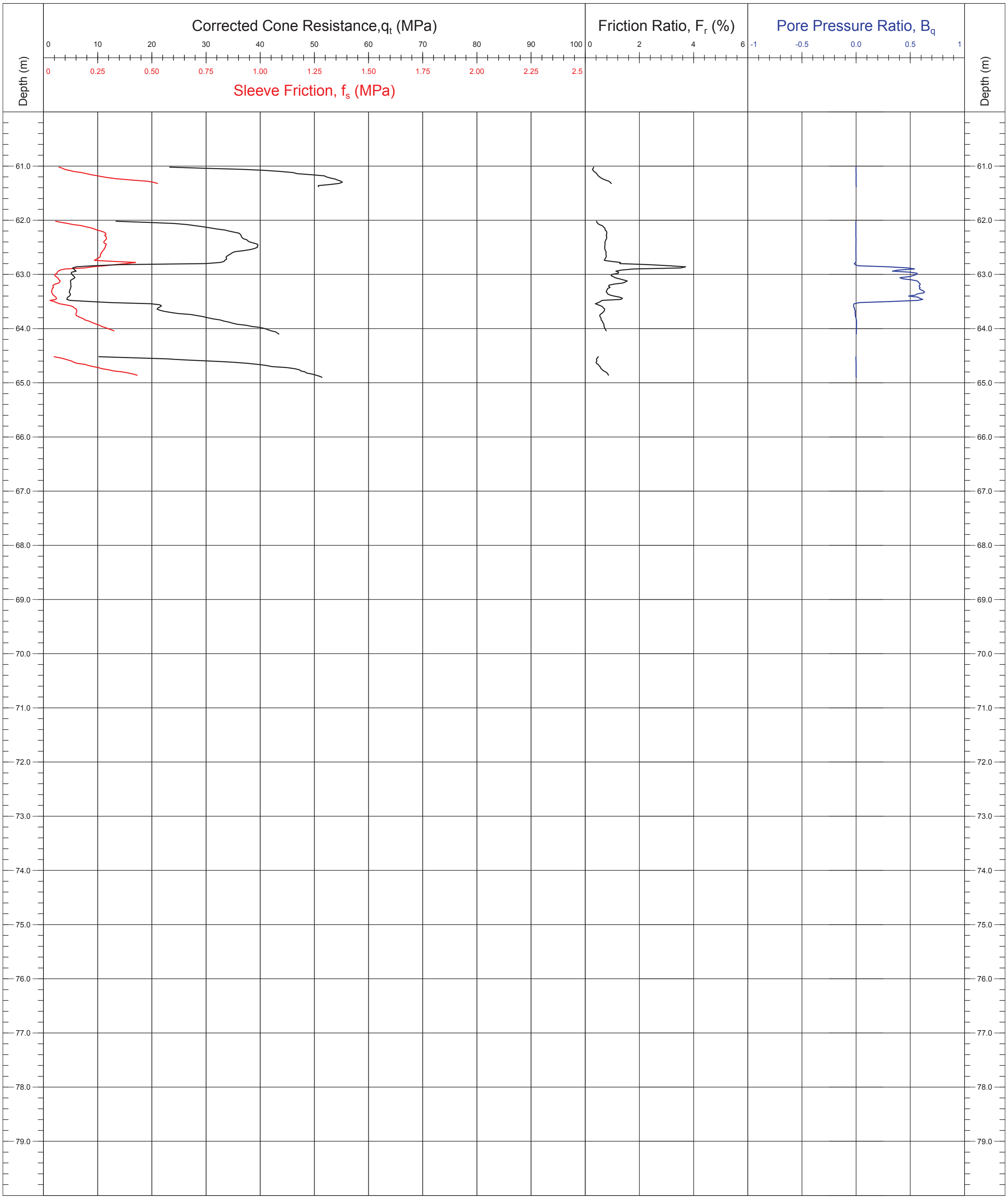
Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	CPT Number
Contract	**10451**	Latitude/ Longitude	**38.352750 74.753547**	**BH - MET TOWER**
Client Name/Ref	**US Wind Inc./REF11449**	Water Depth (mMSL)	**27.7**	
Vessel	**MV Ocean Discovery**	Date of Test (Start/End)	**25/06/2015 to 26/06/2015**	Page: 2/4
Comments: Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa		Cone No.(type)/α Factor	**070815G (10cm^2) / 0.79**	QC Status
		Base Inclination	**X = 0.0° / Y = 0.0°**	Preliminary **NV-S** (27/06/2015) / Draft **SMc** (23/09/2015) / Final **JG** (23/02/2015)
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey
Investigation for the Maryland Wind Energy Area
INSITU CPTU TESTING - DERIVED PARAMETERS



Area	**Maryland USA**	Coordinates	**521533.9E**	**4244983.3N**	CPT Number
Contract	**10451**	Latitude/ Longitude	**38.352750**	**74.753547**	**BH - MET TOWER**
Client Name/Ref	**US Wind Inc./REF11449**	Water Depth (mMSL)	**27.7**		
Vessel	**MV Ocean Discovery**	Date of Test (Start/End)	**25/06/2015 to 26/06/2015**		Page: 3/4
Comments: Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa		Cone No.(type)/α Factor	**070815G (10cm^2) / 0.79**		QC Status
		Base Inclination	**X = 0.0° / Y = 0.0°**		Preliminary / Draft / Final
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**		**NV-S** (27/06/2015) / **SMc** (23/09/2015) / **JG** (23/02/2015)

Geotechnical Marine Survey
Investigation for the Maryland Wind Energy Area
INSITU CPTU TESTING - DERIVED PARAMETERS



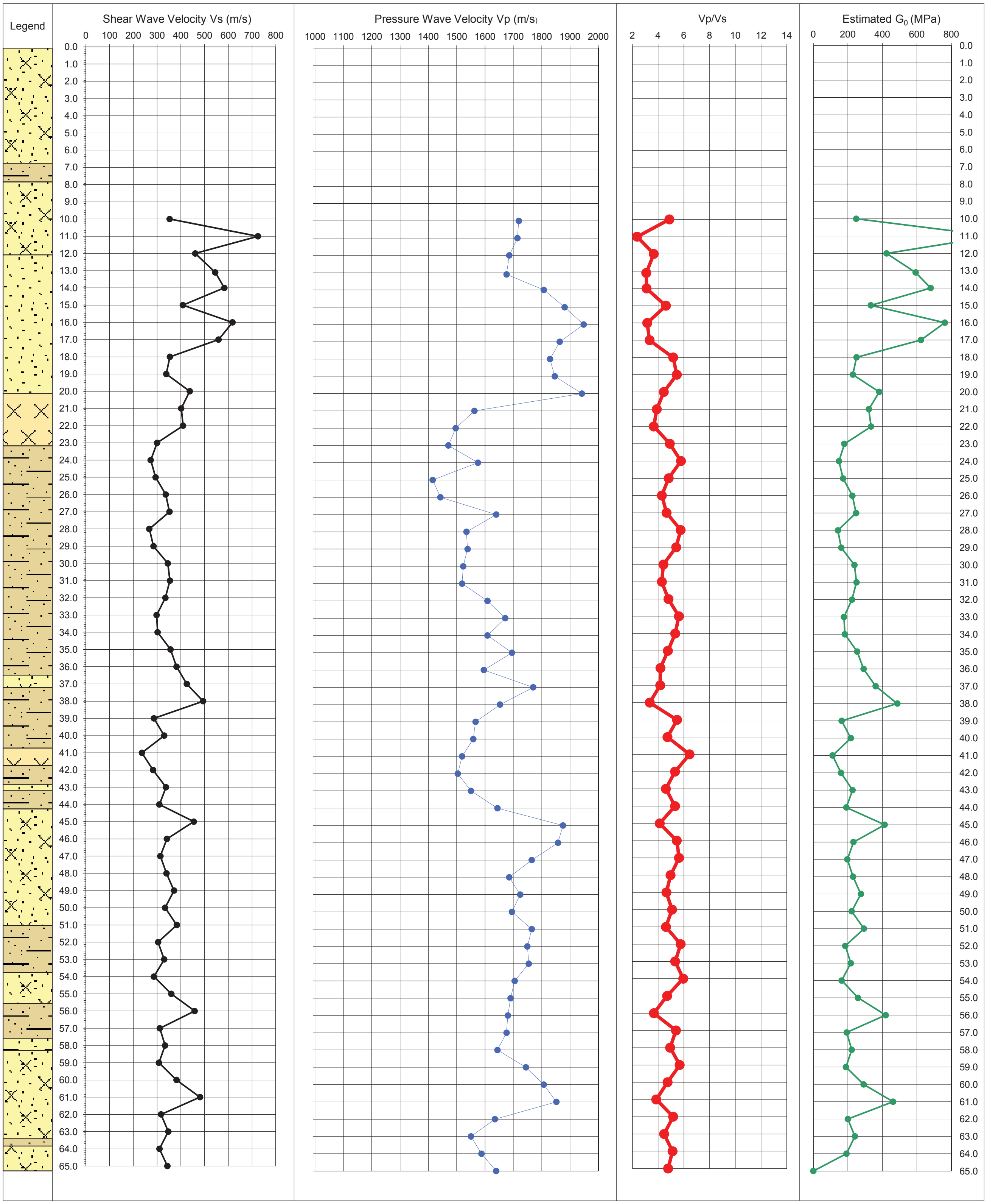
Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	CPT Number
Contract	**10451**	Latitude/ Longitude	**38.352750 74.753547**	**BH - MET TOWER**
Client Name/Ref	**US Wind Inc./REF11449**	Water Depth (mMSL)	**27.7**	
Vessel	**MV Ocean Discovery**	Date of Test (Start/End)	**25/06/2015 to 26/06/2015**	Page: 4/4
Comments: Borehole completed to a final depth of 64.94m at clients request. Pocket Penetrometer readings maxed out at 300kPa		Cone No.(type)/α Factor	**070815G (10cm²) / 0.79**	QC Status
		Base Inclination	**X = 0.0° / Y = 0.0°**	Preliminary: **NV-S** (27/06/2015); Draft: **SMc** (23/09/2015); Final: **JG** (23/02/2015)
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

APPENDIX 5

5.1 PS Logging Results

PS Logging

10451-Geotechnical Marine Survey Investigation for Maryland Wind Energy Area



Borehole No:	BH-MET TOWER	Coordinants:	521533.9 E	4244983.3 N
Client:	US Wind Inc.	Latitude / Longitude	38.35275	74.753547
Vessel:	MV Ocean Discovery	Water Depth (mMSL):	27.70	
Area:	Maryland	Ellipsoid & Projection:	GRS 80 UTM ZONE 18 N (75W)	

Comments:	QC Status:	Preliminary	Draft	Final
	Checked:	XY 27/06/2015	RS 23/09/215	JG 23/02/2015

Appendix E

Marine G&G Survey Report for Met Tower Site Assessment Plan

Survey Report for
US Wind, Inc.

Title:
Marine G&G Survey Report for Site Assessment Plan

Project:
Maryland Wind Energy Area

Survey Date:
June – July 2015

Project Number:
1751

Report Status:
Revision 0

EXECUTIVE SUMMARY

Alpine Ocean Seismic Survey, Inc. (Alpine) carried out a marine survey investigation on behalf of US Wind, Inc. (US Wind) to undertake High Resolution Geophysical (HRG), Geotechnical and Environmental surveys on the Outer Continental Shelf (OCS), in the Maryland Wind Energy Area (WEA). The surveys were conducted to support development of renewable wind energy by providing necessary data for a Site Assessment Plan (SAP), Meteorological (MET) tower engineering and design, and permitting and regulatory purposes.

The marine surveys covered a 300m radial area extending from the MET tower location, located in Outer Continental Shelf Lease number OCS-A 0490. The 300m radial area encompassed the Area of Potential Effect (APE) where bottom disturbance could occur during geotechnical drilling operations and MET tower installation.

Survey operations were conducted in accordance with a Survey Plan developed to satisfy Bureau of Ocean Energy Management's (BOEM) "Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585", dated November 9, 2012.

Geophysical data acquisition was carried out on board the RV Shearwater, which sailed to Ocean City, Maryland on 01-June-2015 with operations continuing until completed on 25-July-2015.

Bathymetric and geophysical data were collected using a multibeam echosounder, side-scan sonar, shallow penetration sub-bottom profiler and a marine magnetometer. A geotechnical borehole was advanced at the MET tower site which included combined drilling and CPT pushing, and also included acquisition of samples for physical description and laboratory testing. Grab samples and underwater video/photography were also performed in the MET tower area and in a baseline area approximately 1 km north of the site. These combined data sets provided seafloor and sub-surface characterization needed to determine site suitability for MET tower design and installation.

Bathymetry data in the MET tower area show the seafloor to be characterized by limited relief, with water depths ranging between 26.3m to 27.1m. Surface sediments in the area are composed of fine to coarse grained sand, with trace amounts of gravel. Small sand ripples are present throughout the area, with average wavelengths of less than 1m, and crest heights less than 0.5m. Sub-surface sediments are dominated by sands, with occasional interlayers of clay and gravel. A shallow reflector was observed throughout the area, occurring 1 to 2m below the seafloor and is interpreted to represent an erosional surface remnant from the last sea level transgression. This surface is interpreted as the boundary between late Pleistocene and early Holocene sediments. Geotechnical data were compared to shallow penetration sub-bottom data collected near the MET tower during the current survey, and also with medium penetration sub-bottom data collected during the 2013 survey. The geophysical and geotechnical data sets correlate well and three main sub-surface units were identified. Unit 1 represents recent Holocene sandy sediments ranging in thickness between 0.5 and 2.5m across the SAP area. Unit 2 represents a channel complex directly underlying Unit 1. Unit 3 represents a thick sequence of sub-parallel layered sediments dominated by silt and clay.

The data sets were reviewed for the presence of any natural or man-made hazards which could impact development of the site. No significant hazards were identified, no sonar contacts were observed and only 9 small magnetic anomalies were detected. None of the anomalies exceeded 21 nT in amplitude and are not expected to impact installation or operation of the MET tower. The SAP area does occur within a military training area so the possibility of shallow buried ordnance should be considered.

SERVICE WARRANTY

USE OF THIS REPORT

This report has been prepared with due care and diligence and with the skill reasonably expected of a reputable contractor experienced in the types of work carried out under the contract and as such the findings in this report are based on an interpretation of data which is a matter of opinion on which professionals may differ and unless clearly stated is not a recommendation of any course of action.

Alpine has prepared this report for the client(s) identified on the front cover in fulfilment of its contractual obligations under the contract and the only liabilities Alpine accept are those contained therein.

Please be aware that further distribution of this report, in whole or part, or the use of the data for a purpose not expressly stated within the contractual work scope is at the client's sole risk and Alpine recommends that this disclaimer be included in any such distribution.

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www.alpineocean.com

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Shallow Isopach Map	1:1000	5
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GLOSSARY OF ABBREVIATIONS

Abbreviation	Meaning	Typical Use in Documents
APE	Area of Potential Effect	
BH	Borehole	
BOEM	Bureau of Ocean Energy Management	
cm	Centimeter	
CHIRP	Compressed High Intensity Radar Pulse	
COP	Construction and Operations Plan	
CORS	Continuously Operating Reference Station	
CP&E	Coastal Planning and Engineering	
CPT	Cone Penetrometer Test	
DGPS	Differential Global Positioning System	
DPR	Daily Progress Report	
DTM	Digital Terrain Model	
Ft	Foot	
G&G	Geophysical and Geotechnical	
GAMS	GPS Azimuth Measurement System	
GNSS	Global Navigation Satellite System	
HRG	High Resolution Geophysical	
Hz	Hertz	
IMU	Inertial Measurement Unit	
Km	Kilometer	
l	Wavelength	<5m l, l >5m
Lat	Latitude	
Long	Longitude	
m	Meter	
MAG	Magnetometer	
MBES	MBES Echosounder	
MEA	Maryland Energy Administration	
MET	Meteorological Tower	
MLLW	Mean Lower Low Water	
MSL	Mean Sea Level	
MV	Motor Vessel	
MW	Megawatt	
nT	Nano-Tesla	
NU	North Up	
NA	Not Applicable	
NAD83	North American Datum of 1983	
OCS	Outer Continental Shelf	
PDOP	Position Dilution of Precision	
PLS	Professional Land Surveyor	
PPK	Post Processing Kinematic	
PPS	Pulse Per Second	
RTK	Real Time Kinematic	
QA/QC	Quality Assurance/Quality Control	
RV	Research Vessel	
SAP	Site Assessment Plan	
SBES	Singlebeam Echosounder	
SBP	Sub-bottom Profiler	
SOW	Scope of Work	
SSS	Side-Scan Sonar	
SVP	Sound Velocity Profile	
USBL	Ultra-short Baseline	

Abbreviation	Meaning	Typical Use in Documents
USCG	United States Coast Guard	
USGS	United States Geological Survey	
UTM	Universal Transverse Mercator Projection	
UXO	Unexploded Ordnance	
WD	Water Depth	WD 23m
WK	Wreck	WK Wreck name
WGS84	World Geodetic System 1984	
WEA	Wind Energy Area	
WTG	Wind Turbine Generator	
XTF	eXtended Triton Format	

DEFINITIONS

Terminology	Definition
Main Contractor/Customer	US Wind, Inc.
Survey Contractor	Alpine Ocean Seismic Survey, Inc.
Acoustic penetration	The ability of acoustic waves to travel through the subsurface.
Acoustic reflector	A subsurface that causes the velocity of seismic waves to change.
Bedding/Layering	A stratified or layered feature associated with sedimentary rocks and/or loose sediments.
Bedform	Any oscillatory topographic deviations from a flat bed produced by fluid movement including wave and current activity, generally in a sandy domain.
Bedrock	The solid rock lying beneath superficial material such as gravels or soils.
Boulder	A separated rock mass larger than a cobble, having a diameter greater than 200 mm. It is rounded in form or shaped by abrasion.
Chart Datum	A level so low that the tide will not frequently fall below it. NOAA interprets it as the approximate level of Mean Lower Low Water (MLLW)
Clay	A complex mineral assemblage with particle size <0.002 mm
Coarse sediment	Sediment composed mainly of sand and gravel.
Cohesive sediment	Sediments, typically clay and/or silt that resist separation due to nature of bonds between fine grained particles.
Continental Shelf	A gently sloping, shallow-water platform extending from the coast to a point where there begins a comparatively sharp descent down the continental slope to the Abyssal floor.
Debris	Sonar contacts attributed to human activity.
Fine sediment	Sediment composed mainly of silt and clay.
Gravel	An unconsolidated accumulation consisting of particles larger than sand (diameter 2 mm – 60mm).
MLLW	The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. This is the lowest level to which sea level can be predicted to fall under normal meteorological conditions. MLLW is not an extreme level, as meteorological conditions can cause a lower level: the level under these conditions is known as a storm surge or negative surge.
Loose sediment	Not cemented sediment, either cohesive or not.
Megaripples	Undulations produced by fluid movement (waves and currents) over sediments, generally with l of 0.5m to 25m.
Ridge	A long narrow raised portion of the seafloor, relatively to its surroundings.
Ripples	Undulations (<0.5m l) produced by fluid movement (waves and currents) over sediments.
Rock outcrop	Rock that is exposed at the seafloor.
Sand	A detrital particle larger than a silt grain and smaller than a gravel, having a diameter in the range of 0.062 mm to 2 mm.
Sandwave	Undulations produced by fluid movement (waves and currents) over sediments, generally with l > 60m.
Very coarse sediment	Sediment composed mainly of cobbles and boulders

1. INTRODUCTION

Alpine Ocean Seismic Survey, Inc. (Alpine) performed High Resolution Geophysical (HRG), Geotechnical and Environmental surveys on behalf of US Wind, Inc. (US Wind) in the Maryland Wind Energy Area (WEA) located on the Outer Continental Shelf (OCS). The surveys were performed to support development of an offshore wind farm, and were conducted in accordance with lease requirements (OCS-A 0489 and OCS-A 0490) as modified by the US Wind Survey Plan that was approved by the Bureau of Ocean Energy Management (BOEM) on 3-June- 2015. This report covers the survey operations and data results for the Area of Potential Effect (APE) surrounding the planned location of a Meteorological (MET) Tower, as carried out by Alpine.

US Wind purchased the two leases described above for the development of a large scale 500 MW offshore wind farm. US Wind contracted Alpine Ocean Seismic Survey, Inc. to undertake the G&G surveys for the offshore WEA.

The surveys were also in line with lease requirements and according to specifications described in BOEM's "Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585", dated 9-November-2012.

The surveys included protected species mitigation measures as detailed in the lease and described in the Marine Mammal Mitigation Plan submitted to BOEM prior to the onset of the survey. The surveys were conducted during 24-hr operations with continuous visual observations by qualified Protected Species Observers (PSO). In addition to visual monitoring, a Passive Acoustic Monitoring system (PAMS) was installed on the survey vessel with trained personnel operating the equipment at all times during survey operations, ramp ups and during shut downs. For more information on protected species mitigation, refer to Appendix B of this report, which includes a detailed PSO report for both the geophysical and geotechnical survey operations.

The RV Shearwater conducted the HRG and environmental surveys, and was mobilized in Ocean City, MD during the period 2-June-2015 to 5-June-2015. The MV Ocean Discovery conducted geotechnical operations and was mobilized in Baltimore, Maryland during the period 16-June-2015 to 18-June-2015. Refer to Appendix A of this report for details and results of the geotechnical investigation. The surveys focused on data and sample acquisition in the MET tower area to provide a framework for a Site Assessment Plan. The surveys also covered the entire planned WTG array area to provide data for future wind farm planning and design, and for the eventual submission of a Construction and Operations Plan (COP).

While the RV Shearwater was docked in Ocean City the vessel took on board survey and mitigation personnel (PSOs & PAMS operators) and undertook DGPS and gyrocompass verifications, as well as initial underwater equipment checks. The vessel commenced work on sailing from Ocean City at 11:15h, 5-June-2015 to conduct calibrations and perform a vessel and HRG equipment noise signature analysis test using the PAMS system to establish baseline sound levels generated by the vessel and survey equipment. The calibrations and tests were completed and the survey began on 6-June-2015 at 19:20h local time. HRG survey data was collected in the MET tower APE during the period 6-June-2015 to 10-June-2015 while benthic grab samples and underwater camera work was completed on 25-July-2015. The drill ship advanced the MET tower borehole during the period 25-June-2015 to 26-June-2015.

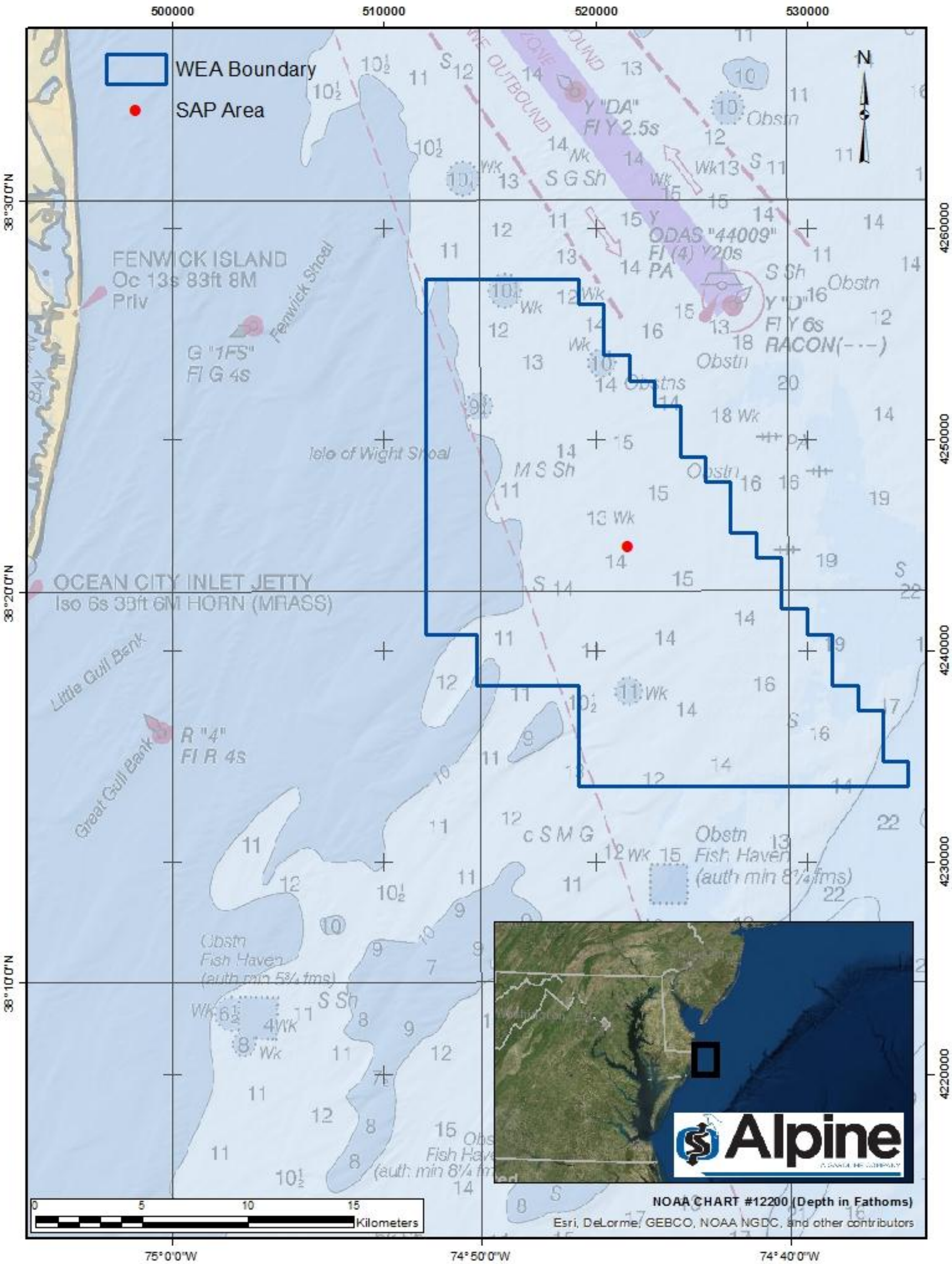

Figure 1.1 Location Map

1.1 Fieldwork Summary

Fieldwork Summary			
Program	Survey Vessel	Task	Dates
HRG & Environmental Surveys	RV Shearwater	Mobilization	2-June-2015 to 5-June-2015
		Calibrations and PAMS Noise Analysis Tests	5-June-2015 to 6-June-2015
		HRG and Environmental Survey Operations	6-June-2015 to 25-July-2015
Geotechnical Surveys	MV Ocean Discovery	Mobilization	16-June-2015 to 18-June-2015
		MET Tower Drilling Operations	25-June-2015 to 26-June-2015

Table 1.1 Field Work Summary

1.2 Time Breakdown HRG Survey

Activity	Project Hours	Percentage of Total
Operational geophysical	753:48	58.48%
Transit	31:35	2.45%
Calibrations	5:55	0.46%
Standby (weather)	189:09	14.67%
Standby (port)	176:00	13.66%
Mobilization	61:00	4.73%
Survey Downtime	36:18	2.82%
PSO Mitigation	35:15	2.73%
Total	**1289:00**	**100%**

Table 1.2 Time Breakdown

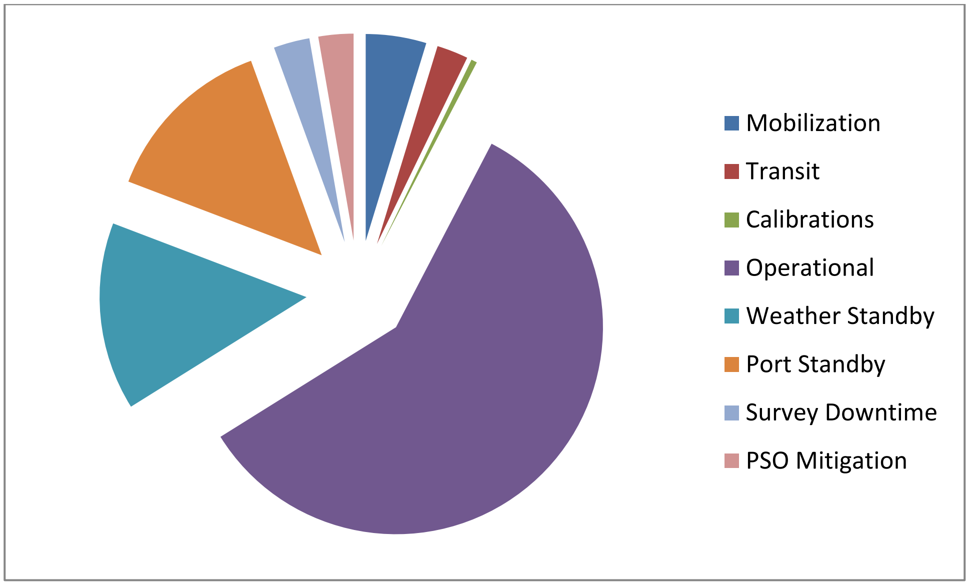

Figure 1.2 Time Breakdown

2. VESSEL SUMMARY

The RV Shearwater was used for the HRG and environmental survey work in the Wind Energy Area.

Brief Particulars	
Class	Multi-Role Survey
Flag	USA
Built	1981 (reconfigured 2011)
Length OA	33.53m
Breadth OA	11.89m
Draft	2.74m
GT	198t
Endurance	21 days (nominal)
Main Engine	2 x 526 HP John Deere Model 6125AFM
Bow thrust/Stern Thrust	Thrustmaster 100 HP / Hydraulically Driven “Z” Drives
Accommodation	20 Berths

Table 2.1 Vessel Specifications

Figure 2.1 RV Shearwater

3. SAFETY

Safety standards and procedures on board the RV Shearwater adhere to company policy which operates under the guidance of Alpine's Health and Safety Manual for Marine Geophysical Operations and is administered by the company's Health and Safety Officer. To maintain these standards every crew member is given a safety induction upon joining the vessel and regular safety drills are carried out during the cruise. Toolbox meetings are also conducted prior to equipment deployment, recovery and survey crew shift changes.

Prior to sailing a safety induction of all joining crew was carried out by the vessel safety officer.

During operations between 06-June and the completion of the surveys on 25-July-2015 a total of 103 toolbox meetings were completed.

Exposure Hours

The survey and marine crew totaled 18 persons during the survey. The total numbers of exposure hours from mobilization on 06-June-to 10-June-2015 were 13,075h during which there were no lost time incidents, no injurious incidents and no occurrences that resulted in damage to the environment.

4. CREW LIST

The following personnel were present on board the survey vessel.

Table 4.1 Field Personnel

Alpine/Gardline Personnel		Period	
Party Chief / Project Manager	Justin Bailey	03-June-2015	06-July-2015
Surveyor in Charge – 1st Rotation	Marcus Kwasek	02-June-2015	21-June-2015
Data Processor – 2nd Rotation	Marcus Kwasek	16-July-2015	25-July-2015
Surveyor in Charge	Chris Stillman	03-June-2015	19-June-2015
Surveyor – 1st Rotation	Kaios Ryan	03-June-2015	19-June-2015
Surveyor in Charge– 2nd Rotation	Kaios Ryan	19-June-2015	24-July-2015
Surveyor	Trevor Hoskins	02-June-2015	24-July-2015
Surveyor	Brett Young	19-June-2015	24-July-2015
Surveyor – 1st Rotation	Rob Vietri	06-July-2015	16-July-2015
Data Processor – 2nd Rotation	Rob Vietri	16-July-2015	25-July-2015
Surveyor in Charge – 1st Rotation	Cam Morrissette	21-June-2015	06-July-2015
Data Processor – 2nd Rotation	Cam Morrissette	06-July-2015	16-July-2015
Surveyor in charge	Farhan Arshad	16-July-2015	24-July-2015
Data Processor	Kelly Johns	03-June-2015	16-July-2015
Data Processor – 1st Rotation	Daniel Whitesell	02-June-2015	06-July-2015
Party Chief – 2nd Rotation	Daniel Whitesell	06-July-2015	25-July-2015
PSO/PAMS Operator	Sharon Doake	03-June-2015	24-July-2015
PSO/PAMS Operator	Randal Counihan	03-June-2015	06-July-2015
PSO/PAMS Operator	Teresa Martin	03-June-2015	24-July-2015
PSO/PAMS Operator	Jack Allum	03-June-2015	06-July-2015
PSO/PAMS Operator	Sam Tufano	03-June-2015	24-July-2015
PSO/PAMS Operator	Lee Slater	06-July-2015	25-July-2015
PSO/PAMS Operator	Robert Lee	06-July-2015	25-July-2015
Captain	Wayne Porter	02-June-2015	25-July-2015
1st Mate – 1st Rotation	Michael Porter	02-June-2015	21-June-2015
1st Mate – 2nd Rotation	Michael Porter	06-July-2015	25-July-2015
Mate	Mike Masek	02-June-2015	06-July-2015
Mate	Jason Giery	21-June-2015	25-July-2015
Deckhand	Sydney Sanchez	02-June-2015	06-July-2015
Deckhand	Steve Miller	02-June-2015	21-June-2015
Cook	Larry Bennet	02-June-2015	06-July-2015
Deckhand	Ovidio Hernandez	21-June-2015	25-July-2015
Deckhand	Brandon Worley	06-July-2015	25-July-2015
Environmental Client-ESS	James Treacy	24-July-2015	25-July-2015
Environmental Scientist-Gardline	Laura Jamieson	24-July-2015	25-July-2015

5. SURVEY PROCEDURES

5.1 General

The US Wind SAP survey comprised an investigation of the bathymetry, seabed features and shallow geology across the APE of the planned site for installation of the MET tower. In addition to the MET tower area, the survey also gathered geophysical data across the entire area US Wind has designated for wind farm development for future advancement of the project pursuant to a Construction and Operations Plan (COP).

5.2 Project Survey Parameters

Datum and projection parameters for all surveys:		
Geodetic datum	NAD83	
Ellipsoid	WGS84	
	semi-major axis (a)	6 378 137.000 meters
	inverse flattening (1/f)	298.257 223 5634
	eccentricity sq. (e2)	0.006694379990
Projection	UTM Zone 18N	
	origin latitude	0°
	origin longitude	-75°
	origin false easting	500000.00
	origin false northing	0.00
	Scale factor	0.9996
	grid unit	meters

Table 5.1 Project Geodetics

Name	WGS84 Geographical	UTM Zone 18N Meters
MET Tower Location	Latitude : 38.352747	Easting: 521,534
	Longitude : -74.753546	Northing: 4,244,983

Table 5.2 Geodetic parameters for survey and charting

5.3 Vertical Datum

MBES Bathymetry data was collected in the MET tower APE, which encompasses a 300m radius circle around the planned installation location. This data was collected to supplant data acquired during the 2013 geophysical survey, which did not attain 100% bottom coverage. Bathymetry data were tide corrected and reduced to Mean Lower Low Water (MLLW) using the Post Processing Kinematic (PPK) method.

PPK techniques use a combination of the POS MV and POSPac Mobile Mapping Suite (MMS) systems. The POSPac MMS is the next generation software for direct geo-referencing of survey sensors using GNSS and inertial technology, specifically integrated with the POS MV for marine mapping applications. POSPac is a powerful post-survey software package that provides maximum accuracy and efficiency for georeferencing the MBES echosounder data. The suite incorporates the Applanix SmartBase™ module that automatically selects, downloads, and imports the best available network of continuously operating reference stations (CORS) surrounding the project area.

The raw POS MV position measurements are adjusted for the differential corrections from the network reference stations and simultaneously processed along with the inertial measurement unit (IMU) data using Applanix IN-Fusion™ technology to solve for GNSS ambiguities (i.e. outages, atmospheric delays) and final vessel position and orientation. Position accuracies are comparable with those achieved using an RTK system, and effectively eliminates the cost and time associated with establishing a local GPS reference station for the project.

CORS Station Used for Bathymetry Processing			
Station	Lat	Long	Height
DEMI	(N)	(W)	(m)
Millsboro, DE	38° 36' 37.00549"	075° 12' 10.33286	-27.437

Table 5.3 CORS Station Parameters

In order to present the bathymetry, sounding data were gridded using a grid cell size of 1 meter.

Area	Depth Range (m)	Cell Size (m)
MET Tower APE	26.25 – 27.1	1

Table 5.4 MBES Gridding

5.4 Summary of Survey Design

The survey design was based on the US Wind Survey Plan that was approved by BOEM prior to the beginning of survey operations. A previous survey was conducted in 2013 by others for the Maryland Energy Administration (MEA), which acquired data on 150m spaced lines throughout the WEA and included MBES bathymetry, SSS imagery, medium penetration sub-bottom profiles, shallow penetration sub-bottom profiles and MAG data. These data were also collected on 900m spaced tie lines, in line with specifications under BOEMs "Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585", dated 09-November-2012. These guidelines detail this minimum line spacing for HRG surveys for hazard assessment and engineering purposes. These guidelines also call for a HRG survey for archaeological resource assessment with a primary line spacing not to exceed 30m throughout the project area, however medium penetration sub-bottom data is not required on these additional lines.

Alpine collected MBES bathymetry, SSS, shallow penetration sub-bottom, and MAG data at a 30m line spacing to supplement the data collected in 2013 and complete data requirements for SAP submittal, as required by BOEM. Singlebeam bathymetric data was also required while running the geophysical equipment for quality control and data correlation/interpretation purposes, but were not used for the bathymetric data presentation. The survey lines previously surveyed in 2013 (150m spaced primary lines, 900m spaced tie lines) were not re-run during the 2015 survey campaign, but the data were merged with the more recent data for final data presentation. The MBES bathymetry and SSS data were not merged, as the recent survey acquired greater than 200% bottom coverage with both swathe data sets, and at a higher resolution, effectively replacing the older data sets. Figure 2.1, shown below, illustrates the survey vessel tracklines for both the 2013 MEA survey and 2015 US Wind survey. Chart 1, provided with this report, presents a “Vessel Tracklines” map, which includes fix marks every 100m for the 2015 survey and also includes tracklines for the 2013 survey.

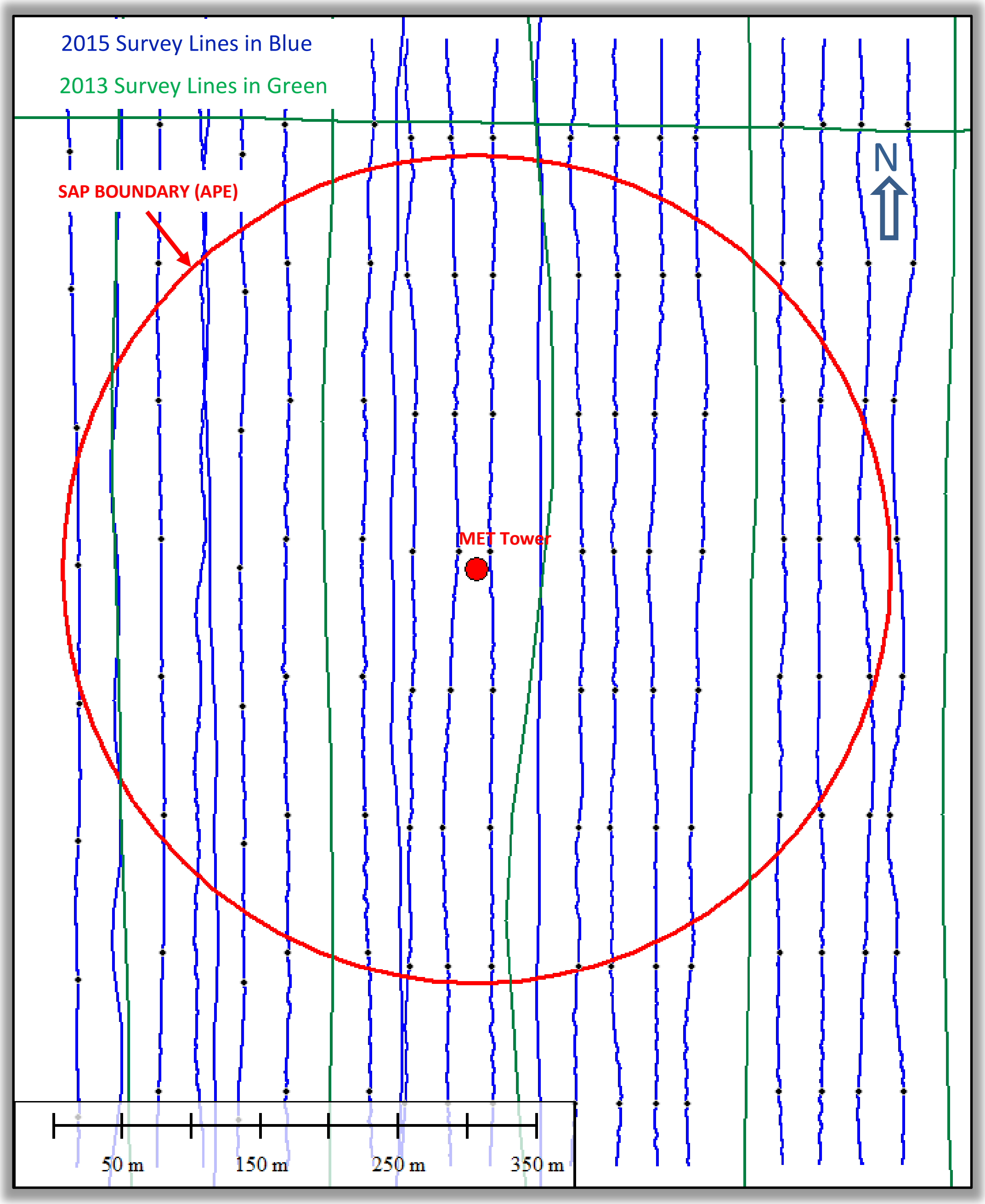

Figure 5.1 SAP Area Survey Line Layout

5.5 Geophysical Survey Equipment and Methods

5.5.1 Vessel Layout

The RV Shearwater provided the survey platform to conduct the bathymetric and geophysical investigation. The vessel provides a large aft deck, crane, hydraulic stern A-frame, fixed starboard A-frame, winches, laboratory and office space with on board processing capabilities. The SSS and MAG towfish were deployed from the stern A-frame using the vessel's main hydraulic winch equipped with 700m of armored cable. The MBES head was installed in the port-side moon pool. The CHIRP and USBL transducers were mounted in the starboard-side moon pool.

5.5.2 Vessel and Equipment Navigation

The Applanix POS MV 320 was used for navigation control during the survey. Differential corrections were received from the USCG stations in Annapolis, MD. This system, which includes a GPS aided Inertial Measurement Unit (IMU), provided precise real-time dynamic sub-meter positioning including heading, heave, pitch and roll.

Aboard the RV Shearwater the IMU was mounted on the main deck near the vessel's center of rotation/gravity. The GPS antennas were mounted on threaded rod above the upper deck and bridge, aligned normal to the longitudinal axis of the vessel. Offsets between the GPS antennas, IMU and all other fixed mounting points for the other geophysical sensors were precisely measured using a laser-ranging total station, with the services of a professional land surveyor (Fabre Engineering, Inc., Pensacola, Florida).

After the navigation system was installed and configured on the survey vessels, the following steps were taken to calibrate the POS MV:

1. The GPS Azimuth Measurement Subsystem (GAMS) Solution was calculated as follows:

    - GAMS calibration began when the number of satellites in view exceeded 5 and PDOP was less than 3.0.
    - The vessel was maneuvered through moderately aggressive turns (figure eights or S-turns) incorporating changes of speed and direction.
    - The operator then waited for the heading accuracy to be below the threshold value entered (0.5 degree) and for the GAMS Status to read Ready Offline.
    - Vessel motion was then stopped and the vessel held to a constant heading.
    - GAMS calibration was started.
    - Once GAMS calibration was complete the values were saved into the system, and were used for the remainder of the survey.

2. Summary of Navigation Data Accuracy

    - The result of the GAMS solution indicated that the azimuth or heading of the vessel was accurate to within 0.25 degrees. This result shows a very high degree of accuracy of the heading data being generated by the navigation system. In the same way, the accuracy of the navigation fix data was determined to be within three meters.

The positioning data from the POS MV was output to a computer equipped with QINSy navigational software, which transmitted continuous navigation data to all systems requiring geo-referencing. Instruments receiving positioning from QINSy included the CHIRP sub-bottom acquisition system, the SSS system and the MAG. The POS MV system output was also directly interfaced to the MBES system using a PPS (pulse per second) device to avoid any latency delays. All offsets from the reference point for the navigation system to the various geophysical instruments were measured and recorded in QINSy. Data from the cable counter was input into QINSy as a backup layback system for the SSS and MAG systems, in the event that the USBL system could not be used. The QINSy navigation software converted the latitude and longitude data to UTM Zone 18 North (m), NAD83 datum, which was used for survey control.

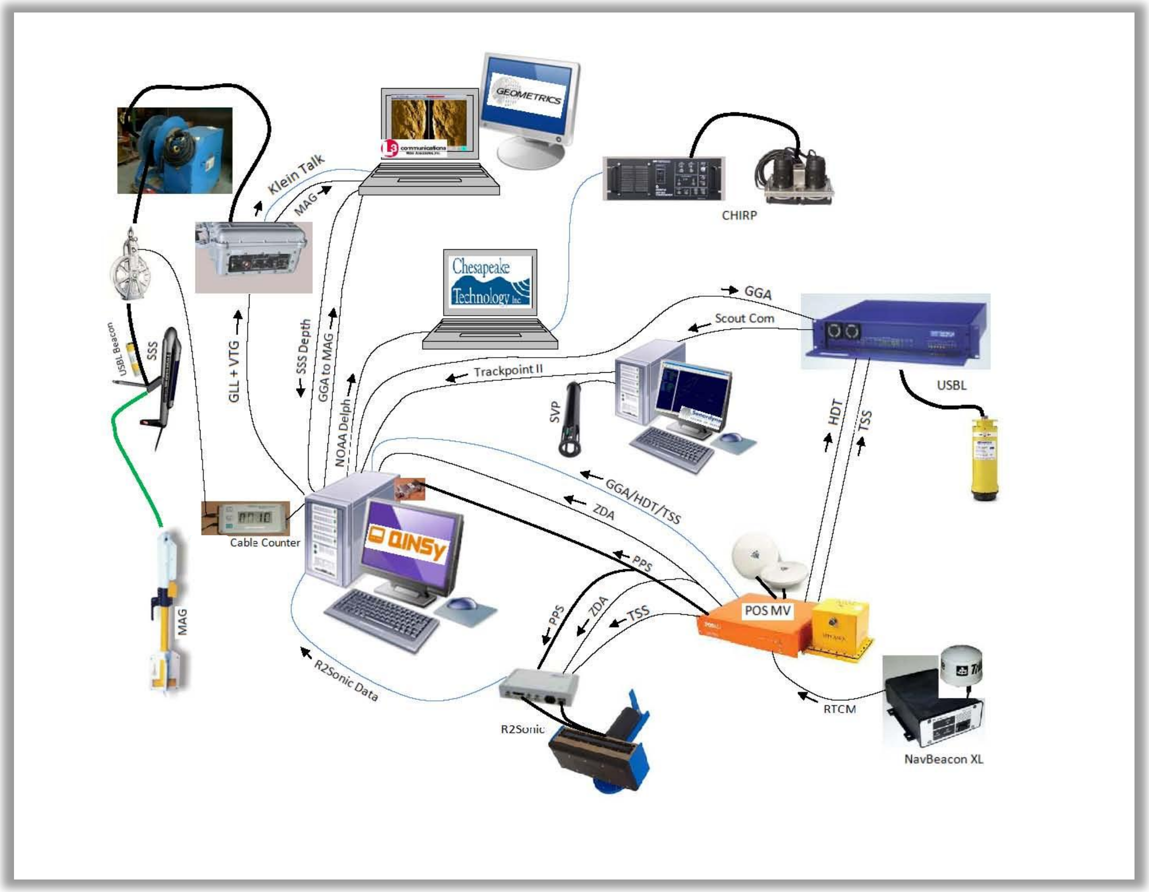

Figure 5.2 Survey Instrumentation Diagram

Vessel :	RV Shearwater					
OFFSET from Ref. Point	☒ meter	☐ feet	+ forward/ - backward	+ right/ - left	+ up/ - down
Primary GPS Antenna			-0.978	-1.591	5.043
Secondary GPS Antenna			-0.939	1.804	5.012
IMU (Internal Measurement Unit)			0.000	0.000	0.000
Waterline					-3.624
MBES Echosounder Transducer			-0.562	-3.972	-6.279
USBL Transducer			-0.780	4.206	-6.551
Single Beam Echosounder Transducer			-0.445	4.099	-6.316
Sub-bottom Profiler Transducer			-0.628	3.825	-6.286
SSS Block Sheave			-16.810	0.005	-3.719

Table 5.5 Survey Equipment Offsets

5.5.3 Multibeam Echosounder (MBES)

An R2Sonic 2024 MBES bathymetry system was used to collect the bathymetric data for SAP survey. On the RV Shearwater the transducer was mounted approximately amidships in the port-side moon pool. The moon pool included an extension pole to lower the transducer below the hull of the vessel, to eliminate hull interference. Once appropriate settings of power and gain were determined, the system was calibrated for pitch, roll, and yaw by running three parallel. This data was then run through a series of calibrations in a post-processing software package (CARIS) to determine the calculated calibration values for pitch, roll, and yaw. Calibration results for the MBES are included in Appendix E.

Data were collected using a signal transmitted at a frequency of 400 kHz and variable settings were used for range/pulse-length and gain for optimal data quality. The speed of sound in water was determined using a Valeport 650 Sound Velocity Profiler (SVP). The SVP sensor data was used to generate a profile of the speed of sound, which was then applied in QINSy to correct for beam steering of the bathymetric data. Heading, heave, pitch and roll output from the Applanix POS MV system was recorded with the bathymetry data in the survey acquisition software (Qinsy), with final post-processing and DTM generation performed using CARIS. SVP casts were conducted at a minimum of every three hours during the SAP survey.

5.5.4 Singlebeam Echosounder (SBES)

An ODOM Echotrac CVM 200 kHz singlebeam bathymetry system was installed on the vessel to observe in real-time and collect data to QA/QC the geophysical instrumentation. Data was logged on all geophysical survey lines, however the data was not processed as greater than 120% bottom coverage was achieved with the MBES system in the SAP area.

5.5.4 Shallow Penetration Sub-bottom Profiler (CHIRP)

A Teledyne Benthos CHIRP III Profiler system was used to generate the sub-bottom acoustic signal, which was transmitted through a set of four transducers mounted on the starboard-side moon pool of the vessel. The transducers were wired in parallel for maximum transmit power and optimum signal reception.

Each pulse consists of a swept frequency (2 - 7 kHz) operated at a 15ms pulse length. The system was operated using a 125 ms sweep length, providing for greater than 90m of recorded data. The signals were received and digitized using the CHIRP topside unit. The CHIRP system received positioning information from the QINSy software so that all the data were continuously geo-referenced. Real-time bottom tracking and display gains were applied to the data in the field using Chesapeake Technologies' SonarWiz software for quality control, and the data were recorded in SEGY format. SonarWiz also provides post-processing capability where the user can perform seafloor tracking, adjust gains and map and export sub-surface reflectors or features.

5.5.5 Ultra-short Baseline (USBL) Acoustic Positioning System

A Sonardyne Scout Pro USBL acoustic positioning system was used to calculate towfish position (SSS & MAG) in real-time on board the RV Shearwater. The system utilizes a hull mounted transceiver (installed on the starboard side moon pool next to the CHIRP transducer) and a transponder (beacon), which is fixed to the armored cable just above the SSS towfish. The USBL transceiver was tilted aft approximately 25 degrees in order to improve system range and performance. The USBL system was interfaced to the QINSy navigation software, which exported corrected sensor positions to the SSS and MAG logging computers.

The USBL system was calibrated using QINSy's calibration routine in approximately 25 meters water depth. The USBL system is interfaced with QINSy software and the Applanix POS MV which provides precise positioning, heave, pitch and roll values. Upon locating a site with a suitable water depth for calibration, a series of calibration lines were established, as shown in the image below. Parallel lines were spaced 50 meters apart (twice the ambient water depth). USBL calibration results are presented in Appendix E.

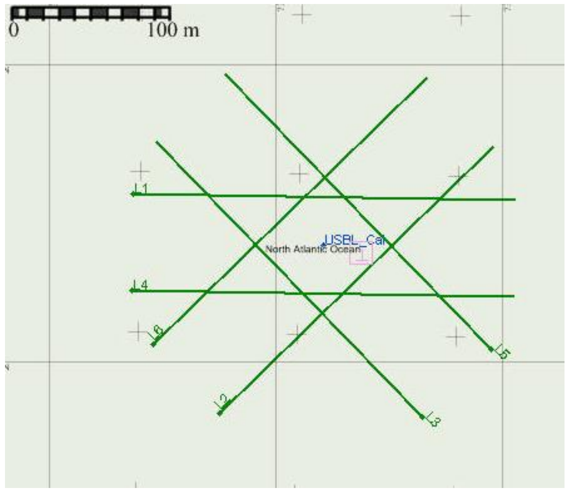

Figure 5.3 USBL Calibration Lines

5.5.6 Side-Scan Sonar System

A Klein model 3900 dual-frequency (500/900 kHz) SSS system was used to collect the side scan data during the survey. The system was interfaced with the QINSy navigation and all data were continuously geo-referenced. Sonar XTF files were recorded using Klein's SonarPro software platform. With SonarWiz the XTF files can be corrected for pitch, roll, slant range, gains and generation of a sonar mosaic at a user specified resolution. Sonar contacts can be picked, measured, saved and exported in a contact report.

Aboard the RV Shearwater the towfish height off seafloor was maintained at 10-20% of the sweep range using a deck mounted hydraulic winch and armored cable. The towfish position was calculated in real-time using the USBL system. A backup system was also used, utilizing a cable counter sheave to measure cable out from the stern of the vessel.

The sweep range was set to 50 m per channel resulting in a 100 m total swath. The system was operated and recorded using a frequency of 500 kHz. All data were displayed in a waterfall format on a high definition LCD monitor during the survey work so that the operator could note any significant targets in the field.

After completing the USBL several SSS files were examined to verify correct positioning of the data. Lines in opposing directions were evaluated where discrete ensonified features could be identified on adjacent lines. An extensive linear feature was observed on the seafloor and imaged with the SSS system (using the USBL for positioning), on adjacent lines that were run in opposite directions (see figure below). The alignment of the linear feature on adjacent lines verifies correct towfish positioning.

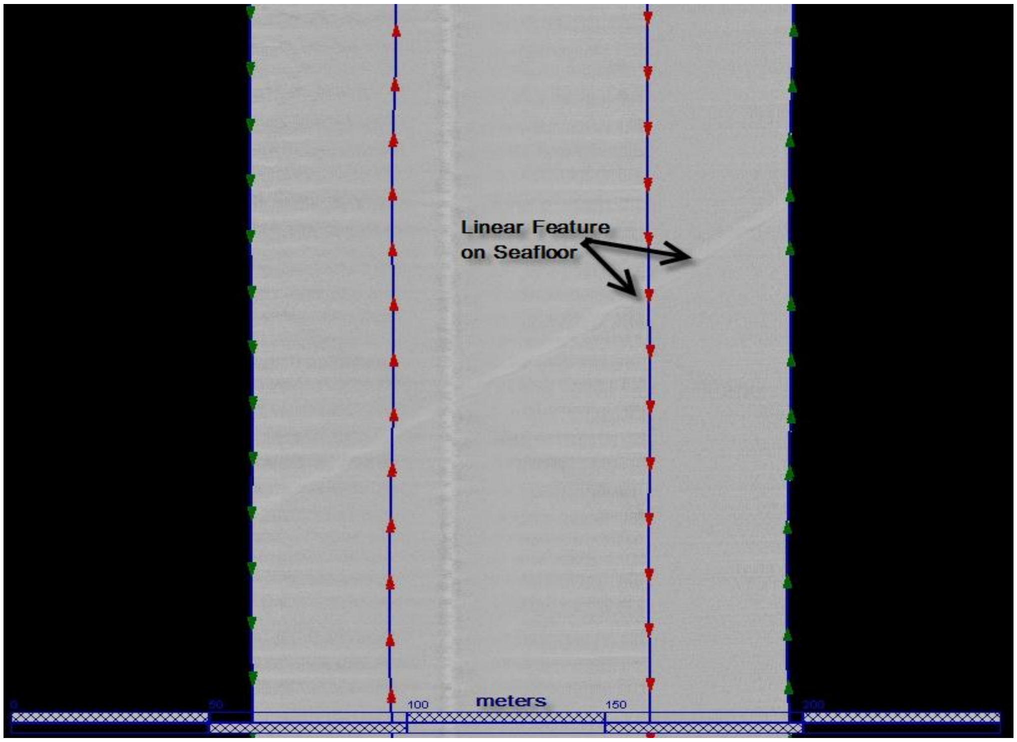

Figure 5.4 USBL Calibration Verification Lines

5.5.7 Marine Magnetometer System

A Geometrics 882 MAG was towed directly behind the SSS towfish using an umbilical cable. This towing configuration was optimal for controlling the altitude of the MAG, which was flown at the appropriate distance (less than six meters) from the seafloor. The MAG data was viewed in real time on board the survey vessel, and recorded in MagLog at 100ms intervals along all survey lines. The position of the towfish was determined using a fixed layback behind the USBL calculated position of the SSS towfish. The MAG data was post-processed using Geometrics' MagPick software platform. MagPick has the capability to remove the regional background field and diurnal variation by using a built-in linear transformation tool, or alternatively by using locally recorded base station data.

6. BACKGROUND GEOLOGY

6.1 Geologic Setting

The Maryland coast is part of a regional feature known as the Delmarva Peninsula. The Delmarva Peninsula is bounded to the north by the Delaware Bay, to the west by the Chesapeake Bay and to the east by the Atlantic Ocean. The Delmarva Peninsula and surrounding features are characterized by three geologic provinces, the Piedmont Plateau, the Coastal Plain, and the Atlantic Continental Shelf. The Piedmont Plateau and Coastal Plain provinces are separated by a “Fall Line”. The Fall Line separates the Coastal Plain on the east, from metamorphosed rocks of the Piedmont province to the west - the remnant core of the ancestral Appalachian Mountains. From the time the ancestral Appalachian Mountains were uplifted between 250 – 450 million years ago they began to erode. Rivers and streams flowing down from the mountain tops carried the eroded material to be spread out and deposited in deltas and outwash plains on the Coastal Plain. East of the Coastal Plain lies the Atlantic Continental Shelf, the submerged continuation of the Coastal Plain extending eastward another 75 miles where sediments exhibit a maximum thickness of 40,000 feet (Maryland Geological Survey, 2015).

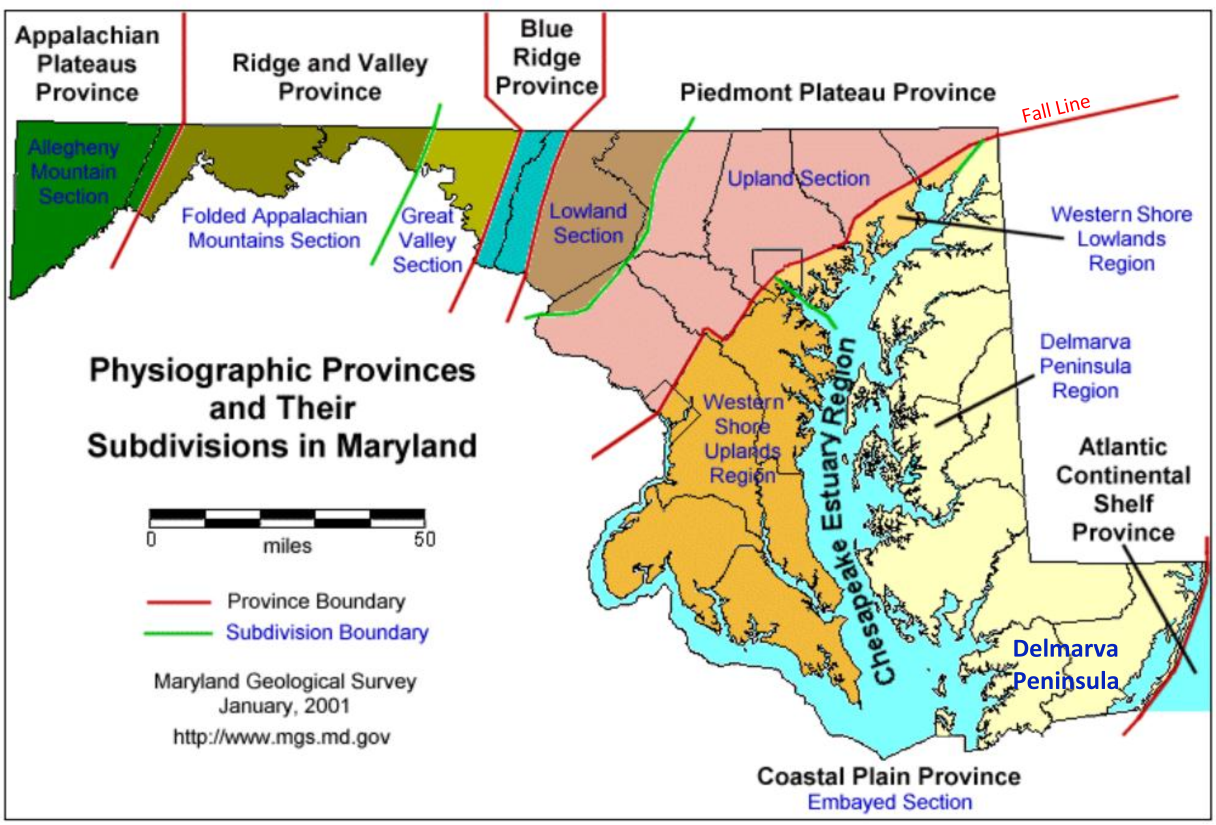

Figure 6.1 Maryland Physiographic Provinces (modified from USGS)

6.2 Stratigraphy

The sediments of the Coastal Plain dip eastward at a low angle, generally less than one degree, thicken eastward and range in age from Triassic to Quaternary.

Linear shoals or sand ridges are among the largest, most pervasive, and enigmatic bedforms on the Delaware-Maryland continental shelf (Figure 8) (Conkwright, and Williams, 1996). Numerous scientists have investigated the seafloor geomorphology and the surficial stratigraphy of the Atlantic shelf to understand the origins and morphology of these linear shoals. Comprehensive reviews of these works have been published by Duane and others (1972), Field (1976, 1980), Toscano (1989), McBride and Moslow (1990), and Wells (1994). As a group, linear shoals share several common features. Duane and others (1972) characterized these features:

1. Linear shoal fields occur in clusters, or fields, from Long Island, New York to Florida.
2. Shoals exhibit relief up to 30 ft, side slopes of a few degrees, and extend for tens of miles.
3. The long axes of linear shoals trend to the northeast and form an angle of less than 35° with the shoreline.
4. Shoals may be shoreface-attached, or detached. Shoreface-attached shoals may be associated with barrier island inlets.
5. Shoal sediments are markedly different from underlying sediments. Shoals are composed of sands and generally overlay fine, occasionally peaty, sediments.

With so many common characteristics, early researchers assumed a common origin for these features. Generally, it was assumed that linear ridges represented relict barriers or subaerial beaches, developed at a lower sea level stand, and preserved with sea level rise. (Veatch and Smith, 1939; Shepard, 1963; Emery, 1966; Kraft, 1971; and many others). Improvements in seismic data collection and reexamination of earlier data led to a new hypothesis of shoal evolution: linear shoals are post-transgressive expressions of modern shelf processes. In particular, Field's (1976, 1980) work on the Delmarva shelf could find no support for the theory of relict, submerged shorelines. Many investigators (including Field 1980; Swift and Field, 1981) concluded that ridge and swale topography developed by the interaction of storm-induced currents and sediments at the base of the shoreface. As the shoreface retreated during transgression, shoreface-attached shoals became detached, and isolated from their sand source. Once detached, the shoals continued to evolve within the modern hydraulic regime.

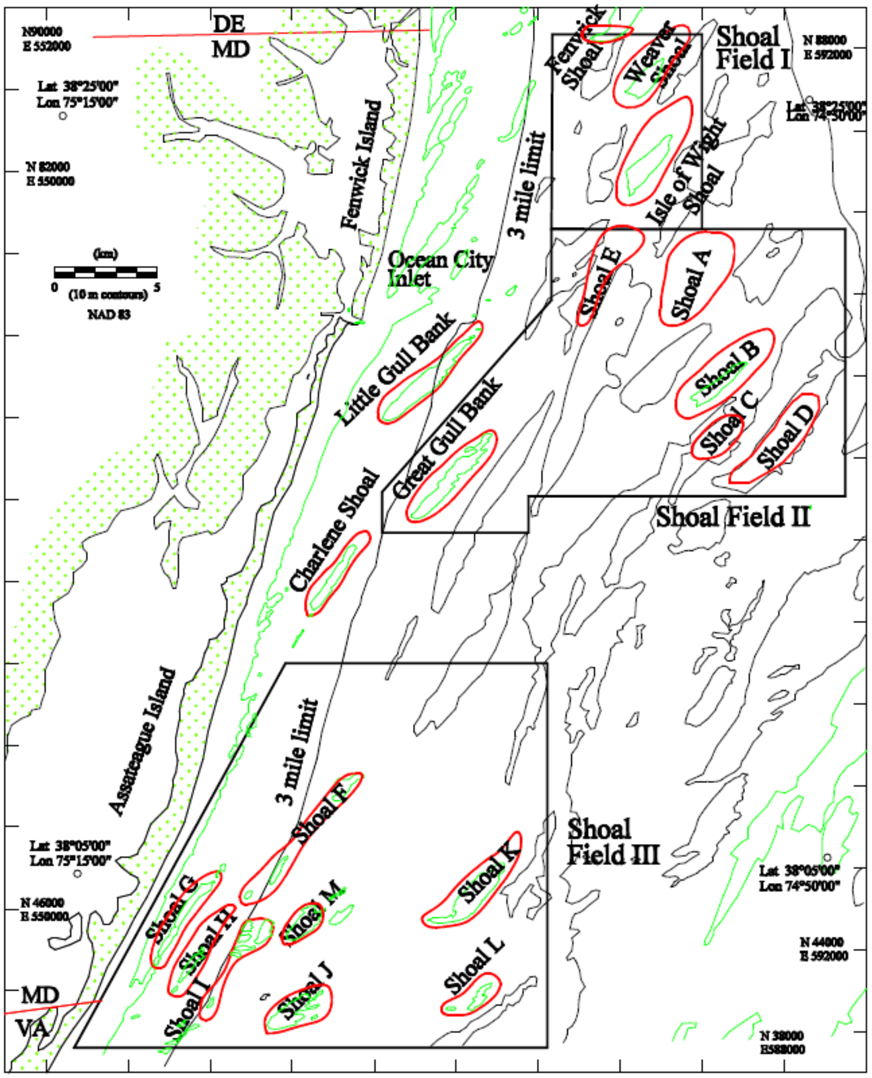

Figure 6.2 Index of Shoal Fields Offshore Maryland

Several shallow geophysical reflectors were mapped in the area in and around a series of sand shoals located offshore of Ocean City, MD. The reflectors described represent the Quaternary geologic sequence for the work area developed by the Maryland Geological Survey between 1987 and 1992 during work conducted as part of the Minerals Management Service Continental Margin Program.

The figure below illustrates the sedimentary sequence described by Wells (1994).

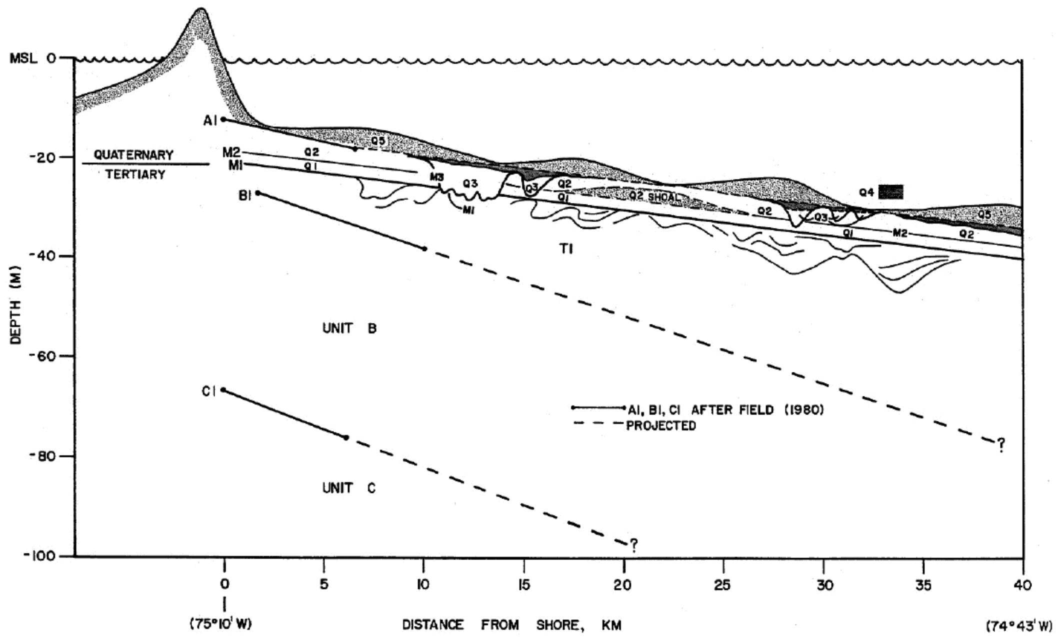

Figure 6.3 Maryland's Inner Continental Shelf Stratigraphy (from Toscano et al., 1989)

The reflectors and depositional units are described as follows (Wells, 1994):

The M1 reflector is correlated to the Tertiary-Quaternary unconformity and is generally present at a depth of 21 to 36m below MSL within 10 miles of the shoreline.

The Q1/Q2 depositional unit immediately overlies the M1 reflector and is characterized by parallel to sub-parallel internal reflectors. A weak reflector, M2, separates the Q1 and Q2 sediments and is generally present at an elevation of 5-6m above M1. The Q1 sediments have been described as sands and gravelly sands containing shells where that unit was penetrated by Vibracore samples. The Q2 unit consists primarily of dewatered fossiliferous mud, with rare lenses of sand. This sequence was deposited during a 50,000 year long lower stand of the sea, correlated with an earlier portion of the Pleistocene.

During a low stand of sea level following deposition of the Q1 and Q2 sediments, a series of river channels were incised across the Maryland continental shelf and infilled with sediments. The most prominent of these is referred to as the St. Martin River paleo-channel, which extends to the southeast offshore of Ocean City, MD. Unit Q3 represents fluvial fill deposits of the ancestral St. Martin tributary system. Other shallower more recent channels are occasionally present on the geophysical data, but these are generally discontinuous due to post-depositional erosion.

The A1 reflector is usually planar and marks the base of the shoals. It represents the boundary between the ravinement surface formed by shoreface erosion and modern trailing edge shelf deposits.

Both the Q4 and Q5 depositional units are Holocene in age. The Q4 is interpreted to be transgressive leading edge deposits (lagoonal/swamp deposits) and overlaps Q3 and Q2 depositional units. Unit Q5 represents modern shelf shoal deposits.

7. GEOPHYSICAL SURVEY RESULTS

7.1 Introduction

The following results describe the findings of the bathymetric and geophysical investigation during the SAP G&G surveys conducted in June-July, 2015. Geotechnical results are presented in Appendix A of this report. Near real-time data processing was conducted on board the RV Shearwater during survey operations. During the survey, preliminary charts were generated for each geotechnical borehole location, reviewed by the on board geophysicists and geologists, and then submitted to the project archaeologist for review. Drilling operations began only after each location was reviewed and cleared of any potential hazards or cultural resources. All final data processing and analysis was completed at Alpine's office in Norwood, NJ.

7.2 Dockside Calibration

While the RV Shearwater was docked in Ocean City, MD a series of quay-side verifications were conducted. Prior to mobilizing the vessel, a local Maryland Professional Land Surveyor (PLS) established two control points along, and parallel to, the USCG dock. The two points were installed in the center of a dolphin structure located near the bow and stern of the vessel. The distance from the vessel reference point to the closest control point was measured using a survey tape and compared to the calculated position using the vessel GNSS system and navigation software (QINSy). The two control points also established a baseline to compare against the survey vessel heading. It should be noted that currents run very strong where the vessel was docked near Ocean City Inlet, as a result the axis of the RV Shearwater was rarely aligned perfectly with the quay-side structure. Before conducting the SAP survey a bar check was conducted to verify water depth measurements with the MBES system. A metal disc was lowered at a fixed and known depth along the side of the vessel near the installation point of the MBES transducer. Depths of the disc measured by the MBES system were compared against the physical depth it was lowered into the water. Results of these checks and verifications are presented in the tables below. Detailed MBES patch test and USBL calibration results are presented in Appendix E of this report.

GNSS Positioning Verification						
Control Point	Published X	Published Y	Observed X	Observed Y	Delta	Measured by Tape
Dolphin USCG Marina	492022.16	4242224.13	492010.14	4242215.72	14.68m	15.03m

Table 7.1 Vessel Positioning Verification

Vessel Heading Verification			
Control Point	Published Heading	Observed Heading	Delta
Baseline USCG Marina	205.114˚	204.089˚	1.025 ˚

Table 7.2 Vessel Heading Verification

MBES Bar check		
MBES Water Depth	Bar Checked Depth	Delta
7.0m	6.93m	0.07m

Table 7.3 Bar Check Results

7.2 Bathymetry

7.2.1 Bathymetry Processing and Analysis

The MBES data collected with the R2 Sonic system was processed using QINSy and CARIS HIPS software. Data were cleaned, tide and datum corrected and exported as a 1m binned ASCII XYZ sounding file. Electronic MBES bathymetry data are provided in Appendix J which includes an XYZ sounding file, a geo-referenced shaded relief image and backscatter data.

7.2.2 Bathymetry Results

The water depth (WD) across the SAP area varies less than 1m and ranged between 26.3m and 27.1m MLLW. In general the seafloor is relatively flat and featureless, and displays down slope gradients of 0.5˚ or less. From the MET tower location, where the WD is 27.0m MLLW, the seafloor slopes gently upward to the northwest and southeast. No apparent surface obstructions or hazards were observed in the SAP area. A bathymetry map is presented on **Chart 2** included with this report. A 1m bin size DTM (XYZ file) of the MBES data is included on a USB drive included with this report (Appendix J).

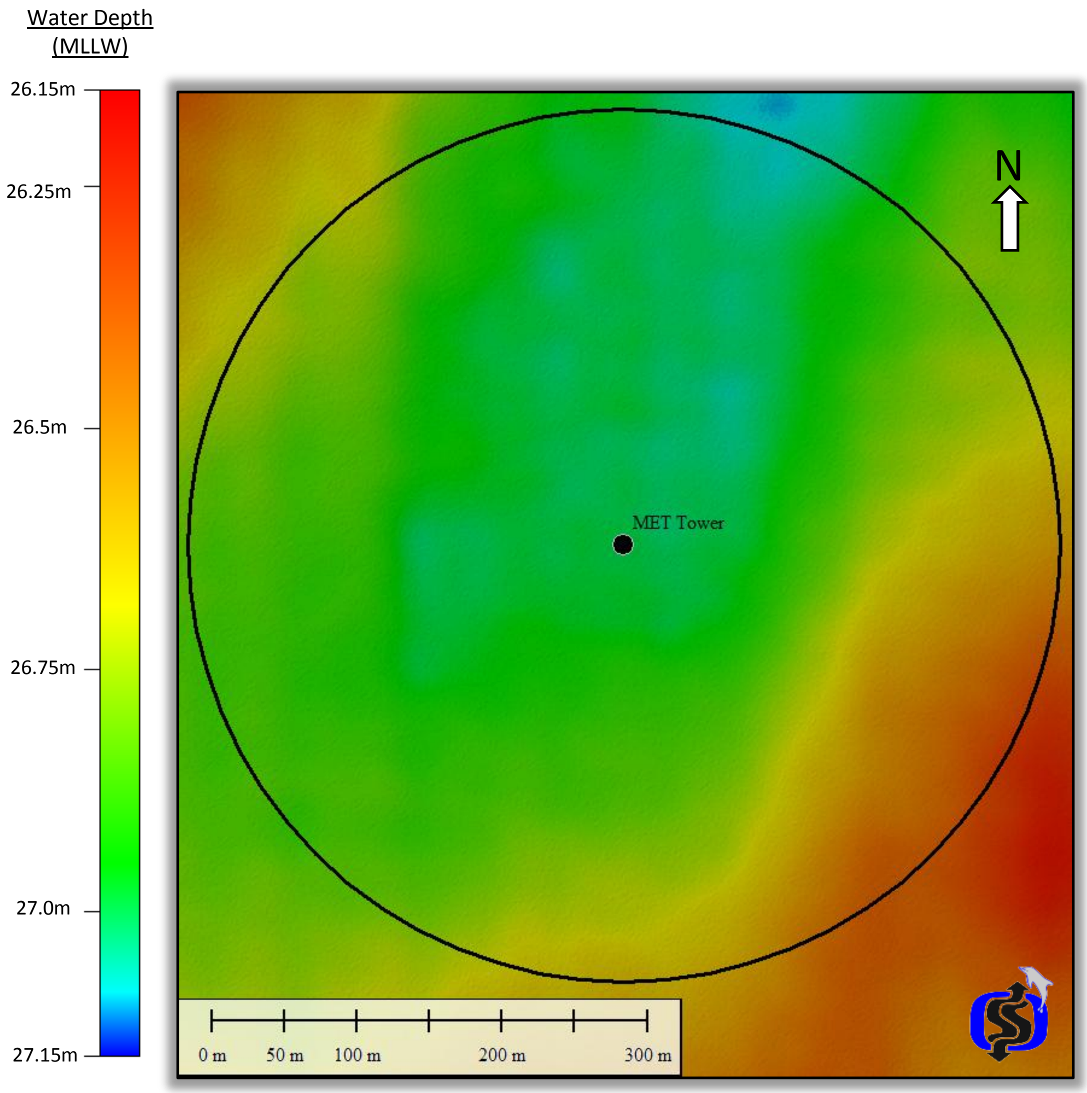

Figure 7.1 MBES Shaded Relief Bathymetry of SAP Area

7.3 Side-Scan Sonar Data

7.3.1 Side-Scan Sonar Processing and Analysis

Side-scan sonar XTF data was collected using SonarPro and imported into Chesapeake's SonarWiz processing software. SonarWiz was used to apply navigation smoothing, seafloor tracking, gain adjustments and slant range correction. A mosaic was created for each survey line file, as well as a mosaic for the overall SAP area. If identified, sonar contacts are chosen, mapped, measured and exported in a contact report. Electronic SSS deliverables are provided in Appendix J.

7.3.2 Side-Scan Sonar Discussion

Side-scan sonar data was collected on every line providing greater than 100% overlapping bottom coverage. The imagery reveal a smooth and featureless seafloor across the SAP area. Bottom reflectivity (backscatter) is light to moderate, suggestive of a seafloor composed mainly of sandy sediments. This interpretation was confirmed by ground truthing with the grab samples collected following the geophysical survey. Grab sampling recovered fine to medium sand with trace gravel in the SAP area. The entire SAP area is characterized by small bedforms, or sand ripples. The sand ripples have an average wavelength of 60cm, and an average height of 7cm. The axis of the ripples are aligned on a bearing ranging between 0˚ and 30˚ east of true north. No SSS contacts were identified in the SAP area. Interpreted seafloor features are presented on **Chart 3** included with this report. The chart includes a bottom sediment type classification, location, orientation and magnitude of sand ripples across the SAP area, magnetic anomaly locations, as well as the environmental station locations, which were investigated with grab samples and underwater camera photos and video.

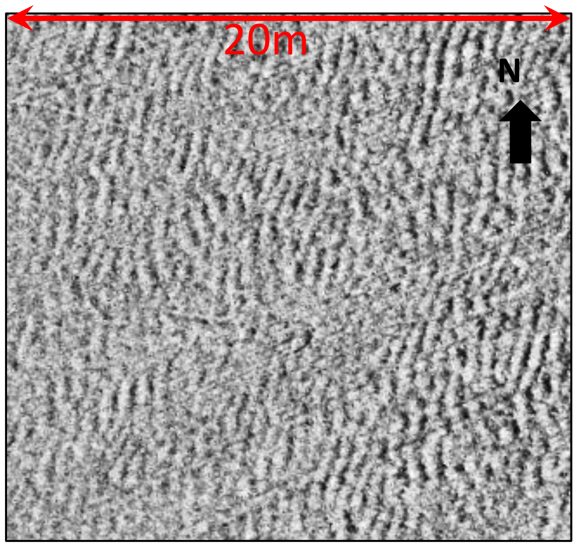

Figure 7.2 Side-scan Sonar Image Showing Sand Ripples in SAP Area

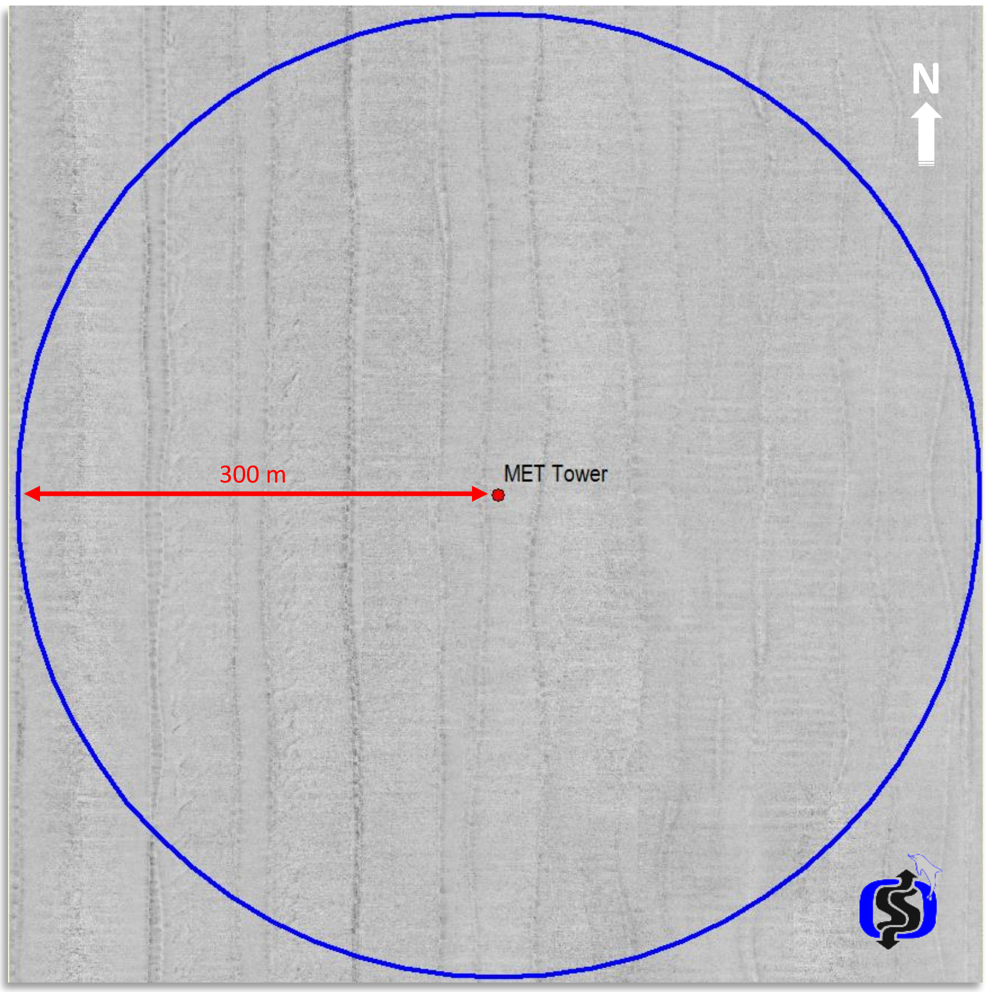

Figure 7.3 Side-scan Sonar Mosaic of SAP Area

7.4 Magnetometer Data

7.4.1 Magnetometer Processing and Analysis

Magnetometer data collected with Geometrics' MagLog software were post-processed using Geometrics' MagPick program. The data was edited for navigation fliers and data spikes before removing the regional background and diurnal variation. Due to the small size of the SAP area and short amount of time required to survey, very little temporal change was observed in the magnetometer data. Good results were achieved by using MagPick's linear transformation to remove the background and diurnal variation. The linear transformation was performed on the MAG data collected in 2013 and the current data set. After removal of the background and diurnal variation the two data sets were merged. The resultant anomaly data was gridded at a 2m cell size and exported as 10 nT contours, and as color shaded geo-referenced image. Magnetic anomalies were also picked and exported in a tabular format. Electronic MAG deliverables are provided in Appendix J.

7.4.2 Magnetometer Data Discussion

After reviewing the processed MAG data set for the SAP area it is apparent that there are no large magnetic anomalies in the MET tower site. A total of nine anomalies were detected in the SAP area, however none exceeded 21 nT in amplitude. The MAG sensor was flown less than 6m above the bottom throughout the entire SAP area, suggesting the detected anomalies represent features with small ferrous masses. The absence of sonar contacts in the area also suggests the features may be buried in the shallow sub-surface. Magnetic anomaly locations are shown on **Chart 3** Seafloor Features, and also in tabular format in Appendix C. A Magnetic Contour map is presented on **Chart 4**.

It should be noted that the coastal and OCS regional magnetic environment offshore Maryland is characterized by a strong geologic influence. The measured magnetic signal is very sensitive to sensor height off the bottom. Sea swell heights throughout the survey were commonly 1m or more, with heave motion experienced by the vessel being induced to the trailing towfish. These swell induced movements of +/- 1m translated to approximately 5 nT of flux in the readings. This phenomena has been observed by Alpine on previous survey projects offshore Maryland. It was also observed in the 2013 survey data provided to the MEA. This effect is exaggerated during poorer weather conditions, and is less pronounced during fair weather and calm seas.

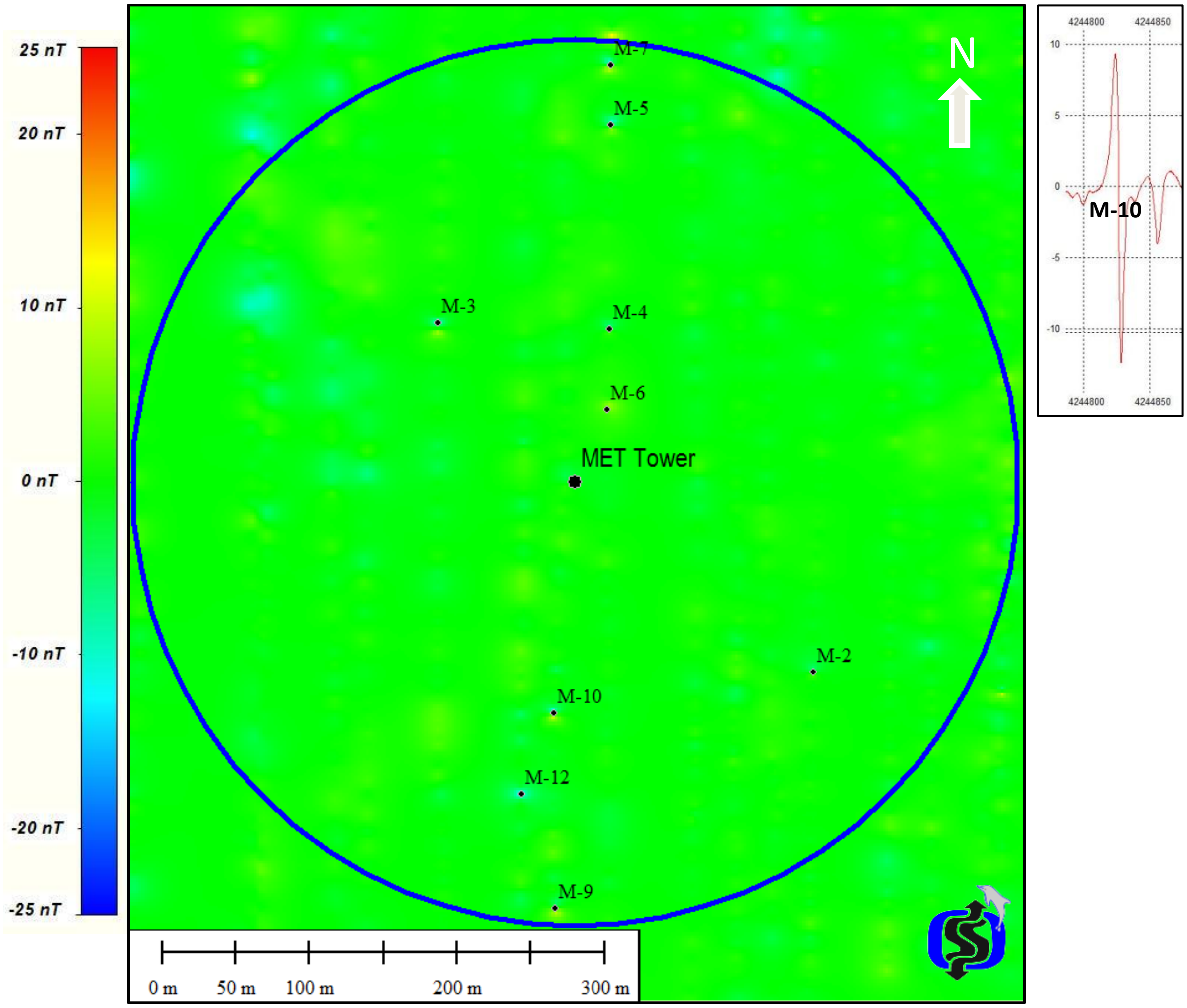

Figure 7.4 Magnetic Anomaly Map of the SAP Area

7.5 Shallow Penetration Sub-bottom Profile Data

7.5.1 Shallow Sub-bottom Data Processing and Analysis

Sub-bottom profile data collected with the CHIRP III system was processed in Chesapeake's SonarWiz software program. Each profile was bottom tracked and applied with a time varying gain. Any significant reflectors identified were mapped and exported as an ASCII XYZ thickness, or Isopach file. This thickness file was merged with the data provided to Alpine from the MEA survey in 2013, and then contoured at a 0.5m interval. The contoured isopach data was then integrated with acquired multibeam bathymetry to produce a shallow structure map in reference to MLLW. The shallow structure map can be seen in **Chart 6.** Electronic sub-bottom deliverables are provided in Appendix J.

7.5.2 Shallow Sub-bottom Discussion

Sub-bottom penetration with the CHIRP system was restricted to approximately 6m below the seafloor in the SAP area, however a wide-spread sub-parallel reflector was identified and mapped in the upper 0.5 to 2.5m of the seafloor. This reflector is interpreted as a shoreline representing an erosional boundary between late Pleistocene and early Holocene sediments. The shoreline mapped with the CHIRP system correlates to the A1 reflector described in Section 6.0 above, described as the boundary between the ravinement surface formed by shoreface erosion and modern shelf deposits (Wells, 1994). This surface also correlates to the base of Unit 1 as mapped by the 2013 MEA survey conducted by Coastal Planning & Engineering (CP&E). Similar to the survey conducted in 2013, CHIRP sub-bottom collected by Alpine in the SAP area detected two sub-surface units. Unit 1 is a thin surficial sheet of Holocene sandy marine sediments, ranging in thickness between 0.5m and 2.5m across the SAP area. In the SAP the CHIRP system was capable of penetrating only into the upper few meters of Unit 2, or channel complex as described during the previous survey. In other areas of the survey beyond the limits of the SAP area, the CHIRP system identified many buried channel features in this unit.

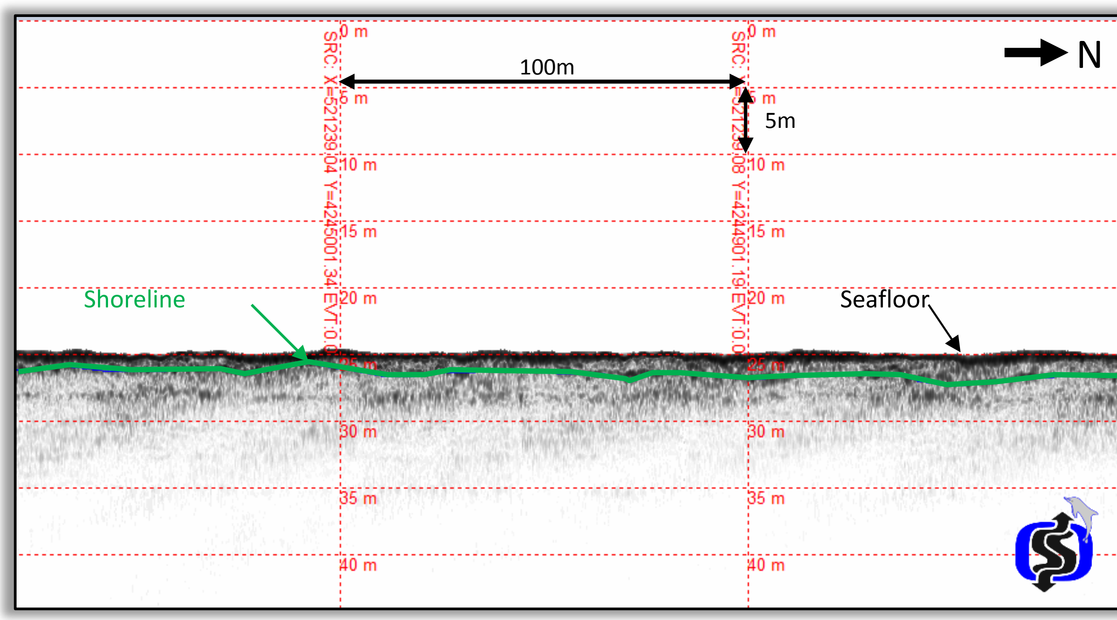

Figure 7.5 CHIRP Sub-bottom Profile Showing Shoreline

7.6 Borehole and CPT Data

During the SAP survey of the Maryland WEA a composite geotechnical Borehole and CPT push was conducted at the MET tower location. A full geotechnical report including borehole logs and photographs are presented in Appendix A of this report. Near surface borehole information was compared to the CHIRP sub-bottom data collected over the MET tower location. The shoreline surface mapped in the sub-bottom data correlates well to a thin gravel layer overlying a clay laminae at approximately 1m below the seafloor. Geotechnical results correlate well to the medium penetration sub-bottom data collected near the MET tower location during the 2013 CP&E survey. Three units were identified in the geophysical data along Line 91, approximately 50m east of the MET tower location.

- Unit 1 – Recent Holocene sandy sediments
- Unit 2 – Pleistocene channel complex
- Unit 3 – Pre-Pleistocene sub-parallel sands and clays

A detailed comparison between geotechnical data at the MET tower and the medium penetration sub-bottom data collected by CP&E is presented in Appendix A.

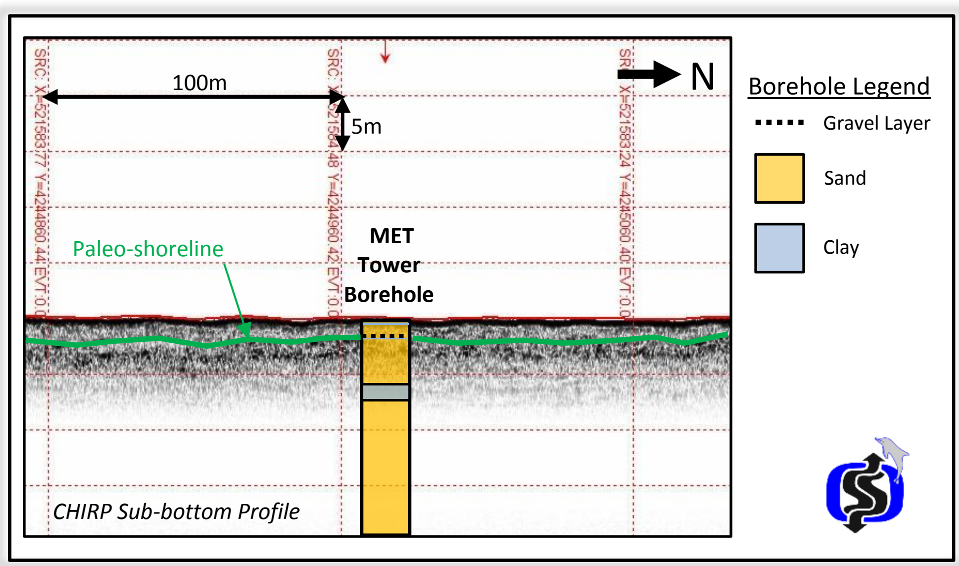

Figure 7.6 CHIRP Sub-bottom Profile with Generalized Boring Overlay

8. HAZARDS SUMMARY

8.1 Seafloor Hazards

The G&G data sets were reviewed and analyzed for potential seafloor hazards that may adversely impact installation and maintenance of the proposed MET tower facility. Following this review no significant hazards were identified on the seafloor within the SAP area. Table 7.1 below summarizes some of the common seafloor hazards and whether they were identified within the SAP area.

Hazard	Identification/Description
Steep Seafloor Slopes	Not present
Sediment Failure / Mass Movement	Not present
Bedforms	Present throughout the SAP area in the form of sand ripples. Wavelengths and ripple heights are centimeter level in scale and do not pose a risk to MET tower installation or operation.
Rock or Hard-bottom	Not present
Diapiric Structures	Not present
Faulting	Not present
Gas or Fluid Expulsion	Not present
Water Scour	Not present
Channels	Not present

Table 7.1 Seafloor Hazards

8.2 Sub-surface Hazards

A review and analysis of the sub-bottom profiler and borehole data was also conducted to identify possible hazards in the SAP area sub-surface. The table below presents typical sub-surface hazards, however none were identified in the SAP area.

Hazard	Identification/Description
Faults	Not present
Sediment Failure / Mass Movement	Not present
Shallow Rock	Not present
Diapiric Structures	Not present
Shallow Gas	Not present
Gas or Fluid Expulsion	Not present
Channels	Not present
Seismic Activity	Not present
Volcanic Activity	Not present

Table 7.2 Sub-surface Hazards

8.2 Man-made Hazards

All data sets were reviewed for potential anthropogenic, or “man-made” hazards. The table presented below lists typical man-made hazards in the marine environment and if they occur within the SAP area. The US Wind SAP area does lie within the FACSFAC VACAPES Operating Area operated by the US Navy and accessible by the entire US military. The entire Maryland WEA is located in Warning Area 386 which is a special-use airspace. Military operations are known to occur within W-386 including flight testing, munitions deployment and general training exercises. While no obvious features were observed lying on the seafloor, there is a potential for shallow buried unexploded ordnance (UXO) in the area.

Hazard	Identification/Description
Shipwrecks	Not present
Debris	Not present
Cables	Not present
Pipelines	Not present
Ordnance	Possible throughout SAP area due to active present and past military use in W-386 area. Several minor magnetic anomalies were identified with potential to be related to shallow buried UXO.
Cultural Resources	None identified, to be confirmed by Professional Archaeologist

Table 8.1 Man-made Hazards

9. REFERENCES

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APPENDICES

APPENDIX A GEOTECHNICAL REPORT

APPENDIX B PROTECTED SPECIES OBSERVER REPORTS

APPENDIX C MAGNETIC ANOMALY TABLE

MET Tower Magnetic Anomaly Table

				WGS 84		UTM Zone 18N meters							
ID	Area	Line	Event	Lat	Lon	X	Y	Amplitude (nT)	Width (m)	Signature	Altitude (m)	Assoc. Sonar contact	Identification
2	MET Tower	204	56614	38.351585	74.751701	521695.5	4244854.4	8	1	D	5	N/A	Possible small buried objects
3	MET Tower	197	1318	38.353722	74.754599	521441.7	4245090.9	14	11	+M	3	N/A	Possible small buried objects
4	MET Tower	200	1545	38.353685	74.753276	521557.3	4245087.1	9	1	D	4	N/A	Possible small buried objects
5	MET Tower	200	1546	38.354930	74.753259	521558.4	4245225.2	17	3	D	4	N/A	Possible small buried objects
6	MET Tower	200	1544	38.353190	74.753290	521556.2	4245032.2	13	8	D	4	N/A	Possible small buried objects
7	MET Tower	200	1547	38.355293	74.753260	521558.2	4245265.5	21	2	D	4	N/A	Possible small buried objects
9	MET Tower	199	1941	38.350150	74.753708	521520.6	4244694.7	14	6	D	4	N/A	Possible small buried objects
10	MET Tower	199	1542	38.351344	74.753715	521519.6	4244827.2	21	1	D	4	N/A	Possible small buried objects
12	MET Tower	198	2359	38.350849	74.753969	521497.6	4244772.2	13	4	-M	4	N/A	Possible small buried objects

APPENDIX D EQUIPMENT SPECIFICATION SHEETS

POS MV™ marine vessels

DATASHEET

POS MV - Providing the Marine Industry with robust, reliable, and repeatable position and orientation solutions

The new POS MV - a tightly-coupled system utilizing advanced Inertially-Aided Real-Time Kinematic (IARTK) technology designed to increase your operational capability and reduce downtime.

