W00459

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Survey

DESCRIPTIVE REPORT

Type of Survey: External Source Data

Registry Number: W00459

LOCALITY

State(s): New York

General Locality: North Atlantic Ocean

Sub-locality: New York Bight

2017

Alpine Ocean Seismic Survey, Inc.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00459

INSTRUCTIONS: The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State(s):	**New York**
General Locality:	**North Atlantic Ocean**
Sub-Locality:	**New York Bight**
Scale:	**10,000**
Dates of Survey:	**06/21/2017 to 08/11/2017**
Project Number:	**ESD-AHB-18**
Data Source:	**Alpine Ocean Seismic Survey, Inc.**
Chief of Party:	**Marcus Kwasek, Field Project Manager**
Soundings by:	**multibeam**
Imagery by:	**multibeam**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**Meters at Mean Lower Low Water**

Remarks:

The purpose of this survey is to provide contemporary data to update National Oceanic and Atmospheric Administration (NOAA) nautical charts. Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of surveyed features is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/.

Products created during office processing were generated in NAD83 UTM 18N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

Alpine
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Survey Report for
INSPIRE Environmental

Title:
Marine Operations Report

Project:
Multibeam Echo Sounder and Sediment Profile and Plan View Imaging Survey In Support of the New York Offshore Wind Master Plan

Survey Date:
21 June – 11 August 2017

Project Number:
1815

Report Status:
Revision 0

REPORT REVISION HISTORY

Rev.	Date	Description	Orig.	Chk.	App.
0	09/08/17	Initial Report	MDK	SJM	SJM

SURVEY OVERVIEW

Alpine Ocean Seismic Survey, Inc. (Alpine) was contracted on behalf of Inspire Environmental to undertake marine bathymetric and environmental surveys offshore New York. The surveys were conducted in tandem with the INSPIRE project team to provide planning-level characterization of the geological (sediment size and type), geotechnical (density of bottom) and benthic (animal habitat) characteristics of all potential offshore wind energy areas within previously identified water depth zones offshore New York.

The survey covered an area offshore New York State and within the NYSERDA-defined Offshore Planning Area.

Bathymetric and environmental data acquisition was carried out by Alpine and Inspire on board the *RV Shearwater*, which was mobilized in New Bedford, MA on 21-June-2017 with operations completing on 11-August-2017. Bathymetric and environmental data were collected by Alpine and Inspire using a multibeam echosounder, and a Sediment Profile Imager (SPI)/Plan View (PV) camera system.

The acoustic and optical data sets were reviewed for the presence of any natural or man-made hazards as well as variations in bottom type, to aid in planning additional investigation areas.

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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GLOSSARY OF ABBREVIATIONS

Abbreviation	Meaning	Typical Use in Documents
CORS	Continuously Operating Reference Station	
DGPS	Differential Global Positioning System	
DPR	Daily Progress Report	
DTM	Digital Terrain Model	
EPSG	European Petroleum Survey Group	
FMGT	Fledermaus Geocoder Toolbox	
ft.	Feet	
GAMS	GPS Azimuth Measurement System	
GNSS	Global Navigation Satellite System	
Hz	Hertz	
IMU	Inertial Measurement Unit	
kHZ	Kilohertz	
kts	Knots	
Lat	Latitude	
Long	Longitude	
m	Meter	
MBE	Multibeam Echosounder	
NA	Not Applicable	
NAD83	North American Datum of 1983	
NAVD88	North American Vertical Datum of 1988	
PDOP	Position Dilution of Precision	
PPK	Post Processing Kinematic	
PPS	Pulse Per Second	
RTK	Real Time Kinematic	
QA/QC	Quality Assurance/Quality Control	
RV	Research Vessel	
SOW	Scope of Work	
SVP	Sound Velocity Profile	
USCG	United States Coast Guard	
usft	United States Survey Feet	
UTM	Universal Transverse Mercator Projection	
VDATUM	North American Vertical Datum Transformation	
WD	Water Depth	WD 23ft
WGS84	World Geodetic System 1984	

DEFINITIONS

Terminology	Definition
Main Contractor/Customer	INSPIRE Environmental
Survey Contractor	Alpine Ocean Seismic Survey, Inc.
Debris	Sonar contacts attributed to human activity.
MLLW	Mean Lower Low Water
NAVD88	The North American Vertical Datum of 1988 (NAVD 88) is the vertical control datum of orthometric height established for vertical control surveying in the United States of America based upon the general adjustment of the North American Datum of 1988.
NYSERDA	New York State Energy Research and Development Authority
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.

1. INTRODUCTION

1.1 System Description

The offshore New York area includes four separate blocks with a total of approximately 2679 survey km and 300 SPI/PV Camera sites.