Tightly integrated inertial navigation – Continuous positioning data can be generated while surveying in areas where GPS reception is compromised by multipath effect and signal loss, such as close to offshore structures, or in ports, harbors, near-shore coastal waters and rivers. Raw GPS data from as few as one satellite can now be processed directly within the POS MV reducing position drift and RTK re-acquisition time.

The POS MV Advantage

The Major Benefits

- Faster, more robust heading aiding from GPS Azimuth Measurement Subsystem (GAMS) when compared to V3
- Proprietary Inertially Aided RTK providing almost instantaneous reacquisition of RTK following a GPS outage
- Superior low elevation tracking performance using lighter, smaller Trimble Zephyr ™ geodetic antenna technology
- Faster initial system calibration
- Maintains heading accuracy longer when in a high multipath environment
- Increased component reliability
- Automatic identification and error estimation for lever arm distances and angles

The Latest Technology

POS MV uses the latest Trimble BD950 receivers with the following attributes:

- Extremely fast response time
- Latency of less than 20 milliseconds (at 20 times per second)
- Very low noise L1 and L2 carrier phase measurements
- Uses the Maxwell 4 Custom Survey GPS chip for enhanced tracking capability

Straightforward Installation and Operation

- All components mounted and installed using a straightforward, one-time-only, systematic procedure.

Faster, More Reliable Networking Potential

- An improved Ethernet raw data logging capability for streamlined data acquisition of all motion variables with microsecond-accurate time stamping

Upgradeability*

- Convenient upgrade program for PCS and antennas, to allow for maximum interoperability when moving from L1 only to a full L1/L2 RTK unit

The Most Accurate Position and Orientation Solution

POS MV maintains positioning accuracy under the most demanding conditions regardless of vessel dynamics. With its high data update rate, the system delivers a full six degree-of-freedom position and orientation solution to provide the following:

- Position (latitude, longitude and elevation)
- Velocity (north, east and vertical)
- Attitude (roll, pitch and true heading)
- Heave (real-time, delayed)
- Acceleration Vectors
- Angular Rate Vectors

** For detailed upgrade information please call your Applanix Marine office*

POS MV now has a 2 Year Warranty

SYSTEM COMPONENTS

POS Computer System (PCS) – A rugged, compact computer system contains the core POS processor and IMU interface electronics, plus two GPS receivers and an optional removable PC-card disk drive. The PCS provides system timing, position and velocity aiding, together with GPS raw observables for use with GAMS.

POS Inertial Measurement Unit – The system's primary sensor allows for the continuous output of position and orientation data.

Primary GPS Receiver Antenna – A dual frequency antenna for use with GAMS.

Secondary GPS Receiver Antenna – A dual frequency antenna for use with GAMS.

APPLANIX
A TRIMBLE COMPANY

POS MV™ marine vessels

SPECIFICATIONS

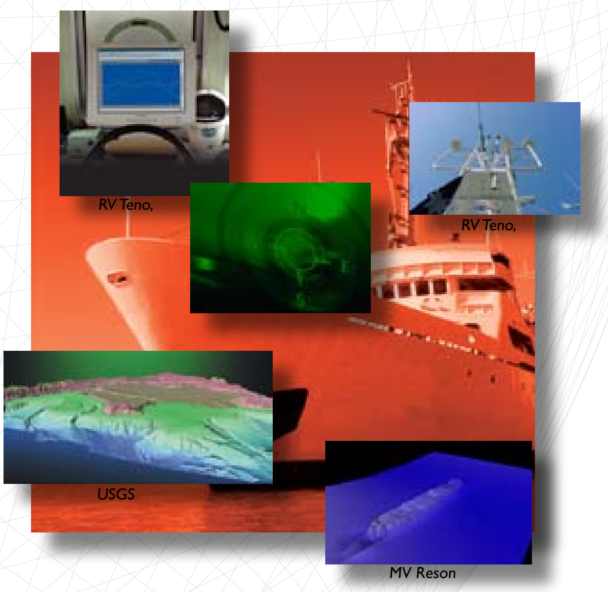
Accuracy

POS MV 320 Main Specifications (with Differential Corrections)

Roll, Pitch accuracy:	0.02° (1 sigma with GPS or DGPS)
	0.01° (1 sigma with RTK)
Heave Accuracy:	5 cm or 5% (whichever is greater) for periods of 20 seconds or less
Heading Accuracy:	0.02° (1 sigma) with 2 m antenna baseline, 0.01 (1 sigma) with 4 m baseline
Position Accuracy:	0.5 - 2 m (1 sigma) depending on quality of differential corrections
	0.02 - 0.10 m (RTK) with input from auxiliary RTK or optional internal RTK receiver
Velocity Accuracy:	0.03 m/s horizontal

POS MV 320 during GPS Outages

Roll, Pitch accuracy:	0.02° (1 sigma)
Heave accuracy:	5 cm or 5% (whichever is greater) for wave periods of 18s or less
Heading accuracy:	Drift less than 1° per hour (negligible for outages < 60s)
Position accuracy degradation:	2.5 m (1 sigma) for 30 s outages <6 m (1 sigma) for 60 s outages



Images courtesy from clockwise RV Teno, MV Reson and the USGS,

Physical Characteristics

Size

IMU:	204 mm X 204 mm X 168 mm	7.95 in X 7.95 in X 6.55 in
PCS:	432 mm X 89 mm X 356 mm	17.00 in X3.50 in X 14.05 in
	2.0U 19 in rack mount	
GPS Antenna (x2):	187 mm X 53 mm	7.4 in X 2.1 in

Weight

IMU:	3.5 kg	7.7 lb (international)
Processor:	5 kg	11.0 lb (international)
GPS Antenna:	<0.5 kg	<1.1 lb (international)

Power

Processor:	110/230 Vac, 50/60 Hz, auto-switching 80 Watt
IMU:	Power provided by PCS
GPS Antennas:	Power provided by PCS

Environmental

Temperature Range (Operating)

IMU:	-40 °C to +60 °C	-40 °F to +140 °F
Processor:	0 °C to +55 °C	+32 °F to +131 °F
GPS Antenna:	-40 °C to +70 °C	-40 °F to +158 °F

Temperature Range (storage)

IMU:	-40 °C to +60 °C	-40 °F to +140 °F
Processor:	-25 °C to +85 °C	-13 °F to +185 °F
GPS Antenna:	-50 °C to +70 °C	-58 °F to +158 °F

Humidity

IMU:	10 - 80% RH, Ingress Protection of 65
Processor:	10 - 80% RH, non-condensing
GPS Antenna:	0 - 100% RH

Shock & Vibration (IMU)

Operating:	90 g, 6 ms terminal saw tooth
Non-Operating:	220 g, 5 ms half-sine

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QINSy

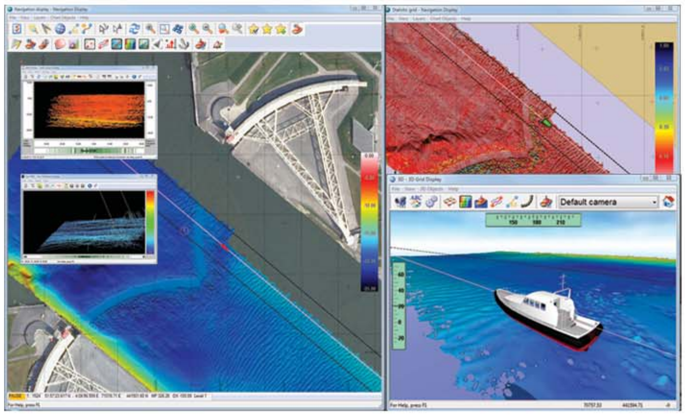
Total hydrographic solution

In a world where everything seems to get faster and bigger, software needs to be even better. The ideal software package needs to be as flexible as the people who use it, and most importantly it must be easy to operate. QINSy provides a total hydrographic solution to serve the small as a well as the large survey companies.
Its modular design and inherent flexibility makes QINSy perfect for a wide variety of applications.

- Inland Surveys
- Hydrographic & Oceanographic Surveys
- Laser Scanning for Land & Maritime applications
- Complete offshore construction and survey applications
- Barge, Tug and Fleet Management
- Dredging Monitoring & Navigation
- Electronic Navigation Chart production

Since its launch in 1996, QINSy has become the standard in marine surveying, bathymetric chart and ENC production.

For this purpose QINSy makes use of a "project template" database which contains all survey configuration parameters relevant to the project. QINSy supports most of the world's datums and projections, multiple units and geoidal models used world-wide. The project template also contains vessel shapes, administrative information, as well as vessel offsets and I/O parameters.
Using real-time depth measurements, sound velocity profiles, tide levels, RTK heights etc. QINSy calculates the final foot print positions on-the-fly and visualizes these on various displays.



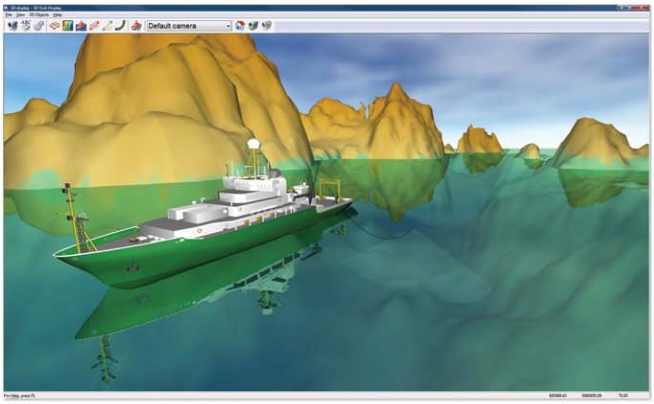
Typical QINSy displays

Real-time DTM production is the dream of every surveyor. In QINSy all computations are performed in 3D. Together with accurate RTK heights or real-time tide gauges, all depth observations are immediately available in absolute survey coordinates. This unique technique is called 'on-the-fly DTM production'.

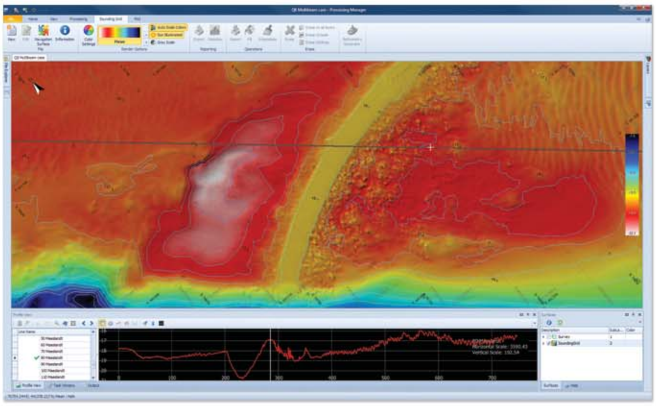
Accurate timing is imperative in the survey industry. QINSy uses a sophisticated timing routine based on the PPS option from the GNSS receiver. All incoming and outgoing data is accurately stamped with a UTC time label. Internally QINSy uses 'observation ring buffers' so that data values can be 'placed' for the exact moment of an event or ping. This combination gives QINSy a proven accuracy of 1 msec.

Online Data Acquisition

- Real-time calculation of footprint positions and on-the-fly DTM production.
- Accurate Timing: Combination of ring buffers and PPS gives QINSy a proven accuracy of 1 msec.
- Storage of Raw sensor data enables total replay of performed survey in the office with different settings.
- Total Propagated Uncertainty (error budget) calculation in real-time which can be used for on-line data clipping.
- Multi-layer sounding grid used for on-line visualization of on the fly DTM, SSS draping, layer differences etc.
- Support for Anchor handling & Tug management.
- Advanced Dredging functionality.
- Multiple ROV positioning & monitoring.
- Side Scan Sonar support for targeting and mosaicking.
- Great flexibility in sensor support which ensures interfacing of almost all sensors.
- Survey planning tool enables you to prepare your project in the office.
- Visualization of project using powerful 2D and 3D visualization techniques together with flexible user defined information displays.
- Ocean Bottom Cable & 2D seismic support.



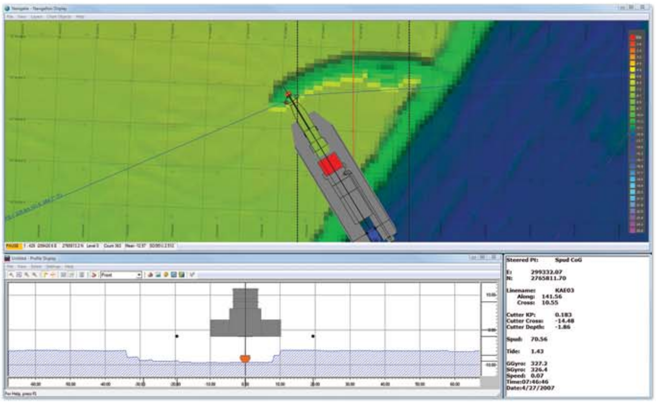
3D View



Processing Manager

Post Processing

- Powerful Data Processing & Validation techniques
- Export to all popular formats and more.
- Sound velocity manager which enables time & spatial processing of SVP casts.
- Plotting of engineering charts with bathymetric data, cross and long profiles.
- Different volume calculation methods.
- S-57 ENC production, both file based and spatial database solutions, incl. notice to mariners, updates.
- S-57 ENC distribution.



Advanced Dredging functionality

Qloud

- Fast area based data cleaning tool.
- Ideal for processing of large multibeam data sets.
- Reliable automatic cleaning methods.
- Manual data clipping.
- Easy to search for problems in the bathymetric data using statistical information.
- Combination of sounding grid and DTM points.
- CUBE support.
- 3D spot sounding generation.
- TIN reduction.

Sonardyne
SOUND IN DEPTH

Coastal Systems Product Guide

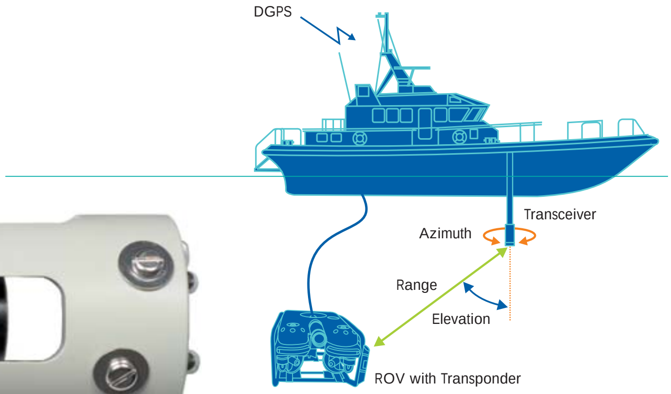
Underwater Positioning, Navigation and Relocation Systems

Scout USBL
Subsea Positioning System

ROV and Towfish Installation
Coastal transponders are compact and rugged and can be installed directly onto ROVs or small towfish attached to the umbilical

Lightweight Release Transponder
The LRT is a versatile acoustic release transponder with a Safe Working Load (SWL) of 125kg

USBL Positioning
The Scout USBL system calculates the position of a target by measuring the range and bearing of a transponder from the vessel



Introduction

Scout USBL is a complete vessel based subsea positioning system for divers, ROVs and towfish.

Scout calculates the position of a subsea target by measuring the range and bearing from a vessel mounted transceiver to a small acoustic transponder fitted to the target; a technique known as Ultra-Short BaseLine (USBL) positioning. USBL positioning is widely used by the offshore and oceanographic industries as it offers high accuracy performance combined with ease of operation.

One of the main advantages of the technique is that no other in-water acoustic equipment has to be deployed before underwater operations can commence. Only the targets being tracked need to be equipped with a transponder. With Scout, a support boat can arrive on location and begin tracking straight away. This has particular benefits for search and salvage applications when search times are critical.

Key Features

- Easy to install and use
- Affordable and high accuracy
- All sensors, software and hardware provided
- 1,000 metre design slant range
- Upgrade path to deep water USBL systems

Scout, Scout Plus and Scout Pro

Three versions of Scout are available: Scout, Scout Plus and Scout Pro.

Scout and Scout Plus are entry level systems designed for general target tracking applications at ranges up to 500 metres. Scout can track one surface vessel and four subsea targets whilst Scout Plus can track six targets and incorporates a responder mode for fast position updates of ROVs and towfish. With both systems, all sensors and hardware are provided whilst the software is simple to learn and intuitive to use. These features make Scout and Scout Plus the ideal solution for users with little or no prior experience of acoustic systems.

Scout Pro is designed to support complex contruction survey applications through its fully featured software. It provides greater accuracy, tracking for up to 10 subsea targets and a 1,000 metre design slant range.

The advanced topside control hardware supplied with Scout Pro systems enables experienced users to operate using Sonardyne's latest Wideband signalling technology and its associated benefits that include greater immunity to noise and a ten fold improvement in measurement repeatability.

This same topside unit can also be used with Sonardyne Ranger USBL, Fusion USBL and Fusion Long BaseLine (LBL) equipment therefore providing a cost effective and versatile upgrade solution for full ocean depth subsea operations.

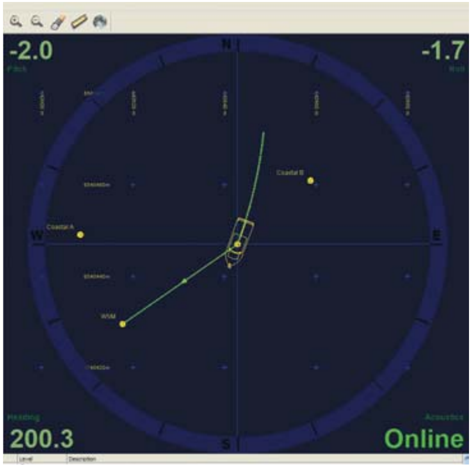
Scout USBL
System Overview

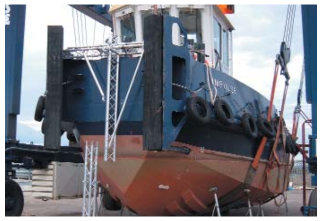
Scout Software Display
Scout's 'Simple' UI software is easy and intuitive to use and requires minimal user training

Scout Transceiver
Scout transceivers are small, easy to deploy and incorprate an internal heading, ptich and roll sensor

Surface Interface Unit
The SIU provides power and communications to the transceiver
Surface Command Unit
The SCU is a self contained PC, display and interface unit for operating Scout and Scout Plus from any type of vessel

Transceiver Deployment
For temporary vessel installations, a dedicated lightweight deployment pole is available from Sonardyne





System Overview

A Scout USBL system is comprised of four main components: control software, vessel based interface unit, acoustic transceiver and transponders.

Software

Scout and Scout Plus software is easy to use and intuitive to operate. It is designed to appeal to users who wish to arrive on location and begin tracking a target immediately.

Scout Pro software shares a common look and feel with Sonardyne's Fusion and Ranger systems and offers users a complete range of survey tools. These include: chart backdrops, industry standard output telegrams and configurable sensor displays.

Interface Unit

As standard, Scout and Scout Plus systems are supplied with a rack-mountable Surface Interface Unit (SIU) that supplies power and communications to the transceiver and is connected to the user's own computer via a serial or USB link.

For complete portability, the optional Surface Command Unit (SCU) enables Scout and Scout Plus to be operated from almost any size of boat. It comprises a PC, high brightness TFT display, sensor interface and rechargeable battery incorporated in an splashproof case.

Scout Pro systems are supplied with a Navigation Controller Unit (NCU). In addition to accurately time stamping incoming data from external devices such as GPS, Gyro and VRU's, the NCU also provides power and communications for the vessel's USBL transceiver.

Transceiver

The Scout transceiver provides a hemispherical pattern of acoustic coverage enabling tracking of targets from far below through to near surface. For this reason, it is suitable for a wide variety of tasks such as towfish tracking.

The compact design of the transceiver makes it easy to install on a simple over-the-side mount or through a gate valve. Sonardyne can supply an easy-to-assemble pole, complete with fittings and advice on installation, if required. Options include a water block protection device and tilted transducer array.

To simplify set-up, an integrated motion sensor automatically compensates for the dynamic motion of the vessel. For higher accuracy applications, external reference sensors can be used with Scout Plus and Scout Pro.

Transponders

Scout USBL is compatible with the Sonardyne's family of low cost HF frequency transponders. Scout Plus and Scout Pro both offer additional compability with the advanced Wideband Sub-Mini (WSM) transponder.

All transponders have been designed for applications where size and weight are important operational factors, such as installation on the back of a diver or ROV. For more information on transponders, turn to Pages 14 and 15.

Scout USBL
System Specifications

System Performance

General	
Design slant Range	500 metres (Scout, Scout Plus) 1,000 metres (Scout Pro)
Acoustic Coverage	±90° below transceiver
Accuracy	±2.75% of Slant Range (With internal Heading and Attitude sensor) ±0.5% of Slant Range (With external VRU and Gyro)
Tracking	Supports tracking of one surface vessel and multiple subsea targets

Transceiver

Type Number	8024
Operating Frequency	Sonardyne HF (35-55kHz)
Sensors	Heading and Attitude
Options	Tilted Array
Deployment Method	Through-hull or Over-the-Side
Mechanical Construction	Aluminium Bronze, Powder Coated
Dimensions – Without Guard (LxDia)	489mm (19.25") x 160mm (6.3")
Weight in Air	18.9kg
Weight in Water	8.9kg

Surface Command Unit (SCU)

Type Number	8039
Processor	Pentium M
Operating System	Windows XP Professional
RAM	512Mb
Hard Disk	40Gb
Ports (Front Panel)	4 x Serial Ports, 1 x USB 2.0
External Inputs	Transceiver, Responder Trigger, GPS Antenna (Optional)
Battery	Internal Li-Ion (UN Transport Approved)
Typical Battery Life	1-2 hours
Power Supply	12-16V DC
Display Panel	12.1” TFT, 1024 x 768
IP Rating	IP65
Dimensions (LxWxH)	444.5mm (17.5”) x 305mm (12”) x 178mm (7”)
Weight	10kg

Surface Interface Unit (SIU)

Type Number	8038
Ports	4 x Serial Ports, 1 x USB 2.0
External Inputs	Transceiver, Power, Responder Trigger
Power Supply	110 / 230V AC
Dimensions (LxWxH)	432mm (17”) x 305mm (12”) x 51mm (2”)
Weight	3kg

Navigation Controller Unit (NCU)

See separate datasheet for full specifications

Transponders
Coastal, LRT, LAT and WSM

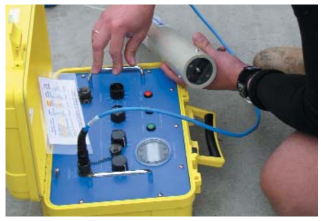
Coastal Transponder
The Coastal transponder is a low cost and versatile transponder suitable for a wide range of shallow water subsea applications

Lightweight Release Transponder (LRT)
The LRT is a combined positioning and acoustic release transponder depth rated to 500 metres

LRT with optional Rope Canister
The LRT Rope Canister is packed with 75 metres of high strength rope to allow seabed items to be pulled up

Screw-off Release
The LRT features a highly reliable screw-off release mechanism

Deck Unit
Testing an LRT on the back deck prior to deployment



Coastal Transponder

The Coastal transponder has been designed for very low cost applications where size and weight are important operational factors. It's the ideal choice for attaching to towfish, underwater structures, diving bells and instrumentation packages so that they can be tracked or relocated using any of the Coastal tracking and relocation product range.

Key Features

- Versatile, low cost transponder
- Depth rated to 500 metres
- Compact and rugged design
- Alkaline battery packs give up to 18 months listening life
- Compatible with AODC emergency channels

Lightweight Release Transponder (LRT)

The LRT is similar to a Coastal transponder but incorporates an acoustic release mechanism for added flexibility. This allows the transponder to be deployed on the seabed with a sinker weight to hold it down and a buoy to keep it upright.

By sending a command from the surface, the transponder releases the sinker weight and floats to the surface for recovery.

Key Features

- 125kg Safe Working Load
- Depth rated to 500 metres
- Up to 4 years listening life with lithium battery pack
- Thousands of secure identities
- Reliable, screw-off release
- Optional 75 metre rope canister

The unique design of the screw-off mechanism ensures a positive release action that overcomes any biological growth.

Unlike similar low cost release transponders, the LRT has both receive and transmit functions, enabling accurate slant ranges to be measured, release actuation to be confirmed and position to be determined.

LRT Rope Canister

An optional attachment for the LRT is a rope canister that allows items left on the seabed, for example, tools, cables and salvage, to be quickly and easily hauled up.

It works by mooring one end of the rope to the item on the seabed and the other end to the LRT via the attached canister of rope. As the transponder ascends to the surface, high strength rope is deployed from the canister. This line can then be used to pull up the item directly or retrieve heavier tag lines.

Remote Actuation
Activating the inflation of a buoyancy bag is just one use for a Lightweight Actuation Transponder

Lightweight Actuation Transponder (LAT)
LATs provide wireless control of subsea devices. Its signal output can be configured to suit customer electronics

Wideband Sub-Mini (WSM)
The WSM is Sonardyne's new sub-mini transponder and incorporates the latest Wideband acoustic signalling technology

Lightweight Actuation Transponder (LAT)

The Lightweight Actuation Transponder (LAT) provides a simple yet reliable way of controlling subsea electrical equipment wirelessly. Applications for the LAT include activating the inflation of buoyancy bags and opening or closing valves. The output from an LAT can be configured to provide multi-width and multi-pulse electrical outputs to suit a wide range of requirements. The LAT can also be interrogated from the surface to determine its position on the seabed and provide confirmation of electrical activation.

Key Features

- Commands and controls subsea devices
- Configurable signal output
- Robust underwater connector
- Depth rated to 500 metres
- Long battery life

Transponder Deck Unit

Coastal, LRT and LAT transponders are commanded using a small deck unit and dunking transducer. The unit is used initially to program the acoustic identity of the transponder, test it and load the release prior to deployment. Once deployed, it can be used to measure ranges to the transponder to relocate it and in the case of an LRT, send release commands. The deck unit can also be controlled via RS232 enabling raw range data to be logged to PC.

Deep Marker Transponder

The Deep Marker Transponder is a deep rated version of the Coastal transponder. The unit has been primarily designed for use with Sonardyne's ROV-Homer guidance system (see Page 12) and enables underwater targets such as structures and seabed equipment to be marked and later relocated.

Deep Marker Transponders are available in 4,000 metre and 12,000 metre depth ratings.

Wideband Sub Mini

The Wideband Sub-Mini (WSM) is a new compact, rugged transponder / responder designed primarily to position ROVs, towfish and other small mobile targets. Available as a 1,000 metre rated omni-directional unit or 3,000 metre rated directional unit, WSMs have the option of a depth sensor for improved positioning accuracy.

In addition, WSMs support intelligent charging of its long-life NiMH battery, Windows-based set-up software, Sonardyne Wideband signals, tone frequencies and all HPR 300 / 400 and HiPAP® channels.

Key Features

- Depth rated up to 3,000 metres
- Transponder or Responder operating modes
- Channel selection via serial data port to PC
- On / Off switch

Transponders
Specifications

Coastal Transponder

Type Number	7815
Depth Rating	500 metres
Operating Frequency	Sonardyne HF (35-55kHz)
Transmit Source Level	184-187dB
Receive Sensitivity	105-115dB re 1µPa @ 1 metre
Number of Unique Addresses	3609 (Field programmable)
Switch On	Continuously operating (No On/Off switch)
Battery Life	Alkaline:18 months
Mechanical Construction	Plastic and Anodised Aluminium Alloy
Dimensions (LxDia)	442mm (17.4”) x 63mm (2.48”)
Weight in Air / Water	1.1kg / 0.75kg
Deck Unit	Type 7967-000-02 (Includes transducer and 10 metres of cable)

Deep Marker Transponder

Type Number	7835	Type 7835
Depth Rating	4,000 metres	12,000 metres
Operating Frequency	HF (35-55kHz)	HF (35-55kHz)
Transmit Source Level	>183dB re 1µPa @ 1 metre	>183dB re 1µPa @ 1 metre
Receive Sensitivity	<100dB re 1µPa	<100dB re 1µPa
Number of Unique Addresses	3609 (Field programmable)	3609 (Field programmable)
Switch On	Continuously operating	Continuously operating
Battery Life	Alkaline: 2 years Lithium: 3 years	Alkaline: 2 years Lithium: 3 years
Mechanical Construction	Anodised Aluminium Alloy and Stainless Steel	Titanium Grade 5
Dimensions (LxDia)	353mm (13.9”) x 64mm (2.5”)	376mm (14.45”) x 80mm (3.15”)
Weight in Air / Water	1.9kg / 1.2kg	5.5kg / 3.8kg

Wideband Sub-Mini (WSM)

Type Number	Type 8071	Type 8070
Depth Rating	1,000 metres	3,000 metres
Transducer Beamshape	Omni-Directional	Directional
Transmit Source Level: External Power: Battery – High Power: Battery – Low Power	 190dB dB re 1µPa @ 1 metre 188dB dB re 1µPa @ 1 metre 185dB dB re 1µPa @ 1 metre	 202dB dB re 1µPa @ 1 metre 199dB dB re 1µPa @ 1 metre 196dB dB re 1µPa @ 1 metre
Receive Sensitivity: High Gain Low Gain	 <100dB dB re 1µPa <110dB dB re 1µPa	 <100dB dB re 1µPa <110dB dB re 1µPa
Operating Channels	All Sonardyne Wideband/Tone HPR 300 and 400 Channels	All Sonardyne Wideband/Tone HPR 300 and 400 Channels
Power Supply	Long-Life NiMH battery or external 24V via ROV’s umbilical	Long-Life NiMH battery or external 24V via ROV’s umbilical
Depth Sensor	Yes (Optional)	Yes (Optional)
Maximum Update Period	750ms	750ms
Mating Connector	Subconn MCIL5F	Subconn MCIL5F
Mechanical Construction	Aluminium Alloy, Anodised	Aluminium Alloy, Anodised
Dimensions (LxDia)	401mm (15.8”) x 75mm (2.95”)	408mm (16.1”) x 87mm (3.42”)
Weight in Air / Water	2.7kg / 1.4kg	5.0kg / 2.6kg

SENSORS SYSTEMS SERVICES
3PS, Inc.
3 Point Solutions

Instrumented Sheave System

with

SD41 Display

20 Inch Sheave System
P/N: SYS-IS-20IN

12 Inch Sheave System
P/N: SYS-IS-842832-01

3PS, Inc. (512) 610-5200
1300 Arrow Point Drive
Cedar Park, TX 78613

email: Sales@3PSInc.com
DOC-OM-SD41-0167

Specifications

General

One 4-20 mA Sensor Input (for Tension Monitoring only)

One Payout Sensor Input

Payout Sensor may be Discrete Proximity Switches or Quadrature Sensor or Most Encoders

Status Indicated for Alarms

Four Form-C Relay Outputs for High (warning) and High-High (critical) External Alarm Monitoring

Calibration and Programming Interface on Rear Cover

Load Cell Calibration via Simulating Tension Loads or Through Applying Known Loads

Environmental

Operation Temperature: -40 to +85°C

Storage Temperature: -40 to +85°C

Reflective Style LCD Displays for Operation in Direct Sun Locations

Adjustable LCD Backlight for Night Time Operation (Red Color)

Electrical

10.5 – 28.0 VDC Power Input, Approximately 200 mA   (120 VAC Version Available)

Transient Voltage Protection

Reverse Polarity Protection

RFI Filtered

Mechanical

Outside Bezel Dimensions: 5.75” (146 mm) High, 7.63” (194 mm) Wide, 0.44” (11 mm) Deep

Panel Cutout Opening: 5.12” (130 mm) High, 7.01” (178 mm) Wide

¼” (6.4 mm) Thick Polycarbonate Lens

May be Panel Mounted, Enclosure or Bracket Mounted (NEMA4X)

High Resolution Multibeam Systems for:

Hydrography

Offshore

Dredging

Defense

Research

R2Sonic LLC
1503-A Cook Pl.
Santa Barbara
California,
USA 93117

T: 805 967 9192
F: 805 967 8611

www.r2sonic.com

SONIC 2024

Multibeam Echo Sounder

Features:

- 60kHz Wideband Signal Processing
- Focused 0.5° Beam Width
- Selectable Frequencies 200-400kHz
- Selectable Swath Sector 10° to 160°
- System Range to 500m
- Embedded Processor/Controller
- Equiangular or Equidistant Beams
- Roll Stabilization
- Rotate Swath Sector

Applications:

- Hydrographic Survey
- Offshore Site Survey
- Pre & Post Dredge Survey
- Defense & Security
- Marine Research

System Description:

The Sonic 2024 is the world's first proven wideband high resolution shallow water multibeam echo sounder. With proven results and unmatched performance, the Sonic 2024 produces reliable and remarkably clean data with maximum user flexibility through all range settings to 500m.

The unprecedented 60 kHz signal bandwidth offers twice the resolution of any other commercial sonar in both data accuracy and image. With over 20 selectable operating frequencies to chose from 200 to 400 kHz, the user has unparalleled flexibility in trading off resolution and range and controlling interference from other active acoustic systems.

In addition to selectable operating frequencies, the Sonic 2024 provides variable swath coverage selections from 10° to 160° as well as ability to rotate the swath sector. Both the frequency and swath coverage may be selected 'on-the-fly', in real-time during survey operations.

The Sonar consists of the three major components: a compact and lightweight projector, a receiver and a small dry-side Sonar Interface Module (SIM). Third party auxiliary sensors are connected to the SIM. Sonar data is tagged with GPS time.

The sonar operation is controlled from a graphical user interface on a PC or laptop which is typically equipped with navigation, data collection and storage applications software.

The operator sets the sonar parameters in the sonar control window, while depth, imagery and other sensor data are captured and displayed by the applications software.

Commands are transmitted through an Ethernet interface to the Sonar Interface Module. The Sonar Interface Module supplies power to the sonar heads, synchronizes multiple heads, time tags sensor data, and relays data to the applications workstation and commands to the sonar head. The receiver head decodes the sonar commands, triggers the transmit pulse, receives, amplifies, beamforms, bottom detects, packages and transmits the data through the Sonar Interface Module via Ethernet to the control PC.

The compact size, low weight, low power consumption of 50W and elimination of separate topside processors make Sonic 2024 *very well suited* for small survey vessel or ROV/AUV operations.

Sonic 2024 Multi Beam Echo Sounder

Systems Specification:

Frequency	200kHz-400kHz
Beamwidth, across track	0.5°
Beamwidth, along track	1.0°
Number of beams	256
Swath sector	Up to 160°
Max Range	500m
Pulse Length	10µs-500µs
Pulse Type	Shaped CW
Ping Rate	Up to 60 Hz
Depth rating	100m
Operating Temperature	0°C to 50°C
Storage Temperature	-30°C to 55°C

Electrical Interface

Mains	90-260 VAC, 45-65Hz
Power consumption	<50W
Uplink/Downlink:	10/100/1000Base-T Ethernet
Data interface	10/100/1000Base-T Ethernet
Sync In, Sync out	TTL
GPS	1PPS, RS-232
Auxiliary Sensors	RS-232
Deck cable length	15m

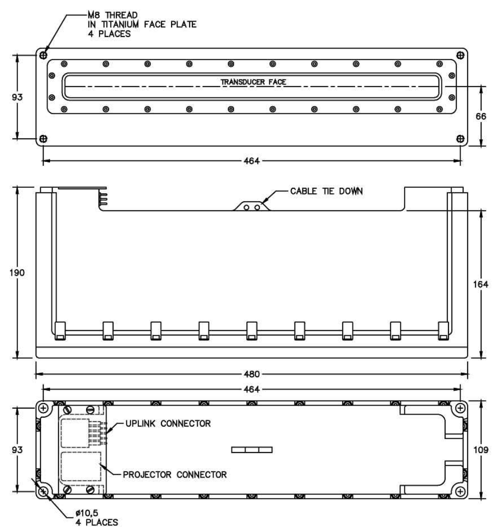
Mechanical:

Receiver Dim (LWD)	480 x 109 x 190 mm
Receiver Mass	12 kg
Projector Dim (LWD)	273 x 108 x 86 mm
Projector Mass	6 kg
Sonar Interface Module Dim (LWH)	280 x 170 x 60 mm
Sonar Interface Module Mass	2.4 kg

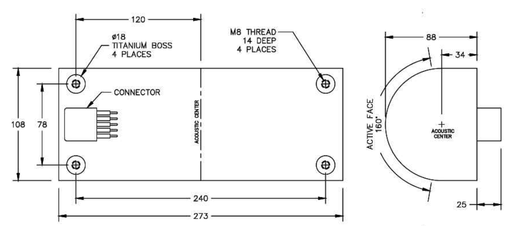
Sonar Options:

Snippets Imagery Output
Switchable Forward Looking Sonar Output
Mounting Frame & Hardware
Over-the-side Pole Mount
Sound Velocity Probe & Profiler
Extended Sonar Deck Cable, 25m or 50m
3000m Depth Immersion Depth

Sonar Interface Module



Sonic 2024 Receiver



Sonic 2022 Projector

High Resolution Multibeam Systems for:

Hydrography

Offshore

Dredging

Defense

Research

R2Sonic LLC
1503-A Cook Pl.
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California,
USA 93117

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www.r2sonic.com

MIDAS SVP Sound Velocity Profiler

The MIDAS SVP is the most accurate Sound Velocity Profiler in the world. As well as using Valeport's digital time of flight sound velocity sensor, it now comes as standard with a 0.01% pressure sensor. Every detail from the sensor accuracy through the titanium construction to the large memory and choice of communications methods has been considered - we truly believe it to be the ultimate SVP.

Sensors

The MIDAS SVP is fitted with Valeport's digital time of flight sound velocity sensor, a high accuracy temperature compensated piezo-resistive pressure transducer, and a fast response PRT temperature sensor.

Sound Velocity

Range:	1375 – 1900m/s
Resolution:	0.001m/s
Accuracy:	±0.02m/s

Temperature

Range:	-5°C to +35°C
Resolution:	0.005°C
Accuracy:	±0.01°C

Pressure

Range:	10, 50, 100, 300 or 600bar
Resolution:	0.001% range
Accuracy:	±0.01% range

Data Acquisition

The MIDAS SVP uses the concept of distributed processing, where each sensor has its own microprocessor controlling sampling and calibration of readings. Each of these is then controlled by a central processor, which issues global commands and handles all the data. This means that all data is sampled at precisely the same instant, giving superior quality profile data.

Sampling Modes

Continuous:	Regular output from all sensors at 1, 2, 4 or 8Hz.
Burst:	Regular sampling pattern, where instrument takes a number of readings, then sleeps for a defined time.
Trip/Profile:	Data is output as a chosen parameter changes by a set value, usually Pressure for profiling.
Conditional:	Instrument sleeps until a selected parameter reaches a set value.
Delay:	Instrument sleeps until predefined start time

Communications

The instrument will operate autonomously, with setup and data extraction performed by direct communications with PC before and after deployment. It also operates in real time, with a choice of communication protocols for a variety of cable lengths, all fitted as standard and selected by pin choice on the output connector:

Standard

RS232	Up to 200m cable, direct to serial port via USB adaptor
RS485	Up to 1000m cable, addressable half duplex comms

Options

FSK	2 wire power & comms up to 6000m cable (cable dependant)
Baud Rate:	2400 - 115200 (FSK fixed at 19200, USB 460800)
Protocol:	8 data bits, 1 stop bit, No parity, No flow control

Memory

The MIDAS SVP is fitted with 16Mb solid state non-volatile FLASH memory. Total capacity depends on sampling mode; continuous & burst modes have a single time stamp at the start of the file, trip mode (profiling) stores a time stamp with each reading. A single line of SVP data uses 8 bytes, and a time stamp uses 7 bytes.

Continuous:	>2,000,000 data points
Profile:	>1,000,000 data points (>100 profiles to 6000m).

Electrical

Internal:	8 x C cells, 1.5v alkaline or 3.6v lithium
External:	9 - 30vDC
Power:	0.6W (sampling), <1mW (sleeping)
Battery Life:	<100 hours operation (alkaline) <250 hours operation (lithium)
Connector:	Subconn Titanium MCBH10F

Physical

Materials:	Titanium housing, polyurethane & carbon composite sensor components, stainless steel (316) deployment cage
Depth Rating:	6000m (may be limited by pressure sensor)
Instrument Size:	88mmØ x 665mm long
Cage Size:	750 x 140 x 120mm
Weight (in cage):	11.5kg (in air), 8.5kg (in water)
Shipping:	100 x 18 x 49cm, 24kg

Software

System is supplied with DataLog Express Windows based PC software, for instrument setup, data extraction and display. DataLog Express is license free.

Ordering

0650003-XX	MIDAS SVP Profiler, supplied with deployment cage, Subconn switch plug, 3m communications lead, USB adaptor, DataLog Express software, manual, tool kit and transit case.
Note:	XX denotes transducer range. Select from 10, 50, 100, 300 and 600bar.
0400002	16 Mbyte memory upgrade (max 64 Mbyte)
0400EA5	FSK modem adaptor
TB0400FSK	Probe board set required for FSK operation

Datasheet Reference: MIDAS SVP version 2C, June 2013

Valeport Limited, St. Peter's Quay Totnes, Devon, TQ9 5EW UK
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ECHOTRAC™ CVM

MOBILE HYDROGRAPHIC SYSTEM

- Portable carry-on case style supports a dual frequency echo sounder with optional DGPS receiver, notebook PC and bundled data acquisition software.
- Features include Ethernet LAN interface, frequency agile configurable transceivers, standard serial interfaces for data acquisition systems, motion sensors and DGPS receivers.

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

ECHOTRAC™ CVM

The rugged and weatherproof Echotrac CVM outperforms other echo sounders in its class, offering the utmost in portability without sacrificing Teledyne Odom performance standards.

With a choice of dual or single frequency operation, optional built-in DGPS and notebook PC bundled with your choice of data acquisition software, the CVM has everything you need in an echo sounder – even when portability isn't an issue.

GENERAL SPECIFICATIONS

Frequency
- High band: 100 kHz – 340 kHz
- Low band: 24 kHz – 50 kHz

Output Power
- High: 200 kHz – 350 W RMS max
- Low: 24 kHz – 420 W RMS max

Input Power
- 24 V DC (nominal) 15 watts
- 110 or 220 V AC

Resolution
- 0.01 m/0.1 ft

Accuracy
- 0.01 m / 0.10 ft +/- 0.1% of depth @ 200 kHz
- 0.10 m / 0.30 ft +/- 0.1% of depth @ 33 kHz

Depth Range
- 0.2 – 200 m/ 0.5 – 600 ft. @ 200 kHz
- 0.5 – 600 m/ 1.5 – 1968 ft. @ 200 kHz

Phasing
- Automatic scale change, 10%, 20%, 30% overlap or manual

Sound Velocity
- 1370 – 1700 m/s
- Resolution 1 m/s

Transducer Draft Setting
- 0 – 15 m (0 – 50 ft)

Depth Display
- On control PC

Clock
- Internal battery backed time, elapsed time and date clock

Annotation
- Internal – date, time, GPS position
- External – from RS232 or Ethernet

Interfaces
- 2 x RS232
- Inputs from external computer, motion sensor
- Outputs to external computer
- Ethernet interface
- Heave –TSS and sounder sentence

Blanking
- 0 to full scale

Software
- E-Chart display, control, and logging software

Help
- The function of each parameter and its minimum and maximum values can be displayed.

Environmental Operating Conditions
- 0° – 50° C, 5 – 90% relative humidity, non-condensing

Dimensions
- 55 cm W x 41.5 cm D x 21.5 cm H

Weight
- 14 kg (31 lbs)

Options
- Single or dual frequency operation
- Side scan transducer – single or dual channel side looking 200 kHz or 340 kHz for search and reconnaissance
- Built-in DGPS
- Ruggedized notebook PC bundled with data aquisition software

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

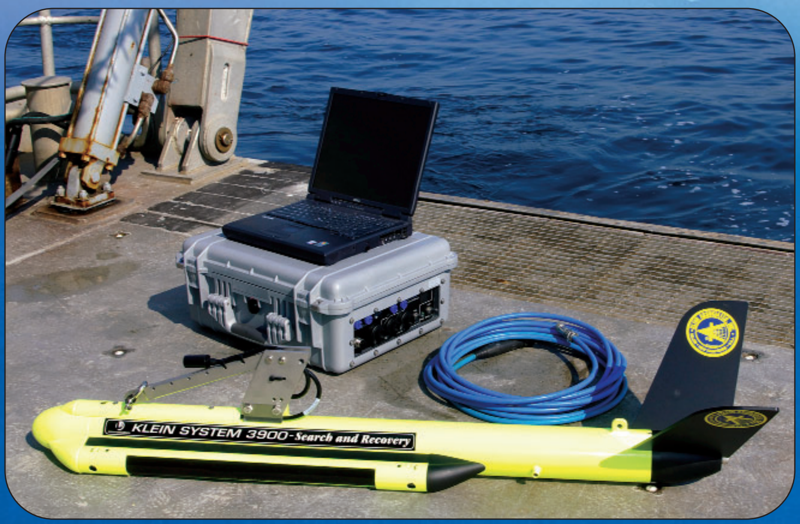
▶ See our entire product line at: **odomhydrographic.com**

1450 Seaboard Avenue ▶ Baton Rouge, Louisiana 70810-6261 USA ▶ (225) 769-3051 ▶ (225) 766-5122 FAX

Klein Associates, Inc.

SYSTEM 3900

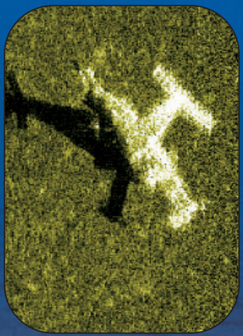
Dual-Frequency Side Scan Sonar for Search and Recovery



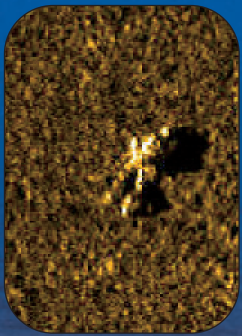
The System 3900 is an extremely high-resolution digital sonar for use in Search and Recovery missions which require a portable side scan system. The model is a selectable dual-frequency system with 445 kHz, which offers excellent range and resolution, and 900 kHz, which offers higher resolution of identified targets. The system is competitively priced and configured to be operated by one man from a small boat in shallow water. The standard system configuration comes complete with a splash-proof Transceiver Processing Unit (TPU), custom-configured laptop and 50m of lightweight tow cable. The Model 3900 Towfish electronics are housed in a stainless steel body with a phosphorescent finish.

KEY FEATURES

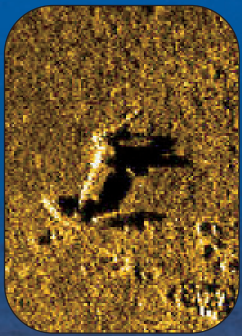
- Very high resolution and long range images
- Lightweight, one-man portable — ideal for small open boat operations
- Special software features for target analysis
- Complete turnkey system ready for field use
- Cost-effective
- Selectable dual-frequency operation (445 kHz and 900 kHz)
- Phosphorescent finish
- Laptop and wireless LAN compatible



Plane



Drowning Victim



Anchor

THE DIFFERENCE
IS IN THE IMAGE

Klein Associates, Inc.

SYSTEM 3900

Dual-Frequency Side Scan Sonar for Search and Recovery

SonarPro® SOFTWARE

Custom-developed software by users and for users of Klein side scan sonar systems operating on Windows XP®. Field-proven for many years. SonarPro® is a modular package combining ease of use with advanced sonar features.

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

SPECIFICATIONS

Towfish	
Frequencies	445 kHz, 900 kHz
Beam width	Horizontal: 0.21° @ 900 kHz, 0.21° @ 445 kHz; Vertical: 40°
Range scales	11 settings: 10 to 200 meters
Maximum range	150 meters @ 445 kHz; 50 meters @ 900 kHz
Depth rating	200 meters standard
Construction	Stainless steel / fluorescent powder coat
Size	122 cm long, 8.9 cm diameter
Weight	29 kg in air
Standard sensors	Roll, pitch, heading
Options	Pressure sensor
Splash-proof Transceiver Processor Unit (TPU)	
Operating system	VxWorks® with custom application
Outputs	100BaseTx, Ethernet LAN, optional wireless LAN
Navigation input	NMEA 0183
Power	120 watts @ 120/240 VAC, 50/60 Hz (includes towfish)
Interfacing	Interfaces to all major sonar data processors
Splash-proof	To IP 65 with waterproof connectors
Klein Sonar Workstation	
Basic operating system	Windows XP®
Sonar software	SonarPro®
Data format	SDF or XTF or both, selectable
Hardware	Laptop
Options	Optional ruggedized laptop
Tow Cables	Lightweight 50m cable; optional armored steel cables

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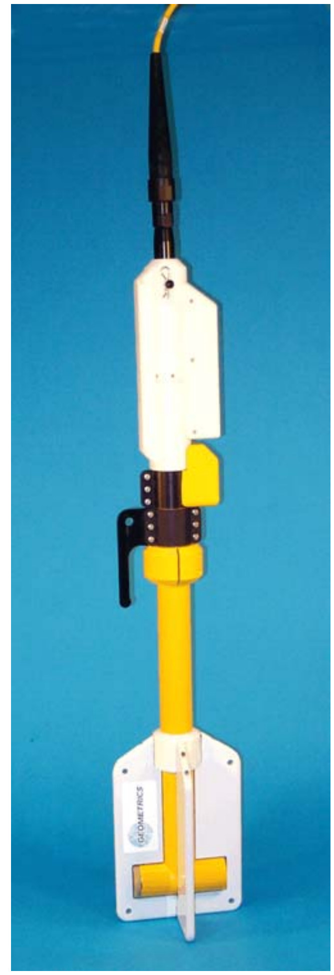
L3 Klein Associates, Inc.

L-3. Headquartered in New York City, L-3 Communications employs over 66,000 people worldwide and is a prime contractor in aircraft modernization and maintenance, C³ISR (Command, Control, Communications, Intelligence, Surveillance and Reconnaissance) systems and government services. L-3 is also a leading provider of high technology products, subsystems and systems.

GEOMETRICS

G-882 MARINE MAGNETOMETER

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



G-882 with Weight Collar Depth Option

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

The G-882 is flexible for operation in small boat, shallow water surveys as well as deep tow applications (4,000 psi rating, telemetry over steel coax available to 10Km). Being small and lightweight (44 lbs net, no weights) it is easily deployed and operated by one man. But add several no-foul weight collars and the system can quickly weigh in at more than 100 lbs. Power may be supplied from a 24 to 30 VDC battery supply or the included 110/220 VAC power supply. The tow cable uses high strength Kevlar and it's length is standard at 200 ft (61 m) with optional cable up to 500m (no telemetry). The shipboard end of the tow cable is attached to a junction box or on-board cable for quick and simple hookup to power and output of data into any IBM PC computer. A rugged fiber-wound fiberglass housing provides selectable orientation of the sensor and therefore maintains operations throughout the world with only small limitations as to direction of survey in equatorial regions.

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

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

The design of this special marine unit is directed toward the largest number of user needs. It is not intended to meet all marine requirements such as deep tow through long cables or monitoring fish altitude. Rugged design with highest performance at lowest cost are the goals.

Typical Detection Range For Common Objects

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

MODEL G-882 CESIUM MARINE MAGNETOMETER SYSTEM SPECIFICATIONS

OPERATING PRINCIPLE:	Self-oscillating split-beam Cesium Vapor (non-radioactive)
OPERATING RANGE:	20,000 to 100,000 nT
OPERATING ZONES:	The earth's field vector should be at an angle greater than 6° from the sensor's equator and greater than 6° away from the sensor's long axis. Automatic hemisphere switching.
CM-221 COUNTER SENSITIVITY:	<0.004 nT/ $\sqrt{\text{Hz}}$ rms. Typically 0.02 nT P-P at a 0.1 second sample rate or 0.002 nT at 1 second sample rate. Up to 10 samples per second
HEADING ERROR:	±1 nT (over entire 360° spin and tumble)
ABSOLUTE ACCURACY:	<3 nT throughout range
OUTPUT:	RS-232 at 9600 Baud
MECHANICAL:	
Sensor Fish:	Body 2.75 in. (7 cm) dia., 4.5 ft (1.37 m) long with fin assembly (11 in. cross width), 40 lbs. (18 kg) Includes Sensor and Electronics and 1 main weight. Additional collar weights are 14lbs (6.4kg) each, total of 5 capable
Tow Cable:	Kevlar Reinforced multiconductor tow cable. Breaking strength 3,600 lbs, 0.48 in OD, 200 ft maximum. Weighs 17 lbs (7.7 kg) with terminations.
OPERATING TEMPERATURE:	-30°F to +122°F (-35°C to +50°C)
STORAGE TEMPERATURE:	-48°F to +158°F (-45°C to +70°C)
ALTITUDE:	Up to 30,000 ft (9,000 m)
WATER TIGHT:	O-Ring sealed for up to 9000 ft (2750 m) depth operation
POWER:	24 to 32 VDC, 0.75 amp at turn-on and 0.5 amp thereafter
ACCESSORIES:	
Standard:	CM-201 View Utility Software operation manual and ship case
Optional:	Telemetry to 10Km coax, gradiometer (longitudinal or transverse)
MagLog Lite™ Software:	Logs, displays and prints Mag and GPS data at 10 Hz sample rate. Automatic anomaly detection and single sheet Windows printer support

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE ***4/03***

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GEOMETRICS Europe Manor Farm Cottage, Galley Lane, Great Brickhill, Bucks,
England MK179AB ● 44-1525-261874 ● Fax 44-1525-261867

GEOMETRICS China Laurel Industrial Co. Inc. - Beijing Office, Room 2509-2511, Full Link Plaza #18
Chaoyangmenwai Dajie, Chaoyang District, Beijing, China 100020
10-6588-1126 (1127..1130), 10-6588-1132 ● Fax 010-6588-1162

GEOMETRICS

Chirp III
SUB BOTTOM PROFILER

High-Resolution Chirp Sub-Bottom Profiler System

Benthos is a pioneer in Chirp technology and was the first to bring a commercial Chirp sub-bottom profiling system to the market. Teledyne Benthos continues that advancement with the Chirp III sub-bottom profiling system.

Portable and affordable, the Chirp III is a low cost system ideally suited for many applications. Its versatile system configuration has been designed to operate with various styles of tow vehicles and hull mounted arrays.

TTV-170 Series

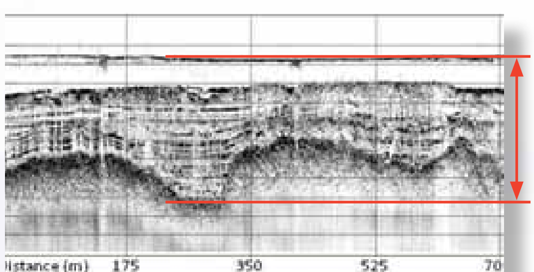
TTV-290 Series

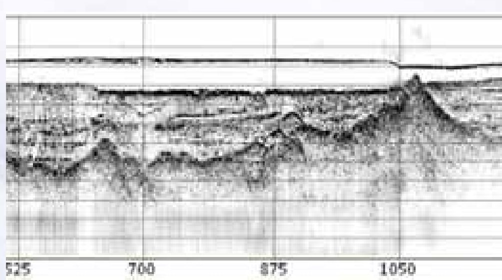
System configurations include:

- TTV-170 Series
- TTV-290 Series
- AUV configuration
- Hull mount configuration

Applications

- Offshore hazard surveys
- Pipeline and small object surveys
- Bridge piling scour and environmental surveys
- Mining and dredging
- Wind farm site survey (See data at right)





UNDERSEA SYSTEMS TECHNOLOGY INNOVATIVE

TELEDYNE BENTHOS
A Teledyne Technologies Company

System Specifications

Main Processor:	PC based sonar work station
Signal Resolution:	16 bit
Data Storage:	Stores raw data in SEG-Y format
Operator Software:	Windows™ environment
Display:	High-resolution display
Ping Rate:	15 pings/second maximum
Pulse Length:	User selectable from 5 msec. to 60 msec. Pulse waveforms stored in memory
Output Power:	4 KW each channel max
Transducers:	AT-471, Chirp bands 2 to 7 kHz AT-12D7, Chirp bands 10 to 20 kHz
Beam Angle:	TTV-170 ....100° Conical TTV-290 (2x2) Array...........45° Hull Mount (4x4) Array......25°
Cable:	Kevlar electrical umbilical cable
Operating Depth:	TTV-170: Shallow water/small vehicle (200m) TTV-290: (200m)
Navigation/Annotation:	NMEA 0183 interface, event/fix marks, external interrupt
Hard Copy Recorder:	Grey scale graphic recorder (optional)
Operator Controls:	HW gain (dual channel) 0-42dB/channel; two stage TVG; bottom tracking (dual channel); smoothing; horizontal/vertical zoom; display gain control; repetition rate control; custom FM waveform design
Operator Displays:	Bathymetry display; reflectivity and hardness display; signal to noise ratio display; voltage display; custom color palette selection; color rotation; navigation map display
Tow Vehicle Dimensions & Weight:	TTV 170: 18 in O.D. x 24 in long; weight in air–98 lbs., weight in water–80 lbs TTV 290: 18 in O.D. x 64 in long; weight in air–300 lbs., weight in water–170 lbs

Chirp III Hardware Features

- Simultaneous dual frequency operation allows for a choice of Chirp FM sweeps from 2 kHz to 20 kHz
- Flexible Chirp III acquisition/processing work station allows for versatile configurations including shallow and deep water vehicles, diverse hull mount arrays, and AUV's
- Ethernet output
- High power output -- up to 4KW each
- Integrated pressure sensor (optional)

Digital Acquisition Computer with Monitor

Chirp III Software Features

- Windows operating system
- User defined ping rate
- Automatic bottom tracking
- Interactive horizon picking
- Switch on the fly Chirp/CW pulse
- Simultaneous dual channel Chirp

Chirp III Transceiver (DSP-6651/DSP-6652)

TELEDYNE BENTHOS
A Teledyne Technologies Company
www.benthos.com

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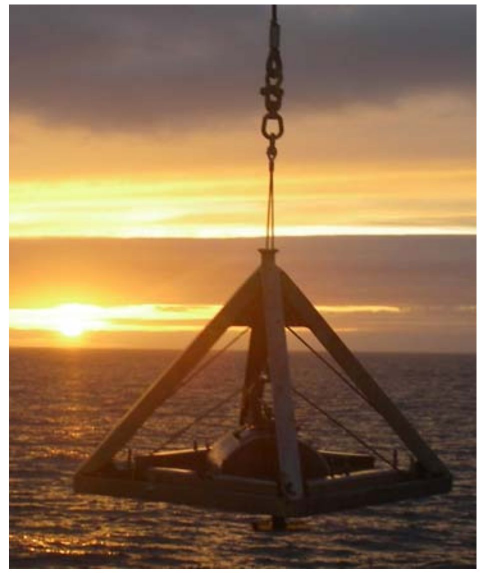
Tel +1 508-563-1000 • Fax +1 508-563-6444 • E-mail: benthos@teledyne.com

Day Grab

Features:

- Depth capability <250 m
- Stainless steel, for reduced contamination
- Variable weight around 150 – 300 kg
- 0.1m2 Sample Area
- Sample volume 15 litres

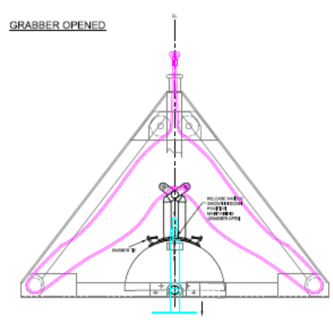


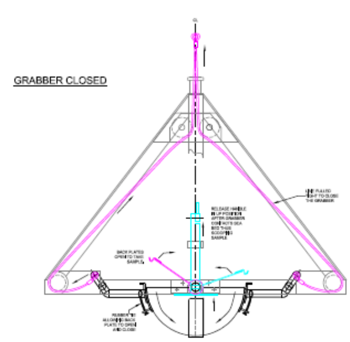
The modified (0.1m^2) Day grab has been constructed entirely of stainless steel and is routinely utilised for projects where the water depths are less than 250m. Low-slung pad feet when in contact with the seabed trigger the instrument. On retrieval (once triggered) the weight of the instrument is transferred along the warp wires, closing the jaws of the grab. The recovered samples are fully enclosed to reduce disturbance and can obtain up to 15 litres of well-preserved sample in most silts and sandy substrates.

The modified grab is also constructed to carry additional weights (providing better penetration) and an extended bucket lip to reduce sediment washout during retrieval.

On recovery, the sample can be processed directly through the large access doors or by emptying the contents into a plastic tray.

Further package includes dry-core galvanised cables, grab stand, sieving trays (0.5 m to 1mm), Gardline AutoSiever, biological sieves, chemicals, safety equipment and clothing.





Shallow Water Video / Camera System

Features:

- Depth capability 250 m
- Operational over 350 m umbilical cable
- Set-up weight ~ 260 kg
- Real time video footage
- Video imagery and still photographs

Gardline's standard digital stills camera systems are built within titanium alloy housing that is mounted within a stainless steel frame.

Still photographs are capture remotely, via an umbilical using a surface control unit. Images are stored on the cameras in internal memory card.

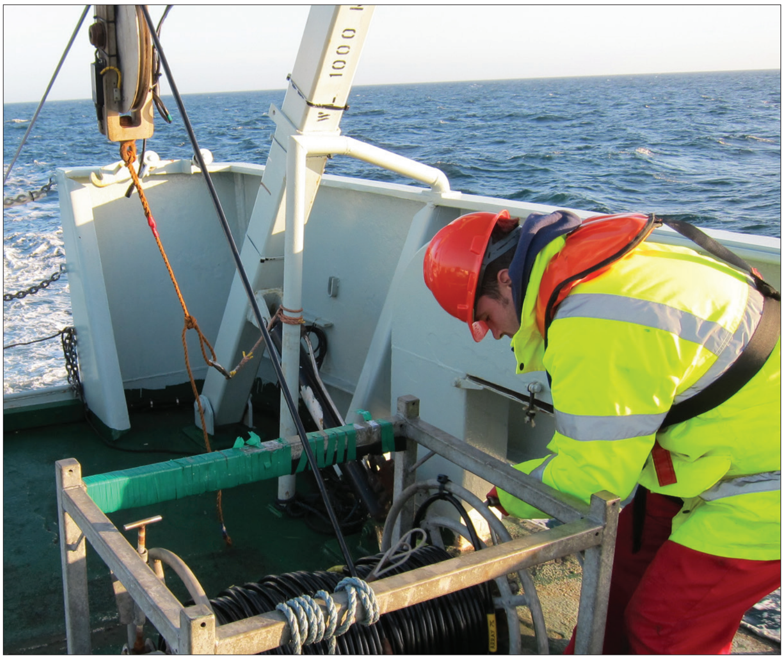
Equipment Specifications	
Manufacturer	Konsberg/Simrad.
Model	OE14-208 or OE14-408
Lens	f 7.2 – 28.8 (35mm format equivalent to 38-140mm) and automatic or manual focus control (50mm to infinity)
Pixels	5.0 M or 10.0 M
Video Resolution	320 x 240p
Video Overlay	Oceantools VO1
Field of View	47.8 (deg H) by 36.2 (deg V)
Trigger	Remote from deck
Height Control	USBL Beacon and Video footage
Lighting	1 strobe, 1 LED/Halogen lamp and integrated flash.

Live footage is overlaid with time, position and site details and recorded directly onto DVD and VHS.

This unique system is ideal for any study that requires real-time high resolution photographic equipment and can be used for a variety of environmental studies and ground truthing surveys.

Optional extras include the integration of a High Definition camera and / or higher resolution camera and green line laser scale bar.

Passive Acoustic Monitoring System



The PAMS comprises of a towed streamer section containing hydrophones with built in pre-amplifiers and a depth sensor, a tow cable, deck cable and a data processing system.

Data Processing System

The data processing system described here, comprises of the following sub systems:

a) High frequency data acquisition for cetacean clicks up to 175 kHz (Max sample rate 500 kHz)
b) Medium frequency data acquisition for cetacean click and whistles up to 48 kHz (Max sample rate 96 kHz)
c) Magrec amplifier and conditioning box (Magrec HP/27st) – VPL and GEL systems only
d) Power supply to the towed array
e) Depth data acquisition
f) Computer based sound acquisition, display and analysis software
g) Remote workstation – Seiche 511 system only

Computer based analysis and display systems

The outputs from the signal processing units are digitised (by National Instruments DAQ card for high frequency data and TC Konnect 24D for medium frequency sound acquisition) and passed to a PC Java based analysis program, enabling the detection of cetacean vocalisations.

The latest version of PAMGUARD software is utilised as a graphical display for sound acquisition, visualisation and finally detection of marine mammal vocalisations over the frequency range 100Hz to 175kHz.

The events can be displayed in real-time or frequency domains (or both). GELs proprietary data model comprises of a click detection module, a whistle detection and moan detection module, a porpoise-specific detector, navigational data logging module and audio recording capabilities.

The system will give an indication of range and bearing of the detected vocalisations (the bearing information has a left / right ambiguity).

General	
Manufacturer	Gardline Environmental Ltd
Model	MK4
Towed streamer section	
Length	N/A integrated into tow cable
Section diameter	16mm over cable, 26mm over mouldings
Number of Hydrophones	6
Hydrophone type	Custom built by Gardline Environmental Limited 3 low frequency, 3 broadband
Receive sensitivity (dB re 1 V/µPa)	-204
Hydrophone separation	Hydrophone 1 and 2 1.2m Hydrophone 2 and 3 1.2m Hydrophone 3 and 4 1.2m Hydrophone 4 and 5 3.15m Hydrophone 5 and 6 6.75m
Preamplifiers	3 low / medium frequency, 3 broadband
Preamplifier type	Sensor Technology SA-02
Depth sensor manufacturer	SensorTechnics
Tow cable	
Length	250 m
Diameter	16 mm
Termination	37 pin CEEP Connectors
Deck cable	
Length	100 m
Diameter	14 mm
Termination	37 pin CEEP Connectors

Alpine
A GARDLINE COMPANY

R/V Shearwater
Multi-role Survey Vessel

R/V Shearwater – Multi-role Survey Vessel

R/V Shearwater combines superior stability and maneuverability with state-of-the art research facilities to provide a flexible, multipurpose platform for marine surveying. The vessel fills the gap between small coastal and large offshore survey platforms providing a cost effective solution for many applications. In addition, the Shearwater allows for a single vessel to complete different tasks, such as geophysical, environmental, and geotechnical surveys, thereby affording our clients the opportunity to save both time and money.

The Shearwater is designed to be flexible enabling it to provide efficient and effective configurations for the completion of its missions. The 110' x 39' aluminium trimaran boasts a hydraulic azimuth drive propulsion system which is fuel efficient while providing superior positioning and line-keeping performance (handling is further enhanced by a 100 HP Bow Thruster). In most instances, this allows the vessel to hold station without resorting to anchoring. The Shearwater also features a large back deck, two equipment moon-pools, a crane, hydraulic stern A-frame, fixed starboard A-frame, dedicated equipment winches, laboratory and office space with onboard data processing capabilities, and accommodation for up to 20 people on a 24-hour basis.

A professional crew, with extensive experience in offshore survey and construction operations, allows clients to take advantage of the full list of impressive capabilities the Shearwater can bring to a project.

R/V SHEARWATER HAS BEEN DESIGNED TO SUPPORT THE FOLLOWING KEY AREAS:

/ Offshore Structure Surveys (Wind, Oil & Gas, Hydrokinetic)
/ Cable and Pipeline Route Surveys
/ Marine Aggregate and Mineral Surveys
/ Environmental Surveys
/ Oceanographic Instrument Deployment and Recovery
/ Port and Breakwater Development Surveys
/ ROV, AUV and Diver Support
/ Offshore Construction Support and Monitoring Surveys

Vessel Details

Name:	Shearwater
Type:	Multi-Role Survey
Year of Build:	1981
Reconfigured, Refit and Repowered:	2011

Dimensions

Length:	110'
Beam:	39'
Draft:	9'
GRT:	198
NRT:	175
Aft Deck:	1175 sq. ft with separate stern rescue deck

Accommodation

Berths:	20 including crew
Survey Lab:	127 sq ft
Processing Office:	72 sq ft

Propulsion and Machinery

Main Engines:	2 x 526 HP John Deere Model 6125AFM
Propulsion:	2 x Hydraulically driven "Z" Drives (raise/lower/tilt with 360 degree steering)
Bow Thruster:	Thrustmaster 100 HP
Generators:	2 x John Deere Model 6081AFM/Marathon (Magna Plus) 135 Kw

Capacities

Desalination System:	Up to 900 gallons/day
Fresh Water Storage:	5000 gallons
Fuel Storage:	13800 gallons
Septic:	Zero discharge with 2000 gallon holding tank
Endurance:	21 days

Fuel Consumption

Survey 24hrs:	300 gallons/day
Steaming:	500-600 gallons/day
Standby at Sea:	70-100 gallons/day

Navigation

Radar:	Furuno 1944C/NT Furuno 1935
Charting System:	Garmin 5208 GPS with Chart Plot
Auto Pilot:	COMNAV
Echosounders:	Furuno FCV 620 – color in each hull
AIS:	Furuno FA 150
Navtex:	Furuno NX700
Survey GPS, Heading and IMU:	Applanix POS MV
Acoustic Positioning:	Moon Pool mounted USBL

Communication

VHF:	2 x Icom IC-M504
SSB:	SEA 245 HF/SSB
SART:	Sevenstar Electronics S.701
Satellite (Phone/Data):	Intellian v80G VSAT

Equipment Handling

Equipment Moon Pools:	Port and Starboard 3 foot diameter moon pools
Hydraulic Stern A-Frame:	2 Ton Capacity Can operate as two separate davits
Fixed Starboard A-Frame:	5 Ton Capacity
Crane:	14 Ton Maximum Capacity 5 Ton w/ single part line 2 Ton at 40' Extension.
Geotechnical Winch:	5 Ton Capacity
Survey Equipment Winch:	2500m (11mm diam.) Capacity

Survey Capabilities

Hydrography and Geophysics

Multibeam and Single Beam Echosounders
Side Scan Sonars
Subbottom Profilers
Boomers
Sparkers
Mini Air Gun
Multi-Channel Streamers
Magnetometers and Gradiometers

Benthic and Oceanographic

CTD and SVPs
Water Sampling Systems
Turbidity Monitoring Systems
Benthic Grabs
Box Corers
Drop Down Cameras

Geotechnical

10 to 30' Pneumatic and Electric Vibracores
Mini-CPTs
Piston Corers
Drop Corers
Grab Samplers

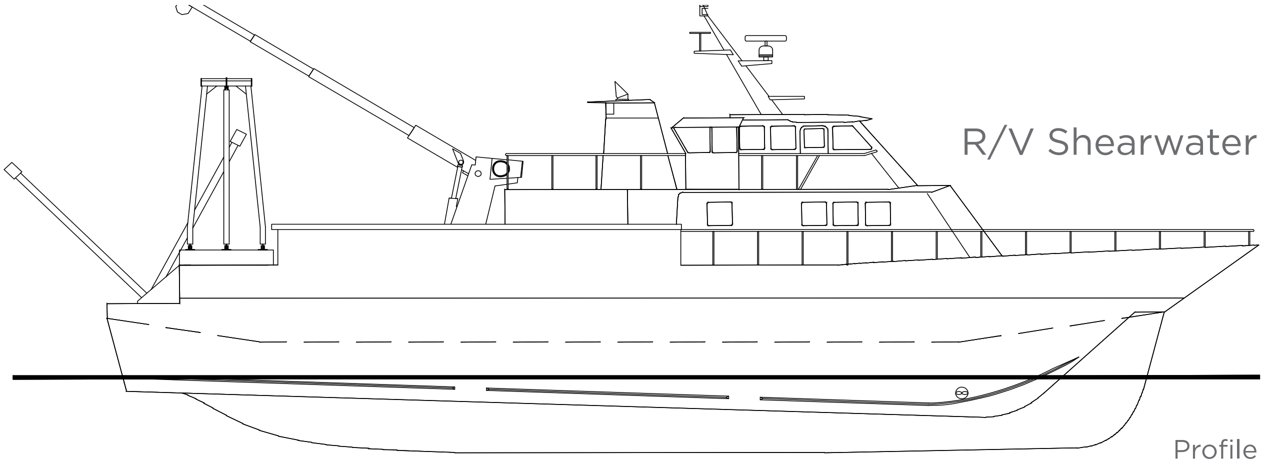
Other

Deployment and Retrieval of Inspection Class ROVs and Compact AUVs

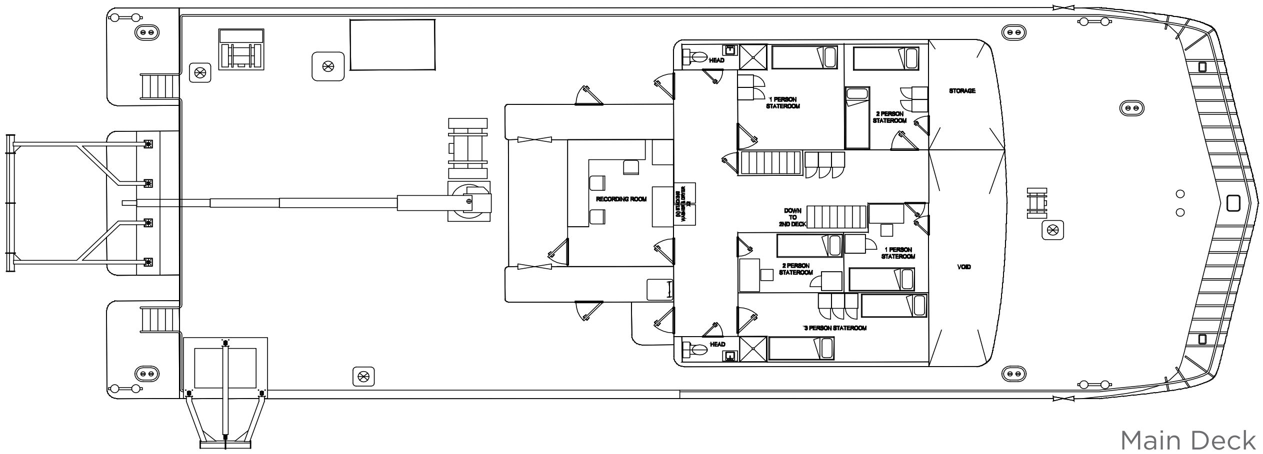
Dive Platform Capable

Permanently Installed Networked Server

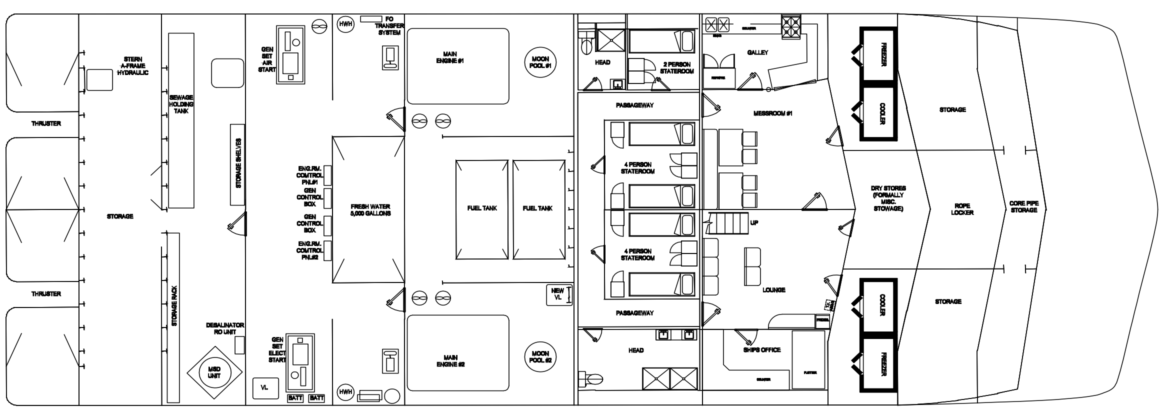
R/V Shearwater



Profile



Main Deck



Below Main Deck

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Email: info@alpineocean.com

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www.alpineocean.com

Alpine Ocean Seismic Survey, Inc. is part of the Gardline Group of Companies

APPENDIX E EQUIPMENT CALIBRATIONS

USBL CALIBRATION

Least Squares

LEAST SQUARES DEFINITIONS

Databases

C:\Program Files (x86)\QPS\USWind		
0022 - 1 - 0001	6/06/2015	15:02:45
0022 - 2 - 0001	6/06/2015	15:07:36
0024 - 3 - 0001	6/06/2015	15:14:17
0025 - 4 - 0001	6/06/2015	15:19:02
0026 - 5 - 0001	6/06/2015	15:23:50
0027 - 6 - 0001	6/06/2015	15:28:55
0028 - 2 - 0001	6/06/2015	15:37:10

Properties

USBL System	**USBL**	Vessel Object	**Shearwater**
Reference Point	**USBL**	Gyro System	**Wavemaster Gyro**
Transducer Node	**USBL**	VRU System	**W**
Transponder Node	**SSS CoG**	Echosounder	**Manual**
Computation	**Wavemaster**		

Statistics

Number of USBL Observations	**302**	**100** %
Number of Used Observations	**295**	**97** %
Number of Disabled Observations	**7**	**2** %

LEAST SQUARES SETTINGS

USBL Observations

Alignment Corrections	**No Corrections**
Reference Point	**Actual USBL Transducer**
Sound Velocity	**Calibrated Sound Velocity**
Computation Parameters	**Scale, Angles (Roll, Pitch, Heading)**
Standard Deviations	**Scaled Calibration Standard Deviations**

LEAST SQUARES RESULTS

Computation Results

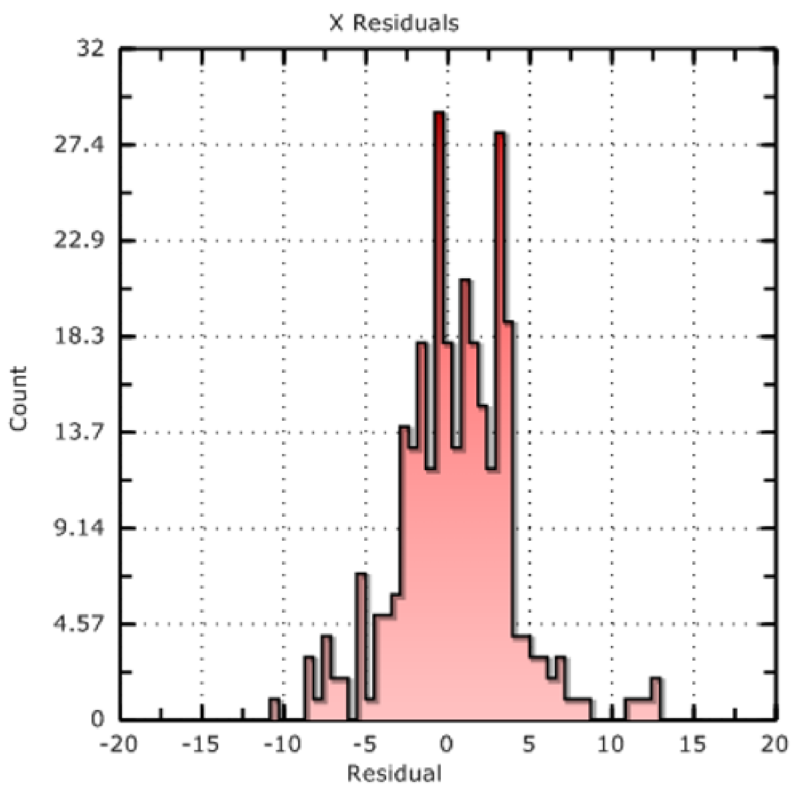
Parameter	Value	SD
Scale Factor	**1.06788**	**0.02882**
Roll Angle	**-5.159** °	**3.504** °
Pitch Angle	**-25.394** °	**1.853** °
Heading Angle	**7.437** °	**2.892** °

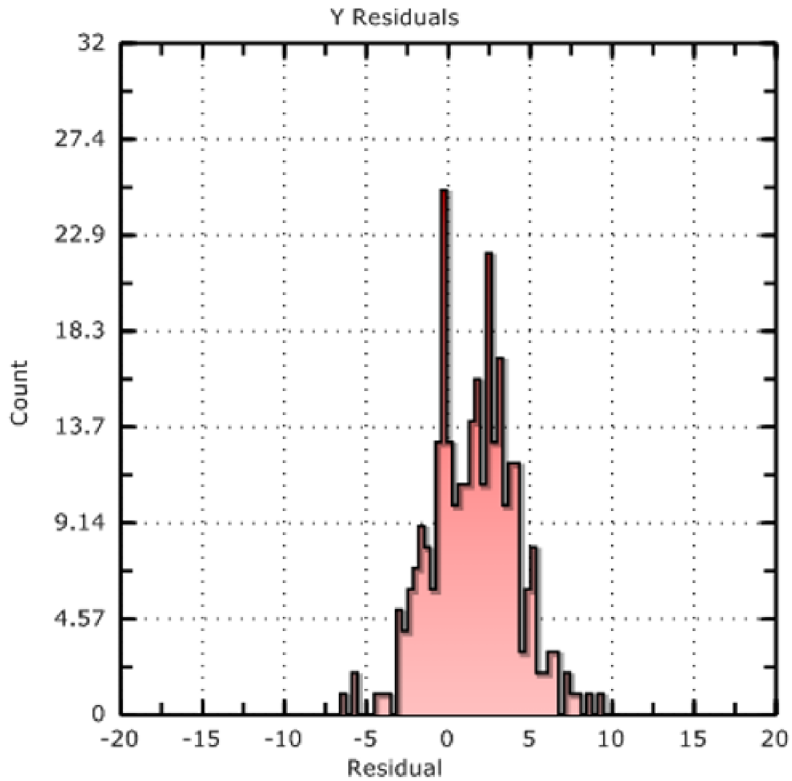
Transponder Position

Coordinate	Value	SD
Easting TP	**615115.29** m	**N/A** m
Northing TP	**4429255.53** m	**N/A** m
Height TP	**-41.81** m	**N/A** m

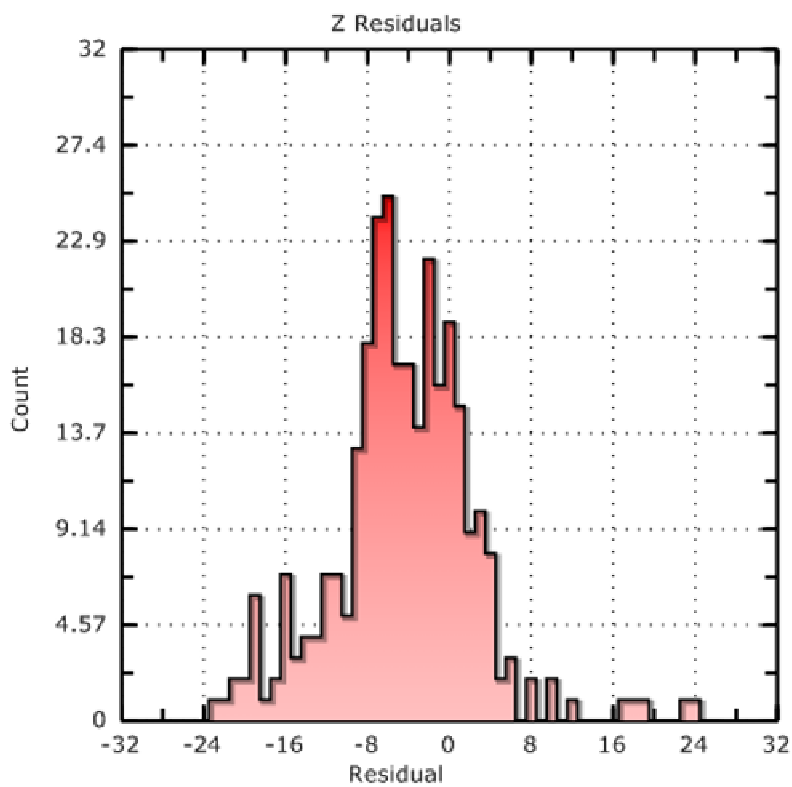
Least Squares

LEAST SQUARES GRAPHS





Y Residuals
Count
Residual
32
27.4
22.9
18.3
13.7
9.14
4.57
0
-20
-15
-10
-5
0
5
10
15
20



Z Residuals
Count
Residual
32
27.4
22.9
18.3
13.7
9.14
4.57
0
-32
-24
-16
-8
0
8
16
24
32

Mean Position

Coordinate	Value
Easting	**0.00** m
Northing	**0.00** m
Height	**0.00** m

Calibrated Transponder Position

USBL Observations

Alignment Corrections	**No corrections**
Reference Point	**No reference point**
Sound Velocity	**No sound velocity**

Computation Results

Parameter	Value	SD
Offset X	**0.00** m	**N/A** m
Offset Y	**0.00** m	**N/A** m
Offset Z	**0.00** m	**N/A** m

Transponder Position

Coordinate	Value	SD
Easting TP	**5000000** m	**N/A** m
Northing TP	**500000** m	**N/A** m
Height TP	**500** m	**N/A** m

USBL Observations

Alignment Corrections	**No corrections**
Reference Point	**No reference point**
Sound Velocity	**No sound velocity**

Depth Observations

Manual Depth	**N/A** m
Transponder Height	**0.00** m

Computation Results

Parameter	Value	SD
Average Offset Z	**0.00** m	**N/A** m

Known Transponder Position

Coordinate	Value
Easting TP	**5000000** m
Northing TP	**500000** m
Height TP	**500** m

Sound Velocity

USBL Observations

Sound Velocity	**Calibrated Sound Velocity**

USBL Calibration Results

Parameter	Value	Factor
Calibration Results	**1585.81** m/s	**1.06788**
Manually Set Values	**N/A**	

QINSy Database Settings

Parameter	Value	Factor
System-Used Velocity	**1485.00** m/s	**1.00000**
Calibrated Velocity	**1485.00** m/s	**1.00000**
0022 - 1 - 0001		
0023 - 2 - 0001		
0024 - 3 - 0001		
0025 - 4 - 0001		
0026 - 5 - 0001		
0027 - 6 - 0001		
0028 - 2 - 0001		

Alignments

USBL Calibration Results

Parameter	Value	SD
Scale Factor	**1.06788**	**0.02882**
Roll Angle	**-5.159** °	**3.504** °
Pitch Angle	**-25.394** °	**1.853** °
Heading Angle	**7.437** °	**2.892** °
Offset X	**0.00** m	**N/A** m
Offset Y	**0.00** m	**N/A** m
Offset Z	**0.00** m	**N/A** m
Easting TP	**0.00** m	**N/A** m
Northing TP	**0.00** m	**N/A** m
Height TP	**0.00** m	**N/A** m

USBL Transponder Positions

Error Ellipse	95 %	SD
Easting Center	**615115.21** m	**4.03** m
Northing Center	**4429253.66** m	**3.62** m
Semi-Major Axis	**9.94** m	**4.06** m
Semi-Minor Axis	**8.78** m	**3.59** m
Azimuth Major Axis	**75.327** °	

Manually Set Values

Parameter	Value	SD
Scale Factor	**1.00000**	**N/A**
Roll Angle	**0.00** °	**N/A** °
Pitch Angle	**0.00** °	**N/A** °
Heading Angle	**0.00** °	**N/A** °
Offset X	**0.00** m	**N/A** m
Offset Y	**0.00** m	**N/A** m
Offset Z	**0.00** m	**N/A** m

QINSy Database Settings

Parameter	Value	SD
Scale Factor	**1.00000**	**N/A**
Roll Angle	**0.000** °	**0.050** °
Pitch Angle	**0.000** °	**0.050** °
Heading Angle	**0.000** °	**0.500** °

0022 - 1 - 0001
0023 - 2 - 0001
0024 - 3 - 0001
0025 - 4 - 0001
0026 - 5 - 0001
0027 - 6 - 0001
0028 - 2 - 0001

MULTI-BEAM ECHO SOUNDER CALIBRATION

The Patch Test routine was performed to specific requirements on 5 June, 2015, and data were acquired using the Universal Transverse Mercator (UTM) coordinate system, Zone 18 North in meters. The Patch Test Calibration was performed in water depths of 15-18 meters.

Calibration Procedure

Navigation lines were designed to run over a debris area as well as an area of featureless seafloor.

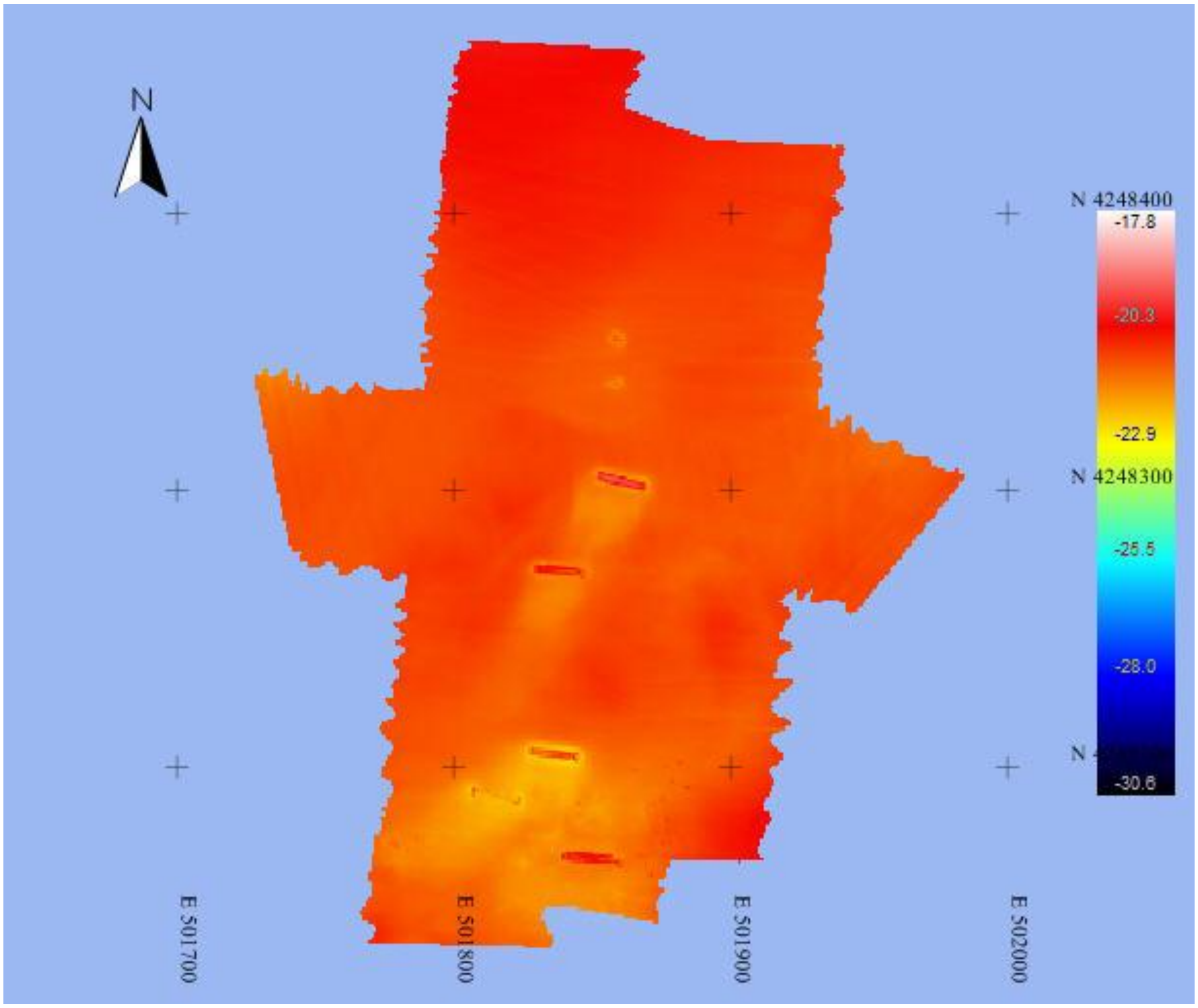
Multiple areas were chosen from the various lines run in order to achieve an average calibration value.

Cal1 Line 501 899.26 (m), 4 248 368.40 (m) to 501 886.62 (m), 4 248 239.76 (m)
Cal2 Line 501 864.43 (m), 4 248 371.82 (m) to 501 851.78 (m), 4 248 243.18 (m)
Cal3 Line 501 829.59 (m), 4 248 375.24 (m) to 501 816.95 (m), 4 248 246.61 (m)
CalCross Line 501 790.47 (m), 4 248 309.41 (m) to 501 940.76 (m), 4 248 296.60 (m)

Survey Line Name	Speed	Heading
0012-Cal1-0001	4kn	005.63°
0013-Cal1-0001	4kn	185.60°
0014-Cal2-0001	4kn	005.63°
0015-Cal2-0001	4kn	185.60°
0016-Cal3-0001	4kn	005.63°
0017-Cal3-0001	4kn	185.60°
0019-CalCross-0001	4kn	274.88°
0020-CalCross-0001	4kn	094.88°

Sound Velocity

Prior to the Patch Test survey lines, a full column sound velocity profile was taken down to approximately 16m water depth at 38° 22‘ 24.46’’ N, 074° 58’ 46.80’’ W.



Summary of Results

Summaries of the calibration results are:

Latency	Roll	Pitch	Yaw
N/A due to PPS	2.13°	-3.35°	1.00°

APPENDIX F SURVEY LOGSHEET

US Wind-R/V Shearwater Survey Line Log

Date	SOL Time (UTC)	EOL Time (UTC)	Line Number	Survey Speed (kts.)	Line Direction (Degrees)	SOL Fix (100 meter events)	EOL Fix (100 meter events)	Towfish Ht SOL (meters)	Towfish Ht EOL (meters)	QINSy File Name
6/6/15	23:22	1:56	208	4.2	180	56299	56498	5.6	4.6	0046-208-MainGeoSurvey-0001
6/7/15	2:00	4:45	204	4.0	0	56499	56697	5.0	5.0	0047-204-MainGeoSurvey-0001
6/7/15	5:02	5:16	207	4.4	180	1	18	6.4	5.5	0048-207-MainGeoSurvey-0001
6/7/15	5:54	7:07	207_2	4.5	180	19	127	5.5	5.5	0049-207-MainGeoSurvey-0001
6/7/15	7:27	8:26	207_3	4.8	180	128	217	5.5	5.5	0050-207-MainGeoSurvey-0001
6/7/15	10:56	12:22	203	4.5	0	218	315	6.0	6.2	0051-203-MainGeoSurvey-0001
6/7/15	13:46	15:11	203_2	4.2	0	316	432	6.0	6.0	0052-203-MainGeoSurvey-0001
6/7/15	15:17	15:28	206	4.3	180	433	446	6.8	6.0	0053-206-MainGeoSurvey-0001
6/7/15	15:39	17:53	206_2	4.5	180	448	633	5.8	5.1	0054-206-MainGeoSurvey-0001
6/7/15	18:03	20:40	202	4.5	0	634	834	6.2	5.9	0055-202-MainGeoSurvey-0001
6/7/15	20:50	23:13	205	4.4	180	835	1035	5.5	4.5	0056-205-MainGeoSurvey-0001
6/7/15	23:21	1:33	201	4.4	0	1036	1236	5.5	5.5	0057-201-MainGeoSurvey-0001
6/8/15	1:46	4:21	197	4.2	180	1237	1438	5.1	6.2	0058-197-MainGeoSurvey-0001
6/8/15	4:31	5:28	200	4.5	0	1439	1523	6.0	6.0	0059-200-MainGeoSurvey-0001
6/8/15	6:16	7:26	200_3	4.8	0	1524	1626	5.5	5.5	0060-200-MainGeoSurvey-0001
6/8/15	7:31	9:41	196	4.6	180	1627	1826	6.0	5.4	0061-196-MainGeoSurvey-0001
6/8/15	10:00	12:27	199	4.1	0	1827	2026	5.9	5.5	0062-199-MainGeoSurvey-0001
6/8/15	12:36	14:21	194	4.1	180	2027	2154	5.8	5.5	0063-194-MainGeoSurvey-0001
6/8/15	14:31	15:35	194_2	4.8	180	2155	2229	5.8	6.0	0064-194-MainGeoSurvey-0001
6/8/15	15:41	16:12	198	4.8	0	2230	2272	5.8	6.0	0065-198-MainGeoSurvey-0001
6/8/15	16:40	18:30	198_2	4.8	0	2272	2444	5.3	5.2	0066-198-MainGeoSurvey-0001
6/10/15	0:54	3:18	192	4.4	180	2478	2678	5.5	4.5	0076-192-MainGeoSurvey-0001
6/10/15	3:26	5:35	195	4.2	0	2679	2879	4.3	5.0	0077-195-MainGeoSurvey-0001
6/10/15	5:41	8:05	190	4.8	180	2880	3080	5.7	5.5	0078-190-MainGeoSurvey-0001
6/10/15	8:09	10:37	193	4.3	0	3081	3282	5.1	5.5	0079-193-MainGeoSurvey-0001

APPENDIX G WEATHER SUMARY

US Wind-R/V Shearwater Weather Records

Ship	Date	Time (UTC)	Speed of vessel (knots)	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility	Sun glare	Precipitation
RV Shearwater	6/6/2015	0:00	2.0	ne	5	c	m	m	n	n
RV Shearwater	6/6/2015	0:28	2.1	ne	4	c	m	p	n	n
RV Shearwater	6/6/2015	1:10	2.9	ne	4	c	m	p	n	n
RV Shearwater	6/6/2015	1:50	3.0	ne	4	c	m	p	n	l
RV Shearwater	6/6/2015	2:15	3.6	ne	5	c	m	p	n	l
RV Shearwater	6/6/2015	3:15	4.2	ne	5	c	m	p	n	n
RV Shearwater	6/6/2015	4:13	3.8	ne	4	c	m	p	n	n
RV Shearwater	6/6/2015	5:00	3.0	ne	4	c	m	p	n	n
RV Shearwater	6/6/2015	6:00	1.0	ne	4	s	m	p	n	n
RV Shearwater	6/6/2015	7:00	1.6	n	3	s	m	p	n	n
RV Shearwater	6/6/2015	8:00	3.7	n	2	s	o	p	n	n
RV Shearwater	6/6/2015	9:00	4.4	n	2	s	o	g	n	n
RV Shearwater	6/6/2015	10:00	4.1	n	2	s	o	g	vf	n
RV Shearwater	6/6/2015	10:20	4.5	n	2	s	o	g	vf	n
RV Shearwater	6/6/2015	11:22	4.2	n	2	s	o	g	sf	n
RV Shearwater	6/6/2015	11:39	4.0	n	2	s	o	g	sf	n
RV Shearwater	6/6/2015	12:10	3.8	n	2	s	o	g	wf	n
RV Shearwater	6/6/2015	12:11	3.8	n	2	s	o	g	wf	n
RV Shearwater	6/6/2015	12:20	3.9	n	2	s	o	g	wf	n
RV Shearwater	6/6/2015	13:02	4.1	n	1	s	o	g	n	l
RV Shearwater	6/6/2015	13:10	4.2	n	1	s	o	g	n	l
RV Shearwater	6/6/2015	13:54	0.8	n	1	s	o	m	n	l
RV Shearwater	6/6/2015	14:13	0.8	n	1	s	o	m	n	l
RV Shearwater	6/6/2015	14:17	0.8	n	1	s	o	m	n	m
RV Shearwater	6/6/2015	14:39	2.2	n	1	s	o	m	n	l
RV Shearwater	6/6/2015	15:49	0.6	n	1	s	o	m	n	n
RV Shearwater	6/6/2015	15:53	3.8	n	1	s	o	m	n	n
RV Shearwater	6/6/2015	16:06	0.5	n	1	s	o	m	n	n
RV Shearwater	6/6/2015	16:17	0.7	n	1	s	o	m	n	l
RV Shearwater	6/6/2015	16:25	4.3	n	1	s	o	m	n	h
RV Shearwater	6/6/2015	16:37	3.9	n	2	s	o	m	n	n

Sea State:
g = glassy (like a mirror)
s = slight (no or few white caps)
c = choppy (many white caps)
r = rough (large waves, foam crests, spray)

Swell height:
o = low (< 2 m)
m = medium (2-4 m)
l = large (> 4 m)

Visibility:
p = poor (< 1 km)
m = moderate (1-5 km)
g = good (> 5 km)

Sun glare:
n = no glare
wf = weak glare forward
sf = strong glare forward
vf = variable glare forward
wb = weak glare behind

Precipitation:
n = no precipitation
l = light rain
m = moderate rain
h = heavy rain
s = snow

RV Shearwater	6/6/2015	17:37	5.5	n	1	s	o	m	n	l
RV Shearwater	6/6/2015	18:05	5.5	n	1	s	o	m	n	n
RV Shearwater	6/6/2015	18:45	1.0	n	3	s	o	m	n	l
RV Shearwater	6/6/2015	19:10	4.4	n	3	s	o	m	n	n
RV Shearwater	6/6/2015	20:00	5.5	n	2	s	o	m	n	m
RV Shearwater	6/6/2015	20:30	3.7	n	4	s	o	m	n	m
RV Shearwater	6/6/2015	21:01	4.0	n	2	s	o	g	n	n
RV Shearwater	6/6/2015	22:06	4.2	n	2	s	o	g	n	n
RV Shearwater	6/6/2015	22:29	3.9	n	2	s	o	g	n	n
RV Shearwater	6/6/2015	22:53	4.0	n	3	s	o	m	n	n
RV Shearwater	6/6/2015	23:53	3.7	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	0:53	4.1	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	1:53	3.7	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	1:55	4.0	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	2:00	3.8	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	3:01	3.7	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	4:00	4.3	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	5:00	4.5	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	5:59	4.1	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	7:06	4.7	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	7:27	5.2	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	8:00	5.3	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	8:26	4.8	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	9:02	0.8	n	2	s	o	g	n	n
RV Shearwater	6/7/2015	10:02	3.4	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	10:24	4.7	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	10:41	4.6	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	11:03	4.1	ne	2	s	o	g	sf	n
RV Shearwater	6/7/2015	12:08	4.0	ne	3	s	o	g	sf	n
RV Shearwater	6/7/2015	13:24	5.5	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	13:41	4.1	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	14:36	4.6	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	15:11	4.1	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	15:17	4.9	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	16:04	4.3	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	17:00	4.4	ne	3	s	o	g	sb	n

RV Shearwater	6/7/2015	18:00	3.9	ne	3	s	o	g	sf	n
RV Shearwater	6/7/2015	19:00	4.2	ne	3	s	o	g	sf	n
RV Shearwater	6/7/2015	20:01	4.8	ne	3	s	o	g	sf	n
RV Shearwater	6/7/2015	20:40	2.8	ne	3	s	o	g	sf	n
RV Shearwater	6/7/2015	20:50	5.1	ne	3	s	o	g	sb	n
RV Shearwater	6/7/2015	22:09	4.6	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	22:55	4.6	ne	2	s	o	g	sb	n
RV Shearwater	6/7/2015	23:13	4.8	ne	2	s	o	g	sb	n
RV Shearwater	6/8/2015	0:00	4.8	ne	2	s	o	m	wf	n
RV Shearwater	6/8/2015	1:00	5.2	ne	3	s	o	p	n	n
RV Shearwater	6/8/2015	2:00	4.2	ne	3	s	o	p	n	n
RV Shearwater	6/8/2015	3:00	4.3	ne	3	s	o	m	n	n
RV Shearwater	6/8/2015	3:59	4.2	ne	3	s	o	g	n	n
RV Shearwater	6/8/2015	5:02	5.1	ne	2	s	o	g	n	n
RV Shearwater	6/8/2015	6:02	4.9	ne	2	s	o	g	n	n
RV Shearwater	6/8/2015	6:54	4.9	se	2	s	o	g	n	n
RV Shearwater	6/8/2015	8:00	4.8	s	2	s	o	g	n	n
RV Shearwater	6/8/2015	8:58	5.3	s	2	s	o	g	n	n
RV Shearwater	6/8/2015	10:00	4.2	s	2	s	o	g	wb	n
RV Shearwater	6/8/2015	11:00	4.6	s	2	s	o	g	vf	n
RV Shearwater	6/8/2015	12:01	5.2	s	2	s	o	g	vf	n
RV Shearwater	6/8/2015	12:58	4.6	s	3	s	o	g	vf	n
RV Shearwater	6/8/2015	13:58	4.5	s	3	s	o	g	vf	n
RV Shearwater	6/8/2015	14:59	3.8	s	3	c	o	g	vf	n
RV Shearwater	6/8/2015	16:05	4.3	s	5	c	o	g	vb	n
RV Shearwater	6/8/2015	17:00	4.8	s	5	c	o	g	sf	n
RV Shearwater	6/8/2015	18:03	5.0	s	5	c	o	g	sf	n
RV Shearwater	6/8/2015	18:34	5.3	s	5	c	m	g	sf	n
RV Shearwater	6/8/2015	19:30	5.7	sw	6	r	m	g	sf	n
RV Shearwater	6/8/2015	20:30	5.3	sw	6	r	m	g	sf	n
RV Shearwater	6/8/2015	21:00	5.7	sw	6	r	m	g	sf	n
RV Shearwater	6/8/2015	21:55	5.4	sw	6	r	m	g	sf	n
RV Shearwater	6/8/2015	22:25	4.9	sw	6	r	o	g	sf	n
RV Shearwater	6/9/2015	0:00	3.3	s	5	c	o	g	sf	n
RV Shearwater	6/9/2015	20:20	3.7	sw	3	s	o	g	sf	n
RV Shearwater	6/9/2015	21:20	5.9	sw	3	s	o	g	sf	n

RV Shearwater	6/9/2015	21:40	5.9	sw	2	s	o	g	vf	n
RV Shearwater	6/9/2015	22:00	6.0	w	3	s	o	g	vb	n
RV Shearwater	6/9/2015	23:00	6.0	w	3	s	o	g	vb	n
RV Shearwater	6/9/2015	23:29	5.9	w	4	s	o	g	vb	n
RV Shearwater	6/10/2015	0:00	4.4	w	4	s	o	g	n	n
RV Shearwater	6/10/2015	0:33	4.6	w	4	s	o	m	n	n
RV Shearwater	6/10/2015	0:53	4.3	w	4	s	o	m	n	n
RV Shearwater	6/10/2015	1:10	4.5	w	4	s	o	m	n	n
RV Shearwater	6/10/2015	2:00	4.3	w	3	s	o	m	n	n
RV Shearwater	6/10/2015	2:59	4.3	se	3	s	o	m	n	n
RV Shearwater	6/10/2015	3:59	4.8	se	3	s	o	m	n	n
RV Shearwater	6/10/2015	5:05	5.3	se	3	s	o	m	n	n
RV Shearwater	6/10/2015	5:56	4.8	se	3	s	o	m	n	n
RV Shearwater	6/10/2015	6:58	3.8	se	3	s	o	m	n	n
RV Shearwater	6/10/2015	8:00	4.2	se	1	s	o	m	n	n
RV Shearwater	6/10/2015	9:00	4.4	se	1	s	o	m	n	n
RV Shearwater	6/10/2015	10:00	4.9	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	10:44	5.5	s	1	s	o	g	wb	n
RV Shearwater	6/10/2015	12:01	5.2	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	13:16	3.9	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	14:01	0.5	s	1	s	o	g	n	n
RV Shearwater	6/10/2015	14:59	3.0	s	1	s	o	g	n	n
RV Shearwater	6/10/2015	16:00	3.7	s	1	s	o	g	n	n
RV Shearwater	6/10/2015	17:00	3.9	s	1	s	o	g	n	n
RV Shearwater	6/10/2015	18:00	3.9	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	19:00	4.1	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	19:06	3.7	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	19:07	3.6	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	20:00	0.3	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	21:00	0.0	s	1	s	o	g	wf	n
RV Shearwater	6/10/2015	22:00	0.0	s	0	g	o	g	wf	n
RV Shearwater	6/10/2015	23:00	3.8	s	1	g	o	g	wf	n
RV Shearwater	6/10/2015	23:25	4.3	s	2	s	o	g	wf	n
RV Shearwater	6/10/2015	23:47	2.5	s	2	s	o	g	n	n

APPENDIX H DAILY PROGRESS REPORTS

Alpine A GARDLINE COMPANY

DAILY REPORT

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Todays Date:	**06 June 2015**
Location:	**Ocean City, MD**	Report No:	**5**
Project:	**Maryland WEA SAP Survey**	Start Date:	**02 June 2015**

All times are ***Local*** *(GMT -* ***4:00*** *hrs)*

AA. VESSEL LOCATION AT 24:00 HRS:

Description: **WEA** Latitude: **38 23.53136** Longitude: **74 45.10924**

BB. WEATHER:

Time (Local)	BAROM in	WIND Speed kts	WIND Dir	WAVE HEIGHT m	VISIB. nmi	SKY CONDS	REMARKS
00:00	29.9	10	E	1.5		overcast	
08:00	29.88			1.2		hazy	
16:00	29.92			0.9	7	clear	
24:00	30.05	5	NE	1.3	7	clear	

CC. PERSONNEL & EQUIPMENT:

C1. Alpine OSS Personnel:

Party Chief:	Justin Bailey	PSO:	Sharon Doake, Teresa Martin	Processor:	Dan Whitesell, Kelly Johns
Shift Supervisor:	Marcus Kwasek, Chris Stillman	PSO:	Randal Counihan, Sam Tufano		
Surveyor:	Kaios Ryan, Trevor Hoskins	PSO:	Jack Allum		

C2. Additional Personnel

C3. Client Personnel:

Client Rep.

C4. Personnel On Board:

ALPINE:	9	CLIENT:	0	VESSEL:	6	OTHERS:	3	TOTAL 18

C5. ALPINE'S Equipment:

Applanix POS MV	ODOM CVM Singlebeam	R2Sonic MBES
Klein 3900 Side Scan Sonar	Valeport SVP	
Geometrics G882 Magnetometer	Gardline PAMS Mark III	
Datasonics CHIRP III Subbottom Profiler	Gen3 Night Vison Goggles w/ COTI	

C6. Additional Equipment

C7. Project Variations (include notices of changes of personnel / equipment)

Off Vessel	On Vessel
Personnel:	**Personnel:**
Equipment:	**Equipment:**

DD. DIARY OF EVENTS TODAY:

From	To	hrs	Code	
00:00	5:15	5:15	O	Continue PAMS vessel noise signature tests
5:15	7:40	2:25	O	PSO watch and ramp up SBES/SBP for HRG noise signature test
7:40	11:00	3:20	O	HRG noise signature test SBES/SBP
11:00	12:30	1:30	C	USBL Calibration
12:30	13:30	1:00	C	Patch test multibeam in WEA area, calm sea conditions
13:30	14:40	1:10	T	Transit to MET Tower for MBES survey
		0:00	O	SVP dip and start MBES SAP survey @ MET Tower
16:40	17:00	0:20	O	MBES survey complete, SVP and deploy PAMS eel
17:00	18:05	1:05	O	PSO/PAMS observations before ramp up, maneuver towards geo survey lines
18:05	18:40	0:35	O	Begin ramp up SBES/SBP
18:40	19:20	0:40	O	Deploy SSS/MAG and tune equipment
19:20	24:00	4:40	O	online, begin survey ops

EE.	PROJECT DATA:
E1.	Time Summary:

Rate	Code		Previous Hours	Today Hours	Total Hours		Percent of Total
Mobilization	M		61:00	0:00	61:00		54.95
Transit	T		4:35	1:10	5:45		5.18
Calibrations	C		3:25	2:30	5:55		5.33
Operational	O		4:45	18:20	23:05		20.80
Weather Standby	W		15:15	0:00	15:15		13.74
Standby on Client	S		0:00	0:00	0:00		0.00
Vessel Downtime	VD		0:00	0:00	0:00		0.00
Port Standby	PS		0:00	0:00	0:00		0.00
Survey Downtime	SD		0:00	0:00	0:00		0.00
PSO Mitigation	MT		0:00	0:00	0:00		0.00
Disputed Time	DT		0:00	0:00	0:00		0.00
			0:00				
		TOTAL	89:00	22:00	111:00		**100.00%**

Hrs. of Daily Operations *24* **Cumulative Hours Check Value=** **120.00**

E2.	Survey Progress:							
Description		Km Left	Area	Total Km	Km Prev	Today Km	Km To Date	% Completed
HRG Survey		5410.20	MD WEA	5446.00	0.00	35.80	35.80	0.66%
0		0.00	0	0.00	0.00		0.00	
0		0.00	0	0.00	0.00		0.00	
0		0.00	0	0.00	0.00		0.00	
	TOTALS:	5410.20	**TOTAL**	5446.00	0.00	**35.80**	**35.80**	0.66%

FF. **SAFETY** (Details & Figures for Vessel and Survey Crews and Client Representatives)

Incidents & Drills	Previous Events	Today's Events	Events To Date
Project & HSE Briefings	3		3
Ships Drill, MOB, Fire & Abandon Ship	1		1
Vessel guided tour	0		0
Medical Treatment / First Aid Cases	0		0
Tool Box Meetings	2	2	4
Incident Reports	0		0
Near Miss Reports	0		0
Savety Observation Card (SOB)	0		0
	0		0
	0		0
No. of survey Man-Hours worked since start of project or LTI.	1483:00	**396:00**	**1879:00**

GG. **VESSEL ROB's at 24:00hrs**

	Fuel (T)	Lube Oil (L)	Water (T)
	0.00	***0.00***	***0.00***
ROB at 00:00 hrs	0.00	0.00	0.00
Consumed Today	0.00	0.00	0.00
Received today	0.00	0.00	0.00
ROB at 24:00 hrs	**0.00**	**0.00**	**0.00**

HH. **EXPECTED WEATHER NEXT 24 HRS:**

NE winds 15 kts, seas 4 to 5 ft.

II. **ANTICIPATED PROGRAM NEXT 24 HRS:**

Continue survey operations

JJ. **PARTY CHIEF'S COMMENTS: (Optional)**

Completed vessel and HRG noise signature tests with PAMS equipment. Finished calibrations of geophysical equipment. Favorable sea states all day, re-ran multibeam calibration while in good weather conditions. Geophysical survey operations began in the WEA area, focused on the MET Tower and nearby boring locations.

KK. **REPRESENTATIVE'S COMMENTS: (Optional)**

For ALPINE		For **US Wind**

Justin Bailey		0
(Survey Party Chief)		(Client Representative)

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Date:	**06 June 2015**
Location:	**Ocean City, MD**	Report No.	**005**
Project:	**Maryland WEA SAP Survey**		

Alpine
A GARDLINE COMPANY

DAILY REPORT

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Todays Date:	**07 June 2015**
Location:	**Ocean City, MD**	Report No:	**6**
Project:	**Maryland WEA SAP Survey**	Start Date:	**02 June 2015**

All times are ***Local*** *(GMT -* ***4:00*** *hrs)*

AA. VESSEL LOCATION AT 24:00 HRS:

Description: **WEA** Latitude: **38 15.5950** Longitude: **74 45.2897**

BB. WEATHER:

Time (Local)	BAROM in	WIND Speed kts	WIND Dir	WAVE HEIGHT m	VISIB. nmi	SKY CONDS	REMARKS
00:00	30.05	5	NE	1.3	7	clear	
08:00	30.16	11	ENE	1.3	7	clear	
16:00	30.16	10	ENE	1.5	7	clear	
24:00	30.11	12	ENE	1.5	7	clear	

CC. PERSONNEL & EQUIPMENT:

C1. Alpine OSS Personnel:

Party Chief:	Justin Bailey	PSO:	Sharon Doake, Teresa Martin	Processor:	Dan Whitesell, Kelly Johns
Shift Supervisor:	Marcus Kwasek, Chris Stillman	PSO:	Randal Counihan, Sam Tufano		
Surveyor:	Kaios Ryan, Trevor Hoskins	PSO:	Jack Allum		

C2. Additional Personnel

C3. Client Personnel:

Client Rep.

C4. Personnel On Board:

ALPINE:	9	CLIENT:	0	VESSEL:	6	OTHERS:	3	**TOTAL 18**

C5. ALPINE'S Equipment:

Applanix POS MV	ODOM CVM Singlebeam	R2Sonic MBES
Klein 3900 Side Scan Sonar	Valeport SVP	
Geometrics G882 Magnetometer	Gardline PAMS Mark III	
Datasonics CHIRP III Subbottom Profiler	Gen3 Night Vison Goggles w/ COTI	

C6. Additional Equipment

C7. Project Variations (include notices of changes of personnel / equipment)

	On Vessel
Personnel:	**Personnel:**
Equipment:	**Equipment:**

DD. DIARY OF EVENTS TODAY:

From	To	hrs	Code	
00:00	8:24	8:24	O	Continue survey ops
8:24	9:24	1:00	MT	PSO Shutdown due to sea turtle in exclusion zone
9:24	9:46	0:22	MT	Start ramp up after 1 hr observations
9:46	24:00	14:14	O	Continue survey ops

EE. PROJECT DATA:

E1. Time Summary:

Rate	Code	Previous Hours	Today Hours	Total Hours	Percent of Total
Mobilization	M	61:00	0:00	61:00	45.19
Transit	T	5:45	0:00	5:45	4.26
Calibrations	C	5:55	0:00	5:55	4.38
Operational	O	23:05	22:38	45:43	33.86
Weather Standby	W	15:15	0:00	15:15	11.30
Standby on Client	S	0:00	0:00	0:00	0.00
Vessel Downtime	VD	0:00	0:00	0:00	0.00
Port Standby	PS	0:00	0:00	0:00	0.00
Survey Downtime	SD	0:00	0:00	0:00	0.00
PSO Mitigation	MT	0:00	1:22	1:22	1.01
Disputed Time	DT	0:00	0:00	0:00	0.00
		0:00			
TOTAL		111:00	24:00	135:00	**100.00%**

Hrs. of Daily Operations *24* **Cumulative Hours Check Value=** **144.00**

E2. Survey Progress:

Description	Km Left	Area	Total Km	Km Prev	Today Km	Km To Date	% Completed
HRG Survey	5290.20	MD WEA	5446.00	35.80	120.00	155.80	2.86%
0	0.00	0	0.00	0.00		0.00	
0	0.00	0	0.00	0.00		0.00	
0	0.00	0	0.00	0.00		0.00	
TOTALS:	5290.20	**TOTAL**	5446.00	35.80	**120.00**	**155.80**	2.86%

FF. SAFETY (Details & Figures for Vessel and Survey Crews and Client Representatives)

Incidents & Drills	Previous Events	Today's Events	Events To Date
Project & HSE Briefings	3		3
Ships Drill, MOB, Fire & Abandon Ship	1		1
Vessel guided tour	0		0
Medical Treatment / First Aid Cases	0		0
Tool Box Meetings	4	3	7
Incident Reports	0		0
Near Miss Reports	0		0
Savety Observation Card (SOB)	0		0
	0		0
	0		0
No. of survey Man-Hours worked since start of project or LTI.	1879:00	**432:00**	**2311:00**

GG. VESSEL ROB's at 24:00hrs

	Fuel (T)	Lube Oil (L)	Water (T)
	0.00	***0.00***	***0.00***
ROB at 00:00 hrs	0.00	0.00	0.00
Consumed Today	0.00	0.00	0.00
Received today	0.00	0.00	0.00
ROB at 24:00 hrs	**0.00**	**0.00**	**0.00**

HH. EXPECTED WEATHER NEXT 24 HRS:

small craft advisory from this afternoon through Tuesday, 15-25 kt S winds 4-7 ft seas with thunderstorms

II. ANTICIPATED PROGRAM NEXT 24 HRS:

continue survey operations as long as weather allows.

JJ. PARTY CHIEF'S COMMENTS: (Optional)

Good production today with one PSO shutdown for a Sea Turtle entering exclusion zone. Discussed procedures for SVP casts - PSOs were disconnecting hydrophone eel to recover before conducting SVP cast which requires 1-hr watch and ramp up. Now they well leave connected and in water during SVP cast so they can keep mitigating, avoiding PSO watch and ramp up. Weather may suspend operations tonight - if so we will likely take cover inside Delaware Bay until things calm down. Extended forecast is favorable.

KK. REPRESENTATIVE'S COMMENTS: (Optional)

For ALPINE		For **US Wind**

Justin Bailey (Survey Party Chief)		**0** (Client Representative)

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Date:	**07 June 2015**
Location:	**Ocean City, MD**	Report No.	**006**
Project:	**Maryland WEA SAP Survey**		

Alpine A GARDLINE COMPANY

DAILY REPORT

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Todays Date:	**08 June 2015**
Location:	**Ocean City, MD**	Report No:	**7**
Project:	**Maryland WEA SAP Survey**	Start Date:	**02 June 2015**

All times are ***Local*** *(GMT -* ***4:00*** *hrs)*

AA. VESSEL LOCATION AT 24:00 HRS:

Description: **Delaware Bay / Harbor of Refuge** Latitude: **38 49.296** Longitude: **75 06.211**

BB. WEATHER:

Time (Local)	BAROM in	WIND Speed kts	WIND Dir	WAVE HEIGHT m	VISIB. nmi	SKY CONDS	REMARKS
00:00	30.11	12	ENE	1.5	7	clear	
08:00	30.07	13	S	1.5	7	clear	
16:00	29.91	20	S	1.5	7	clear	
24:00	29.84	20-25	s	2	7	clear	

CC. PERSONNEL & EQUIPMENT:

C1. Alpine OSS Personnel:

Party Chief:	Justin Bailey	PSO:	Sharon Doake, Teresa Martin	Processor:	Dan Whitesell, Kelly Johns
Shift Supervisor:	Marcus Kwasek, Chris Stillman	PSO:	Randal Counihan, Sam Tufano		
Surveyor:	Kaios Ryan, Trevor Hoskins	PSO:	Jack Allum		

C2. Additional Personnel

Wayne Porter (1st Capt), Michael Porter (2nd Captn), Mike (3rd Captn), Steve Miller (deckhand), Sydney (deckhand), Larry James (cook)

C3. Client Personnel:

Client Rep.

C4. Personnel On Board:

ALPINE:	9	CLIENT:	0	VESSEL:	6	OTHERS:	3	TOTAL 18

C5. ALPINE'S Equipment:

Applanix POS MV	ODOM CVM Singlebeam	R2Sonic MBES
Klein 3900 Side Scan Sonar	Valeport SVP	
Geometrics G882 Magnetometer	Gardline PAMS Mark III	
Datasonics CHIRP III Subbottom Profiler	Gen3 Night Vison Goggles w/ COTI	

C6. Additional Equipment

C7. Project Variations (include notices of changes of personnel / equipment)

Off Vessel	On Vessel
Personnel:	**Personnel:**
Equipment:	**Equipment:**

DD. DIARY OF EVENTS TODAY:

From	To	hrs	Code	
00:00	12:30	12:30	O	continue survey ops WEA
12:30	12:45	0:15	O	wind and seas building, difficult keeping vessel online, loop around cont. line
12:45	14:50	2:05	W	end survey, weather inhibits data acquisition and safety, recover gear
14:50	20:10	5:20	W	transit to Delaware Bay for safe harbor
20:10	24:00	3:50	W	Drop anchor in Harbor of Refuge - inside Cape Henlopen Delaware Bay, Standby for weather
		0:00		
		0:00		
		0:00		
		0:00		
		0:00		
		0:00		
		0:00		

		0:00		

EE.	PROJECT DATA:
E1.	**Time Summary:**

Rate	Code		Previous Hours	Today Hours	Total Hours		Percent of Total
Mobilization	M		61:00	0:00	61:00		38.36
Transit	T		5:45	0:00	5:45		3.62
Calibrations	C		5:55	0:00	5:55		3.72
Operational	O		45:43	12:45	58:28		36.77
Weather Standby	W		15:15	11:15	26:30		16.67
Standby on Client	S		0:00	0:00	0:00		0.00
Vessel Downtime	VD		0:00	0:00	0:00		0.00
Port Standby	PS		0:00	0:00	0:00		0.00
Survey Downtime	SD		0:00	0:00	0:00		0.00
PSO Mitigation	MT		1:22	0:00	1:22		0.86
Disputed Time	DT		0:00	0:00	0:00		0.00
			0:00				
		TOTAL	135:00	24:00	159:00		**100.00%**

Hrs. of Daily Operations *24* **Cumulative Hours Check Value=** **168.00**

E2.	Survey Progress:

Description	Km Left	Area	Total Km	Km Prev	Today Km	Km To Date	% Completed
HRG Survey	5173.20	MD WEA	5446.00	155.80	117.00	272.80	5.01%
0	0.00	0	0.00	0.00		0.00	
0	0.00	0	0.00	0.00		0.00	
0	0.00	0	0.00	0.00		0.00	
TOTALS:	5173.20	**TOTAL**	5446.00	155.80	**117.00**	**272.80**	5.01%

FF.	**SAFETY** (Details & Figures for Vessel and Survey Crews and Client Representatives)

Incidents & Drills	Previous Events	Today's Events	Events To Date
Project & HSE Briefings	3		3
Ships Drill, MOB, Fire & Abandon Ship	1		1
Vessel guided tour	0		0
Medical Treatment / First Aid Cases	0		0
Tool Box Meetings	7	2	9
Incident Reports	0		0
Near Miss Reports	0		0
Savety Observation Card (SOB)	0		0
	0		0
	0		0
No. of survey Man-Hours worked since start of project or LTI.	2311:00	**432:00**	**2743:00**

GG.	VESSEL ROB's at 24:00hrs

	Fuel (T)	Lube Oil (L)	Water (T)
	0.00	***0.00***	***0.00***
ROB at 00:00 hrs	0.00	0.00	0.00
Consumed Today	0.00	0.00	0.00
Received today	0.00	0.00	0.00
ROB at 24:00 hrs	**0.00**	**0.00**	**0.00**

HH. EXPECTED WEATHER NEXT 24 HRS:

S winds 20-30 kts, 5-6 ft seas

II. ANTICIPATED PROGRAM NEXT 24 HRS:

Standby until weather improves

JJ. PARTY CHIEF'S COMMENTS: (Optional)

Good production today until wind and seas built up to inhibit data acquisition. No protected species sightings or shutdowns. We were unable to make it into Ocean City due to the swell direction and needing high tide to get into inlet. We transited up to Cape Henlopen in Delaware Bay for a Harbor of Safe Refuge until weather conditions improve.

KK. REPRESENTATIVE'S COMMENTS: (Optional)

For ALPINE | For **US Wind**

Justin Bailey		0
(Survey Party Chief)		(Client Representative)

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Date:	**08 June 2015**
Location:	**Ocean City, MD**	Report No.	**007**
Project:	**Maryland WEA SAP Survey**		

Alpine A GARDLINE COMPANY

DAILY REPORT

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Todays Date:	**09 June 2015**
Location:	**Ocean City, MD**	Report No:	**8**
Project:	**Maryland WEA SAP Survey**	Start Date:	**02 June 2015**

All times are ***Local*** *(GMT -* ***4:00*** *hrs)*

AA. VESSEL LOCATION AT 24:00 HRS:

Description: **WEA survey area** Latitude: **38 18.041** Longitude: **74 45.534**

BB. WEATHER:

Time (Local)	BAROM in	WIND Speed kts	WIND Dir	WAVE HEIGHT m	VISIB. nmi	SKY CONDS	REMARKS
00:00	29.84	20-25	S	2	7	clear	
08:00	29.77	20	S	2	7	clear	
16:00	29.73	10-15	W	1.5	7	clear	
24:00	29.8	10	SW	1	7	clear	

CC. PERSONNEL & EQUIPMENT:

C1. Alpine OSS Personnel:

Party Chief:		PSO:	Sharon Doake, Teresa Martin	Processor:	Dan Whitesell, Kelly Johns
Shift Supervisor:	Marcus Kwasek, Chris Stillman	PSO:	Randal Counihan, Sam Tufano		
Surveyor:	Kaios Ryan, Trevor Hoskins	PSO:	Jack Allum		

C2. Additional Personnel

C3. Client Personnel:

Client Rep.

C4. Personnel On Board:

ALPINE:	9	CLIENT:	0	VESSEL:	6	OTHERS:	3	**TOTAL 18**

C5. ALPINE'S Equipment:

Applanix POS MV	ODOM CVM Singlebeam	R2Sonic MBES
Klein 3900 Side Scan Sonar	Valeport SVP	
Geometrics G882 Magnetometer	Gardline PAMS Mark III	
Datasonics CHIRP III Subbottom Profiler	Gen3 Night Vison Goggles w/ COTI	

C6. Additional Equipment

C7. Project Variations (include notices of changes of personnel / equipment)

Off Vessel	**On Vessel**
Personnel:	**Personnel:**
Equipment:	**Equipment:**

DD. DIARY OF EVENTS TODAY:

From	To	hrs	Code	
00:00	15:10	15:10	W	Weather standby in Delaware Bay Harbor of Safe Refuge
15:10	19:00	3:50	W	fire up mains, retrieve anchor and transit offshore to MEA survey area
19:00	19:15	0:15	W	SVP cast - 1.5 hrs from WEA
19:15	20:30	1:15	W	deploy PAMS and begin observations pre-survey, cont. transit to site
20:30	20:55	0:25	W	deploy SSS/MAG and begin ramp up
20:55	24:00	3:05	O	Resume survey ops in WEA

EE.	PROJECT DATA:						
E1.	Time Summary:						
Rate	Code		Previous Hours	Today Hours	Total Hours		Percent of Total
Mobilization	M		61:00	0:00	61:00		33.33
Transit	T		5:45	0:00	5:45		3.14
Calibrations	C		5:55	0:00	5:55		3.23
Operational	O		58:28	3:05	61:33		33.63
Weather Standby	W		26:30	20:55	47:25		25.91
Standby on Client	S		0:00	0:00	0:00		0.00
Vessel Downtime	VD		0:00	0:00	0:00		0.00
Port Standby	PS		0:00	0:00	0:00		0.00
Survey Downtime	SD		0:00	0:00	0:00		0.00
PSO Mitigation	MT		1:22	0:00	1:22		0.75
Disputed Time	DT		0:00	0:00	0:00		0.00
		TOTAL	159:00	24:00	183:00		**100.00%**

Hrs. of Daily Operations *24* **Cumulative Hours Check Value=** **192.00**

E2.	Survey Progress:						
Description	Km Left	Area	Total Km	Km Prev	Today Km	Km To Date	% Completed
HRG Survey	5111.20	MD WEA	5446.00	272.80	62.00	334.80	6.15%
0	0.00	0	0.00	0.00		0.00	
0	0.00	0	0.00	0.00		0.00	
0	0.00	0	0.00	0.00		0.00	
TOTALS:	5111.20	**TOTAL**	5446.00	272.80	**62.00**	**334.80**	6.15%

FF.	**SAFETY** (Details & Figures for Vessel and Survey Crews and Client Representatives)		
Incidents & Drills	Previous Events	Today's Events	Events To Date
Project & HSE Briefings	3		3
Ships Drill, MOB, Fire & Abandon Ship	1		1
Vessel guided tour	0		0
Medical Treatment / First Aid Cases	0		0
Tool Box Meetings	9	2	11
Incident Reports	0		0
Near Miss Reports	0		0
Savety Observation Card (SOB)	0		0
	0		0
	0		0
No. of survey Man-Hours worked since start of project or LTI.	2743:00	**432:00**	**3175:00**

GG.	VESSEL ROB's at 24:00hrs		
	Fuel (T)	Lube Oil (L)	Water (T)
	0.00	***0.00***	***0.00***
ROB at 00:00 hrs	0.00	0.00	0.00
Consumed Today	0.00	0.00	0.00
Received today	0.00	0.00	0.00
ROB at 24:00 hrs	**0.00**	**0.00**	**0.00**

HH. EXPECTED WEATHER NEXT 24 HRS:

Light and variable winds, 0.5 - 1 m seas

II. ANTICIPATED PROGRAM NEXT 24 HRS:

continue survey operations in MEA

JJ. PARTY CHIEF'S COMMENTS: (Optional)

Pulled anchor and began transit back to WEA when wind switched from S to W. Sea states much improved, continued survey operations in WEA.

KK. REPRESENTATIVE'S COMMENTS: (Optional)

For ALPINE		For **US Wind**

0		0
(Survey Party Chief)		(Client Representative)

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Date:	**09 June 2015**
Location:	**Ocean City, MD**	Report No.	**008**
Project:	**Maryland WEA SAP Survey**		

DAILY REPORT

Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Todays Date:	**10 June 2015**
Location:	**Ocean City, MD**	Report No:	**9**
Project:	**Maryland WEA SAP Survey**	Start Date:	**02 June 2015**

All times are ***Local*** *(GMT -* ***4:00*** *hrs)*

AA. VESSEL LOCATION AT 24:00 HRS:

Description: **WEA** Latitude: **38 20.83305** Longitude: **74 50.16253**

BB. WEATHER:

Time (Local)	BAROM in	WIND Speed kts	WIND Dir	WAVE HEIGHT m	VISIB. nmi	SKY CONDS	REMARKS
00:00	29.8	10	SW	1	7	clear	
08:00	29.92	light	E	<1	7	hazy	
16:00	29.91	light	E	<1	7	clear	
24:00	29.91	light	E	<1	7	clear	

CC. PERSONNEL & EQUIPMENT:

C1. Alpine OSS Personnel:

Party Chief: Justin Bailey
Shift Supervisor: Marcus Kwasek, Chris Stillman
Surveyor: Kaios Ryan, Trevor Hoskins
PSO: Sharon Doake, Teresa Martin
PSO: Randal Counihan, Sam Tufano
PSO: Jack Allum
Processor: Dan Whitesell, Kelly Johns

C2. Additional Personnel

C3. Client Personnel:

Client Rep.

C4. Personnel On Board:

ALPINE:	CLIENT:	VESSEL:	OTHERS:	TOTAL
9		6	3	**18**

C5. ALPINE'S Equipment:

Applanix POS MV	ODOM CVM Singlebeam	R2Sonic MBES		
Klein 3900 Side Scan Sonar	Valeport SVP			
Geometrics G882 Magnetometer	Gardline PAMS Mark III			
Datasonics CHIRP III Subbottom Profiler	Gen3 Night Vison Goggles w/ COTI			

C6. Additional Equipment

C7. Project Variations (include notices of changes of personnel / equipment)

Off Vessel	On Vessel
Personnel:	**Personnel:**
Equipment:	**Equipment:**

DD. DIARY OF EVENTS TODAY:

From	To	hrs	Code	
00:00	9:30	9:30	M	continue survey operations in WEA
9:30	16:15	6:45	SD	MAG failure, troubleshoot
16:15	17:00	0:45	SD	Power supply failed in SSS towfish, replacement ordered for delivery tomorrow via Sea Tow
17:00	24:00	7:00	O	re-do PAMS noise tests, calm water so vessel can go "dead in the water"

EE.	**PROJECT DATA:**						
E1.	**Time Summary:**						
Rate	Code		Previous Hours	Today Hours	Total Hours		Percent of Total
Mobilization	M		61:00	9:30	70:30		34.06
Transit	T		5:45		5:45		2.78
Calibrations	C		5:55		5:55		2.86
Operational	O		61:33	7:00	68:33		33.12
Weather Standby	W		47:25		47:25		22.91
Standby on Client	S						
Vessel Downtime	VD						
Port Standby	PS						
Survey Downtime	SD			7:30	7:30		3.62
PSO Mitigation	MT		1:22		1:22		0.66
Disputed Time	DT						
		TOTAL	183:00	24:00	207:00		**100.00%**

Hrs. of Daily Operations *24* **Cumulative Hours Check Value=** **216.00**

E2.	**Survey Progress:**						
Description		Km Left	Area	Total Km	Km Prev	Today Km	Km To Date	% Completed
HRG Survey		5039.20	MD WEA	5446.00	334.80	72.00	406.80	7.47%
	TOTALS:	5039.20	**TOTAL**	5446.00	334.80	**72.00**	**406.80**	7.47%

FF.	**SAFETY** (Details & Figures for Vessel and Survey Crews and Client Representatives)			
Incidents & Drills	Previous Events	Today's Events	Events To Date	
Project & HSE Briefings	3		3	
Ships Drill, MOB, Fire & Abandon Ship	1		1	
Vessel guided tour				
Medical Treatment / First Aid Cases				
Tool Box Meetings	11	2	13	
Incident Reports				
Near Miss Reports				
Savety Observation Card (SOB)				
No. of survey Man-Hours worked since start of project or LTI.	3175:00	**432:00**	**3607:00**	

GG.	**VESSEL ROB's at 24:00hrs**		
	Fuel (T)	Lube Oil (L)	Water (T)
ROB at 00:00 hrs			
Consumed Today			
Received today			
ROB at 24:00 hrs			

HH. **EXPECTED WEATHER NEXT 24 HRS:**

SW winds 5 - 15 kts, seas 2 - 3 ft

II. **ANTICIPATED PROGRAM NEXT 24 HRS:**

complete PAMS noise signature test, repair SSS and continue geo survey operations

JJ. **PARTY CHIEF'S COMMENTS: (Optional)**

During survey operations today we had a system failure - the MAG power supply inside the SSS towfish needs to be replaced. A new power supply will be delivered to Hank Fulmer tomorrow AM along with a spare SSS system for backup. In the meantime we are re-shoooting the vessel noise signature data as the weather conditions are good enought to allow for the vessel to go "dead in the water". We were unable to do this during the first testing due to weather / sea states, safety etc. We anticipate delivery of the new parts for the SSS around 11:30 - 12:00 and will repair the equipment and resume surveying.

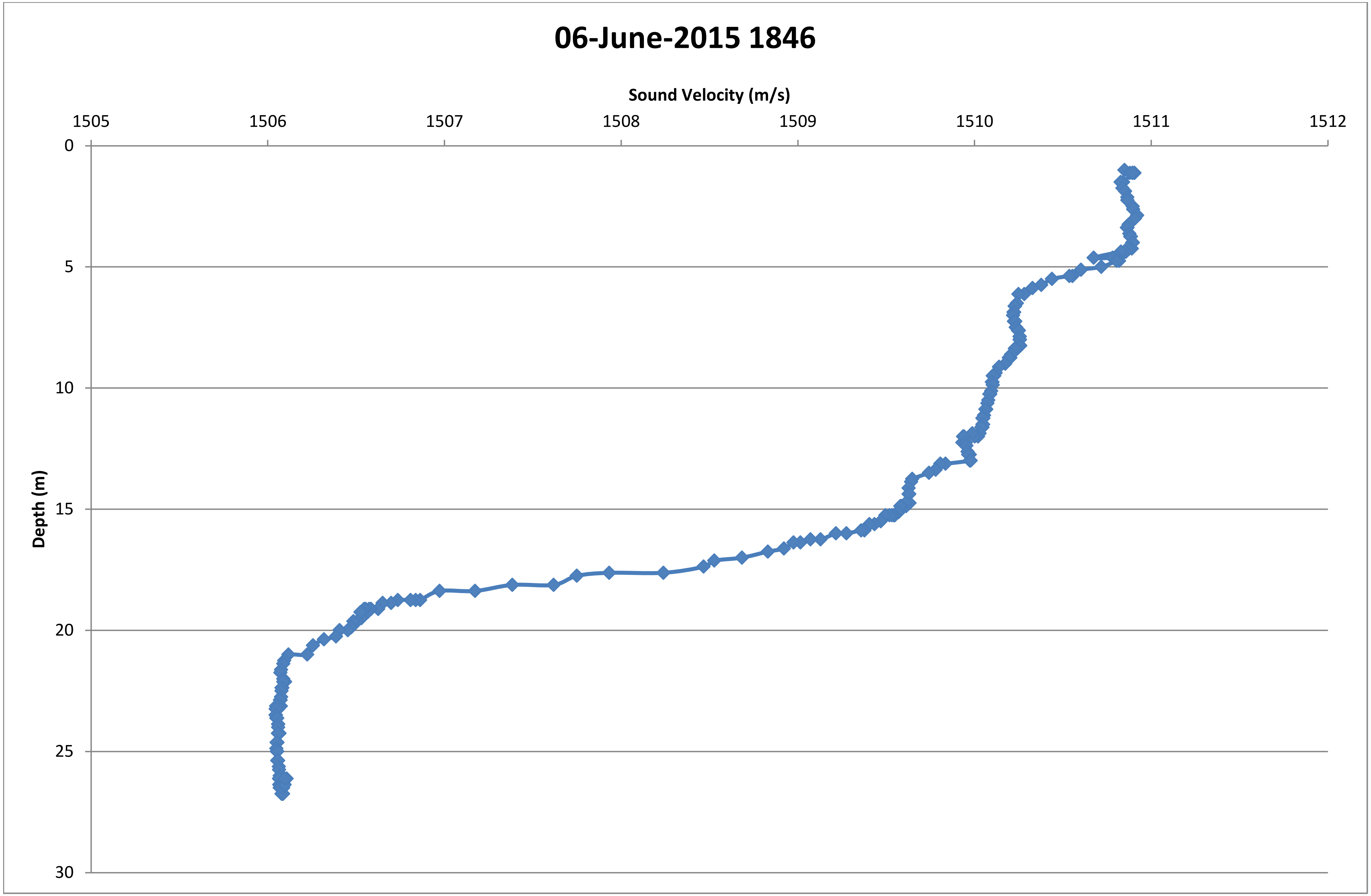
KK. **REPRESENTATIVE'S COMMENTS: (Optional)**

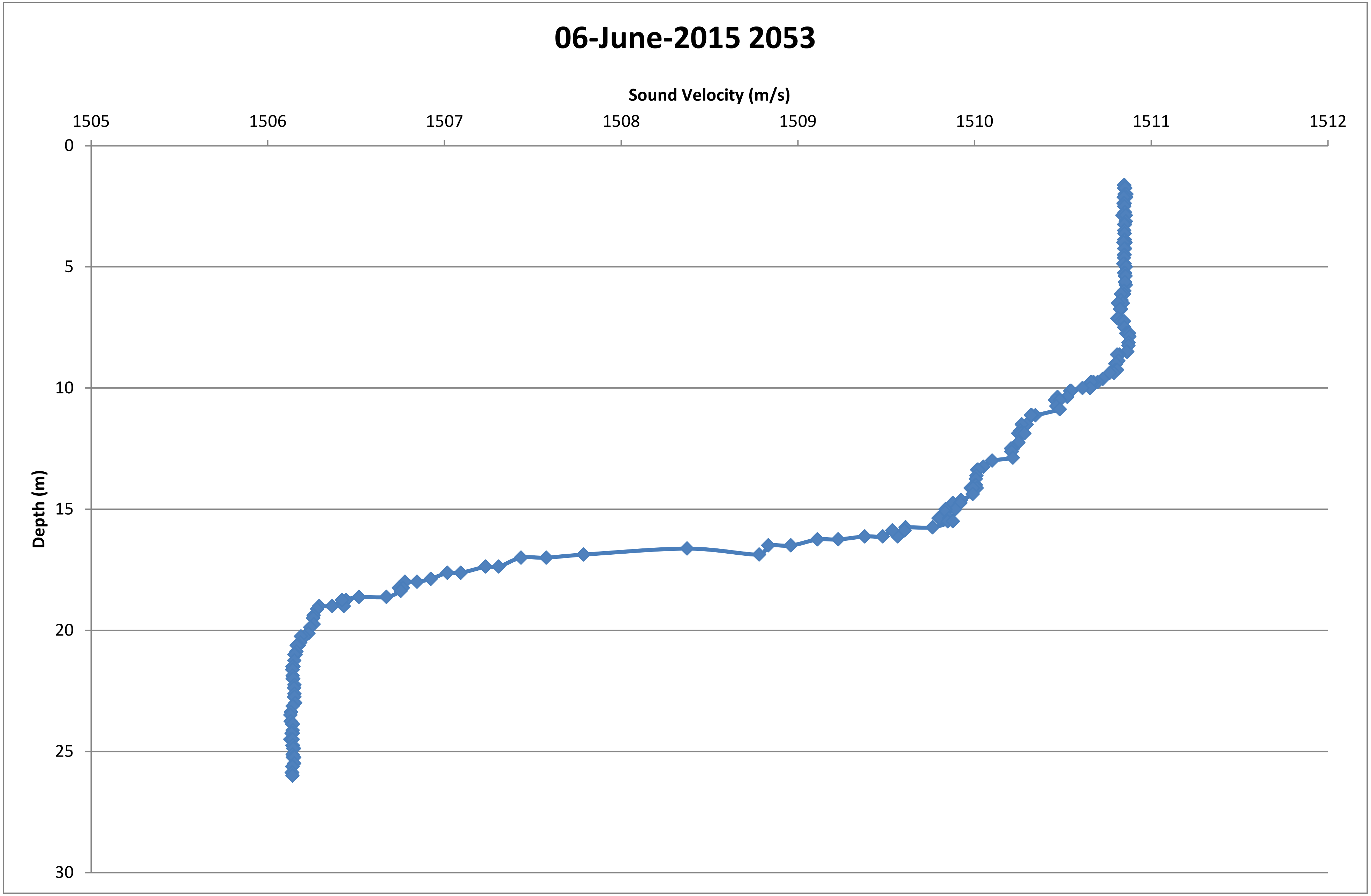
For ALPINE		For **US Wind**

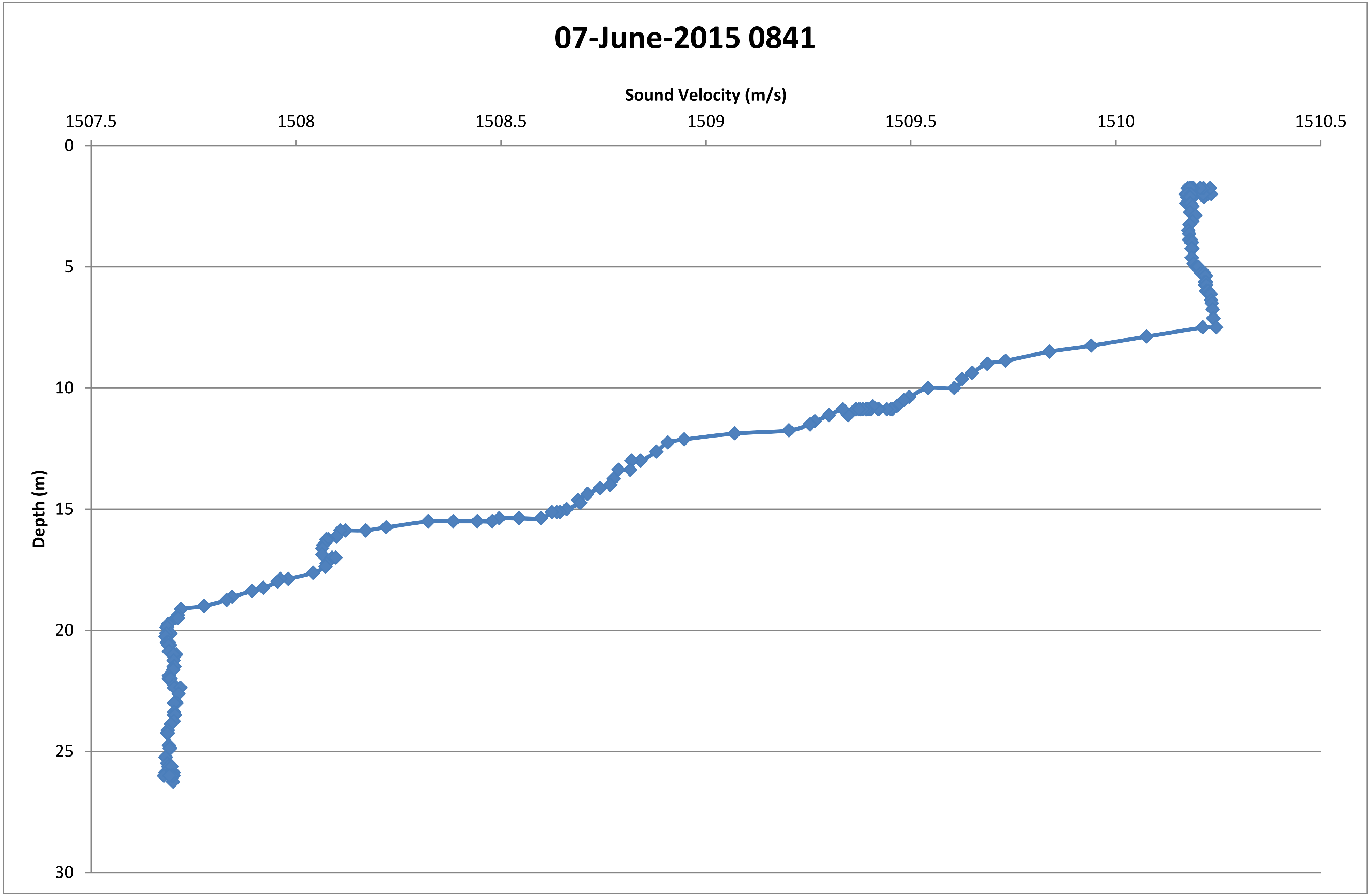
Justin Bailey		
(Survey Party Chief)		(Client Representative)

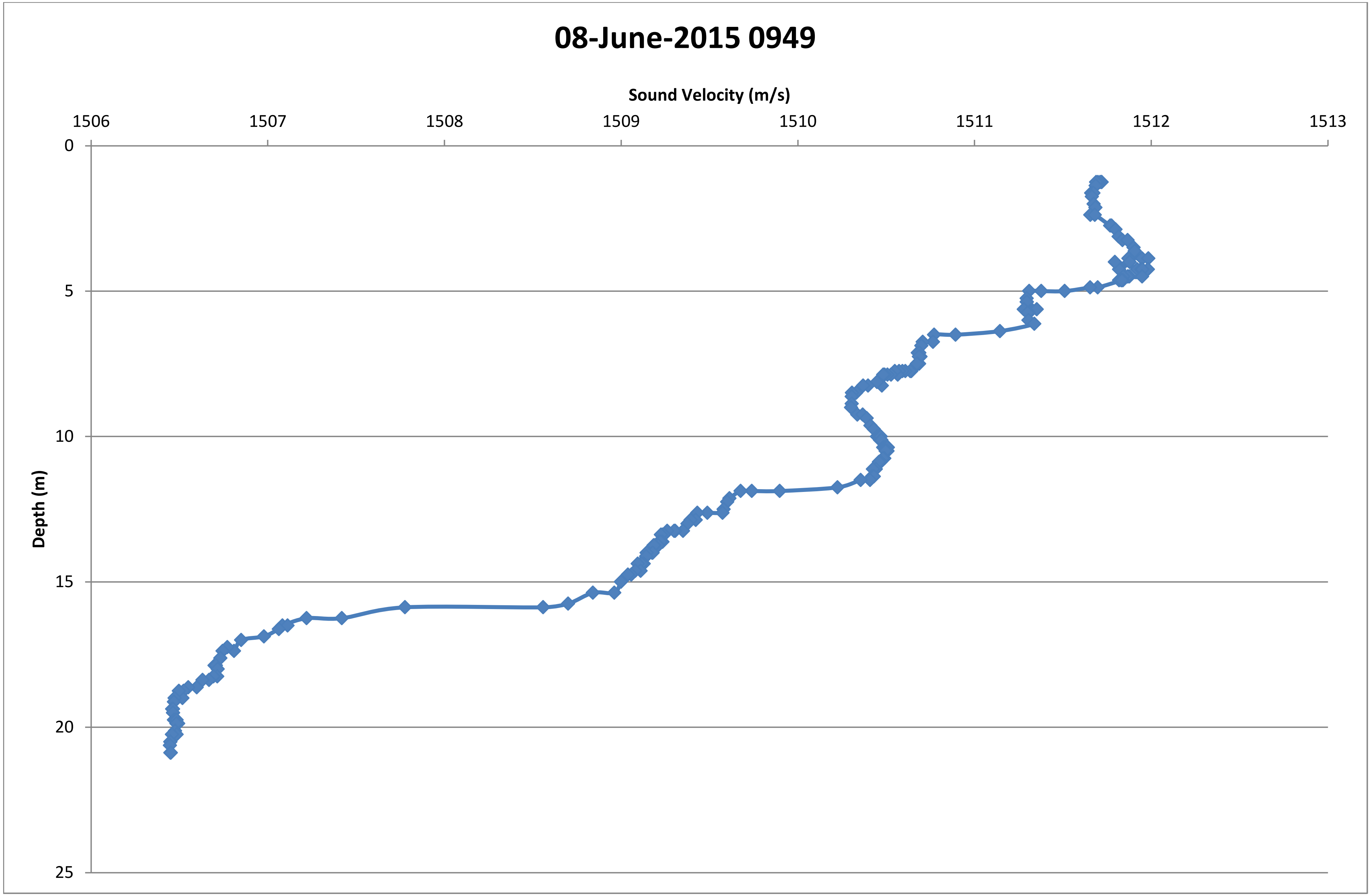
Vessel:	**RV Shearwater**	Project No:	**1751**
Client:	**US Wind**	Date:	**10 June 2015**
Location:	**Ocean City, MD**	Report No.	**009**
Project:	**Maryland WEA SAP Survey**		

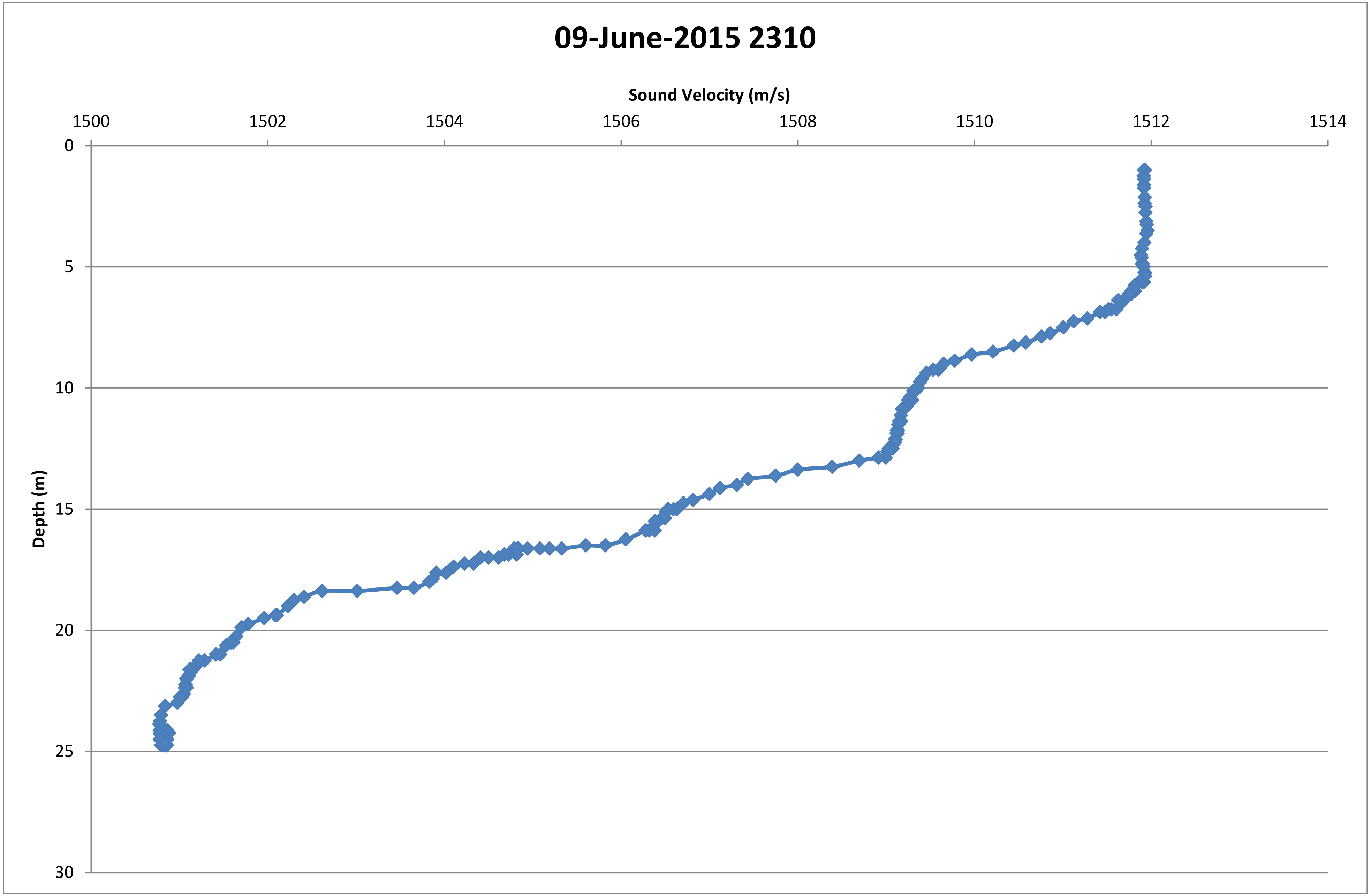
APPENDIX I SOUND VELOCITY PROFILES


06-June-2015 1846
Sound Velocity (m/s)
1505
1506
1507
1508
1509
1510
1511
1512
Depth (m)
0
5
10
15
20
25
30


06-June-2015 2053
Sound Velocity (m/s)
1505
1506
1507
1508
1509
1510
1511
1512
0
5
10
15
20
25
30
Depth (m)

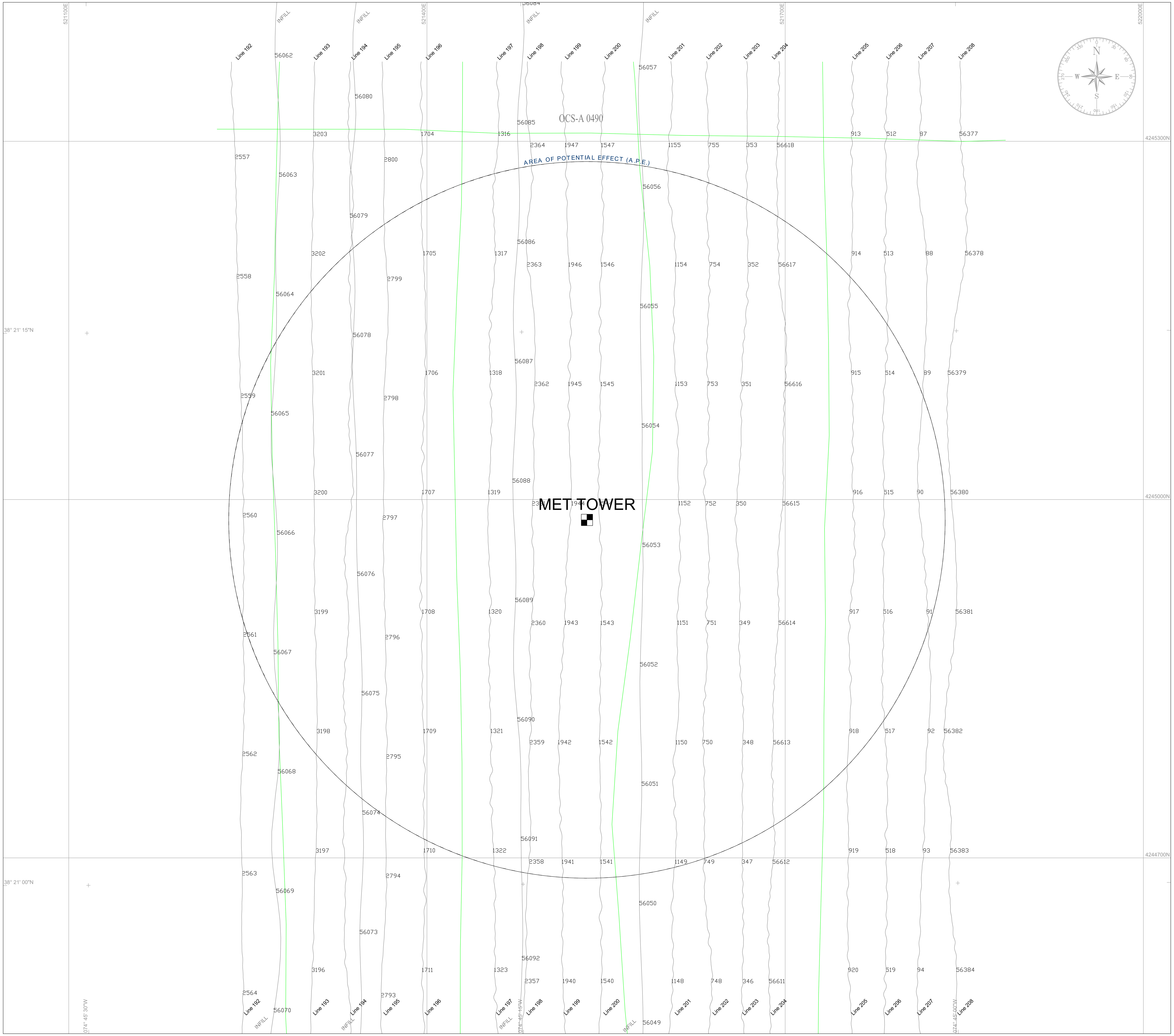

07-June-2015 0841
Sound Velocity (m/s)
1507.5
1508
1508.5
1509
1509.5
1510
1510.5
Depth (m)
0
5
10
15
20
25
30


08-June-2015 0949
Sound Velocity (m/s)
1506
1507
1508
1509
1510
1511
1512
1513
Depth (m)
0
5
10
15
20
25



09-June-2015 2310
Sound Velocity (m/s)
1500
1502
1504
1506
1508
1510
1512
1514
Depth (m)
0
5
10
15
20
25
30

CHARTS



LEGEND

OCS-A 0490 OUTER CONTINENTAL SHELF LEASE NUMBER

VESSEL TRACK LINES WITH FIX & LINE ID (2015 US WIND SURVEY)

VESSEL TRACK LINES (2013 MEA SURVEY)

BATHYMETRY

20 MAJOR BATHYMETRY CONTOUR - @ 1 m INTERVAL (MLLW)

20.5 MINOR BATHYMETRY CONTOUR - @ .5 m INTERVAL (MLLW)

DOWNSLOPE GRADIENT IN DEGREES

SEAFLOOR FEATURES AND SHALLOW GEOLOGY

FINE SEDIMENT (CLAY/SILT)

FINE TO COARSE SEDIMENT (FINE TO COARSE SAND and GRAVEL)

VERY COARSE SEDIMENT (COBBLES and BOULDERS)

2 MAJOR ISOPACH CONTOUR - @ 1 m INTERVAL

1.5 MINOR ISOPACH CONTOUR - @ 0.5 m INTERVAL

29 MAJOR STRUCTURE CONTOUR - @ 1 m INTERVAL (MLLW)

28.5 MINOR STRUCTURE CONTOUR - @ 0.5 m INTERVAL (MLLW)

BORE LOCATION & ID

MAGNETOMETER TARGET & ID

LINEAR TARGET

SIDE SCAN SONAR TARGET & ID

G1 SEAFLOOR GRAB SAMPLE AND UNDERWATER CAMERA LOCATION WITH REFERENCE NUMBER

0.84 0.21 ORIENTATION OF SEDIMENT RIPPLE CREST (WITH HEIGHT AND WAVELENGTH IN METERS)

CHARTED OR REPORTED WRECK

WK001 LOCATED WRECK WITH REFERENCE NO.

GENERAL NOTES:

Offshore Survey Vessel	RV Shearwater
Surface Positioning System	Applanix POS MV V4 with Trimble Nav Beacon
Underwater Positioning System	Sonardyne USBL Scout Pro
Bathymetry	R2 Sonic 2024 Multibeam Echo Sounder
Morphology and Stratigraphy	Klein 3900 Side Scan Sonar / Teledyne Benthos CHIRP III Sub-bottom Profiler
Magnetometer Survey	Geometrics G882

SHALLOW STRUCTURE SHADED RELIEF COLOR SCALE (m)
29.00 28.50 28.00 27.50 27.00

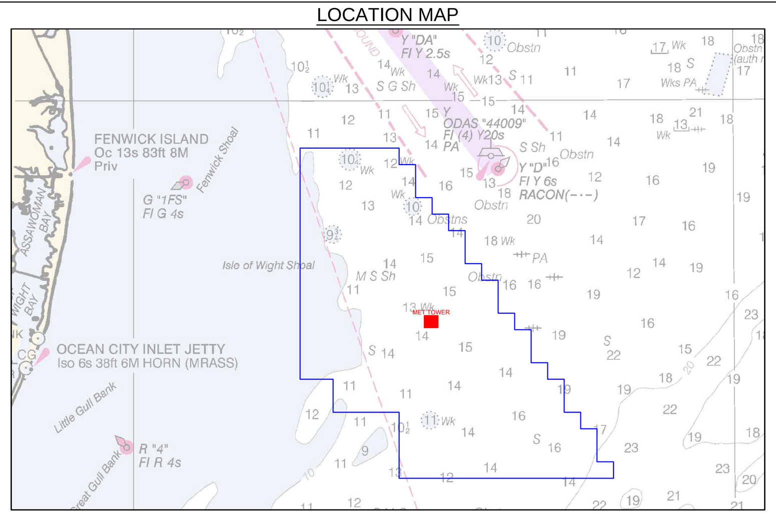
SHALLOW ISOPACH SHADED RELIEF COLOR SCALE (m)
2.2 2.1 2 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1 0.9 0.8 0.7 0.6

BATHYMETRIC SHADED RELIEF COLOR SCALE (m,MLLW)
27.50 27.25 27.00 26.75 26.50 26.25 26.00

MAGNETIC ANOMALY INTENSITY COLOR SCALE (nT)
25 20 10 0 -10 -20 -25

US Wind
1 North Charles Street, Suite 2310
Baltimore, MD 21201

LOCATION MAP



VESSEL TRACKLINE MAP

US Wind SAP G&G Survey
Meteorological Tower Area

SCALE 1 : 1,000
(1 cm = 10 meters)
10 0 20 40 80

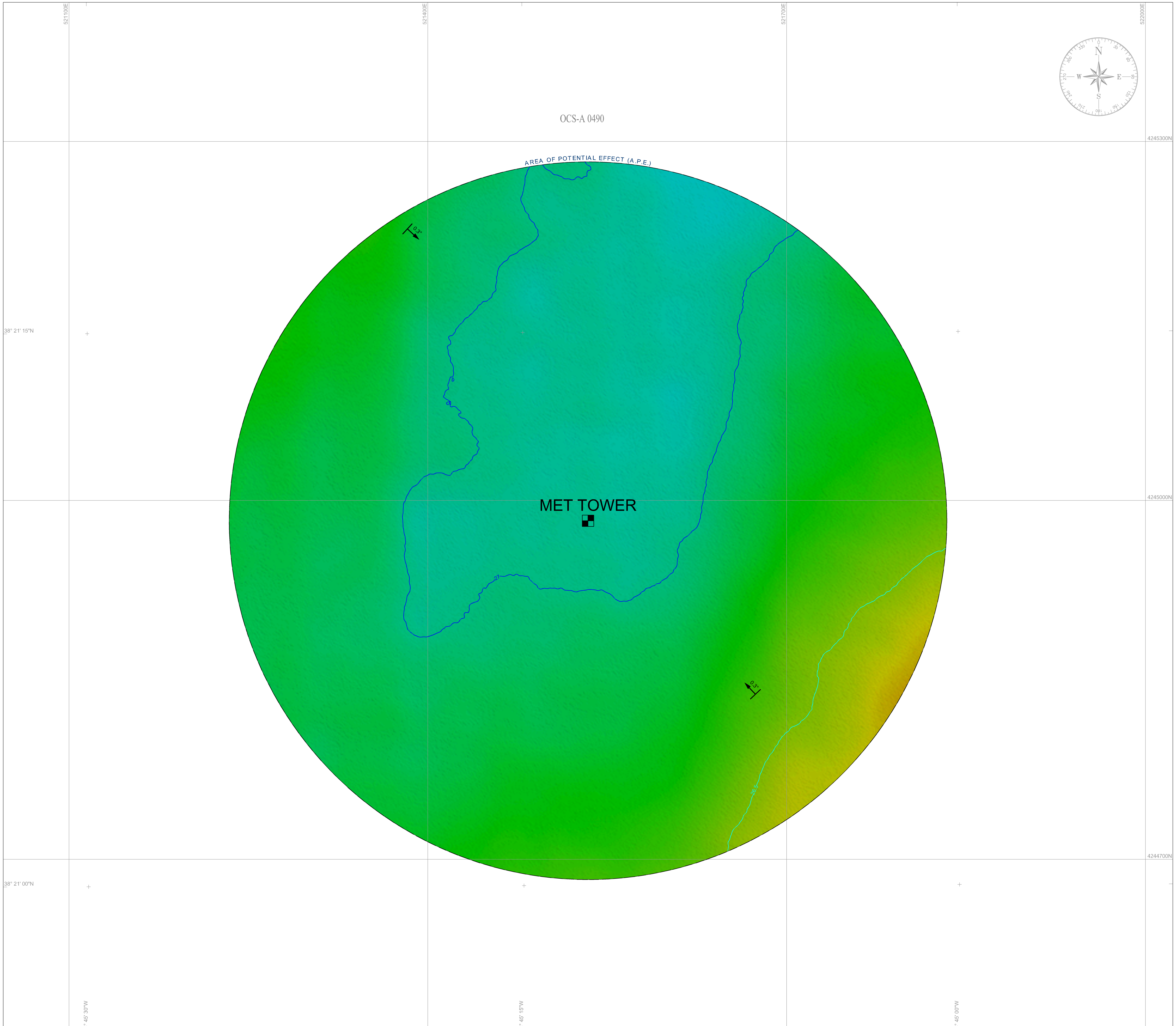
GEODETIC INFORMATION
DATUM : NAD83
VERTICAL : MLLW
PROJECTION : UTM83-18

Drawing Name:	
Vessel:	RV Shearwater, MV Ocean Discovery
Approved By:	M. Kosakowski
Interp. By:	J. Bailey / D. Whitesell
Party Chief:	J. Bailey
Drawn By:	B. Ehman
Revision:	--
Issue Date:	30-Sept.-2015
Survey Date:	June-July 2015
Chart Num :	1 of 6

Alpine

PROFESSIONAL GEOLOGISTS SIGNATURE :

ALPINE OCEAN SEISMIC SURVEY INC 155 Hudson Ave Norwood New Jersey 07648 Tel 201-768-8000 Fax 201-768-5750 www.alpineocean.com



LEGEND

OCS-A 0490 OUTER CONTINENTAL SHELF LEASE NUMBER

VESSEL TRACK LINES WITH FIX & LINE ID (2015 US WIND SURVEY)

VESSEL TRACK LINES (2013 MEA SURVEY)

BATHYMETRY

MAJOR BATHYMETRY CONTOUR - @ 1 m INTERVAL (MLLW)

MINOR BATHYMETRY CONTOUR - @ .5 m INTERVAL (MLLW)

DOWNSLOPE GRADIENT IN DEGREES

SEAFLOOR FEATURES AND SHALLOW GEOLOGY

FINE SEDIMENT (CLAY/SILT)

FINE TO COARSE SEDIMENT (FINE TO COARSE SAND and GRAVEL)

VERY COARSE SEDIMENT (COBBLES and BOULDERS)

MAJOR ISOPACH CONTOUR - @ 1 m INTERVAL

MINOR ISOPACH CONTOUR - @ 0.5 m INTERVAL

MAJOR STRUCTURE CONTOUR - @ 1 m INTERVAL (MLLW)

MINOR STRUCTURE CONTOUR - @ 0.5 m INTERVAL (MLLW)

BORE LOCATION & ID

MAGNETOMETER TARGET & ID

LINEAR TARGET

SIDE SCAN SONAR TARGET & ID

SEAFLOOR GRAB SAMPLE AND UNDERWATER CAMERA LOCATION WITH REFERENCE NUMBER

0.84 0.21 ORIENTATION OF SEDIMENT RIPPLE CREST (WITH HEIGHT AND WAVELENGTH IN METERS)

CHARTED OR REPORTED WRECK

WK001 LOCATED WRECK WITH REFERENCE NO.

GENERAL NOTES:

Offshore Survey Vessel	RV Shearwater
Surface Positioning System	Applanix POS MV V4 with Trimble Nav Beacon
Underwater Positioning System	Sonardyne USBL Scout Pro
Bathymetry	R2 Sonic 2024 Mutibeam Echo Sounder
Morphology and Stratigraphy	Klein 3900 Side Scan Sonar / Teledyne Benthos CHIRP III Sub-bottom Profiler
Magnetometer Survey	Geometrics G882

SHALLOW STRUCTURE SHADED RELIEF COLOR SCALE (m)
29.00 28.50 28.00 27.50 27.00

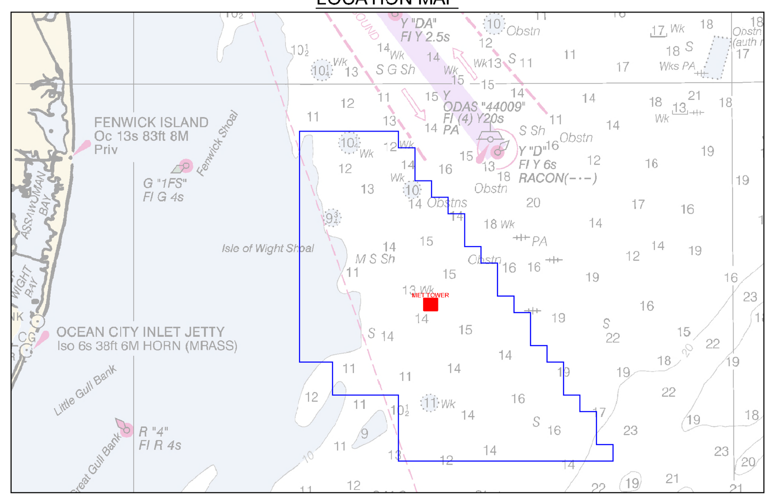
SHALLOW ISOPACH SHADED RELIEF COLOR SCALE (m)
2.2 2.1 2 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1 0.9 0.8 0.7 0.6

BATHYMETRIC SHADED RELIEF COLOR SCALE (m,MLLW)
27.50 27.25 27.00 26.75 26.50 26.25 26.00

MAGNETIC ANOMALY INTENSITY COLOR SCALE (nT)
25 20 10 0 -10 -20 -25

US Wind
1 North Charles Street, Suite 2310
Baltimore, MD 21201

LOCATION MAP



BATHYMETRY MAP

US Wind SAP G&G Survey
Meteorological Tower Area

SCALE 1 : 1,000
(1 cm = 10 meters)
10 0 20 40 80

GEODETIC INFORMATION
DATUM : NAD83
VERTICAL : MLLW
PROJECTION : UTM83-18

Drawing Name:	
Vessel:	RV Shearwater, MV Ocean Discovery
Approved By:	M. Kosakowski
Interp. By:	J. Bailey / D. Whitesell
Party Chief:	J. Bailey
Drawn By:	B. Ehman
Revision:	--
Issue Date:	30-Sept.-2015
Survey Date:	June-July 2015
Chart Num :	2 of 6

PROFESSIONAL GEOLOGISTS SIGNATURE :

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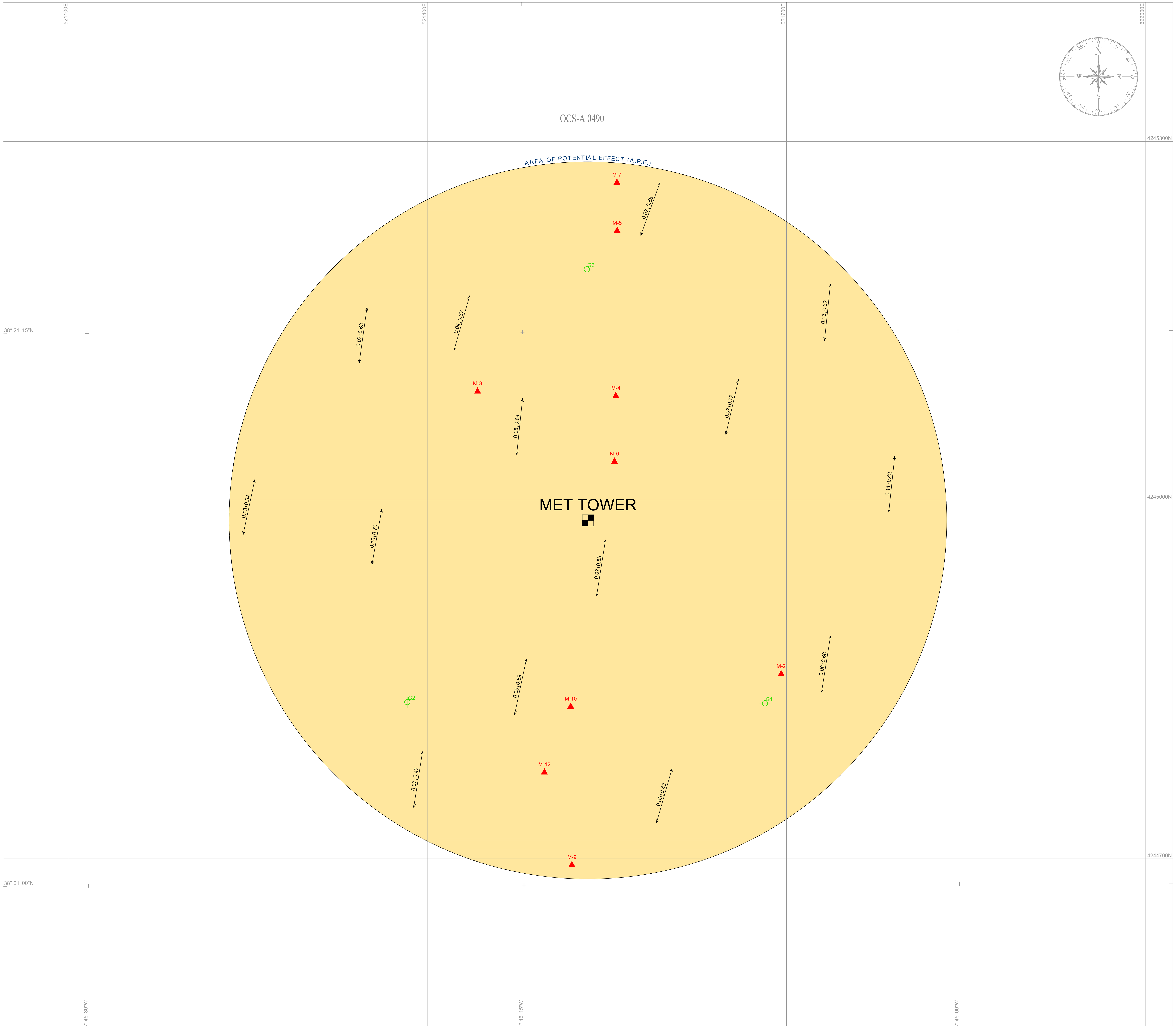


LEGEND

OCS-A 0490 OUTER CONTINENTAL SHELF LEASE NUMBER

VESSEL TRACK LINES WITH FIX & LINE ID (2015 US WIND SURVEY)

VESSEL TRACK LINES (2013 MEA SURVEY)

BATHYMETRY

MAJOR BATHYMETRY CONTOUR - @ 1 m INTERVAL (MLLW)

MINOR BATHYMETRY CONTOUR - @ .5 m INTERVAL (MLLW)

DOWNSLOPE GRADIENT IN DEGREES

SEAFLOOR FEATURES AND SHALLOW GEOLOGY

FINE SEDIMENT (CLAY/SILT)

FINE TO COARSE SEDIMENT (FINE TO COARSE SAND and GRAVEL)

VERY COARSE SEDIMENT (COBBLES and BOULDERS)

MAJOR ISOPACH CONTOUR - @ 1 m INTERVAL

MINOR ISOPACH CONTOUR - @ 0.5 m INTERVAL

MAJOR STRUCTURE CONTOUR - @ 1 m INTERVAL (MLLW)

MINOR STRUCTURE CONTOUR - @ 0.5 m INTERVAL (MLLW)

BORE LOCATION & ID

MAGNETOMETER TARGET & ID

LINEAR TARGET

SIDE SCAN SONAR TARGET & ID

SEAFLOOR GRAB SAMPLE AND UNDERWATER CAMERA LOCATION WITH REFERENCE NUMBER

ORIENTATION OF SEDIMENT RIPPLE CREST (WITH HEIGHT AND WAVELENGTH IN METERS)

CHARTED OR REPORTED WRECK

WK001 LOCATED WRECK WITH REFERENCE NO.

GENERAL NOTES:

Offshore Survey Vessel	RV Shearwater
Surface Positioning System	Applanix POS MV V4 with Trimble Nav Beacon
Underwater Positioning System	Sonardyne USBL Scout Pro
Bathymetry	R2 Sonic 2024 Multibeam Echo Sounder
Morphology and Stratigraphy	Klein 3900 Side Scan Sonar / Teledyne Benthos CHIRP III Sub-bottom Profiler
Magnetometer Survey	Geometrics G882

SHALLOW STRUCTURE SHADED RELIEF COLOR SCALE (m)

29.00 28.50 28.00 27.50 27.00

SHALLOW ISOPACH SHADED RELIEF COLOR SCALE (m)

2.2 2.1 2 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1 0.9 0.8 0.7 0.6

BATHYMETRIC SHADED RELIEF COLOR SCALE (m,MLLW)

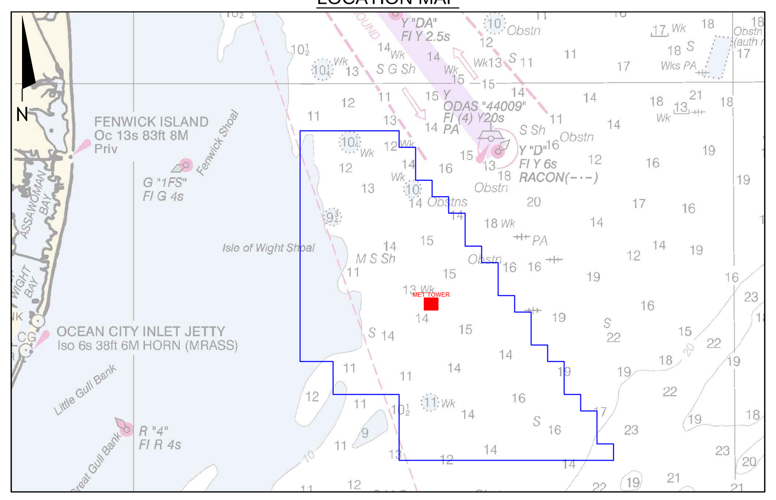
27.50 27.25 27.00 26.75 26.50 26.25 26.00

MAGNETIC ANOMALY INTENSITY COLOR SCALE (nT)

25 20 10 0 -10 -20 -25

US Wind
1 North Charles Street, Suite 2310
Baltimore, MD 21201

LOCATION MAP



SEAFLOOR FEATURES MAP

US Wind SAP G&G Survey
Meteorological Tower Area

SCALE 1 : 1,000
(1 cm = 10 meters)
10 0 20 40 80

GEODETIC INFORMATION	
DATUM :	NAD83
VERTICAL :	MLLW
PROJECTION :	UTM83-18

Drawing Name:	
Vessel:	RV Shearwater, MV Ocean Discovery
Approved By:	M. Kosakowski
Interp. By:	J. Bailey / D. Whitesell
Party Chief:	J. Bailey
Drawn By:	B. Ehman
Revision:	--
Issue Date:	30-Sept.-2015
Survey Date:	June-July 2015
Chart Num :	3 of 6

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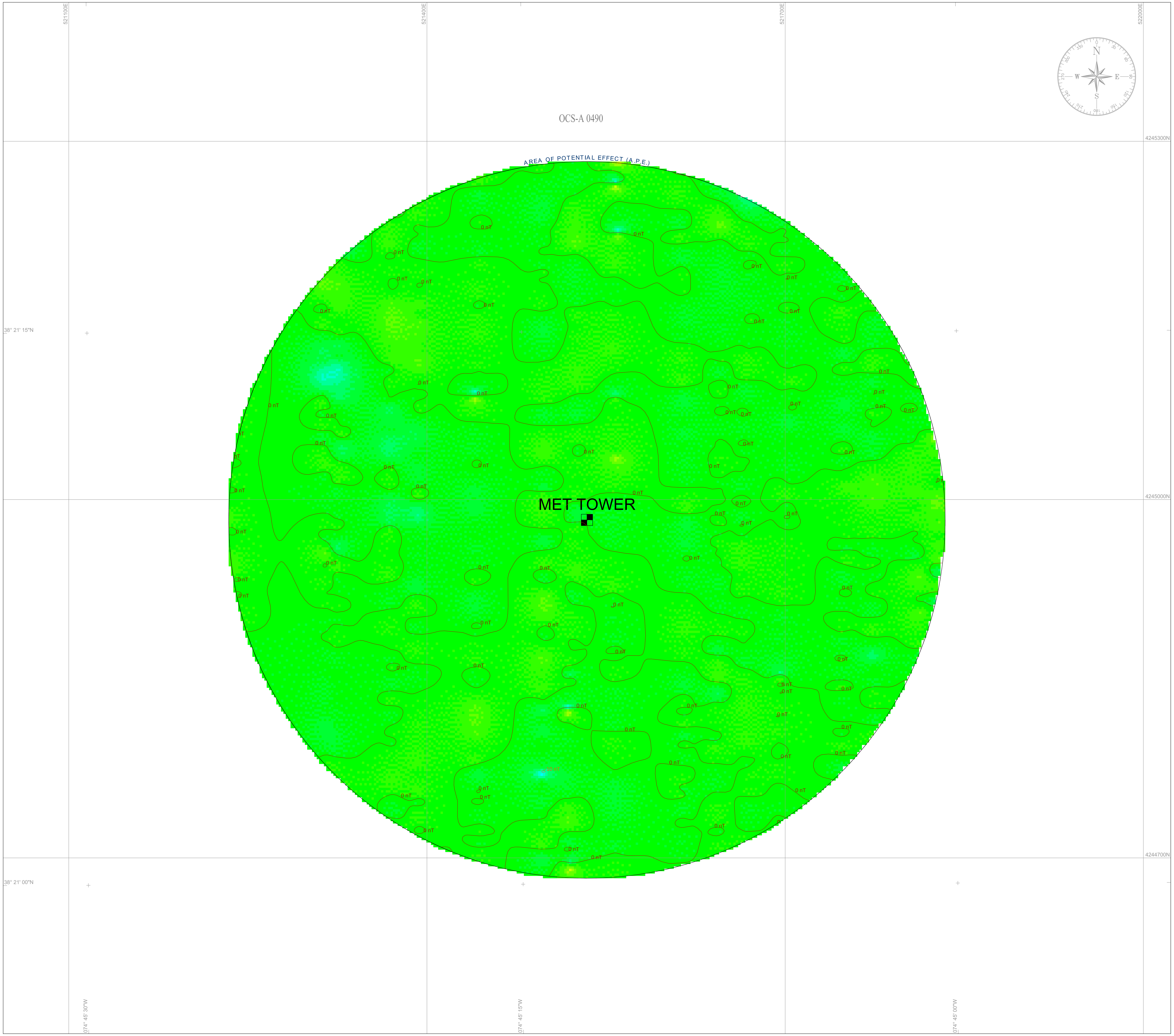


LEGEND

OCS-A 0490 OUTER CONTINENTAL SHELF LEASE NUMBER

VESSEL TRACK LINES WITH FIX & LINE ID (2015 US WIND SURVEY)

VESSEL TRACK LINES (2013 MEA SURVEY)

BATHYMETRY

20 MAJOR BATHYMETRY CONTOUR - @ 1 m INTERVAL (MLLW)

20.5 MINOR BATHYMETRY CONTOUR - @ .5 m INTERVAL (MLLW)

DOWNSLOPE GRADIENT IN DEGREES

SEAFLOOR FEATURES AND SHALLOW GEOLOGY

FINE SEDIMENT (CLAY/SILT)

FINE TO COARSE SEDIMENT (FINE TO COARSE SAND and GRAVEL)

VERY COARSE SEDIMENT (COBBLES and BOULDERS)

2 MAJOR ISOPACH CONTOUR - @ 1 m INTERVAL

1.5 MINOR ISOPACH CONTOUR - @ 0.5 m INTERVAL

29 MAJOR STRUCTURE CONTOUR - @ 1 m INTERVAL (MLLW)

28.5 MINOR STRUCTURE CONTOUR - @ 0.5 m INTERVAL (MLLW)

BORE LOCATION & ID

MAGNETOMETER TARGET & ID

LINEAR TARGET

SIDE SCAN SONAR TARGET & ID

G1 SEAFLOOR GRAB SAMPLE AND UNDERWATER CAMERA LOCATION WITH REFERENCE NUMBER

ORIENTATION OF SEDIMENT RIPPLE CREST (WITH HEIGHT AND WAVELENGTH IN METERS)

CHARTED OR REPORTED WRECK

WK001 LOCATED WRECK WITH REFERENCE NO.

GENERAL NOTES:

Offshore Survey Vessel	RV Shearwater
Surface Positioning System	Applanix POS MV V4 with Trimble Nav Beacon
Underwater Positioning System	Sonardyne USBL Scout Pro
Bathymetry	R2 Sonic 2024 Multibeam Echo Sounder
Morphology and Stratigraphy	Klein 3900 Side Scan Sonar / Teledyne Benthos CHIRP III Sub-bottom Profiler
Magnetometer Survey	Geometrics G882

SHALLOW STRUCTURE SHADED RELIEF COLOR SCALE (m)
29.00 28.50 28.00 27.50 27.00

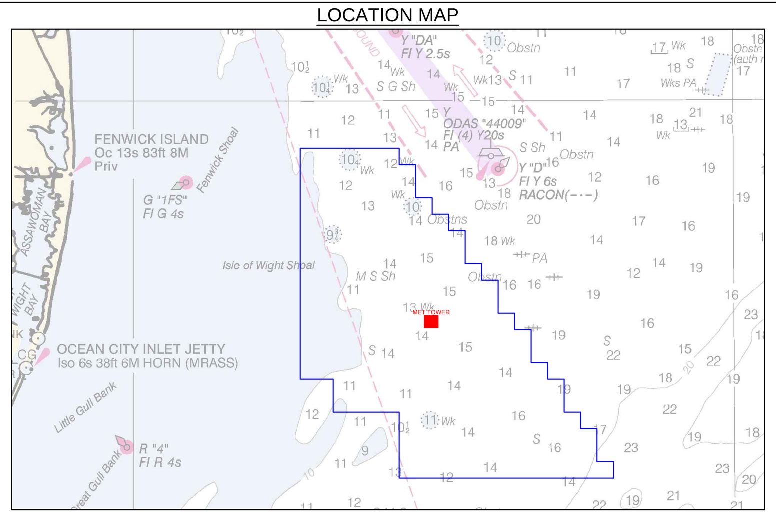
SHALLOW ISOPACH SHADED RELIEF COLOR SCALE (m)
2.2 2.1 2 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1 0.9 0.8 0.7 0.6

BATHYMETRIC SHADED RELIEF COLOR SCALE (m,MLLW)
27.50 27.25 27.00 26.75 26.50 26.25 26.00

MAGNETIC ANOMALY INTENSITY COLOR SCALE (nT)
25 20 10 0 -10 -20 -25

US Wind
1 North Charles Street, Suite 2310
Baltimore, MD 21201

LOCATION MAP



MAGNETIC CONTOUR MAP

US Wind SAP G&G Survey
Meteorological Tower Area

SCALE 1 : 1,000
(1 cm = 10 meters)
10 0 20 40 80

GEODETIC INFORMATION	
DATUM :	NAD83
VERTICAL :	MLLW
PROJECTION :	UTM83-18

Drawing Name:	
Vessel:	RV Shearwater, MV Ocean Discovery
Approved By:	M. Kosakowski
Interp. By:	J. Bailey / D. Whitesell
Party Chief:	J. Bailey
Drawn By:	B. Ehman
Revision:	--
Issue Date:	30-Sept.-2015
Survey Date:	June-July 2015
Chart Num :	4 of 6

PROFESSIONAL GEOLOGISTS SIGNATURE :

ALPINE OCEAN SEISMIC SURVEY INC 155 Hudson Ave Norwood New Jersey 07648 Tel 201-768-8000 Fax 201-768-5750 www.alpineocean.com

LEGEND

OCS-A 0490 OUTER CONTINENTAL SHELF LEASE NUMBER

Line 207 94 VESSEL TRACK LINES WITH FIX & LINE ID (2015 US WIND SURVEY)

VESSEL TRACK LINES (2013 MEA SURVEY)

BATHYMETRY

20 MAJOR BATHYMETRY CONTOUR - @ 1 m INTERVAL (MLLW)

20.5 MINOR BATHYMETRY CONTOUR - @ .5 m INTERVAL (MLLW)

0.3° DOWNSLOPE GRADIENT IN DEGREES

SEAFLOOR FEATURES AND SHALLOW GEOLOGY

FINE SEDIMENT (CLAY/SILT)

FINE TO COARSE SEDIMENT (FINE TO COARSE SAND and GRAVEL)

VERY COARSE SEDIMENT (COBBLES and BOULDERS)

2 MAJOR ISOPACH CONTOUR - @ 1 m INTERVAL

1.5 MINOR ISOPACH CONTOUR - @ 0.5 m INTERVAL

29 MAJOR STRUCTURE CONTOUR - @ 1 m INTERVAL (MLLW)

28.5 MINOR STRUCTURE CONTOUR - @ 0.5 m INTERVAL (MLLW)

BORE LOCATION & ID

MAGNETOMETER TARGET & ID

LINEAR TARGET

SIDE SCAN SONAR TARGET & ID

G1 SEAFLOOR GRAB SAMPLE AND UNDERWATER CAMERA LOCATION WITH REFERENCE NUMBER

0.84 0.21 ORIENTATION OF SEDIMENT RIPPLE CREST (WITH HEIGHT AND WAVELENGTH IN METERS)

CHARTED OR REPORTED WRECK

WK001 LOCATED WRECK WITH REFERENCE NO.

GENERAL NOTES:

Offshore Survey Vessel	RV Shearwater
Surface Positioning System	Applanix POS MV V4 with Trimble Nav Beacon
Underwater Positioning System	Sonardyne USBL Scout Pro
Bathymetry	R2 Sonic 2024 Multibeam Echo Sounder
Morphology and Stratigraphy	Klein 3900 Side Scan Sonar / Teledyne Benthos CHIRP III Sub-bottom Profiler
Magnetometer Survey	Geometrics G882

SHALLOW STRUCTURE SHADED RELIEF COLOR SCALE (m)

29.00 28.50 28.00 27.50 27.00

SHALLOW ISOPACH SHADED RELIEF COLOR SCALE (m)

2.2 2.1 2 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1 0.9 0.8 0.7 0.6

BATHYMETRIC SHADED RELIEF COLOR SCALE (m,MLLW)

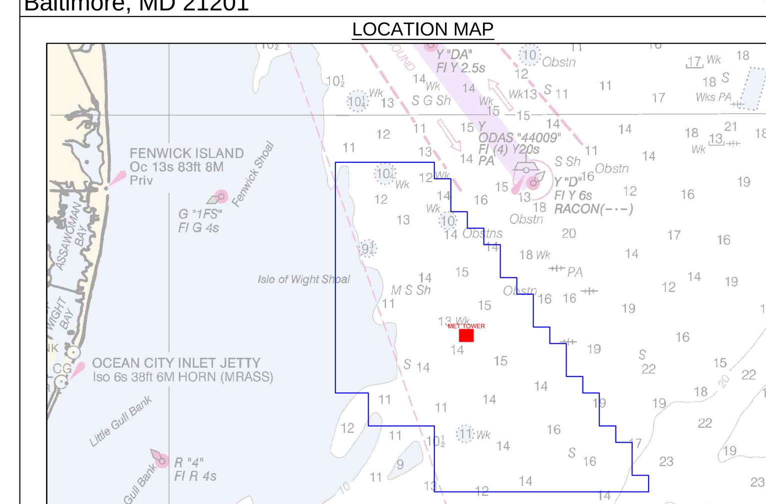
27.50 27.25 27.00 26.75 26.50 26.25 26.00

MAGNETIC ANOMALY INTENSITY COLOR SCALE (nT)

25 20 10 0 -10 -20 -25

US Wind
1 North Charles Street, Suite 2310
Baltimore, MD 21201

LOCATION MAP



SHALLOW ISOPACH MAP

US Wind SAP G&G Survey
Meteorological Tower Area

SCALE 1 : 1,000
(1 cm = 10 meters)
10 0 20 40 80

GEODETIC INFORMATION
DATUM : NAD83
VERTICAL : MLLW
PROJECTION : UTM83-18

Drawing Name:	
Vessel:	RV Shearwater, MV Ocean Discovery
Approved By:	M. Kosakowski
Interp. By:	J. Bailey / D. Whitesell
Party Chief:	J. Bailey
Drawn By:	B. Ehman
Revision:	--
Issue Date:	30-Sept.-2015
Survey Date:	June-July 2015
Chart Num :	5 of 6

Alpine

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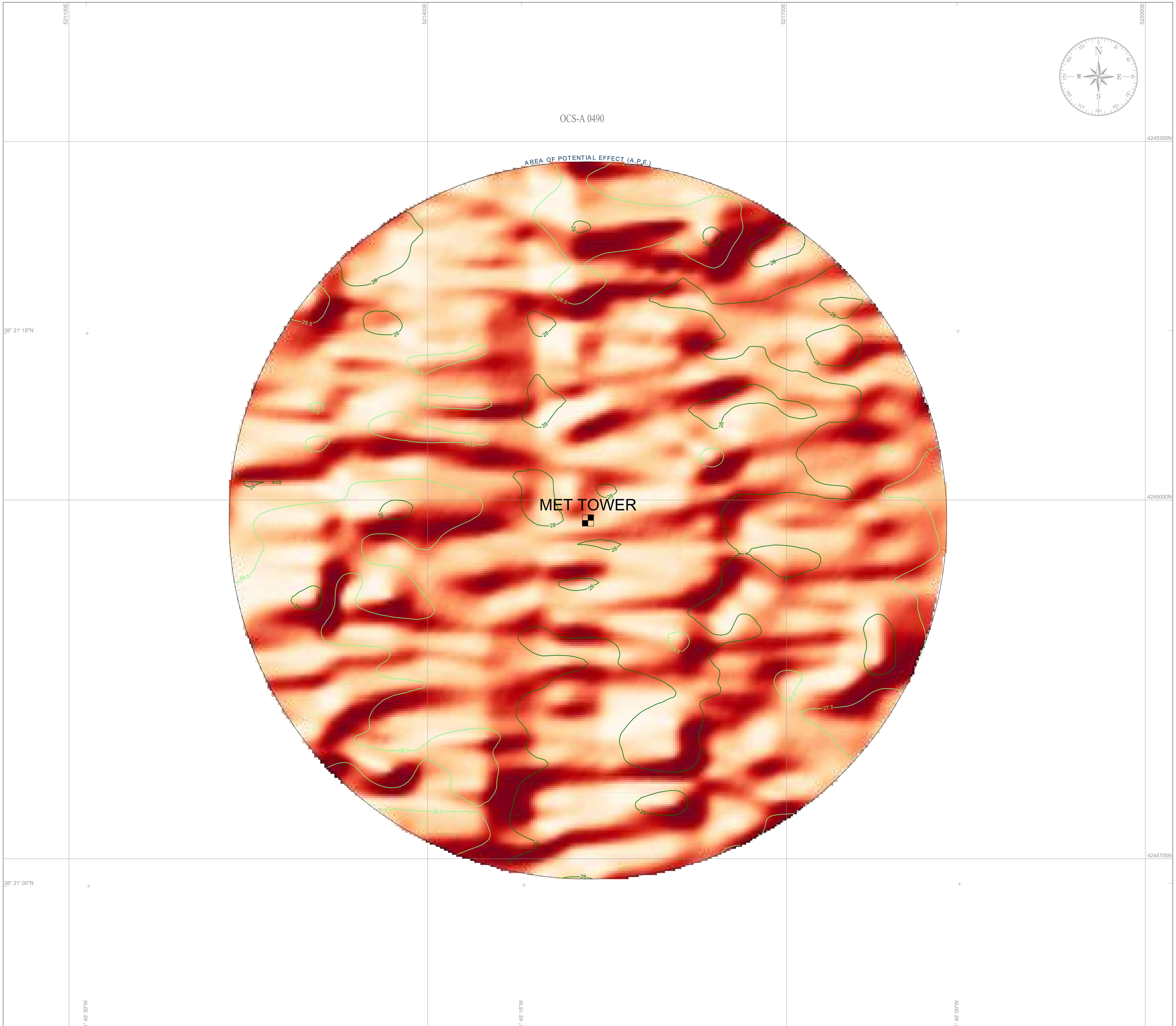


LEGEND

OCS-A 0490 OUTER CONTINENTAL SHELF LEASE NUMBER

VESSEL TRACK LINES WITH FIX & LINE ID (2015 US WIND SURVEY)

VESSEL TRACK LINES (2013 MEA SURVEY)

BATHYMETRY

MAJOR BATHYMETRY CONTOUR - @ 1 m INTERVAL (MLLW)

MINOR BATHYMETRY CONTOUR - @ .5 m INTERVAL (MLLW)

DOWNSLOPE GRADIENT IN DEGREES

SEAFLOOR FEATURES AND SHALLOW GEOLOGY

FINE SEDIMENT (CLAY/SILT)

FINE TO COARSE SEDIMENT (FINE TO COARSE SAND and GRAVEL)

VERY COARSE SEDIMENT (COBBLES and BOULDERS)

MAJOR ISOPACH CONTOUR - @ 1 m INTERVAL

MINOR ISOPACH CONTOUR - @ 0.5 m INTERVAL

MAJOR STRUCTURE CONTOUR - @ 1 m INTERVAL (MLLW)

MINOR STRUCTURE CONTOUR - @ 0.5 m INTERVAL (MLLW)

BORE LOCATION & ID

MAGNETOMETER TARGET & ID

LINEAR TARGET

SIDE SCAN SONAR TARGET & ID

SEAFLOOR GRAB SAMPLE AND UNDERWATER CAMERA LOCATION WITH REFERENCE NUMBER

ORIENTATION OF SEDIMENT RIPPLE CREST (WITH HEIGHT AND WAVELENGTH IN METERS)

CHARTED OR REPORTED WRECK

WK001 LOCATED WRECK WITH REFERENCE NO.