1.2 Purpose

INSPIRE Environmental (INSPIRE) contracted Alpine Ocean Seismic Survey, Inc. (Alpine) to undertake marine bathymetric and environmental surveys offshore New York. The surveys were conducted to provide planning-level characterization of the geological (sediment size and type), geotechnical (density of bottom) and benthic (animal habitat) characteristics of potential offshore wind energy areas offshore New York.

The project consisted of two scopes of work:

1. Perform a bathymetric survey along survey lines with a 3.5 km spacing within the four designated survey Blocks.
2. Perform a SPI/PV camera survey in areas of variable bottom type and potential habitat.

This report presents the results for bathymetric survey conducted by Alpine in support of the NYSERDA project.

Figure 1.1 below shows the mainline survey offshore of New York. The survey lines are spaced at 3.5 km.

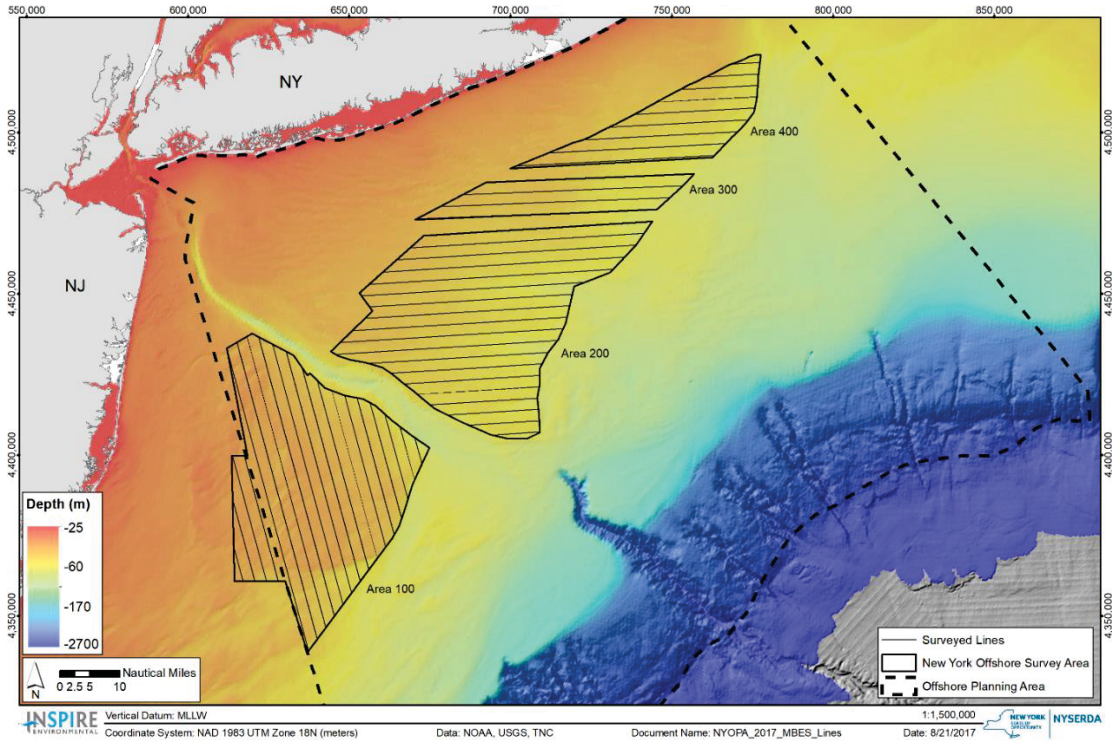

Figure 1.1: Offshore New York Mainline Survey

1.3 Fieldwork Summary

Table 1.1 Field work summary

Fieldwork Summary			
Program	Survey Vessel	Task	Dates
Mobilization	*RV Shearwater*	Travel to New Bedford, MA Mobilize survey equipment, perform calibrations	21-Jun-2017 to 22-Jun-2017
Marine Bathymetric Survey	*RV Shearwater*	Bathymetric Profile Survey	22-Jun-2017 to 21-Jul-2017
Marine SPI/PV Survey	*RV Shearwater*	SPI/PV Survey	21-Jul-2017 to 11-Aug-2017
Demobilization	*RV Shearwater*	Field survey equipment demobilization Return to New Bedford, MA	11-Aug-2017

1.4 Time Breakdown Marine Bathymetric and Environmental Survey

The project totaled 1077.75 hours, 457.00 of which were operational bathymetric survey hours and 147.25 were operational environmental survey. Bad weather conditions caused the survey to last longer than expected.