GENERAL NOTES:

Offshore Survey Vessel	RV Shearwater
Surface Positioning System	Applanix POS MV V4 with Trimble Nav Beacon
Underwater Positioning System	Sonardyne USBL Scout Pro
Bathymetry	R2 Sonic 2024 Multibeam Echo Sounder
Morphology and Stratigraphy	Klein 3900 Side Scan Sonar / Teledyne Benthos CHIRP III Sub-bottom Profiler
Magnetometer Survey	Geometrics G882

SHALLOW STRUCTURE SHADED RELIEF COLOR SCALE (m)
29.00 28.50 28.00 27.50 27.00

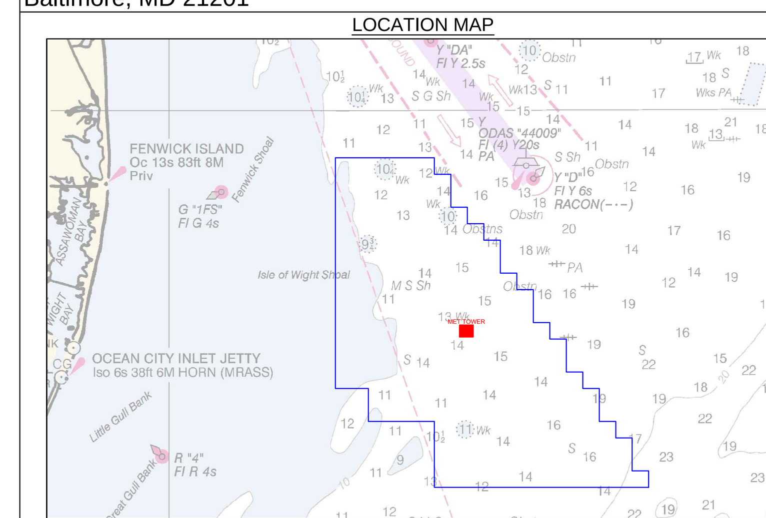
SHALLOW ISOPACH SHADED RELIEF COLOR SCALE (m)
2.2 2.1 2 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1 0.9 0.8 0.7 0.6

BATHYMETRIC SHADED RELIEF COLOR SCALE (m,MLLW)
27.50 27.25 27.00 26.75 26.50 26.25 26.00

MAGNETIC ANOMALY INTENSITY COLOR SCALE (nT)
25 20 10 0 -10 -20 -25

US Wind
1 North Charles Street, Suite 2310
Baltimore, MD 21201

LOCATION MAP



SHALLOW STRUCTURE MAP

US Wind SAP G&G Survey
Meteorological Tower Area

SCALE 1 : 1,000
(1 cm = 10 meters)
10 0 20 40 80

GEODETIC INFORMATION	
DATUM :	NAD83
VERTICAL :	MLLW
PROJECTION :	UTM83-18

Drawing Name:	1751.MetTowr.01.dwg
Vessel:	RV Shearwater, MV Ocean Discovery
Approved By:	M. Kosakowski
Interp. By:	J. Bailey / D. Whitesell
Party Chief:	J. Bailey
Drawn By:	B. Ehman
Revision:	--
Issue Date:	30-Sept.-2015
Survey Date:	June-July 2015
Chart Num :	6 of 6

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Appendix F

Data Integration and Engineering Report

Geotechnical Report for
US Wind Inc.

Project:
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area (Met Tower)

Description:
Volume III: Data Integration and Engineering Report

Survey Date:
22 June 2015 – 07 July 2015

Project Number:
10451

Client Reference:
REF11449

Report Status:
Final

REPORT AUTHORISATION AND DISTRIBUTION

Report Status		Volume III	Final
Compilation	Civil Engineer	.... Simon McDowell	
	Engineering Geologist	.... Ryan Barnes	
Authorisation	Senior Civil Engineer	.... Jerome Garnon	
QC Approval	GeoConsultancy Manager	.... Roi Santos	

Revision	Date	Title	Report Ref
0	25 Sep 2015	Volume III: Data Integration and Engineering Report	Volume III (Draft)
1	28 Sep 2015	Volume III: Data Integration and Engineering Report	Volume III (Draft)
2	23 Feb 2015	Volume III: Data Integration and Engineering Report	Volume III (Final)

Distribution

1 copy

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REPORT STRUCTURE

VOLUME I	VOLUME II	VOLUME III:
FIELD OPERATIONS & PRELIMINARY RESULTS	FIELD MEASURED & DERIVED GEOTECHNICAL PARAMETERS AND FINAL RESULTS	DATA INTEGRATION AND ENGINEERING REPORT
(BS EN ISO 19901)	(BS EN ISO 19901)	(BS EN ISO 19901)

Executive Summary	Executive Summary	Executive Summary
1. Scope of Project	1. Scope of Project	1. Scope of Report
2. Offshore Activities	2. Soil Description and Profiles	2. Summary of Soil Conditions
3. Drilling Operations	3. Triaxial Laboratory Test Results	3. Assessment of Data
4. InSitu Testing-CPTU	4. Chemical Results	4. Ground Model
5. InSitu Testing-PS Logging	5. Laboratory Testing Procedures	5. Representative Soil Parameters
6. Sampling Operations	6. CPTU Analysis	6. List of Symbols and Abbreviations
7. Field Laboratory	7. In Situ Testing – PS Logging	7. References
8. Preliminary Geotechnical logs and Soil profiles	8. List of Symbols and Abbreviations	
9. Classification Laboratory results	9. References	
10. CPTU Analysis		
11. Laboratory Testing Procedures		
12. Geodetic Information and Water Depths		
13. Health Safety and Environment		
14. References		

EXECUTIVE SUMMARY

The purpose of this report is the presentation and interpretation of geotechnical information acquired at the proposed Met Tower location at the Maryland Wind Energy Area approximately 10km off the coast of Maryland.

At the Met Tower location, one composite borehole comprising of CPTU, sample and PS Logging was completed down to a depth of 64.94m to determine the geotechnical properties of the underlying soils in order to perform an engineering analysis in connection with conceptual foundation design.

This report represents the interpreted geotechnical results well as proposed representative profiles for soil parameters. Geophysical data acquired at the Maryland Wind Energy Area in 2013 by Coastal Planning & Engineering Inc. was provided by US Wind Inc. The sub-bottom profile data was interpreted and correlated with the geotechnical soil units.

Representative geotechnical parameter profiles for relative density, friction angle, undrained shear strength, moisture content, total unit weight and overconsolidation ratio are presented for each soil unit.

A summary of the identified geotechnical units at the proposed MetTower location is shown in Table 1 below.

Table 1 Stratigraphic Progression

Geotechnical Units	Soil Type
Unit 1	Poorly graded SAND with gravel.
Unit 2	Poorly graded SAND with silt. Dense to compact. Few stratifications of GRAVEL, Few pockets of clayey SAND. Few laminations of black organic staining. Micaceous.
Unit 3	Poorly graded SAND. Very dense to compact. Few laminations of black organic staining. Micaceous.
Unit 4	Sandy SILT. Medium dense to dense locally loose.
Unit 5	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt. Micaceous.
Unit 6	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.
Unit 7	Poorly graded SAND with silt. Compact.
Unit 8	Sandy CLAY. Hard.
Unit 9	Clayey SAND becoming SAND with silt.

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1 Scope of Report

1.1 General

Gardline was commissioned by US Wind Inc. to carry out a geotechnical survey across the Maryland Wind Energy Area situated approximately 10km off the coast of Maryland.

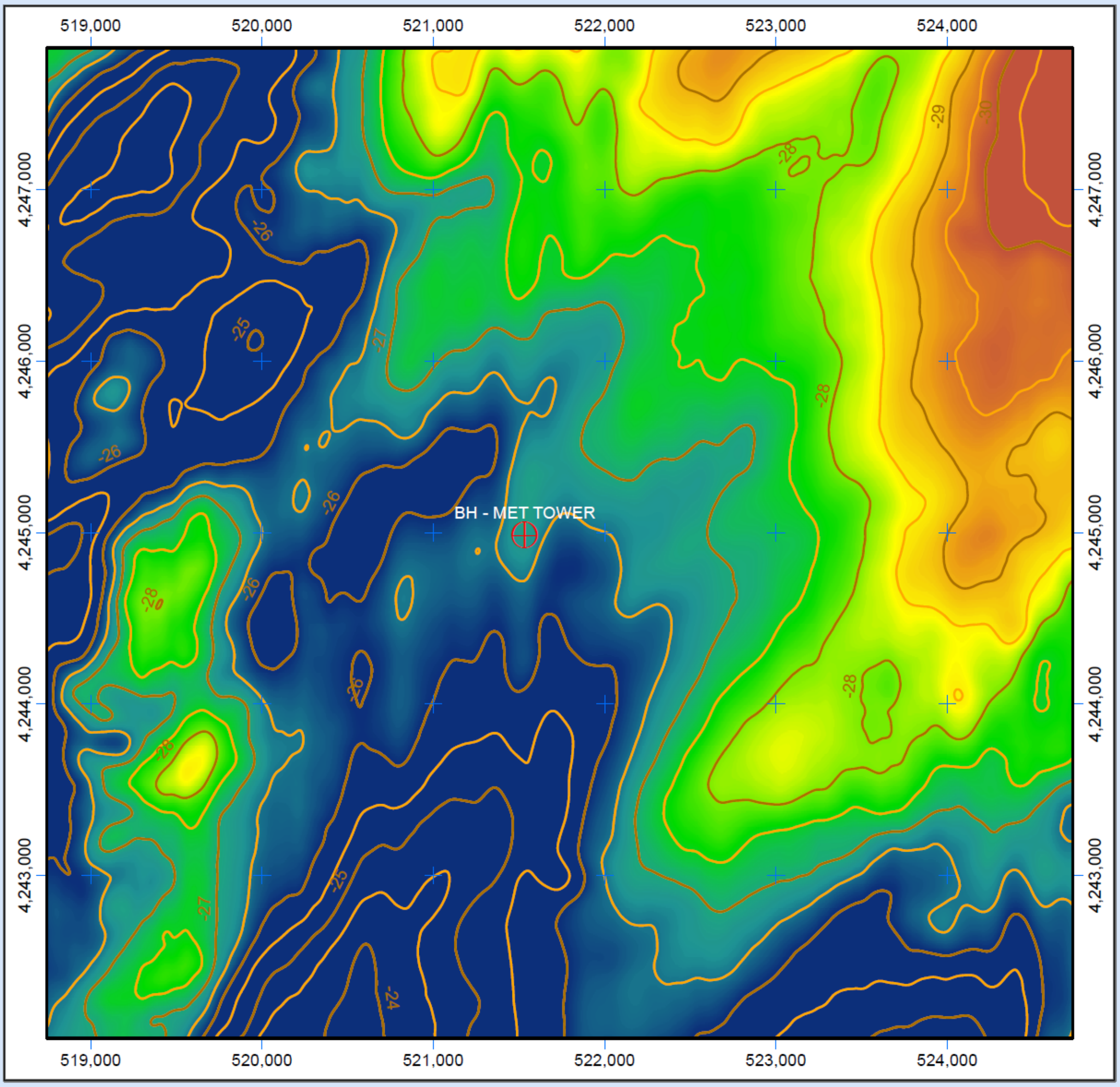
The purpose of this report is the presentation and interpretation of geotechnical data acquired at the proposed Met Tower location approximately 10km off the coast of Maryland and 27.7m water depth.

One composite borehole was completed at this location. The borehole consisted of alternative sampling and CPTU testing. In addition PS Logging operations were completed down to a depth of 64.94m at the Met Tower location to determine propagation velocity characteristics of shear and pressure waves.

The scope of the report is to provide a ground model by the integration of geophysical and geotechnical data. The model defines and describes the morphologies of soil units and soil provinces. Geophysical data acquired at the Maryland Wind Energy Area in 2013 by Coastal Planning & Engineering Inc. was provided by US Wind Inc. for this purpose. In addition the report defines representative soil geotechnical parameters that can be used for geotechnical assessment and design at the Met Tower location.

Representative geotechnical parameters for relative density, friction angle, undrained shear strength, moisture content, total unit weight and overconsolidation ratio are presented for each unit.

Figure 1.1 Overview Map



Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Overview Map

Legend & Map Scale (A4)

- Combined Borehole (CPTU/Sampling) & PS Logging
- 1.0m Contours
- 0.5m Contours

Bathymetry
-26.0m
-30.0m

Kilometers
0 0.4 0.8 1.2 1.6 2
1:35,000

Coordinate Reference System

Datum	NAD 83
Ellipsoid	GRS 80
Projection	UTM Zone 18N (75W)
Overview Data	ESRI

Contract Information

Gardline Job	10451
Client	US Wind Inc.
Client Ref	REF11449
Vessel	MV Ocean Discovery

Gardline Geosciences Ltd, Hewett Park, Hewett Road, Great Yarmouth, Norfolk. United Kingdom. NR31 0NN.

2 Summary of Soil Conditions

2.1 General

The proposed Met Tower location is situated within US Waters, approximately 10km off the coast of Maryland immediately southwest of the Delaware outwash basin.

The geophysical results clearly show high degree of spatial variability both lateral and vertical on the shallow sediments. The geophysical interpretations were validated with the geotechnical results and allowed to describe the shallow geology in detail, the correlation of the two datasets are described in chapter 4.

A chart presented in Appendix 1.2 presents the geophysical line showing geological conditions and formation boundaries identified at the Met Tower location. Full details of the geophysical interpretation are presented in the Maryland Energy Administration High Resolution Geophysical Resource Survey Final Report of Investigations Project Number DEXR240005.

Table 2.1 provides a summary of the encountered soil units and general soil type. Units were selected based on CPTU and sample data and correlated with geophysical profiles.

Table 2.1 Stratigraphic Progression

Geophysical Units	Geotechnical Units	Soil Type
Unit 1- Holocene Superficial Sediments	Unit 1	Poorly graded SAND with gravel.
Unit 2 – Channel Complex	Unit 2	Poorly graded SAND with silt. Dense to compact. Few stratifications of GRAVEL, Few pockets of clayey SAND. Few laminations of black organic staining. Micaceous.
	Unit 3	Poorly graded SAND. Very dense to compact. Few laminations of black organic staining. Micaceous.
Unit 3 – Sub-parallel beds	Unit 4	Sandy SILT. Medium dense to dense locally loose.
	Unit 5	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt. Micaceous.
	Unit 6	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.
	Unit 7	Poorly graded SAND with silt. Compact.
	Unit 8	Sandy CLAY. Hard.
	Unit 9	Clayey SAND becoming SAND with silt.

Geotechnical units are discussed further in Chapter 4.

2.2 Water Depth

The seabed depth was determined by Multibeam echosounder. Water depth at the Met Tower location is 27.7m MSL. Over the Maryland Wind Energy Area the water depth varied between 12.2m and 42.0m MSL.

2.3 Seafloor Conditions

Table 2.2 presents seafloor conditions across the Maryland Wind Energy Area. Assessments of seafloor conditions are based on data acquired during the geophysical survey conducted in 2013. Note that seafloor conditions may change over time.

Table 2.2 Seafloor Conditions across Maryland Wind Energy Area

Seafloor Conditions	
Seafloor Topography and Gradient	- Sand ridges trending northeast. Mainly present in the west and south of the site. - Seabed generally flat, however maximum gradients of 10° on ridges mainly present to west and southwest of the surveyed area - Areas showing potential scour
Seabed Sediments	- The seabed is characterised by SAND with gravel.

2.4 Potential Hazards

Potential Hazards are listed in the Table 2.3. It is important to note that the extent of this section is limited to Hazards that were identified on the basis of available information.

Table 2.3 Potential Hazards

Geohazard	Locations	Geotechnical Unit(s)	Description	Possible Impact
Sediment Transport	All	Units 1 and 2	Geophysical data shows spatial trends related to sediment movement.	Removal of sediments around foundations – scour. Additional deposition of sediments on or around foundations.
Steep Slopes	West and South	Units 1 and 2	Steep slopes identified as part of sand ridges present across site	Potential to cause issues during installation of foundations.
Debris / Shipwrecks	All	Seabed	Well documented potential for shipwreck remain. Numerous sidescan sonar contacts and magnetic anomalies indicate possible debris and shipwrecks	Debris could cause damage to equipment and foundations during installation operations.

3 Assessment of Data

3.1 General

Geophysical and geotechnical data was obtained across the Maryland Wind Energy Area. The geotechnical and geophysical data acquired at the Met Tower locations is generally good quality and fit for purpose. Further details about quality are provided below.

3.2 Geophysical Data

Geophysical data was collected using multi-beam hydrographic data, sidescan sonar, magnetometer, shallow-penetration chirp sub-bottom profiler, and medium-penetration multi-channel sparker seismic-reflection geophysical systems.

More information can be found in the Coastal Planning & Engineering Inc. Maryland Energy Administration High Resolution Geophysical Resource Survey Final Report of Investigations Project Number DEXR240005.

3.3 Geotechnical Data

Thirty-five CPTU tests were conducted in downhole mode at the Met Tower location.

The CPTUs were within accuracy Class 1 and 2, the appropriate classes for the tested soils as set out by ISO 22476-1:2012. In general, the zero reading offsets were consistent before and after testing and there is no evidence of possible sensor drift effects.

Fifteen push samples were acquired during composite borehole operations at the Met Tower location.

Push samples were subjected to a variety of testing during offshore operations. Samples were then sent back to Gardline onshore laboratory facility where further testing was carried out.

All CPTU, push sample and laboratory data was used for the engineering analyses.

4 Ground Model

4.1 General

Geotechnical and geophysical datasets were combined to build a two-dimensional ground model. This enabled correlations between datasets and provided visual representations of the site survey.

4.2 Integration of Geotechnical and Geophysical Data

Geotechnical and geophysical datasets were combined to build a two dimensional ground model at the Met Tower location. The geophysical and geotechnical results correlates relatively well at this location. Coastal Planning and Engineering Inc. report identify three main geophysical units. These seem to match reasonably well with the geotechnical records. The geotechnical records depicts further detail of the sedimentary sequence and allowed the identification of additional soil units here referred as Geotechnical Units

SEG-Y files from the 2013 geophysical campaign were processed by Gardline team and four horizons identified along line 091, the closest line to the Met Tower location being less than fifty meters to the east.

Four horizons were identified within the geophysical data for line 091;

- Horizon 10 was identified as a the boundary between the Holocene Superficial sediments (Geophysical Unit 1) and the Channel Complex (Geophysical Unit 2)
- Horizon 20 was identified as an internal boundary in the Channel Complex (Geophysical Unit 2)
- Horizon 25 was identified as the base of the Channel Complex (Geophysical Unit 2) and the boundary with Geophysical Unit 3 characterised by sub parallel beds of sand and clay.
- Horizon 30 and 40 both thicken to the south of the site. These horizons are internal horizons within Unit 3. Horizon 40 pinches out north of Met Tower and mark a transition from succession of clays and silts to a predominantly sandy material

A chart presenting bathymetry data and two geophysical and geotechnical integration cross sections at the Met Tower location are shown in Appendix 1.2 where the comparisons between the datasets are shown.

A seabed multiple was identified on Line 091 and has been marked on the geophysical image as a black line between Horizons 25 and 30.

4.3 Geotechnical Units

Table 4.1 provides a summary of the units identified and a brief soil description. It should be noted that the base depths reflect maximum reach of the geotechnical data.

Table 4.1 Identified Units

Geophysical Unit	Geotechnical Unit	Depths (m)		Soil Description
		Top	Base	
Unit 1- Holocene Superficial Sediments	Unit 1	0.00	0.10	Poorly graded SAND with gravel.
Unit 2 – Channel Complex	Unit 2	0.10	12.50	Poorly graded SAND with silt. Dense to compact. Few stratifications of GRAVEL, Few pockets of clayey SAND. Few laminations of black organic staining. Micaceous.
	Unit 3	12.50	20.16	Poorly graded SAND. Very dense to compact. Few laminations of black organic staining. Micaceous.
Unit 3 – Sub-parallel beds	Unit 4	20.16	23.23	Sandy SILT. Medium dense to dense locally loose.
	Unit 5	23.30	26.50	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt. Micaceous.
	Unit 6	26.50	44.01	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.
	Unit 7	44.01	50.77	Poorly graded SAND with silt. Compact.
	Unit 8	50.77	57.30	Sandy CLAY. Hard.
	Unit 9	57.30	64.94	Clayey SAND becoming SAND with silt.

5 Representative Soil Parameters

5.1 General

Geotechnical data has been presented on soil profiles, where derived geotechnical parameters are plotted against depth. The soil profiles and composite CPTU profiles are presented in the following appendices:

- Relative Density (Appendix 2)
- Friction Angle (Appendix 3)
- Undrained Shear Strength (Appendix 4)
- Unit Weight (Appendix 5)
- Moisture Content (Appendix 6)
- Overconsolidation Ratio (Appendix 7)
- Effective Vertical Stress (Appendix 8)
- CPTU (Appendix 9)

5.2 Relative Density

Outlined below is the method used to calculate the relative density presented in the plots found in Appendix 2. The relative density estimates were calculated using the Jamiolkowski et al. (1988) equation. Relative Density provides a relationship between the in situ voids ratio, e, to the minimum and maximum densities, e min and e max, of the soil.

For a list of all symbols relating to this formula and all subsequent formulae within this report please refer to Section 6.

$$D_r = \left[\frac{1}{2.93}\right] \ln\left[\frac{q_c}{205\left(\sigma_m'^{0.51}\right)}\right] x100$$

$$\sigma_m' = \left[\frac{\sigma'_{vo}\left(1+2K_0\right)}{3}\right]$$ Estimated mean effective stress at test depth

K_0 (coefficient of lateral earth pressure) values of 0.5 for the upper bound calculation and 3.0 for the lower bound calculation were used. It is important to note the derived values for relative density are subject to a certain degree of uncertainty due to the empiric nature of the equation proposed by Jamiolkowski et al. (1988). Most of the existing methods for deriving relative density from CPTU data were obtained using a calibration chamber filled with clean medium sand, predominantly silica sand. Thus if the equations are used in a natural sand layer with a different composition to the sand used in the calibration chamber the level of uncertainty in the estimation will inevitably increase. The sands encountered during this investigation are mainly fine to medium sands with a low percentage of silt or gravel within. Relative densities should be appropriate for the material tested. However, they should be considered an approximation due to the empiric nature of the calculation.

5.3 Friction Angle

Friction angles were obtained using the following methodologies:

1. Shear Box Test (BS1377: Part 7: 1990 – Section 4)
2. Derived from CPTU data

Plots showing the results and recommended design lines are presented in Appendix 3. The friction angle derived from CPTU results were obtained based on the calculated relative density following guidelines from API (2000). The derived friction angles are listed in Table 5.1 below.

Relative density (shown in Table 5.1) values derived from CPTU data are based on the assumptions that the material is clean sand, i.e. has no silt or clay content (as discussed in Section 5.2). Sands of differing properties can result in the derivation of higher or lower than anticipated friction angles using this correlation with relative density. Therefore care is required when using this methodology.

Table 5.1 API (2000) Internal Friction Angles

Relative Density	Soil Description	Equivalent Internal Friction Angle, φ' (°)
Very Loose Loose Medium	Sand Sand – Silt Silt	20
Loose Medium Dense	Sand Sand – Silt Silt	25
Medium Dense	Sand Sand – Silt	30
Dense Very Dense	Sand Sand – Silt	35
Dense Very Dense	Gravel Sand	40

5.4 Undrained Shear Strength

The design undrained shear strength (Su) profiles are presented in Appendix 4. The shear strength has been inferred from the CPTU data based on the corrected cone end resistance (q_{net}). The following relationship has been used:

Undrained Shear Strength = q_{net} / N_{kt}
Where N_{kt} = 15 and 20

CPTU data often shows variations that provide more detailed shear strength profiles than those that can be obtained from laboratory results. The depths below seabed to the tested soil units can also be determined more accurately from the CPTU measurements. The adopted N_{kt} values (displayed above) are considered to be reasonable to infer the shear strengths at the Met Tower location.

5.5 Unit Weight

Unit weight data was obtained using the following methodologies:

1. Bulk Density Test (BS1377: Part 7: 1990 – Section 7)
2. Derived from Moisture Content (BS1377: Part 7: 1990 – Section 3)

Theoretical unit weights were calculated under the assumption the soils were 100 percent saturated in in-situ using the following equation:

$$\gamma = \gamma_{wsea}\left[\frac{G_s(1+w)}{1+wG_s}\right]$$

Where: G_s = specific gravity (an average value of 2.65 is considered representative)

The results are presented in the plots found in Appendix 5.

5.6 Moisture Content

Composite plots for moisture (or water) content is presented in Appendix 6 for the proposed Met Tower location.

5.7 Overconsolidation Ratio

Overconsolidation ratio (OCR) is derived from CPTU data using the method from Andersen et al. (1979).

The derived profile for OCR is presented in Appendix 7.

5.8 Effective Vertical Stress

The recommended profile for the effective vertical stress, p'_0, is derived from the recommended unit weight profiles given in Table 5.2 or Appendix 5. The effective stresses are derived assuming hydrostatic pore pressure in-situ.

Composite plots for the effective stress profile at the proposed Met Tower location are presented in Appendix 8.

5.9 CPTU

Composite plots of the Corrected Cone End Resistance (CER), sleeve friction and pore water pressure are presented in Appendix 9 for the proposed Met Tower location.

5.10 Recommended Soil Parameters

Recommended geotechnical parameters for the proposed Met Tower location are shown in Appendices 2 to 9. Table 5.2 presents a summary of the recommended geotechnical parameters.

Table 5.1 Recommended Soil Parameter Summary

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Total Unit Weight, γ (kN/m^3)	Moisture Content, W (%)
Unit 1	Poorly graded SAND with gravel.	No Data				
Unit 2	Poorly graded SAND with silt. Dense to compact. Few stratifications of gravel, Few pockets of clayey sand. Few laminations of black organic staining. Micaceous.	*0.10m – 9.50m* UB = 100 LB = 80 *9.50m – 12.50m* UB = 75 LB = 55	*0.10m – 9.50m* UB = 42 LB = 37 *9.50m – 12.50m* UB = 36 LB = 31	Bed of CLAY *6.67m – 7.74m* UB = 90 LB = 70	*0.10m – 0.30m* γ = 19.3 *0.30m – 1.50m* γ = 20.6 *1.50m – 6.67m* γ = 19.8 *6.67m – 7.74m* No Data *7.74m – 12.50m* γ = 20.6	*0.10m – 0.30m* MC = 21 *0.30m – 1.50m* MC = 20 *1.50m – 6.67m* MC = 29 *6.67m – 7.74m* No Data *7.74m – 12.50m* MC = 21
Unit 3	Poorly graded SAND. Very dense to compact. Few laminations of black organic staining. Micaceous.	*12.50m – 20.16m* UB = 100 LB = 80	*12.50m – 20.16m* UB = 42 LB = 37	N/A	*7.74m – 12.50m* γ = 19.0	*7.74m – 12.50m* MC = 21
Unit 4	Sandy SILT. Medium dense to dense locally loose.	*20.16m – 23.30m* UB = 65 - 45 LB = 45 - 25	*20.16m – 23.30m* UB = 33 - 28 LB = 28 – 23	N/A	No Data	No Data

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Total Unit Weight, γ (kN/m^3)	Moisture Content, W (%)
Unit 5	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt. Micaceous.	N/A	N/A	*23.30m – 26.50m* UB = 195 LB = 145	*23.30m – 26.50m* γ = 19.6	*23.30m – 26.50m* MC = 31
Unit 6	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.	N/A	N/A	*26.50m – 29.00m* UB = 280 LB = 180 *29.00m – 35.00m* UB = 240 LB = 140 *35.00m – 39.00m* UB = 340 LB = 240 *39.00m – 40.50m* UB = 240 LB = 140 *40.50m – 44.01m* UB = 300 LB = 200	*26.50m – 40.50m* γ = 19.0 *40.50m – 41.53m* γ = 16.7 *41.53m – 44.01m* γ = 19.0	*26.50m – 40.50m* MC = 29 *40.50m – 41.53m* MC = 50 *41.53m – 44.01m* MC = 29
Unit 7	Poorly graded SAND with silt. Compact.	*44.01m – 50.77m* UB = 100 LB = 80	*44.01m – 50.77m* UB = 41 LB = 36	N/A	*44.01m – 50.77m* γ = 19.5	*44.01m – 50.77m* MC = 50

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Total Unit Weight, γ (kN/m^3)	Moisture Content, W (%)
Unit 8	Sandy CLAY. Hard.	*Bed of SAND* *53.5m – 55.30m* UB = 65 LB = 45	*Bed of SAND* *53.5m – 55.30m* UB = 33 LB = 28	*50.77m – 53.50m* UB = 300 LB = 200 *55.30m – 57.30m* UB = 300 LB = 200	*50.77m – 53.50m* γ = 18.6 *53.50m – 55.30m* γ = 19.3 *55.30m – 57.30m* γ = 18.6	*50.77m – 53.50m* MC = 32 *53.50m – 55.30m* MC = 27 *55.30m – 57.30m* MC = 32
Unit 9	Clayey SAND becoming SAND with silt.	*57.30m – 64.90m* UB = 85 LB = 65	*57.30m – 64.90m* UB = 37 LB = 32		*57.30m – 64.90m* γ = 19.4	*57.30m – 64.90m* MC = 23

6 List of Symbols and Abbreviations

°	Degrees
<	Less Than
>	Greater Than
"	Inches
%	Percentage
φ'	Angle of Internal Friction
≈	Approximately
γ	Total Unit Weight
$\gamma_{w\ sea}$	Unit Weight of Sea Water
σ_m'	Mean Effective Stress
σ'_{v0}	Effective Vertical Overburden Stress
cm	Centimetres
d	Depth
D_r	Relative Density
e	Voids Ratio
e_{max}	Maximum Density
e_{min}	Minimum Density
G_s	Specific Gravity
k_0	Coefficient of Lateral Earth Pressure
ln	Natural Log
m	Metres
N_{kt}	Factor for calculating Undrained Shear Strength
P'_0	Effective Vertical Overburden Stress
q_c	Measured Cone Tip Resistance
q_{net}	Net Cone End Resistance
q_t	Corrected Cone End Resistance
s_u	Undrained Shear Strength
w	Natural Water Content
API	American Petroleum Institute
BSF	Below Sea Floor
CER	Cone End Resistance
CPTU	Cone Penetration Test with pore pressure reading (u2 position)
E	East
MSL	Mean Sea Level
N	North
NE	North East
NNE	North North East
NW	North West
NNW	North North West
OCR	Overconsolidation Ratio
R	Radius
RD	Relative Density
S	South
SE	South East
SSE	South South East
SW	South West
SSW	South South West
UK	United Kingdom

7 References

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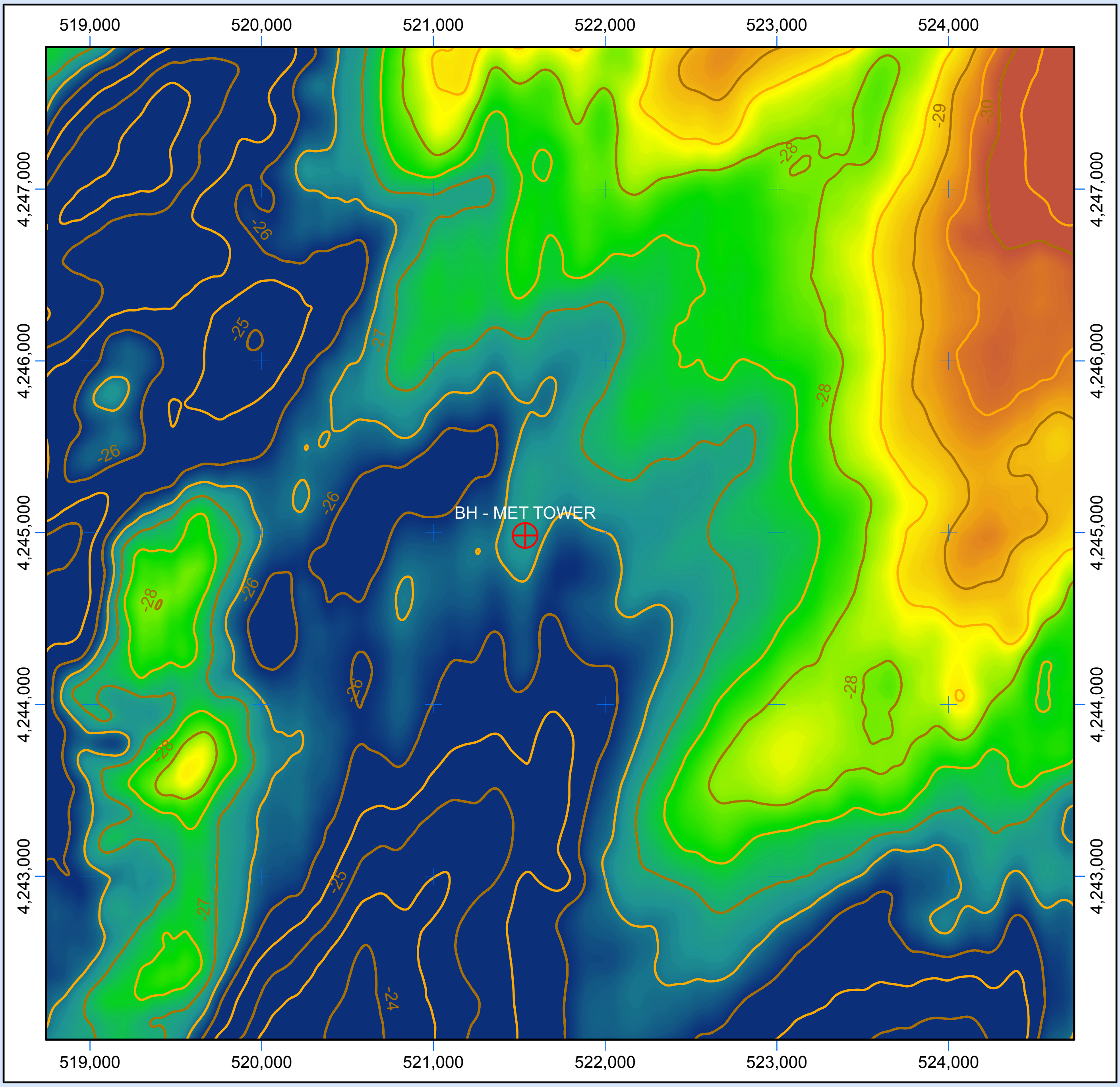
APPENDIX 1

1.1 Location Summary

1.2 Integration Chart

1.1 Location Summary



Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Overview Map

Legend & Map Scale (A4)

- Combined Borehole (CPTU/Sampling) & PS Logging
- 1.0m Contours
- 0.5m Contours

Bathymetry
-26.0m
-30.0m

Kilometers
0 0.4 0.8 1.2 1.6 2

1:35,000

Gardline

US Wind inc sea energy

Coordinate Reference System

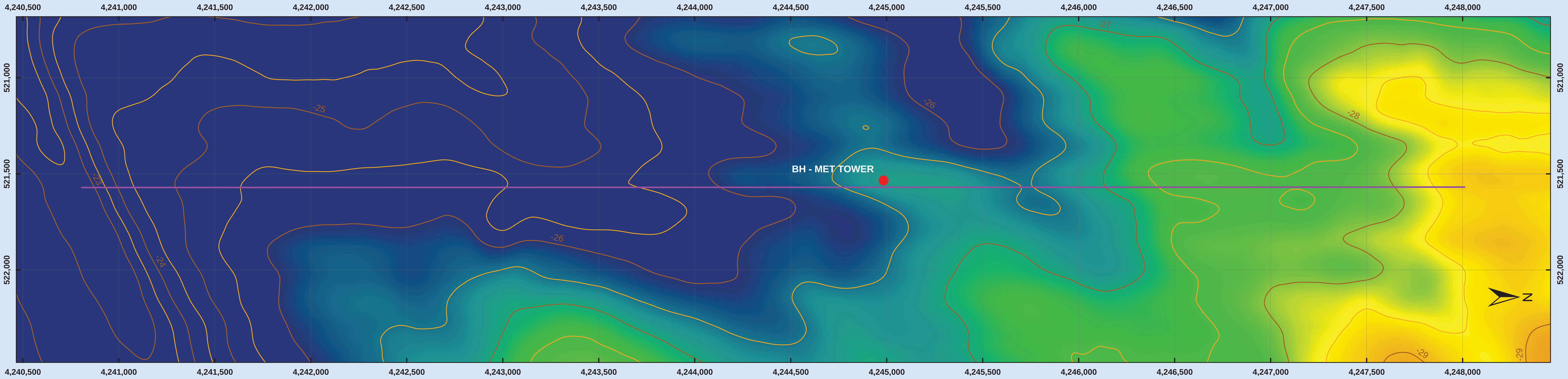
Datum	NAD 83
Ellipsoid	GRS 80
Projection	UTM Zone 18N (75W)
Overview Data	ESRI

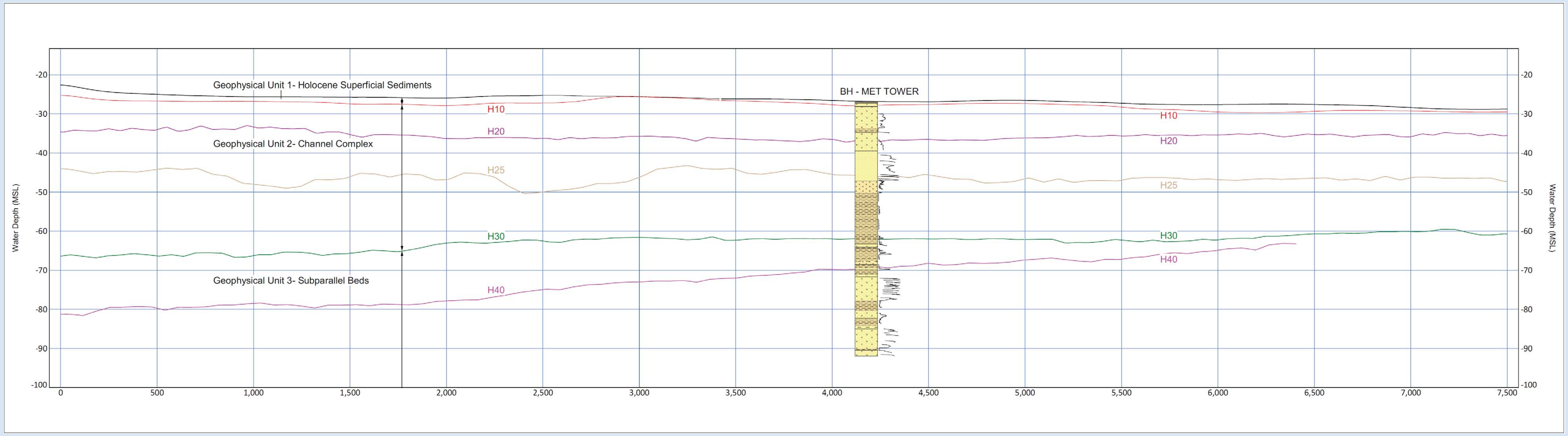
Contract Information

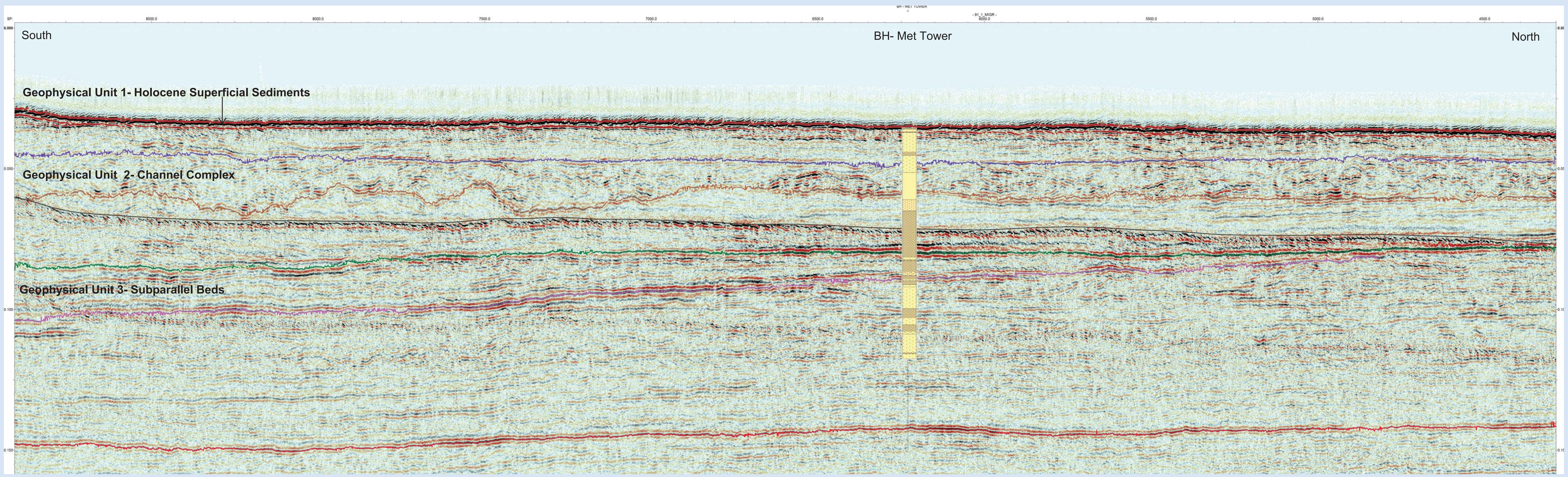
Gardline Job	10451
Client	US Wind Inc.
Client Ref	REF11449
Vessel	MV Ocean Discovery

Gardline Geosciences Ltd, Hewett Park, Hewett Road, Great Yarmouth, Norfolk. United Kingdom. NR31 0NN.

1.2 Integration Chart







Client

US Wind Inc.

Project Title

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Drawing Title

Integration of Geotechnical and Geophysical Data Met Tower Location

Legend

- BH- Met Tower Location
- Geophysical Sectoin (Line 091)
- 1.0m Contours
- 0.5m Contours

Bathymetry
-26.0m
-30.0m

Soil Identification Symbology

CLAY	COBBLES
SILT	VOID
SAND	CHALK
GRAVEL	Mixed Soil

Produced By

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Web: www.gardline.com

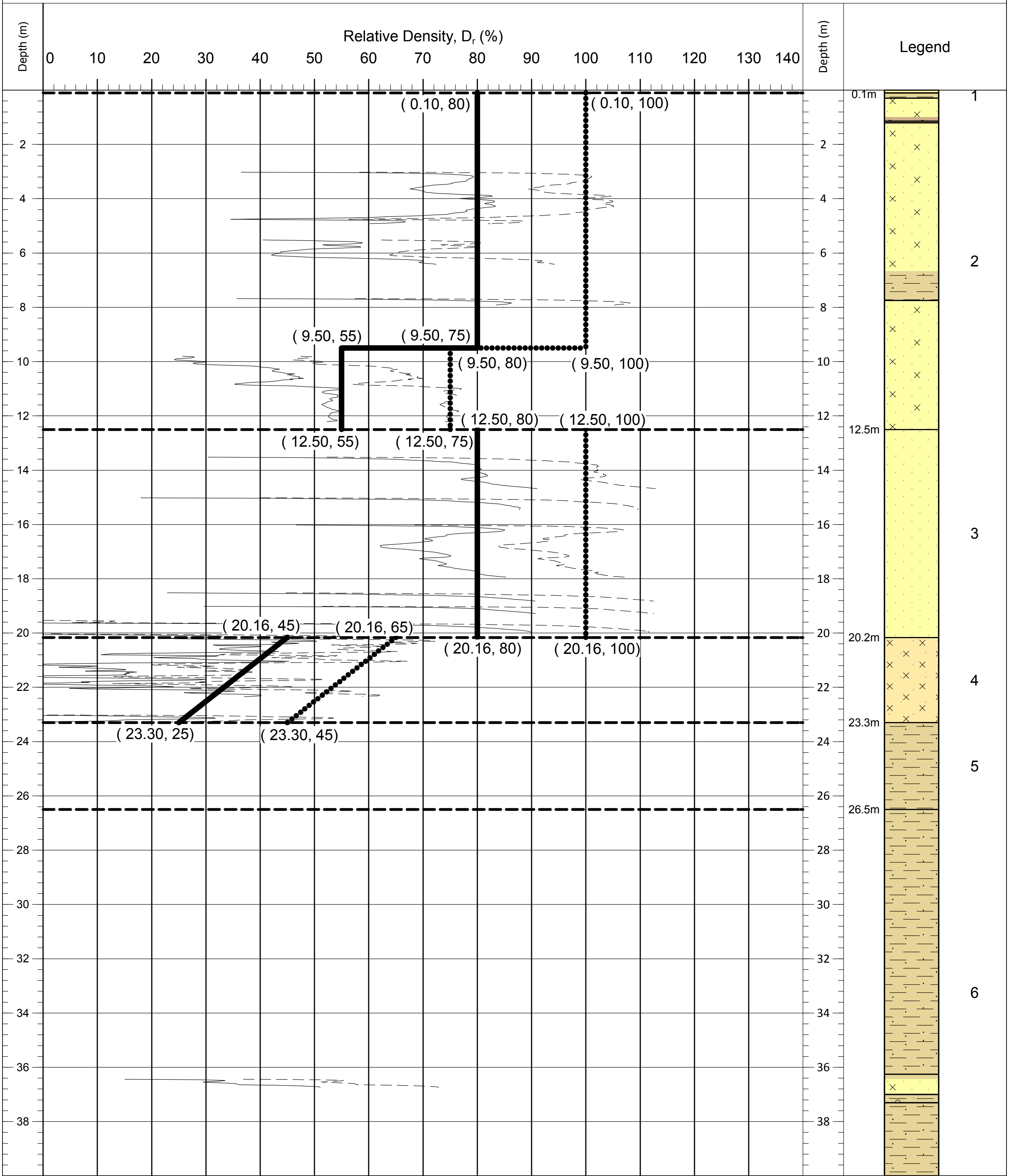
Coordinate Reference System	Country/ Area	Drawing Scale/ Drawn At
NAD 83 UTM Zone 18N	USA / Maryland	1:12,000 / A1

Date	Revision No.	Author	Revision Remarks
23/09/15	Rev 0	RB	Issued for reference
28/09/15	Rev 1	RB	Issued for reference, updated horizons

APPENDIX 2

2.1 Relative Density

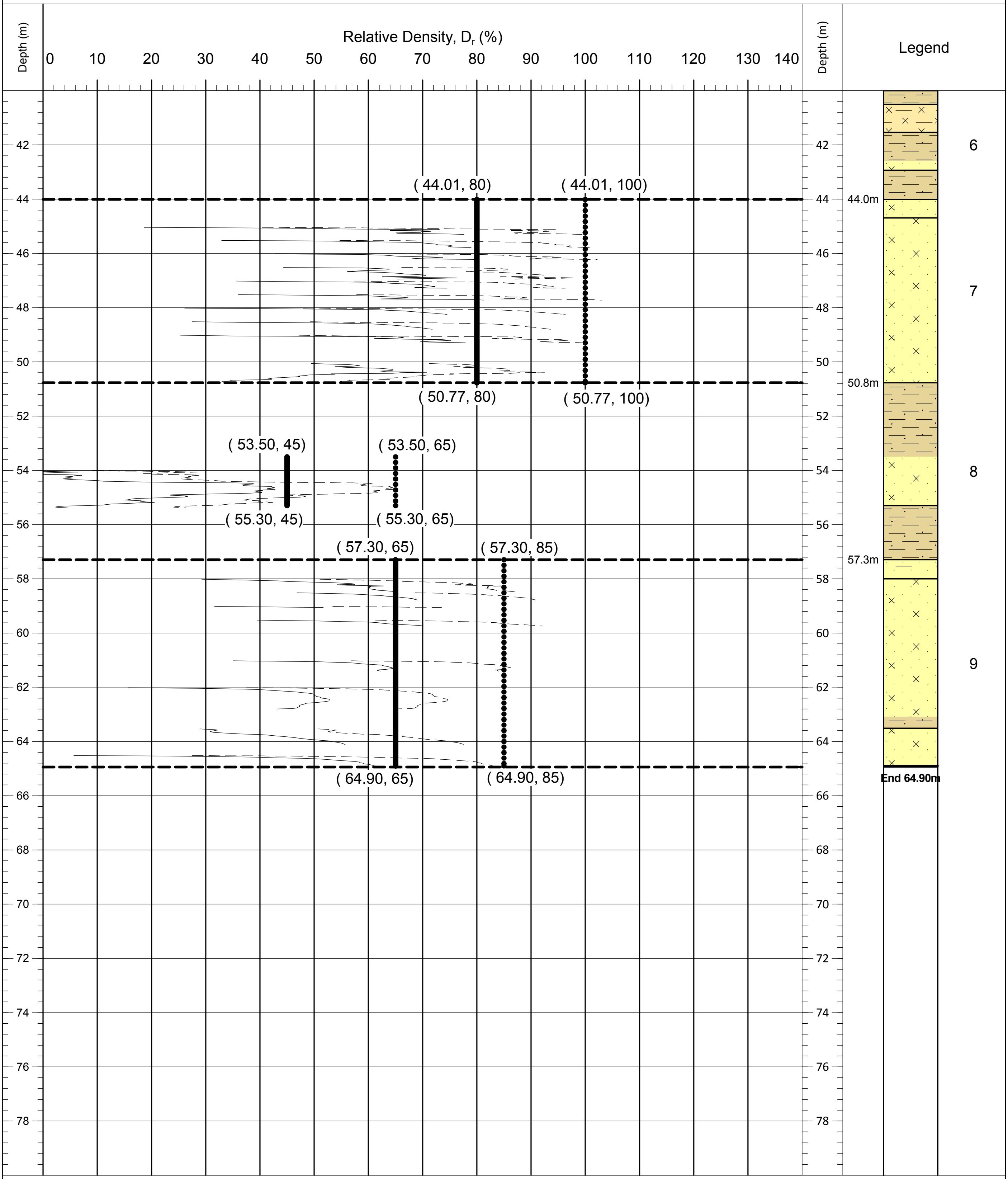
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
RELATIVE DENSITY



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number
Contract	**10451**	Water Depth (mMSL)	**27.7**	BH - MET TOWER
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	Filename - 1.001
Comments:		Hole Type	**Borehole (Combined)**	QC Status
		CRS **GRS 80 UTM ZONE 18 N (75 W)**		

Preliminary	Draft	Final
()	**SMc** **(23/09/2015)**	()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
RELATIVE DENSITY



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**
Contract	**10451**	Water Depth (mMSL)	**27.7**
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**
Comments:		Hole Type	**Borehole (Combined)**
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Borehole Number

BH - MET TOWER

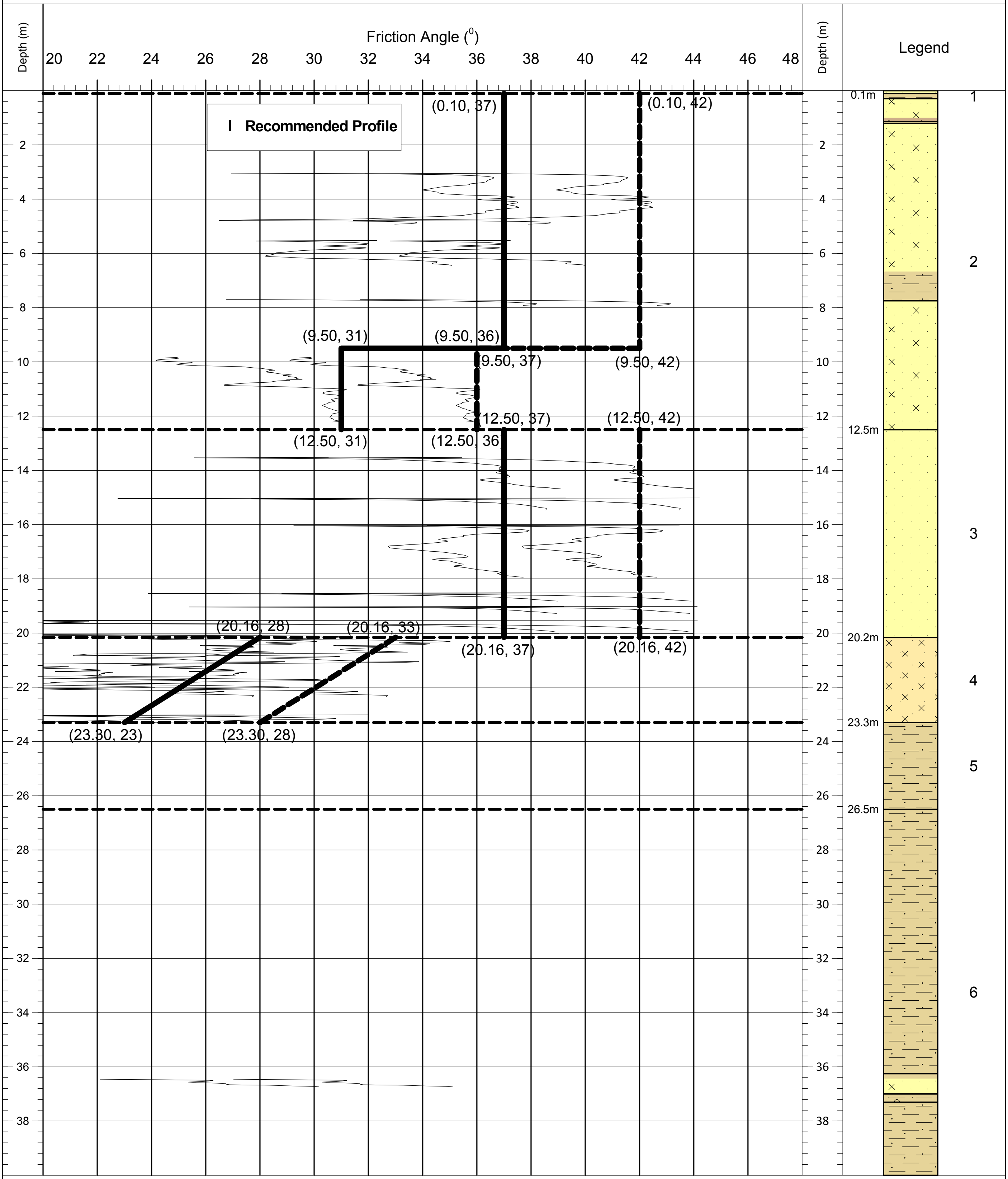
Filename - 1.001

QC Status		
Preliminary	Draft	Final
()	SMc (23/09/2015)	()

APPENDIX 3

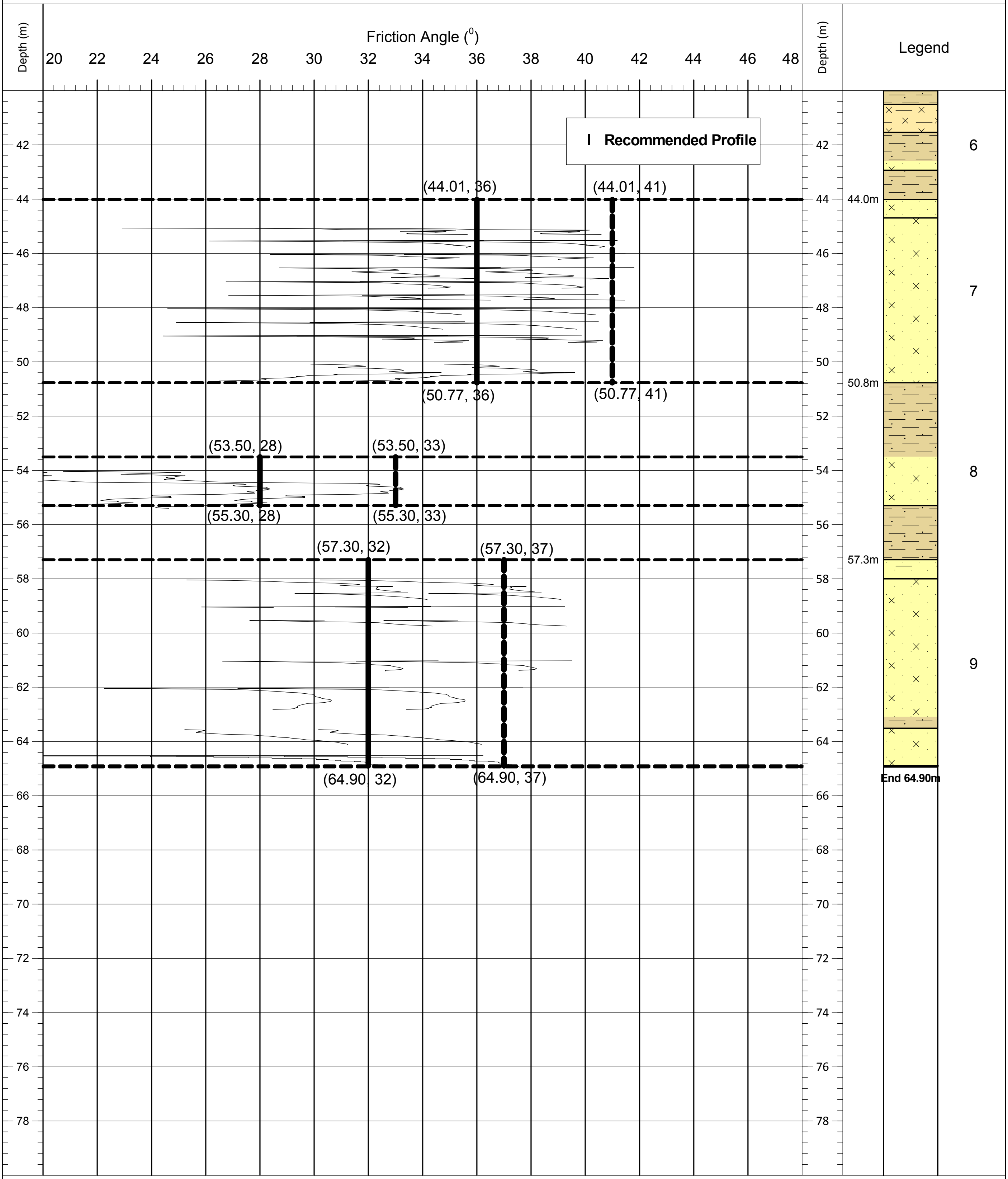
3.1 Friction Angle

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
FRICTION ANGLE PROFILE



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number BH - MET TOWER
Contract	**10451**	Water Depth (mMSL)	**27.7**	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	QC Status
Comments:		Hole Type	**Borehole (Combined)**	Preliminary: () / Draft: **SMc (23/09/2015)** / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
FRICTION ANGLE PROFILE



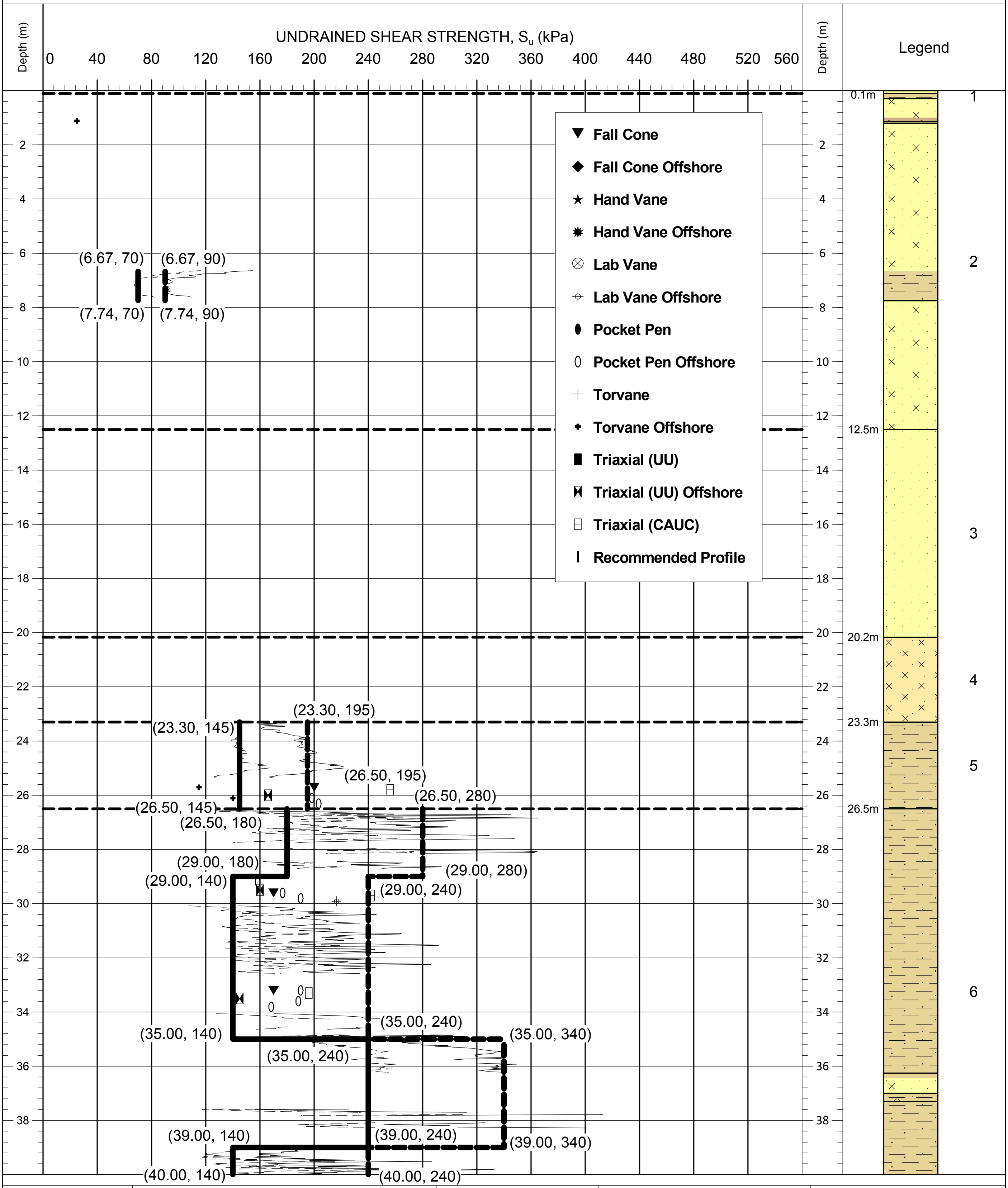
Area	Maryland USA	Coordinates	521533.9E 4244983.3N	Borehole Number
Contract	10451	Water Depth (mMSL)	27.7	BH - MET TOWER
Client Name/Ref	US Wind Inc./REF11449	Date of Test (Start-End)	25/06/2015 - 26/06/2015	
Vessel	MV Ocean Discovery	Final Depth	64.90m	Filename - 1.001
Comments:		Hole Type	Borehole (Combined)	QC Status
		CRS	GRS 80 UTM ZONE 18 N (75 W)	

Preliminary	Draft	Final
()	SMc (23/09/2015)	()

APPENDIX 4

4.1 Undrained Shear Strength

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE

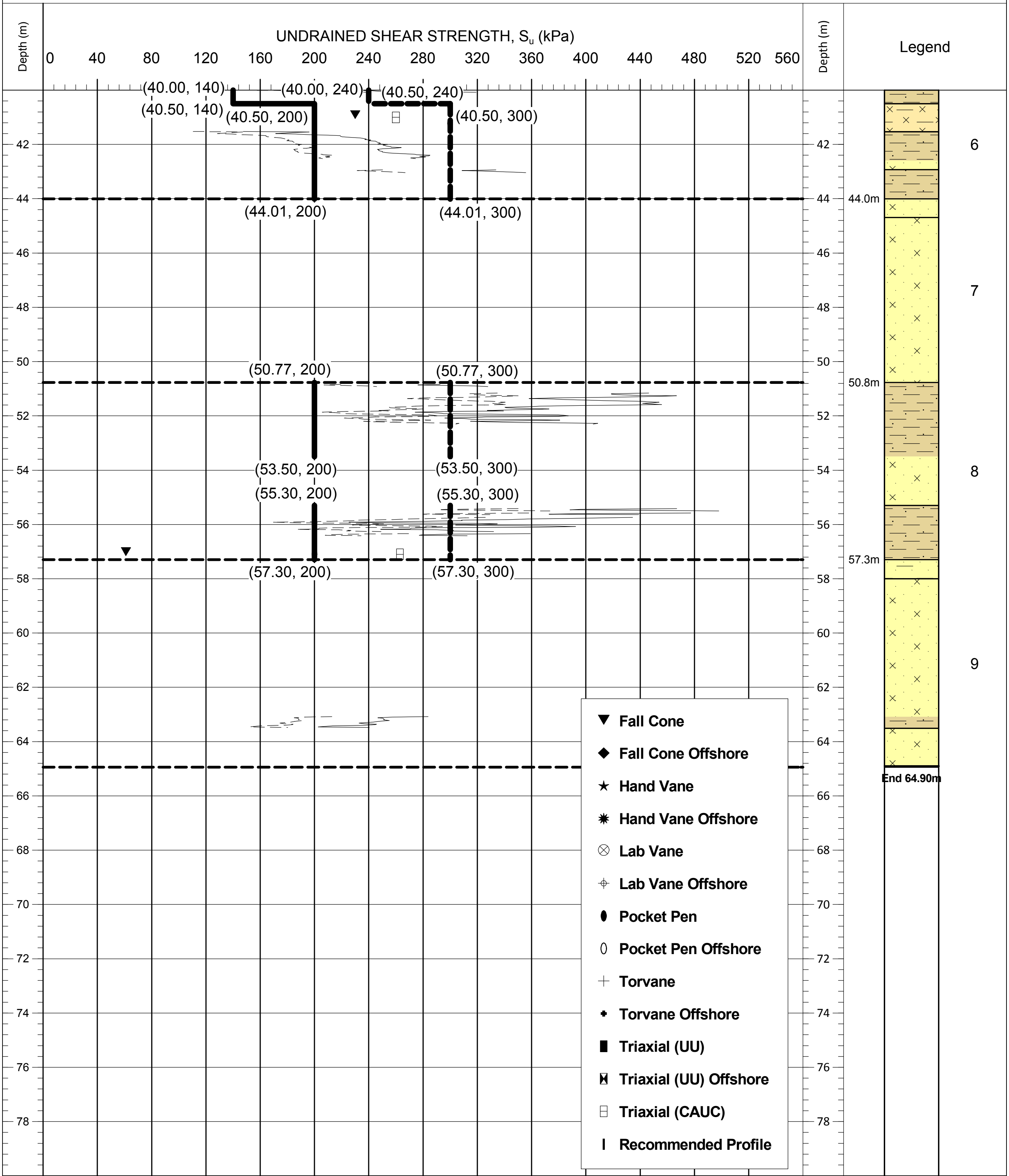


Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number BH - MET TOWER
Contract	**10451**	Water Depth (mMSL)	**27.7**	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	QC Status
Comments: Pocket Penetrometer readings maxed out at 300kPa		Hole Type	**Borehole (Combined)**	Preliminary: 0 / Draft: **SMc (23/09/2015)** / Final: 0
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Gardline

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE

US Wind inc sea energy



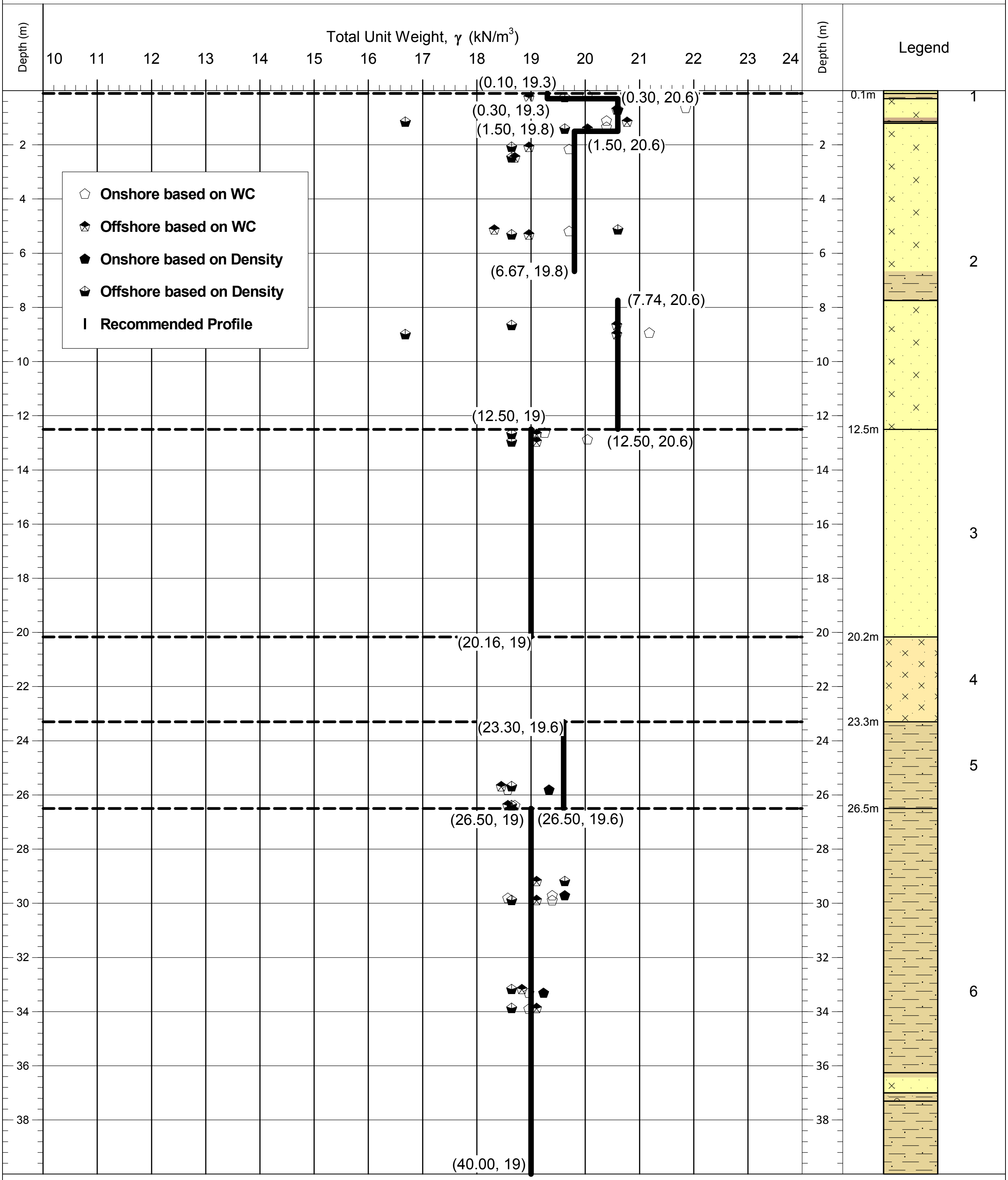
Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number
Contract	**10451**	Water Depth (mMSL)	**27.7**	BH - MET TOWER
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	Filename - 1.001
Comments: Pocket Penetrometer readings maxed out at 300kPa		Hole Type	**Borehole (Combined)**	QC Status
		CRS **GRS 80 UTM ZONE 18 N (75 W)**		

Preliminary	Draft	Final
()	**SMc** **(23/09/2015)**	()

APPENDIX 5

5.1 Total Unit Weight

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
TOTAL UNIT WEIGHT PROFILE



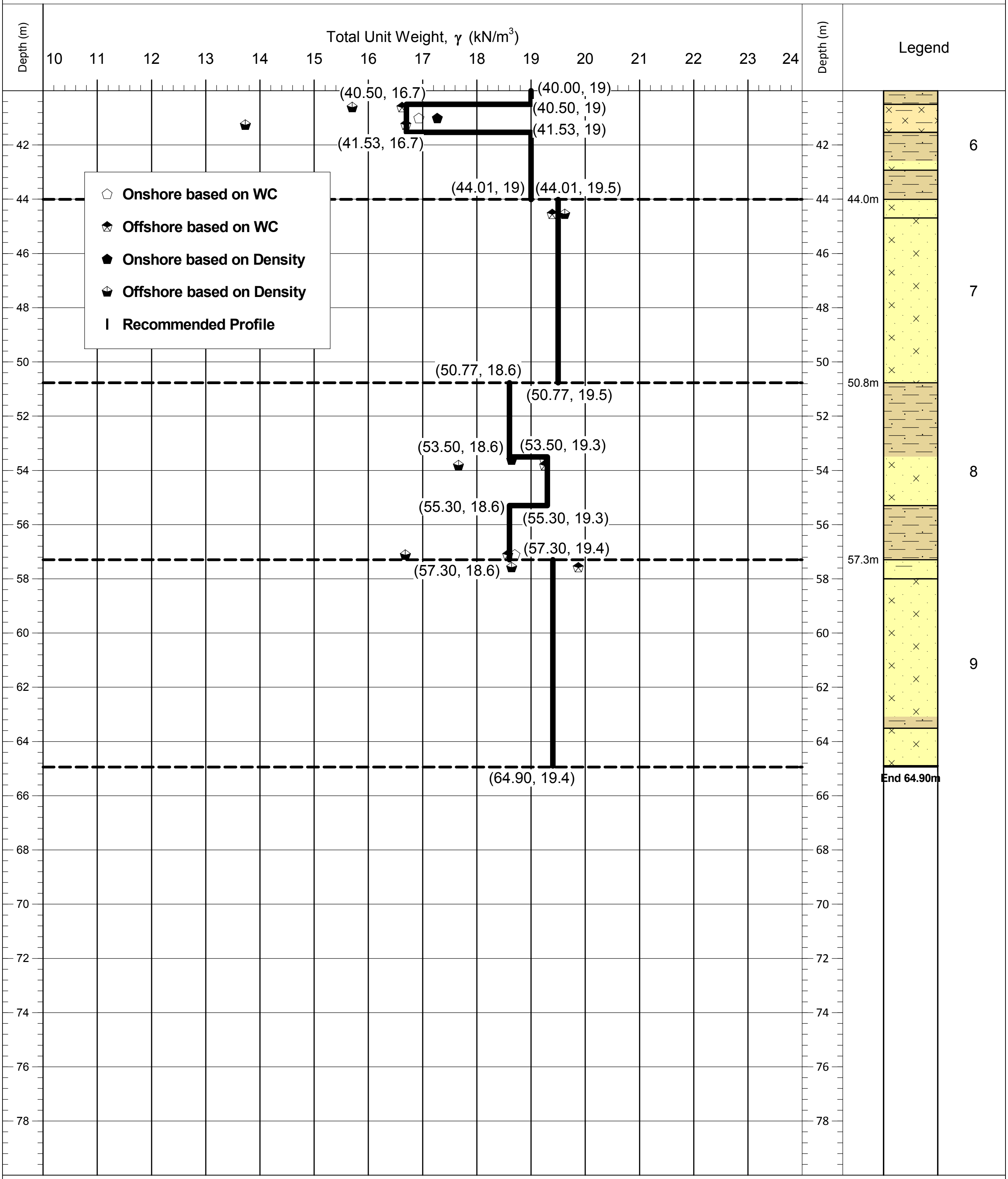
Area	Maryland USA	Coordinates	521533.9E 4244983.3N	Borehole Number
Contract	10451	Water Depth (mMSL)	27.7	BH - MET TOWER
Client Name/Ref	US Wind Inc./REF11449	Date of Test (Start-End)	25/06/2015 - 26/06/2015	
Vessel	MV Ocean Discovery	Final Depth	64.90m	Filename - 1.001
Comments: Parameters not provided for Units 1, 4 and some beds within other units due to them being identified through CPTU data only.		Hole Type	Borehole (Combined)	QC Status
		CRS	GRS 80 UTM ZONE 18 N (75 W)	

Preliminary	Draft	Final
()	SMc (23/09/2015)	()

Gardline

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
TOTAL UNIT WEIGHT PROFILE

US Wind inc sea energy



Area	Maryland USA	Coordinates	521533.9E 4244983.3N
Contract	10451	Water Depth (mMSL)	27.7
Client Name/Ref	US Wind Inc./REF11449	Date of Test (Start-End)	25/06/2015 - 26/06/2015
Vessel	MV Ocean Discovery	Final Depth	64.90m
Comments: Parameters not provided for Units 1, 4 and some beds within other units due to them being identified through CPTU data only.		Hole Type	Borehole (Combined)
		CRS	GRS 80 UTM ZONE 18 N (75 W)

Borehole Number

BH - MET TOWER

Filename - 1.001

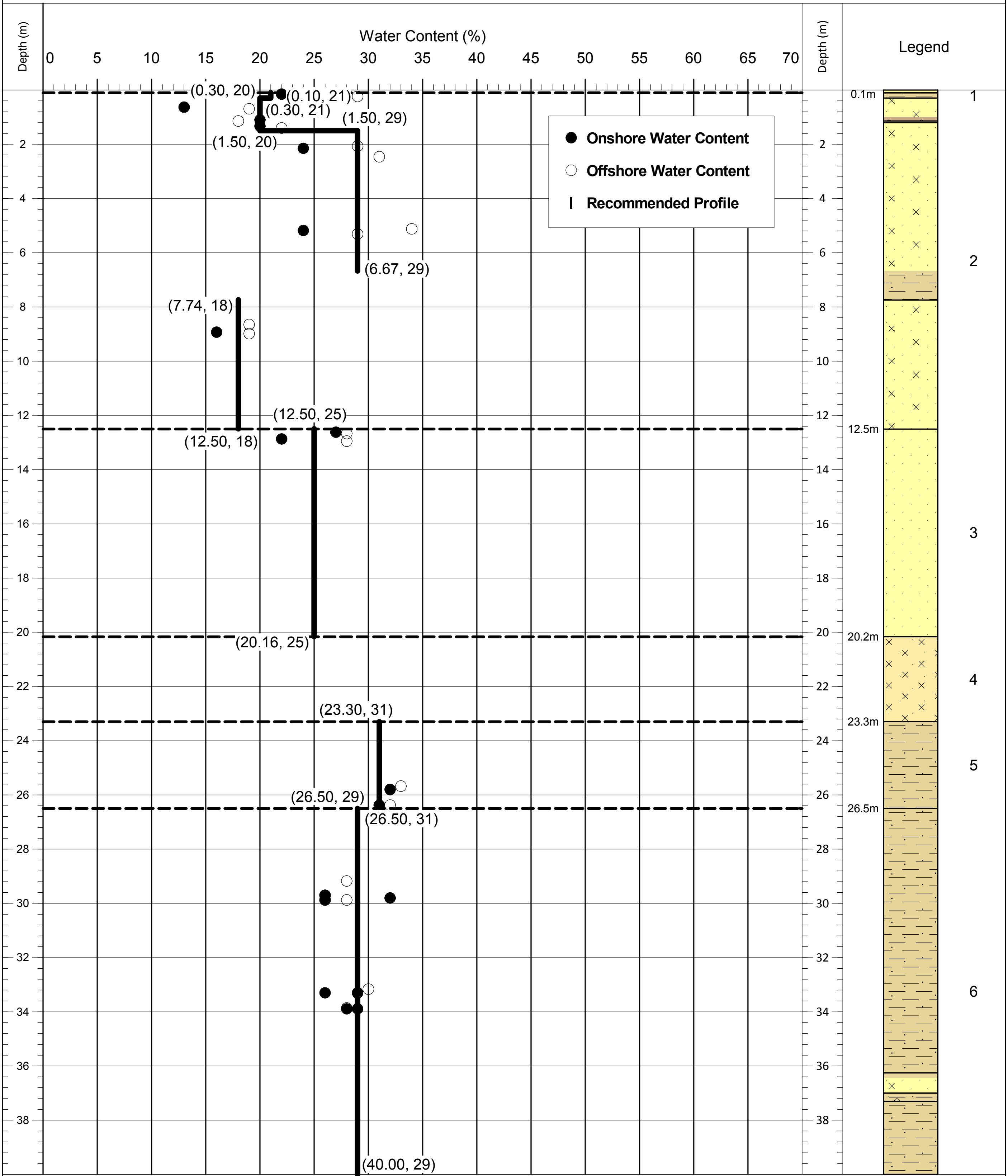
QC Status

Preliminary	Draft	Final
()	SMc (23/09/2015)	()

APPENDIX 6

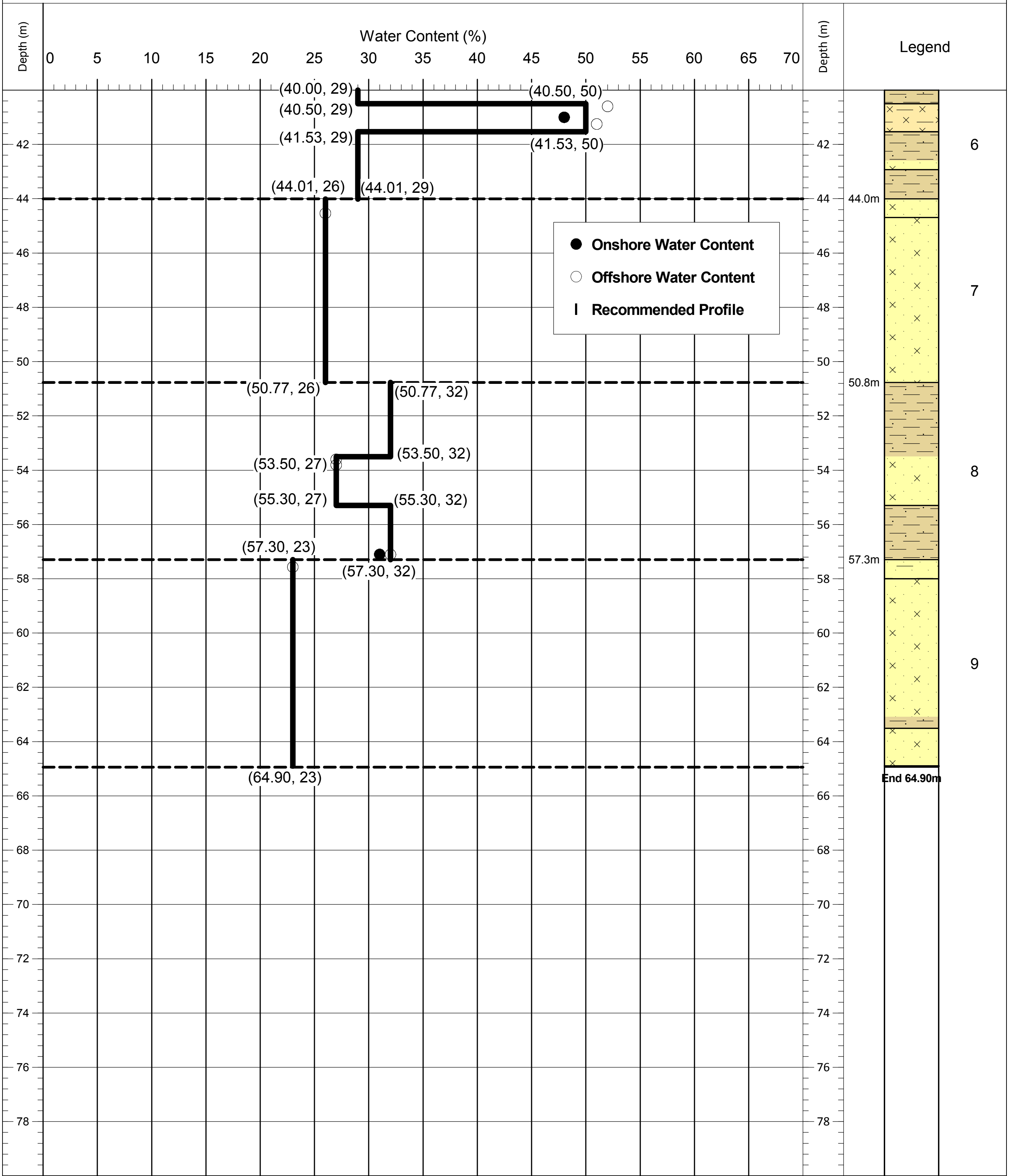
6.1 Moisture Content

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number BH - MET TOWER
Contract	**10451**	Water Depth (mMSL)	**27.7**	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	Filename - 1.001 QC Status
Comments: Parameters not provided for Units 1, 4 and some beds within other units due to them being identified through CPTU data only.		Hole Type	**Borehole (Combined)**	Preliminary () / Draft **SMc (23/09/2015)** / Final ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE

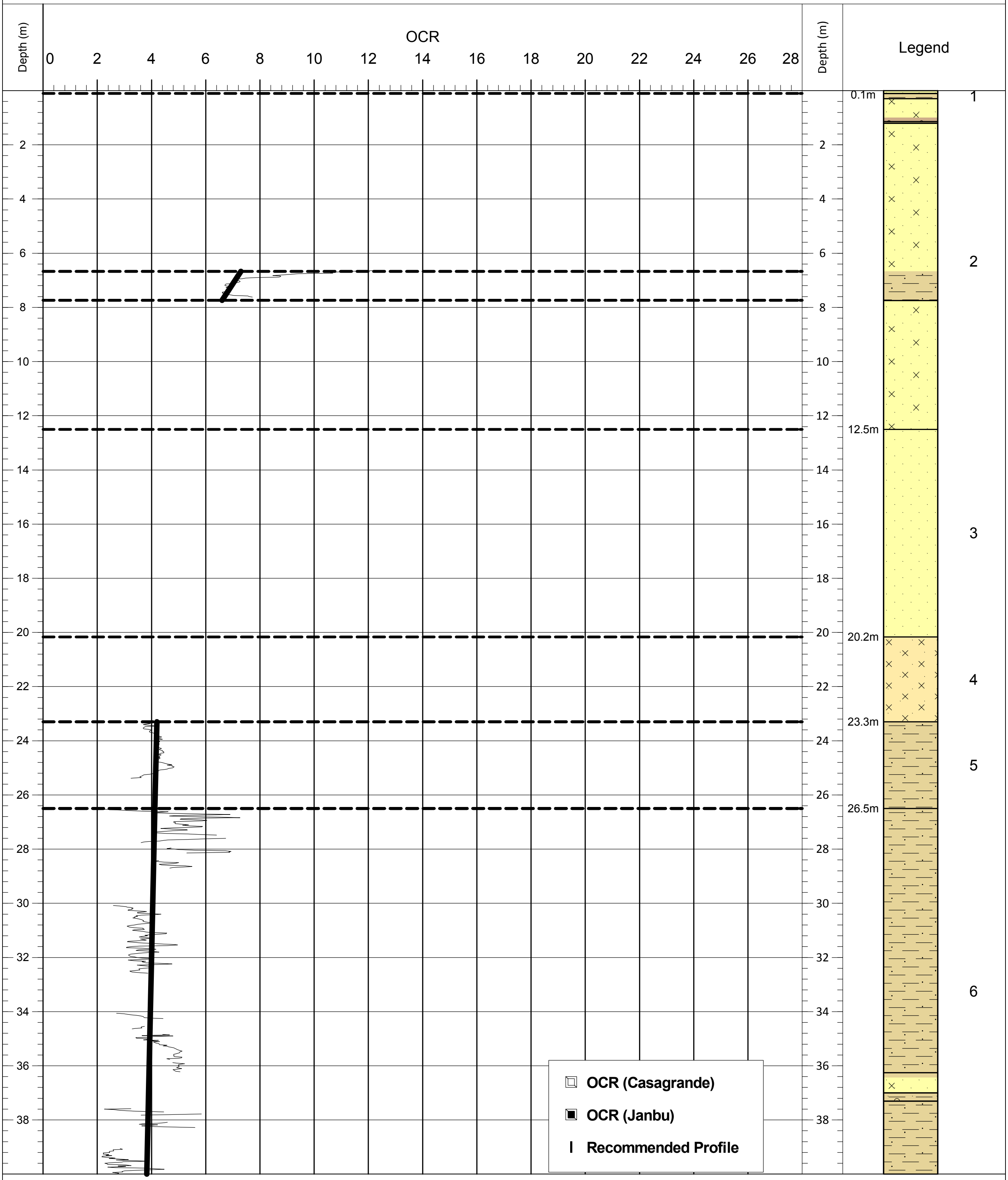


Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number BH - MET TOWER
Contract	**10451**	Water Depth (mMSL)	**27.7**	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	QC Status
Comments: Parameters not provided for Units 1, 4 and some beds within other units due to them being identified through CPTU data only.		Hole Type	**Borehole (Combined)**	Preliminary: () / Draft: SMc (23/09/2015) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

APPENDIX 7

7.1 Overconsolidation Ratio

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
OVERCONSOLIDATION RATIO

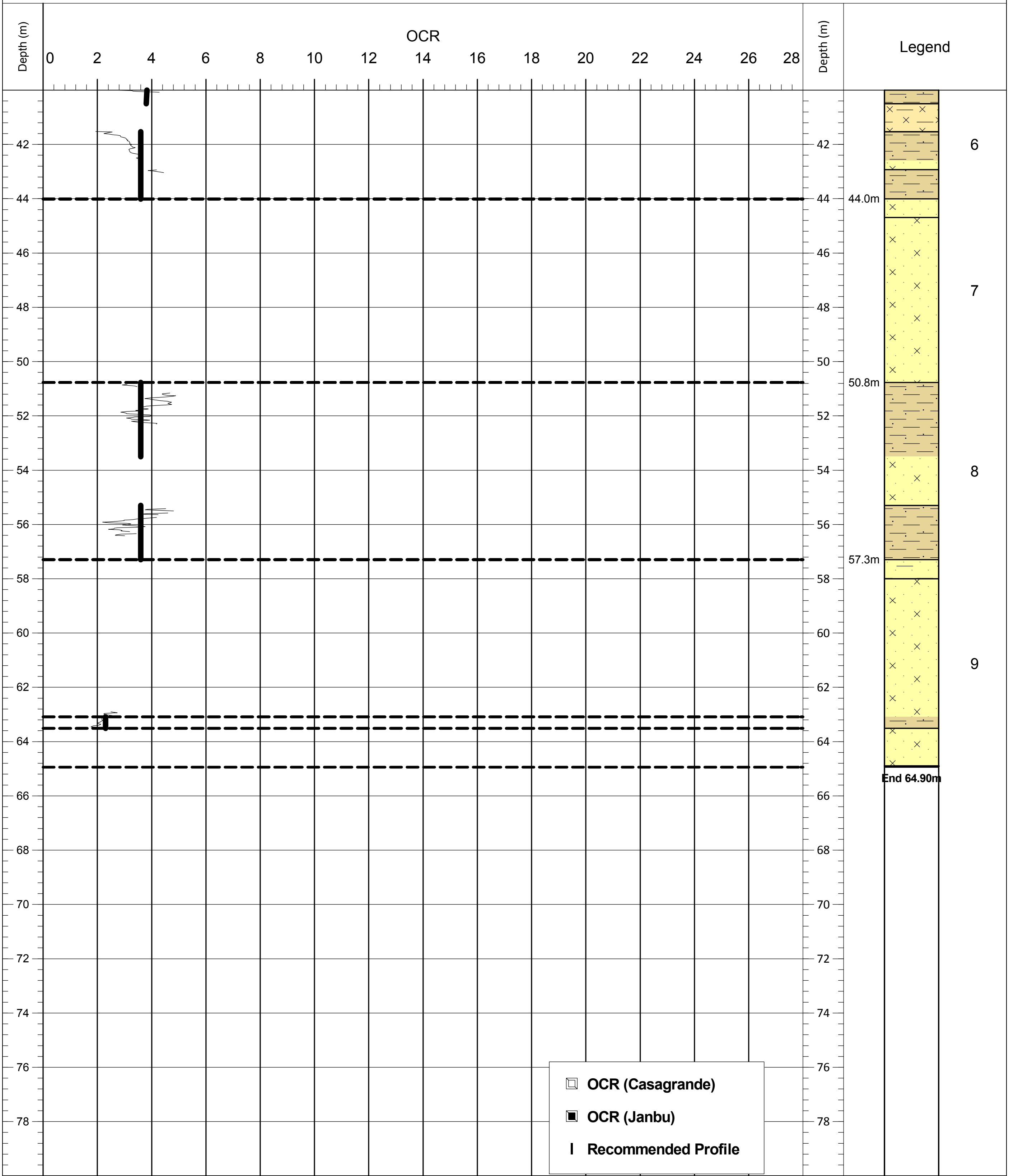


Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number BH - MET TOWER
Contract	**10451**	Water Depth (mMSL)	**27.7**	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	QC Status
Comments:		Hole Type	**Borehole (Combined)**	Preliminary: () / Draft: **SMc** (23/09/2015) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Gardline

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
OVERCONSOLIDATION RATIO

US Wind inc sea energy

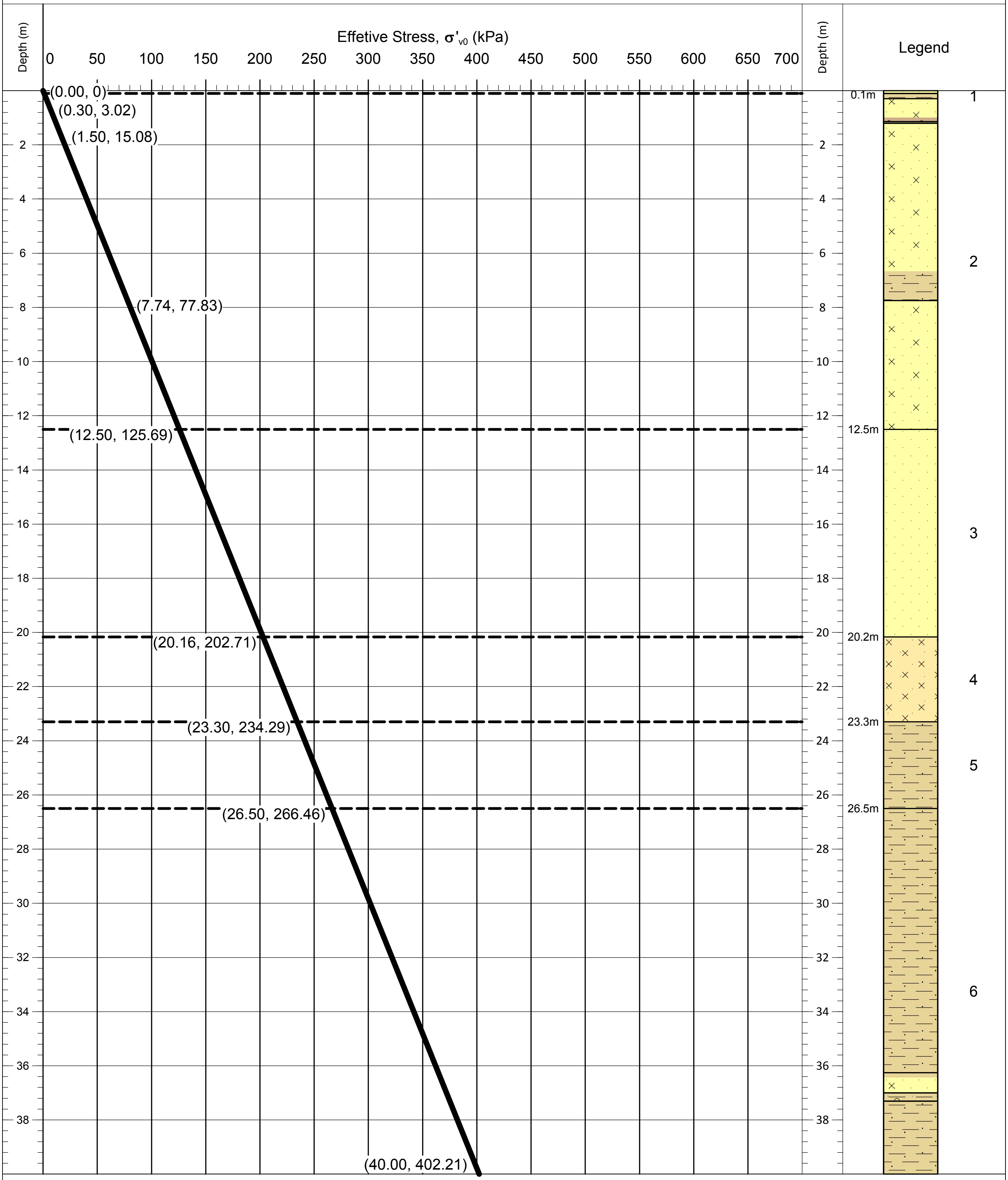


Area	Maryland USA	Coordinates	521533.9E 4244983.3N	Borehole Number BH - MET TOWER
Contract	10451	Water Depth (mMSL)	27.7	
Client Name/Ref	US Wind Inc./REF11449	Date of Test (Start-End)	25/06/2015 - 26/06/2015	Filename - 1.001
Vessel	MV Ocean Discovery	Final Depth	64.90m	QC Status
Comments:		Hole Type	Borehole (Combined)	Preliminary: () / Draft: SMc (23/09/2015) / Final: ()
		CRS	GRS 80 UTM ZONE 18 N (75 W)	

APPENDIX 8

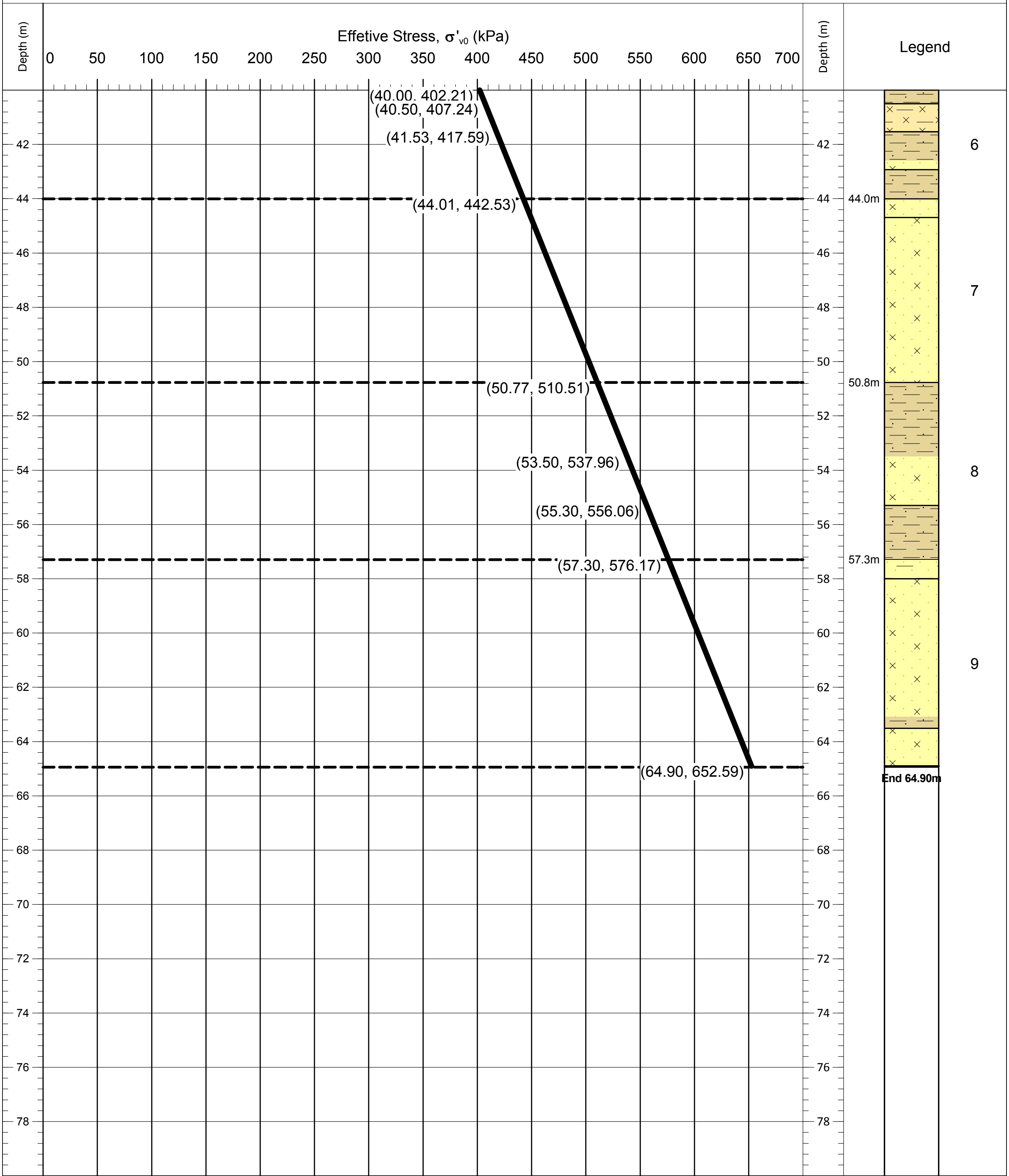
8.1 Effective Vertical Stress

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
EFFECTIVE STRESS PROFILE



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number BH - MET TOWER
Contract	**10451**	Water Depth (mMSL)	**27.7**	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	QC Status
Comments:		Hole Type	**Borehole (Combined)**	Preliminary: () / Draft: **SMc (23/09/2015)** / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
EFFECTIVE STRESS PROFILE



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**
Contract	**10451**	Water Depth (mMSL)	**27.7**
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**
Comments:		Hole Type	**Borehole (Combined)**
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Borehole Number
BH - MET TOWER

Filename - 1.001

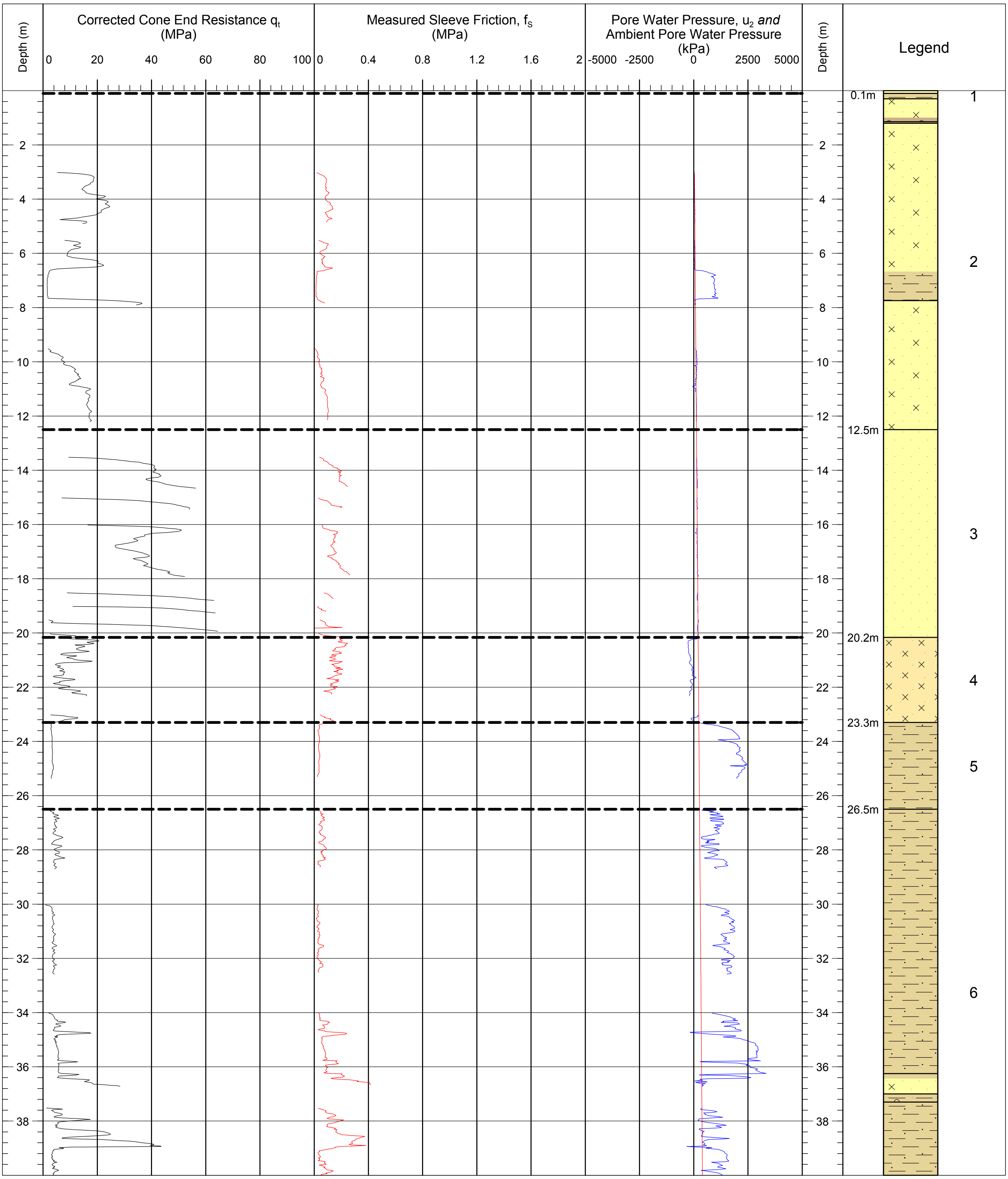
QC Status

Preliminary	Draft	Final
()	**SMc** (23/09/2015)	()

APPENDIX 9

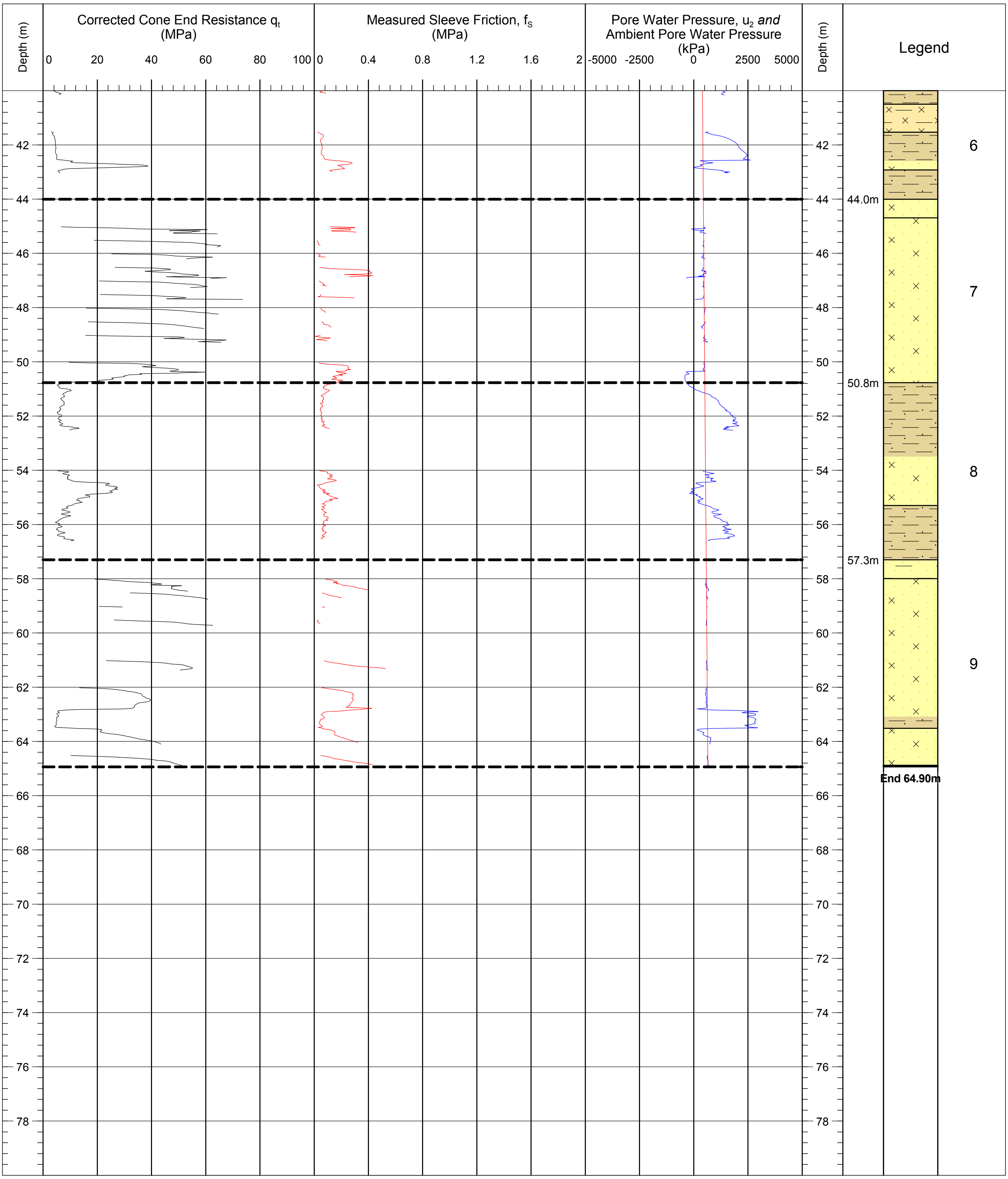
9.1 CPTU

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT
Met Tower



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number
Contract	**10451**	Water Depth (mMSL)	**27.7**	BH - MET TOWER
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**25/06/2015 - 26/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	Filename - 1.001
Comments:		Hole Type	**Borehole (Combined)**	QC Status: Preliminary / Draft / Final
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Draft: **SMc (23/09/2015)**

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT
Met Tower



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number BH - MET TOWER
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Comments:		Hole Type	**Borehole (Combined)**	Preliminary / Draft: **SMc (23/09/2015)** / Final
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Appendix G

Marine Archaeological Resource Assessment (Confidential)

Appendix H

Benthic Assessment Report

US Wind Benthic Macroinvertebrate Community and Habitat Assessment

Site Assessment Plan Area

PREPARED FOR:
US Wind, Inc.
1 North Charles Street, Suite 2310
Baltimore, Maryland 21201

PREPARED BY:
ESS Group, Inc.
100 Fifth Avenue, 5th Floor
Waltham, Massachusetts 02451

ESS Project No. U167-003

October 21, 2015

US WIND BENTHIC MACROINVERTEBRATE COMMUNITY AND HABITAT ASSESSMENT
Site Assessment Plan Area

Prepared For:

US Wind, Inc.
1 North Charles Street, Suite 2310
Baltimore, Maryland 21201

Prepared By:

ESS Group, Inc.
100 Fifth Avenue, Fifth Floor
Waltham, Massachusetts 02451

ESS Project No. U167-003

October 21, 2015

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1.0 INTRODUCTION

1.1 Background

ESS Group, Inc. (ESS) conducted a benthic habitat assessment survey in the vicinity of the proposed meteorological tower associated with the Site Assessment Plan (SAP) for the Maryland Wind Energy Area (MD WEA) leased by US Wind, Inc. (US Wind). Sampling was conducted in accordance with *Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585* issued November 4, 2013 the Bureau of Ocean Energy Management (BOEM).

The survey included photodocumentation of seafloor habitat in the SAP area as well as the collection and analysis of benthic grab samples. These data were used to supplement existing studies and generate a taxonomic classification of benthic habitat in the SAP area to the lowest practicable taxonomic level under the Coastal and Marine Ecological Classification Standard (CMECS) (FGDC 2012).

1.2 Definitions

Benthic macroinvertebrate: For the purposes of this assessment, benthic macroinvertebrates are defined as those invertebrate organisms greater than 500 microns (µm) in length that either live on (epifauna) or within (infauna) the substrate, including but not limited to annelid (segmented) worms, mollusks, crustaceans, and echinoderms.

Hard bottom: Coral, cobble, rock, clay outcroppings, or other shelter forming features.

SAV: Submerged aquatic vegetation, such as eelgrass (*Zostera marina*) or macroalgae.

Sensitive habitat: Benthic habitats containing hard bottom or SAV features.

2.0 APPROACH

The BOEM guidelines for benthic habitat survey (issued November 4, 2013) were used as the primary guidance document for developing the survey approach. Additional comments received from BOEM on February 23, 2015 were also incorporated into the approach.

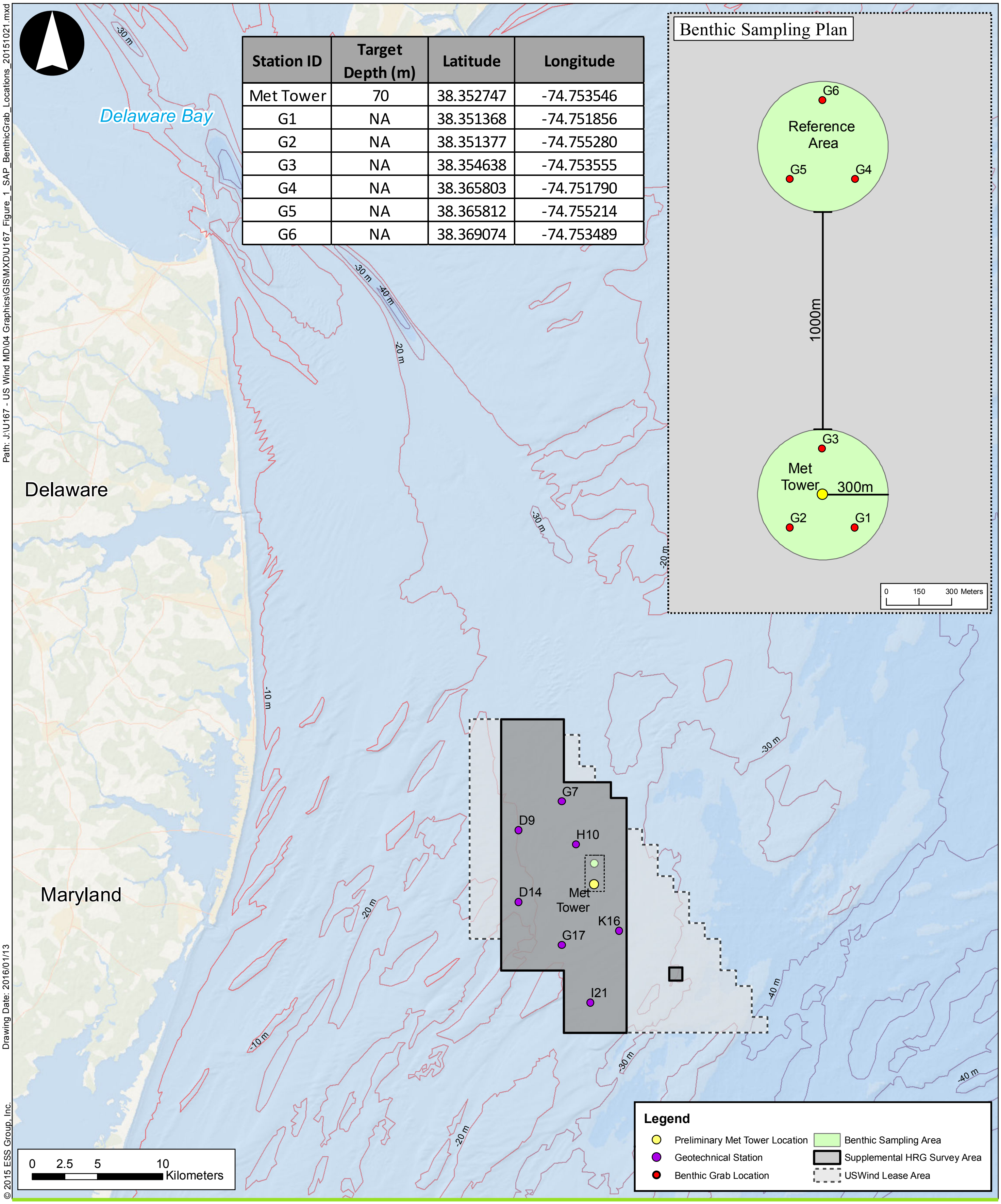
The benthic field survey was conducted from the R/V *Shearwater* on July 25, 2015 and was composed of two primary elements, including 1) collection of still images of the seafloor and 2) collection of benthic grab samples for laboratory analysis of taxonomic composition.

To obtain site-specific information on the benthic community, the benthic field survey focused on three locations near the site of the proposed meteorological tower (Figure 1). Three additional benthic samples were collected from an area of comparable habitat located 1,000 m (3,281 ft) north of the SAP area (reference area). This area was selected to represent background conditions as it is well outside the area of anticipated impact from the installation, operation and decommissioning of the proposed meteorological tower.

The survey vessel navigated to and recorded each sampling position using a Differential Global Positioning System (DGPS).

2.1 Benthic Imagery

Images of the seafloor were captured at each survey location with a Kongsberg/Simrad OE14-208 5.0-megapixel underwater camera with a dedicated strobe and video lamp, mounted within a stainless steel frame (Attachment A). The camera was equipped with a 10-centimeter (cm) laser scale. An ultra-short baseline (USBL) positioning beacon was attached to the camera frame for acoustic positioning.



Station ID	Target Depth (m)	Latitude	Longitude
Met Tower	70	38.352747	-74.753546
G1	NA	38.351368	-74.751856
G2	NA	38.351377	-74.755280
G3	NA	38.354638	-74.753555
G4	NA	38.365803	-74.751790
G5	NA	38.365812	-74.755214
G6	NA	38.369074	-74.753489

Path: J:\U167 - US Wind MD\04 Graphics\GIS\MXD\U167_Figure_1_SAP_BenthicGrab_Locations_20151021.mxd

Drawing Date: 2016/01/13

ESS group environmental consulting & engineering services

US Wind Maryland

Offshore Maryland

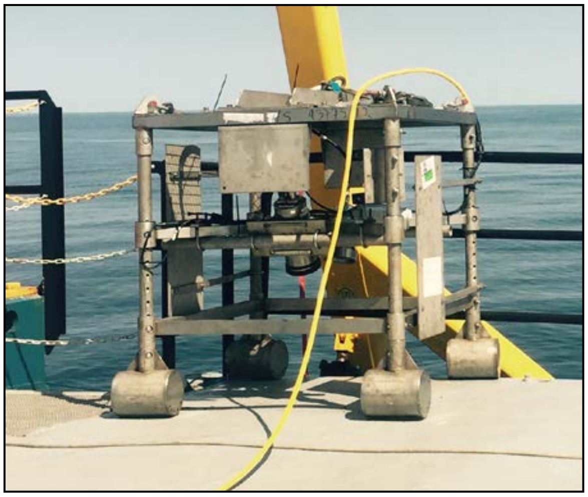
1 inch = 10 kilometers

Source: 1) ESRI-NOAA-NGDC, Online Coastal Basemap
2) BOEM, OCS Atlantic Aliquots, 2012
3) NOAA-CRM, Bathymetric Contours

Benthic Sampling Locations

Figure 1

A hover and drift technique allowed the frame to move progressively along the seafloor as the vessel traversed the study area. Footage was viewed in real time via an umbilical, assisting in the control of the digital stills camera and selection of still photograph locations. Images were captured using the surface control unit and initially stored on the camera's internal memory card. On completion, photographs were downloaded onto a PC and copied onto CD-ROM.



Underwater camera on aft deck of R/V Shearwater

The number of images captured at each station ranged from 13 to 18 and individual still photographs that were separated by a time gap of approximately 5 to 10 seconds (Attachment A and Attachment B). Substrate type was characterized and visible benthic taxa were identified in each set of images.

2.2 Benthic Grab Sampling

2.2.1 Sample Collection

Surface benthic grab samples were successfully collected using a Van Veen grab sampler at each of the six sampling locations (Attachment A). The sampler measured approximately 11.8 inches by 11.8 inches (30 cm by 30 cm) at the sampling interface. After retrieval, each sample was examined for quality and a decision was made to accept or reject the sample based on representativeness of the grab. Sample grabs that did not retain at least 2.5 inches (6.4 cm) of material or showed evidence of uneven penetration (i.e. angled sample) were rejected as incomplete and the grab was redeployed until an acceptable sample was retained. Over the course of the field program, only one sample attempt was rejected. This occurred at Station G5, due to inadequate sample material recovery (Attachment C). The subsequent sample attempt at Station G5 was successful and no additional corrective action was necessary.

Preparing Van Veen grab sampler on R/V Shearwater

Once an acceptable sample was retrieved, a subsample was removed from a 0.04 m^2 area of the sampler. A stainless steel divider plate was inserted directly into the retrieved sample to isolate the area for subsampling. Descriptions of sample recovery and sediment type (i.e. grain size) were recorded in a field notebook (Attachment C).

Example of typical recovery in grab samples

The volume of sediment from the subsampled area was then removed from the sampler using a stainless steel spoon and sieved in the field. Prior to sieving, sediment type was observed and described. Sieving consisted of gently rinsing the sample material through a bucket sieve with 500-μm mesh to remove fine sediments. Sieved samples were preserved in a solution containing 10% buffered formalin in seawater. Preserved samples were stored in plastic quart-size sample jars and labeled with the project name, sample identification code, sampling date, preservative, and the initials of the collector.

Preserved samples were returned to ESS offices in East Providence, Rhode Island for storage and laboratory analysis.

2.2.2 Laboratory Analysis

Upon receipt at the laboratory, each sample was logged in and decanted through a 500-μm sieve. Samples were gently rinsed in the sieve to remove formalin and remaining fine sediments. Once thoroughly rinsed, each sample was returned to a labeled jar and preserved with 70% ethanol for storage.

For sorting, the contents of each sample were examined using a high-power dissecting microscope (7X to 45X magnification) and high-intensity gooseneck fiber optic lamp. Due to the large sample volume, sample sorting was conducted using a randomized sub-sampling methodology. For the sub-sampling process, sample material was emptied into and evenly distributed within a gridded tray, each cell of which was assigned a number. Cells were then randomly selected, one at a time, for sorting using a random number generator. Randomized selection of cells continued until a target of at least 100 organisms was retained for each sample. All randomly selected fractions of sample material were sorted in their entirety.

Organisms found during the sorting process were removed with forceps and placed in 70% ethanol. Each vial was labeled with the project name, collection date and sample identification number. All residue (sediment and organic matter) from the sorted and unsorted portion of each sample was placed in a separate labeled container and re-preserved in 70% ethanol.

Sorted organisms were subsequently identified by a qualified taxonomist to the lowest taxonomic level possible using a dissecting microscope and readily available taxonomic keys and references (Bartholomew, 2001; Martinez, 1999; Abbott and Morris, 1995; Weiss, 1995; Gosner, 1978; Bousfield, 1973; Gosner, 1971; Smith, 1964; Pettibone, 1963). Temporary slide mounts were prepared for annelid worms, as necessary to improve the taxonomic precision of identification for these groups. Slide-mounted organisms were identified under a compound microscope capable of 64X to 1600X magnification.

For quality assurance and quality control (QA/QC) purposes, a second qualified staff member (quality assurance officer) resorted 10% of the samples analyzed by each sorter to ensure organisms were being adequately retained. The quality assurance officer checked the sorted sample material for any remaining organisms and calculated an efficiency rating (E) using the following formula:

$$E = 100 \times \frac{n_a}{n_a + n_b}$$

Where n_a is the number of individuals originally sorted and verified as identifiable organisms by the QC checker and n_b is the number of organisms recovered by the QC checker. If the original sorter achieved E < 90% (i.e., less than 90% of the organisms in the sample removed), corrective action was taken to ensure greater sorting efficiency for other samples sorted by the same individual. Corrective action includes but is not necessarily limited to, additional training on organism recognition and re-sorting of sample material.

In the identification phase, the QA/QC reviewer checked at least 10% of taxonomic identifications for accuracy. Incorrect identifications were reviewed with the taxonomist and revised, as applicable, in the project taxonomic database.

2.2.3 Data Analysis

Measures of benthic diversity, abundance and community structure were selected to describe the affected environment. The rationale behind selection of each measure is as follows:

Diversity: *Taxa richness* is the number of different taxa that are found within a given area or community and is widely accepted as a good assessment measure of diversity (Magurran 2003). For this study, taxa richness is defined as the total number of unique taxa found in a sample.

Abundance: *Macrofaunal density* is a measure of abundance expressed as an estimate of the number of individuals per unit area. Although density often reflects the productivity of marine habitats (Williams et al. 2001), it may also serve as an indication of stress or disturbance at a location. Consequently, the density of benthic organisms may increase or decrease in response to different types of stress (e.g., thermal or chemical pollution, sediment deposition, physical abrasion or displacement).

The density of benthic organisms responds to disturbance as mitigated by the tolerance (or preference) of a given organism to the particular source of disturbance. However, density may vary substantially over small areas or short periods of time and should therefore be interpreted cautiously. For this study, macrofaunal density is expressed as the number of organisms per square meter.

Community structure: *Community composition* is a multivariate measure identifying the different benthic taxa present and respective abundances of each taxon. This descriptive measure provides detail to complement and help interpret summary metrics like taxa richness and macrofaunal density. Multivariate statistical analyses can also be used to evaluate changes in community composition over time.

3.0 RESULTS

3.1 Benthic Imagery

Benthic imagery suggests the bottom type is very similar between the SAP area and the reference area, primarily consisting of sand with shell hash and occasional debris (Attachment A and Attachment B). No sensitive habitats, such as areas of hard bottom or SAV were observed.

Qualitative analysis of the benthic imagery obtained indicated the presence of at least seven macrofaunal taxa overall, including six in the SAP area (Table A). Most of the observed taxa were primarily epifaunal species. Hermit crabs and sand dollars were the most frequently observed taxa. Slow-moving epifauna, such as sand dollars and moon snails, were present at each sampling location but rarely exceeded more than one individual per photograph. Most photographs indicated the presence of multiple annelid worm burrows and tubes.

Table A. Summary of Macroinvertebrate Taxa Observed in Benthic Imagery

Common Name	Scientific Name	SAP Area	Reference Area
Hermit crabs	Paguridae	X	X
Sand dollars	Clypeasteroida	X	X
Sea stars	Asteroidea	X	X
Segmented worms	Annelida	X	X
Moon snails (includes egg collars)	Naticidae	X	X
Crabs	Decapoda	X	X
Hydrozoans	Hydrozoa		X

The results of the benthic imagery in the SAP area and reference area are consistent with recent video surveys and survey trawls of the WEA, which suggest that the primary benthic epifaunal taxa include common sand dollar (*Echinarachnius parma*), hermit crab (*Pagurus* spp.), rock crab (*Cancer irroratus*), moon snails (Naticidae), nassa snails (*Ilyanassa* [=*Nassarius*] spp.), and sea stars (*Asterias* spp.) (Guida et al. 2015).

3.2 Benthic Grab Sampling

The benthic grab samples provided additional information on the benthic community, especially infaunal taxa. The taxa richness, density and community composition of the samples collected from the SAP area were very similar to the reference area (Table B).

Table B. Summary of Key Statistics

Statistic	SAP Area	Reference Area
Number of Samples	3	3
Mean Density per Square Meter (±1 SD)	3,567 ± 666	3,300 ± 361
Mean Taxa Richness (±1 SD)	9 ± 1	9 ± 2
Total Number of Taxa	16	14
Number of Taxa Observed by Taxonomic Group		
Mollusks	4	3
Oligochaetes	1	1
Polychaetes	8	6
Crustaceans	1	2
Other	2	1
Percent of Total Abundance by Taxonomic Group		
Mollusks	4.7	3.0
Oligochaetes	8.4	11.1
Polychaetes	33.6	37.4
Crustaceans	6.5	12.1
Other	46.7	36.4

3.2.1 Taxa Richness

Overall, 19 species of benthic fauna were observed from the 6 grab samples. Taxa richness was fairly consistent overall, ranging from 7 to 10 at each sampling location (Attachment D), and averaging nine taxa in both the SAP area and reference area (Table C). Polychaete worms were the most taxonomically rich group, contributing as much as half of the taxa richness in the study area. Mollusks were less taxonomically rich, with just a handful of taxa encountered. Crustaceans, oligochaete worms and other taxonomic groups contributed one or two taxa each.

Table C. Taxa Richness

Taxon	Taxa Richness					
	G1	G2	G3	G4	G5	G6
Crustacea	1	1	1	2	2	2
Mollusca	1	1	2	2	0	1
Oligochaeta	0	1	1	0	1	1
Other	1	2	1	1	1	1
Polychaeta	5	4	4	2	3	5
Total	**8**	**9**	**9**	**7**	**7**	**10**

3.2.2 Macrofaunal Density

The highest macrofaunal density for this study (4,300 individuals/m^2) was found at G2, while faunal density was lowest (3,000 individuals/m^2) at G3 and G4 (Table D).

Overall macrofaunal density was comparable between the SAP area and the reference area (Table B). Nematode worms were the most abundant organism encountered in the site-specific benthic grab sampling program, although they made up a larger portion of the benthic community near the meteorological tower than in the reference area. Polychaete worms were the second-most abundant benthic organism observed, followed by oligochaete worms, crustaceans and mollusks.

Table D. Macrofaunal Density

Taxon	Density (Individuals/m^2)					
	G1	G2	G3	G4	G5	G6
Crustacea						
Tanaissus psammophilus	400	100	200	400	400	100
Trichophoxus epistomus	0	0	0	100	100	100
Mollusca						
Astarte castanea	0	0	0	100	0	0
Ensis directus	0	200	0	100	0	0
Ilyanassa trivittata	0	0	100	0	0	0
Spisula solidissima	0	0	100	0	0	100
Tellinidae	100	0	0	0	0	0
Oligochaeta						
Tubificidae	0	700	200	0	200	900
Other						
Nematoda	1800	1700	600	1500	1200	900

Taxon	Density (Individuals/m^2)					
	G1	G2	G3	G4	G5	G6
Turbellaria	0	900	0	0	0	0
Polychaeta						
Capitellidae	200	0	0	0	0	0
Cirratulidae	100	0	0	0	0	0
Exogone hebes	0	0	0	0	0	100
Glycinde solitaria	300	200	800	0	0	0
Lumbrinerides acuta	300	100	500	0	300	400
Orbiniidae	0	0	0	0	100	0
Paraonis sp.	200	100	0	100	0	100
Polygordius sp.	0	300	400	700	900	900
Sigalion arenicola	0	0	100	0	0	100
Total	**3400**	**4300**	**3000**	**3000**	**3200**	**3700**

The average faunal density observed within the study area is consistent with that reported for the WEA by Guida et al. (2015).

3.2.3 Community Composition

Most of the benthic macrofaunal taxa observed in the site-specific benthic grab samples were small burrowing or tube-building taxa. The most commonly observed polychaete taxa include *Polygordius* sp. and *Lumbrinerides acuta* (Table E), both typical of sandy shelf habitats (Solis-Weiss 1995, Ramey 2008). The most abundant crustacean (the tanaid *Tanaissus psammophilus*) and mollusk (the razor clam *Ensis directus*) are also shallow burrowers in sand (Weiss 1995).

No taxa indicative of sensitive habitats were observed in the benthic grab samples.

Table E. Relative Abundance of Taxa Observed in Site-Specific Benthic Grabs

	% Relative Abundance		
Taxon	Overall	SAP Area	Reference Area
Nematoda	37.38	38.32	36.36
Polygordius sp.	15.53	6.54	25.25
Tubificidae	9.71	8.41	11.11
Lumbrinerides acuta	7.77	8.41	7.07
Tanaissus psammophilus	7.77	6.54	9.09
Glycinde solitaria	6.31	12.15	0.00
Turbellaria	4.37	8.41	0.00
Paraonis sp.	2.43	2.80	2.02
Ensis directus	1.46	1.87	1.01
Trichophoxus epistomus	1.46	0.00	3.03
Capitellidae	0.97	1.87	0.00
Sigalion arenicola	0.97	0.93	1.01
Spisula solidissima	0.97	0.93	1.01
Astarte castanea	0.49	0.00	1.01
Cirratulidae	0.49	0.93	0.00

Taxon	% Relative Abundance Overall	SAP Area	Reference Area
Exogone hebes	0.49	0.00	1.01
Ilyanassa trivittata	0.49	0.93	0.00
Orbiniidae	0.49	0.00	1.01
Tellinidae	0.49	0.93	0.00

Larger nematode worms (longer than 500 microns) were included in the site-specific data analysis. However, nematodes are often treated entirely as meiofauna and not included in analyses of the benthic macroinvertebrate community (e.g., Guida et al. 2015).

When nematodes are removed from the site-specific dataset, polychaete worms become the dominant taxonomic group, contributing 54.5 percent and 58.7 percent of the total benthic abundance, respectively. These community composition results are consistent with previous grab sampling of the benthic community near the proposed meteorological tower (Site F in Guida et al. 2015).

4.0 TAXONOMIC CLASSIFICATION OF BENTHIC HABITAT

Benthic habitat in the Maryland WEA is generally characterized by sandy substrates on gentle slopes with evidence of at least moderate levels of mobility (CB&I 2014, Guida et al. 2015). Shell hash frequently accompanies mineral substrates in the WEA and the resultant variations in sediment type and slope are minor.

Benthic habitat within the SAP area for the proposed meteorological tower is typical of the WEA, consisting primarily of sand with shell hash. Water depths are between 26 m and 27 m (85 ft and 89 ft). Sensitive or unique benthic habitats such as hard bottom, live bottom and SAV do not appear to be present. The proposed meteorological tower is located in one of the flattest portions of the WEA (CB&I 2014, Guida et al. 2015) and bedforms are generally muted.

Based on information reviewed in CB&I (2014), Guida et al. (2015) and site-specific investigations, benthic habitat in the SAP area has been classified to the lowest achievable taxonomic level under the Coastal and Marine Ecological Classification System (CMECS).

Biogeographic Setting:

Realm: Temperate North Atlantic

Province: Cold Temperate Northwest Atlantic

Ecoregion: Virginian

Aquatic Setting:

System: Marine

Subsystem: Marine Nearshore

Tidal Zone: Marine Subtidal

Water Column Component:

Water Column Layer: Marine Nearshore Lower Water Column

Salinity Regime: Euhaline Water

Temperature Regime: Moderate Water (Seasonal Variation from Cold to Warm)

Geoform Component:

Tectonic Setting: Passive Continental Margin

Physiographic Setting: Continental Shelf

Geoform Origin: Geologic

Level 1 Geoform: Sediment Wave Field

Substrate Component:

Substrate Origin: Geologic Substrate

Substrate Class: Unconsolidated Mineral Substrate

Substrate Subclass: Fine Unconsolidated Substrate

Substrate Group: Sand

Co-occurring Element: Substrate Subclass: Shell Hash

Biotic Component

Biotic Setting: Benthic Biota

Biotic Class: Faunal Bed

Biotic Subclass: Soft Sediment Fauna

Biotic Group: Small Surface-Burrowing Fauna

Co-occurring Element: Biotic Group: Small Tube-Building Fauna

Co-occurring Element: Biotic Group: Mobile Crustaceans on Soft Sediments

Co-occurring Element: Biotic Group: Sand Dollar Bed

5.0 SUMMARY

A benthic field survey was completed to collect supplemental site-specific data near the site of the proposed meteorological tower for the MD WEA leased by US Wind. Three locations in the SAP area and three locations in a reference area 1,000 m to the north were sampled using collection of still images of the seafloor and collection of benthic grab samples. These data were used to characterize the benthic community and generate a taxonomic classification of benthic habitat in the SAP area to the lowest practicable taxonomic level under CMECS.

Benthic imagery documented seafloor habitats dominated by sand with varying degrees of shell hash. Epifauna observed in the benthic imagery collected under this survey were consistent with those reported in recent video and trawl surveys of the WEA (Guida et al. 2015).

Taxa richness in the SAP area was somewhat lower than expected. However, macrofaunal density and community composition were consistent with recent observations (Guida et al. 2015). The benthic taxa found in this study are common and representative of sandy shelf habitats of the mid-Atlantic U.S. coast (Wigley and Theroux 1981). No rare taxa or taxa indicative of sensitive habitats were observed in the benthic grab samples.

Overall, benthic habitat was documented to be consistent with previous observations of the WEA by CB&I (2014) and Guida et al. (2015). The sandy offshore continental shelf habitat observed appears to support a benthic biotic community characterized by common soft sediment fauna. No sensitive habitats, such as SAV or hard bottom, were encountered.

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Attachment A

Environmental Field Report

Survey Report for
Alpine Ocean Seismic Survey, Inc.

Project:
The Provision of Geological Services and Geophysical Marine Survey Investigation

Offshore Maryland

Description:
Environmental Field Report

Survey Date:
Survey: 05-Jun-2015 to 25-Jul-2014
Environmental: 25-Jul-2015 to 25-Jul-2015

Project Number:
10505

Client Reference
ESS Project No. U167-002

REPORT AUTHORISATION AND DISTRIBUTION

Compilation	Environmental	L Jamieson
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Distribution

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For attention of

Justin Bailey/Rob Mecarini

SERVICE WARRANTY

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1 PROJECT SUMMARY

Table 1.1 Survey Details

Item	Details
Type of survey	Benthic Habitat Assessment
Lease Areas	OCS-A0489 & OCS-A0490
Client	Alpine Ocean Seismic Survey, Inc.
SoW document ref(s) and date issued	FINAL SAP Survey Plan 052715.pdf, Issued May 27th, 2015 Memo_2014-12-19_Benthic Sampling Guidance, Issued December 19th, 2014 USwind_MEA_Bathy2.pdf USwind_MEA_Geology.pdf
Object(s) of survey	Acquired data in order to conduct a habitat assessment at six locations across the survey area. Three at the proposed Met Tower location and a further three at a baseline reference site approximately 1,000 meters north (See Figure 2.1). Camera imagery was to be acquired at each of these locations. In addition, grab samples were collected by ESS at these same locations using a modified Van Veen grab sampler (or similar). Benthic material will be sieved in the field through a 0.5 mm sieve bucket and jarred with preservative. Samples will be delivered to the environmental consultant for sample processing, identification and enumeration of benthic organisms to the lowest practicable taxonomic level. Results of the benthic habitat assessment of the Met Tower and reference samples will be presented in the SAP. In accordance with BOEM guidelines, results will be presented in both tabular and geospatial format. Geospatial data will be submitted according to BOEM's Spatial Data Submission Guidelines. Furthermore, the results will include classification of benthic habitat using the lowest taxonomic level achievable under the Coastal and Marine Ecological Classification Standard (CMECS). Combined with G&G survey results that characterize seabed conditions (including grain size), and the Assessment of Benthic Habitats in the Maryland Wind Energy Area commissioned by NOAA Northeast Fisheries Science Center, the benthic sampling program will meet BOEM guidelines for SAP benthic habitat assessment.
Sampling strategy in SoW	As above
Variations to SoW	None
Issues raised at pre-job meeting	None
Vessel (s)	RV Shearwater
Onboard environmentalists	Laura Jamieson, ENV/ MMO, 23-Jul-2015 to 27-Jul-2015, 12 hour ops
Size of survey area and orientation	Irregular shape, approximately 19.2km x 9.5km at largest extent
Any other operations (e.g. geophysical site survey)	A high resolution geophysical (HRG) survey was completed prior to environmental operations using the following equipment: Klein 3900 Dual Frequency SSS, Teledyne Benthos CHIRP III SBP, R2Sonic 2024 MBES, ODOM Echotrac CVM SBES, and Geometrics G-882 MAG. In addition, a geotechnical survey was completed using a combined borehole/ cone penetration test (CPTU) approach.

Table 1.2 Proposed MET Tower Co-ordinates

Proposed Co-ordinates	WGS84		UTM Zone 18 (N)	
	Latitude	Longitude	Easting	Northing
MET Tower	38° 21' 9.8892"N	74° 45' 12.7656"W	521533.96	4244982.95

Table 1.3 Intended and Achieved Survey Strategy

Environmental Survey Strategy	Intended	Achieved (give reasons if different from intended)
Survey template (e.g. cruciform)	Six predetermined stations, three located within the Met Tower area and another three located in a baseline reference area located approximately 1,000 metres North.	As intended
Number of stations (for each type of equipment)	Six	As intended
Equipment (e.g. Day grab, Deep water camera system)	Shallow water camera system	As intended
Sieve size	N/A	N/A

2 PRELIMINARY RESULTS

Table 2.1 Target Locations

Station	Reason for selecting target or feature	Distance and Direction from Proposed Met Tower	Target Easting	Target Northing	Required data	Data / Samples Obtained
G1	Predetermined	213m SE	521682	4244830	Camera	Camera
G2	Predetermined	214m SW	521383	4244831	Camera	Camera
G3	Predetermined	210m N	521533	4245193	Camera	Camera
G4	Predetermined	1457m N	521683	4246432	Camera	Camera
G5	Predetermined	1457m N	521384	4246432	Camera	Camera
G6	Predetermined	1812m N	521534	4246795	Camera	Camera

For further details on specific issues please refer 'Survey Strategy' and 'Issues Arising' tables.

Table 2.2 Initial Interpretation

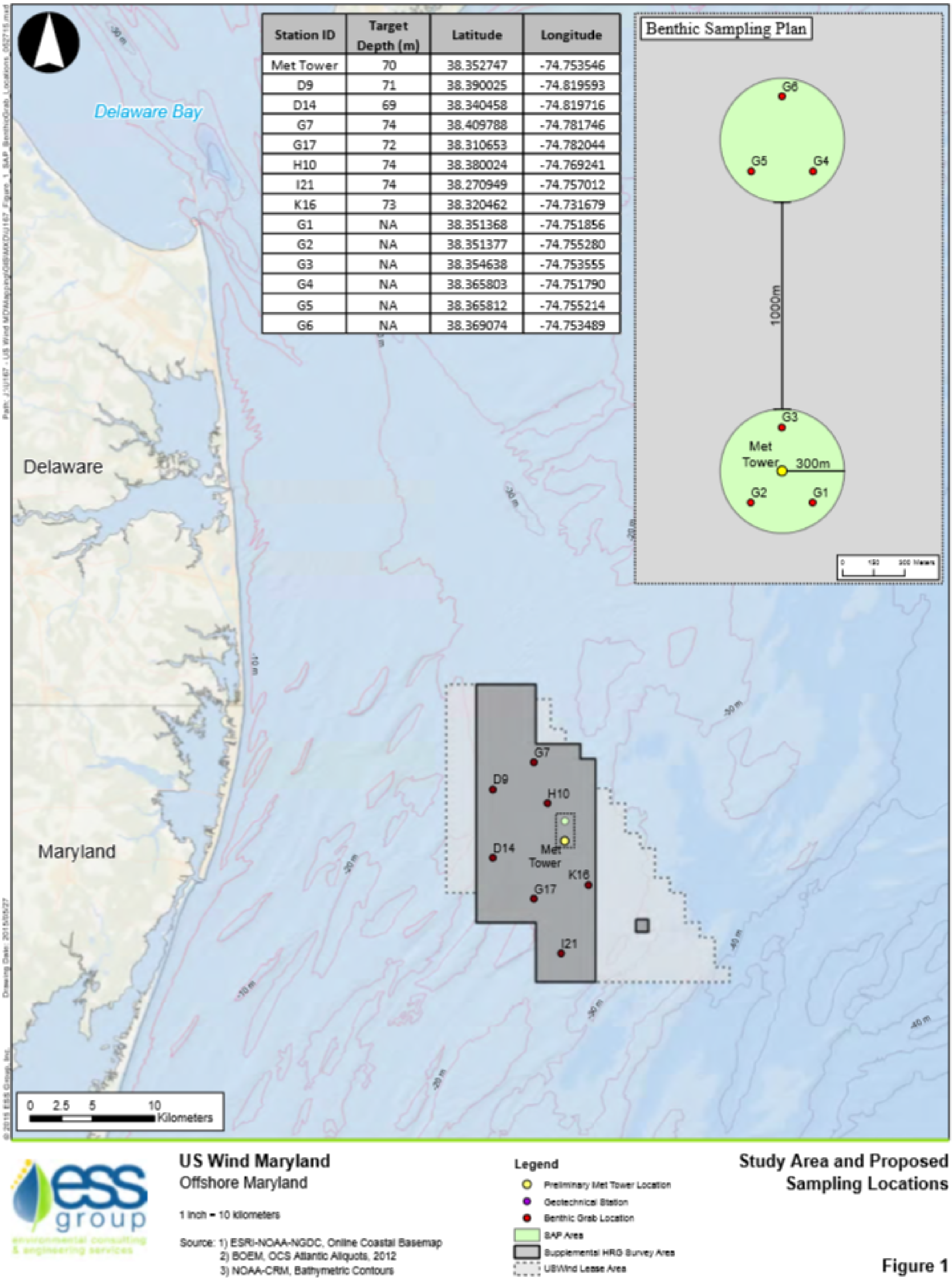
Item	Detail
Brief summary of sonar and bathy data (main seabed types and features of interest)	Sonar and bathymetry data were assessed for operational safety reasons only, no thorough review undertaken for additional features of environmental interest as stations were predetermined.
How did this influence your survey strategy / sampling locations?	Stations were predetermined.
Preliminary seabed imagery findings (sediment and fauna)	**Sediment:** The video footage revealed yellow/ brown sand with shells and shell fragments at all stations. **Fauna:** Observed faunal density and diversity were relatively low at all stations. Observed fauna included Annelida (indet. tube worms), Crustacea (Paguridae and Decapoda) and Echinodermata (Asteroidea and Clypeasteroida).
Preliminary seabed sampling findings (sediment and fauna)	Not applicable as this was carried out seperately by ESS.
Any sensitive habitats or species?	No sensitive habitats or species observed
Dominant current direction (inc tide table if possible)	The dominant current direction is SE to NW.

Table 2.3 Summary of Data Obtained

Station	Water Depth (to nearest m)*	VIDEO	PHOTOS
G1	27	VHS/DVD	18
G2	27	VHS/DVD	16
G3	27	VHS/DVD	17
G4	27	VHS/DVD	13
G5	27	VHS/DVD	14
G6	27	VHS/DVD	18

* water depths relate to the first camera fix location and are not corrected to LAT

Figure 2.1 Target Locations Plot



Station ID	Target Depth (m)	Latitude	Longitude
Met Tower	70	38.352747	-74.753546
D9	71	38.390025	-74.819593
D14	69	38.340458	-74.819716
G7	74	38.409788	-74.781746
G17	72	38.310653	-74.782044
H10	74	38.380024	-74.769241
I21	74	38.270949	-74.757012
K16	73	38.320462	-74.731679
G1	NA	38.351368	-74.751856
G2	NA	38.351377	-74.755280
G3	NA	38.354638	-74.753555
G4	NA	38.365803	-74.751790
G5	NA	38.365812	-74.755214
G6	NA	38.369074	-74.753489

3 SURVEY ISSUES AND ACTIONS

Table 3.1 Issues Arising During the Survey and Remedial Action Taken

Issue	Details and Remedial Action
Equipment	Wire fitted to winch had no eye so used Crosby Wedge belonging to vessel (see images in misc folder).
Safety	None
Weather	None
Currents	None
Beacon and Positioning	QINSy was utilised to produce navigation string for overlay and to take fixes. There were a few minor issues with integrating this, which were mostly overcome during the mobilisation. The fix number had to be changed manually by the surveyor and at the start of the project the fix number was incorrect until first fix taken where it is reset to 1. A number of items were not logged during initial Station G1 including depth range and bearing. These were calculated after the project and depth was taken from the overlaid navigation string. Lastly dN/ dE was not filled in the log and this was also added after the project. Overall the integration was successful.
Existing infrastructure (e.g. exclusion zones)	Advised by party chief that no infrastructure was within areas of intended camera operations.
Failed sampling attempts	N/A
Recommendations for future surveys	None
Contamination (e.g. greased wire)	N/A
Any other (please specify)	None

Table 3.2 Summary of Equipment Success

Equipment Type	Camera
Successful deployments	6
Attempted deployments	6
% Success	100

4 SURVEY METHODS

4.1 Camera Procedure

Environmental seabed images were taken by means of a digital stills camera system with a dedicated strobe and video lamp, mounted within a stainless steel frame. A USBL positioning beacon was attached to the camera frame.

Footage was viewed in real time via an umbilical, assisting in the control of the digital stills camera. This allowed for shot selection, in the event that the system recorded a sediment change or feature at the seafloor.

A minimum of 10 seabed photographs were taken at each station using a hover and drift technique, separated by a time gap of approximately 5-10 seconds. This technique allowed the frame to move progressively along the seabed as the vessel traversed the work area on its thrusters or drifted. The images were captured remotely using the surface control unit and stored on the camera's internal memory card. Video footage was overlaid with time, position, and depth, and recorded directly onto VHS video and DVD. On completion, photographs were downloaded onto a PC via a USB download cable and copied onto CD-Rom. All CDs, DVDs and videos were labelled with the relevant job details, write-protected and stored.

Main instrumental and acquisition details are as follows:

Equipment	
Manufacturer	Konsberg/Simrad.
Model	OE14-208
Pixels	5.0 M
Standard Lens	f 7.2 – 28.8 (35mm format equivalent to 38 – 140mm)
Focus Control	Automatic or manual 50mm to infinity
Trigger	Remote from deck
Height Control	USBL Beacon and Video footage
Video Overlay	Oceantools HDO
Field of View	47.8 (deg H) by 36.2 (deg V)
Lighting	1 strobe, 1 Bowtech lamp
Scale bar	10cm green laser lines

APPENDICES

APPENDIX A ENVIRONMENTAL LOGS

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SEABED IMAGERY LOG SHEET (Deck)							QPRO-0753		
Job No: 10505			Area: Offshore Maryland		Vessel: RV Shearwater		Operator: LJ		
Date: from: 25-Jul-2015 to: 25-Jul-2015			Page: 1 of 2		Client: Alpine Ocean Seismic Survey, Inc.		Scale bar: 10cm (Lasers)		
Project: Provision of Geological Services and Geophysical Marine Survey Investigation							Equipment: Shallow water camera system		
Sample Number	**Station Number**	**Time on overlay**	**DVD/ Video No**	**DVD Chapter**	**Counter (start & end)**	**Sediment Description**	**Comments**	**TOT FIXES**	**FIXES Nos**
25-Jul-15 Wx SE Force 2, Swell <0.5m									
1	G1	09:48:06	1	1, 2	00:00:00	**Sediment:** Yellow/brown sand with shells and shell fragments **Visible fauna:** Numerous jellyfish including Ctenophora in water column, blue starfish (Asteroidea) and Paguridae.	Depth readings on nav string have extra digits. Numbers are correct up to two decimal places. i.e -21.55 High Turbidity at all stations.	18	1 to 18
		10:12:20	1		00:24:14				
2	G2	10:30:17	1	3, 4 (5 G3 Site Marker)	00:24:14	**Sediment:** Yellow/brown sand with shells and shell fragments **Visible fauna:** Numerous jellyfish including Ctenophora in water column, Decapoda, Paguridae and Annelida.	Depth readings corrected to two decimal places only.	16	19 to 34
		10:46:00	1		00:40:31				
3	G3	11:04:40	2	1	00:40:31	**Sediment:** Yellow/brown sand with shells and shell fragments **Visible fauna:** Numerous jellyfish including Ctenophora in water column, sand dollar (Clypeasteroida), Paguridae, Annelida and egg mass of Naticidae.	No photo taken for Fix 39	17	35 to 52
		11:18:45	1		00:54:33				

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SEABED IMAGERY LOG SHEET (Deck)								QPRO-0753		
Job No:	10505		**Area:** Offshore Maryland			**Vessel:** RV Shearwater	**Operator:** LJ			
Date:	from: 25-Jul-2015 to: 25-Jul-2015		**Page:** 2 of 2			**Client:** Alpine Ocean Seismic Survey, Inc.	**Scale bar:** 10cm (Lasers)			
Project:	Provision of Geological Services and Geophysical Marine Survey Investigation						**Equipment:** Shallow water camera system			
Sample Number	**Station Number**	**Time on overlay**	**DVD/ Video No**	**DVD Chapter**	**Counter (start & end)**	**Sediment Description**	**Comments**	**TOT FIXES**	**FIXES Nos**	
4	G4	11:40:45	2	2, 3	00:54:33	**Sediment:** Yellow/brown sand with shells and shell fragments **Visible fauna:** Numerous jellyfish including Ctenophora in water column, sand dollar (Clypeasteroida) and Paguridae.		13	53 to 65	
		11:52:52	1		01:06:40					
5	G5	12:04:21	2	4, 5	01:06:40	**Sediment:** Yellow/brown sand with shells and shell fragments **Visible fauna:** Numerous jellyfish including Ctenophora in water column, sand dollar (Clypeasteroida) and Paguridae.		14	66 to 79	
		12:19:25	1		01:21:44					
6	G6	12:31:00	2	6, 7	01:21:44	**Sediment:** Yellow/brown sand with shells and shell fragments **Visible fauna:** Numerous jellyfish including Ctenophora in water column, sand dollar (Clypeasteroida), Decapoda, Paguridae and indeterminate Hydrozoa.		18	80 to 97	
		12:45:25	1		01:36:09					

APPENDIX A ENVIRONMENTAL LOGS

Gardline Geosurvey — Seafloor Sampling Positioning Summary

Job No	10505			Vessel	RV Shearwater						
Client	Alpine Ocean Seismic Survey, Inc.			Vessel Reference Point (VRP)	IMU						
Project Name	Provision of Geological Services and Geophysical Marine Survey Investigation			Deployment Location	Starboard Drop Point Aft Deck (Environmental Camera)	x	NA	y	NA	z	NA
Primary Positioning System	Applanix POS MV			Actual Coordinates derived from	Beacon						
Geodetic Reference System	Datum	NAD83	Ellipsoid GRS80	Projection	UTM Zone 18 (N)			Vertical / Tidal Datum			

Date	Time (UTC/GMT)	Fix number	Stn No	Penetration	Sample Retention	Retention	Observed Seafloor Depth (m)	Actual coordinates		Target coordinates		Offset from target				Surveyor	Remarks
								Easting	Northing	Easting	Northing	dE	dN	Range	Bearing		
25-Jul-2015	09:55:19	1	G1			Camera	26.82	521682.31	4244829.17	521682.00	4244830.00	-0.31	0.83	0.89	339.52	MK	
25-Jul-2015	09:55:53	2	G1			Camera	26.67	521681.42	4244831.42	521682.00	4244830.00	0.58	-1.42	1.53	157.78	MK	
25-Jul-2015	09:56:36	3	G1			Camera	26.47	521683.00	4244828.50	521682.00	4244830.00	-1.00	1.50	1.80	326.31	MK	
25-Jul-2015	09:57:15	4	G1			Camera	26.50	521682.55	4244830.90	521682.00	4244830.00	-0.55	-0.90	1.05	211.43	MK	
25-Jul-2015	09:58:08	5	G1			Camera	26.33	521682.53	4244829.38	521682.00	4244830.00	-0.53	0.62	0.82	319.47	MK	
25-Jul-2015	09:58:47	6	G1			Camera	25.69	521682.13	4244829.88	521682.00	4244830.00	-0.13	0.12	0.18	312.71	MK	
25-Jul-2015	10:00:14	7	G1			Camera	26.67	521684.52	4244826.72	521682.00	4244830.00	-2.52	3.28	4.14	322.47	MK	
25-Jul-2015	10:00:31	8	G1			Camera	26.33	521687.22	4244822.96	521682.00	4244830.00	-5.22	7.04	8.76	323.44	MK	
25-Jul-2015	10:00:48	9	G1			Camera	26.54	521688.92	4244821.40	521682.00	4244830.00	-6.92	8.60	11.04	321.18	MK	
25-Jul-2015	10:01:21	10	G1			Camera	26.36	521690.26	4244824.16	521682.00	4244830.00	-8.26	5.84	10.12	305.26	MK	
25-Jul-2015	10:02:27	11	G1			Camera	26.69	521688.76	4244835.99	521682.00	4244830.00	-6.76	-5.99	9.03	228.46	MK	
25-Jul-2015	10:03:40	12	G1			Camera	26.55	521679.80	4244841.01	521682.00	4244830.00	2.20	-11.01	11.23	168.70	MK	
25-Jul-2015	10:04:57	13	G1			Camera	26.65	521671.88	4244835.90	521682.00	4244830.00	10.12	-5.90	11.71	120.24	MK	
25-Jul-2015	10:06:11	14	G1			Camera	26.55	521673.16	4244820.08	521682.00	4244830.00	8.84	9.92	13.29	41.71	MK	
25-Jul-2015	10:06:33	15	G1			Camera	26.41	521675.90	4244817.51	521682.00	4244830.00	6.10	12.49	13.90	26.03	MK	
25-Jul-2015	10:07:13	16	G1			Camera	26.28	521682.30	4244818.08	521682.00	4244830.00	-0.30	11.92	11.92	358.56	MK	
25-Jul-2015	10:10:03	17	G1			Camera	26.43	521700.27	4244833.26	521682.00	4244830.00	-18.27	-3.26	18.56	259.88	MK	
25-Jul-2015	10:11:31	18	G1			Camera	26.61	521694.93	4244842.49	521682.00	4244830.00	-12.93	-12.49	17.98	225.99	MK	
25-Jul-2015	10:31:15	19	G2			Camera	26.62	521381.67	4244831.03	521383.00	4244831.00	1.33	-0.03	1.33	91.29	MK	
25-Jul-2015	10:31:30	20	G2			Camera	26.81	521382.19	4244831.25	521383.00	4244831.00	0.81	-0.25	0.85	107.15	MK	
25-Jul-2015	10:32:18	21	G2			Camera	26.79	521381.30	4244829.64	521383.00	4244831.00	1.70	1.36	2.18	51.34	MK	
25-Jul-2015	10:32:59	22	G2			Camera	26.86	521382.40	4244831.36	521383.00	4244831.00	0.60	-0.36	0.70	120.96	MK	
25-Jul-2015	10:34:09	23	G2			Camera	26.73	521382.54	4244830.18	521383.00	4244831.00	0.46	0.82	0.94	29.29	MK	
25-Jul-2015	10:35:34	24	G2			Camera	26.72	521385.01	4244836.65	521383.00	4244831.00	-2.01	-5.65	6.00	199.58	MK	
25-Jul-2015	10:36:33	25	G2			Camera	26.67	521384.96	4244838.83	521383.00	4244831.00	-1.96	-7.83	8.07	194.05	MK	
25-Jul-2015	10:36:59	26	G2			Camera	26.58	521382.10	4244837.64	521383.00	4244831.00	0.90	-6.64	6.70	172.28	MK	
25-Jul-2015	10:37:37	27	G2			Camera	26.64	521376.16	4244837.71	521383.00	4244831.00	6.84	-6.71	9.58	134.45	MK	
25-Jul-2015	10:38:50	28	G2			Camera	26.55	521369.38	4244829.25	521383.00	4244831.00	13.62	1.75	13.73	82.68	MK	
25-Jul-2015	10:39:52	29	G2			Camera	26.51	521374.24	4244822.55	521383.00	4244831.00	8.76	8.45	12.17	46.03	MK	
25-Jul-2015	10:41:00	30	G2			Camera	26.33	521385.47	4244817.52	521383.00	4244831.00	-2.47	13.48	13.70	349.62	MK	
25-Jul-2015	10:41:56	31	G2			Camera	26.91	521391.87	4244822.31	521383.00	4244831.00	-8.87	8.69	12.42	314.41	MK	
25-Jul-2015	10:43:28	32	G2			Camera	26.49	521392.26	4244833.88	521383.00	4244831.00	-9.26	-2.88	9.70	252.72	MK	
25-Jul-2015	10:44:45	33	G2			Camera	26.42	521389.42	4244845.47	521383.00	4244831.00	-6.42	-14.47	15.83	203.93	MK	
25-Jul-2015	10:45:28	34	G2			Camera	26.86	521385.42	4244846.46	521383.00	4244831.00	-2.42	-15.46	15.65	188.90	MK	
25-Jul-2015	11:05:23	35	G3			Camera	26.67	521530.81	4245192.76	521533.00	4245193.00	2.19	0.24	2.20	83.75	MK	
25-Jul-2015	11:06:39	36	G3			Camera	26.88	521532.04	4245193.61	521533.00	4245193.00	0.96	-0.61	1.14	122.43	MK	
25-Jul-2015	11:07:23	37	G3			Camera	26.81	521532.62	4245192.49	521533.00	4245193.00	0.38	0.51	0.64	36.69	MK	

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Client	Alpine Ocean Seismic Survey, Inc.			Vessel Reference Point (VRP)	IMU						
Project Name	Provision of Geological Services and Geophysical Marine Survey Investigation			Deployment Location	Starboard Drop Point Aft Deck (Environmental Camera)	x	NA	y	NA	z	NA
Primary Positioning System	Applanix POS MV			Actual Coordinates derived from	Beacon						
Geodetic Reference System	Datum	NAD83	Ellipsoid GRS80	Projection	UTM Zone 18 (N)			Vertical / Tidal Datum			

Date	Time (UTC/GMT)	Fix number	Stn No	Penetration	Sample Retention	Retention	Observed Seafloor Depth (m)	Actual coordinates		Target coordinates		Offset from target				Surveyor	Remarks
								Easting	Northing	Easting	Northing	dE	dN	Range	Bearing		
25-Jul-2015	11:08:17	38	G3			Camera	26.65	521538.05	4245196.57	521533.00	4245193.00	-5.05	-3.57	6.18	234.74	MK	
25-Jul-2015	11:08:24	39	G3			Camera	26.78	521539.06	4245197.30	521533.00	4245193.00	-6.06	-4.30	7.43	234.64	MK	No Photo. Extra Fix
25-Jul-2015	11:09:17	40	G3			Camera	26.56	521539.91	4245201.85	521533.00	4245193.00	-6.91	-8.85	11.23	217.98	MK	
25-Jul-2015	11:09:51	41	G3			Camera	26.87	521536.47	4245203.73	521533.00	4245193.00	-3.47	-10.73	11.28	197.92	MK	
25-Jul-2015	11:10:18	42	G3			Camera	26.70	521531.52	4245204.85	521533.00	4245193.00	1.48	-11.85	11.94	172.88	MK	
25-Jul-2015	11:10:43	43	G3			Camera	26.72	521527.16	4245202.88	521533.00	4245193.00	5.84	-9.88	11.48	149.41	MK	
25-Jul-2015	11:11:22	44	G3			Camera	26.74	521519.01	4245196.60	521533.00	4245193.00	13.99	-3.60	14.45	104.43	MK	
25-Jul-2015	11:12:19	45	G3			Camera	26.53	521521.39	4245186.68	521533.00	4245193.00	11.61	6.32	13.22	61.44	MK	
25-Jul-2015	11:13:24	46	G3			Camera	26.36	521530.38	4245180.96	521533.00	4245193.00	2.62	12.04	12.32	12.28	MK	
25-Jul-2015	11:14:08	47	G3			Camera	26.40	521541.02	4245184.01	521533.00	4245193.00	-8.02	8.99	12.05	318.26	MK	
25-Jul-2015	11:14:57	48	G3			Camera	26.29	521546.07	4245188.02	521533.00	4245193.00	-13.07	4.98	13.99	290.86	MK	
25-Jul-2015	11:16:26	49	G3			Camera	26.68	521543.90	4245198.67	521533.00	4245193.00	-10.90	-5.67	12.29	242.52	MK	
25-Jul-2015	11:17:35	50	G3			Camera	26.17	521541.82	4245221.00	521533.00	4245193.00	-8.82	-28.00	29.36	197.48	MK	
25-Jul-2015	11:18:19	51	G3			Camera	26.42	521544.72	4245233.05	521533.00	4245193.00	-11.72	-40.05	41.73	196.31	MK	
25-Jul-2015	11:18:34	52	G3			Camera	26.64	521545.27	4245237.25	521533.00	4245193.00	-12.27	-44.25	45.92	195.50	MK	
25-Jul-2015	11:41:15	53	G4			Camera	27.39	521682.62	4246431.76	521683.00	4246432.00	0.38	0.24	0.45	57.72	MK	
25-Jul-2015	11:41:43	54	G4			Camera	26.90	521682.53	4246430.59	521683.00	4246432.00	0.47	1.41	1.49	18.43	MK	
25-Jul-2015	11:42:29	55	G4			Camera	27.09	521682.13	4246432.22	521683.00	4246432.00	0.87	-0.22	0.90	104.19	MK	
25-Jul-2015	11:43:31	56	G4			Camera	27.42	521682.52	4246436.31	521683.00	4246432.00	0.48	-4.31	4.34	173.65	MK	
25-Jul-2015	11:44:38	57	G4			Camera	27.32	521678.46	4246443.32	521683.00	4246432.00	4.54	-11.32	12.20	158.15	MK	
25-Jul-2015	11:45:28	58	G4			Camera	26.86	521668.59	4246438.55	521683.00	4246432.00	14.41	-6.55	15.83	114.44	MK	
25-Jul-2015	11:46:17	59	G4			Camera	27.02	521667.68	4246428.95	521683.00	4246432.00	15.32	3.05	15.62	78.74	MK	
25-Jul-2015	11:47:00	60	G4			Camera	27.67	521675.74	4246416.62	521683.00	4246432.00	7.26	15.38	17.01	25.27	MK	
25-Jul-2015	11:47:51	61	G4			Camera	27.22	521679.84	4246420.44	521683.00	4246432.00	3.16	11.56	11.98	15.29	MK	
25-Jul-2015	11:48:43	62	G4			Camera	27.21	521690.63	4246425.00	521683.00	4246432.00	-7.63	7.00	10.35	312.53	MK	
25-Jul-2015	11:49:32	63	G4			Camera	26.98	521695.47	4246434.04	521683.00	4246432.00	-12.47	-2.04	12.64	260.71	MK	
25-Jul-2015	11:51:56	64	G4			Camera	27.28	521650.25	4246437.63	521683.00	4246432.00	32.75	-5.63	33.23	99.75	MK	
25-Jul-2015	11:52:43	65	G4			Camera	27.51	521640.76	4246431.26	521683.00	4246432.00	42.24	0.74	42.25	89.00	MK	
25-Jul-2015	12:04:45	66	G5			Camera	27.36	521382.02	4246432.15	521384.00	4246432.00	1.98	-0.15	1.99	94.33	MK	
25-Jul-2015	12:05:03	67	G5			Camera	27.54	521383.27	4246432.38	521384.00	4246432.00	0.73	-0.38	0.82	117.50	MK	
25-Jul-2015	12:06:41	68	G5			Camera	27.47	521384.87	4246436.83	521384.00	4246432.00	-0.87	-4.83	4.91	190.21	MK	
25-Jul-2015	12:07:27	69	G5			Camera	27.47	521381.02	4246443.60	521384.00	4246432.00	2.98	-11.60	11.98	165.59	MK	
25-Jul-2015	12:08:33	70	G5			Camera	27.23	521369.59	4246433.18	521384.00	4246432.00	14.41	-1.18	14.46	94.68	MK	
25-Jul-2015	12:09:42	71	G5			Camera	27.29	521374.17	4246417.89	521384.00	4246432.00	9.83	14.11	17.20	34.86	MK	
25-Jul-2015	12:11:18	72	G5			Camera	26.84	521386.90	4246420.68	521384.00	4246432.00	-2.90	11.32	11.69	345.63	MK	
25-Jul-2015	12:12:04	73	G5			Camera	26.93	521394.14	4246427.12	521384.00	4246432.00	-10.14	4.88	11.25	295.70	MK	
25-Jul-2015	12:12:54	74	G5			Camera	27.03	521395.60	4246436.45	521384.00	4246432.00	-11.60	-4.45	12.42	249.01	MK	

APPENDIX A ENVIRONMENTAL LOGS

Gardline Geosurvey — Seafloor Sampling Positioning Summary

Job No	10505				Vessel	RV Shearwater							
Client	Alpine Ocean Seismic Survey, Inc.				Vessel Reference Point (VRP)	IMU							
Project Name	Provision of Geological Services and Geophysical Marine Survey Investigation				Deployment Location	Starboard Drop Point Aft Deck (Environmental Camera)	x	NA	y	NA	z	NA	
Primary Positioning System	Applanix POS MV				Actual Coordinates derived from	Beacon							
Geodetic Reference System	Datum	NAD83	Ellipsoid	GRS80	Projection	UTM Zone 18 (N)				Vertical / Tidal Datum			

Date	Time (UTC/GMT)	Fix number	Stn No	Penetration	Sample Retention	Retention	Observed Seafloor Depth (m)	Actual coordinates		Target coordinates		Offset from target				Surveyor	Remarks
								Easting	Northing	Easting	Northing	dE	dN	Range	Bearing		
25-Jul-2015	12:13:30	75	G5			Camera	27.13	521389.82	4246440.28	521384.00	4246432.00	-5.82	-8.28	10.12	215.10	MK	
25-Jul-2015	12:14:24	76	G5			Camera	27.24	521376.11	4246443.86	521384.00	4246432.00	7.89	-11.86	14.24	146.37	MK	
25-Jul-2015	12:16:34	77	G5			Camera	27.26	521368.02	4246423.09	521384.00	4246432.00	15.98	8.91	18.30	60.86	MK	
25-Jul-2015	12:18:31	78	G5			Camera	27.03	521385.51	4246442.94	521384.00	4246432.00	-1.51	-10.94	11.04	187.86	MK	
25-Jul-2015	12:19:04	79	G5			Camera	27.30	521389.58	4246448.12	521384.00	4246432.00	-5.58	-16.12	17.06	199.09	MK	
25-Jul-2015	12:31:40	80	G6			Camera	27.02	521534.08	4246794.29	521534.00	4246795.00	-0.08	0.71	0.71	353.57	MK	
25-Jul-2015	12:32:25	81	G6			Camera	27.24	521532.38	4246795.98	521534.00	4246795.00	1.62	-0.98	1.89	121.17	MK	
25-Jul-2015	12:32:52	82	G6			Camera	27.30	521531.96	4246794.45	521534.00	4246795.00	2.04	0.55	2.11	74.91	MK	
25-Jul-2015	12:33:28	83	G6			Camera	27.48	521530.92	4246796.12	521534.00	4246795.00	3.08	-1.12	3.28	109.98	MK	
25-Jul-2015	12:34:40	84	G6			Camera	27.22	521532.29	4246802.64	521534.00	4246795.00	1.71	-7.64	7.83	167.38	MK	
25-Jul-2015	12:35:18	85	G6			Camera	27.49	521525.57	4246802.63	521534.00	4246795.00	8.43	-7.63	11.37	132.15	MK	
25-Jul-2015	12:36:25	86	G6			Camera	27.18	521518.21	4246788.06	521534.00	4246795.00	15.79	6.94	17.25	66.27	MK	
25-Jul-2015	12:37:09	87	G6			Camera	27.61	521525.79	4246779.30	521534.00	4246795.00	8.21	15.70	17.72	27.61	MK	
25-Jul-2015	12:38:26	88	G6			Camera	27.16	521542.51	4246787.34	521534.00	4246795.00	-8.51	7.66	11.45	311.99	MK	
25-Jul-2015	12:39:35	89	G6			Camera	27.49	521547.52	4246795.19	521534.00	4246795.00	-13.52	-0.19	13.52	269.19	MK	
25-Jul-2015	12:40:28	90	G6			Camera	27.63	521539.78	4246804.70	521534.00	4246795.00	-5.78	-9.70	11.29	210.79	MK	
25-Jul-2015	12:41:13	91	G6			Camera	27.31	521523.56	4246806.23	521534.00	4246795.00	10.44	-11.23	15.33	137.09	MK	
25-Jul-2015	12:41:48	92	G6			Camera	27.18	521515.93	4246800.77	521534.00	4246795.00	18.07	-5.77	18.97	107.71	MK	
25-Jul-2015	12:42:36	93	G6			Camera	27.54	521527.69	4246782.20	521534.00	4246795.00	6.31	12.80	14.27	26.24	MK	
25-Jul-2015	12:43:03	94	G6			Camera	27.05	521532.38	4246777.65	521534.00	4246795.00	1.62	17.35	17.43	5.33	MK	
25-Jul-2015	12:43:36	95	G6			Camera	27.30	521533.01	4246779.70	521534.00	4246795.00	0.99	15.30	15.33	3.70	MK	
25-Jul-2015	12:44:27	96	G6			Camera	27.06	521536.50	4246779.01	521534.00	4246795.00	-2.50	15.99	16.18	351.11	MK	
25-Jul-2015	12:45:09	97	G6			Camera	27.15	521539.01	4246767.02	521534.00	4246795.00	-5.01	27.98	28.42	349.85	MK	

Attachment B

Benthic Imagery (Electronic)

Attachment C

Field Notes

Location Ocean City Maryland / Shearwater vessel Date July 23-

Project / Client US Wind

Van Veen → Sub Sample: 20 cm by 20 cm of 10 by 4

* Describe type and amount of substrate material, note presence of any large or unusual organisms.

- arrive @ Boat docked at **1515** (7/23/15)
- Sub Sample: 20 cm by 20 cm, 4 cm depth
  - ~~ma~~ * take from one side of scoop if pos

Van Veen Grab

Grab measurements: 30 by 30 cm, depth: 15 cm

7/24/15

1230 - left dock from Ocean City

1245 - observed bottlenose dolphins in harbor

1500 - Deployed and calibrated "US-BL" (Alpine)

1640 - observed leatherback sea turtle (gardline)

1645 - finished calibration of USBL

1650 - deployed PAMS cable (gardline)

7/25/15

0145 - finished PAMS

0500 - Start taking photos / videos w/ shallow water cam.

0845 - finish shallow water photos

0900 - Arrive @ G-6 for Grab

0910 - accept Grab, sand and shell hash (8 cm)

0915 - arrive @ G-5
- reject 1st attempt (not enough material)
- 2nd attemp accept - (12 cm)
  Sand + Shell hash

Location Maryland / Shearwater vessel Date 7/25/15

Project / Client US Wind

0925 - arrive @ G-4
1st attempt - accept 10 cm (Sand) Shell hash

0940 - arrive @ G-3 (photo)
1st attempt - accept 11 cm Sand / shell hash
↳ coarser sand

0945 - arrive @ G-2 - Sample split into 2 Jars
1st attempt accept (13 cm)
↳ coarser sand + shell hash

0950 - arrive @ G-1
1st attempt accept - 12 cm
Coarse sand + Shell hash

1000 - head back to Ocean City

Depths (meters)	
26.8	G1 - Lat: 38°21.0819009 N Long: 74°45.1113856 W
26.6	G2 - Lat: 38°21.0828731 N Long: 74°45.3166996 W
26.6	G3 - Lat: 38°21.2784039 N Long: 74°45.2130349 W
27.0	G4 - Lat: 38°21.9481582 N Long: 74°45.1077416 W
27.4	G5 - Lat: 38°21.9485899 N Long: 74°45.3130982 W
27.4	G6 - Lat: 38°22.1446609 N Long: 74°45.2094107 W

1330 - Arrive back @ dock in Ocean City

Appendix I

Final PSO Report

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Alpine Ocean Seismic Survey Inc.
on behalf of US Wind Inc.

Project:
Offshore Maryland Geophysical Survey

Description:
Shearwater **Protected Species Observer Report**

Survey Dates:
2nd June to 25th July 2015

Project Number:
10505

Lease Reference Number
OCS-A 0489 & OCS-A 0490

REPORT AUTHORISATION AND DISTRIBUTION

Protected Species Observers / Passive Acoustic Monitoring Operators	Marine Wildlife Department	S. Doake R. Counihan T. Martin J. Allum S. Tufano R. Lee L. Slater
Compilation	Marine Wildlife Department	S. Doake L. Slater
Q.C.	Marine Wildlife Department	S. Ponting
Authorisation	Marine Wildlife Department	K. Preston K. Preston

Revision	Date	Title
1	25th August 2015	Draft

Distribution

One copy to

Alpine Ocean Seismic Surveying Inc.
155 Hudson Avenue,
Norwood,
New Jersey,
U.S.A,
07468

For attention of
Justin Bailey
jbailey@alpineocean.com

EXECUTIVE SUMMARY

- Monitoring for marine mammals and sea turtles occurred during a high resolution geophysical (HRG) survey offshore Maryland, USA. This survey was conducted onboard the *R.V. Shearwater* from 2nd June to 25th July 2015.

- Weather conditions recorded during marine mammal and sea turtle monitoring were good, with predominately good visibility, slight seas and low swell (>2m). Beaufort wind force was between 0 and 6 and was mainly from a south-westerly direction.

- The survey was run in accordance with the mitigation requirements stipulated in the lease (OSC-A 0489 and OCS-A 490) and mitigation plan submitted to the Bureau of Ocean Energy Management (BOEM). Mitigation measures covered mitigation for vessel strike avoidance and for the avoidance of disturbance and harm from geophysical survey activities.

- Watches for marine mammals and sea turtles occurred on 44 days of the survey and resulted in 913 hours and 35 minutes of observer effort and 64 observations.

- Acoustic monitoring for marine mammals occurred on 42 days of the survey and resulted in 804 hours and 48 minutes of monitoring effort and 10 acoustic detections.

- There were no encounters of North Atlantic right whales, two encounters of other non-delphinid cetaceans, 39 encounters of delphinids and 29 sightings of marine turtle. All appropriate separation distances and avoidance measures were maintained and implemented during the survey.

- There were no occasions where vessel speed was reduced to 10 knots or less due to large assemblages, mother/calf pairs, designation of a Dynamic Management Zone or on entering a Seasonal Management Area.

- The geophysical survey utilised single beam echo sounder and chirper on 43 days to run a total of 373 lines (including reruns) and four tests.

- There were 42 ramp-ups of HRG equipment during the survey of which 37 were during daylight hours. All ramp-ups of HRG equipment were covered by full dedicated pre-start watches and acoustic monitoring.

- There were three delays to the start up of HRG equipment due to marine mammals or sea turtle encounters during the survey.

- There were 15 shut-downs of HRG equipment due to non-delphinid cetaceans or sea turtles during the survey. There were 12 power downs due to delphinid cetaceans during the survey.

- There were two reports of sightings of injured or dead protected species during the survey. All incidences were reported directly to the appropriate authorities within 24 hours.

SERVICE WARRANTY

USE OF THIS REPORT

This report has been prepared with due care and diligence and with the skill reasonably expected of a reputable contractor experienced in the types of work carried out under the contract and as such the findings in this report are based on an interpretation of data which is a matter of opinion on which professionals may differ and unless clearly stated is not a recommendation of any course of action.

Gardline Environmental Ltd. has prepared this report for the client(s) identified on the front cover in fulfilment of its contractual obligations under the contract and the only liabilities Gardline Environmental Ltd. accept are those contained therein.

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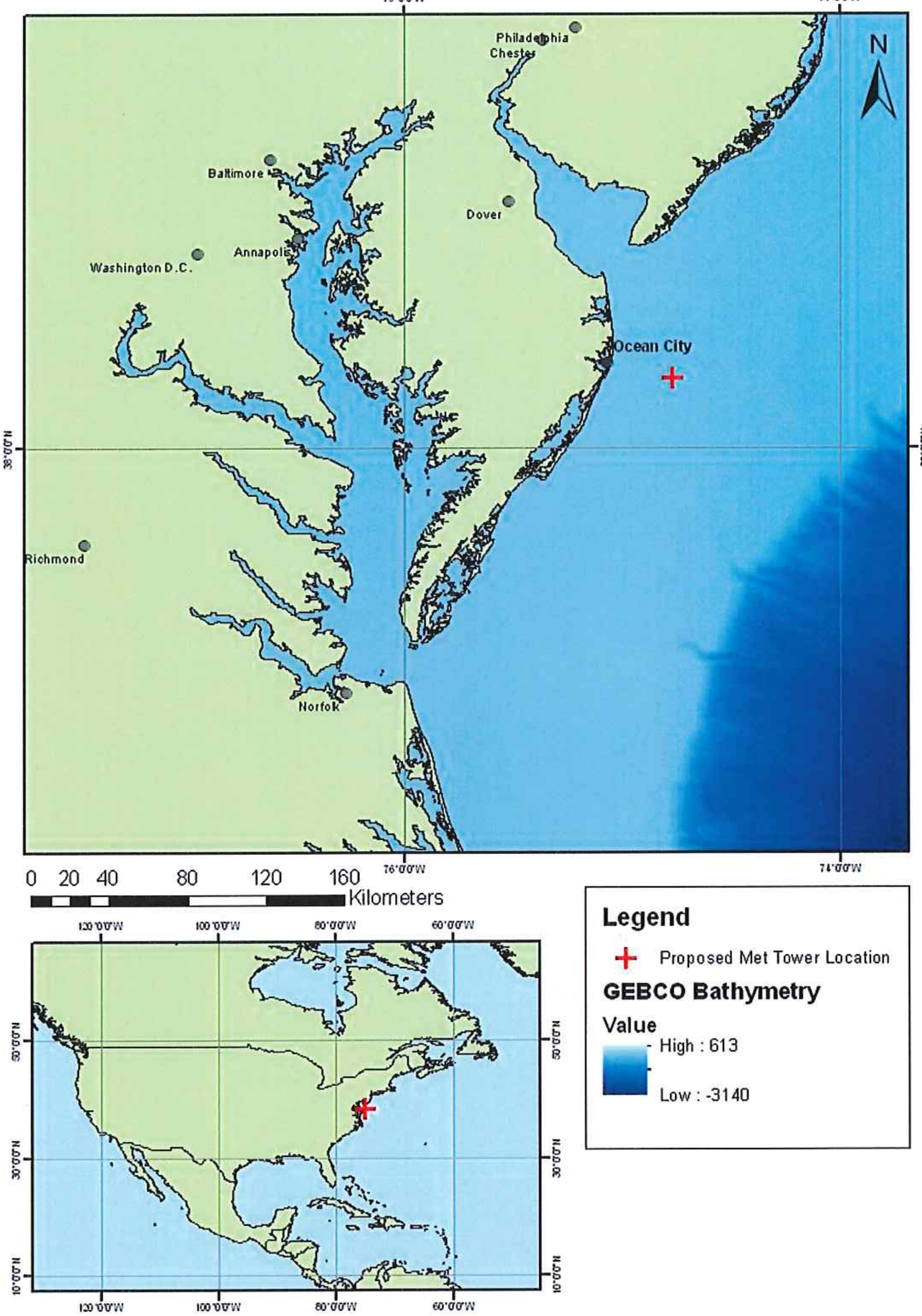
LOCATION MAP



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1. INTRODUCTION

1.1 Marine Geophysical Surveys

Marine geophysical surveys are performed to establish and investigate seabed conditions, water depths and oceanographic and environmental condition within an area. Shallow geophysical survey equipment such as sub-bottom profilers, multi beam echo sounders and side scan sonar are used to characterise the sediments and layers just below the seabed. Such equipment predominantly produces sound between 0.4 and 30 kHz with source levels between 200 and 230 dB re 1 µPa^2 m^2 (Richardson *et al.*, 1995).

1.2 Sound and Marine Mammals and Sea Turtles

1.2.1 Marine mammals

Sound is conducted through water approximately 4.5 times faster than through air and is the most important sense for many marine organisms. This is especially true for marine mammals which use sound to communicate, navigate, forage and for predator avoidance (Richardson *et al.*, 1995). The functional frequency range used by marine mammals varies between 7 Hz and 180 kHz, with the large baleen whales using the lower frequencies while smaller toothed whales use higher frequencies (Southall *et al.*, 2007) (Figure 1.1).

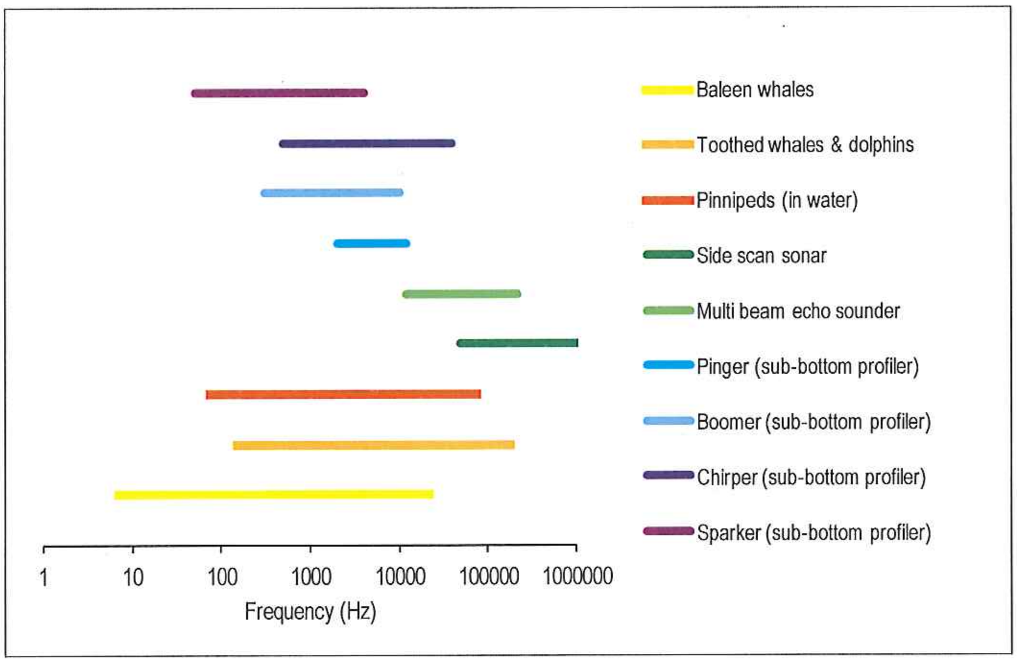

Figure 1.1 Auditory frequencies used by marine mammals and the main frequency range of analogue equipment (Based on Gotz *et al.*, 2009 & Southall *et al.*, 2007)

Anthropogenic sound can impact marine mammals in a number of ways from direct injury (physiological and auditory effects) and behavioural responses, to perceptual and indirect effects (Gotz *et al.*, 2009; Southall *et al.*, 2007). While the operating frequency of analogue equipment is generally above the hearing range of marine mammals, their operation can generate sound that falls within the functional hearing range of marine mammals. Therefore such sources may be detectable over distances of several hundred metres, and although generally below harmful levels could potentially affect the behaviour of marine mammals within close proximity (Deng *et al.*, 2014). Recent investigations into a mass stranding of melon-headed whale (*Peponocephala electra*) indicate the event was primarily triggered by a multi beam echo sounder system (Southall *et al.*, 2013).

It is clear that behavioural responses to sound are highly variable and context specific, with spatial and temporal relationship, habitat quality, previous experience and similarity to biologically significant sounds, as well as the species, gender, age and behavioural state of the individual influencing the type and severity of the response or even if one is observed at all (Southall *et al.*, 2007; Ellison *et al.*, 2012).

The ability to perceive biologically important sounds is critical to marine mammals (Richardson *et al.*, 1995). Masking by increased sound levels in the natural environment can reduce the range over which signals are perceived and reduced the signal's quality of information, which can have implications for survival, reproduction and foraging (Weilgart, 2007). In many cases changes in vocalisation rates and the frequencies used have been suggested to be compensatory behaviour to elevated background noise levels (Di Iorio & Clark, 2010).

1.2.2 Sea turtles

Sea turtles are another group potentially impacted by acoustic activity although their hearing sensitivity falls in the low frequency range (<1 kHz) (Bartol *et al.*, 1999). McCauley *et al.* (2000) demonstrated avoidance behaviour in two species exposed to a single airgun source. Strong site fidelity to nesting sites, specific feeding grounds and migratory routes (Broderick *et al.*, 2007) could mean sea turtles are unable to avoid particular areas and consequently acoustic activity.

1.3 Vessel Strikes

There is increasing evidence that collisions between vessels and cetaceans (whales, dolphins and porpoises) is occurring more frequently than previously thought, and that in some cases this may pose a significant conservation threat particularly for geographically isolated and endangered populations (Dolman *et al.,* 2006; Van Waerebeek *et al.*, 2007; Knowlton & Kraus, 2001). There are several variables which may either make a collision more likely or influence the kind of injuries inflicted or whether the collision is fatal. These include vessel speed, with speeds >11 knots more likely to cause a fatality (Vanderlaan & Taggart, 2007), type and size of vessel, visibility, condition and behaviour of individual and species (Dolman *et al.*, 2006; McKenna *et al.*, 2015). In the north-west Atlantic the North Atlantic right whale (*Eubalaena glacialis*) is particularly vulnerable to vessel strikes (Knowlton & Kraus, 2001), and as such a number of mitigation measures have been implemented in order to reduce the number of vessel strikes offshore of the northeast coast of the USA (Laist *et al.*, 2014; NOAA, 2008).

1.4 Legislation

There are two US Federal Legislations appropriate to marine mammals and sea turtles: the Marine Mammal Protection Act (MMPA) (1972, and last amended in 2007) and the Endangered Species Act (ESA) (1973).

The MMPA was established to prevent species and populations from 'declining to the point where they cease to be significant functioning elements of the ecosystems of which they are a part'. The Act established a moratorium on the *taking* of marine mammals, with the word *take* defined as 'to hunt, harass, capture or kill any marine mammal or attempt to do so'. Under the MMPA, Incidental

Harassment Authorisations (IHAs) were established to allow incidental 'takes' of small numbers of marine mammals by harassment. There are two levels of harassment defined under the IHAs: Level A covers any act with the potential to injure and Level B covers any act with the potential to disturb by causing disruption of behavioural patterns.

The ESA protects endangered and threatened species, which includes 22 species of marine mammal and all sea turtles, and their habitats by prohibiting the take of listed animals.

The Bureau of Ocean Energy Management (BOEM) considers all permit applications for geological and geophysical activities throughout the Mid-Atlantic and South Atlantic Planning Areas. Such permits are then subject to mitigation measures for avoidance of disturbance and injury to marine mammals and turtles. Such measures include, but are not limited to, guidance for vessel strike avoidance and measures to minimise disturbance and injury from acoustic surveys.

In accordance with the lease issued by BOEM the current survey was run in accordance with mitigation measures that cover vessel strike avoidance, reducing disturbance and harm from geophysical activities and reporting (Appendix A).

1.5 Objective

This report presents the findings of dedicated marine mammal and sea turtle monitoring during a high resolution geophysical (HRG) survey, offshore Maryland, USA (see Location Map). This survey was conducted by Alpine Ocean Seismic Survey Inc. on behalf of US Wind Inc. onboard the *R.V. Shearwater* from 2nd June to 25th July 2015.

The report provides a summary of HRG survey activities as well as compliance with measures implemented to reduce the risk of vessel strikes and disturbance and harm from geophysical survey activities. The report also includes an assessment of the methods of detection equipment and includes any recommendations.

2. THE MARINE ENVIRONMENT

2.1 Physical Environment and Oceanographic Features

The ocean is a highly heterogeneous environment with large, intermediate and small-scale spatial and temporal patterns in physical, chemical and biological processes (Hunt & Schneider, 1987). Variation in such processes has an effect on primary production and therefore the abundance and distribution of plankton (Mackas *et al.*, 1985), which in turn affects marine populations at higher trophic levels (Thompson & Ollason, 2001). Physical processes such as circulatory patterns may also have large-scale implications on the dispersion of marine life. Equally important small-scale features or localised episodes will also have an effect (Hunt & Schneider, 1987). Seasonal fluctuations in temperature, salinity and the formation of fronts will also influence dispersion and primary production (Le Fèvre, 1986; Ellett & Blindheim, 1992).

The distribution of marine animals is primarily related to the movement and abundance of their food source (e.g. Evans, 1990; Macleod *et al.*, 2004; Friedlaender *et al.*, 2006). Other behavioural, morphological and energetic constraints will also have an influence on the movement and distribution of marine species. For example many species of baleen whale migrate to low latitude breeding grounds during winter (Stern, 2002) while sea turtles migrate between feeding, nesting and developmental areas (Plotkin, 2003; Bolten, 2003). Such seasonal patterns in biology are likely to have evolved to take advantage of oceanographic conditions. As the distribution and abundance of marine animals is influenced by oceanographic characteristics, it is important to describe the marine processes in the survey area.

The survey area is located off the coast of the eastern coast of the U.S.A, encompassing the waters surrounding Maryland. The site is located 9 nm offshore in an area of water approximately 27 m (90 feet) deep. The bathymetry of the study site and surrounding area is comprised of a gently sloping outer continental shelf (the mid-Atlantic bight), that attains depths of up to 50 m before quickly descending to depths of over 1000 m past the shelf break (Firestone *et al.*, 2010; Grothe *et al.*, 2010).

The hydrographical regime of the waters off Maryland reflects the currents that affect the Mid-Atlantic Bight further north (Vincent *et al.*, 1981). The currents along the New York Bight (a northern subsection of the Mid-Atlantic Bight) and surrounding waters generally flow in a south-westerly direction, although this is modulated by storm induced flows along the continental shelf (Vincent *et al.*, 1981). The waters off the continental shelf are also highly affected by the gulf stream, with the direction of the gulf stream catalysing or slowing the current from 0 – 40 cm S^{-1} (Bane *et al.*, 1988).

2.2 Marine Communities

There is a strong correlation with phytoplankton productivity and depth in the Atlantic Ocean off the eastern U.S.A. with areas close to freshwater inputs having productivity levels of approximately 430 gC m^{-2} a $year^{-1}$, and the outer shelf waters maintaining productivity of between 100 – 160 gC m^{-2} a $year^{-1}$ (Malone, 1978). The density of phytoplankton and zooplankton is also seasonally driven, with annual spring blooms occurring throughout the Mid-Atlantic Bight (Flagg *et al.*, 1994).

The benthic communities of the Mid-Atlantic Bight are comprised of 149 species of polychaetes, crustaceans, molluscs and echinoderms *(Maurer et al., 1976)*. There is a seasonal shift in the abundance and biomass of species within the area, with polychaetes such as *Goniadella gracilis* and *Lumbrineris acuta* dominating in May, but *Polygordius sp.* dominating in November (Maurer *et al.*, 1976). The species that have been recorded in the area are typical of those that are commonly recorded in clean sand areas along the inner continental shelf of the Mid-Atlantic Bight (Maurer *et al.,* 1976).

The pelagic fish assemblages of the Mid-Atlantic Bight are comprised of over 300 species (Martin *et al.,* 1978). This primarily includes the Percifromes (perch (*Percidae*), mackerel (*Scombridae*), tuna and bass (*Serranidae*)) and especially the commercially viable skipjack (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), albacore (*Thunnus alalunga*) and Atlantic mackerel (*Scomber scombrus*). The most numerous benthic fish species in the area include spotted hake (*Urophycis regius*), fourspot flounder (*Hippoglossina oblonga*) and butterfish (*Stromateidae sp.)* (Gabriel, 1994). The waters surrounding Maryland are also inhabited by basking sharks (*Cetorhinus maximus*), which have been recorded in the area from both boat & aerial surveys (Kenney *et al*., 1985) and through tagging experiments (Skomal *et al*., 2004).

There have been 26 species of marine mammal recorded along the Maryland coast, comprising 19 odontocetes, five mysticetes and two pinniped species (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015) (Table 2.1). All species of cetacean are listed under the Marine Mammal Protection Act (MMPA) (1972). Cetaceans listed as endangered or threatened under the Endangered Species Act (ESA) and found within the region include, humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*) and the North Atlantic right whale (*Eubalaena glacialis*). Of particular concern is the North Atlantic right whale, whose population numbered at a minimum of 455 individuals in 2013, although the population is exhibiting a positive and slowly accelerating trend (Waring *et al*., 2009). The North Atlantic right whale is most likely to be seen on transit as the waters of Maryland form part of the bi-annual migratory corridor used by this species (Brown and Marx, 2000) The bottlenose dolphin (*Tursiops truncatus*) is the most abundant species of odontocetes recorded off the Maryland coast. The north-west Atlantic stock is estimated to be around 77,500 (NOAA, 2014).

There are two species of pinniped that have been recorded in the area. The harbour seal (*Phoca vitulina*) is the most common and is often found in near shore waters year round off Maine and seasonally off southern New England to Virginia (Thompson & Härkönen, 2008). Grey seals (*Halichoerus grypus*) range from New York to Labrador, with three established breeding colonies off Maine and Massachusetts, although individuals occasionally stray further south and in to the survey area.

Table 2.1 below was created from strandings records completed in the last 20 years, NOAA stock assessments and extrapolated from species recorded in the mid-Atlantic bight south of south New England (Kenney *et al.,* 1997; Marine Mammal & Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015).

All species of sea turtle are listed on the Endangered ESA. Four species of turtle have been recorded in the area: the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) green (*Chelonia mydas*) and leatherback turtle (*Dermochelys coriacea*) (Marine Mammal & Sea Turtle Stranding, 2015). All turtle species are migrants that come to forage along the coastal shelves (Shoop, 1987).

Table 2.1 Marine mammal species recorded off the Maryland coast

Species	Scientific Name	IUCN Status
Humpback whale	*Megaptera novaeangliae*	Least concern
North Atlantic right whale	*Eubalaena glacialis*	Endangered
Minke whale	*Balaenoptera acutorostrata*	Least concern
Sei whale	*Balaenoptera borealis*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Gervais' beaked whale	*Mesoplodon europaeus*	Data deficient
Cuvier's beaked whale	*Ziphius cavirostris*	Least concern
Sowerby's beaked whale	*Mesoplodon bidens*	Data deficient
Blainville's Beaked whale	*Mesoplodon densirostris*	Data deficient
True's beaked whale	*Mesoplodon mirus*	Data deficient
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Least concern
Bottlenose dolphin	*Tursiops truncates*	Least concern
Short-beaked common dolphin	*Delphinus delphis*	Least concern
Striped dolphin	*Stenella coeruleoalba*	Least concern
Pantropical spotted dolphin	*Stenella attenuate*	Least concern
Atlantic spotted dolphin	*Stenella frontalis*	Data deficient
Spinner dolphin	*Stenella longirostris*	Data deficient
Pygmy sperm whale	*Kogia breviceps*	Data deficient
Dwarf sperm whale	*Kogia sima*	Data deficient
Sperm whale	*Physeter catodon*	Vulnerable
Long-finned pilot whale	*Globicephala melas*	Data deficient
Short-finned pilot whale	*Globicephala macrorhynchus*	Data deficient
False killer whale	*Pseudorca crassidens*	Data deficient
Risso's dolphin	*Grampus griseus*	Least concern
Harbour seal	*Phoca vitulina*	Least concern
Grey seal	*Halichoerus grypus*	Least concern

3. METHODOLOGY

3.1 *Survey Area*

The HRG survey was carried out by Alpine Ocean Seismic Survey Inc. on behalf of US Wind Inc. The site was located offshore Maryland (see Location Map) in an area of water approximately 27 m deep and 15 km east from Ocean City. The position of the proposed Met Tower location, around which the survey was completed, can be found in Table 3.1.

Table 3.1 Survey location

Site	Latitude	Longitude	Coordinate System
Met Tower	38° 19.230" N	74° 46.309" W	UTM 18N

3.2 *Survey Vessel*

The HRG survey was carried out onboard the *R.V. Shearwater* from 2nd June to 25th July 2015. The vessel details are as displayed in Table 3.2.

Table 3.2 Vessel specifications

R. V. Shearwater	Specifications
Manager	Alpine Ocean Seismic Survey
Flag	United States of America
Type	Multi-Role Survey
Built	1981 (reconfigured 2011)
Length OA	110 ft (33.53 m)
Breadth OA	39 ft (11.89 m)
Draft	7 ft (2.13 m)
Main Engine	2 x 526 HP John Deere Model 6125AFM
Thrusters	2 x Hydraulically driven "Z" Drives (360 degree steering)
Endurance	14 days
Accommodation	20 berths

3.3 *Survey Parameters*

The survey comprised of HRG data acquisition with survey speed approximately 4.5 knots.

The purpose of the survey was to characterise the seabed for the future construction of a wind farm. The survey is being conducted in an area covering 184 km^2 within the lease areas.

Shallow geophysical data were collected using single and multi beam echo sounders, side scan sonar and sub-bottom profiler (chirper). Details of the equipment used during the survey can be found in Table 3.3.

Table 3.3 Analogue survey equipment

Equipment	Sample model type	Frequency
Multi-beam depth sounder	R2Sonic 2024	200-400 kHz
Single beam depth sounder	ODOM Echotrac	200 kHz
Side scan sonar	Klein Dual 3900	450 and 900 kHz
Shallow-penetration sub-bottom profiler (chirper)	Teledyne Benthos CHIRP III	2-7 kHz

3.4 *Operators Procedures*

In line with the requirements stipulated in the lease (OSC-A 0489 and OCS-A 490) the survey was run in accordance with a number of mitigation measures which covered vessel strike avoidance, the reduction of the risk of disturbance and injury from geophysical survey operations and reporting requirements.

3.4.1 *Vessel strike avoidance*

In order to avoid causing injury or death to marine mammals and sea turtles the following measures were implemented.

Protected Species Observers (PSOs) and the vessel operator maintained a vigilant watch for marine mammals and turtles, and either slowed down or stopped the vessel in order to avoid striking any sighted individuals.

Vessel speed was reduced to 10 knots or less when groups including mother and calf pairs or large groups of cetaceans were encountered. Vessel speed was also reduced to 10 knots or less in any Dynamic Management Areas (DMAs) and Seasonal Management Areas (SMAs) implemented for North Atlantic right whales.

During the survey the National Marine Fisheries Service (NMFS) North Atlantic Right Whale Reporting Systems were monitored for the presence of North Atlantic right whales within or adjacent to the survey area. This includes the following:

- Early Warning System
- Sightings Advisory System
- Mandatory Ship Reporting System

A minimum separation distance of 500 m was maintained between the vessel and any North Atlantic right whales encountered. If a North Atlantic right whale was encountered within 500 m, the vessel steered a course away from the whale at 10 knots or less until it was more than 500 m from the vessel. If North Atlantic right whales were encountered within 100 m of the vessel the following avoidance measures were taken:

- Vessel speed was reduced and the vessel engine shifted to neutral.
- Engines were not engaged until the whale was more than 100 m away.
- Vessel then steered a course at 10 knots or less away from the individual/s until the 500 m minimum separation distance was established.

A minimum separation distance of 100 m was maintained between the vessel and any other non-delphinid cetaceans encountered. If individuals were encountered within 100 m, the vessel reduced speed and shifted engines into neutral. Engines were only engaged once the individual/s was more than 100 m away.

For delphinid cetaceans a minimum separation distance of 50 m was maintained. If delphinids were encountered within 50 m the vessel maintained a parallel course with the group wherever possible, avoiding abrupt changes in direction and excessive speed. Course and speed were only adjusted once the animals moved more than 50 m from the vessel or they had moved abeam.

For all marine turtle and pinniped encounters a minimum distance of 50 m was maintained.

3.4.2 Reporting injured or dead protected species

During the survey PSOs reported any sightings of dead or injured protected species (including all marine mammals, sea turtles and sturgeon) immediately regardless of whether the injury or death was caused by the survey vessel. All such incidences were reported to BOEM and the NMFS Northeast Regional Stranding Hotline (866-755-6622) within 24-hours. Any sightings of dead, injured or entangled North Atlantic right whales were also reported to the US Coast Guard via CHF Channel 16. A standardised incident report was also completed for all injured or dead protected species sighted (Appendix B).

3.4.3 Mitigation for the HRG survey

PSOs and PAMS Operators maintained dedicated monitoring for marine mammals and sea turtles for a minimum of 60 minutes prior to an acoustic source starting. Following a period with no marine mammal or sea turtle recorded within the 200 m mitigation zone the acoustic source commenced firing.

If a marine mammal or sea turtle was detected within the 200 m mitigation zone surrounding the acoustic source during the 60 minute pre-shoot period a delay to the activation of the acoustic source was implemented. Start up was delayed by 60 minutes from the last time the marine mammal or sea turtle was detected within the mitigation zone, or until the animals were successfully tracked outside of the mitigation zone.

A ramp-up of all acoustic survey equipment was conducted at the start and restart of all survey activities. The ramp-up began with the power of the smallest acoustic source at its lowest output. Power output was then increased gradually and other acoustic sources added so that the source level increased in steps not exceeding 6 dB per 5-minute period.

Once the acoustic equipment was active if a non-delphinid cetacean or sea turtle was detected within the 200 m mitigation zone the source was immediately shut-down. The acoustic source resumed firing with a ramp-up after at least 60 minutes had passed since they were last detected within the mitigation zone.

If a delphinid cetacean or pinniped was detected within the 200 m mitigation zone the acoustic source was powered down to its lowest possible power output. Subsequent power up followed a ramp-up procedure and only occurred once the mitigation zone was clear of delphinid cetaceans or pinnipeds or after 10 minutes of observations it was clear that the animals were approaching voluntarily to bow-ride or chase towed equipment.

If low frequency vocalisations were detected by the PAMS but range could not be determined and the animal not detected visually then a shut-down or delay was implemented as a precautionary measure.

No HRG survey operations were conducted in any established DMAs.

Any breaks in acoustic activity of less than 20 minutes (other than those caused by a non-delphinid or sea turtle shut-down) resumed at operational levels straight away providing the PSO and PAMS Operator had been conducting monitoring during the break and no marine mammals or sea turtles were detected within the mitigation zone. Breaks of more than 20 minutes resumed following full dedicated pre-shoot monitoring and a full ramp-up procedure.

3.5 Observation Methods

The PSOs carried out dedicated watches for marine mammals and sea turtles during all operations, including transit to and from site. Watches were conducted 24-hours, with night–vision binoculars and thermal imaging technology utilised during the hours of darkness. The Joint Nature Conservation Committee (JNCC) standardised recording forms were completed by the PSOs during all operations and transit.

Watches were carried out from the bridge and bridge wings. Prior to beginning a watch, the time (UTC) and weather conditions were recorded on the JNCC Location and Effort Form (Appendix C). Weather conditions (Beaufort wind force and direction, sea state, swell height and visibility) were noted every hour and whenever a change in conditions occurred. The used definitions of Beaufort wind force and sea state are provided in Appendix D. In addition, the start and end times of marine mammal and sea turtle watches and the start and end times of the firing of the acoustic sources were recorded each day on the JNCC Record of Operations Form (Appendix C).

The primary observation technique used to detect marine mammals and sea turtles during daylight hours was to scan the visible area of sea using the naked eye, and scanning areas of interest with binoculars (magnification x 8 & x 10) (e.g. waves going against the prevailing direction, white water during calm periods, bird activity, bird transiting direction etc.). This technique gave both a wide field of view and the ability to have a sufficient range of 3-4 km in ideal conditions. Reticule binoculars and a range-finder stick (Heinemann, 1981) were used to establish the distance to all marine mammal and sea turtles sighted.

During the hours of darkness the PSOs used night-vision binoculars (PVS-7 night vision goggle Generation 3 Pinnacle) with additional clip-on thermal imaging (COTI) technology. All watches with night-vision optics were carried out from a platform with no visual barriers.

PSOs calibrated reticule binoculars and range finder sticks using standard methods (Appendix E). Calibrations were conducted during mobilisation and at a minimum once a week throughout the survey.

Identifications were based on a combination of the observer's previous experience, aided by the field guide "Whales, Dolphins and Seals: A field guide to the marine mammals of the world" by Shirihai and Jarrett (2006).

PSOs were also equipped with bearing finding equipment and a stills camera with 70-300 mm lens.

The JNCC Marine Mammal Recording Forms were available to record sightings made by the PSOs (Appendix C). The information recorded included the date and time, the vessels position, course, depth and acoustic activity. The species, certainty of identification, number of animals, behaviour, distance from the vessel and direction of travel were also recorded. Any additional information, such as details on the features used to identify the animals and the reaction of the animals to the acoustic source was also noted.

3.6 Acoustic Monitoring Methods

Passive Acoustic Monitoring (PAM) uses hydrophones (underwater microphones) to detect and monitor the presence of marine mammals through the detection of their vocalisations. Most cetaceans (whales, dolphins and porpoises) vocalise regularly and produce a variety of sounds ranging from low frequency vocalisations of baleen whales (down to about 15 Hz) to relatively high frequency echolocation clicks of some toothed whales (up to about 160 kHz) (Sturtivant *et al.*, 1994; Richardson *et al.*, 1995; Berchok *et al.*, 2006). This method of detection is only effective when mammals are vocalising.

During the Offshore Maryland Geophysical Survey a Passive Acoustic Monitoring System (PAMS) was used to acoustically monitoring for marine mammals 24-hours a day. Details of the PAMS used during the survey are provided below.

Prior to commencing monitoring the time (UTC) and weather conditions were recorded on the JNCC Location and Effort Form (Appendix C). Weather conditions were recorded every hour and whenever a change in conditions or source activity occurred. The used definitions of Beaufort wind force and sea state are provided in Appendix D. In addition the start and end times of dedicated pre-shoot monitoring and the start and end times of firing of the acoustic source was recorded on the JNCC Record of Operations Form (Appendix C).

The JNCC Sightings Form (Appendix C) was available to record detections made by the PAMS Operator. The information recorded included the date and time, the vessel's position, course, water depth, acoustic source activity, range and bearing to marine mammals and a description of the detection. Where possible the species and number of individuals were also recorded.

PAMS Operators calibrated the PAMS using standard methods, including dry tap tests on deck, and wet tests with the cable in the water. Calibrations were conducted during mobilisation and a minimum of once a week throughout the survey. The software used was optimised to minimise background noise from the vessel and HRG equipment – for example, the spectrogram resolution and thresholds adjusted, in order to maximise the chance of detecting vocalisations.

3.6.1 The PAMS

The PAMS comprised of a towed hydrophone array connected to a data processing system, enabling the acquired sound to be inspected both aurally and visually. The hydrophones are connected to dry-end hardware which digitises the analogue signal allowing it to then be read by the laptop computers. The computers run analysis software which highlights the number of varied clicks and whistles produced by different species of marine mammals.

The system utilised low and broadband frequency hydrophones in order to cover the frequency range of vocalising marine mammals, from low frequency mysticete (baleen whale) moans to high frequency odontocete (toothed whale and dolphin) clicks. The signal receive by the hydrophones is then monitored in real-time by the dedicated software PAMGuard which, through the use of click detectors, whistle and moan detectors and filters, allows the automatic detection of the presence of vocalising marine mammals. Detectors and filters can be adjusted manually by the PAMS Operator in order to increase positive detections. The detections were then stored in a database (Figure 3.1).

The data processing system comprises the following sub systems:

a) High frequency data acquisition for cetacean clicks up to 250 kHz (max sample rate 500 kHz).
b) Medium/low frequency data acquisition for cetacean click and whistles up to 48 kHz (max sample rate 96 kHz) and cetacean moans down to 10 Hz.
c) Depth data acquisition.
d) Computer based sound acquisition, display and analysis software.

The directionality and range of the marine mammal is determined by the time difference of the arrival of the acoustic signal (vocalisation) to each hydrophone of the array.

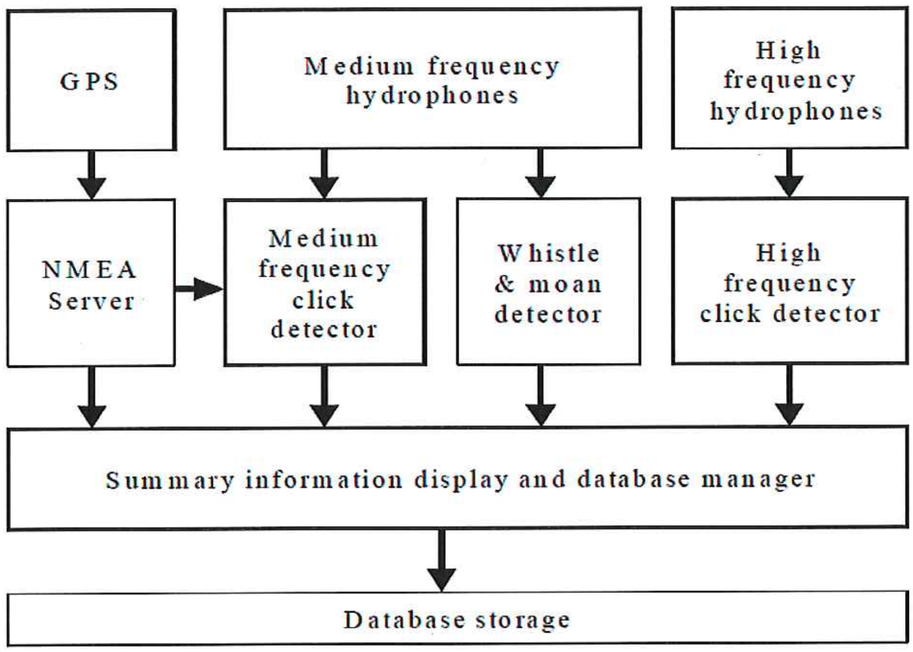

Figure 3.1 Schematic set up of PAMS

3.6.2 *The hydrophone array*

The PAMS used during the survey was a GEL MK4 system and consisted of six hydrophones; three low frequency and three broadband frequency. The manufacturer's specification for the PAMS can be found in Appendix F. The hydrophone array was wired into a tow cable, an electric cable of 250 m in length, and towed behind the vessel.

3.6.3 *The monitoring system*

The latest version of PAMGuard software Version (1.13.00 Beta) was utilised as a graphical display for sound acquisition, visualisation and detection of marine mammal vocalisations. PAMGuard is an open-source software, that is platform-independent (e.g. Windows or Linux), flexible and built in a modular architecture.

For mitigation purposes, during the current survey the PAMS used a specific data model configuration created by Gardline Environmental Ltd. Using the most appropriate modules and specifications, a low/medium frequency and a high frequency data module configuration was utilised simultaneously using a single computer interface (Figure 3.2).

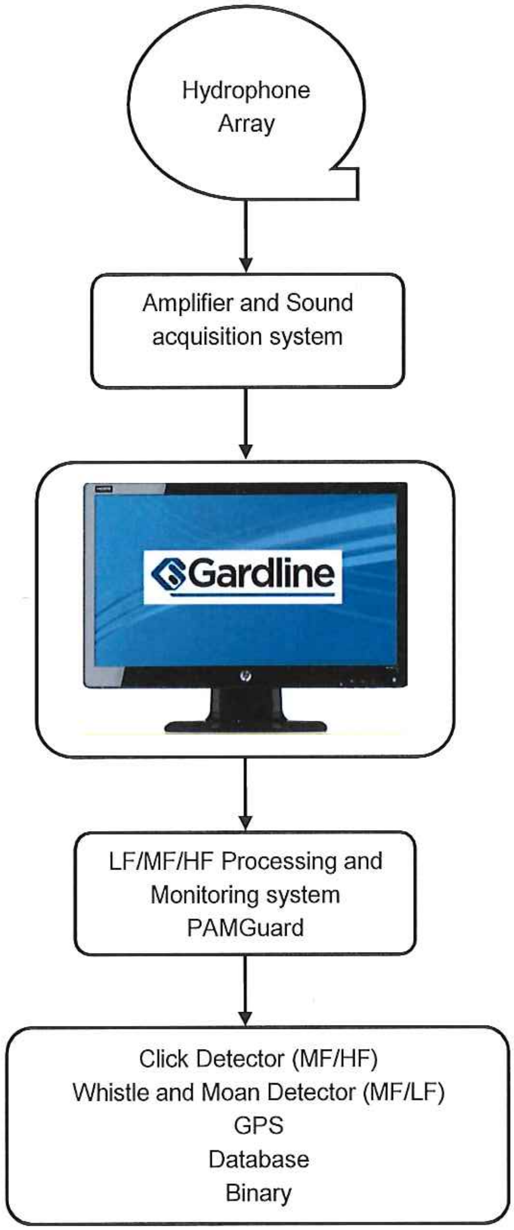

Figure 3.2 Schematic plug-in modules used in PAMGuard

The medium/low frequency configuration is programmed to specifically track and localise clicks, whistles and moans produced by cetaceans in the vicinity of the hydrophones. This includes odontocete clicks and whistles up to 48 kHz and mysticete moans down to 10 Hz.

The high frequency configuration is programmed to detect the clicks of odontocetes (including dolphins and porpoises) up to 250 kHz.

All of the detection modules were run in real time and monitored by a dedicated PAMS Operator, with audio recordings and screenshots taken for any detections during the survey.

4. RESULTS

4.1 *Survey Coverage*

The *R.V. Shearwater* began mobilisation in Ocean City on 2nd June 2015. On 5th June the vessel left port and transited out to site at 15:15h (UTC). Upon arrival, calibrations of the geophysical equipment were undertaken and the noise assessment data was collected using PAMS. The vessel then began multi beam data acquisition before ramping up the sub-bottom profiler and single beam depth sounder and beginning the first line at 23:22h on 6th June. Operations continued until 19th June when the vessel headed to Ocean City for replenishment at 04:25h. On 22nd June the vessel returned to site and continued running HRG survey lines at 19:23h. Operations continued until another replenishment port call was required on 6th July. The vessel returned to site on 8th July and resumed running lines at 19:51h. Data acquisitions continued until 19:50h on 13th July when the PAMs cable became entangled in the propeller, and after replacing the array, survey operations resumed at 01:29h on 14th July. At 19:16h on 14th July operations were halted for adverse sea conditions and the vessel made a routine port call, arriving alongside in Ocean City at 13:20h on 15th July. The *R.V. Shearwater* transited back to site at 11:30h on 17th July and survey operations recommenced at 14:57h on the same day. The vessel continued running HRG survey lines until 12:55h on 22nd July when the USBL transceiver stopping transmitting. It was then decided to return to Ocean City to replace the equipment and the vessel arrived alongside at 16:00h on the same day. The vessel left port at 16:30h on 24th July and, following a USBL calibration, the geophysical survey continued at 21:05h on the same day. All HRG data acquisition was completed on 24th July. Environmental activities including shallow water camera work and grab samples were undertaken at 05:45h with the entire survey being completed at 14:00h on 25th July. At 16:30h on the same day the *R.V. Shearwater* arrived back in Ocean City for demobilisation.

During the survey a total of 373 HRG survey lines, including 87 reruns, were run over 43 days. In addition there were four tests conducted. Table 4.1 provides a summary of data acquisition during the survey.

Table 4.1 Summary of data acquisition for the geophysical survey

Data acquisition	Offshore Maryland geophysical survey
Number of lines (incl. reruns)	286 (373)
Number of tests	4
Total hours of acoustic equipment active (hrs:mm)	736:26
Number of ramp-ups	42
Number of daylight ramp-ups	37

4.2 *Protected Species Observer Effort*

A total of 913 hours and 35 minutes of dedicated marine mammal and sea turtle watches and 804 hours and 48 minutes of dedicated acoustic monitoring effort were carried out by the PSOs between 6th June and 25th July 2015. This included 42 hours of dedicated full pre-start watches and acoustic monitoring.

4.3 *Weather Conditions*

Weather conditions recorded during the survey were good. The sea state varied between glassy and choppy, but was primarily slight (Figure 4.1). Swell height was predominately low (<2 m) 95%

of the time and moderate (2 – 4 m) 5% of the time. Visibility was generally good although moderate and poor at times (Figure 4.2). Beaufort wind force varied between Force 0 and 6 (Figure 4.3) and was mainly either southerly or south westerly in direction (Figure 4.4).

It should be noted that weather observations were only made during dedicated marine mammal and sea turtle monitoring and hence may not fully reflect weather throughout the survey.

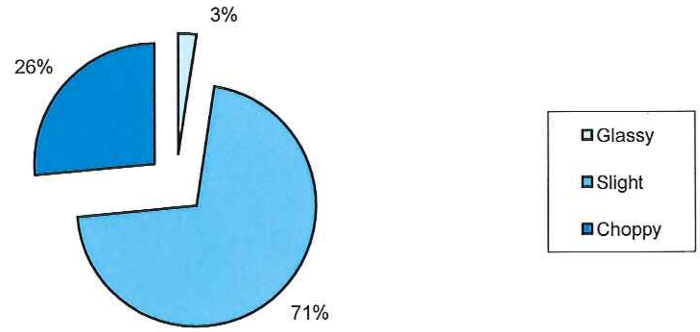

Figure 4.1 Sea state recorded during dedicated marine mammal and sea turtle monitoring during the geophysical survey

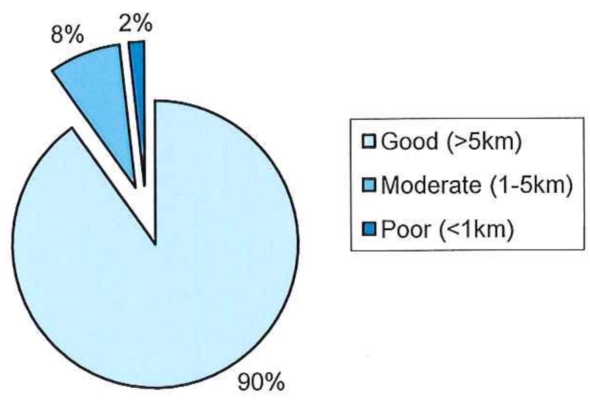

Figure 4.2 Visibility recorded during dedicated marine mammal and sea turtle monitoring during the geophysical survey

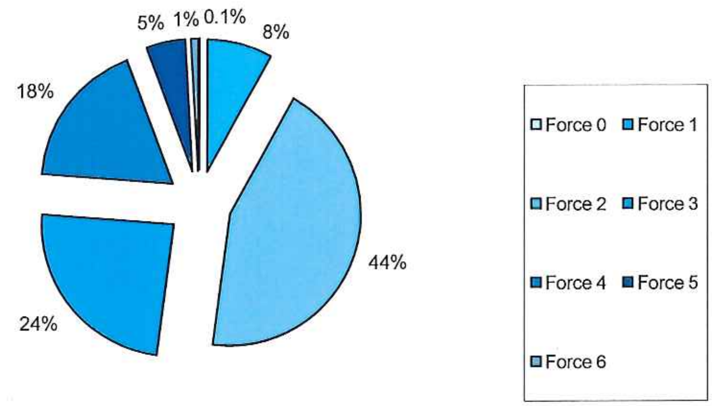

Figure 4.3 Beaufort wind force recorded during dedicated marine mammal and sea turtle monitoring during geophysical survey

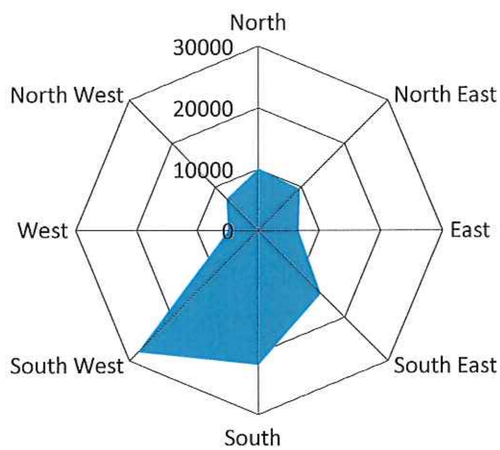

Figure 4.4 Wind direction recorded during dedicated marine mammal and sea turtle monitoring during the geophysical survey

4.4 Compliance with Protected Species Mitigation Measures

The Offshore Maryland Geophysical Survey was run in accordance with a specific mitigation measures stipulated in the lease (OSC-A 0489 and OSC-A 490). PSOs conducted dedicated watches and acoustic monitoring during all survey operations and visual monitoring during all transits to and from site.

There were no encounters with North Atlantic right whale during the survey.

There were two encounters with non-delphinid cetaceans during the survey. A minimum separation distance of 100 m was maintained during one encounter of an unidentified baleen whale on 29th

June 2015 sighted at 4000 m. On one occasion, non-delphinid cetaceans were encountered within 100 m of the vessel during transit to port: on 22nd July a mother and calf pair of pygmy sperm whale were sighted a minimum of 10 m from the vessel. The vessel speed remained below 10 knots throughout the encounter as the vessel was coming in to port, however there were a high number of vessels and fishing gear in the vicinity, therefore it was deemed unsafe to put the vessel into neutral. However, the vessel maintained a constant slow speed to minimise the risk of collision and the animals were passed safely.

There were 39 encounters with delphinid cetaceans during the survey. A minimum separation distance of 50 m was maintained during 31 encounters. On eight occasions delphinid cetaceans were encountered within 50 m of the vessel; on all such occasions the appropriate avoidance measures were implemented.

There were 29 encounters with sea turtles and no encounters with pinnipeds during the survey. A minimum separation distance of 50 m was maintained during 16 encounters. On 13 occasions marine turtles were encountered within 50 m of the vessel; on all such occasions the appropriate avoidance measures were implemented.

Full details of all the marine mammal and sea turtle encounters during the survey are provided in Sections 4.5 and 4.6 below.

During the survey there were no incidences of vessel strikes with marine mammals or sea turtles. There were two sightings of dead, unidentified turtle species but no other sightings of injured or dead protected species. The first dead turtle was sighted on 14th June at 15:58h. It was floating belly up and was moderately decomposed (signs of bloating and muscle/ tissue degradation). The second sighting was on 11th July, when a dead turtle was sighted at 20:20h. It was also floating belly up and moderately decomposed. During both sightings, seabirds were seen feeding on the remains. Both sightings were reported to the NOAA NMFS Northeast Region Stranding Hotline within 24-hours and a full incident report completed (Appendix B).

Vessel speed was maintained at 4 - 5 knots throughout geophysical survey operations. During transit there were no occasions where vessel speed was reduced to less than 10 knots due to the presence of mother and calf pairs, large groups of cetaceans or due to the designation of a DMA for North Atlantic right whales.

The lease stipulated that the Early Warning System, Sighting Advisory System and Mandatory Ship Recording System must be used in Seasonal Management Areas in the designated period of 1st November to 30th April. Although the survey did not take place during this period, this system was still monitored for the presence of North Atlantic right whales throughout operations and transit.
During the survey there were 42 ramp-ups of the geophysical survey equipment, of which 37 occurred during daylight hours including one during lowlight hours at dusk; and five occurred during the hours of darkness. Full dedicated pre-start monitoring (visual and acoustic) was completed prior to all full ramp-ups of acoustic equipment. If a power-down was required due to a delphinid cetacean or pinniped entering the mitigation zone, then full monitoring would continue throughout the encounter.

All breaks in firing (for reasons other than shut-down due to non-delphinid cetaceans or turtles) were covered by the appropriate monitoring and ramp-up where appropriate.

During the survey there were three occasions where the start-up of geophysical equipment was delayed due to the close proximity of marine mammals or turtles. There were 15 occasions where the active source was shut-down due to the close proximity of non-delphinid cetaceans and turtles, and there were 12 occasions when the active source was powered down due to the close proximity of a delphinid cetacean (Table 4.2).

Table 4.2 Summary of mitigation during the geophysical survey

Date dd/mm/yy	Time animal entered mitigation zone(UTC)	Species	Closest distance from source	Source activity	Action taken	Length of delay/shut down/power down / mins
07/06/15	12:22	Loggerhead turtle	50	Full power	Shut down	60
12/06/15	00:07	Atlantic spotted dolphin	5	Full power	Power down	9
12/06/15	17:08	Loggerhead turtle	5	Full power	Shut down	60
13/06/15	16:04	Unidentified turtle sp.	20	Full power	Shut down	60
16/06/15	15:09	Unidentified turtle sp.	100	Full power	Shut down	60
17/06/15	15:45	Unidentified turtle sp.	10	Full power	Shut down	60
17/06/15	16:37	Unidentified turtle sp.	100	Not active	Delay ramp up	52
17/06/15	19:13	Loggerhead turtle	75	Full power	Shut down	60
17/06/15	19:26	Loggerhead turtle	40	Not active	Delay ramp up	13
17/06/15	19:31	Loggerhead turtle	200	Not active	Delay ramp up	4
17/06/15	21:45	Unidentified turtle sp.	10	Full power	Shut down	60
24/06/15	20:55	Loggerhead turtle	50	Full power	Shut down	60
25/06/15	16:39	Unidentified dolphin sp.	180	Full power	Power down	4
29/06/15	17:21	Loggerhead turtle	60	Full power	Shut down	60
30/06/15	13:46	Bottlenose dolphin	2	Full power	Power down	22
30/06/15	19:27	Loggerhead turtle	20	Full power	Shut down	62
01/07/15	10:30	Bottlenose dolphin	100	Full power	Power down	30
01/07/15	17:42	Loggerhead turtle	50	Full power	Shut down	60
09/07/15	15:16	Unidentified turtle sp.	50	Full power	Shut down	62
09/07/15	22:25	Bottlenose dolphin	150	Full power	Power down	5

09/07/15	22:45	Bottlenose dolphin*	60	Ramp up	Power down	17
10/07/15	02:15	Atlantic spotted dolphin	10	Full power	Power down	7
10/07/15	02:29	Atlantic spotted dolphin *	15	Ramp up	Power down	10
10/07/15	10:25	Unidentified turtle sp.	150	Full power	Shut down	60
18/07/15	11:16	Atlantic spotted dolphin	5	Full power	Power down	6
18/07/15	12:03	Atlantic spotted dolphin	5	Full power	Power down	9
20/07/15	15:43	Unidentified turtle sp.	50	Full power	Shut down	60
21/07/15	15:37	Green turtle	30	Full power	Shut down	61
22/07/15	00:04	Bottlenose dolphin	150	Ramp up	Power down	4
22/07/2015	00:15	Bottlenose dolphin *	5	Ramp up	Power down	7

* denotes when the same animal/s re-entered the mitigation zone

4.5 *Marine Mammal and Sea Turtle Encounters*

There were 64 sightings of marine mammals and sea turtles, and 10 acoustic detections of marine mammals throughout the duration of the survey, from 5th June to 25th July 2015. Encounters included bottlenose dolphin, Atlantic spotted dolphin, unidentified dolphin species, pygmy sperm whale, unidentified baleen whale species, loggerhead turtle, leatherback turtle, green turtle and unidentified turtle species.

During the geophysical survey there were no sightings of North Atlantic right whales.

A summary of the species encountered is provided in Table 4.2; full details of the sightings and acoustic detections are provided in the sections below while a general description of each species encountered is provided in Appendix G. Figure 4.5 shows a distribution map of the encounters.

Table 4.3 Summary of marine mammal and sea turtle encounters during the geophysical survey

Species	Daylight		Night time	
	Number of Sightings	Number of Acoustic Detections	Number of Sightings	Number of Acoustic Detections
Loggerhead turtle	12	0	0	0
Green turtle	1	0	0	0
Leatherback turtle	2	0	0	0
Unidentified turtle sp.	13	0	1	0
Bottlenose dolphin	27	3	0	0
Atlantic spotted dolphin	3	1	1	1
Pygmy sperm whale	1	0	0	0
Unidentified dolphin sp	2	0	0	5
Unidentified baleen whale sp.	1	0	0	0

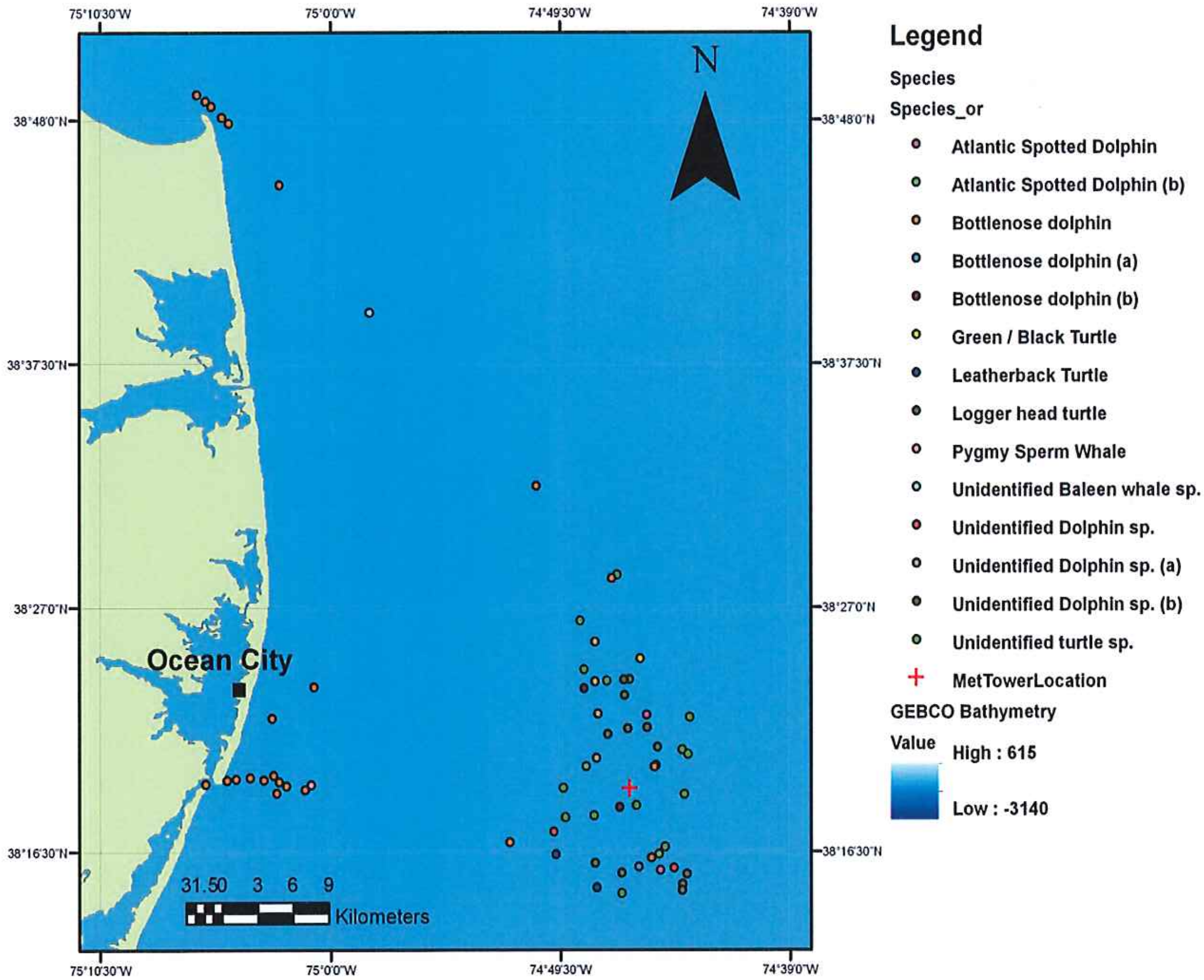

Figure 4.5 Distribution map of the marine mammals and sea turtles encountered during the geophysical survey. (a) denotes species acoustically detected whilst (b) denotes species detected both visually and acoustically. All other encounters were visual only.

4.6 Marine Mammal and Sea Turtle Sightings

4.6.1 Unidentified baleen whale

There was one sighting of a large baleen whale during the geophysical survey. On the 29th June at 10:29h a series of tall blows were sighted (Figure 4.6), although the body of the whale was not visible. At the time of the sighting, there was no acoustic output from the vessel and the individual remained 4000 m away and so mitigation action or vessel avoidance was not required.

Figure 4.6 Large baleen whale sighted on 29th June during the geophysical survey

4.6.2 Atlantic spotted dolphin (Stenella frontalis)

There were four sightings of Atlantic spotted dolphin (Figure 4.7) during the geophysical survey - these are summarised in the table below (Table 4.4).

Table 4.4 Summary of Atlantic spotted dolphin sightings/detections during the geophysical survey

Date (dd/mm/yy)	Start time of sighting (UTC)	End time of sighting (UTC)	Number of Individuals	Distance from vessel when first sighted / m	Bearing from North / degrees	Method of detection	Method first detected
12/06/15	00:07	00:18	17	150	160	Visual	N/A
10/07/15	02:14	02:38	10	10	265	Both*	Acoustic
18/07/15	11:16	11:16	3	10	160	Visual	N/A
18/07/15	11:58	11:58	20	250	180	Both	Visual

* denotes when the animals were seen with the night vision binoculars

Figure 4.7 Atlantic spotted dolphins sighted on 12th June during the geophysical survey

4.6.3 *Bottlenose dolphin (Tursiops truncatus)*

There were 27 sightings of bottlenose dolphins (Figure 4.8) during the geophysical survey - these are summarised in the table below (Table 4.5)

Table 4.5 Summary of bottlenose dolphin sightings/detections during the geophysical survey

Date (dd/mm/ yy)	Start time of sight (UTC)	End Time of sighting (UTC)	No. of Individuals	Distance from vessel when first sighted / m	Bearing from North / degrees	Method of detection	Method first detected
09/06/15	01:00	01:05	2	50	280	Visual	N/A
09/06/15	20:25	20:30	12	900	260	Visual	N/A
09/06/15	21:13	21:15	1	1300	230	Visual	N/A
09/06/15	22:55	22:56	6	700	70	Visual	N/A
10/06/15	20:00	20:01	1	1000	150	Visual	N/A
19/06/15	14:46	14:47	10	10	315	Visual	N/A
22/06/15	15:10	15:13	10	200	60	Visual	N/A
22/06/15	15:26	15:33	40	350	117	Visual	N/A
26/06/15	19:39	19:41	7	400	225	Visual	N/A
26/06/15	20:20	20:23	1	1000	225	Visual	N/A
26/06/15	20:26	20:29	2	300	260	Visual	N/A
30/06/15	13:46	13:58	14	180	210	Both	Visual
01/07/15	10:25	10:42	100	1000	100	Visual	N/A
08/07/15	16:23	16:26	1	500	350	Visual	N/A
09/07/15	22:20	22:58	50	300	310	Both	Acoustic

14/07/15	22:34	22:35	3	600	340	Visual	N/A
14/07/15	23:19	23:23	2	200	165	Visual	N/A
15/07/15	10:48	10:51	1	50	340	Visual	N/A
15/07/15	12:35	12:32	4	100	270	Visual	N/A
17/07/15	12:30	12:32	4	100	70	Visual	N/A
21/07/15	14:21	14:23	1	1500	120	Visual	N/A
22/07/15	00:02	00:20	30			Both	Acoustic
22/07/15	16:27	16:32	6	500	230	Visual	N/A
24/07/15	16:52	17:06	3	600	30	Visual	N/A
24/07/15	17:22	17:25	8	500	10	Visual	N/A
24/07/15	18:46	18:49	1	500	125	Visual	N/A
25/07/15	16:42	16:44	1	300	180	Visual	N/A

Figure 4.8 Bottlenose dolphins sighted on 30th June during the geophysical survey

4.6.4 *Unidentified dolphin species*

There were two visual sightings of unidentified dolphin species during the geophysical survey.

At 16:39h on 25th June a pod of five unidentified dolphins were seen 180 m from the vessel. The sighting resulted in a 4-minute power-down of the acoustic source.

At 18:30h on the 3rd July a pod of seven unidentified dolphins were sighted 2000 m from the vessel. The sighting lasted for seven minutes and resulted in no mitigation action being required.

4.6.5 *Pygmy sperm whale (Kogia breviceps)*

There was one sighting of pygmy sperm whale during the geophysical survey (Figure 4.9). Between 15:11h and 15:15h on 22nd July a mother and calm pygmy sperm whale were seen 50 m off the port bow of the vessel. At the time of the sighting the vessel was transiting back to port therefore no mitigation action was required however the vessel kept in line with vessel strike avoidance measures where possible. Due to the number of vessels and fishing gear in the vicinity it was not possible to put the vessel into neutral however a constant speed below 10 knots was maintained to reduce the collision risk and the animals were passed safely.

Figure 4.9 Pygmy sperm whale sighted on 22nd July during the geophysical survey

4.6.6 *Loggerhead turtle (Caretta caretta)*

There were 12 confirmed sightings of loggerhead turtles during the geophysical survey (Figure 4.10), these are summarised in the table below (Table 4.6).

Table 4.6 Summary of loggerhead turtle sightings during the offshore Maryland geophysical survey

Date	Start Time of sighting (UTC)	End time of sighting (UTC)	Number of Individuals	Distance from vessel when first sighted / m	Bearing from North / degrees
07/06/15	12:22	12:23	1	50	340
10/06/15	11:36	11:37	1	250	193
11/06/15	00:12	00:14	1	200	212
12/06/15	17:08	17:10	1	10	300
17/06/15	19:13	19:16	1	100	42
17/06/15	19:26	19:28	1	80	128
17/06/15	19:31	19:33	1	200	215
24/06/15	20:55	20:58	1	75	68
29/06/15	17:20	17:22	1	230	33
30/06/15	19:27	19:28	1	20	313
01/07/15	17:42	17:42	1	75	191
22/07/15	13:13	13:14	1	250	15

Figure 4.10 Loggerhead turtle sighted on 30th June during the geophysical survey

4.6.7 *Green turtle (Chelonia mydas)*

There was one sighting of a probable green turtle during the geophysical survey. At 15:37h on 21st July 2015 a probable green turtle was recorded. The individual had a dark carapace, but pale flippers. The animal was seen 30 m from the vessel and initiated a shutdown of the acoustic source.

4.6.8 Leatherback turtle

There were two sightings of leatherback turtle during the geophysical survey.

At 20:27h on 24th July a single leatherback turtle was seen 500 m from the vessel. The individual was seen slowly swimming before taking a dive out of sight at 20:28h.

The second leatherback turtle sighting occurred at 21:11h on the same day. The turtle was sighted 500 m from the vessel and again performed a deep dive at 21:13h. On both occasions, no mitigation action was required.

Figure 4.11 Leatherback turtle sighted on 24th July during the offshore Maryland geophysical survey

4.6.9 Unidentified turtle species

There were 14 sightings of unidentified turtle species during the geophysical survey, including two dead specimens. Live sighting are summarised in the table below (Table 4.7).

Table 4.7 Summary of unidentified turtle sightings during the geophysical survey

Date	Start time of sighting (UTC)	End time of sighting (UTC)	Number of Individuals	Distance from vessel when first sighted / m	Bearing from North / degrees
10/06/15	21:08	21:09	1	300	60
10/06/15	21:58	21:59	1	215	280
*11/06/15	08:30	08:30	1	75	100
13/06/15	16:04	16:04	1	20	30
16/06/15	15:09	15:10	1	100	80
17/06/15	15:45	15:46	1	10	110
17/06/15	16:37	16:37	1	100	90
17/06/15	21:45	21:46	1	15	90
09/07/15	15:16	15:17	1	50	340
10/07/15	10:25	10:26	1	150	230
20/07/15	15:43	15:45	1	50	300
24/07/15	21:54	21:55	1	650	355

* denotes when the animals were seen with the night vision binoculars

4.7 *Marine Mammal Acoustic Detections*

4.7.1 *Atlantic spotted dolphin (Stenella frontalis)*

There were two detections of Atlantic spotted dolphin during the geophysical survey.

The first detection occurred at 02:14h on 10th July. The pod, estimated to be between 10 -15 individuals, was recorded for 24 minutes in total, and the species identity was confirmed visually using night vision binoculars. The dolphins were observed entering the mitigation zone twice at a minimum distance of 10 m from the equipment (Figure 4.12). The first time the animals entered the mitigation zone the equipment was at full power and a power down was initiated, the animals left the mitigation zone at 02:22h however the animals re-entered the mitigating zone during ramp up at 02:29h. Another power down was initiated until the PSOs and PAMS Operator on watch gave the all clear that the animals had left the mitigation zone at 02:38h.

The second detection occurred at 11:58h on 18th July. The detection lasted until 12:13h and was comprised of whistle, clicks and echolocation buzzes that ranged in frequency from 12 - 24 kHz. This sighting was confirmed visually at a distance of 250 m however the animals moved into the mitigation zone within 5 m of the vessel. The equipment was in operation during this time and a power down was initiated until the PSO and PAMs Operator on watch gave the all clear that the animals had left the mitigation zone and a ramp up to began at 12:13h.

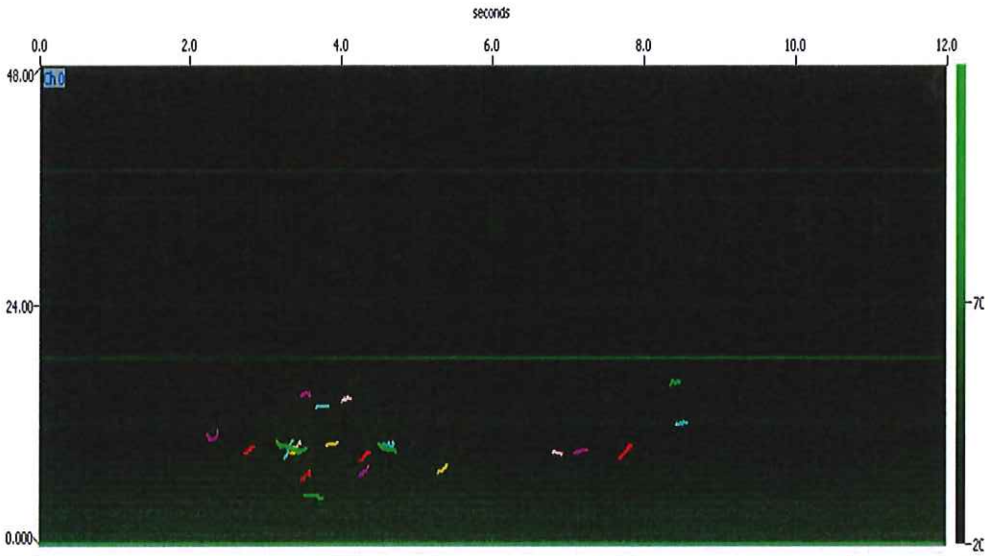

Figure 4.12 Acoustic detection of Atlantic spotted dolphins recorded on 10th July during the geophysical survey

4.7.2 *Bottlenose dolphin (Tursiops truncatus)*

There were three detections of bottlenose dolphin during the geophysical survey. On all three occasions the species identification was confirmed by the PSO on watch.

The first detection occurred at 13:46h on the 30th June and lasted for 12 minutes. The PSO on watch confirmed the identification and distance of the species at 180 m however the animals moved inside the mitigation zone to within 5 m of the vessel, a power down was initiated until the PSO and PAMS Operator on watch gave the all clear that the animals had left the mitigation zone at 13:59h, ramp up of equipment began at 14:08h.

The second detection occurred at 22:20h on the 9th July, the detection lasted for 20 minutes (Figure 4.13). The identification was confirmed by the PSO on watch and animals were sighted at 300 m, before entering the mitigation zone at 22:25h. A power down was initiated and the animals left the mitigation zone at 22:29 before re-entering at 22:45h during ramp up of equipment. The animals left the mitigation zone and 22:51h and the PSO and PAMS Operator on watch gave the all clear for ramp up procedures to begin.

The third detection occurred at 00:02h on 22nd July and lasted for 18 minutes. The detection comprised of regular whistles between 5 -18 kHz. The species was confirmed by the PSO on watch and the animals were observed entering the mitigation zone twice. The first time occurred at 00:04h during equipment ramp up, the animals left the mitigation zone at 00:08h. The animals then re-entered the mitigation zone at 00:15h during ramp up. A power down was initiated which lasted for 7 minutes, operations resumed following a ramp up after the PAMS Operator and PSO on watch gave the all clear.

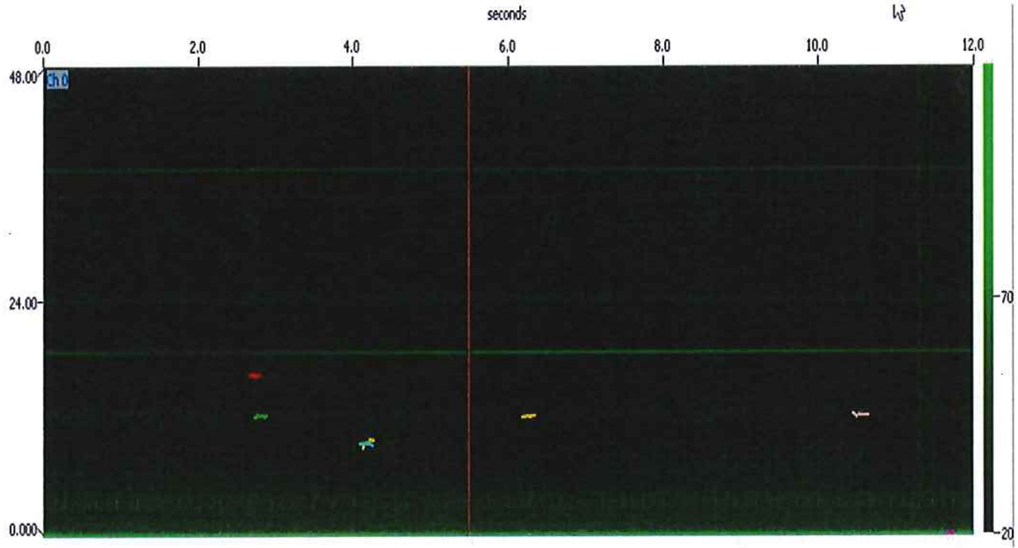

Figure 4.13 Acoustic detection of bottlenose dolphin recorded on 9th July during the geophysical survey

4.7.3 *Unidentified dolphin species*

There were five acoustic detections of unidentified dolphin species during the geophysical survey Table 4.8), these detections have been summarised in the table below. These were all during night time operations.

Table 4.8 Summary of unidentified dolphin species detections during the geophysical survey

Date	Start Time of encounter (UTC)	End time of encounter (UTC)	Number of Individuals	Distance from vessel when first sighted / m	Frequency range
01/07/15	02:52	03:07	1	500	Whistles: 5-10 kHz
12/07/15	02:04	02:10	1	1000	Whistles: 8–13 kHz
12/07/15	02:25	02:33	1	1500	Whistles: 8–13 kHz
12/07/15	04:22	04:24	1	1000	Whistles: 8–13 kHz
12/07/15	05:56	05:59	1	1500	Whistles: 8–13 kHz

4.8 *Comparison of Detection Methods*

During the geophysical survey, three different detection methods were used: PAMS was operated 24 hours a day to detect cetaceans acoustically, while reticule binoculars were used during the day to detect animals visually and at night, and night vision binoculars were used to detect animals visually during the hours of darkness.

There were 12 sightings of cetaceans (six bottlenose dolphin, four Atlantic spotted dolphin and two unidentified dolphin sp.) recorded when PAMS was deployed and four of these resulted in acoustic detections (Figure 4.14). There were also 23 sightings of cetaceans when PAMS was not deployed (due to the vessel waiting on weather or being in transit) (Figure 4.14). There was one sighting of Atlantic spotted dolphins that occurred at night with the night vision binoculars.

There were 12 sightings of loggerhead turtles, two sightings of leatherback turtle, one sighting of a probable green turtle and 14 sightings of unidentified turtle species, one of which occurred during the hours of darkness using night vision binoculars (Figure 4.15).

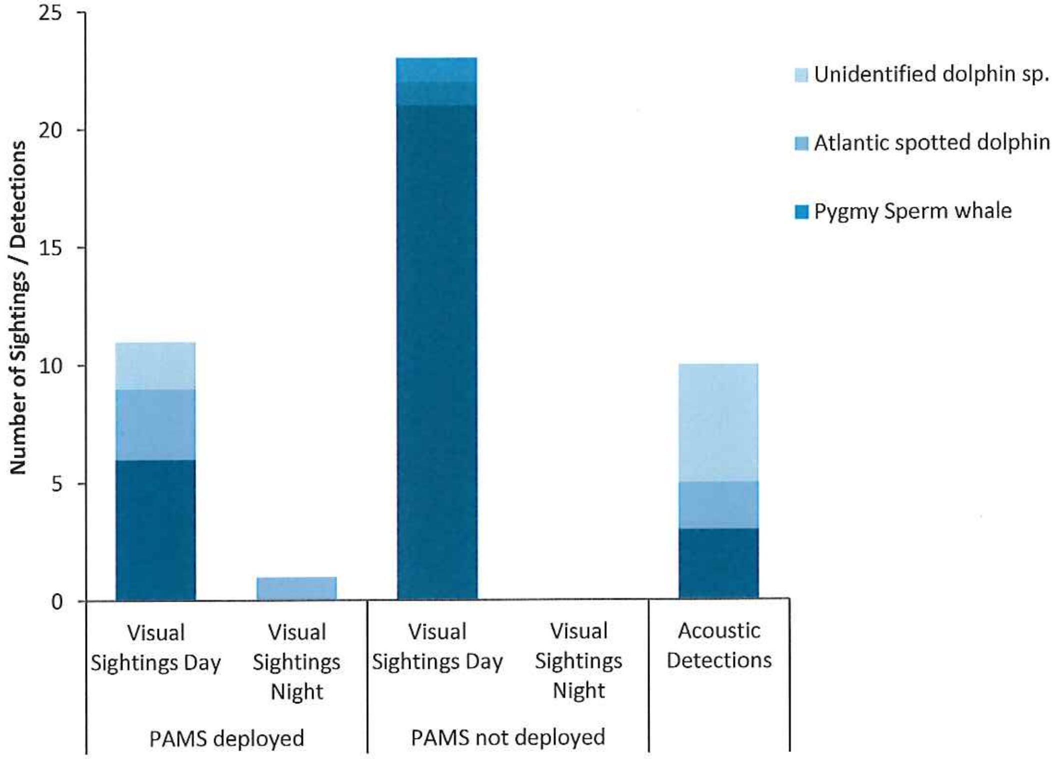

Figure 4.14 Number of visual sightings and acoustic detections of cetaceans during the geophysical survey

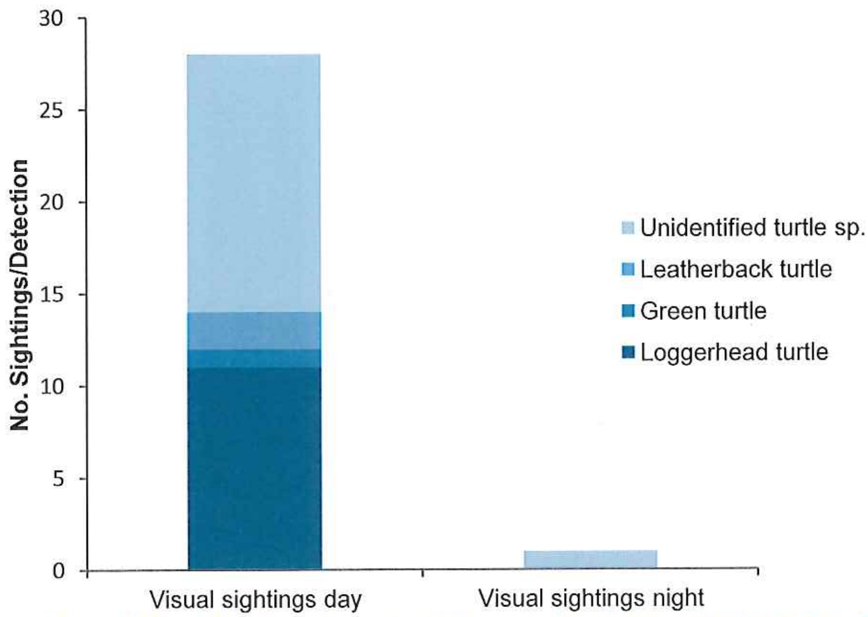

Figure 4.15 Number of visual sightings of sea turtles during both day and night during the geophysical survey

4.9 Accuracy of Distance Estimation Instruments

During the geophysical survey, the PSOs used two methods to estimate distance of animals from the vessel: reticule binoculars and range finder sticks. Both instruments were calibrated regularly against the vessel's radar with objects such as other vessels and the results were recorded in a standardised form. The minimum distance that was used for calibration was 455 m - any objects observed closer to this to the *Shearwater* were too small to be detected by radar and therefore could not be used for calibration of the visual equipment. A table recording distances can be found in Appendix E.

A comparison of the average differences in the accuracy of distance estimation showed that the range finder stick tended to be more accurate, with an average percentage error of 12.3% compared to 21.1% with the reticule binoculars out to 6000 m, and nine accurate readings. Both pieces of equipment tended to underestimate distance rather than overestimate: 23 out of 43 measurements were overestimated using the range finder, and 24 out of 50 were overestimated using the reticule binoculars.

Both pieces of equipment were more accurate at estimating closer distances with average percentage error reducing to 7.1% for reticule binoculars and 6.0% for the range finder stick at a maximum distance of 1200 m. Figure 4.16 shows the comparison of distance using reticule binoculars and range finder sticks with the ships radar up to a distance of 1200 m. Few calibrations were possible within the mitigation zone (closest distance 460 m) however the percentage errors are expected to decrease further the closer the objects are to the observer.

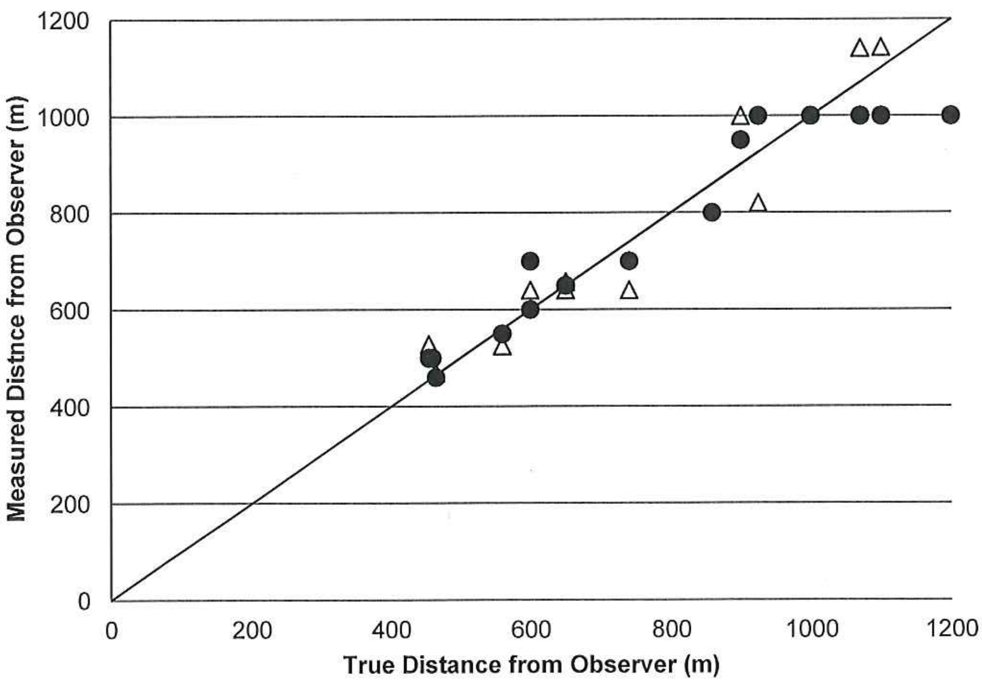

Figure 4.16 Comparison of distances using ship's radar (solid line), range finder stick (filled circles and reticule binoculars (open triangles) out to 1200 m

5. DISCUSSION

5.1 *Marine Mammal and Sea Turtle Detection*

Marine mammal and sea turtle research carried out previously within the waters of the eastern Atlantic off Maryland have recorded 24 cetacean species, two species of pinniped and four species of sea turtle occurring throughout the year (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN, 2015). While these species occur in spatially distinct areas (Kenney *et al.,* 1997; NOAA 2014; IUCN 2015), and not necessarily in the current survey area, it must be remembered that marine mammals and sea turtles are highly mobile. It was therefore anticipated that marine mammal and sea turtle encounters were possible, and as such visual and acoustic monitoring was conducted during all operations including transit to and from site.

The spatio-temporal distribution and high mobility of marine mammals and sea turtles may also have had an effect on detection. Many species of marine animal migrate at certain times of the year, primarily in relation to prey abundance and distribution, breeding opportunities and availability of space (Stern, 2002; Plotkin, 2003). In the survey area the distribution of marine mammals and turtles is seasonally variable (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015). Therefore certain species may not have been present, or present in abundance, in the area during the survey period.

Weather can affect the ability to detect marine animals in a number of ways, with increasing sea state, wind force and decreasing visibility reducing the detection probability of marine animals (Forney, 2000) particularly those with inconspicuous surfacing behaviour such as the harbour porpoise (Palka, 1996). Weather conditions recorded during marine mammal and sea turtle monitoring were good, with wind force predominantly Force 2, slight seas and low swell (<2 m), however there were a few periods when wind force reached up to Force 6, and seas were choppy. It is likely that in these conditions some species would be very difficult to see, especially sea turtles.

5.2 *Comparison of Detection Methods*

During the HRG survey between 2nd June and 25th July 2015 there were 63 sightings of marine mammals and turtles and 10 acoustic detections of vocalising marine mammals. Of the visual sightings, 61 occurred during daylight and two during night time operations. Of the acoustic detections, three occurred during daylight and seven during night time operations.

Although there were 35 visual sightings of cetaceans, compared to only 10 acoustic detections, the majority of sightings (23) occurred when PAMs was not deployed, while the vessel was waiting on weather, or during transit to or from the survey area. Of the 10 acoustic detections, five detections were confirmed visually by the PSOs, although in four of these incidences, the animals were detected acoustically first.

The majority of sightings of marine animals occurred during daylight hours, with two sightings occurring at night using the night vision binoculars.

Night vision binoculars with COTI were seen to be most effective at close distances: their effectiveness is greatest within 300 m of the observer and decreases thereafter, however the 500 m range can still be patrolled effectively and the likelihood of detecting a large baleen whale at this distance is still high.

During the hours of darkness the observer is not able to scan the horizon with the naked eye, which has the potential to narrow the field of view for the observer, however this can be taken into account and observation methods altered accordingly to ensure that the mitigation area is scanned effectively.

The levels of background and ambient light did however make a difference to the application of night vision binoculars: PSOs reported that observed distances were greatest when facing the coastline due to residual light however scanning the horizon became more difficult in the presence of bright artificial light close to the observer (e.g lights from the vessel). In addition, weather conditions and the moon phase altered visibility using the night vision binoculars.

The night vision binoculars were particularly effective when utilised in conjunction with PAMS. If a detection was heard at night, the PSO could scan around the vessel to confirm the detection and range visually. This was evident during a detection of Atlantic spotted dolphin during the hours of darkness when the dolphins were initially detected acoustically - the PAMS Operator informed the PSO, and the PSO was able to locate the animals with the night vision binoculars and confirm their range, and provide additional information such as species, and number of animals.

Weather can affect the ability to detect marine animals in a number of ways, with increasing sea state, wind force and decreasing visibility reducing the detection probability of marine animals (Forney, 2000) particularly those with inconspicuous surfacing behaviour such as the harbour porpoise (Palka, 1996). Weather conditions recorded during marine mammal and sea turtle monitoring were predominantly good. Sea states were generally slight with a low swell and good visibility during daylight hours therefore weather conditions were not likely to have significantly affected the visual detection of marine mammal or turtle species. As with daylight visual detection, poor weather conditions and high sea states have a negative effect on night vision detection ability.

The acoustic detection of marine mammals is generally not as restricted by the weather as visual observations, although the range of hydrophones is occasionally reduced during poor weather conditions due to increased levels of background noise from wave action, precipitation or swell noise. PAMS is a highly reliable technique for detecting marine mammals at night, however animals must be vocalising in order to be detected therefore it is ineffective at monitoring turtle and pinniped species which are not known to vocalise underwater. Over half of the visual sightings recorded by the PSOs were of turtles, therefore it is expected that during this survey PAMS will have a lower detection rate than visual observations.

For some species, particularly baleen whales, vocal activity may vary with season, location, behaviour and gender (Mellinger *et al.*, 2007; Boisseau *et al.*, 2008). Some species of cetacean are notoriously difficult to monitor acoustically, for example the beaked whales (Barlow & Gisner, 2006). Despite this, many species of cetacean are audible for a greater proportion of time than they are visible at the surface (Gordon *et al.*, 2003). In general PAMS has the advantage of being able to detect elusive or small mammals, like the harbour porpoise, that can often be missed by observers during unfavourable weather conditions and the hours of darkness (O'Brien, 2009).

Despite the limitations discussed, night time monitoring did result in two visual sightings and six acoustic detections. The greatest distance of the acoustic detection was at 1500m whilst the furthest visual sighting was at 265 m however night vision binoculars are effective up to 500 m especially when detecting large animals such as north Atlantic right whales. This demonstrates that both are effective at detecting animals in the mitigation zone. Using both night-vision binoculars (for non-vocalising species) and PAMS (for vocalising species) therefore provided optimal monitoring during night time hours and allowed suitable mitigation to be applied during geophysical operations.

5.3 Marine Mammal and Sea Turtle Encounters

During the survey, three confirmed species of cetacean (bottlenose dolphin, Atlantic spotted dolphin and pygmy sperm whale), two confirmed species of sea turtle (loggerhead turtle and leatherback turtle) and one probable species (green turtle) were identified. Bottlenose dolphins are the most frequently recorded dolphin species in the area while Atlantic spotted dolphin are less frequent however not uncommon. Although there are four sea turtle species that can occur in the area, loggerhead turtles are the most commonly recorded (NOAA, 2014). The sighting of a pygmy sperm whale mother and calf was the most unexpected sighting of the survey: they have been recorded along the eastern coast of North America, but sightings are rare, with most records coming from strandings (Baird *et al.*, 1994). When this species is seen at sea, it is usually recorded around the edge of continental shelves, whereas the sighting during the offshore Maryland geophysical survey occurred in a shallow water depth of 27.6 m.

During the geophysical survey, no specific avoidance behaviour by marine mammals or sea turtles was recorded by the mitigation team. Delphinid cetaceans were commonly recorded exhibiting bow-riding behaviour whilst geophysical operations were underway, whilst turtle sightings were often brief and therefore observations on animal behaviour were not possible.

5.4 Recommendations

In order to minimise the impacts on marine mammals and sea turtles the geophysical survey was run in accordance with dedicated protection species mitigation measures. The measures implemented during the survey successfully achieved a high standard of mitigation suitable for the project. The success relied on the use of experienced and dedicated observers, who were available and operational on a 24/7 basis to provide both acoustic and visual monitoring for protected species, and able to communicate effectively with the survey crew and each other.

Using a number of detection methods in conjunction with each other increases the effectiveness of detection of all animals in the area. All methods available (daylight visual, night-time visual, and acoustic) have some limitations, however using a combination of methods provides a complementary approach. It is therefore recommended that in order to enable the continued use of 24-hour geophysical survey operations for further projects in the region, the same mitigation measures as were employed during this survey are utilised. This will ensure that the risks to protected marine mammal and sea turtle species are minimised in the most cost effective manner.

Finally, it is recommended that data regarding marine mammal and sea turtle presence in an area is shared between developers, as this can assist with designing suitable mitigation measures for survey operations, particularly in areas where little information on the abundance and distribution of protected species is available.

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APPENDICES

APPENDIX A MARINE MAMMAL MITIGATION PLAN

Marine Mammal Monitoring and Mitigation Plan

US Wind Inc. (US Wind) proposes to conduct marine Geophysical and Geotechnical (G&G) surveys as required by BOEM to file a Site Assessment Plan (SAP) for offshore wind facility development on leases OCS-A 0489 and OCS-A 0490. The Project team intends to begin these site characterization studies in early-May, 2015.

US Wind submitted a formal survey plan, dated January 30, 2015, in accordance with the Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585 for these G&G activities to BOEM. In response to BOEM comments, US Wind submitted a revised survey plan on March 4, 2015. A pre-survey meeting was held at BOEM headquarters on March 11, 2015 in accordance with US Wind's lease. In response to comments received at that meeting, US Wind submitted a further revised SAP Survey Plan. This Marine Mammal Monitoring and Mitigation Plan is part of that revised plan.

DESCRIPTION OF PROPOSED G & G ACTIVITY

The G&G survey activity that will be conducted to support preparation of the SAP is described below. Additional detail can be found in the SAP Survey Plan.

High Resolution Geophysical Survey

US Wind proposes to conduct an HRG survey utilizing the following acoustic survey equipment: multi beam and single beam depth sounders, side scan sonar, and shallow penetration subbottom profiler. Medium penetration equipment will not be used, as the project will rely on existing data previously collected for the Lease Areas.[1] The equipment systems (or equivalent) proposed for use during the HRG surveys are included in Table 1 below. The HRG Survey is estimated to last approximately 47 days under 24-hour operations, not including weather or protected species down time.

Table 1. Equipment to be utilized (or equivalent) during HRG Survey

Survey Task	Sample Equipment Model Type	Frequency (kilohertz)
Multi Beam Depth Sounder	R2Sonic 2024	200 – 400 kHz
Single Beam Depth Sounder	ODOM Echotrac CVM	200 kHz
Side Scan Sonar	Klein Dual 3900	450 and 900 kHz
Shallow-penetration Subbottom Profiler (chirp)	Teledyne Benthos CHIRP III	2-7 kHz

Sound emitted by the HRG survey equipment proposed for use by US Wind is as indicated in Table 1. This proposed equipment meets industry standards and is consistent with equipment previously evaluated for acoustic impacts by BOEM and National Marine Fisheries Service (NMFS) in the PEIS[2] and for other offshore renewable energy projects.

The proposed side scan sonar equipment operates at frequencies above the hearing threshold of marine mammals (7 Hz to 180 kHz) and sea turtles (<1,600 Hz) and therefore should have no adverse impact on these protected species. Similarly, the multibeam, which will only be used at the MET tower location, will

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[1] The Maryland Energy Administration commissioned a similar geophysical survey that acquired medium penetration subbottom data throughout the Project Area and therefore this equipment will not be utilized during the upcoming field program.

[2] Bureau of Ocean Energy Management. 2014. Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement.

be operated at its highest frequencies (400 kHz) to achieve the highest resolution possible; therefore, the sounds from the multibeam will also be above the hearing threshold of the species of concern.

The single beam depth sounder and shallow-penetration subbottom profiler (chirp) emit sound within the hearing threshold of marine mammals. However, during pre-construction surveys conducted for the Cape Wind Energy Project[3], field testing performed by JASCO Applied Sciences to determine sound pressure levels (SPL) showed that neither the single beam nor the subbottom profiler exceeded 180 dB harassment threshold for protected species, and that the distance to the 160 dB isopleth was 2m and 10m, respectively. Again, no higher impact medium penetration survey equipment is proposed for the US Wind HRG survey.

Geotechnical Survey

Following the completion of the HRG survey, a geotechnical program will be conducted. Approximately twelve sampling locations are proposed across the Project Area. These will be sampled using a combination a cone penetrometer and soil boring equipment. The Geotechnical sampling activities are estimated to take approximately 20 days to complete under 24-hour operations, not including weather or protected species down time.

EXCLUSION ZONES AND ALTERNATIVE MONITORING PLAN

As requested by BOEM, US Wind will staff and equip the SAP survey team to provide both 24-hour Passive Acoustic Monitoring System (PAMS) observations and 24-hour visual observations. The exclusion zones for G&G survey activities will be monitored by qualified Protected Species Observers (PSOs) and PAMS operators and all applicable conditions and procedures contained in the lease (e.g. clearance before start up, ramp up, shut down, etc.) will be implemented.

In order to continue operations at night or during periods of impaired visibility, US Wind will implement additional mitigation measures agreed upon by BOEM and US Wind. These will include supplemental monitoring technologies, as described below, to detect the presence of protected species.

Passive Acoustic Monitoring System

US Wind is teaming with Alpine Ocean Seismic Survey and its parent company Gardline to operate the PAMS system during the G&G program. Gardline has been providing underwater acoustic monitoring and mitigation services to the offshore energy industry since 2002. For US Wind, the HRG survey team will use a towed system specifically designed around the survey vessel specifications provided in Appendix B of the SAP Survey Plan.

The PAMS system will be operated 24 hours per day during the survey to provide a range and bearing to any marine mammals in the vicinity of the survey vessel. Visual observations will be conducted to confirm protected species sightings. US Wind will engage multiple PAMS operators onboard allowing relief to prevent fatigue (see below).

Visual Observers

For night time operations, visual observers will use high performance night vision goggles, i.e., PVS-7-3AG. Observers will also test clip-on thermal imaging (COTI) technology, the specifications for which were provided by BOEM. Due to the potential for reflectivity from bridge windows that could interfere with the use of the night vision optics, PSOs will be required to make night time observations from a platform with no visual barriers.

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[3] http://www.nmfs.noaa.gov/pr/pdfs/permits/capewind_iha_application_renewal.pdf

Gardline will employ standard techniques to calibrate the visual observation equipment. This will include observations of known objects at set distances and under various lighting conditions. This calibration will be performed during mobilization and periodically throughout the survey operation.

Observers will document their sighting results throughout survey operations in accordance with Addendum C, Appendix B of the Lease. Where applicable, a notation will be included regarding the type(s) of equipment in use during the observations.

Protected Species Monitoring Logistics

To provide MMO/PAMS coverage 24-hours a day for the SAP survey, 4 professionals, each of whom is both a certified PSO and an experienced PAMS operator will be required. Two certified PSO professionals who are also trained PAMS operators will work simultaneously on each watch - one on PAMS, the other on visual - on an alternating basis during both day time and night time operations. All of these professionals will have effective training and experience with using night vision optics. These personnel would do no more than 4 hours at each monitoring station (visual or acoustic) and after 4 hours of one discipline would change to another, i.e. change from visually monitoring the sea with binoculars to monitoring the PAMS laptops. Each operator will have a 12 hour break during each 24 hour period. Vessel crews will be available to cover short breaks in PSO coverage to allow the mitigation team to have sufficient meals and rest room breaks. Gardline will ensure that all vessel crew have a short training session prior to or during mobilization to enable them to cover the PSO duties for these short periods. This 4-person staffing program is consistent with berthing available on the survey vessels.

Protected Species Monitoring/Night Time Operations Mitigation Summary

- US Wind will ensure that no night time operations take place without both night vision and PAM systems being fully operational. Redundancy planning will be implemented to achieve this coverage for 24 hour operations.
- PSOs will be required to make night time observations from a platform with no visual barriers.
- The separation distance of 500 m for North Atlantic right whales, 100 m separation distance for all non-delphinoid species and the 50 m separation distance for delphinoid and sea turtle species, as well as the 200 m exclusion zone during G&G surveys operating below 200 kHz, will be ensured and monitored by vessel operators, vessel crew and PSOs, in accordance with the standard operating conditions of the leases.
- Two certified PSO professionals who are also trained PAMS operators will work simultaneously on each watch - one on PAMS, the other on visual - on an alternating basis during both day time and night time operations. All of these professionals will have effective training and experience with using night vision optics.
- Shut down or delaying operations will occur to maintain required exclusion zones when low frequency vocalizations are detected but are not possible to be localized on with the PAMS.
- A spectrum of frequencies will be analyzed in the empirical acoustic data collected by US Wind in order to cover vessel noise, biological noise and HRG equipment noise (i.e., 50, 100, 200, 500 Hz and 1, 2, 5, 7, 10, 20, 50, 100 and 150 kHz). A sub sample of acoustic, and corresponding visual observation, data will be provided to BOEM within 3 weeks after the commencement of HRG surveys.
- All vessel operators will be required to monitor the NMFS North Atlantic right whale reporting systems (e.g., the Early Warning System, Sighting Advisory System, and Mandatory Ship Reporting System for the presence of North Atlantic right whales during HRG survey operations.

- Boring operations will be initiated during daytime and night vision optics will be used at night by PSOs throughout the operation to monitor the 200 m exclusion zone for protected species.
- US Wind will conduct a comparative assessment of protected species detection using PAM and visual monitoring during day and night time operations, including calibration exercises. The assessment and subsequent final report will be submitted to BOEM 30 days after the surveys are completed.

Protected Species Detection Comparison Report

US Wind will provide BOEM with a post-survey report that will include presentation, analysis, and discussion of the marine mammal detections and methods during the survey. This report will also include an assessment of the methods of detection, equipment, and recommendations.

Noise Assessment

To assess the operational sound signature produced by the survey vessel *Shearwater*, a sound assessment will be conducted. This assessment involves a two-step process:

1. A background noise measurement will be taken while the vessel is dead in the water (or as practicably as possible due to safety) with the towed PAMS cable deployed to collect .wav file data recordings for 30 minutes. Recordings do not need to be for 30 minutes continuously.

2. A vessel noise assessment will be taken with the towed PAMS cable deployed while the vessel is operating at normal survey speed(s) to collect .wav file data recordings for 30 minutes. Recordings do not need to be continuous.

Both sets of vessel noise assessments will be taken at multiple locations to cover variations in site conditions e.g. water depth, bottom conditions, etc. The acoustic signature will also be measured at various vessel RPMs over these site conditions. US Wind will also collect representative baseline and vessel signature data for the geotechnical vessel.

Once data is collected, an underwater noise analysis will be performed using Matlab. In this process, the noise level recorded from the vessel operation will be extracted from the acoustic data in terms of sound pressure level and then compared to the background noise level. This will provide an approximation of the vessel noise level without the contribution of any ambient noise. An acoustic spectrogram will be computed to visualize the vessel's acoustic signature. This will provide the relative received noise levels from the vessel at the hydrophone under various site conditions. US Wind expects to be able to provide preliminary acoustic data from the *Shearwater* to BOEM within two weeks after the start of the survey program. This timeframe should be sufficient to allow for the transfer of data from the offshore survey area to shore plus 7-10 days for processing once the data is received.

POTENTIAL IMPACT TO PROTECTED SPECIES

The US Wind Lease includes specific terms, conditions, and stipulations (Addendum C) that apply to the site characterization studies proposed by US Wind and its team of subcontractors. US Wind understands that these lease conditions, which include exclusion zones for G&G activities and limit nighttime and low visibility activities, were developed as a result of extensive environmental analysis by BOEM and the National Marine Fisheries Service[4]. However, with the monitoring and mitigation proposed by US Wind in

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[4] Bureau of Ocean Energy Management. 2014. Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement.

National Marine Fisheries Service. 2013. Biological Opinion.

Bureau of Ocean Energy Management. 2012. Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Biological Assessment.

this plane, 24-hour G&G survey operations can proceed in a manner that will maintain compliance with exclusion zones as specified in the Lease.

In addition, while protected species may be present in the project vicinity during the G&G activities, the Lease Area is not considered critical habitat to any Endangered Species Act (ESA)-listed whale species and the closest Right Whale Seasonal Management Area is located several nautical miles to the north of the Lease Area. Similarly, none of the ESA-listed sea turtles, have critical habitats within the Lease Area and Maryland does not have any primary turtle nesting sites or any reported turtle nesting sites (PEIS). All vessel operators will be required to monitor the NMFS North Atlantic right whale reporting systems (e.g., the Early Warning System, Sighting Advisory System, and Mandatory Ship Reporting System for the presence of North Atlantic right whales during HRG survey operations.

For those animals that are in the vicinity of the Lease Area during survey activities, the use of PAMS and night vision goggles should provide sufficient supplemental information for trained observers to detect the presence of protected species so that exclusion zones can be maintained and applicable operating procedures regarding avoidance, reduction in survey activity, shutdown and ramp up can be implemented as required.

In addition, for the HRG survey activities, the 200m exclusion zone specified to mitigate sound impacts is highly conservative relative to the low-impact types of equipment proposed for the US Wind Survey. Based on operational data collected by JASCO as cited above, the US Wind team estimates that the approximate distance to the 160 dB Level B harassment threshold during the HRG survey will be only 10 meters from the chirp and 2 meters from the single beam. The use of the proposed equipment, combined with the use of PAMS and night vision goggles should ensure that protected species are not exposed to level A or level B harassment sound levels from this activity. US Wind is confident that following BOEM's required monitoring and mitigation measures will ensure that no marine mammals or sea turtles will be harassed during the survey program, and therefore, US Wind does not intend to request Incidental Harassment Authorization from NMFS.

APPENDIX B INJURED OR DEAD PROTECTED SPECIES INCIDENT REPORTS

INCIDENT REPORT: PROTECTED SPECIES INJURY OR MORTALITY

Photographs and/or video footage should be taken of all injured or dead animals, if possible

Observer's full name and/or Reporter's full name: Sam Tufano / Sharon Doake
Date and Time animal observed: 14/06/2015 at 15:58 UTC
Date and Time animal/samples collected: N/A
Location of Incident (Latitude/Longitude): 38 19.24 N / 74 49.36 W
Species Identification (closest taxonomic level possible): Unidentified turtle species
Photograph/Video footage collected: **YES**/NO
If Yes, was the data provided to NMFS? **YES**/NO

Name of vessel, vessel speed at the times of incident, and activity ongoing at the time of observation (e.g. transit, survey, pile driving):
Sighted from the R.V. Shearwater, doing 4 knots while undertaking a geophysical survey in the area, the vessel was on line at the time. (Survey lease number OCS-A 0489)

Environmental conditions at time of observation (i.e. Beaufort sea state, cloud cover, wind speed, glare):
Wind south, Force 2, Sea state 1, cloud cover 0, glare – strong forward

Water temperature (°C) and depth at site of observation:
Depth 23m, Water temperature unknown

Describe location of animal and events leading up to, including, and after, the incident:
During a geophysical survey, a PSO onboard the vessel saw a dead turtle float past at about 100 m away while the vessel was running a line. The turtle was floating belly up and a number of seabirds were pecking at it, it appeared to have been dead for awhile, estimated at least a week.

Status of all sound-source use in the 24 hours preceding the incident:
In the past 24 hours the vessel has been on site collecting data, using analogue equipment such as side scan sonar, sub-bottom profiler and single beam depth sounder to map the seabed.

Describe all marine mammal, sea turtle, and sturgeon observations in the 24 hours preceding the incident:
In the past 24 hours a turtle of unknown species was sighted at 16:04 (UTC) on 13th June while the vessel was running a line. It was seen floating at the surface with its head up, about 20 m from the vessel and according to procedures documented in the lease for the survey, the analogue equipment was shut down for 60 mins before eamp up porcedures were followed.

Protected species Information:
Injuries observed: Dead
Condition/description of animal: turtle was belly up, brown/white shell. The flippers appeared to be absent and there may have been what look like shark bites to the shell, this could have occurred before or after death. It was in a good state of decompostion and had been dead for awhile.

Other remarks: –

–

Date and time of incident reported to NMFS Stranding Hotline: –

Sea Turtle Species Information (*Please designate cm/m or inches*):

Weight (kg or lbs):

Sex (circle): MALE FEMALE UNKNOWN How was sex determined?

Straight carapace length: Straight carapace width:

Curved carapace length: Curved carapace width:

Plastron length: Plastron width:

Tail length: Head width:

Condition of specimen/description of animal:

Existing Flipper Tag Information:

Left: Right:

PIT Tag #:

Miscellaneous:

Genetic biopsy taken: YES / NO

Photos taken: YES / NO

Turtle Release Information

Date: Time:

Latitude: Longitude:

State: County:

Remarks: (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propeller damage, papillomas, old tag locations, etc.):

INCIDENT REPORT: PROTECTED SPECIES INJURY OR MORTALITY

Photographs and/or video footage should be taken of all injured or dead animals, if possible

Observer's full name and/or Reporter's full name: Teresa Martin / Sharon Doake
Date and Time animal observed: 11/07/15 seen at 20:20 and 20:38 UTC
Date and Time animal/samples collected: N/A
Location of Incident (Latitude/Longitude): 38°18.05 N / 74°47.95 W and 38°18.42 N / 74°47.89 W
Species Identification (closest taxonomic level possible): Unidentified turtle species
Photograph/Video footage collected: **YES**/NO
If Yes, was the data provided to NMFS? **YES**/NO

Name of vessel, vessel speed at the times of incident, and activity ongoing at the time of observation (e.g. transit, survey, pile driving):
Sighted from the R.V. Shearwater, doing 4 knots while undertaking a geophysical survey in the area, the vessel was on line at the time. (Survey lease number OCS-A 0489)

Environmental conditions at time of observation (i.e. Beaufort sea state, cloud cover, wind speed, glare):
Wind south, Force 2, Sea state 1, cloud cover 3, glare – strong forward

Water temperature (°C) and depth at site of observation:
Depth 23.7m, Water temperature unknown

Describe location of animal and events leading up to, including, and after, the incident:
During a geophysical survey, a PSO onboard the vessel initially saw a dead turtle float past at 20:20 UTC, about 600 m away while the vessel was running a line. The turtle was floating belly up and a fewstorm petrels were pecking at it. Then the vessel turned around and headed back the same way and the PSO saw presumably the same dead turtle in roughly the same location at 20:38. about 1000 m from the vessel.

Status of all sound-source use in the 24 hours preceding the incident:
In the past 24 hours the vessel has been on site collecting data, using analogue equipment such as side scan sonar, sub-bottom profiler and single beam depth sounder to characterise the seabed.

Describe all marine mammal, sea turtle, and sturgeon observations in the 24 hours preceding the incident:
In the past 24 hours no marine mammals, sea turtles or sturgeon were sighted

Protected species Information:
Injuries observed: Dead
Condition/description of animal: turtle was belly up, brown/yellow/green shell. It appeared to be moderately decomposed(likely deceased several days, signs of bloating and muscular breakdown). The PSO reported seeing fishing line entangled around the carcass although this is not evident in the pictures.

Other remarks: –

–

Date and time of incident reported to NMFS Stranding Hotline: –

Sea Turtle Species Information (*Please designate cm/m or inches*):
Weight (kg or lbs):
Sex (circle): MALE FEMALE UNKNOWN How was sex determined?
Straight carapace length: Straight carapace width:
Curved carapace length: Curved carapace width:
Plastron length: Plastron width:
Tail length: Head width:
Condition of specimen/description of animal:

Existing Flipper Tag Information:
Left: Right:
PIT Tag #:
Miscellaneous:
Genetic biopsy taken: YES / NO
Photos taken: YES / NO
Turtle Release Information
Date: Time:
Latitude: Longitude:
State: County:

Remarks: (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propeller damage, papillomas, old tag locations, etc.):

Gardline

APPENDIX C COMPLETED JNCC RECORDING FORMS

The completed JNCC forms can be found in the Excel document entitled 10505_US Wind_Shearwater_MMOforms

APPENDIX D BEAUFORT WIND, SEA CONDITIONS AND VISIBILITY

WIND SPEED

Beaufort Scale	Name	Knots	Metres/second
0	Calm	0 - 1	0 - 0.2
1	Light air	1 - 3	0.3 - 1.5
2	Light breeze	4 - 6	1.6 - 3.3
3	Gentle breeze	7 - 10	3.4 - 5.4
4	Moderate breeze	11 - 16	5.5 - 7.9
5	Fresh breeze	17 - 21	8.0 - 10.7
6	Strong breeze	22 - 27	10.8 - 13.8
7	Near gale	28 - 33	13.9 - 17.1
8	Gale	34 - 40	17.2 - 20.7
9	Strong gale	41 - 47	20.8 - 24.4
10	Storm	48 - 55	24.5 - 28.4
11	Violent storm	56 - 63	28.5 - 32.6
12	Hurricane	64+	32.7+

SEA STATE

Symbol	Name	Height in metres
0	Calm (glassy)	0
1	Calm (rippled)	0 – 0.10
2	Smooth (wavelets)	0.10 – 0.50
3	Slight	0.50 – 1.25
4	Moderate	1.25 – 2.50
5	Rough	2.50 – 4.00
6	Very rough	4.00 – 6.00
7	High	6.00 – 9.00
8	Very high	9.00 – 14.00
9	Phenomenal	14.00+

VISIBILITY

Name	Visibility (nautical miles)
Fog or dense snow fall	Less than 0.5
Poor visibility	0.5 – 2.0
Moderate visibility	2.0 – 5.0
Good visibility	5.0 – 25.0
Very good visibility	More than 25.0

Gardline

APPENDIX E MONITORING EQUIPMENT CALIBRATION FORMS

Calibration For Distance Estimation								
Week #	Date	Name of Observer	Reticule Binoculars Distance (m)	Range Finder Distance (m)	Distance provided by the system onboard	Sea state (Beaufort Scale)	Wind force (Beaufort Scale)	Swell (m)
1	06/06/2015	J. Allum	1140	1000	1070	1	1	1
1	06/06/2015	S. Doake	1147	n/a	1270	1	1	1
1	06/06/2015	S. Doake	n/a	2000	2960	1	1	1
1	07/06/2015	S. Doake	n/a	1000	1000	2	3	1
1	07/06/2015	S. Doake	1906	n/a	4310	3	3	2
1	07/06/2015	T. Martin	1898	2500	1560	3	3	2
1	08/06/2015	J. Allum	640	1000	1295	3	3	2
2	10/06/2015	S. Tufano	1147	1000	1295	3	3	2
2	10/06/2015	T. Martin	1898	n/a	5550	1	1	1
2	10/06/2015	T. Martin	n/a	2400	2300	1	1	1
2	11/06/2015	T. Martin	n/a	500	460	3	3	1
2	11/06/2015	S. Doake	1147	1500	1850	4	4	1
2	11/06/2015	T. Martin	1142	1300	1350	4	4	1
2	11/06/2015	S. Doake	1147	1560	1700	2	2	1
2	13/06/2015	S. Doake	824	1000	1500	2	2	1
2	13/06/2015	J. Allum	1140	1200	1850	1	2	0.5
2	13/06/2015	T. Martin	1898	2300	2270	1	2	0.5
2	14/06/2015	T. Martin	820	1000	925	2	3	0.5
2	14/06/2015	S. Doake	n/a	800	859	2	3	0.5
2	15/06/2015	T. Martin	1898	1900	1850	2	3	0.5
2	16/06/2015	R. Counihan	2500	2000	2300	2	2	0.5
2	16/06/2015	R. Counihan	5000	5000	5550	2	2	0.5
2	17/06/2015	J. Allum	640	700	740	3	4	1
2	17/06/2015	T. Martin	n/a	1850	1850	3	4	1
2	19/06/2015	R. Counihan	1000	950	900	2	2	1
3	24/06/2015	T. Martin	1898	2450	2400	2	1	0.5
3	25/06/2015	S. Doake	824	1500	1700	2	2	1
3	25/06/2015	T. Martin	657	650	650	1	2	0.5
4	30/06/2015	T. Martin	640	650	650	3	3	0.5
4	02/07/2015	J. Allum	640	700	600	3	3	0.5
4	03/07/2015	T. Martin	1682	1875	1850	2	1	0.25
4	03/07/2015	S. Doake	1147	1500	1500	2	2	0.5

4	03/07/2015	T. Martin	1142	1700	1600	2	2	0.5
4	03/07/2015	S. Doake	528	500	455	2	2	0.25
5	05/07/2015	S. Tufano	1147	2000	1500	3	2	0.5
5	05/07/2015	T. Martin	469	460	465	2	1	0.25
6	06/07/2015	S. Tufano	1147	1500	1500	2	2	0.25
6	08/07/2015	T. Martin	525	550	560	4	4	0.5
6	09/07/2015	T. Martin	640	600	600	2	1	0.25
6	11/07/2015	T. Martin	n/a	n/a	1820	2	1	0.25
6	13/07/2015	S. Doake	1906	3000	2730	1	1	0.25
7	15/07/2015	S. Tufano	1800	2000	2000	2	3	0.5
7	15/07/2015	L. Slater	1800	2000	2000	2	3	0.5
7	17/07/2015	T. Martin	1898	2000	2180	2	3	0.5
7	18/07/2015	S. Tufano	n/a	n/a	3300	2	2	0.5
7	18/07/2015	L. Slater	n/a	2500	1800	2	3	0.5
7	18/07/2015	L. Slater	n/a	4500	5000	2	2	0.5
7	18/07/2015	S. Doake	n/a	1000	1200	2	2	0.5
7	18/07/2015	L. Slater	n/a	1000	1000	2	2	0.5
7	19/07/2015	S. Tufano	n/a	n/a	3000	2	2	0.5
7	19/07/2015	L. Slater	1850	2000	2400	2	2	0.5
7	19/07/2015	R. Lee	1300	2000	1420	2	2	0.5
7	20/07/2015	R. Lee	1940	2000	2500	2	2	0.3
7	20/07/2015	S. Tufano	n/a	2000	2500	2	2	0.3
7	20/07/2015	T. Martin	1142	1000	1100	2	2	0.25
8	21/07/2015	T. Martin	1142	1250	1230	2	2	0.5

APPENDIX F PASSIVE ACOUSTIC MONITORING SYSTEM SPECIFICATIONS

General	
Manufacturer	Gardline Environmental Ltd
Model	MK4
Towed streamer section	
Length	N/A integrated into tow cable
Section diameter	14mm over cable, 24mm over mouldings
Number of Hydrophones	6
Hydrophone type	Custom built by Gardline Environmental Limited 3 low frequency, 3 broadband
Receive sensitivity (dB re 1 V/µPa)	-204
Hydrophone separation	Hydrophone 1 and 2 1.2m Hydrophone 2 and 3 1.2m Hydrophone 3 and 4 1.2m Hydrophone 4 and 5 3.15m Hydrophone 5 and 6 6.75m
Preamplifiers	6 broadband
Preamplifier type	Sensor Technology SA-03
Depth sensor manufacturer	SensorTechnics
Tow cable	
Length	250 m
Diameter	14 mm
Termination	37 pin CEEP Connectors
Deck cable	
Length	100 m
Diameter	14 mm
Termination	37 pin CEEP Connectors

APPENDIX G SPECIES DESCRIPTIONS

Common Bottlenose Dolphin (Tursiops truncatus)

The common bottlenose dolphin is widely-distributed occurring in coastal and continental shelf waters of tropical and temperate regions. Although population density appears higher in near-shore areas, there are also pelagic populations (Culik, 2011). The common bottlenose dolphin is a large, robust dolphin, with a moderate stocky beak sharply demarcated from the melon. The dorsal fin is tall and falcate, set near the middle of the back. Colour varies from light grey to nearly black on back and sides fading to white on the belly. There is however extensive geographical variation in size, shape, appendages and colouration of this species, and confusion remains as to its taxonomy. In many areas markedly differentiated inshore and offshore populations occur in close proximity (Jefferson et al., 2008). Common bottlenose dolphins range in size from 1.9 to 4.1 m, and weigh between 150 and 650 kg (Shirihai & Jarrett, 2006). The species is found in a range of habitats, from rocky reefs, to calm lagoons and open waters. They are generalist feeders, preying on a wide variety of prey, mostly fish and squid, and are known to feed cooperatively (Jefferson et al., 2008). Group size is commonly between two and 15 animals, although they can be encountered individually and in groups of several hundred to thousands offshore. They commonly associate with other species of cetacean, although some interactions are reported to be aggressive (Culik, 2011). Based on regional population estimates, the world-wide population is estimated to be a minimum 600,000 (Hammond et al., 2012). The species is listed as 'Least Concern' on the IUCN Red List (IUCN, 2015).

Atlantic Spotted Dolphin (Stenella frontalis)

Atlantic spotted dolphins are distributed in the tropical and warm temperate waters of the Atlantic Ocean, where they primarily occur in continental shelf (<200 m) and continental slope (200-2000 m) waters. Some populations are known to inhabit shallow, coastal waters or deep, oceanic waters (Culik, 2011). Atlantic spotted dolphins have a moderately long, stocky beak and fairly robust body, with a tall, falcate dorsal fin. Juveniles are unspotted, with spots developing with age, although there is much variation in the amount of spotting and adults in some offshore populations remain unspotted. Colouration otherwise is generally light grey sides, dark dorsal cape and white belly. There is also a distinct spinal blaze, which sweeps up into the dorsal cape (Jefferson et al., 2008). Adults range between 1.6 and 2.3 m and weigh between 100 and 143 kg (Shirihai & Jarrett, 2006). Group size tends to be small to moderate, generally less than 50 individuals, with coastal groups tending to be smaller with five to 15 individuals. Groups are often segregated by sex and age, with studies indicating a very fluid social structure (Jefferson et al., 2008). Atlantic spotted dolphins are generalist feeders, taking a variety of epi- and mesopelagic fish and squid and have been reported to feed using coordinated feeding techniques (Culik, 2011). Fast swimmers, Atlantic spotted dolphins are known to breach frequently and often approach to bow-ride vessels (Shirihai & Jarrett, 2006). No global population estimate exists and although the species is widespread it is listed as 'Data Deficient' on the IUCN Red List (IUCN, 2015).

Pygmy Sperm Whale (Kogia breviceps)

Pygmy sperm whales are widely distributed in tropical and temperate seas, and are usually encountered in waters off the continental shelf (Culik, 2011). This is a small, inconspicuous animal that rarely shows demonstrative behaviour making it hard to spot, as a result is rarely recorded alive at sea, but is one of the most frequently stranded odontocetes in certain parts of the world (Shirihai & Jarrett, 2006). This species has a blunt head with a narrow underslung lower jaw. The overall body is counter shaded and can vary between dark to light grey across the spine, typically with a pinkish tone on the underside. There is a light coloured bracket shape that runs from the eyes to the pectoral fins (dubbed the "false gill"), although variability among the cheek and eye markings make the false gill possibly less prominent. The overall body length is 2.7 m to 3.4 m and adults may weigh up to 450 kg (Jefferson et al., 2008; Shirihai & Jarrett, 2006). The dorsal fin is hooked shaped and set low along the spine, it is the primary characteristic that visually differentiates the pygmy and dwarf sperm whale (Kogia sima). The diet of pygmy sperm whales is primarily comprised of deep-

water cephalopods, with stomach content analysis showing that they also occasionally feed on fish and crustacean species (Santos et al., 2006). Group size is usually small, ranging from single individuals up to groups of 10 (McAlpine, 2009). There are no global estimates of abundance with population trends unknown and the species is listed as 'Data Deficient' on the IUCN Red List (IUCN, 2015).

Green Turtle (Chelonia mydas)

Green turtles are widely distributed throughout tropical and subtropical waters, near continental coasts and around islands. They usually remain within the 20°C isotherms and follow seasonal latitudinal changes in these limits, although they are occasionally reported in temperate waters (Márquez, 1990). The green turtle has a slightly depressed oval shaped, smooth carapace which ranges in colour from shades of black, grey, green, brown and yellow (NOAA, 2012). Records of maximum size are of 139.5 cm and 235 kg, with males generally smaller than females (Márquez, 1990). Green turtles are highly migratory, using a range of habitats during their lifecycle. On leaving the nesting beach, hatchlings begin an oceanic phase (Carr, 1987) floating passively in major current systems which serve as open-ocean development grounds. Once the turtles reach 30 to 40 cm in length they settle in neritic developmental areas rich in seagrass and or marine algae, such as tropical tidal and sub-tidal coral and rocky reefs. Here they forage and remain until maturity (Musick & Limpus, 1997), when then commence breeding migrations between foraging grounds and nesting areas, often traversing oceanic zones, every few years. Nesting occurs in over 80 countries worldwide (Hirth, 1997). During non-breeding periods adults remain at coastal neritic feedings areas that may coincide with juvenile development habitats. There is substantial variability in the proportion of the population that nests in any given year (Seminoff, 2004). Analysis of subpopulation changes indicates a 48% to 67% decline in the number of mature females nesting annually as a result of over exploitation of eggs and adult females at nesting sites, juveniles and adults in foraging areas and to a lesser extent Incidental mortality relating to marine fisheries and degradation of habitat (Seminoff, 2004). The species is listed under Appendix I of the Convention on International Trade in Endangered Fauna and Flora (CITES) and under Appendix II of the Convention on Migratory Species (CMS). It is listed as 'Endangered' on the IUCN Red List (IUCN, 2015).

Loggerhead Turtle (Caretta caretta)

Loggerhead turtles are widely distributed in coastal tropical and subtropical waters ranging between 16 and 20°C, although it is also commonly recorded in temperate waters at the boundaries of warm currents (Márquez, 1990). The heart-shaped carapace is reddish brown in colour. Adults reach between 82 and 105.3 cm, with a mean weight of approximately 75 kg (Márquez, 1990). The species is distinguished by its large head and strong jaws. Adult loggerhead turtles are known to undertake long distance migrations between nesting beaches and foraging grounds (Polovina et al., 2004; Nichols et al., 2000). Loggerhead hatchlings and juveniles are frequently associated with sea fronts, down-wellings and eddies where they feed on epipelagic animals. Between 7 and 12 years old juveniles migrate from oceanic habitats to neritic zones to continue maturing until adulthood. The neritic zone also provides crucial foraging, inter-nesting and migratory habitat for adult loggerheads (NOAA, 2012). Recent reviews indicate only two loggerhead nesting aggregations have more than 10,000 females nesting annually. Intermediate sized nesting aggregations occur in the US, Mexico, Brazil, the Cape Verde Islands and Western Australia (US Fish & Wildlife, 2012). The primary threat to loggerhead populations is incidental capture in marine fisheries gear (NOAA, 2012). The species is listed under Appendix I CITES and under Appendices I and II of the CMS, and is listed as 'Endangered' on the IUCN Red List (IUCN, 2015).

Leatherback Turtle (Dermochelys coriacea)

The leatherback turtle is the largest marine turtle, with the largest specimen recorded at 256.5 cm (Márquez, 1990). The body is large and spindle shaped, with a leathery, unscaled carapace. The colour is essentially black with scattered white patches (Márquez, 1990). Adult leatherbacks are adapted to colder water due to their protective thick and oily skin. Therefore the species is more widely distributed, with numerous records from higher latitudes in waters between 10°C and 20°C (Márquez, 1990). Leatherback turtles nest on sandy beaches in tropical waters, with hatchlings remaining in warm tropical coastal waters until they are more than

100 cm in length. As adults leatherbacks are pelagic, ranging widely in the open ocean although they will often forage in coastal habitats also (Sarti Martinez, 2000; NOAA, 2012). Leatherbacks are carnivorous, feeding on jellyfish and other soft-bodied animals. They are the deepest diving reptile, reaching depths of over 1200 m (Spotila, 2004) although in temperate regions dives tend to be shallower (McMahon & Hays, 2006; James et al., 2006). Global population size was estimated to be between 20,000 and 30,000 adult females in 1996, an estimated 78% reduction compared to previous estimations in 1982 (Sarti Martinez, 2000). The largest nesting populations are found within the eastern and western Atlantic and the Caribbean (Spotila et al., 1996). The species is listed under Appendix I of both CITES and CMS, and are listed as 'Vulnerable' on the IUCN Red List (IUCN, 2015).

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Gardline

Alpine Ocean Seismic Survey Inc on behalf of
US Wind Inc

Project:
PSO Report – *M.V. Ocean Discovery* for US Wind Maryland

Description:
Protected Species Observer Report

Survey Dates:
16th June to 9th July 2015

Project Number:
10505

Lease Reference Number
OCS-A-0489 & OCS-A-0490

REPORT AUTHORISATION AND DISTRIBUTION

Protected Species Observers / Passive Acoustic Monitoring Operators	Marine Wildlife Department	L. Buckland G. Duguid C. Gilchrist G. James R. Price
Compilation	Marine Wildlife Department	G. Duguid G. James R. Price
Q.C.	Marine Wildlife Department	S. Ponting
Authorisation	Marine Wildlife Department	N. Robinson

Revision	Date	Title
1	19th November 2015	Draft

Distribution

One copy to

Alpine Ocean Seismic Survey Inc.
155 Hudson Avenue
Norwood, NJ, 07648

For attention of

Justin Bailey
jbailey@alpineoceon.com

EXECUTIVE SUMMARY

- Monitoring for marine mammals and sea turtles occurred during a geotechnical survey on the Maryland Wind Energy site, offshore Maryland, USA. This survey was conducted onboard the *M.V. Ocean Discovery* from 16th June to 9th July 2015.

- Weather conditions recorded during marine mammal and sea turtle monitoring were mostly good, but occasionally moderate. The sea state was mostly slight, with a predominantly low swell, and good visibility. Beaufort wind force was variable between Force 0 and 7 with Force 4 occurring most frequently and from a general southerly direction.

- The survey was run in accordance with the mitigation requirements stipulated in the lease (OSC-A-0489 & A-0490) and mitigation plan submitted to the Bureau of Ocean Energy Management (BOEM). Mitigation measures covered mitigation for vessel strike avoidance and for the avoidance of disturbance and harm from geotechnical activities.

- Watches for marine mammals and sea turtles occurred 19 days of the survey and resulted in 405 hours and 36 minutes of observer effort and 16 observations.

- During the survey, there were six encounters of delphinids including one sighting of a dead unidentified dolphin and ten sightings of marine turtle. There were no encounters of north Atlantic right whales or pinnipeds. A total two sightings were recorded during the hours of darkness using night vision binoculars whilst 14 sightings were during daylight hours.

- Acoustic monitoring for marine mammals occurred on 16 days of the survey and resulted in 277 hours and 3 minutes of monitoring effort and three acoustic detections.

- There was one detection of a probable humpback whale and two detections of unidentified dolphins. No visual detections were made in association with these.

- All appropriate separation distances and avoidance measures were maintained and implemented for marine mammals and sea turtles during the survey.

- There were no occasions where vessel speed was reduced to 10 knots or less due to large assemblages, mother/calf pairs, and designation of a Dynamic Management Zone or on entering a Seasonal Management Area.

- The geotechnical survey involved combined borehole drilling and Cone Penetration Testing (CPT) and was utilised on 13 days to complete a total of seven sampling stations.

- Geotechnical equipment was activated on 12 of occasions during the survey, all of which occurred during the hours of daylight. All start ups of geotechnical equipment were covered by full dedicated pre-start watches dedicated and acoustic monitoring.

- There were two delays to the start-up of geotechnical equipment due to marine mammals or sea turtle encounters during the survey.

SERVICE WARRANTY

USE OF THIS REPORT

This report has been prepared with due care and diligence and with the skill reasonably expected of a reputable contractor experienced in the types of work carried out under the contract and as such the findings in this report are based on an interpretation of data which is a matter of opinion on which professionals may differ and unless clearly stated is not a recommendation of any course of action.

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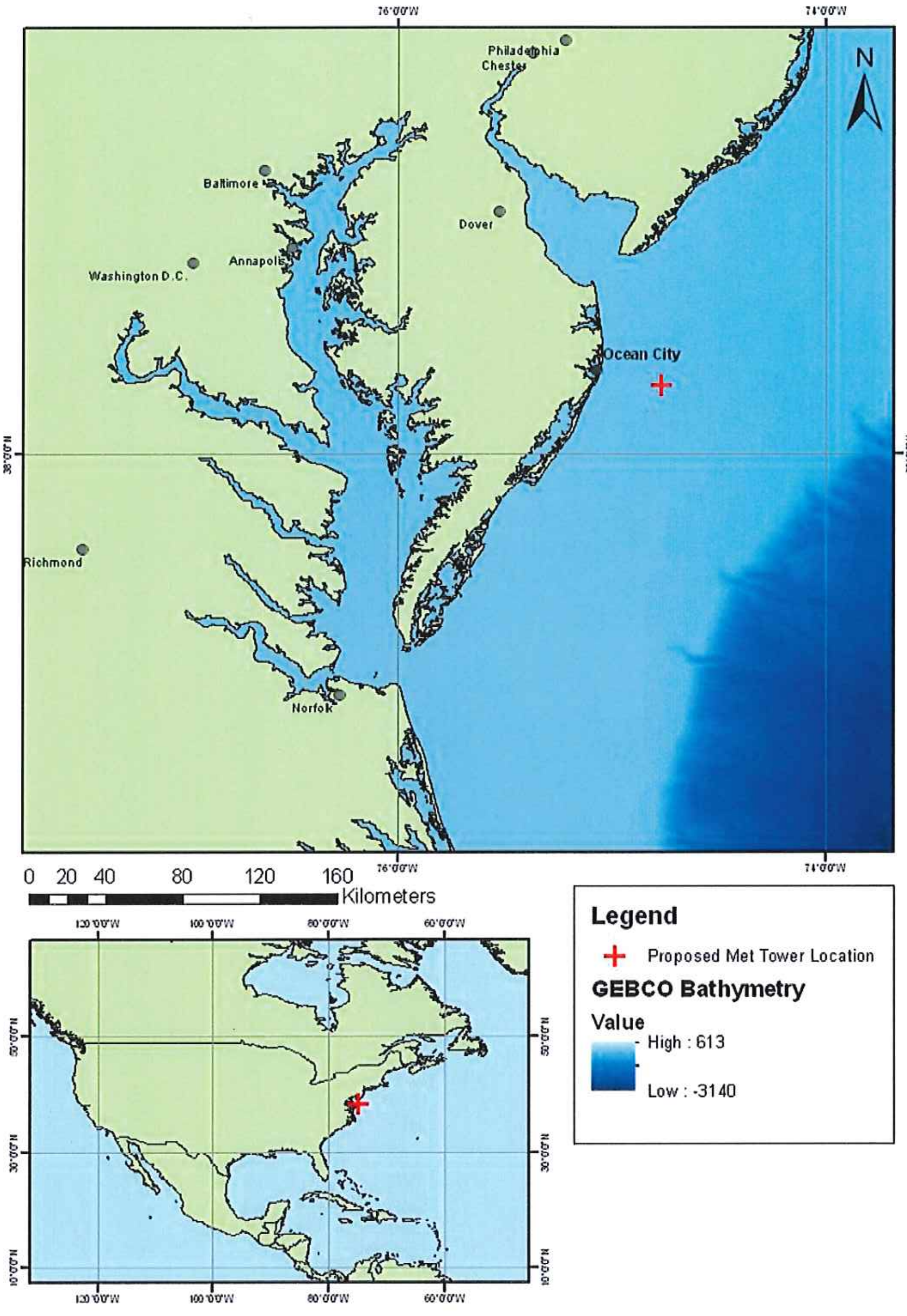
LOCATION MAP



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1. INTRODUCTION

1.1 Marine Geotechnical Surveys

Marine geotechnical surveys are being performed in order to characterise and investigate seabed conditions in the area to aid planning and development of a potential wind farm site. Little is known about the sound levels produced by equipment such as vibrocores, soil boring equipment and cone penetrometer equipment. Noise measurements recorded during a geotechnical survey in the Chukci Sea presented threshold distances of 1800 m for 120 dB re 1 µPa although this accounted for dynamic positioning systems onboard as well as coring activity (Hartin *et al.*, 2011).

1.2 Sound and Marine Mammals and Sea Turtles

1.2.1 Marine mammals

Sound is conducted through water approximately 4.5 times faster than through air and is the most important sense for many marine organisms. This is especially true for marine mammals which use sound to communicate, navigate, forage and for predator avoidance (Richardson *et al.*, 1995). The functional frequency range used by marine mammals varies between 7 Hz and 180 kHz, with the large baleen whales using the lower frequencies while smaller toothed whales use higher frequencies (Southall *et al.*, 2007).

Anthropogenic sound can impact marine mammals in a number of ways from direct injury (physiological and auditory effects) and behavioural responses, to perceptual and indirect effects (Gotz *et al.*, 2009; Southall *et al.*, 2007).

It is clear that behavioural responses to sound are highly variable and context specific, with spatial and temporal relationship, habitat quality, previous experience and similarity to biologically significant sounds, as well as the species, gender, age and behavioural state of the individual influencing the type and severity of the response or even if one is observed at all (Southall *et al.*, 2007; Ellison *et al.*, 2012).

The ability to perceive biologically important sounds is critical to marine mammals (Richardson *et al.*, 1995). Masking by increased sound levels in the natural environment can reduce the range over which signals are perceived and reduced the signal's quality of information, which can have implications for survival, reproduction and foraging (Weilgart, 2007). In many cases changes in vocalisation rates and the frequencies used have been suggested to be compensatory behaviour to elevated background noise levels (Di Iorio & Clark, 2010).

1.2.2 Sea turtles

Sea turtles are another group potentially impacted by anthropogenic acoustic activity although their hearing sensitivity falls in the low frequency range (<1 kHz) (Bartol *et al.*, 1999). Strong site fidelity to nesting sites, specific feeding grounds and migratory routes (Broderick *et al.*, 2007) could mean marine turtles are unable to avoid particular areas and consequently acoustic activity.

1.3 Vessel Strikes

There is increasing evidence that collisions between vessels and cetaceans (whales, dolphins and porpoises) is occurring more frequently than previously thought, and that in some cases this may post a significant conservation threat particularly for geographically isolated and endangered populations (Dolman *et al.*, 2006; Van Waerebeek *et al.*, 2007; Knowlton & Kraus, 2001). There are several variables which may either make a collision more likely or influence the kind of injuries inflicted or whether the collision is fatal. These include vessel speed, with speeds >11 knots more likely to cause a fatality (Vanderlaan & Taggart, 2007), type and size of vessel, visibility, condition and behaviour of individual and species (Dolman *et al.*, 2006; McKenna *et al.*, 2015). In the north-west Atlantic the northern right whale (*Eubalaena glacialis*) is particularly vulnerable to vessel strikes (Knowlton & Kraus, 2001). A number of mitigation measures have been implemented in order to reduce the number of vessel strikes offshore of the northeast coast of the USA (Laist *et al.*, 2014; NOAA, 2008).

1.4 Legislation

There are two US Federal Legislations appropriate to marine mammals and sea turtles, the Marine Mammal Protection Act (MMPA) (1972, and last amended in 2007) and the Endangered Species Act (ESA) (1973).

The MMPA was established to prevent species and populations from 'declining to the point where they cease to be significant functioning elements of the ecosystems of which they are a part'. The Act established a moratorium on the *taking* of marine mammals, with the word *take* defined as 'to hunt, harass, capture or kill any marine mammal or attempt to do so'. Under the MMPA, Incidental Harassment Authorisations (IHAs) were established to allow incidental 'takes' of small numbers of marine mammals by harassment. There are two levels of harassment defined under the IHAs: Level A covers any act with the potential to injure and Level B covers any act with the potential to disturb by causing disruption of behavioural patterns.

The ESA protects endangered and threatened species, which includes 22 species of marine mammal and all sea turtles, and their habitats by prohibiting the take of listed animals.

The Bureau of Ocean Energy Management (BOEM) considers all permit applications for geological and geophysical activities throughout the Mid-Atlantic and South Atlantic Planning Areas. Such permits are then subject to mitigation measures for avoidance of disturbance and injury to marine mammals and turtles. Such measures include, but are not limited to, guidance for vessel strike avoidance and measures to minimise disturbance and injury from acoustic surveys.

In accordance with the lease issued by BOEM the current survey was run in accordance with mitigation measures that cover vessel strike avoidance, reducing disturbance and harm from geotechncial activities and reporting (Appendix A).

1.5 Objective

This report presents the findings of dedicated marine mammal and sea turtle monitoring during a geotechnical survey on the Maryland Wind Energy Area site in the eastern Atlantic Ocean (see Location Map). This survey was conducted for Alpine Ocean Seismic Survey Inc on behalf of US Wind Inc. onboard the *M.V. Ocean Discovery* from 16th June to 9th July 2015.

The report provides a summary of geotechnical survey activities as well as compliance with measures implemented to reduce the risk of vessel strikes and disturbance and harm from geophysical survey activities. The report also includes an assessment of the methods of detection, equipment and includes any recommendations.

2. THE MARINE ENVIRONMENT

2.1 Physical Environment and Oceanographic Features

The ocean is a highly heterogeneous environment with large, intermediate and small-scale spatial and temporal patterns in physical, chemical and biological processes (Hunt & Schneider, 1987). Variation in such processes have an effect on primary production and therefore the abundance and distribution of plankton (Mackas *et al.*, 1985), which in turn affects marine populations at higher trophic levels (Thompson & Ollason, 2001). Physical processes such as circulatory patterns may also have large-scale implications on the dispersion of marine life. Equally important small-scale features or localised episodes will also have an effect (Hunt & Schneider, 1987). Seasonal fluctuations in temperature, salinity and the formation of fronts will also influence dispersion and primary production (Le Fèvre, 1986; Ellett & Blindheim, 1992).

The distribution of marine animals is primarily related to the movement and abundance of their food source (e.g. Evans, 1990; Macleod *et al.*, 2004; Friedlaender *et al.*, 2006). Other behavioural, morphological and energetic constraints will also have an influence on the movement and distribution of marine species. For example many species of baleen whale migrate to low latitude breeding grounds during winter (Stern, 2002) while sea turtles migrate between feeding, nesting and developmental areas (Plotkin, 2003; Bolten, 2003). Such seasonal patterns in biology are likely to have evolved to take advantage of oceanographic conditions. As the distribution and abundance of marine animals is influenced by oceanographic characteristics, it is important to describe the marine processes in the survey area.

The survey area is located off the coast of the eastern coast of the U.S.A, encompassing the waters surrounding Maryland. The site is located 9 nm offshore in an area of water approximately 27 m (90 feet) deep. The bathymetry of the study site and surrounding area is comprised of a gently sloping outer continental shelf (the mid-Atlantic bight), that attains depths of up to 50 m before quickly descending to depths of over 1000 m past the shelf break (Firestone *et al.*, 2010; Grothe *et al.*, 2010).

The hydrographical regime of the waters of the Maryland reflects the currents that affect the Mid-Atlantic Bight further north (Vincent *et al.*, 1981).. The currents along the New York Bight (a northern subsection of the Mid-Atlantic Bight) and surrounding waters generally flow in a south-westerly direction, although this is modulated by storm induced flows along the continental shelf (Vincent *et al.*, 1981).The waters off the continental shelf are also highly affected by the gulf stream, with the direction of the gulf stream catalysing or slowing the current from 0 – 40 cm S^{-1} (Bane *et al.*, 1988).

2.2 Marine Communities

There is a strong correlation with phytoplankton productivity and depth in the Atlantic Ocean off eastern U.S.A. with areas close to freshwater inputs having productivity levels of approximately 430gC m^{-2} a $year^{-1}$, and the outer shelf waters maintaining productivity of between 100 – 160 gC m^{-2} a $year^{-1}$ (Malone, 1978). The density of phytoplankton and zooplankton is also seasonally driven, with annual spring blooms occurring throughout the Mid-Atlantic Bight (Flagg *et al.*, 1994).

The benthic communities of the Mid-Atlantic Bight are comprised of 149 species of polychaetes, crustaceans, molluscs and echinoderms *(*Maurer *et al., 1976)*. There is a seasonal shift in the abundance and biomass of species within the area, with polychaetes such as *Goniadella gracilis and Lumbrineris acuta* dominating in May, but *Polygordius sp.* dominating in November (Maurer *et* *al.,* 1976). The species that have been recorded in the area, are typical of those that are commonly recorded in clean sand areas along the inner continental shelf of the Mid-Atlantic Bight (Maurer *et al.,* 1976).

The pelagic fish assemblages of the Mid-Atlantic Bight are comprised of over 300 species (Martin *et al.,* 1978). This primarily includes the Percifromes (perch (*Percidae*), mackerel (*Scombridae*), tuna and bass (*Serranidae*)) and especially the commercially viable skipjack (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), albacore (*Thunnus alalunga*) and Atlantic mackerel (*Scomber scombrus*). The most numerous benthic fish species in the area include spotted hake (*Urophycis regius*), fourspot flounder (*Hippoglossina oblonga*) and butterfish (*Stromateidae sp.)* (Gabriel, 1994). The waters surrounding Maryland are also inhabited by Basking sharks (*Cetorhinus maximus*), they have been recorded in the area from both boat & aerial surveys (Kenney *et al.*, 1985) and through tagging experiments (Skomal *et al.*, 2004).

There have been 26 species of marine mammal recorded along the Maryland coast (this is comprised of 19 odontocetes, five mysticetes and two pinniped species) (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015) (Table 2.1). All species of cetacean are listed under the Marine Mammal Protection Act (MMPA) (1972). Cetaceans listed as endangered or threatened under the Endangered Species Act (ESA) and found within the region include, humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*) and the North Atlantic right whale (*Eubalaena glacialis*). Of particular concern is the North Atlantic right whale, whose population numbered at a minimum of 444 individuals in 2009, although the population is exhibiting a positive and slowly accelerating trend (Waring *et al.*, 2009). The north Atlantic right whale is most likely to be seen on transit, as the waters of Maryland form part of the bi-annual migratory corridor used by this species (Brown and Marx, 2000) The bottlenose dolphin (*Lagenorhynchus acutus*) is the most abundant species of odontocetes recorded off the Maryland coast. The north-west Atlantic stock is estimated to be around 77,500 (NOAA, 2014).

There are two species of pinniped that have been recorded in the area. The harbour seal (*Phoca vitulina*) is the most common and are often found in near shore waters year round off Maine and seasonally off southern New England to Virginia (Thompson & Härkönen, 2008). Grey seals (*Halichoerus grypus*) range from New York to Labrador, with three established breeding colonies off Maine and Massachusetts, these individuals occasionally stray further south and in to the survey area.

Table 2.1 Marine mammal species recorded off the Maryland coast

Species	Scientific Name	IUCN Status
Humpback whale	*Megaptera novaeangliae*	Least concern
North Atlantic right whale	*Eubalaena glacialis*	Endangered
Minke whale	*Balaenoptera acutorostrata*	Least concern
Sei whale	*Balaenoptera borealis*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Gervais' beaked whale	*Mesoplodon europaeus*	Data deficient
Cuvier's beaked whale	*Ziphius cavirostris*	Least concern
Sowerby's beaked whale	*Mesoplodon bidens*	Data deficient
Blainville's Beaked whale	*Mesoplodon densirostris*	Data deficient
True's beaked whale	*Mesoplodon mirus*	Data deficient
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Least concern

Bottlenose dolphin	*Tursiops truncates*	Least concern
Short-beaked common dolphin	*Delphinus delphis*	Least concern
Striped dolphin	*Stenella coeruleoalba*	Least concern
Pantropical spotted dolphin	*Stenella attenuata*	Least concern
Atlantic spotted dolphin	*Stenella frontalis*	Data deficient
Spinner dolphin	*Stenella longirostris*	Data deficient
Pygmy sperm whale	*Kogia breviceps*	Data deficient
Dwarf sperm whale	*Kogia sima*	Data deficient
Sperm whale	*Physeter catodon*	Vulnerable
Long-finned pilot whale	*Globicephala melas*	Data deficient
Short-finned pilot whale	*Globicephala macrorhynchus*	Data deficient
False killer whale	*Pseudorca crassidens*	Data deficient
Risso's dolphin	*Grampus griseus*	Least concern
Harbour seal	*Phoca vitulina*	Least concern
Grey seal	*Halichoerus grypus*	Least concern

This table is created through strandings recorded completed in the last 20 years, NOAA stock assessments and extrapolated from species recorded in the mid-Atlantic bight south of south New England (Kenney *et al.,* 1997; Marine Mammal & Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015).

All species of sea turtle are listed on the Endangered Species Act. Four species of turtle have been recorded in the area: the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) green (*Chelonia mydas*) and leatherback turtle (*Dermochelys coriacea*) (Marine Mammal & Sea Turtle Stranding, 2015). All turtle species are migrants that come to forage along the coastal shelves (Shoop, 1987).

3. METHODOLOGY

3.1 Survey Area

The Maryland Wind Energy Area geotechnical survey was carried out for Alpine Ocean Seismic Survey Inc on behalf of US Wind Inc. The site was located offshore Maryland in the eastern North Atlantic (see Location Map) in an area of water approximately 20-30 m deep and 27 km west from Ocean City, Maryland. The position of the site can be found in Table 3.1.

Table 3.1 Survey location

Site	Latitude	Longitude	Coordinate System
Meteorology (Met) Tower	38°19.230 N	74°46.309 W	UTM 18N

3.2 Survey Vessel

The geotechnical survey was carried out onboard the *M.V. Ocean Discovery* from16th June to 9th July 2015. The vessel details are as displayed in Table 3.2.

Table 3.2 Vessel specifications

M.V. Ocean Discovery	Specifications
Owner	Gardline Marine Sciences
Flag	UK
Class	I+hull+MACH+Special service+DynaPos AT+AUT-UMS
Built / Re-configured	1983 / 2010
Length Overall	86.9 m
Breadth Overall	18 m
Draft	7 m
Gross Tonnage	4027
Main Engine	Bergen diesel
Propulsion	Single Controllable Pitch Propellor, 2x Schottel azimuths
Bow Thrusters	2x Brunvoll tunnel
Maximum Speed	12 Knots
Endurance	28 days
Accommodation	50 Berths

3.3 Survey Parameters

The survey comprised of geotechnical sampling and data acquisition whilst stationary on a four point anchor mooring system.

The purpose of the survey was to characterize geological, archaeological, and benthic habitat resources to support design, engineering, construction and operation of the Met Tower and to support the assessment of potential environmental impacts as required in the Site Assessment Plan to gain BOEM approval of the proposed wind facility development.

Geotechnical data were collected using soil boring and CPT equipment. The survey comprised seven borehole locations with the Meteorological (Met) Tower location being the main priority. The survey was conducted in an area covering 184 km2 within the lease areas. The preliminary sampling plan is shown in Figure 3.1.

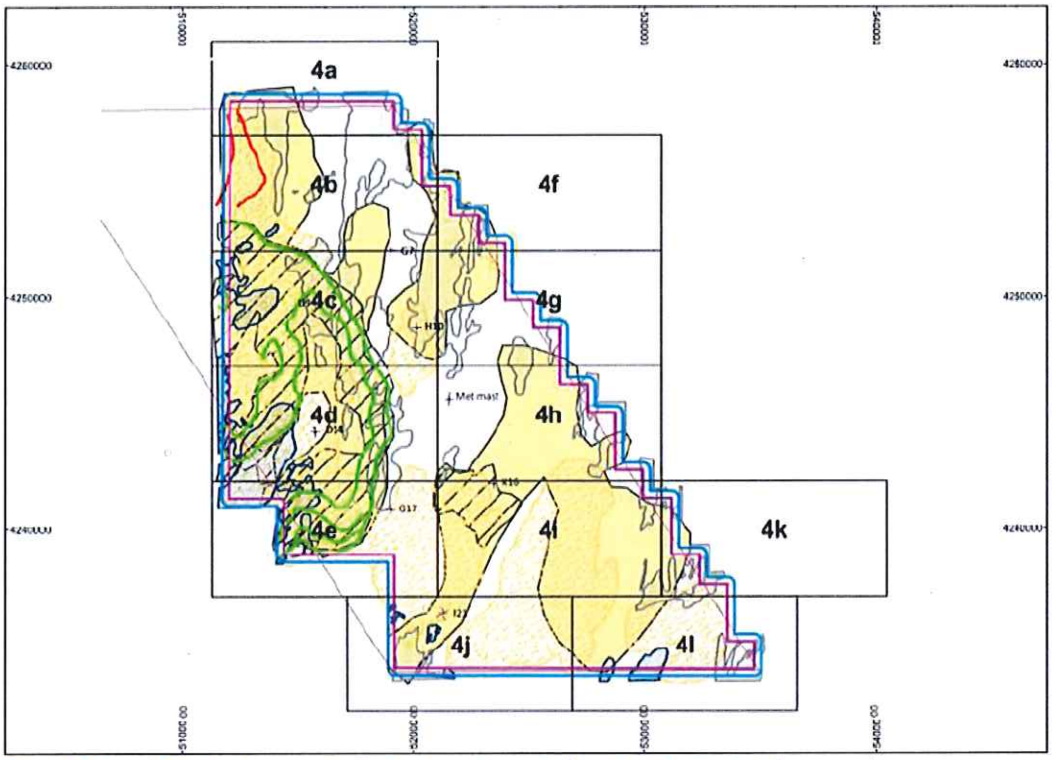

Figure 3.1 Preliminary geotechnical sampling plan for the Geotechnical survey

3.4 Operators Procedures

In line with the requirements stipulated in the lease OCS-A-0489 and OCS-A-0490 the survey was run in accordance with a number of mitigation measures which covered vessel strike avoidance, the reduction of the risk of disturbance and injury from geophysical survey operations and reporting requirements.

3.4.1 Vessel strike avoidance

In order to avoid causing injury or death to marine mammals and sea turtles the following measures were implemented.

Protected Species Observers (PSOs) and the vessel operator maintained a vigilant watch for marine mammals and turtles, and either slowed down or stopped the vessel in order to avoid striking any sighted individuals.

Vessel speed was reduced to 10 knots or less when groups including mother and calf pairs or large groups of cetaceans were encountered. Vessel speed was also reduced to 10 knots or less in any Dynamic Management Areas (DMAs) and Seasonal Management Areas (SMAs) implemented for North Atlantic right whales.

During the survey the National Marine Fisheries Service (NMFS) North Atlantic Right Whale Reporting Systems were monitored for the presence of North Atlantic right whales within or adjacent to the survey area. This includes the following:

- Early Warning System
- Sightings Advisory System
- Mandatory Ship Reporting System

A minimum separation distance of 500 m was maintained between the vessel and any North Atlantic right whales encountered. If a North Atlantic right whale was encountered within 500 m, the vessel steered a course away from the whale at 10 knots or less until it was more than 500 m from the vessel. If North Atlantic right whales were encountered within 100 m of the vessel the following avoidance measures were taken:

- Vessel speed was reduced and the vessel engine shifted to neutral.
- Engines were not engaged until the whale was more than 100 m away.
- Vessel then steered a course at 10 knots or less away from the individual/s until the 500 m minimum separation distance was established.

A minimum separation distance of 100 m was maintained between the vessel and any other non-delphinid cetaceans encountered. If individuals were encountered within 100 m, the vessel reduced speed and shifted engines into neutral. Engines were only engaged once the individual/s was more than 100 m away.

For delphinid cetaceans a minimum separation distance of 50 m was maintained. If delphinids were encountered within 50 m the vessel maintained a parallel course with the group wherever possible, avoiding abrupt changes in direction and excessive speed. Course and speed were only adjusted once the animals moved more than 50 m from the vessel or they had moved abeam.

For all marine turtle and pinniped encounters a minimum distance of 50 m was maintained.

3.4.2 Reporting injured or dead protected species

During the survey PSOs reported any sightings of dead or injured protected species (including all marine mammals and sea turtles) regardless of whether the injury or death was caused by the survey vessel. All such incidences were reported to BOEM and the NMFS Northeast Regional Stranding Hotline (866-755-6622) within 24-hours. Any sightings of dead, injured or entangled North Atlantic right whales were also reported to the US Coast Guard via VHF Channel 16. A standardised incident report was also completed for all injured or dead protected species sighted (Appendix B).

3.4.3 Mitigation for the geotechnical survey

PSOs and PAMS Operators maintained dedicated monitoring for marine mammals and sea turtles for a minimum of 60 minutes prior to geotechnical equipment starting. Following this period with no marine mammal or sea turtle recorded within the 200 m mitigation zone the equipment was activated.

If a marine mammal or sea turtle was detected within the 200 m mitigation zone surrounding the geotechnical equipment during the 60 minute pre-start period a delay to the activation of the equipment was implemented. Start up was delayed by 60 minutes from the last time the marine mammal or sea turtle was detected within the mitigation zone, or until the animals were successfully tracked outside of the mitigation zone.

If low frequency vocalisations were detected by the PAMS but range could not be determined and the animal not detected visually then a delay to start-up operations was implemented.

Due to operational constraints and health and safety considerations, once geotechnical equipment was active equipment was not shut-down if a marine mammal or sea turtle was sighted or detected within the 200 m mitigation zone.

No geotechnical survey operations were conducted in any established DMAs.

If there were any breaks in geotechnical operations (other than those caused by a non-delphinid or sea turtle shut-down), operations resumed as soon as practically possible providing the PSO and PAMS Operator had been conducting monitoring during the break and no marine mammals or sea turtles were detected within the mitigation zone. For breaks where the seabed frame was removed from the seabed, operations could not resume until a full dedicated pre-start watch had been completed once the vessel had moved to its new location.

3.5 Observation Methods

The PSOs carried out dedicated watches for marine mammals and sea turtles during all operations, including transit to and from site. Watches were conducted 24-hours, with night–vision binoculars and thermal imaging technology utilised during the hours of darkness. The Joint Nature Conservation Committee (JNCC) standardised recording forms were completed by the PSOs during all operations and transit.

Watches were carried out from the bridge and bridge wings. Prior to beginning a watch, the time (UTC) and weather conditions were recorded on the JNCC Location and Effort Form (Appendix C). Weather conditions (Beaufort wind force and direction, sea state, swell height and visibility) were noted every hour and whenever a change in conditions occurred. The used definitions of Beaufort wind force and sea state are provided in Appendix D. In addition, the start and end times of marine mammal and sea turtle watches and the start and end times of geotechnical operations were recorded each day on the JNCC Record of Operations Form (Appendix C).

The primary observation technique used to detect marine mammals and sea turtles during daylight hours was to scan the visible area of sea using the naked eye, and scanning areas of interest with binoculars (magnification x 8) (e.g. waves going against the prevailing direction, white water during calm periods, bird activity, bird transiting direction etc.). This technique gave both a wide field of view and the ability to have a sufficient range of 3-4 km in ideal conditions. Reticule binoculars and a range-finder stick (Heinemann, 1981) were used to establish the distance to all marine mammal and sea turtles sighted.

During the hours of darkness the PSOs used night-vision binoculars (PVS-7 night vision goggle Generation 3 Pinnacle) with additional clip-on thermal imaging (COTI) technology. All watches with night-vision optics were carried out from a platform with no visual barriers.

PSOs calibrated reticule binoculars and range-finder sticks using standard methods (Appendix E). Calibrations were conducted during mobilisation and a minimum of once a week throughout the survey.

Identifications were based on a combination of the observer's previous experience, aided by the field guide Whales, Dolphins and Seals: A field guide to the marine mammals of the world by Shirihai and Jarrett (2006).

PSOs were also equipped with bearing finding equipment and a digital stills camera with 70-300 mm lens.

The JNCC Marine Mammal Recording Forms were available to record sightings made by the PSOs (Appendix C). The information recorded included the date and time, the vessels position, course, depth and geotechnical activity. The species, certainty of identification, number of animals, behaviour, distance from the vessel and direction of travel were also recorded. Any additional information, such as details on the features used to identify the animals and the reaction of the animals to the geotechnical equipment was also noted.

3.6 Acoustic Monitoring Methods

Passive Acoustic Monitoring (PAM) uses hydrophones (underwater microphones) to detect and monitor the presence of marine mammals through the detection of their vocalisations. Most cetaceans (whales, dolphins and porpoises) vocalise regularly and produce a variety of sounds ranging from low frequency vocalisations of baleen whales (down to about 15 Hz) to relatively high frequency echolocation clicks of some toothed whales (up to about 160 kHz) (Sturtivant *et al.*, 1994; Richardson *et al.*, 1995; Berchok *et al.*, 2006). Non vocalising animals cannot be detected using PAMS.

During the project a Passive Acoustic Monitoring System (PAMS) was used to acoustically monitor for marine mammals 24-hours a day during all drilling operations. However this was not possible during short transits between drilling locations and whilst anchoring for safety reasons. Details of the PAMS used during the survey are provided below.

Prior to commencing monitoring the time (UTC) and weather conditions were recorded on the JNCC Location and Effort Form (Appendix C). Weather conditions were recorded every hour and whenever a change in conditions or source activity occurred. The used definitions of Beaufort wind force and sea state are provided in Appendix D. In addition the start and end times of dedicated pre-shoot monitoring and the start and end times of geotechnical operations was recorded on the JNCC Record of Operations Form (Appendix C).

The JNCC Sightings Form (Appendix C) was available to record detections made by the PAMS Operator. The information recorded included the date and time, the vessels position, course, depth, geotechnical operations, range and bearing to marine mammals and a description of the detection. Where possible the species and number of individuals were also recorded.

PAMS Operators could not calibrate the PAMS due to the vertical deployment method necessary as the vessel was stationary. The difference in time of arrival of sound sources could not be calculated as the site was in shallow water and the hydrophone positions were not spaced laterally in the water column.

3.6.1 The PAMS

The PAMS comprised of a vertically deployed hydrophone array connected to a data processing system, enabling the acquired sound to be inspected both aurally and visually. The hydrophones are connected to dry-end hardware which digitises the analogue signal allowing it to then be read by the laptop computers. The computers run analysis software which highlights the number of varied clicks and whistles produced by different species of marine mammals.

The system utilised low and broadband frequency hydrophones in order to cover the frequency range of vocalising marine mammals, from low frequency mysticete (baleen whale) moans to high frequency odontocete (toothed whale and dolphin) clicks. The signal receive by the hydrophones is then monitored in real-time by the dedicated software PAMGuard, which through the use of click detectors, whistle and moan detectors, and filters allows the automatic detection of the presence of marine mammals. Detectors and filters can be adjusted manually by the PAMS Operator in order to increase positive detections. The detections were then stored in a database (Figure 3.2).

The data processing system comprises the following sub systems:

a) High frequency data acquisition for cetacean clicks up to 250 kHz (max sample rate 500 kHz).
b) Medium/low frequency data acquisition for cetacean click and whistles up to 48 kHz (max sample rate 96 kHz) and cetacean moans down to 10 Hz.
c) Depth data acquisition.
d) Computer based sound acquisition, display and analysis software.

The directionality and range of the marine mammal is determined by the time difference of the arrival of the acoustic signal (vocalisation) to each hydrophone of the array.

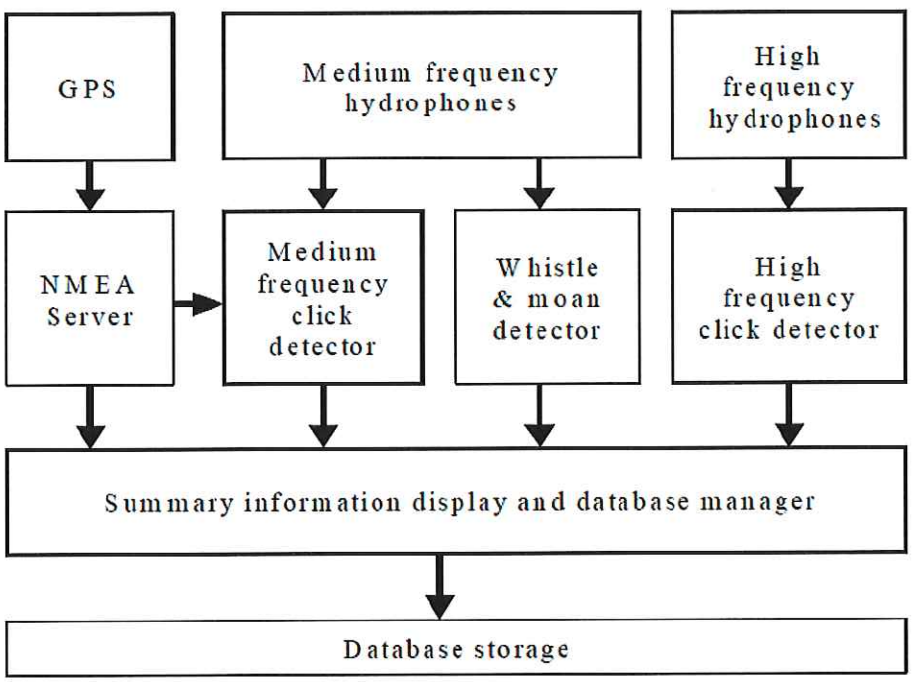

Figure 3.2 Schematic set up of PAMS

3.6.2 The hydrophone array

The PAMS used during the survey was a GEL MK3 system and consisted of four hydrophones; one low frequency and three broadband frequency. The manufacturer's specification for the PAMS can be found in Appendix F. The hydrophone array was wired into a tow cable, an electric cable of 250 m in length, and deployed vertically from the vessel to a depth appropriate to the site depth.

3.6.3 The monitoring system

The latest version of PAMGuard software (Version 1.13.02 Beta) was utilised as a graphical display for sound acquisition, visualisation and detection of marine mammal vocalisations. PAMGuard is an open-source software, that is platform-independent (e.g. Windows or Linux), flexible and built in a modular architecture.

For mitigation purposes, during the current survey the PAMS used a specific data model configuration created by Gardline Environmental Ltd. Using the most appropriate modules and specifications, a low/medium frequency and a high frequency data module configuration was utilised simultaneously using a single computer interface (Figure 3.3).

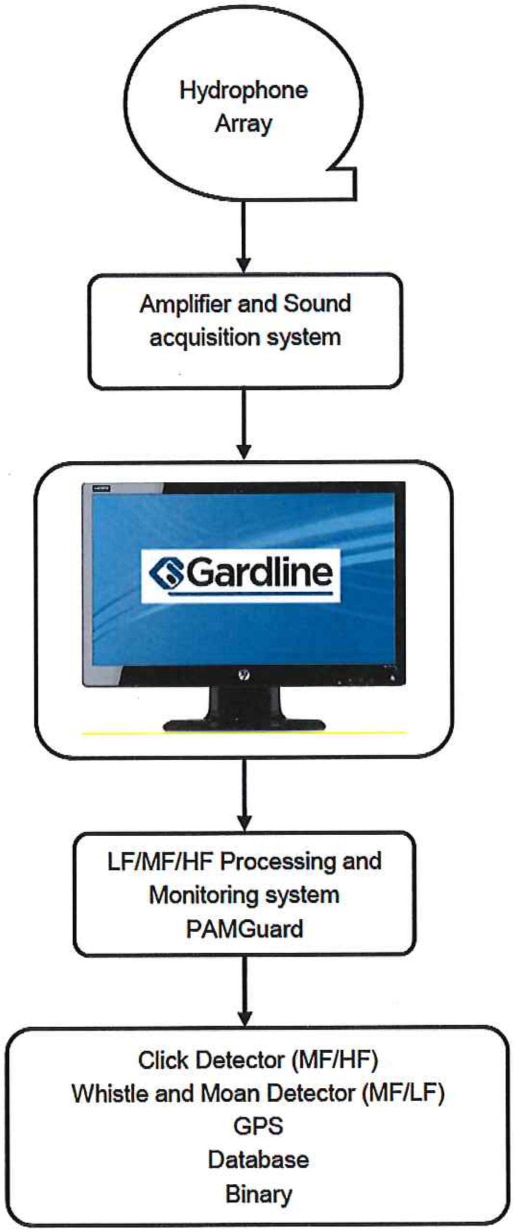

Figure 3.3 Schematic plug-in modules used in PAMGuard

The medium/low frequency configuration is programmed to specifically track and localise clicks, whistles and moans produced by cetaceans in the vicinity of the hydrophones. This includes odontocete clicks and whistles up to 48 kHz and mysticete moans down to 10 Hz.

The high frequency configuration is programmed to detect the clicks of odontocetes (including dolphins and porpoises) up to 175 kHz.

All of the detection modules were run in real time and monitored by a dedicated PAMS Operator, with audio recordings and screenshots taken for any detections during the survey.

4. RESULTS

4.1 Survey Coverage

The *M.V. Ocean Discovery* mobilised on 16th June 2015 in Baltimore, with MMO's arriving on the vessel on the 17th June. Once completed at on 18th July the vessel began transit to the Maryland Wind Energy Area (MWEA) location at 15:00h (UTC). Prior to arrival at the MWEA site, the PAMS cable was deployed at 07:00h on 19th June to carry out a 30 minute acoustic recording. On arrival at the location of the first bore hole, the Met Tower, at 8:00h on 19th June, the vessel conducted Dynamic Positioning trials and a weather assessment. At 14:20h, the vessel began deploying the four point mooring anchors. Operations were suspended due to equipment damage, and the ship left site at 04:00h on 20th June arriving in Baltimore 20:42h.

The vessel departed Baltimore to transit to site at 18:08h on 21st June, arriving at location I21 at 14:33h on the 22nd June. Drilling operations began at 21:45h the same day. At 02:15h on 23rd June drilling operations on this borehole were suspended. Operations recommenced at this location at 12:00h. At 02:56h on 24th June, equipment was recovered due to weather and operations were suspended. At 13:20h the same day, operations resumed with the final stage of drilling at this location taking place between 11:20h and 13:35h on 25th June.

The vessel transited to the Met tower location at 16:15h on 25th June, with drilling operations at this location taking place between 20:50h on 25th and 08:47h on 27th June. After moving to the next borehole location (D14), the vessel waited on weather until 07:24h on 29th June. Drilling on this site commenced at 17:50h however operations were delayed due to equipment damage at 15:50h. The equipment was redeployed at 20:53h on 30th June and operations resumed. Geotechnical operations at this location were completed at 19:57h on 1st July, and the vessel moved to the next location.

Geotechnical operations began at location G17 at 23:35h on 1st July and were suspended at 16:30h on 2nd July due to weather. Drilling resumed at 22:57h on 2nd July and geotechnical operations at this location were completed at 12:37h on 3rd July. The vessel arrived on location K16 at 13:07h, and at 16:40h drilling commenced. Geotechnical operations at this location were complete at 04:18h on 5th July. The vessel relocated to H10, with geotechnical operations taking place between 11:08h on 5th July and 11:54h on 6th July. The vessel moved on to location G7, geotechnical operations began at 20:09h on 6th July, and were deemed complete at 22:09h on 7th July. Once all seabed equipment was recovered, the vessel began the transit to the port of Baltimore and arrived alongside at 21:00h on 8th July. The vessel completed demobilisation on 9th July.

During survey a total of seven geotechnical sampling stations were completed over 13 days. Table 4.1 provides a summary of data acquisition during the survey.

Table 4.1 Summary of data acquisition for the geotechnical survey

Data acquisition	Name
Number of sampling stations	7
Total hours of geotechnical equipment active (hrs:mm)	239:65
Number of start ups	12
Number of daylight start ups	12

4.2 *Protected Species Observer Effort*

A total of 405 hours and 36 minutes of dedicated marine mammal and sea turtle watches and 277 hours and 3 minutes of dedicated acoustic monitoring effort were carried out by the PSOs between 19th June and 8th July 2015 this included 18 hours and 37 minutes of dedicated pre-start watch and 18 hours and 20 minutes of dedicated pre-start acoustic monitoring.

4.3 *Weather Conditions*

Weather conditions recorded during the survey were mostly good, but occasionally moderate. The sea state was mostly slight, often choppy and occasionally rough or glassy (Figure 4.1), with a predominantly low swell, i.e. ≤2m (94%) and medium for the rest of the time (6%). Visibility was good for the majority of the survey however it was moderate and poor at times, this included observations taken during hours of darkness (Figure 4.2). Beaufort wind force was variable between Force 0 and Force 7 with a Force 4 occurring most frequently (Figure 4.3) from a general southerly direction (Figure 4.4).

It should be noted that weather observations were only made during dedicated marine mammal and sea turtle monitoring and hence may not fully reflect weather throughout the survey.

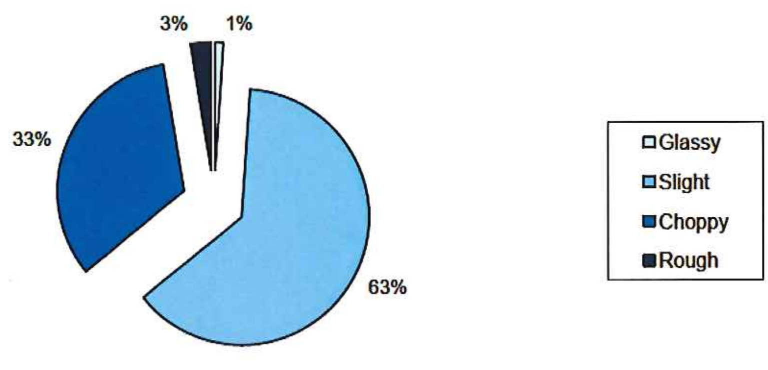

Figure 4.1 Sea state recorded during dedicated marine mammal and sea turtle monitoring during the geotechnical survey

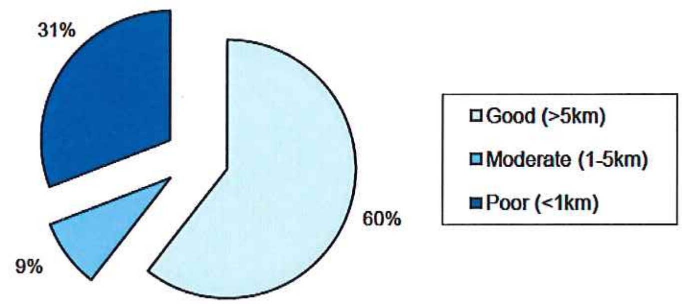

Figure 4.2 Visibility recorded during dedicated marine mammal and sea turtle monitoring during the geotechnical survey

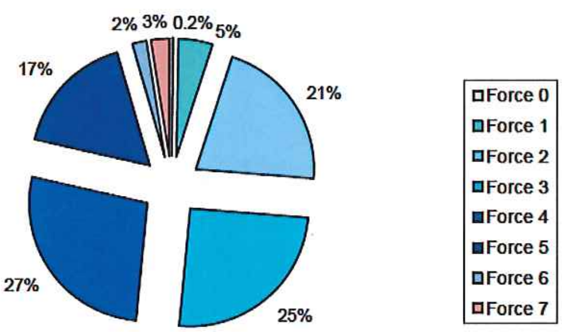

Figure 4.3 Beaufort wind force recorded during dedicated marine mammal and sea turtle monitoring during the geotechnical survey

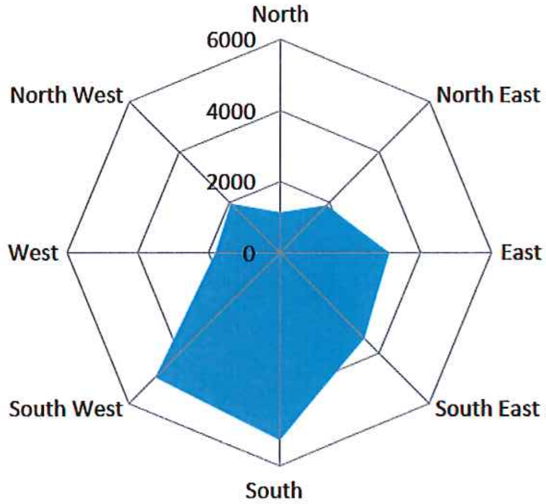

Figure 4.4 Wind direction recorded during dedicated marine mammal and sea turtle monitoring during the geotechnical survey

4.4 *Compliance with Mitigation Measures*

The Maryland Wind Energy Area geotechnical survey was run in accordance with a specific mitigation measures stipulated in the lease OCS-A489 and OCS-A490. PSOs conducted dedicated watches and acoustic monitoring during all survey operations and during transit to and from site.

There were no encounters with North Atlantic right whale during the survey.

There was one encounter with a non-delphinid cetacean during the survey, when a low frequency detection was made on PAMS during drilling operations. The non-delphinid cetacean was encountered when the vessel was stationary therefore no avoidance or mitigation was required.

There were eight encounters with delphinid cetaceans during the survey. A minimum separation distance of 50 m was maintained during all encounters.

There were ten encounters with sea turtles and no encounters with pinnipeds during the survey. A minimum separation distance of 50 m was maintained during all encounters during transits. There were five encounters when turtles were observed within 50m whilst the vessel was stationary on site.

Full details of all the marine mammal and sea turtle encounters during the survey are provided in Sections 4.5 and 4.6 below.

During the survey there were no incidences of vessel strikes with marine mammals or sea turtles. There was one sighting of a dead protected species, which was reported to the NOAA NMFS Northeast Region Stranding Hotline within 24-hours and a full incident report completed (Appendix B).

Vessel speed was maintained below eight knots throughout the geotechnical survey. During transit there were no occasions where vessel speed was reduced due to the presence of mother and calf pairs, large groups of cetaceans, due to the designation of a DMA or on entering a SMA for North Atlantic right whales.

Although the survey was not within the designated period of 1st November to 30th April stipulated in the lease, the Early Warning System, Sighting Advisory System and Mandatory Ship Recording System were monitored for the presence of North Atlantic right whales throughout operations and transit.

During the survey there were 12 start-ups of the geotechnical equipment, all of which occurred during daylight hours. Full dedicated pre-start monitoring (visual and acoustic) was completed prior to all start-ups of geotechnical equipment.

During the survey there were two occasions where the start-up of geotechnical equipment was delayed due to the close proximity of turtles.

Both delays occurred on 6th June during the pre-start monitoring period. The first occasion occurred at 18:17h when a leatherback turtle was visually sighted entering the 200 m mitigation zone with its closest approach to the vessel 150 m. A delay of one hour was implemented from 18:18h, the time the turtle was last seen within the mitigation zone.

The second occasion occurred at 19:01h on the same day whilst a delay was being implemented for the previous sighting. A loggerhead turtle was visually detected at 15 m from the vessel within the 200 m mitigation zone. A delay of one hour was implemented from 19:08h, the time the turtle was last seen within the mitigation zone. Survey operations commenced at 20:09h after the PSO on watch gave the all clear to start operations.

4.5 Marine Mammal and Sea Turtle Encounters

There were 16 sightings of marine mammals and sea turtles included one sighting of a dead protected species, and three acoustic detections of marine mammals throughout the duration of the survey, from 16th June to 9th July 2015. Encounters comprised of bottlenose dolphins, humpback whale, loggerhead turtles, leatherback turtles, as well as unidentified dolphins and turtle species. There were no encounters of north Atlantic right whales during the survey. A summary of the species encountered is provided in Table 4.2; full details of the sightings and acoustic detections are provided in the sections below.

Table 4.2 Summary of marine mammal and sea turtle encounters during the geotechnical survey

Species	Daylight		Night time	
	Number of Sightings	Number of Acoustic Detections	Number of Sightings	Number of Acoustic Detections
Bottlenose Dolphin	2	0	0	0
Loggerhead turtle	4	0	1	0
Leatherback turtle	1	0	0	0
Unidentified turtle sp.	3	0	1	0
Unidentified dolphin sp.	4	1	0	1
Humpback whale	0	0	0	1

4.6 Marine Mammal and Turtle Sightings

4.6.1 Bottlenose Dolphin (Tursiops truncatus)

The common bottlenose dolphin is widely-distributed occurring in coastal and continental shelf waters of tropical and temperate regions. Although population density appears higher in near-shore areas, there are also pelagic populations (Culik, 2011). The common bottlenose dolphin is a large, robust dolphin, with a moderate stocky beak sharply demarcated from the melon. The dorsal fin is tall and falcate, set near the middle of the back. Colour varies from light grey to nearly black on back and sides fading to white on the belly. There is however extensive geographical variation in size, shape, appendages and colouration of this species, and confusion remains as to its taxonomy. In many areas markedly differentiated inshore and offshore populations occur in close proximity (Jefferson et al., 2008). Common bottlenose dolphins range in size from 1.9 to 4.1 m, and weigh between 150 and 650 kg (Shirihai & Jarrett, 2006). The species is found in a range of habitats, from rocky reefs, to calm lagoons and open waters. They are generalist feeders, preying on a wide variety of prey, mostly fish and squid, and are known to feed cooperatively (Jefferson et al., 2008). Group size is commonly between two and 15 animals, although they can be encountered individually and in groups of several hundred to thousands offshore. They commonly associate with other species of cetacean, although some interactions are reported to be aggressive (Culik, 2011). Based on regional population estimates, the world-wide population abundance is estimated to be a minimum of 600,000 (Hammond et al., 2012). The species is listed as 'Least Concern' on the IUCN Red List (IUCN, 2015).

On the 22nd June, between 10:08h and 10:18h, a group of bottlenose dolphins were seen during vessel transit to site (Figure 4.5). The dolphins were spotted 1000 m from the vessel, with closest distance of 400 m at 10:14h, engaging in feeding type behaviour and slow swimming in a north westerly direction. The pod was estimated to be comprised of 40 individuals with at least 10 juveniles and 5 calves present within the group. No mitigation was required.

On 28th June between 11:15h and 11:25h, a group of bottlenose dolphins were spotted on site whilst vessel was waiting on weather (Figure 4.6). The dolphins were 900 m from the vessel travelling in a south easterly direction (500 m at their closest point at 11:18h), engaging in milling, slow swimming and leaping behaviours. It was estimated 15 individuals including two juveniles were present within the group. No mitigation was required.

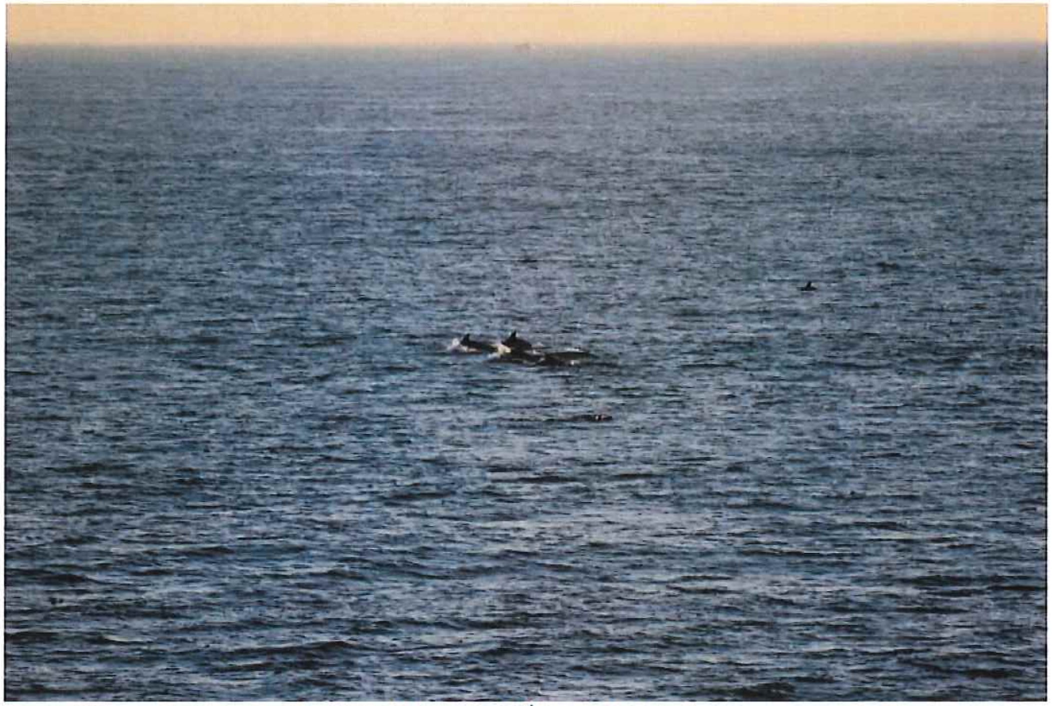

Figure 4.5 Bottlenose dolphins sighted on 22nd June 2015 during the geotechnical survey

Figure 4.6 Bottlenose dolphins sighted on 28th June 2015 during the geotechnical survey

4.6.2 Unidentified Dolphin species

On 19th June between 09:16h and 09:19h, three unidentified dolphins were seen 500 m from the vessel during transit to site. The dolphins were fast swimming in a south westerly direction crossing perpendicular ahead of the vessel. No mitigation was required.

Later on 19th June between 09:40h and 09:45h, a group of unidentified dolphins were spotted 1000 m from the vessel during transit to site (Figure 4.7). It was estimated the group consisted of 10 individuals including three juveniles, travelling in a south easterly direction in the opposite direction to the vessel. No mitigation was required.

On 3rd July between 10:30h and 10:35h, a group of unidentified dolphins were spotted 2000 m from the vessel when survey operations were active. It was estimated that the group was comprised of five adults displaying leaping behaviours whilst travelling in a south easterly direction away from the vessel. No mitigation was required.

Figure 4.7 Unidentified dolphin species sighted on 19th June 2015 during the geotechnical survey

On 22nd June at 10:49h, a dead unidentified dolphin was spotted 400 m from the vessel during transit to site (Figure 4.8). The dolphin had a pronounced beak, pale ventral side and darker flanks with a pointed pectoral fin. The sighting was reported to BOEM and NMFS. No mitigation was required.

Figure 4.8 unidentified dead dolphin sighted on 22nd June 2015 during the geotechnical survey

4.6.3 Loggerhead Turtle (Caretta caretta)

Loggerhead turtles are widely distributed in coastal tropical and subtropical waters ranging between 16 and 20°C, although it is also commonly recorded in temperate waters at the boundaries of warm currents (Márquez, 1990). The heart-shaped carapace is reddish brown in colour. Adults reach between 82 and 105.3 cm, with a mean weight of approximately 75 kg (Márquez, 1990). The species is distinguished by its large head and strong jaws. Adult loggerhead turtles are known to undertake long distance migrations between nesting beaches and foraging grounds (Polovina et al., 2004; Nichols et al., 2000). Loggerhead hatchlings and juveniles are frequently associated with sea fronts, down-wellings and eddies where they feed on epipelagic animals. Between 7 and 12 years old juveniles migrate from oceanic habitats to nertic zones to continue maturing until adulthood. The neritic zone also provides crucial foraging, inter-nesting and migratory habitat for adult loggerheads (NOAA, 2012). Recent reviews indicate only two loggerhead nesting aggregations have more than 10,000 females nesting annually. Intermediate sized nesting aggregations occur in the US, Mexico, Brazil, the Cape Verde Islands and Western Australia (US Fish & Wildlife, 2012). The primary threat to loggerhead populations is incidental capture in marine fisheries gear (NOAA, 2012). The species is listed under Appendix I CITES and under Appendices I and II of the CMS, and is listed as 'Endangered' on the IUCN Red List (IUCN, 2013).

There were five Loggerhead turtle sightings between17th June to 8th July of the Geotechnical survey.

On 28th June between 14:10h and 14:15h, a Loggerhead turtle was spotted surfacing 200 m from the vessel whilst on site waiting on weather. The turtle was travelling in a westerly direction away from the vessel. No mitigation action was required.

On 2nd July between 08:25h and 08:33h, a Loggerhead turtle was spotted during the hours of darkness using night vision binoculars. The turtle surfaced 10 m from the vessel whilst survey operations were active. No mitigation action was required.

On 4th July between 12:25h and 12:28h, a Loggerhead turtle was spotted surfacing 30 m from the vessel whilst survey operations were active. The turtle remained stationary at the surface before diving. No mitigation action was required.

On 6th July between 19:01h and 19:08h, a Loggerhead turtle was spotted surfacing 5 m from the vessel during the pre-shoot monitoring period (Figure 4.9). The turtle was within the 200 m mitigation zone and therefore a delay to start of operations was implemented.

Later the same day, between 21:40h and 21:58h, two Loggerhead turtles were spotted surfacing and displaying sexual behaviour 200 m from the vessel whilst survey operations were active (Figure 4.10). The two turtles were travelling in a westerly direction towards the vessel. No mitigation action was required.

Figure 4.9 Loggerhead turtle sighted at 19:01h on 6th July 2015 during the geotechnical survey

Figure 4.10 Two Loggerhead turtles displaying active sexual behaviour sighted at 21:40h on 6th July 2015 during the geotechnical survey

4.6.4 Leatherback Turtle (Dermochelys coriacea)

The leatherback turtle is the largest marine turtle, with the largest specimen recorded at 256.5 cm (Márquez, 1990). The body is large and spindle shaped, with a leathery, unscaled carapace. The colour is essentially black with scattered white patches (Márquez, 1990). Adult leatherbacks are adapted to colder water due to their protective thick and oily skin. Therefore the species is more widely distributed, with numerous records from higher latitudes in waters between 10°C and 20°C (Márquez, 1990). Leatherback turtles nest on sandy beaches in tropical waters, with hatchlings remaining in warm tropical coastal waters until they are more than 100 cm in length. As adults leatherbacks are pelagic, ranging widely in the open ocean although they will often forage in coastal habitats also (Sarti Martinez, 2000; NOAA, 2012). Leatherbacks are carnivorous, feeding on jellyfish and other soft-bodied animals. They are the deepest diving reptile, reaching depths of over 1200 m (Spotila, 2004) although in temperate regions dives tend to be shallower (McMahon & Hays, 2006; James et al., 2006). Global population size was estimated to be between 20,000 and 30,000 adult females in 1996, an estimated 78% reduction compared to previous estimations in 1982 (Sarti Martinez, 2000). The largest nesting populations are found within the eastern and western Atlantic and the Caribbean (Spotila et al., 1996). The species is listed under Appendix I of both CITES and CMS, and are listed as 'Critically Endangered' on the IUCN Red List (IUCN, 2015).

On 6th July between 18:17h and 18:18h, a Leatherback turtle was spotted surfacing 200 m from the vessel during the pre-shoot monitoring period (Figure 4.11). The turtle entered the 200 m mitigation zone; therefore a delay to start up operations was implemented. The turtle crossed perpendicular ahead of the vessel in a westerly direction.

Figure 4.11 Leatherback turtle sighted at 18:17h on 6th July 2015 during the geotechnical survey

4.6.5 Unidentified turtle species

On 28th June at 23:45h, an unidentified turtle species was spotted surfacing briefly 100 m from the vessel whilst on site waiting on weather. The turtle was crossing perpendicular ahead of the vessel in a south westerly direction. No mitigation action was required.

On 29th June between 03:32h and 03:34h, an unidentified turtle was spotted during the hours of darkness using night vision binoculars. The turtle surfaced 100 m from the vessel whilst on site waiting on weather, and was travelling towards the vessel in a westerly direction. No mitigation action was required.

On 3rd July at 11:38h, an unidentified turtle species was spotted surfacing 800 m from the vessel whilst survey operations were inactive. The turtle was stationary at the surface before diving. No mitigation action was required.

On 4th July between 18:55h and 18:59h, an unidentified turtle species was spotted surfacing 20 m from the vessel whilst survey operations were active. The turtle was travelling parallel to the vessel in a south easterly direction. No mitigation action was required.

4.7 Marine Mammal Acoustic Detections

4.7.1 Humpback whale (Megaptera novaeangliae)

The humpback whale is a widely distributed species, occurring seasonally in all oceans worldwide, with distinct populations located in virtually every sea. All populations except one (in the Arabian Sea) undertake migrations between breeding and feeding grounds (Fleming & Jackson, 2011). This is a familiar whale, with a stout, robust body and very long pectoral fins (up to 1/3 of the body *length) that have a series of bumps known as tubercles on them. The head is rounded and flat and also covered in tubercles. The dorsal fin is located 2/3 along the back and is low, often sitting on a raised hump of tissue and is highly variable in shape and size (Jefferson et al., 2008). Flukes are large, with a serrated trailing edge and are often raised high during diving (Shirihai & Jarrett, 2006). The humpback whale is black to blue-black in colour, with pale to white undersides that show black markings that vary according to the individual. They measure between 11-17 m in length, with the females generally larger than the males, and they weigh up to 35 tonnes (Jefferson et al., 2008). The blow is bushy but visible, reaching 2.5 to 3 m (Shirihai & Jarrett, 2006). Humpback whales are 'gulp' feeders; although unlike other species have many varied methods of feeding, including lunge feeding, tail flicking and bubble-netting (Fleming & Jackson, 2011). Humpback whales often congregate in large, loose groups for breeding and feeding (Shirihai & Jarrett, 2006). The mating system is thought to be male-dominance polygyny, where males compete for individual females and exhibit competitive behaviour. The 'song' of male humpback whales is a long, complex vocalisation produced usually on the winter breeding grounds, but also on migration and seasonally on feeding grounds. Studies suggest the song is used to advertise for females and to establish dominance amongst males (Fleming & Jackson, 2011). Available population estimates total more than 60,000 animals with populations continuing to increase; therefore the species is listed as 'Least Concern' on the IUCN Red List (IUCN, 2015). However concern does remain about apparent discrete and small subpopulations for which information remains lacking.*

On 2nd July at 04:41h, there was a low frequency acoustic detection identified of a probable humpback whale during the hours of darkness (Figure 4.12). The spectrogram showed a tonal down-sweep vocalisation centred at 300Hz with a harmonic at 700Hz lasting 2-3 seconds in duration. It was not possible to determine distance and bearing to the sound source. Survey operations were active at the time of the acoustic detection but no mitigation action was required.

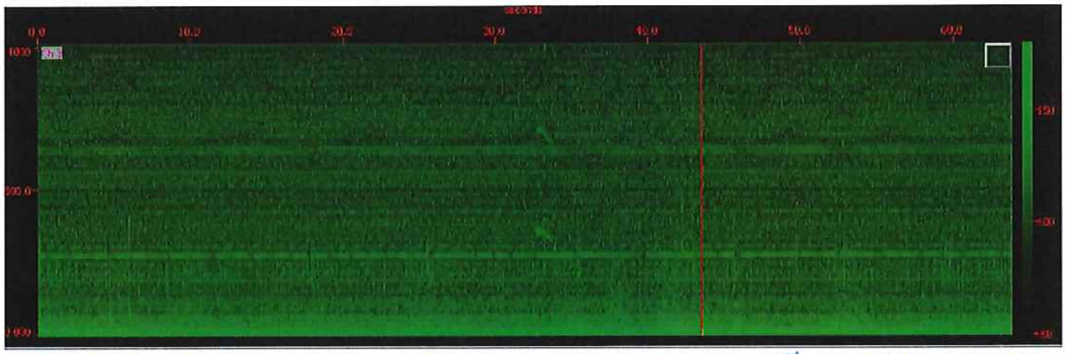

Figure 4.12 Acoustic detection of humpback whale recorded on 2nd July 2015 during the geotechnical survey

4.7.2 Unidentified dolphin species

On 3rd July between 09:37h and 10:20h, acoustic detections of whistles from unidentified dolphins were detected on the spectrogram (Figure 4.13). The spectrogram showed frequency modulated whistles ranging between 6 – 18 kHz. Survey operations were active at the time of the acoustic detections but no mitigation action was required.

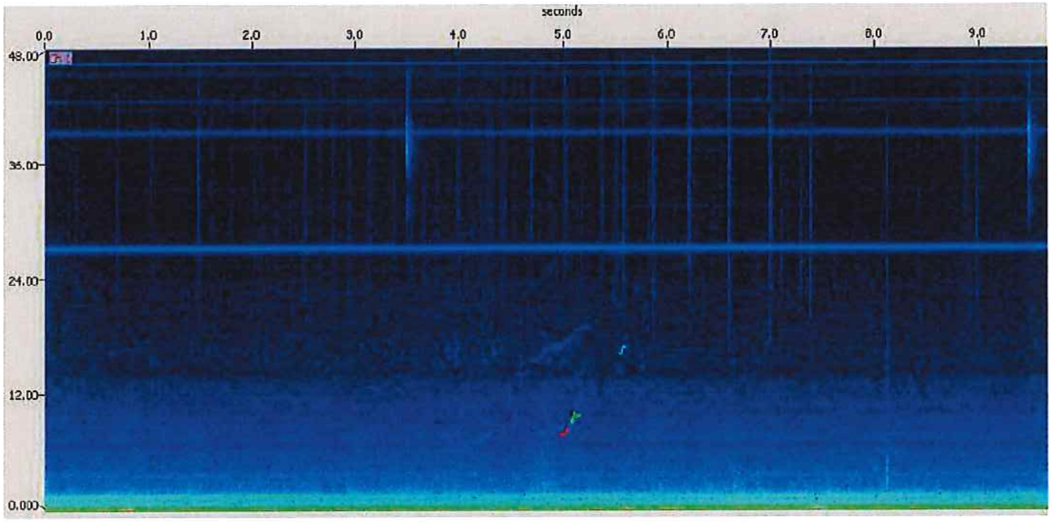

Figure 4.13 Acoustic detection of an unidentified dolphin recorded on 3rd July 2015 during the geotechnical survey

On 7th July between 01:15h and 02:02h, acoustic detections from a group of unidentified dolphins were detected on the spectrogram whilst survey operations were active. The vocalisations consisted of whistles ranging between 8 – 24 kHz (Figure 4.14), echolocation clicks and frequency modulated burst pulses (Figure 4.15).

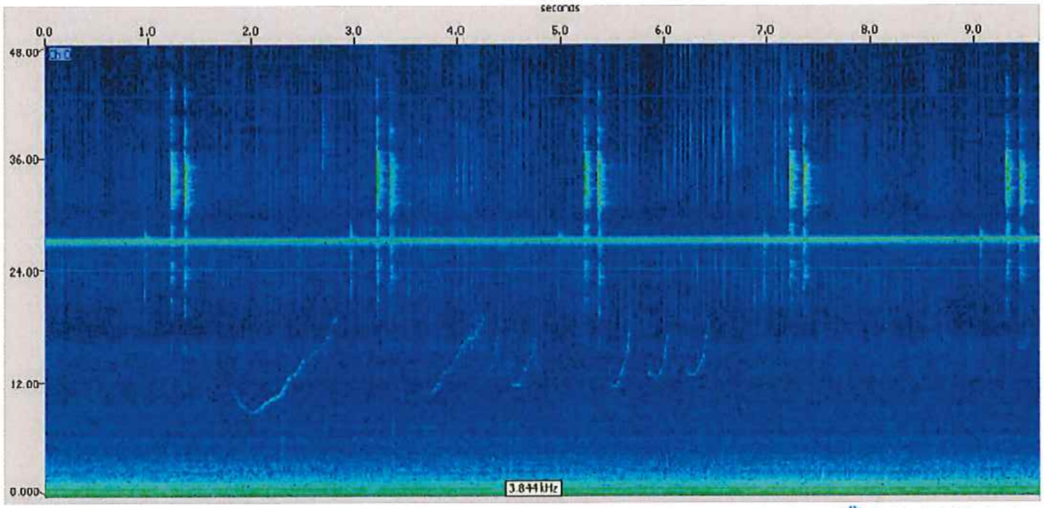

Figure 4.14 Acoustic whistle detection of unidentified dolphins recorded on 7th July 2015 during the geotechnical survey

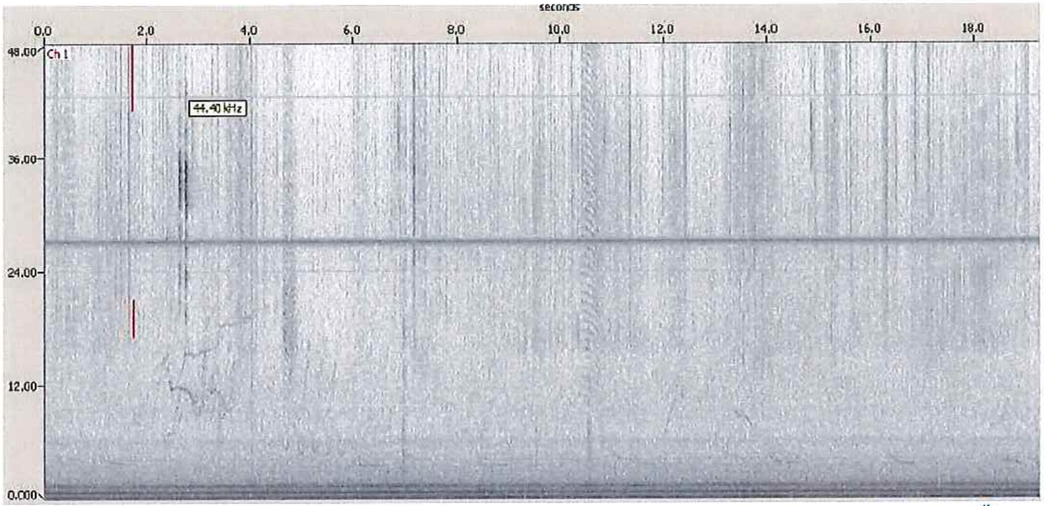

Figure 4.15 Acoustic click and burst pulse detection of unidentified dolphins recorded on 7th July 2015 during the geotechnical survey

4.8 Comparison of Detection Methods

During the geotechnical survey, three different detection methods were used. PAMS was operated 24-hours a day during data acquisition to detect cetaceans acoustically, while reticule binoculars were used during daylight hours and night-vision binoculars with COTI were used at night, to detect marine mammals and sea turtles visually.

There was one sighting of cetacean (unidentified dolphins) recorded whilst PAMS was deployed. There was five sightings of cetaceans (two bottlenose dolphins and three unidentified dolphins including one dead species) recorded while PAMS was not deployed either when waiting on weather or during transit to site (Figure 4.16). There were three further acoustic detections of one during daylight and two during hours of darkness.

All sightings of cetaceans occurred during daylight hours. None were visually detected at night (Figure 4.16).

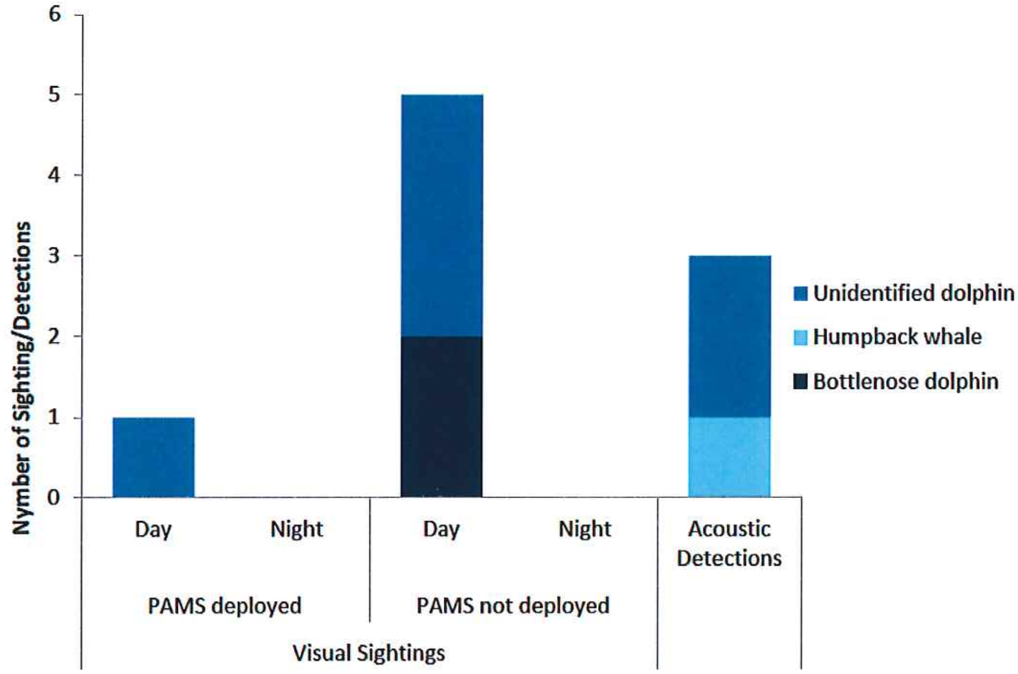

Figure 4.16 Number of visual sightings and acoustic detections of cetaceans during the geotechnical survey including transit when PAMS was not deployed

In addition to cetacean sightings, there were five sightings of loggerhead turtle, one sighting of a leatherback turtle and four sightings of unidentified turtles. Of these, two were sighted during hours of darkness and eight were sighted during daylight hours (Figure 4.17).

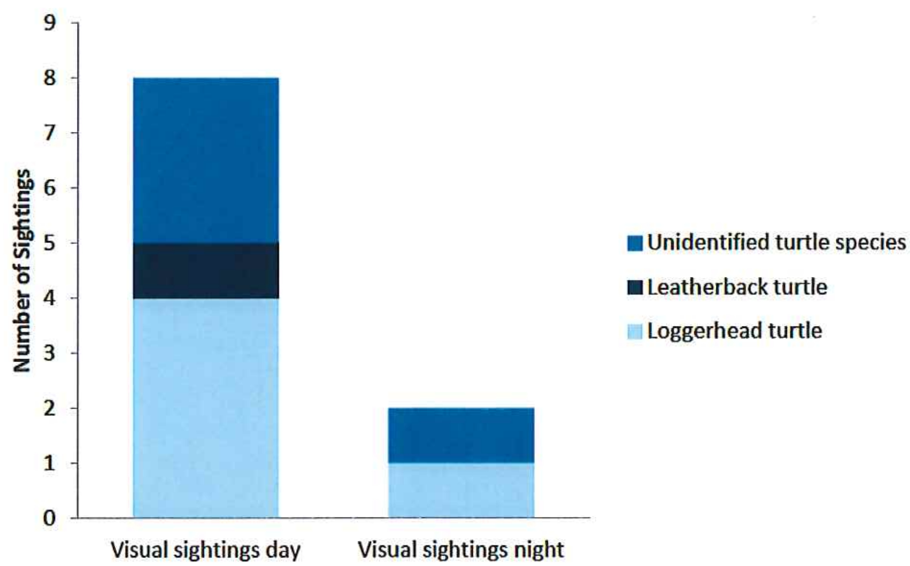

Figure 4.17 Number of visual sightings of sea turtles during the geotechnical survey

4.9 Accuracy of Distance Estimation Instruments

During the geotechnical survey, the PSOs used two methods to estimate distance of marine mammals or sea turtles from the vessel during daylight hours: reticule binoculars and range finder sticks. Both instruments were calibrated regularly against the vessel's radar with objects such as other vessels and the results were recorded in a standardised form. The minimum distance that was used for calibration was 470 m – any objects that were observed closer than this to the *M.V. Discovery* were too small to be detected by radar and therefore could not be used for calibration of the visual equipment. A table detailing the recorded distances can be found in Appendix E.

A comparison of the average differences in the accuracy of distance estimation showed that the range finder stick and reticule binoculars had a similar percentage error of 6.7% and 6.9% respectively. Both pieces of equipment tended to underestimate distance more than overestimate, for the reticular binoculars nine out of 15 measurements were underestimated, whilst 11 out of 15 measurements were underestimated using the range finder stick.

At distances less than 1000m, the errors of the range finder and reticule binoculars were reduced to 3.5% and 0.6%, respectively. It is therefore clear that both measuring devices are more accurate at distances less than 1000 m from the observer. Within the mitigation zones themselves (50 – 500 m), few calibrations were possible, however it is likely that these errors will be low.

Figure 4.18 shows the errors of the range finders and reticule binoculars out to a distance of 3000 m compared against the true values taken from the vessel's radar.

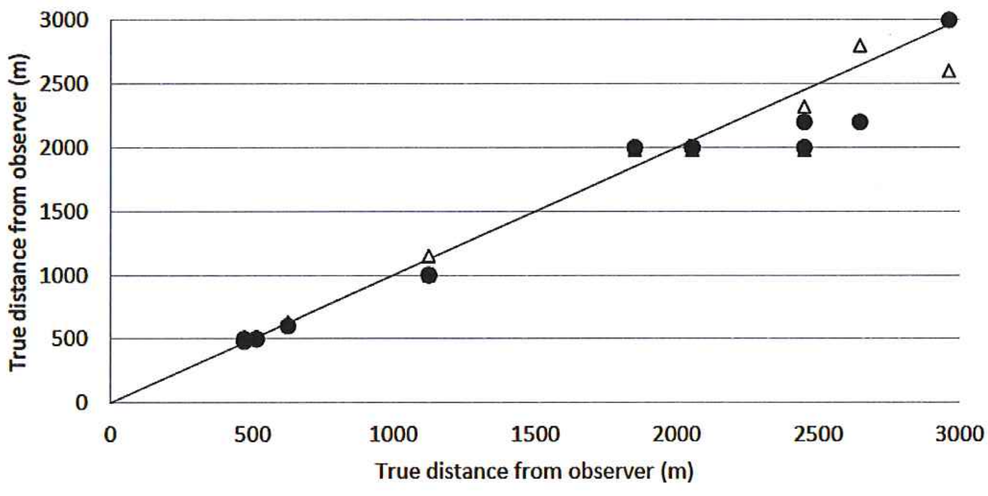

Figure 4.18 Comparison of distances measured using ship's radar (solid line), range finder stick (filled circles) and reticule binoculars (open triangles) out to 3000 m

5. DISCUSSION

5.1 Marine Mammal and Sea Turtle Detection

Marine mammal and sea turtle research carried out previously within the waters of the eastern Atlantic off Maryland have recorded 24 cetacean species, two species of pinniped and four species of sea turtle occurring throughout the year (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015). While these species occur in spatially distinct areas (Kenney *et al.,* 1997; NOAA 2014; IUCN 2015), and not necessarily in the current survey area, it must be remembered that marine mammals and sea turtles are highly mobile. It was therefore anticipated that marine mammal and sea turtle encounters were possible, and as such visual and acoustic monitoring was conducted during all operations including transit to and from site.

The spatio-temporal distribution and high mobility of marine mammals and sea turtles may also have had an effect on detection. Many species of marine animal migrate at certain times of the year, primarily in relation to prey abundance and distribution, breeding opportunities and availability of space (Stern, 2002; Plotkin, 2003). In the survey area the distribution of marine mammals and turtles is seasonally variable (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015). Therefore certain species may not have been present, or present in abundance, in the area during the survey period.

5.2 Comparison of Detection Methods

During the geotechnical survey between 16th June and 9th July there were 16 visual sightings of marine mammals and turtles and three acoustic detections of marine mammals. Of the visual sightings, 14 occurred during daylight and two during night time operations. Of the acoustic detections one occurred during daylight and two during night time operations.

Weather can affect the ability to detect marine animals in a number of ways, with increasing sea state, wind force and decreasing visibility reducing the detection probability of marine animals (Forney, 2000) particularly those with inconspicuous surfacing behaviour such as the harbour porpoise (Palka, 1996). Weather conditions recorded during marine mammal and sea turtle monitoring were predominantly good. Sea states were generally slight with a low swell and good visibility during daylight hours so conditions are were not likely to have significantly affected the visual detection of marine mammal or turtle species. As with daylight visual detection, poor weather conditions and high sea states have a negative effect on detection ability; this may have more effect during hours of darkness.

Night vision binoculars with COTI are most effective at close distances. Their effectiveness is greatest within 300 m of the vessel and decreases thereafter however the 500 m range can still be patrolled effectively and the likelihood of detecting a large animal such as the north Atlantic right whale at this distance is still high.

All but one sighting of cetacean was observed outside 500 m and none were observed within the 200 m mitigation zone therefore it is not unexpected that there were only two visual sightings at night. Marine turtles often remain below the surface which can make night time visual detection difficult however the two night time visual detections during the survey were turtles.

During the hours of darkness the observer is not able to scan the horizon with the naked eye, this has the potential to narrow the field of view for the observer however this can be averted if this is taken into account by the observer and they alter their visual scanning accordingly to increase the chances of detecting animals.

PAMS is a highly reliable technique for detecting marine mammals at night however animals must be vocalising in order to be detected therefore it is ineffective at monitoring turtle and pinniped species which are not known to vocalise underwater. Over half of the visual sightings were of turtles therefore it is expected that during this survey PAMS will have a lower detection rate than visual observations.

For some species, particularly baleen whales, vocal activity may vary with season, location, behaviour and gender (Mellinger *et al.*, 2007; Boisseau *et al.*, 2008). Some species of cetacean are notoriously difficult to monitor acoustically, for example the beaked whales (Barlow & Gisner, 2006). Despite this many species of cetacean are audible for a greater proportion of time than they are visible at the surface (Gordon *et al.*, 2003). In general PAMS has the advantage of being able to detect elusive or small mammals, like the harbour porpoise, that can often be missed by observers during unfavourable weather conditions and the hours of darkness (O'Brien, 2009).

Of the six cetacean sightings, four occurred when drilling was not taking placed therefore PAMS was not deployed and one of these sightings was of a dead delphinid. The final sighting occurred ten minutes after a PAMS detection which may have been the same pod of dolphins. The two other detections occurred during hours of darkness. The detection of a probable humpback whale was estimated by the operator to be at least one kilometre away, meaning a visual sighting would have been less likely.

During this project the PAMS was vertically deployed as the vessel was stationary during operational periods. This meant that it was hard to estimate distances of detections.

5.3 Accuracy of Distance Estimation Instruments

Comparison of the accuracy of distance estimation between reticule binoculars and range finder sticks with objects (e.g. other boats) on the vessel's radar revealed that both pieces of equipment has a similar accuracy overall with both range finders and reticule binoculars being highly accurate within 1000 m of the observer, which more than adequately covers the mitigation zones in place during the current survey.

5.4 Marine Mammal and Sea Turtle Encounters

During the survey two species of cetacean were positively identified and at least one other species of cetacean was encountered during the unidentified species detections (visual and acoustic). No species of pinniped and two species of sea turtle were identified. All protected species identified are commonly encountered within the region (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015). Bottlenose dolphins are resident along the eastern United States coastline. Loggerhead turtles are annual visitors to the area during the summer months (Shoop, 1987). Although less common, Leatherback turtles are also a common inhabitant to the region (Shoop, 1987).

There four occasions when cetaceans' species were encountered while the drilling equipment was active, equalling the number of encounters when drilling was inactive. No conclusions could be drawn from the observed behaviours to indicate whether the cetaceans were avoiding the drilling vessel.

There were four sightings of turtles while drilling operations were ongoing, and the animals did not exhibit any adverse behavioural reactions during any of these encounters. There was two delays to operations on the 7th July due to the presence of turtles. Operations were delayed for 60 minutes after each encounter.

The sighting of a dead dolphin occurred during the transit to the survey area, and thus the animals death could not have been caused by the geotechnical survey activity. The full details of the incident were immediately relayed to the appropriate authorities, and is included in the appendix (Appendix B)

5.5 Recommendations

In order to minimise the impacts on marine mammals and sea turtles the geotechnical survey was run in accordance with a dedicated MMMP. The MMMP implemented during the survey successfully achieved a high standard of mitigation suitable for the project. This success relied on the use of experienced and dedicated observers.

The passive acoustics system was limited in its ability to estimate distance in this instance due to the vertical deployment method which prevented time of arrival calculations on acoustic signals. A three dimensional array would be beneficial in future situations when the passive acoustics deployment platform is stationary.

Using of a number of detection methods in conjunction with each other increases the effectiveness of detection of all animals in the area. All methods available have some form of limitation however using various detection methods will allow the effect of this to be minimised. It is therefore recommended that there is continued use of 24 hour operations is for further projects, utilising more than one detection method.

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APPENDICES

APPENDIX A MARINE MAMMAL MITIGATION PLAN

APPENDIX B INJURED OR DEAD PROTECTED SPECIES INCIDENT REPORTS

INCIDENT REPORT: PROTECTED SPECIES INJURY OR MORTALITY

Photographs and/or video footage should be taken of all injured or dead animals, if possible

Observer's full name and/or Reporter's full name: Gareth Duguid
Date and Time animal observed: 22nd June 2015 @ 10:49 UTC
Date and Time animal/samples collected: N/A
Location of Incident (Latitude/Longitude): 38° 35.55N 74°52.45W
Species Identification (closest taxonomic level possible): Delphinid, probable bottlenose dolphin
Photograph/Video footage collected: YES
If Yes, was the data provided to NMFS? YES
Name of vessel, vessel speed at the times of incident, and activity ongoing at the time of observation (e.g. transit, survey, pile driving): M.V. Ocean Discovery, 5.9 knots, transit to survey site.

Environmental conditions at time of observation (i.e. Beaufort sea state, cloud cover, wind speed, glare): Slight seas, low swell, NW force 2, 2 Oktas, strong glare, good visibility.

Water temperature (°C) and depth at site of observation: Unknown temperature, 28.7m depth
Describe location of animal and events leading up to, including, and after, the incident: Carcass was observed on the starboard side approximately 400m away from the vessel as we proceeded south-east on transit to survey site from Baltimore.

Status of all sound-source use in the 24 hours preceding the incident: None, in port for previous 24hrs.

Describe all marine mammal, sea turtle, and sturgeon observations in the 24 hours preceding the incident:
Observation was made 30 minutes after a sighting of approximately 40 bottlenose dolphins off the port quarter, heading in the opposite direction. Probable basking shark sighting made at 09:20 UTC.

Marine Mammal Information:
Injuries observed: No obvious injury
Condition/description of animal: Animal was moderately decomposed, bloated and appeared to have an area of skin and blubber missing on it's belly where it had most likely been pecked by seabirds.

Other remarks:

Date and time of incident reported to NMFS Stranding Hotline:
22nd June 2015 @ 12:20 UTC

APPENDIX C COMPLETED JNCC RECORDING FORMS

The completed JNCC forms can be found in the Excel document entitled (10505_USWind_Discovery).

APPENDIX D BEAUFORT WIND, SEA CONDITIONS AND VISIBILITY

WIND SPEED

Beaufort Scale	Name	Knots	Metres/second
0	Calm	0 - 1	0 - 0.2
1	Light air	1 - 3	0.3 - 1.5
2	Light breeze	4 - 6	1.6 - 3.3
3	Gentle breeze	7 - 10	3.4 - 5.4
4	Moderate breeze	11 - 16	5.5 - 7.9
5	Fresh breeze	17 - 21	8.0 - 10.7
6	Strong breeze	22 - 27	10.8 - 13.8
7	Near gale	28 - 33	13.9 - 17.1
8	Gale	34 - 40	17.2 - 20.7
9	Strong gale	41 - 47	20.8 - 24.4
10	Storm	48 - 55	24.5 - 28.4
11	Violent storm	56 - 63	28.5 - 32.6
12	Hurricane	64+	32.7+

SEA STATE

Symbol	Name	Height in metres
0	Calm (glassy)	0
1	Calm (rippled)	0 – 0.10
2	Smooth (wavelets)	0.10 – 0.50
3	Slight	0.50 – 1.25
4	Moderate	1.25 – 2.50
5	Rough	2.50 – 4.00
6	Very rough	4.00 – 6.00
7	High	6.00 – 9.00
8	Very high	9.00 – 14.00
9	Phenomenal	14.00+

VISIBILITY

Name	Visibility (nautical miles)
Fog or dense snow fall	Less than 0.5
Poor visibility	0.5 – 2.0
Moderate visibility	2.0 – 5.0
Good visibility	5.0 – 25.0
Very good visibility	More than 25.0

APPENDIX E MONITORING EQUIPMENT CALIBRATION FORMS

Calibration For Distance Estimation								
Week #	Date	Name of Observer	Reticule Binoculars Distance (m)	Range Finder Distance (m)	Distance provided by the system onboard (m)	Sea state (Beaufort Scale)	Wind force (Beaufort Scale)	Swell
1	22/06/2015	G. Duguid	1980	2000	2055	2	2	low
1	22/06/2016	R. Price	1980	2000	1852	2	2	low
1	22/06/2017	G. James	1980	2000	2055	2	2	low
1	22/06/2018	L. Buckland	2600	3000	2963	2	2	low
1	22/06/2019	C. Gilchrist	1980	2000	2055	2	2	low
2	29/06/2015	G. Duguid	510	500	513	4	4	low
2	29/06/2015	R. Price	630	600	625	4	4	low
2	29/06/2015	G. James	510	500	513	4	4	low
2	29/06/2015	L. Buckland	510	480	470	4	4	low
2	29/06/2015	C. Gilchrist	510	500	470	4	4	low
3	06/07/2015	G. Duguid	1150	1000	1126	4	4	low
3	06/07/2015	R. Price	1980	2000	2452	5	5	low
3	06/07/2015	G. James	1000	1000	1126	4	4	low
3	06/07/2015	L. Buckland	2320	2200	2452	5	5	low
3	06/07/2015	C. Gilchrist	2800	2200	2646	4	4	low

APPENDIX F PASSIVE ACOUSTIC MONITORING SYSTEM SPECIFICATIONS

General	
Manufacturer	Gardline Environmental Ltd
Model	MK3
Towed streamer section	
Length	N/A integrated into tow cable
Section diameter	14/16mm over cable, 24/29mm over mouldings
Number of Hydrophones	4
Hydrophone type	Custom Built by Gardline Environmental Ltd 1 low frequency 3 broadband frequency
Receive sensitivity (dB re 1 V/µPa)	-204
Hydrophone separation	Hydrophone 1 and 2 0.25 m Hydrophone 2 and 3 1.2 m Hydrophone 3 and 4 1.2 m
Preamplifiers	4 broadband
Preamplifier type	Sensor Technology SA-02
Depth sensor manufacturer	SensorTechnics
Tow cable	
Length	250 m
Diameter	14 mm
Termination	37 pin CEEP Connectors
Deck cable	
Length	100 m
Diameter	14 mm
Termination	37 pin CEEP Connectors

Appendix J

Threatened and Endangered Species Information

Threatened and Endangered Species Information

Maryland Offshore Wind Project
Lease OCS-A 0490

PREPARED FOR:
US Wind, Inc.
401 East Pratt Street
Baltimore, Maryland 21202

PREPARED BY:
ESS Group, Inc.
10 Hemingway Drive, 2nd Floor
East Providence, RI 02915

May 4, 2020

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TABLES

FIGURES

1.0 FISHERIES AND ESSENTIAL FISH HABITAT (§ 585.611(B)(3-5))

The following section provides additional information about fisheries and essential fish habitat (EFH) within the Maryland (MD) Wind Energy Area (WEA).

Table 1.1 Major Fish Species Potentially Occurring in the Lease Area

Species	Habitat Association	EFH in Project Area	Commercial / Recreational Importance
Albacore tuna *(Thunnus alalunga)*	Pelagic	●	●
Alewife (*Alosa pseudoharengus*)	Pelagic		●
American eel (*Anguilla rostrata*)	Demersal		
American shad (*Alosa sapidissima*)	Pelagic		●
Atlantic angel shark *(Squantina dumeril)*	Demersal	●	
Atlantic butterfish *(Peprilus triacanthus)*	Demersal / Pelagic (spring to fall)	●	●
Atlantic cod *(Gadus morhua)*	Demersal	●	●
Atlantic croaker *(Micropogonias undulates)*	Demersal		●
Atlantic herring *(Clupea harengus)*	Pelagic	●	●
Atlantic mackerel *(Scomber scombrus)*	Pelagic	●	●
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)	Pelagic	●	
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*)	Demersal		
Atlantic surf clam (*Spisula solidissima*)	Benthic	●	
Bay anchovy (*Anchoa mitchilli*)	Pelagic		●
Black sea bass *(Centropristis striata)*	Demersal	●	●
Blueback herring (*Alosa aestivalis*)	Pelagic		
Bluefin tuna *(Thunnus thynnus)*	Pelagic	●	●
Bluefish *(Pomatomus saltatrix)*	Pelagic	●	●
Blue shark (*Prionace glauca*)	Pelagic	●	
Broad striped anchovy (*Anchoa hepsetus*)	Pelagic		
Clearnose skate *(Raja eglanteria)*	Demersal	●	
Common thresher shark (*Alopias vulpinus*)	Pelagic	●	
Crevalle jack (*Caranx hippos*)	Pelagic		●
Dusky shark *(Carcharhinus obscurus)*	Pelagic	●	●
Little skate *(Leucoraja erinacea)*	Demersal	●	
Longfin inshore squid (*Doryteuthis pealeii*)	Pelagic		●
Monkfish (*Lophius americanus*)	Demersal	●	●
Mummichog (*Fundulus heteroclitus*)	Demersal		
Northern sea robin *(Prionotus carolinus)*	Demersal		
Red hake *(Urophycis chuss)*	Demersal	●	●
Sand tiger shark *(Carcharias taurus)*	Pelagic	●	●
Sandbar shark *(Carcharhinus plumbeus)*	Pelagic	●	●

Species	Habitat Association	EFH in Project Area	Commercial / Recreational Importance
Scup *(Stenotomus chrysops)*	Demersal (fall) / Pelagic	●	●
Shortfin mako *(Isurus oxyrinchus)*	Pelagic	●	●
Shortnose sturgeon (*Acipenser brevirostrum*)	Demersal		
Silver hake (*Merluccius bilinearis*)	Demersal (night) / Pelagic (day)	●	●
Skipjack tuna *(Katsuwonus pelamis)*	Pelagic	●	●
Smoothhound shark *(Mustelus canis)*	Demersal	●	
Spiny dogfish *(Squalus acanthias)*	Demersal	●	●
Spot *(Leiostomus xanthurus)*	Demersal		●
Spotted hake *(Urophycis regia)*	Demersal		
Summer flounder *(Paralichthys dentatus)*	Demersal	●	●
Tautog (*Tautoga onitis*)	Demersal		
Tiger shark (*Galeocerdo cuvier)*	Pelagic	●	
Weakfish *(Cynoscion regalis)*	Demersal		
Windowpane flounder *(Scopthalmus aquosus)*	Demersal	●	
Winter flounder (*Pseudopleuronectes americanus*)	Demersal	●	●
Winter skate *(Leucoraja ocellata)*	Demersal	●	
Witch flounder (*Glytocephalus cynoglossus*)	Demersal	●	
Yellowfin tuna *(Thunnus albacares)*	Pelagic	●	●
Yellowtail flounder *(limanda ferruginea)*	Demersal	●	●

1.1 Threatened and Endangered Fish

1.1.1 Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)

The Atlantic sturgeon is an estuarine-dependent, anadromous species that is found along the eastern coast of North America from Canada to Florida. They spend the majority of their lives in the marine environment, but spawn in freshwater. They are present in 36 coastal rivers in the United States, and spawning takes place in at least 20 of these rivers. Larvae and juveniles remain in riverine or estuarine areas where they were spawned and move to higher salinity waters as subadults. Subadults and adults migrate seasonally throughout marine waters. In the summer, they are found in shallow waters of about 10 to 20 m (32.8 to 65.6 ft), and in the winter, they move to deeper waters of about 20 to 50 m (65.6 to 164.0 ft). Current threats to Atlantic sturgeon include ship strikes, bycatch, habitat degradation/loss, and habitat impediments such as dams (BOEM 2013) (NOAA 2017a). Critical habitat for the New York Bight Distinct Population Segment (DPS) of Atlantic sturgeon includes approximately 547 km (340 mi) of aquatic habitat in the Hudson, Connecticut, Housatonic, and Delaware Rivers (82 FR 39160), and does not coincide with the Project Area.

In 2011, telemetered Atlantic sturgeon were detected in nearshore waters off the coast of Maryland, along the southern end of the Delmarva Peninsula. Atlantic sturgeon were observed in shallow, well-mixed, relatively warm freshwater near the 25 m (82 ft) isobath and appeared to be associated with a water mass tied to Delaware Bay (Oliver *et al*. 2013). Additionally, matching telemetry records with derived seascapes indicate that Atlantic sturgeon prefer a seascape that is associated with the coastline of Delaware Bay and the Atlantic Ocean, with a mean temperature of 19.8°C (67.6 ^{o}F)and mean reflectance of 0.0073 sr^{-1} at 443 mm (1.45 ft) (Breece *et al*. 2016). Based on these studies, Atlantic sturgeon would be more likely to occur near the coast rather than further offshore in the WEA.

1.1.2 Shortnose Sturgeon (*Acipenser brevirostrum*)

The shortnose sturgeon is an anadromous species found in large rivers and estuaries of the North America eastern seaboard from the St. John River in Florida to the St. Johns River in Canada, including in the Delaware River. Adults migrate downstream in fall and upstream in spring to spawn. Larvae and juveniles are found in deep channels of rivers with strong currents. Shortnose sturgeon are most commonly found in the estuary of their respective river. While they do occasionally enter the marine environment, they generally remain close to shore, and are not likely to be present in the WEA (Moser and Ross 1995, Collins and Smith 1997, Dadswell et al. 1984). Current threats to shortnose sturgeon include dams, pollution, and habitat alteration (NOAA 2015a).

1.1.3 Other Species of Concern

Three shark species, including the dusky shark, the porbeagle shark, and the sand tiger shark, are considered species of concern and may be found in the mid-Atlantic. The dusky shark may be found in the mid-Atlantic, occurring from the surf zone to well offshore, and from surface waters to depths of 39.6 m (130 ft). The dusky shark is not commonly found in estuaries due to a lack of tolerance for low salinities. The species migrates northward in summer and southward in fall. Sand tiger sharks may also be found in the mid-Atlantic. They are generally a coastal species, usually found from the surf zone to depths of about 22.9 m (75 ft). They are, however, sometimes found at depths of 182.9 m (600 ft). Porbeagle sharks are pelagic and rarely enter shallow coastal waters. They are distributed in the water column from the surface down to depths of up to 305 m (1,000 ft). On the Atlantic Outer Continental Shelf (OCS) the species range from Maine to New Jersey with the primary concentration the Gulf of Maine and Georges Bank.

Atlantic bluefin tuna (*Thunnus thynnus*) is a highly migratory, pelagic species that is found from the Gulf of Mexico to Newfoundland in coastal and open ocean environments (NOAA 2020). Spawning occurs principally in the Gulf of Mexico from mid-April to June (NOAA 2020).

Herrings and smelts are generally found throughout the mid-Atlantic in nearshore waters, coastal bays and estuaries up to spawning grounds in upstream riverine habitats. Their decline has generally been attributed to loss of upstream habitat due to man-made impediments (i.e., dams) and fishing pressure.

American eel (*Anguilla rostrata*) are found in fresh, brackish, and coastal waters from the southern tip of Greenland to northeastern South America. American eels begin their lives as eggs hatching in the Sargasso Sea. They take years to reach freshwater streams where they mature, and then they return to their Sargasso Sea birth waters to spawn and die. Threats to American eel include habitat loss, including riverine impediments, pollution and nearshore habitat destruction; and fishing pressure (Greene et al. 2009).

2.0 MARINE MAMMALS AND SEA TURTLES (§ 585.611(B)(3-5))

The following section provides additional information about marine mammals and sea turtles in the MD WEA.

2.1 Marine Mammals

Table 2.1 Marine Mammals with Potentially Occurring in the Lease Area

Common Name	Scientific Name	Stock	ESA/MMPA Status[a]	Best Abundance Estimate of Stock[b]	Max Density in Lease Area (#/km^2)	Month of Max density
Order Cetacea						
Baleen Whales (Mysticeti)						
North Atlantic right whale	*Eubalaena glacialis*	Western North Atlantic	E	451	0.0018	Dec - March
Fin whale	*Balaenoptera physalus*	Western North Atlantic	E	1,618	0.0040	September
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine		896	0.0018	January
Minke whale	*Balaenoptera acutorostrata*	Canadian East Coast		2,591	0.0040	May
Sei whale	*Balaenoptera borealis*	Nova Scotia	E	357	0.0002	April
Toothed Whales (Odontoceti)						
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic		48,819	0.0284	April
Bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic Offshore; W. N. Atl. Northern Migratory Coastal	D[c]	77,532; 6,639	0.7492	June
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/ Bay of Fundy		79,883	0.1068	March
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic		5,636	0.0022[e]	Annual
Risso's dolphin	*Grampus griseus*	Western North Atlantic		15,197	0.0012	July
Short-beaked common dolphin	*Delphinus delphis*	Western North Atlantic		70,184	0.2375	January
Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic		28,924	0.0022[e]	Annual
Sperm Whale	*Physeter macrocephalus*	North Atlantic	E	2,288	0.0005	July
Order Carnivora						
Earless seals (Phocidae)						
Harbor seal	*Phoca vitulina*	Western North Atlantic		75,834	0.0974	Fall, Winter, Spring
Gray seal	*Halichoerus grypus*	Western North Atlantic		27,131	0.0974[f]	Annual

Common Name	Scientific Name	Stock	ESA/MMPA Status[a]	Best Abundance Estimate of Stock[b]	Max Density in Lease Area (#/km^2)	Month of Max density

[a]All species are protected under the MMPA, D = Depleted under the MMPA, E = Endangered under the ESA, T= Threatened under the ESA
[b]Source: NOAA Stock Assessment Reports (Hayes et al. 2017, 2018, 2019; Waring et al. 2016, 2015, 2014, 2008). UNK indicates that stock size is unknown.
[c]Western North Atlantic Northern Migratory Coastal stock only
[d]Estimated abundance includes both dwarf and pygmy sperm whales
[e]Estimated density includes both long-finned and short-finned pilot whales
[f]Gray seal density estimates are based on estimated harbor seal density.

2.2 ESA-listed Marine Mammal Species Profiles

2.2.1 North Atlantic Right Whale (*Eubaelena glacialis*)

North Atlantic right whales (NARW) are among the rarest of all marine mammal species. They average approximately 15.25 meters (50 feet) in length and can weigh about 63,503 kilograms (70 tons) (NOAA Fisheries 2019b). They have stocky, black bodies with no dorsal fin, and bumpy, coarse patches of skin on their heads called callosities. Right whales are slow moving grazers that feed on dense concentrations of prey, primarily zooplankton and copepods belonging to the *Calanus* and *Pseudocalanus* genera (Hayes et al. 2019), at or below the water's surface, as well as at depth (NOAA Fisheries 2019b). Research suggests that NARW must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall NARW habitats (Kenney et al. 1986, Kenney, Winn, and Macaulay 1995). Historically, the population suffered severely from commercial overharvesting and has more recently been threatened by incidental fishery entanglement and ship strikes. The NARW is a strategic stock[1] and is listed as endangered under the Endangered Species Act (ESA). This species is also currently experiencing an unusual mortality event (NOAA Fisheries 2020).

These baleen whales have two separate stocks: the eastern and western Atlantic stocks. The NARW occurring in U.S. waters belong to the western Atlantic stock. The western Atlantic NARW population ranges primarily from calving grounds in coastal waters of the southeastern United States to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence (Hayes et al. 2019). The size of this stock is considered to be extremely low relative to its Optimum Sustainable Population (OSP) in the U.S. Atlantic Exclusive Economic Zone (EEZ). In the Western North Atlantic, right whales are subject to relatively high levels of injury and mortality from collisions with vessels and entanglement in fishing gear (Knowlton and Kraus 2001, Kraus et al. 2005). The minimum rate of annual human-caused mortality and serious injury to right whales averaged 5.56 individuals per year for the period of 2012 through 2016 (Hayes et al. 2019). The best available estimates of minimum NARW population size are 451 individuals (presented in the 2019 NOAA stock assessment report, (Hayes et al. 2019), and 411 individuals (based upon assessments published in the 2018 NARW annual report card (Pettis, Pace, and Hamilton 2018).

The NARW is a strongly migratory species that undertakes well-defined, strongly seasonal movements from their northeast feeding grounds (generally spring, summer and fall habitats) south along the U.S. east coast to their sole known calving and wintering grounds in the waters of the southeastern U.S.

[1] A strategic stock is defined by the MMPA as a stock for which the level of direct human-caused mortality exceeds the potential biological removal, is declining and is likely to be listed as threatened under the ESA in the foreseeable future, or is currently listed as threatened or endangered under the ESA of designated as depleted under the MMPA.

(Kenney and Vigness-Raposa 2009). Mid-Atlantic waters are a primary migration corridor during these seasonal migrations (Knowlton, Ring, and Russel 2002, Firestone et al. 2008). NARWs are usually observed in groups of less than twelve (12) individuals, and most often as single individuals or pairs. Larger groups may be observed in feeding or breeding areas (Jefferson, Webber, and Pitman 2008). Surveys have demonstrated the existence of seven areas where Western North Atlantic right whales congregate seasonally: the coastal waters of the southeastern United States; the Great South Channel; Jordan Basin; Georges Basin along the northeastern edge of Georges Bank; Cape Cod and Massachusetts Bays; the Bay of Fundy; and the Roseway Basin on the Scotian Shelf (Hayes et al. 2019). NMFS has designated two critical habitat areas for the NARW: The Gulf of Maine/Georges Bank region, and the southeast calving grounds from North Carolina to Florida. Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the North Atlantic right whale (Brown et al. 2009).

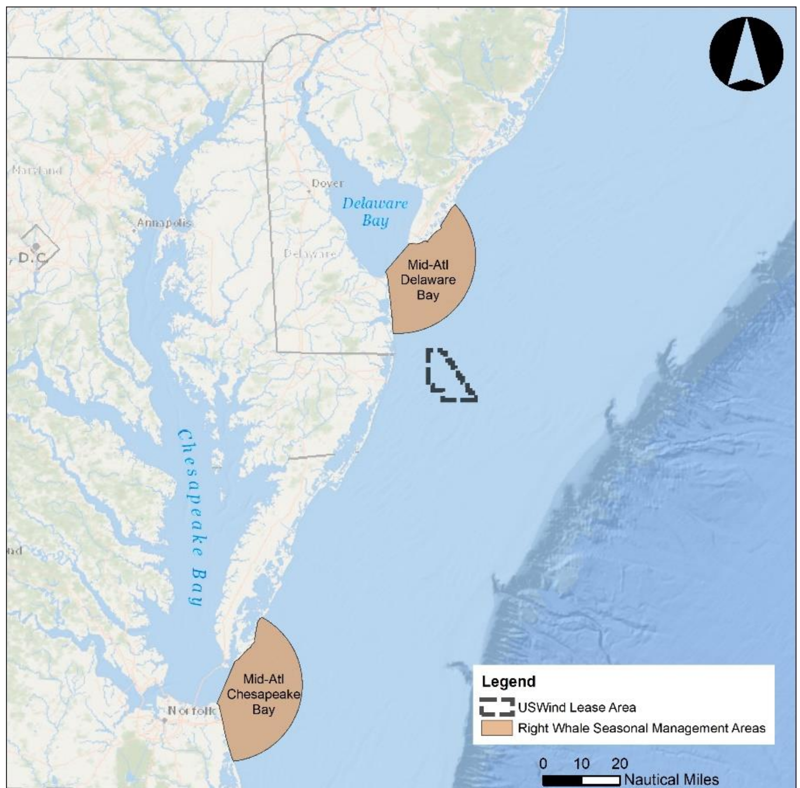

Figure 2.2.1. Right Whale Seasonal Management Areas

Observations from recent aerial and acoustic surveys indicate that NARW are present in the region of the Lease Area (Williams et al. 2015a, Bailey et al. 2018, Barco et al. 2015) This species was visually observed in the Mid-Atlantic in February and March (Williams et al. 2015a), and in the Lease Area from January to March (Williams et al. 2015a, Barco et al. 2015). However, acoustic data indicate that NARW are present in the vicinity of the Lease Area throughout the year, with maximum abundance reported during the late winter and early spring (Bailey et al. 2018). These findings align with observations from North Carolina and Georgia waters, where NARW were acoustically detected in all seasons (Hodge et al. 2015). These observation patterns suggest that though pulses of NARW travel through Mid-Atlantic waters during seasonal migrations, the region may also be a destination for non-breeding individuals (Barco et al. 2015). This species was not sighted during the 2015 High Resolution Geophysical (HRG) surveys of the Lease Area or the 2016 and 2017 HRG surveys of the proposed transmission cable route in offshore Maryland waters and Indian River Bay. Roberts et al. (2018, 2017, 2016) and Curtice et al. (2019) indicate that the highest density of NARW in the Lease Area and adjacent waters during the site characterization activity period (June through November) occurs in June and is estimated to be 0.01 individuals per 10 km grid square.

In order to protect this species, Seasonal Management Areas (SMAs) for reducing ship strikes of NARWs have been designated in the U.S. and Canada. All vessels greater than 19.8 meters (65 feet) in overall length must operate at speeds of 10 knots or less within these areas during seasonal time periods. The closest SMA is located approximately 13 km (7 nautical miles) from the northwestern portion of the Lease Area and is active between November 1 and April 30 each year (Figure 2.2.1).

2.2.2 Fin Whale (*Balaenoptera physalus*)

Fin whales are the second-largest species of baleen whale, with a maximum length of about 23 m (75 ft) in the Northern Hemisphere (NOAA Fisheries 2019a). These whales have a sleek, streamlined body with a V-shaped head, making them fast swimmers. This species has a distinctive coloration pattern; the dorsal and lateral sides of the body are black or dark brownish gray and the ventral surface is white. Fin whales feed on krill, small schooling fish (e.g. herring, capelin and sand lance), and squid by lunging into schools of prey with their mouths open (Kenney and Vigness-Raposa 2009). They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally (NOAA Fisheries 2019a). Fin whales are the most commonly sighted large whales in continental shelf waters from the Mid-Atlantic coast of the United States to Nova Scotia (Sergeant 1977, Sutcliffe and Brodie 1977, CeTAP 1982, Hain et al. 1992, Waring et al. 2015). The fin whale is listed as endangered under the ESA.

Fin whales off the eastern coast of the United States, Nova Scotia, and the southeastern coast of Newfoundland are believed to constitute a single Western North Atlantic stock under the present International Whaling Commission (IWC) scheme (Donovan 1991). The best abundance estimate available for the Western North Atlantic fin whale stock is 1,618 individuals (Hayes et al. 2019). The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown, but the North Atlantic population is listed as a strategic stock under the Marine Mammal Protection Act (MMPA). Like most other whale species present along the U.S. east coast, ship strikes and fisheries entanglements are perennial causes of serious injury and mortality. For the period 2012 through 2016, the minimum annual rate of human-caused mortality and serious injury to fin whales was 2.5 individuals per year (Hayes et al. 2019).

The fin whales' range in the Western North Atlantic extends from the Gulf of Mexico and Caribbean Sea, to the southeastern coast of Newfoundland in the north (Hayes et al. 2019). Fin whales are common in waters of the U. S. Atlantic EEZ, principally from Cape Hatteras northward. While fin whales typically feed in the Gulf of Maine and the waters surrounding New England, mating and calving (and general wintering) areas are largely unknown (Hayes et al. 2019). It is likely that fin whales occurring in the U.S. Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions. However, the popular notion that entire fin whale populations make distinct annual migrations like some other mysticetes has questionable support (Hayes et al. 2019). Based on an analysis of neonate stranding data, Hain et al. (1992) suggested that calving takes place during October to January in latitudes of the U.S. Mid-Atlantic region. Fin whales are the dominant large cetacean species during all seasons from Cape Hatteras to Nova Scotia, having the largest standing stock, the largest food requirements, and therefore the largest influence on ecosystem processes of any cetacean species (Hain et al. 1992, Kenney et al. 1997). There are currently no critical habitat areas established for the fin whale.

Recent acoustic and visual surveys indicate that fin whales are present in the region of the Lease Area in all seasons, and are relatively abundant in the area, compared to other baleen whale species (Williams et al. 2015a, Bailey et al. 2018, Barco et al. 2015). Though this species was not observed in Maryland waters during the Williams et al. (2015b) study, fin whales were the most frequently observed whale species during the Barco et al. (2015) surveys, and were one of the most frequently detected large whale species during the Bailey et al. (2018) study. This species was most abundant in the region of the Lease Area during the winter and early spring (Barco et al. 2015, Williams et al. 2015a), but is present in the area during all seasons, with lowest abundances likely occurring in summer and early fall (Bailey et al. 2018). These findings align with those of other passive acoustic surveys conducted to the south of the Lease Area in North Carolina, Georgia, and New Jersey, which detected fin whale presence year round (Rice et al. 2014, Geo-Marine 2010). Fin whales were not sighted during the 2015 HRG surveys of the Lease Area, or during 2016 and 2017 HRG surveys of the proposed transmission cable route in offshore Maryland waters and Indian River Bay. Roberts et al. (2018, 2017, 2016) and Curtice et al. (2019) indicate that the highest density of fin whales in the Lease Area and adjacent waters during the site characterization activity period (June through November) occurs in September and is estimated to be 0.40 individuals per 10 km grid square.

2.2.3 Sei Whale (*Balaenoptera borealis*)

Sei whales are large, sleek-bodied baleen whales that can reach 12-18 meters (40-60 feet) in length and dive for up 20 minutes (NOAA Fisheries 2019c). This species is dark-bluish gray to black in color, with a pale underside, and is usually observed in small groups of two to five individuals (NOAA Fisheries 2019c). Sei whales are largely planktivorous, feeding primarily on euphausiids and copepods, but will also feed on small schooling fishes and cephalopods (NOAA Fisheries 2019c). The sei whale is often found in the deeper waters characteristic of the continental shelf edge region (Hain et al. 1985), though they have been observed to make episodic and unpredictable incursions into shallower inshore waters (Hayes et al. 2017). This species is listed as endangered under the ESA.

Sei whales found in US Mid-Atlantic waters belong to the Nova Scotia stock, which includes the continental shelf waters north to Newfoundland. The best abundance estimate available for the Nova Scotia sei whale stock is 357 individuals (Hayes et al. 2017). However, this estimate is considered conservative as the surveyed area was only a portion of the sei whale range, and uncertainties exist regarding population structure and sei whale movement patterns (Hayes et al. 2017). Though ship strikes and fisheries entanglements are regarded as threats to this species, no confirmed fishery-related mortalities or serious injuries of sei whales were reported for the period of 2010 to 2014 (Hayes et al. 2017).

Though the distribution and movement patterns of the sei whale are not well known (NOAA Fisheries 2019c), the Nova Scotia sei whale stock is likely centered in northerly waters, perhaps on the Scotian Shelf, during much of the year (Mitchell and Chapman 1977). Sei whale abundance in U.S. waters is greatest in spring, with sightings concentrated along the southwestern and eastern margins of Georges Bank and into the Northeast Channel area (CeTAP 1982). Though the sei whale is a widely distributed and highly migratory species, it appears to be more restricted to mid-latitude temperate zones than other large whales (Reeves, Stewart, and Clapham 2002, Shirihai and Jarrett 2006, Jefferson, Webber, and Pitman 2008). The migratory pattern of this species is thought to encompass long distances from high-latitude feeding areas in summer to low-latitude breeding areas in winter; however, the location of winter areas remains largely unknown (Perry, DeMaster, and Silber 1999). The sei whale does not commonly occur in the Mid-Atlantic, and sightings reported from this area are likely to be extralimital. There are currently no critical habitat areas established for the sei whale.

Recent visual and acoustic surveys did not yield any confirmed sightings or detections of sei whales in the region of the Lease Area (Barco et al. 2015, Bailey et al. 2018, Williams et al. 2015a, b) though this species was sighted once during surveys of the Mid-Atlantic (Williams et al. 2015a). Sei whales were also not observed during the 2015 HRG surveys of the Lease Area and were not sighted during 2016 and 2017 HRG surveys of the proposed transmission cable route in offshore Maryland waters and Indian River Bay. Roberts et al. (2018, 2017, 2016) and Curtice et al. (2019) indicate that the highest density of sei whales in the Lease Area and adjacent waters during the site characterization activity period (June through November) occurs in October and is estimated to be 0.01 individuals per 10 km grid square.

2.2.4 Sperm Whale (*Physeter macrocephalus*)

The sperm whale is the largest of all toothed whales; males can reach 16 meters (52 feet) in length and weigh over 40,823 kg (45 tons), and females can attain lengths of up to 11 meters (36 feet) and weigh over 13,607 kg (15 tons) (Perrin, Wursig, and Thewissen 2002). This species tends to be uniformly dark gray in color, though lighter spots may be present on the ventral surface. Sperm whales frequently dive to depths of over 400 meters (1,300 feet) in search of their prey, which includes large squid, fishes, octopus, sharks, and skates (Perrin, Wursig, and Thewissen 2002). Sperm whales have a worldwide distribution in deep water and range from the equator to the edges of the polar ice packs (Whitehead 2002). Sperm whales form stable social groups and exhibit a geographic social structure; females and juveniles form mixed groups and primarily reside in tropical and subtropical waters, whereas males are more solitary and wide-ranging and are found at higher latitudes (Whitehead 2002, Whitehead 2003). This species is listed as endangered under the ESA.

Though Reeves and Whitehead (1997) and Dufault et al. (1999) suggest that sperm whale populations lack clear geographic structure, all sperm whales found off the US Atlantic coast are part of the North Atlantic stock. The best recent population estimate for the North Atlantic stock of sperm whale is 2,288 individuals, though this estimate was not corrected for dive-time (Waring et al. 2015). This estimate was generated from the sum of surveys conducted in 2011, and is likely an underestimate of total abundance, as these surveys were not corrected for sperm whale dive-time. Total annual estimated average human caused mortality to this stock during the period from 2008 to 2012 was 0.8 sperm whales (Waring et al. 2015). The status of the North Atlantic sperm whale stock relative to OSP is unknown, but this stock is classified as depleted and strategic under the MMPA.

Sperm whales mainly reside in deep-water habitats on the outer continental shelf, along the shelf edge, and in mid-ocean regions (NMFS 2010a). Sperm whale migratory patterns are not well defined. However, general tends suggest that most mid-latitude populations move poleward during summer months (Waring et al. 2015). In U.S. Atlantic EEZ waters, sperm whales appear to exhibit seasonal movement patterns (CeTAP 1982, Scott and Sadove 1997). During the winter, sperm whales are concentrated to the east and north of Cape Hatteras. This distribution shifts northward in spring, when sperm whales are most abundant in the central portion of the Mid-Atlantic bight to the southern region of Georges Bank. In summer, this distribution continues to move northward, including the area east and north of Georges Bank and the continental shelf to the south of New England. In fall months, sperm whales are most abundant on the continental shelf to the south of New England and remain abundant along the continental shelf edge in the Mid-Atlantic bight. There are no critical habitat areas designated for the sperm whale.

Recent visual and acoustic surveys did not yield any confirmed sightings or detections of sperm whales in the region of the Lease Area (Bailey et al. 2018, Barco et al. 2015, Williams et al. 2015b) or in the Mid-Atlantic (Williams et al. 2015a). Sperm whales were also not observed during the 2015 HRG surveys of the Lease Area and were not sighted during 2016 and 2017 HRG surveys of the proposed transmission cable route in offshore Maryland waters and Indian River Bay. Roberts et al. (2018, 2017, 2016) and Curtice et al. (2019) indicate that the highest density of sperm whales in the Lease Area and adjacent waters during the site characterization activity period (June through November) occurs in July and is estimated to be 0.05 individuals per 10 km grid square.

2.3 Sea Turtles

Table 2.3 Sea Turtles Potentially Occurring in the Lease Area

Common Name	Scientific Name	ESA Status	Relative Occurrence in Project Area
Family Cheloniidae (hardshell sea turtles)			
Loggerhead sea turtle	*Caretta caretta*	Threatened	Common
Green sea turtle	*Chelonia mydas*	Threatened	Uncommon
Kemp's Ridley sea turtle	*Lepidochelys kempii*	Endangered	Uncommon
Family Dermochelyidae (leatherback sea turtle)			
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Common

Source: BOEM 2012.

2.4 ESA-listed Sea Turtle Species Profiles

2.4.1 Loggerhead Turtle (*Caretta caretta*)

Loggerhead turtles can reach 1 m (3 ft) in length, have a reddish-brown, slightly heart shaped carapace, and feed primarily upon hard-shelled prey including whelks and conch (NOAA 2017d). This species has a circumpolar distribution, and inhabits continental shelves, bays, estuaries, and lagoons throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd 1998). Loggerheads occur in continental shelf waters of the Northwest Atlantic from Florida to Nova Scotia (NMFS and USFWS 2008), although their presence varies seasonally due to changes in water temperature (Shoop and Kenney 1992, Epperly, Braun, and Chester 1995, Epperly, Braun, and Veishlow 1995, Braun-McNeill and Epperly 2004). The primary threat to loggerhead turtle populations worldwide is incidental capture in fishing gear, primarily in longlines and gillnets, but also in trawls, traps and pots, and dredges (NOAA 2014). Loggerhead sea turtles in the Northwest Atlantic Ocean DPS are listed as threatened under the ESA.

The most recent regional abundance data for the loggerhead turtle was collected in 2010. The preliminary regional abundance was approximately 588,000 individuals based on only positive identifications of loggerhead sightings, and approximately 801,000 individuals based on positive identifications and a portion of unidentified turtles from the survey (National Marine Fisheries Service Northeast Fisheries Science Center 2011).

In the Atlantic, the loggerhead turtle's range extends from Newfoundland to as far south as Argentina (NOAA 2014). Adult loggerheads migrate seasonally from nesting beaches to foraging grounds, primarily driven by changes in sea surface temperatures (TEWG 2000). This species occurs year-round in ocean waters off North Carolina, South Carolina, Georgia, and Florida. As coastal water temperatures warm in the spring, loggerheads begin to migrate to inshore waters of the Southeast U.S. and move up the U.S. Atlantic Coast (Epperly, Braun, and Chester 1995, Epperly et al. 1995, Braun-McNeill and Epperly 2004). During spring and summer months, loggerhead turtles are abundant in coastal waters off New York and the mid-Atlantic states, and are found as far north as New England (Morreale and Standora 1989). In late September through mid-October, loggerhead turtles begin to migrate southward to coastal areas off the south Atlantic states, particularly from Cape Hatteras, North

Carolina, to Florida (Morreale and Standora 1989, Musick, Barnard, and Keinath 1994). During the winter, loggerhead turtles tend to aggregate in warmer waters along the western boundary of the Gulf Stream off Florida (Thompson 1988), or hibernate in bottom waters and soft sediments in channels and inlets along the Florida coast (Ogren and McVea Jr. 1981, Butler, Nelson, and Henwood 1987). In the winter and spring, loggerheads congregate off southern Florida before migrating northward to their summer feeding ranges (CeTAP 1982). There are 38 critical habitat areas designated for the Northwest Atlantic Ocean DPS of loggerhead sea turtles, including nearshore reproductive habitat, sargassum habitat, migratory corridors, breeding areas and wintering habitat. All critical habitat areas are located to the south of the Project Area.

Recent multi-year surveys specific to the MD Lease Area and the surrounding nearshore waters indicate that loggerhead sea turtles are common between May and October (Williams et al. 2015b). This species was the most frequently observed turtle in the MD WEA; loggerheads accounted for 93% of all turtles identified to species during the Virginia Aquarium & Marine Science Center Foundation (VAQF) survey (Barco et al. 2015). This species was detected within the MD WEA during the spring, summer, and fall (Williams et al. 2015b). Loggerheads appear to enter the area beginning in mid-May, and leave the region when water temperatures drop in October (Barco et al. 2015). The calculated annual density of loggerhead turtles observed within the MD WEA during the Mid-Atlantic Baseline Studies (MABS) surveys was 0.00047 individuals per hour per square km (0.29 square nautical mile) (Williams et al. 2015a, b). The MABS survey provides valuable data regarding loggerhead turtle distribution. However, the figures presented above are based only upon confirmed loggerhead sightings, and the majority of small turtles observed during aerial surveys could not be identified to species. Therefore, it is possible that populations of this species could be underestimated (Williams et al. 2015b). This species was sighted twelve times in the MD WEA during the 2015 HRG surveys for the Project, and was not observed during 2016 and 2017 HRG surveys of the proposed transmission cable route in offshore Maryland waters and Indian River Bay.

2.4.1 Leatherback Turtle (*Demochelys coriacea*)

Leatherbacks are the largest living turtles, reaching up to two meters (6.5 ft) in length, and are the only sea turtle that lacks a hard, bony shell (NOAA 2017c). The leatherback gets its name from its distinctive longitudinally-ridged carapace, which is composed of layers of oily connective tissue overlain on loosely interlocking dermal bones (NOAA 2017c). This species is the most wide-ranging of all sea turtles, and is found in tropical, subtropical, and cold-temperate waters (NMFS and USFWS 1992). Leatherbacks have evolved physiological and anatomical adaptations that allow them to survive in cold waters (Frair, Ackman, and Mrosovsky 1972, Greer, Lazell, and Wright 1973, NMFS and USFWS 1992), enabling them to range along the entire east coast of the U.S. (NMFS and USFWS 1992). Unlike most other sea turtles, which feed upon hard-shelled organisms, leatherbacks consume soft bodied prey including salps and jellyfish (NOAA 2017c). In the North Atlantic Ocean, leatherback turtles regularly occur in deep waters (>100 m (328 ft)), but are also sighted in coastal areas of the U.S. continental shelf (NMFS and USFWS 1992). Incidental capture in fishing gear, including gillnets, trawls, traps and pots, longlines, and dredges, is the primary threat to this species. Leatherback populations are also threatened by intentional harvesting of eggs and adults, and incidental ingestion of marine debris (NOAA 2016). Leatherback turtles are listed as endangered under the ESA.

Leatherback turtles found along the eastern U.S. Atlantic coast belong to the Northwest Atlantic subpopulation. Nearly all leatherback nesting on continental United States shores occurs on the eastern coast of Florida (FFWCC 2017). Though the breeding population of leatherback turtles in Florida remains small (likely less than 1,000 individuals), the number of nests across the state has increased at a rate of approximately 10% per year since 1979 (Stewart et al. 2011). Though accurate information regarding the entire Atlantic leatherback population is lacking (NOAA 2017c), estimates based on data from the seven nesting sites in this region range from 34,000 to 94,000 individuals (TEWG 2007, NMFS and USFWS 2007b).

Leatherback turtles are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale et al. 1994, Eckert 1999). Adult leatherbacks migrate extensively throughout the Atlantic basin in search of food, and may swim 6,000 to 12,000 km (3,240 to 6,480 nm) in a year (James et al. 2006). These seasonal movement patterns are dictated by sea surface temperatures (Davenport and Balazs 1991, Luschi et al. 2006). Following breeding and nesting in Florida and the tropical Caribbean and aided by the northward flow of the Gulf Stream, leatherback turtles move northward and westward beyond the shelf break in the spring. During summer months, leatherbacks move into fairly shallow coastal waters, apparently following their preferred jellyfish prey. Leatherbacks become more numerous off the mid-Atlantic and southern New England coasts in late spring and early summer, and by late summer and early fall, leatherbacks may be found in the waters off eastern Canada (CeTAP 1982, Shoop and Kenney 1992, Thompson et al. 2001, James et al. 2006). In response to cooling sea surface temperatures in the fall, leatherback turtles move offshore and begin a southward migration to their winter breeding grounds (Payne, Selzer, and Knowlton 1984) in Florida, the Caribbean, Puerto Rico, the Virgin Islands, and French Guiana (NOAA 2016). There are no critical habitat areas designated for the leatherback sea turtle along the U.S. Atlantic coast.

Recent multi-year surveys specific to the MD Lease Area and the surrounding nearshore waters indicate that leatherback sea turtles routinely occur between May and October (Williams et al. 2015b, Barco et al. 2015). This species was the second most frequently observed turtle species in the MD WEA in the Williams et al. (2015b) study, and third most frequently observed turtle species in the Barco et al. (2015) study. Leatherbacks accounted for 2% of all turtles identified to species during the VAQF survey (Barco et al. 2015). This species was infrequently detected in spring, and was most abundant in the MD WEA in summer and fall (Barco et al. 2015). The MABS survey identified September and October as the peak period of leatherback occurrence in the Project Area (Williams et al. 2015b). The calculated annual density of leatherback turtles observed within the MD WEA during the MABS surveys was 0.00025 individuals per hour per square km (0.29 square nautical mile) (Williams et al. 2015a, b). This species was sighted two times in the US Wind Lease Area during the 2015 HRG surveys of the WEA and was not observed during 2016 and 2017 HRG surveys of the proposed transmission cable route in offshore Maryland waters and Indian River Bay.

2.4.3 Green Turtle (*Chelonia mydas*)

The green turtle is the largest hard-shelled sea turtle, and can reach over 1 m (3 ft) in length (NOAA 2017b). This species has an oval carapace that is variable in color and can be green, brown, yellow, gray, or black (NOAA 2017b). Unique among sea turtles, the adult green turtle is exclusively herbivorous and eats seagrass and algae (NOAA 2017b). Green turtles are found worldwide, and are known to occur in temperate waters, though they are generally found in tropical and subtropical regions (NOAA 2017b, NMFS and USFWS 1991). Current human-caused threats to green sea turtles include destruction of nesting habitats, noise and light pollution on coastal beaches, boat strikes, disease, and entanglements with fishing gear and marine debris (Epperly, Braun, and Chester 1995, TEWG 2000, USDOC et al. 2007, NOAA 2017b). Green turtles in waters along the eastern U.S. Atlantic coast belong to the North Atlantic DPS, which is listed as threatened under the ESA.

Green turtles in the North Atlantic DPS nest to the south of the Project Area, in small numbers in the U.S. Virgin Islands, Puerto Rico, Georgia, South Carolina, and North Carolina, and in larger numbers in Florida (USFWS 2017). The Florida green turtle nesting aggregation is a regionally significant colony, and data indicate that over 5,000 females nested in the state in 2010 . Estimates of the population size of the North Atlantic DPS of green turtles are population of this species are unavailable

In the Western North Atlantic, green turtles are found in inshore and nearshore waters from Texas to Massachusetts (NOAA 2017b). Like other sea turtles, green turtles display highly migratory behavior, making seasonal coastal and annual transoceanic migrations (Godley et al. 2003, Godley et al. 2008, Godley et al. 2010). However, green turtles appear to occupy smaller home ranges than other sea turtle species (Seminoff, Resendiz, and Nichols 2002, Makowski, Seminog, and Salmon 2006, Broderick et al. 2007). This species generally feeds in shallow lagoons, inlets, reefs, shoals, and bays that have abundant algae or sea grass (USDOC et al. 2007). Females nest between June and September on mainland or island sandy beaches along the southeastern U.S. coast, and are not know to nest as far north as the mid-Atlantic states (NOAA 2015b). Though green turtles are reported to use the coastal waters of North Carolina and Virginia as summer foraging habitat (Mansfield et al. 2009), this species is generally classified as uncommon in the mid-Atlantic, and is usually a transient species present during the summer and fall. The only designated critical habitat area for green sea turtles surrounds an island off the coast of Costa Rica, and is far to the south of the Project Area (NOAA 2017b).

Green turtles were the second most frequently observed turtle species in the MD WEA in the VAQF study; they accounted for 5% of all turtles identified to species and were most abundant during the summer (Barco et al. 2015). In contrast, green turtles were uncommonly observed in Maryland waters during the MABS survey; only five were identified over the duration of the study (Williams et al. 2015b). One green sea turtle was sighted during the 2015 HRG surveys of the WEA, and this species was not observed during 2016 and 2017 HRG surveys of the proposed transmission cable route in offshore Maryland waters and Indian River Bay. The calculated annual density of green turtles observed within the MD WEA during the MABS surveys was 0.0020 individuals per hour per square km (0.29 square nautical mile) (Williams et al. 2015a, b). Though the MABS survey is a source of data regarding green turtle abundance, the majority of small turtles observed during aerial surveys could not be identified to species. Therefore, it is possible that green turtle populations could be underestimated (Williams et al. 2015b).

2.4.4 Kemp's Ridley Turtle (*Lepidochelys kempii*)

The Kemp's ridley turtle has a nearly circular grayish-green carapace and is the smallest sea turtle in the world, reaching only 60 to 70 cm in length (24 to 28 in). This species feeds primarily on swimming crabs, but will also consume fish, jellyfish, and mollusks (NOAA 2017e). Kemp's ridley turtles primarily reside in the nearshore neritic zone, and rarely venture into waters deeper than 50 m (160 ft) (NOAA 2017e, Byles, Nelson, and Henwood 1994). Like other sea turtle species, the Kemp's ridley is threatened by habitat loss (specifically of nesting beaches in the Gulf of Mexico), commercial fishery gear entanglement, disease, climatic changes, and pollution (USDOI and USFWS 1999). The Kemp's ridley turtle is listed as endangered under the ESA.

Kemp's ridley sea turtles exhibit unique nesting behavior observed in only one other sea turtle species; during events called "arribada" female turtles arrive onshore in very large, synchronous aggregations to nest (NOAA 2017e). This species nests almost exclusively in the Western Gulf of Mexico, primarily in the states of Tamaulipas and Veracruz, Mexico (BOEM 2014). Though extremely large arribadas occurred in the 1940s (as many as 42,000 Kemp's ridley turtles were observed in one day in 1947), populations plummeted between the 1940s and the 1980s, reaching a low of fewer than 250 nesting females in 1985 (NOAA 2017e). Conservation efforts led to annual increases of approximately 15% in Kemp's ridley breeding populations through 2009. However, recent data indicate a decrease in the number of Kemp's ridley nests since 2010 (NOAA 2017e). The most recent estimate of the Kemp's Ridley turtle population is 7,000 to 8,000 nesting females (NMFS and USFWS 2007a). As this species is female biased, there are likely several thousand additional males (NMFS and USFWS 2007a).

The Kemp's ridley sea turtle is found most commonly along the eastern coast of North America, from the Gulf of Mexico to Nova Scotia (NOAA 2017e, BOEM 2014). After nesting and breeding in Mexico, this species travels to foraging grounds in shallow coastal waters, embayments, and estuarine systems along the Atlantic seaboard, where they remain for the duration of the spring and summer (BOEM 2014). The Kemp's ridley is present in areas including Chesapeake Bay, Pamlico Sound, Charleston Harbor, and Delaware Bay during the summer (NMFS and USFWS 2007a), and is the second most common turtle reported off the coast of Virginia (VIMS 2014). Kemp's ridley turtles begin leaving northern areas in mid-September, and most have departed for warmer southern waters by the beginning of November (Burke, Standora, and Morreale 1989, Morreale and Standora 1989). Wintering habitats for Kemp's ridley turtles include shelf habitats off Florida and waters south of Cape Hatteras, North Carolina (Gitschlag 1996). There are no critical habitat areas designated for the Kemp's ridley sea turtle, though petitions to designate areas on the Texas coast and marine habitat in the Gulf of Mexico are currently being reviewed.

Kemp's ridley turtles occur in the Project Area, but were the most infrequently observed turtle species in the MD WEA during the VAQF study (Barco et al. 2015). Only one sighting of this species was reported during the study, in August 2014, accounting for just 0.1% of all turtles identified to species (Barco et al. 2015). This species was also infrequently observed during the MABS survey; only eight Kemp's ridley turtles were positively identified in Maryland waters over the duration of the study (all of which were observed during aerial surveys) (Williams et al. 2015b). Most observations of this species in the Project Area were reported in September and October (Williams et al. 2015b). The calculated annual density of Kemp's ridley turtles observed within the MD WEA during the MABS surveys was 0.00012 individuals per hour per square km (Williams et al. 2015a, b). Though the MABS survey is a source of data regarding Kemp's ridley turtle abundance, the majority of small turtles observed during aerial surveys could not be identified to species. Therefore, it is possible that Kemp's ridley turtle populations could be underestimated (Williams et al. 2015b). Kemp's ridley turtles were not observed during 2015 HRG surveys of the WEA, or during 2016 and 2017 HRG surveys of the proposed transmission cable route in offshore Maryland waters and Indian River Bay.

3.0 COASTAL AND MARINE BIRDS AND BATS (585.611(B)(3-5))

The following section contains additional information about marine birds and bats in the MD WEA.

3.1 ESA-Listed Bird Species Profiles

3.1.1 Piping Plover (*Charadrius melodus*)

The piping plover (*Charadrius melodus*) is a small, migratory shorebird that breeds on beaches from Newfoundland to North Carolina (Elliot-Smith and Haig 2004, USDOI and USFWS 1996) According to the United States Department of Interior Fish and Wildlife Service (USDOI and USFWS 2009b), piping plovers that breed on the Atlantic Coast belong to the subspecies *C. melodus melodus*. The Atlantic Coast population is classified as threatened (USDOI and USFWS 2015a) and by both Delaware and Maryland as endangered (DNREC 2013, MDNR 2016). The most recent abundance estimates by

United States Fish and Wildlife Services (USFWS) estimate approximately 1,762 nesting pairs in 2011 (USDOI and USFWS 2012).

Piping plovers inhabit coastal sandy beaches and mudflats. They use open, sandy beaches close to the primary dune of barrier islands for breeding, preferring sparsely vegetated open sand, gravel, or cobble for nesting sites. They feed on marine worms, fly larvae, beetles, insects, crustaceans, mollusks, and other small invertebrates. They forage along the wrack zone, or line, where dead or dying seaweed, marsh grass, and other debris is left on the upper beach by high tides (USDOI and USFWS 2015a).

A key threat to the Atlantic Coast population is habitat loss resulting from shoreline development (USDOI and USFWS 1996). Piping plovers are very sensitive to human activities, and disturbances from anthropogenic activities can cause breeding birds to abandon their nests. Since the listing of this species under the ESA in 1986, the Atlantic Coast piping plover population has increased 234 percent (USDOI and USFWS 2009b). Although increased abundance has reduced near-term vulnerability to extinction, piping plovers remain sparsely distributed across their Atlantic Coast breeding range, and populations are highly vulnerable to even small declines in survival rates of adults and fledged juveniles (USDOI and USFWS 2009b).

The United States Fish and Wildlife Service (USFWS) has designated critical habitat for the wintering population of piping plovers in coastal areas south of the Project Area from North Carolina to Texas (USDOI and USFWS 2001, 2008, 2009a). Some piping plovers migrate to the Bahamas and West Indies from mid-September to March. Although precise routes of migration are not firmly established, it is possible that piping plovers could fly over the Project Area during migration.

3.1.2 Roseate Tern (*Sterna dougallii*)

Roseate terns (*Sterna dougallii*) are medium-sized waterbirds that are strongly associated with coastal and marine habitats, including seacoasts, bays, estuaries, and offshore waters. Roseate terns forage mainly by plunge-diving and contact-dipping (in which the bird's bill briefly contacts the water) or surface-dipping over shallow sandbars, reefs, or schools of fish. They are adapted for fast flight and relatively deep diving and often submerge completely when diving for fish (USDOI and USFWS 2015b). Along the Atlantic Coast, roseate terns nest primarily on islands in sandy beach, open bare ground, and grassy habitats, typically near areas with cover or shelter (NatureServ 2015).

Roseate tern is a widespread but localized species in coastal habitats throughout the world. The Atlantic subspecies (*S. d. dougallii*) breeds in two discrete areas in the western hemisphere: northeastern North America from the Canadian Maritime Provinces to Long Island, New York, and the northern Caribbean, including the Bahamas and the Florida Keys (USDOI and USFWS 1998). The northeastern population is listed as endangered by the governments of the United States and Canada, as well as by several northeastern states. Historically, the northeastern breeding population extended as far south as Virginia; however, several factors have caused the breeding range of the population to contract (USDOI and USFWS 2015b). Northeastern roseate terns are thought to migrate through the eastern Caribbean and along the northern coast of South America to wintering grounds along the eastern coast of Brazil (USDOI and USFWS 2010). The most current abundance estimate for the northeastern population is approximately 3,200 nesting pairs (Nisbet, Gochfeld, and Burger 2014). The Caribbean breeding population is listed as threatened at the federal level. Individuals from this population are occasionally found nesting along the southeastern coast of the United States as far north as the Carolinas (USDOI and USFWS 2015b).

The need for extending ESA protections to the roseate tern was identified based primarily on the concentration of the population into a small number of breeding sites, and to a lesser extent, observed declines in the population (USDOI and USFWS 1998). The most important factor in breeding colony loss was predation by herring gulls (*Larus smithsonianus*) and/or great black-backed gulls (*Larus marinus*). To date, critical habitat for roseate tern has not been designated by the USFWS.

Roseate tern breeding colonies once existed on Assateague Island in Maryland (Stewart and Robbins 1958); however, there are currently no roseate tern breeding colonies in Maryland or Delaware. During boat and aerial surveys conducted between 1978 and 2009 this species was observed in Maryland and Delaware waters during spring months (O'Connell et al. 2009). Though roseate terns was not detected in the WEA during the MABS surveys (Williams et al. 2015a, b), it is possible that this species could fly over the Project Area during spring and fall migration.

3.1.3 *Rufa* Red Knot (*Calidris canutus rufa*)

The *rufa* red knot (*Calidris canutus rufa*) is a medium-sized shorebird that was added to the list of threatened species under the ESA in December of 2014 (USDOI and USFWS 2014). Its listing became effective on January 15, 2015. Large flocks of red knot migrate long distances between breeding grounds in the mid- and high-arctic and wintering grounds in southern South America (USDOI and USFWS 2013). Their northward migration through the contiguous United States (U.S.) occurs April-June, and southward migration occurs July-October.

Delaware Bay is the most important spring migration stopover in the eastern U.S., because it is the final place at which the birds can refuel in preparation for their nonstop journey to the Arctic (Baker et al. 2013). Red knots arriving at Delaware Bay depend on readily-available and easily digestible foods such as juvenile clams and mussels and horseshoe crab eggs to restore their depleted energy reserves (USDOI and USFWS 2013). Up to 90 percent of the entire red knot population can be present in Delaware Bay in a single day (Cornell University 2017). Although the precise migration route has not been firmly established (Niles et al. 2010), it is possible that these birds could fly over the Project Area during spring and fall migrations. Due to challenges with the species' migratory habits and differing survey methods across the red knots' range, a range-wide population estimate does not exist; however, survey counts in the mid-Atlantic estimate 48,955 knots stopping in Delaware Bay (2013) and 5,547 to 8,482 knots annually stopping in Virginia (2011-2014) (USDOI and USFWS 2014).

Surveys of wintering knots along the coasts of southern Chile and Argentina and during spring migration along the U.S. coast indicate that a serious population decline occurred in the 2000s (USDOI and USFWS 2013). This population decline has been attributed to a reduction in horseshoe crabs (Cornell University 2017, USDOI and USFWS 2013), which are harvested primarily for use as bait and secondarily to support the biomedical industry (USDOI and USFWS 2003). Other threats to red knot include habitat destruction resulting from beach erosion and shoreline protection and stabilization projects, the inadequacy of existing regulatory mechanisms, human disturbance, and competition with other species for limited food resources.

Along the mid-Atlantic coast, red knots forage along sandy beaches, tidal mudflats, salt marshes, and peat banks (USDOI and USFWS 2014). In Delaware Bay, they feed primarily on horseshoe crab eggs, and the timing of their arrival at the bay typically coincides with the annual peak of the horseshoe crab spawning period (USDOI and USFWS 2014). Red knots are also known to occur in Maryland (USDOI and USFWS 2014), but they were not observed in the MABS surveys (Williams et al. 2015c, Williams et al. 2015d).

3.1.4 Bermuda Petrel (*Pterodroma cahow*)

The Bermuda petrel (*Pterodroma cahow*), also known as the cahow, is a medium-sized petrel in the tubenose family that also includes shearwaters and fulmars. Like other tubenoses, Bermuda petrels are strongly aerial and pelagic. Feeding occurs at sea and individuals come to land only to nest on a few small, rocky islands in the Bermuda Archipelago.

The Bermuda petrel population declined rapidly in the years following European colonization of Bermuda due primarily to predation by introduced pests and over-exploitation by humans. The decline of the Bermuda petrel occurred so rapidly that by the early to mid-1600s the species was believed to be extinct. Scattered observations of living and deceased birds were reported in the early 20th century, prompting the organization of a formal survey effort. In 1951, seven pairs of Bermuda petrels were discovered nesting on a few small islands off Bermuda. The government of Bermuda implemented measures to conserve the species following its rediscovery, which have resulted in population gains (Madeiros, Flood, and Zufelt 2014). Nevertheless, the Bermuda petrel continues to be imperiled due to several factors, including low population size, restricted geographic range, predation, hurricanes, and climate change. Recent estimates indicate a total population of approximately 400-500 individuals (Madeiros 2005, 2012). In 1970, the Bermuda petrel was listed by the U.S. Department of the Interior under the Endangered Species Conservation Act of 1969 (35 FR 6069), later replaced by the Endangered Species Act of 1973.

Despite its highly restricted breeding range, Bermuda petrels may occur over a relatively large area of the northwestern Atlantic Ocean during the non-breeding season. The non-breeding range of the species is poorly understood due to the low number of confirmed observations; Bermuda petrels are similar in appearance to other related species that also occur in the northwestern Atlantic, and distinguishing between species at sea can be challenging. Bermuda petrels may occur in deep waters between Newfoundland and South Carolina, based on a combination of visual observations and a satellite telemetry study of twelve individuals (Madeiros 2012).

Due to the small population size and the relatively small size of the Project Area relative to the potential range of Bermuda petrels in the northwestern Atlantic, this species is unlikely to occur in the Project Area.

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Appendix K

Alpine Metocean Buoy Area Summary Letter

Alpine

Client: **US Wind, Inc.**

US Wind

Fuelling our future, naturally.

Project Title: **Maryland Wind Energy Area**
2015 G&G Survey
Metocean Buoy Area

Project Date: **2015 June to July**

Project No.: **1751**

Doc. Type: **Summary Letter**

Doc. Date: **2020.06.30**

Doc. No: **AOSS-R-CLR-1751-03**

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Document Summary

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AOSS-R-CLR-1751-03	Clearance Letter	2020.06.30	Rev. 1

Distribution

US Wind, Inc.	PDF Copy
World Trade Center	FAO: Bill Follett
401 East Pratt Street	
Baltimore, MD	
21202	

Executive Summary

Alpine Ocean Seismic Survey, Inc. (Alpine) carried out a marine survey on behalf of US Wind, Inc. (US Wind) comprising high-resolution geophysical, geotechnical, and environmental investigations on the Outer Continental Shelf in the Maryland Wind Energy Area. The surveys were conducted to support the development of renewable energy by providing necessary data for permitting and regulation as well as wind turbine construction purposes. This survey was carried out in the summer of 2015.

Alpine were contacted in 2020 to provide a location summary based on the 2015 data in a specific area where the original survey was undertaken. The 2015 survey stipulated the installation of a Met Tower in the area; this has been changed to a Metocean Buoy instead of the originally planned Met Tower.

No new data collection was undertaken, and, as such, the obstruction and hazard descriptions that relate to the transient nature of the marine environment can only be considered up to date as of July 2015 when the original survey demobilized.

The 2015 survey operations were conducted in accordance with the Bureau of Ocean Energy Management's "Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585", dated 09-Nov-2012.

Other Alpine reports related to this project are tabulated below.

Date	Report
1751-1	Marine G&G Survey Report for Site Assessment Plan
1751-2	Marine G&G Survey Report
1751-03	Metocean Buoy Area Summary Letter

This report is the 1751-03 Metocean Buoy Area Summary Letter.

Location Summary

Client	US Wind, Inc.	
Site Reference	Maryland Wind Energy Area	
Survey Dates	06-Jun-2015 to 25-Jun-2015	
Equipment Used	Bathymetry	R2 Sonic 2024
	Side Scan Sonar	Klein 3900 (500/900kHz)
	Magnetometer	Geometrics 882
	Sub-Bottom Profiler	Teledyne Benthos CHIRP III

Report Note

This report is a re-issue for changes in location details, specifically, its name, for a 2020 BOEM submission based on survey data acquired in 2015. No more recent data has been incorporated into this report.

Proposed Metocean Buoy Location

Coordinates	**UTM Zone 18N NAD83 (meters)**	
	521 533.96	m E
	4 244 982.95	m N
	Geographic WGS84	
	38° 21’ 09.889’’	N
	074° 45’ 12.766’’	W

Water Depths

27.0m MLLW.

Range of Depths

26.3m MLLW to 27.1m MLLW.

General Topography

The seabed is generally flat, sloping towards the north-west at <1°. The greatest slopes within 300m of the location are <1°.

Seabed Sediments

Seabed sediments at the Proposed Metocean Buoy Location comprise fine to medium sands with traces of gravel.

Seabed Features & Obstructions

The area is characterized by sand ripples.

One object, Contact745 of 10cm height, was interpreted within 300m of the proposed location 293m WNW of the Proposed Metocean Buoy Location.

Ten magnetic anomalies were interpreted within 300m of the Proposed Metocean Buoy Location. The closest of these to the Proposed Metocean Buoy Location is magnetic anomaly ID6 which was interpreted 58m NNE of the location.

No other obstructions were interpreted within 300m of the proposed location based on the 2015 dataset.

Shallow Soils Succession

Unit 1 is a surficial sheet of Holocene sandy marine sediments. Base Unit 1 occurs at 0.5m below seabed at the Proposed Metocean Buoy Location. Within 300m of the proposed location, the reflector varies in depth from 0.5m to 0.9m below seabed.

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This report has been prepared with due care and diligence and with the skill reasonably expected of a reputable contractor experienced in the types of work carried out under the contract. As such the findings in this report are based on an interpretation of data which is a matter of opinion on which professionals may differ and unless clearly stated is not a recommendation of any course of action.

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Glossary of Abbreviations

Abbreviation	Meaning
AB	Acoustic Basement
APE	Area of Potential Efect
cfm	Cubic feet per minute
CHIRP	Compressed High Intensity Radar Pulse
CORS	Continuously Operating Reference Station
DGPS	Differential Global Positioning System
DPR	Daily Progress Report
DTM	Digital Terrain Model
FAO	For the attention of
ft	Feet
GAMS	GPS Azimuth Measurement System
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GRS80	Geodetic Reference System 1980
HRG	High Resolution Geophysical
HSSE	Health, Safety, Security, and Environment
Hz	Hertz
IMU	Inertial Measurement Unit
kHZ	Kilohertz
KP	Kilometer Post
kn	Knots
Lat	Latitude
Long	Longitude
m	Meter
MBES	Multi-beam Echo Sounder
MLLW	Mean Lower Low Water
MV	Motor Vessel
nT	Nanotesla
N/A	Not Applicable
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
PDOP	Position Dilution of Precision
PPK	Post Processing Kinematic
PPS	Pulse Per Second

Abbreviation	Meaning
psi	Pounds per square inch
QA	Quality Assurance
QC	Quality Control
RTK	Real Time Kinematic
RV	Research Vessel
SBES	Single-beam Echo Sounder
SBP	Sub-bottom Profiler
SEG	Society of Exploration Geophysicists
SEG-Y	SEG data storage format
SOW	Scope of Work
SSS	Side Scan Sonar
SVP	Sound Velocity Profile
USCG	United States Coast Guard
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VERTCON	North American Vertical Datum Transformation
WGS84	World Geodetic System 1984
XTF	eXtended Triton Format
ybp	Years before present

Technical Terminology

Terminology	Definition
Geodetic datum	A set of constants used for calculating the coordinates of points on the Earth.
GRS80	Geodetic Reference System 1980 refers to the global reference ellipsoid that was originally used for the definition of the World Geodetic System 1984 (WGS 84), and is defined by its semi-major axis and flattening.
MLLW	The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.
National Tidal Datum Epoch	The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values for tidal datums. It is necessary for standardization because of periodic and apparent secular trends in sea level. The present NTDE is 1983 through 2001 and is actively considered for revision every 20-25 years. Tidal datums in certain regions with anomalous sea level changes (Alaska, Gulf of Mexico) are calculated on a Modified 5-Year Epoch.
Technical terminology is referenced with respect to the organization that defines the specific concept (e.g., NOAA for "MLLW").	

1 Introduction

Alpine Ocean Seismic Survey, Inc. (Alpine) carried out a marine survey on behalf of US Wind, Inc. (US Wind) comprising high-resolution geophysical, geotechnical, and environmental investigations on the Outer Continental Shelf in the Maryland Wind Energy Area. The surveys were conducted to support the development of renewable energy by providing necessary data for permitting and regulation as well as wind turbine

Alpine were contacted in 2020 to provide a location summary based on the 2015 data in a specific area where the original survey was undertaken. The 2015 survey stipulated the installation of a Met Tower in the area; this has been changed to a Metocean Buoy instead of the originally planned Met Tower.

No new data collection was undertaken, and, as such, the obstruction and hazard descriptions that relate to the transient nature of the marine environment can only be considered up to date as of July 2015 when the original survey demobilized.

The location around which the summary report was to be based was detailed in e-mail communications on 18-Jun-2020, and is detailed in Table 1.1.

Table 1.1 Location

Proposed Metocean Buoy Location				
Latitude	38° 21’ 09.889’’	N	Easting	521 533.96
Longitude	074° 45’ 12.766’’	W	Northing	4 244 982.95

The 2015 survey operations were conducted in accordance with the Bureau of Ocean Energy Management’s “Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585”, dated 09-Nov-2012.

The surveys included protected species mitigation measures as detailed in the lease and described in the Marine Mammal Mitigation Plan submitted to BOEM prior to the onset of the survey. The surveys were conducted as 24-hr operations with continuous visual observations by qualified Protected Species Observers. In addition to visual monitoring, a Passive Acoustic Monitoring System was installed on the survey vessel with personnel operating the equipment night-time during operations, ramp ups, and shut downs.

The RV *Shearwater* conducted the HRG and environmental surveys, and was mobilized in Ocean City, MD, between 02-Jun-2015 and 05-Jun-2015. The surveys focused on data and sample acquisition in the Met Tower area to provide a framework for a Site

Assessment Plan and also covered the entire planned WTG array area to provide data for future wind farm planning and design, and for the eventual submission of a Construction & Operations Plan.

RV Shearwater sailed from Ocean City, MD, on 05-Jun-2015 to conduct calibrations and to perform a vessel and equipment noise analysis test to establish the survey's baseline sound levels. The calibrations were completed, and survey operations began on 06-Jun-2015. Survey data collection was completed on 25-Jun-2015.

Other Alpine reports related to this project are listed in Table 1.2.

Table 1.2 Project 1751 Report Listing

Date	Report
1751.1	Marine G&G Survey Report for Site Assessment Plan
1751.2	Marine G&G Survey Report
1751-03	Metocean Buoy Area Summary Letter

This report is the 1751-03 Metocean Buoy Area Summary Letter.

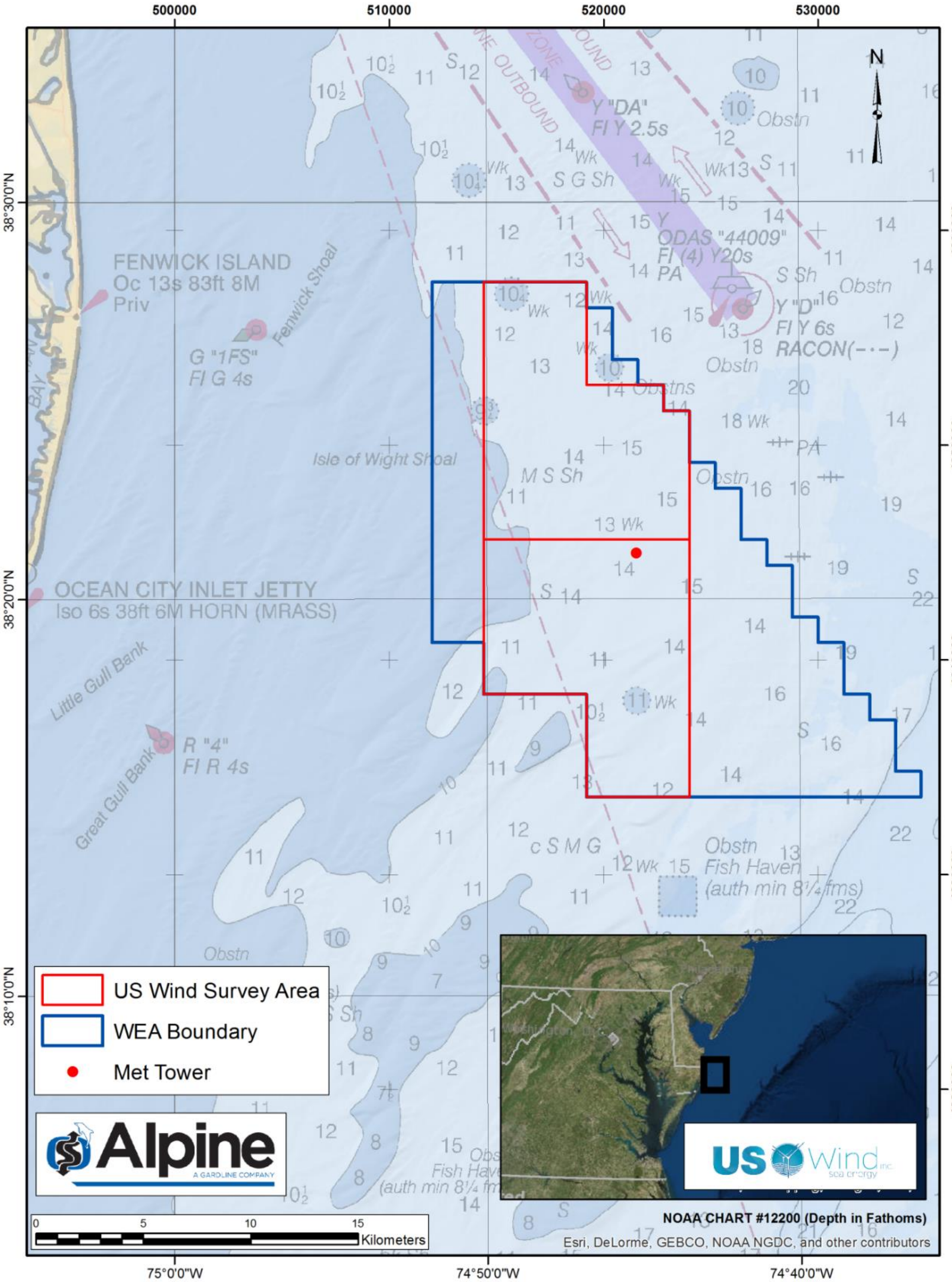

Figure 1.1 Survey Location Map

1.1 Field Work Summary

Table 1.3 details key facts regarding field operations.

Table 1.3 Field Work Summary

Description	
Mobilization Port & Date	Ocean City, MD, 02-Jun-2015
Survey Duration	06-Jun-2015 to 25-Jun-2015
Surveyed Line Kilometers	552.4km
Total Survey Duration	1289:00:00h

2 Vessel Summary

The RV Shearwater is a multi-purpose survey vessel with capabilities to perform bathymetric, geophysical, geotechnical, and environmental surveys. The RV Shearwater has two fast-action hydraulic winches and a heavy-duty crane (S.W.L. 8,000 lbs) for overhead operations.

Table 2.1 RV Shearwater Specifications

Vessel Specifications	
Flag	United States of America
Class	Multi-Role Survey
Built	1981 (Reconfigured 2011)
Overall Length / Breadth	33.53m / 11.89m
Draft	2.74m
Gross Tonnage	198t
Main Engine	2 x 526 HP John Deere Model 6125AFM
Bow Thrust / Stern Thrust	Thrustmaster 100 HP / Hydraulically Driven “Z” Drives
Accommodation	20 berths
Nominal Endurance	14 days

Figure 2.1 RV Shearwater

3 Survey Parameters

3.1 Project Geodetics

Table 3.1 Project Geodetics

Project Geodesy	
Ellipsoid	WGS84
Semi Major Axis	6 378 137.000m
Inverse Flattening	298.2572235634
Coordinate System	Universal Transverse Mercator
Projection Method	Transverse Mercator
Zone	18 North
Central Meridian	075°00'00.000" W
Reference Latitude	00°00'00.000" N
False Easting	500,000.000
False Northing	0.000
Scale Factor	0.99960000
Survey Units	Meters (m)

3.2 Vertical Datum

Bathymetry data were tidally corrected to the Mean Lower Low Water (MLLW) datum.

Refer to the 1751.2 Marine G&G Survey Report for the specific methodology.

4 Survey Procedures

4.1 General

The geophysical and environmental scope on the RV Shearwater comprised an investigation of the bathymetry, seabed features, and shallow geology across the designated area.

The RV Shearwater acquired multi-beam echo sounder, single beam echo sounder, side scan sonar, sub-bottom profiler, and marine magnetometer data.

All data was acquired in accordance to Alpine standard operating procedures and in line with industry standard practices.

Both the 2013 and 2015 datasets, with the exception of side scan sonar data from 2013, were merged in the interpretation process after the 2015 survey for final presentation.

4.2 Survey Design Summary

Alpine's 2015 summary was designed with respect to the Bureau of Ocean Energy Management's 09-Nov-2012 guidelines, "Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585".

As a previous dataset had been acquired in the area of interest in 2013 by Coastal Planning & Engineering, Inc., the 2015 Alpine survey was designed to infill gaps and to expand on the 2013 data collection.

Refer to the 1751.2 Marine G&G Survey Report for the specific methodology.

4.3 Survey Equipment and Methods

4.3.1 Vessel Configuration

The RV Shearwater provided the survey platform to conduct the bathymetric and geophysical investigation.

Tables 4.1 and 4.2 detail the survey equipment and software used during the 2015 survey.

Table 4.1 Survey Equipment

Equipment Type	Equipment Model
Primary GNSS	Applanix POS MV 320
Ultra-Short Base Line (USBL)	Sonardyne Scout Pro
Sound Velocity Probe (SVP)	Valeport 650 Sound Velocity Profiler
Single Beam Echo Sounder (SBES)	ODOM Echotrac CVM
Multi-Beam Echo Sounder (MBES)	R2 Sonic 2024
Side Scan Sonar (SSS)	Klein 3900 (500/900kHz)
Magnetometer	Geometrics 882
Sub-Bottom Profiler (SBP)	Teledyne Benthos CHIRP III

Table 4.2 Survey Software

Equipment Type	Acquisition & Processing Software
Navigation	QINSy
Single Beam Echo Sounder (SBES)	N/A; SSS & SBP QA only
Multi-Beam Echo Sounder (MBES)	QINSy & Caris HIPS
Side Scan Sonar (SSS)	SonarPro & SonarWiz
Magnetometer	MagLog & MagPick
Sub-Bottom Profiler (SBP)	SonarWiz

5 Results

Refer to the 1751.2 Marine G&G Survey Report for results regarding the entire survey area. This section focuses on the Metocean Buoy area only.

5.1 Bathymetry

Water depth at the Proposed Metocean Buoy Location is 27.0m MLLW. Figure 5.1 illustrates bathymetry around the location.

Water depths within a 300m range of the location are between 26.3m MLLW and 27.1m MLLW.

The seabed is generally flat, sloping towards the north-west at <1°. The greatest slopes within 300m of the location are <1°.

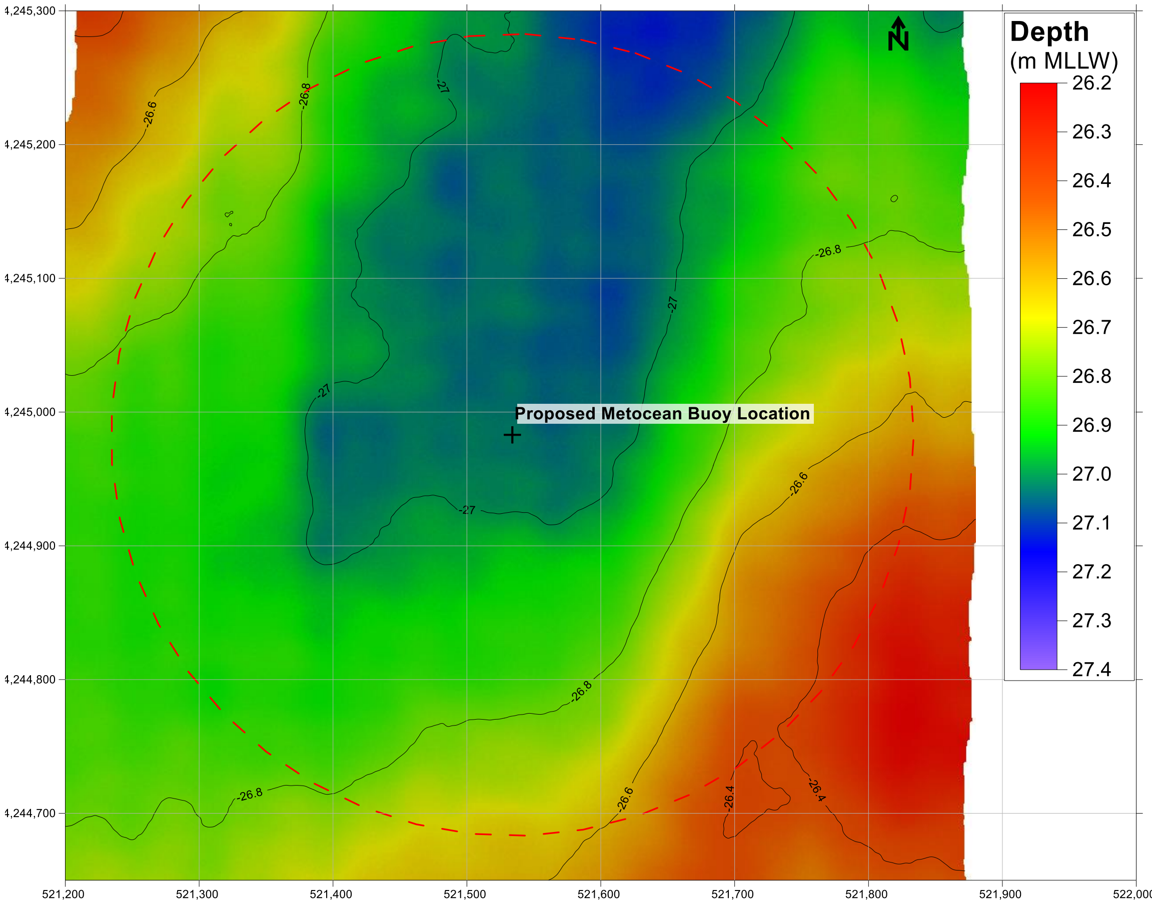

Figure 5.1 Bathymetry at the Proposed Metocean Buoy Location

No other significant features or obstructions were interpreted within 300m of the proposed location based on the 2015 dataset.

5.2 Seabed Features

Seabed sediments at the Proposed Metocean Buoy Location comprise fine to medium sands with traces of gravel. Figure 5.2 illustrates seabed conditions around the location.

The seabed around the proposed area is interpreted to comprise of mainly sandy sediments, primarily fine to medium sand as confirmed by grab sampling. Grab samples also recovered trace gravel.

The area is characterized by sand ripples of an average wavelength of 60cm and a height of 7cm. The ripples are aligned on a bearing ranging between 0˚ and 30˚ east of true north.

One object, Contact745 of 10cm height, was interpreted within 300m of the proposed location 293m WNW of the Proposed Metocean Buoy Location. Ten magnetic anomalies were interpreted within 300m of the Proposed Metocean Buoy Location. These are tabulated in Table 5.1.

Table 5.1 Magnetic Anomalies

Easting	Northing	ID	Description	Signature	Width (m)
521,695.46	4,244,854.40	2	Small object	Dipole	0.9
521,441.72	4,245,085.61	3	Small object	Dipole	12.8
521,557.31	4,245,087.05	4	Small object	Dipole	0.8
521,558.41	4,245,225.20	5	Small object	Dipole	3.3
521,556.34	4,245,037.35	6	Small object	Dipole	2.6
521,558.22	4,245,265.44	7	Small object	Dipole	1.9
521,520.63	4,244,694.43	9	Small object	Dipole	6.2
521,519.58	4,244,827.25	10	Small object	Dipole	1.3
521,497.63	4,244,772.22	12	Small object	Monopole	3.6
521,267.72	4,245,043.00	2709	Small object	Dipole	3.8

The closest of these to the Proposed Metocean Buoy Location is magnetic anomaly ID6 which was interpreted 58m NNE of the location. No other magnetic anomalies were interpreted within 100m of the proposed location. None of the magnetic anomalies exceed 21nT in amplitude, and they are likely to represent small buried ferrous objects.

No other obstructions were interpreted within 300m of the proposed location based on the 2015 dataset.

A caveat included with the 2015 survey report noted:

> The coastal and OCS regional magnetic environment offshore Maryland is characterized by a strong geologic influence. The measured magnetic signal is very sensitive to sensor height off the bottom. Sea swell heights throughout the survey were commonly 1m or more, with heave motion experienced by the vessel being induced to the trailing towfish. These swell induced movements of ±1m translated to approximately 5nT of flux in the readings. This phenomenon has been observed by Alpine on previous survey projects offshore Maryland. It was also observed in the 2013 survey data provided to the MEA. This effect is exaggerated during poorer weather conditions, and is less pronounced during fair weather and calm seas.

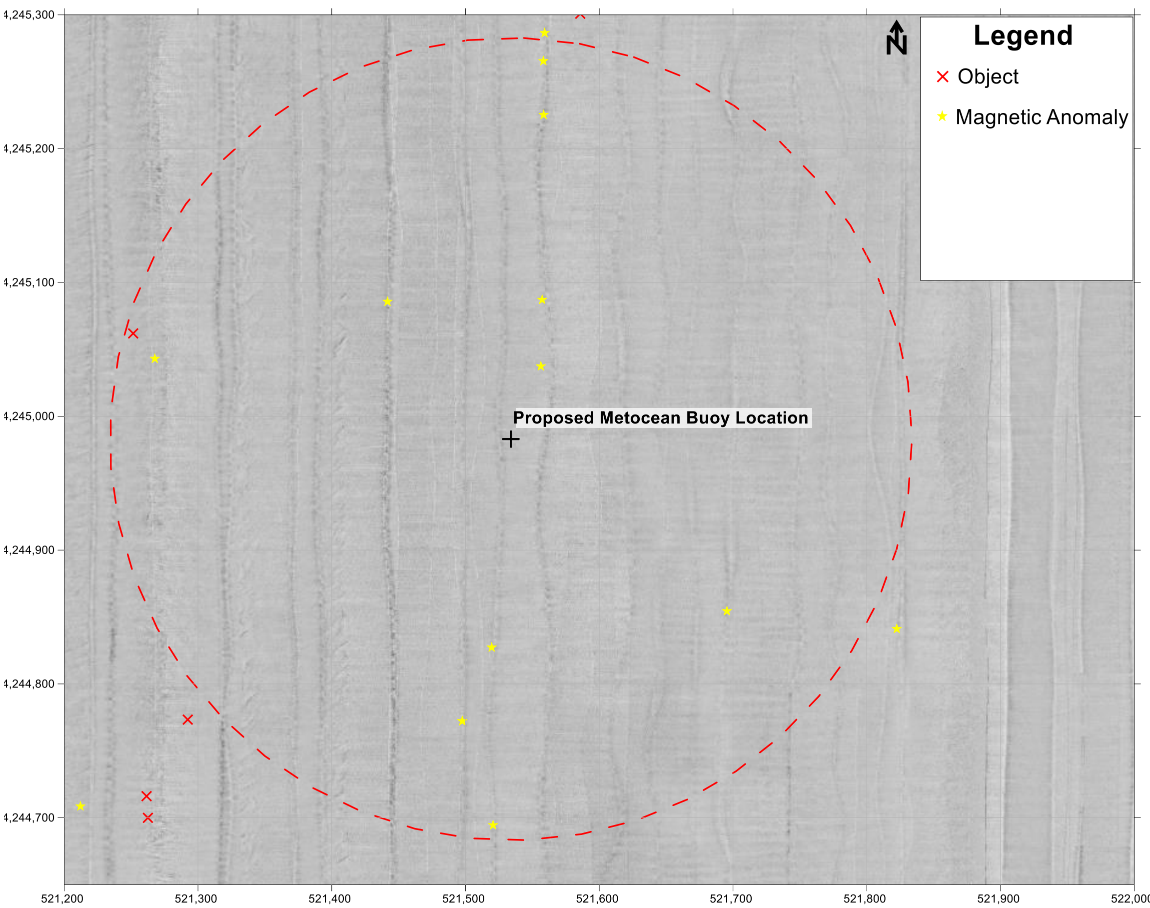

Figure 5.2 Seabed Conditions at the Proposed Metocean Buoy Location

5.3 Shallow Geology

Sub-bottom penetration with the CHIRP system was restricted to approximately 6m below the seafloor. Two units were interpreted in the 2015 dataset, along the same lines as the 2013 survey.

Geotechnical information was also acquired in 2015. Correlating these results at the Proposed Metocean Buoy Location showed good results between the ravinement surface mapped in the sub-bottom data and a thin gravel layer overlying clay lamina at approximately 1m below the seafloor.

The maximum penetration achieved throughout the area of interest was approximately 5m below seabed. In general, the sub-bottom profiler did not penetrate much into Unit 2.

These results also correlated well with medium-penetration seismic data collected during the 2013 CP&E survey. Three units were identified in that survey, on a line approximately 50m east of the Proposed Metocean Buoy Location, and described as:

- Unit 1 – Holocene Sandy Sediments;
- Unit 2 – Pleistocene Channel Complex;
- Unit 3 – Pre-Pleistocene Sub-Parallel Sands and Clays.

For a detailed comparison between geotechnical data at the location and the medium penetration sub-bottom data collected by CP&E, refer to the 1751-1 and 1751-2 reports.

5.3.1 Unit 1

Unit 1 is a surficial sheet of Holocene sandy marine sediments. Base Unit 1 is a regionally prevalent sub-parallel reflector to the seabed, interpreted as a ravinement surface representing the erosional boundary between Late Pleistocene and Early Holocene sediments.

Base Unit 1 occurs at 0.5m below seabed at the Proposed Metocean Buoy Location. Within 300m of the proposed location, the reflector varies in depth from 0.5m to 0.9m below seabed. Figure 5.3 illustrates the thickness of Unit 1 around the Proposed Metocean Buoy Location.

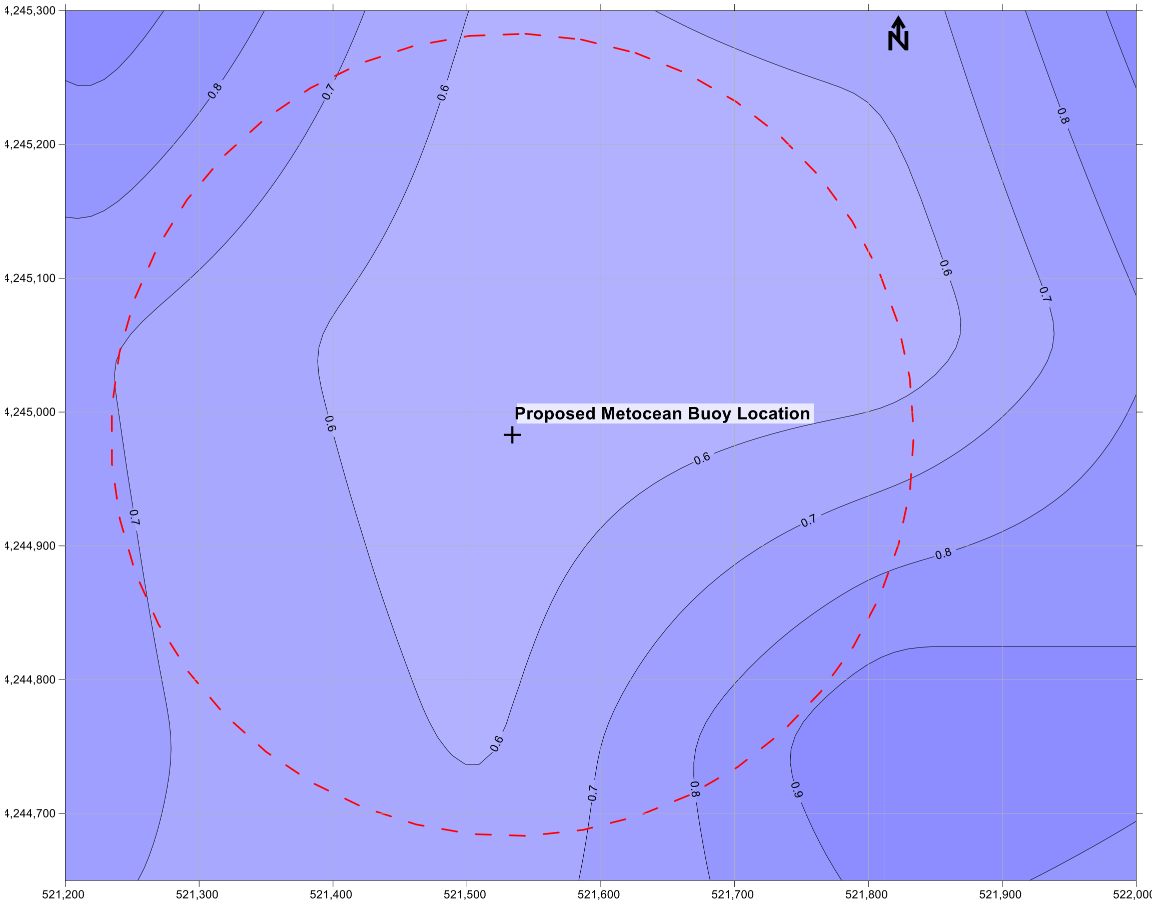

Figure 5.3 Shallow Soils, Unit 1, at the Proposed Metocean Buoy Location

The ravinement surface reflector is usually planar and marks the base of topographic highs. The reflector represents the boundary between the ravinement surface formed by shoreface erosion and modern trailing edge shelf deposits. This surface also correlates to Base Unit 1 as mapped by the 2013 MEA survey conducted by Coastal Planning & Engineering (CP&E).

5.3.2 Unit 2

Unit 2 underlies Unit 1, and represents the Pleistocene-age channel complex. The sub-bottom data resolved the upper few meters of Unit 2 only and its thickness was not determined. In areas beyond the proximity of the Proposed Metocean Buoy Location, the sub-bottom profiler identified numerous buried channel features.

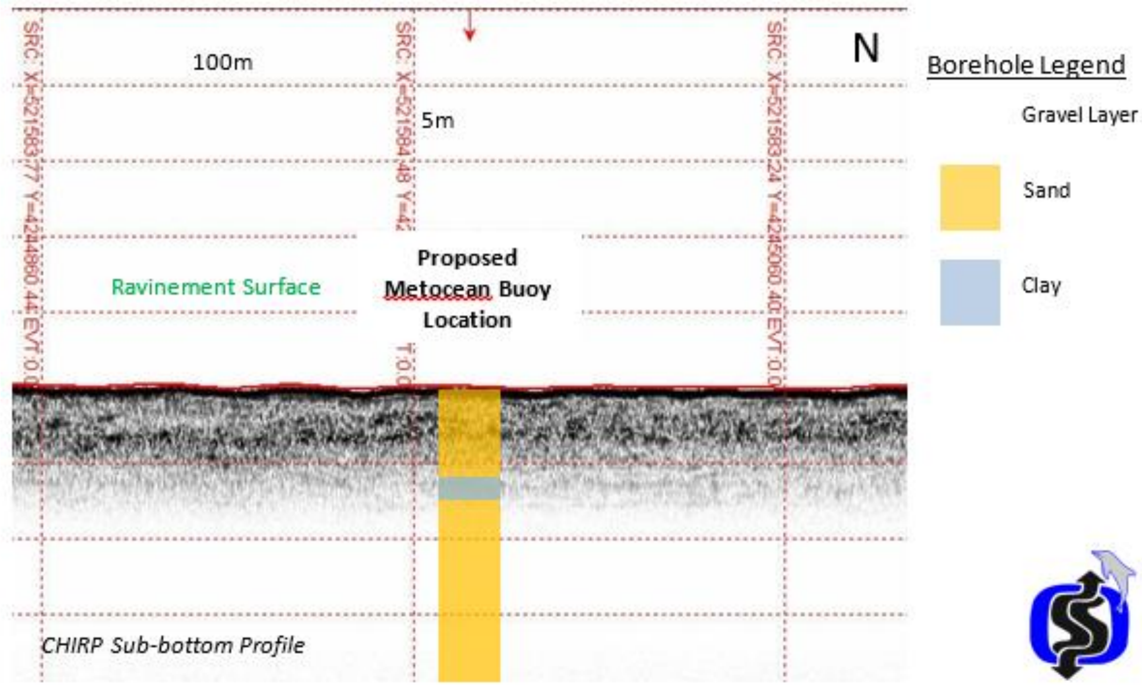

Figure 5.4 CHIRP Sub-Bottom Profile with Borehole Overlay (from 1751-2 Report).

5.4 Hazard Summary

Summaries of seabed and sub-seabed hazards are included as Tables 5.2 and 5.3. A summary of potential obstructions is included as Table 5.4.

All of the hazard assessments refer to the 2015 dataset, and are subject to interpretation limits and quality factors on that dataset. **Italicized hazard identifications relate to the transient nature of the marine environment, and can only be considered up to date as of July 2015 when the original survey demobilized.**

Table 5.2 Seabed Hazards

Hazard	Identification
Boulders	Not present
High Seabed Gradients	Not present
Sediment Failure / Mass Movement	Not present
Bedforms	Sand ripples present throughout.
Rock or Hard-bottom	Not present
Diapiric Structures	Not present
Faulting	Not present
Gas or Fluid Expulsion	Not present
Water Scour	Not present
Channels	Not present

Table 5.3 Sub-Seabed Hazards

Hazard	Identification
Sediment Failure / Mass Movement	Not present
Shallow Rock or Hard-bottom	Not present
Diapiric Structures	Not present
Faulting	Not present
Gas or Fluid Expulsion	Not present
Channels	Not present

Hazard	Identification
Shallow Gas	Not present
Seismic Activity	Not present
Volcanic Activity	Not present

Table 5.4 Anthropogenic Obstructions

Hazard	Identification
Debris	*One object identified within 300m of the location.*
Cables	*None identified.*
Pipelines	*None identified.*
Wrecks	*None identified.*
Unexploded Ordnance	*This location is within the FACSFAC VACAPES Operating Area of the US Navy and is accessible to all US Armed Forces. Warning Area 386 (W-386) is also a special-use airspace, in which military operations are known to occur, including flight testing, munitions deployment, and general training exercises. Unexploded ordnance is a possibility within this area.* *Numerous minor magnetic anomalies were identified within 300m of the location.*
Archaeological Heritage	Not assessed.

No other significant features or obstructions were interpreted within 300m of the proposed location based on the 2015 dataset.

Appendix L

RCG&A Site Assessment Plan Amendment Letter

R. CHRISTOPHER GOODWIN & ASSOCIATES, INC.
cultural resource management and preservation planning

August 19, 2020

Mr. Steve Wood, Vice President
ESS Group, Inc.
10 Hemingway Drive, 2nd Floor
East Providence, RI 02915

RE: Maryland Offshore Wind Energy Area, Site Assessment Plan Amendment

Dear Mr. Wood:

R. Christopher Goodwin & Associates, Inc. (RCG&A), is pleased to submit this letter report detailing the results of a Phase I submerged cultural resources review of geophysical investigations conducted by US Wind, Inc. (US Wind) within the Maryland Offshore Wind Energy Area (MDWEA) to support an offshore renewable energy development project. US Wind obtained development rights to the MDWEA through a competitive auction and executed commercial leases of submerged lands (OCS-A 0489 & OCS-A-0490) for renewable energy development on the Outer Continental Shelf with Bureau of Ocean Energy Management (BOEM) on October 6, 2014. This review considers modifying the Site Assessment Plan (SAP) to support the project's current requirements for deployment, operation and decommissioning, as a result of the change from a meteorological tower to a meteorological (met) ocean buoy.

Introduction

US Wind submitted its original SAP for the installation of a meteorological tower on November 23, 2015 and the SAP was approved on March 22, 2018. To support the project's near-term objectives, US Wind has decided to deploy a met ocean buoy and reserve the possible installation of the meteorological tower for a later date. In support of the SAP amendment and evaluation of the proposed modifications to the US Wind Project, a Qualified Marine Archaeologist, has reviewed the previous archaeological assessments of the high resolution geophysical (HRG) investigations conducted by Alpine Ocean Seismic Survey, Inc. (Alpine), in 2015 (Schmidt et al. 2016). Alpine conducted the HRG survey within a 300-meter (m) radius (69.8 acres [ac]) that is the Area of Potential Effect (APE), centered on the originally proposed met tower location (figures 1 and 2). Alpine carried out HRG survey and marine investigations over the period June 1-28, 2015.

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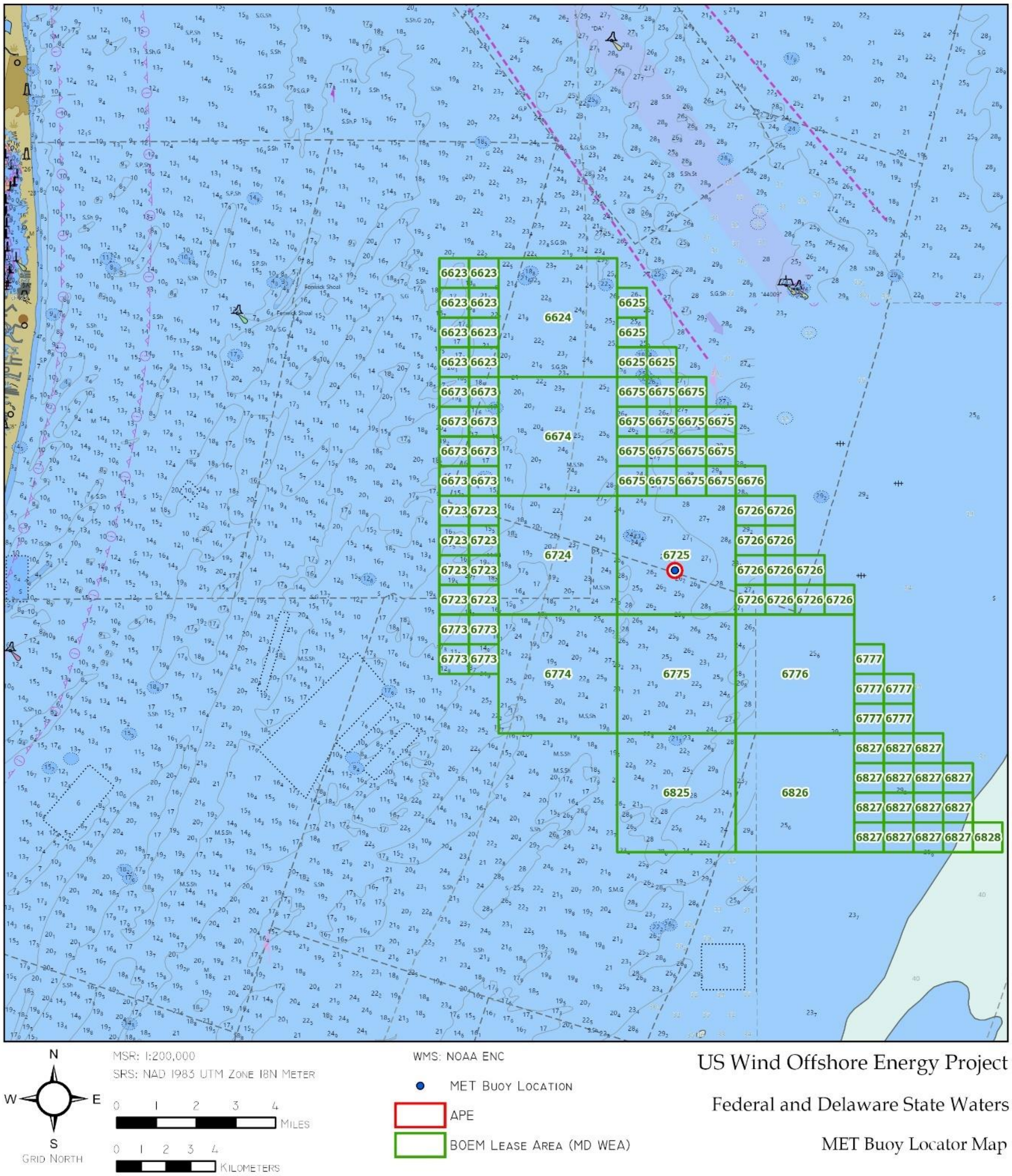
New Orleans, LA Lawrence, KS Frederick, MD Las Cruces, NM



R. Christopher Goodwin & Associates, Inc.
NAUTICAL DIVISION
MARINE ARCHAEOLOGY FROM STEM TO STERN
WWW.RCGOODWIN.COM | KMAY, 8.12.2020

Figure 1. Met ocean buoy location within the MDWEA

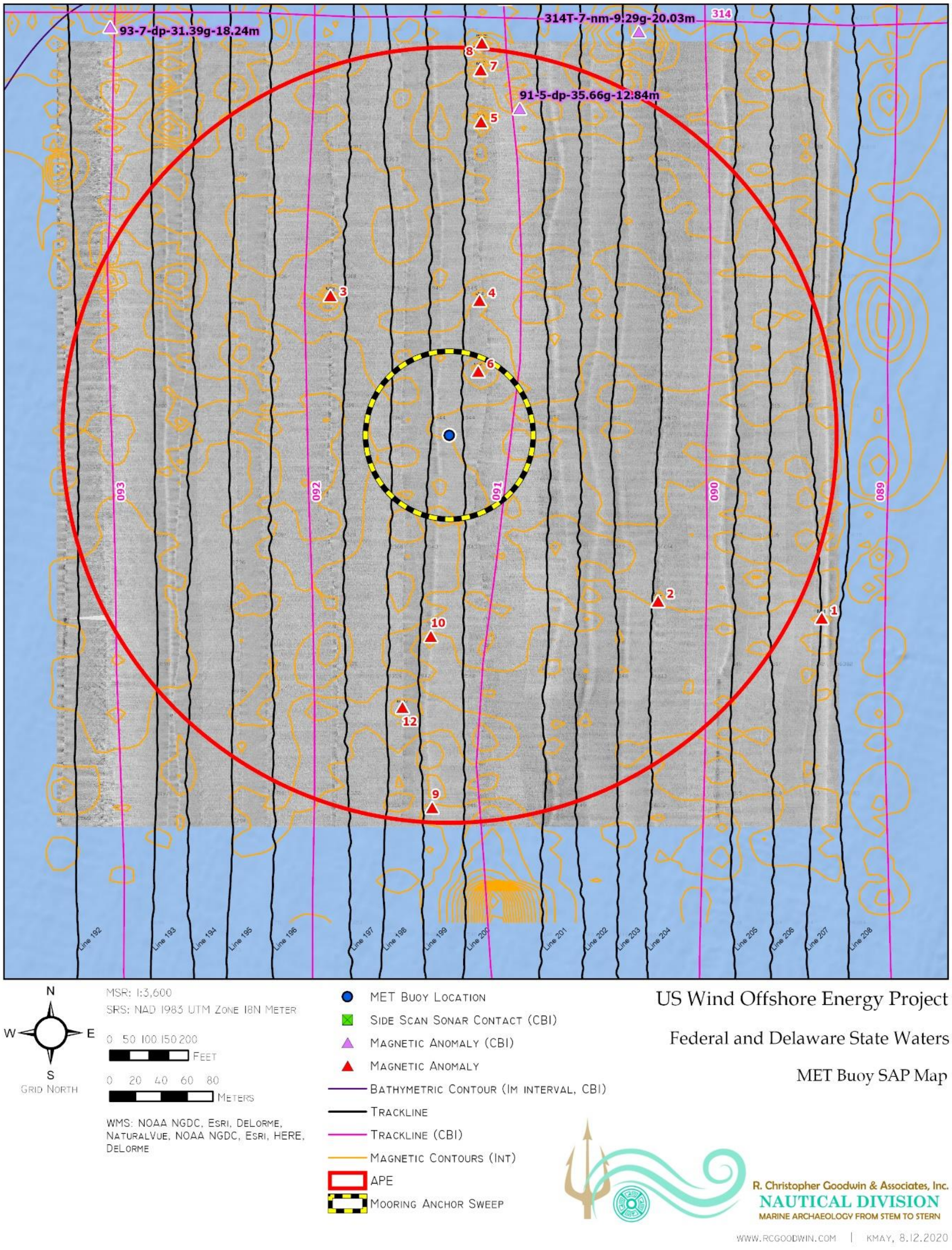


Figure 2. Met ocean buoy archaeological resources map

Description of Proposed Modification and Undertaking

Site Assessment Activities

US Wind proposes to deploy, operate and maintain one (1) met ocean buoy within the MDWEA. The met ocean device to be deployed is an EOLOS FLS200 LiDAR Buoy (Table 1; Figure 3), which will float on the surface and be moored to the seafloor (Figure 4). Table 2 provides the LiDAR buoy's proposed deployment and operation location (coordinates, water depth).

Table 1. Buoy location and water depth

OCS Block	Easting[1]	Northing[1]	Latitude[2]	Longitude[2]	Depth
6725	521533.96	4244982.95	38° 21' 9.889" N	74° 45' 12.766" W	27.0 m (88.6 feet [ft])

[1]NAD83, UTM 18N, Meters (EPSG 26918)
[2]Geographic coordinates referenced to NAD83

The FLS200 is equipped with ZX 300M LiDAR system, which provides remote wind measurements (e.g., wind speed and direction) using the weather transmitter mounted to the buoy mast. The buoy system also measures sea state characteristics (e.g., wave direction, wave height, current velocity and direction, and, water temperature) and meteorological parameters (e.g., air temperature/humidity, air pressure, and precipitation). The buoy will be equipped with biological sensors including: avian acoustic recorder, bat ultrasonic recorder, marine mammal hydrophone, and bird and fish nanotag detectors. The anchor footprint is estimated at one (1) m^2 (10.8 ft^2) and the maximum mooring chain sweep is 65 m (213 ft) around the anchor (Figure 3). Previous sampling has indicated that sediments at the deployment location are composed of dense sand with some gravel. Although no penetration of the anchor or anchor chain sweep into the seabed is anticipated based on seabed conditions, this evaluation has conservatively assumed a maximum penetration of -0.6 m [2 ft]). Table 3 provides the proposed APE for direct effects.

Table 2. EOLOS FLS200 LiDAR Buoy

Dimensions	4 m (13.1 ft) length and width, approximately 3.1 m (10.2 ft) above sea level
Weight	4,062 kilograms (kg) (4.5 tons)
Mounting	A single 5,000 kg (5.5 tons) anchor with approximately 92 m (302 ft) of 38 millimeter (mm) and 26 mm anchor chain
Mooring chain sweep	65 m (213 ft) radius around the anchor

Table 3. APE for direct effects

Buoy Component	Horizontal APE	Anchor Sweep – Maximum Vertical APE (Depth Below Seabed)
Met ocean buoy	300-m radius (69.8 ac)	-
Anchor footprint	1 m^2 (10.8 ft^2)	0.6 m (2 ft)
Anchor chain sweep	65 m (213 ft)	0.6 m (2 ft)

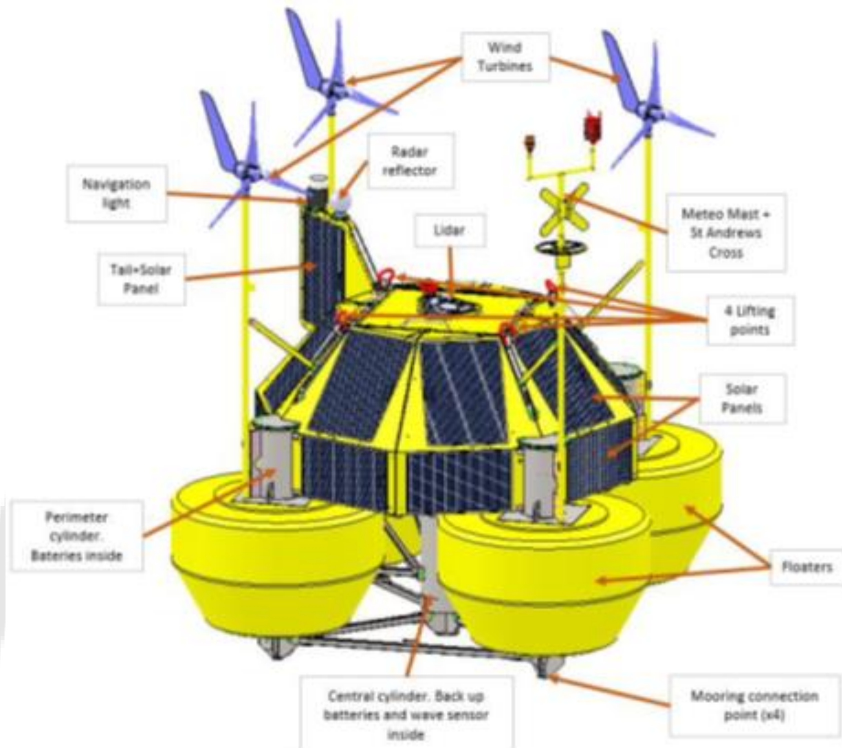


Figure 3. Rendering of the EOLOS FLS200 LiDAR Buoy (ESS Group, Inc. [ESS] 2020:11)

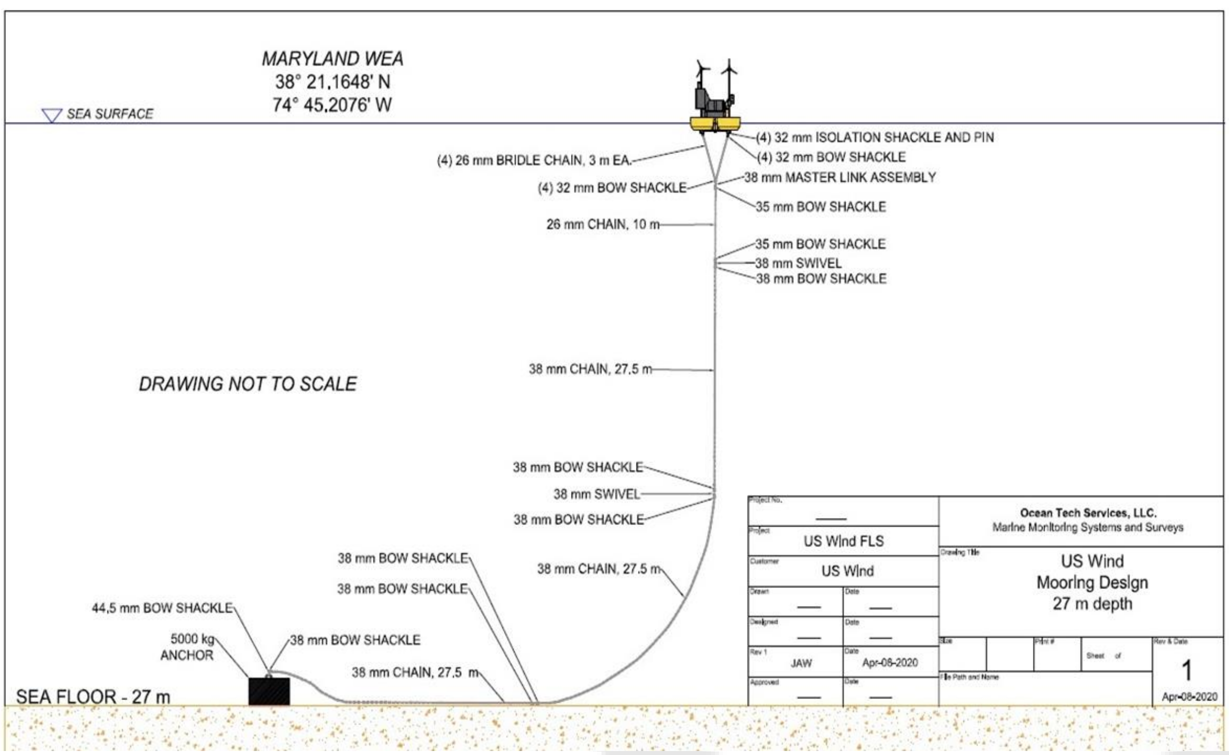


Figure 4. LiDAR mooring system (ESS 2020:10)

Conclusions and Recommendations

RCG&A conducted a review of previous archaeological assessment of the HRG survey data collected by Alpine in 2015 (Schmidt et al. 2016) and associated with the proposed met ocean buoy APE. The review identified no side scan sonar contacts and no magnetic anomalies that may represent submerged cultural resources. Shallow penetration subbottom profiler data were analyzed to identify paleolandscape features. The seismic data indicated that no paleolandforms are present that may preserve inundated archaeological sites within the APE It is our conclusion that no potential submerged archeological resources or paleolandscape features that may preserve inundated archeological sites will be affected by the proposed met ocean buoy installation, operation and decommissioning activities within the Area of Potential Effect (APE). Therefore, a determination of "No historic properties affected" (36 CFR 800.4) is recommended and concurrence with this recommendation is sought from BOEM.

We are pleased to be of service to ESS.

Please do not hesitate to contact us with questions.

Best regards,

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