Table 1.2: Time Breakdown Marine Bathymetric and Environmental Survey

Activity	Project Hours	Percentage of Total
Mob/Demob	41:30	3.85%
Contractor's Time	21:45	2.02%
Ops MBE & SPI	457:00	42.40%
Ops SPI/PV Only	147:15	13.66%
Standby MBE & SPI	191:00	17.72%
Standby SPI Only	152:15	14.13%
Port Call	65:30	6.08%
Vessel Downtime	1:30	0.14%
Total	1077:45	100.00%

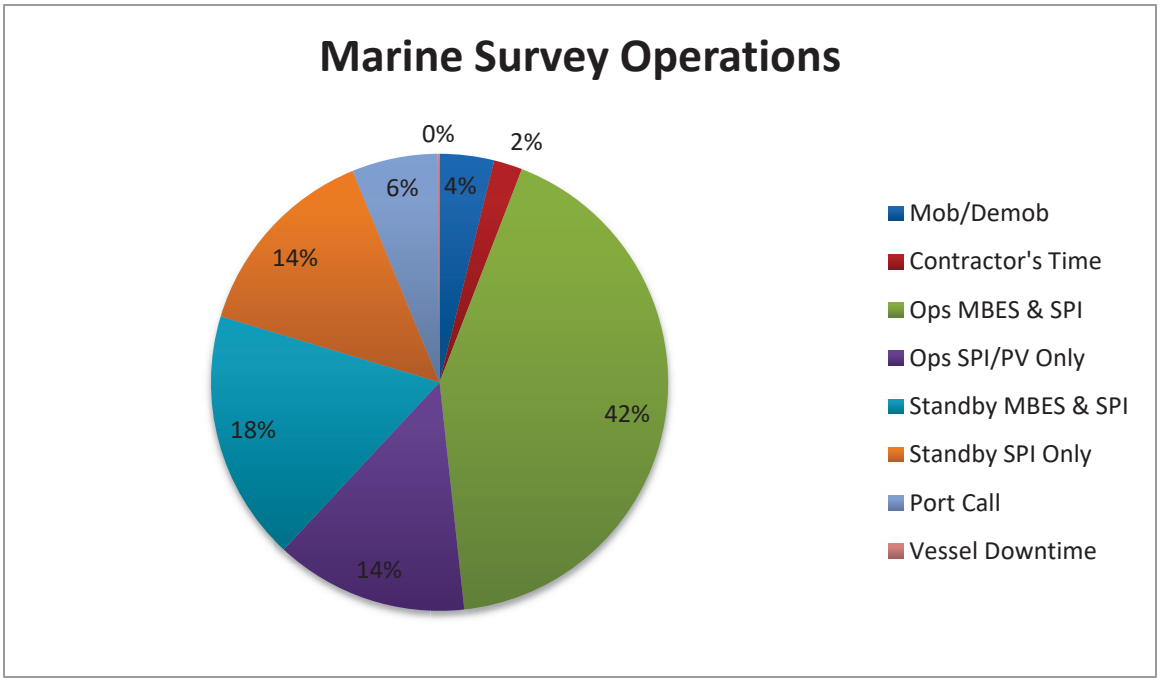

Figure 1.2: Time breakdown Marine Bathymetric and Environmental Survey

2. VESSEL SUMMARY

Figure 2.1: The *RV Shearwater*

Marine Survey operations were conducted on board Alpine's *RV Shearwater*. The *RV Shearwater* is a multi-purpose survey vessel with capabilities to perform bathymetric and high-resolution geophysical surveys, geotechnical investigations, and environmental studies. The *RV Shearwater* has two fast-action hydraulic winches and a heavy-duty (S.W.L. 8,000 lbs.) overhead crane for heavy operations.

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. Every crew member is given a safety induction upon joining the vessel and regular toolbox meetings are also conducted prior to back deck operations, equipment deployment and recovery.

During the entire survey operation a total of 104 toolbox meetings were completed.

Start of day, and end of day check ins were completed by the Party Chief with the designated INSPIRE representative.

Exposure Hours

The survey and marine crew totaled 11 to 15 persons throughout the survey operations. The total numbers of exposure hours from onsite mobilization on 21-June to survey completion on 11-August-2017 were 4415.25 hours 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 during mobilization, calibration and survey operations on the NYSERDA project.

Table 4.1 Field Personnel

Alpine Personnel			
Geophysical Survey		**Period**	
Field Project Manager / Surveyor	Marcus Kwasek	21-Jun-2017	11-Aug-2017
Hydrographic Surveyor	Steve MacDonald	21-Jun -2017	29-Jun-2017
	Dario Manchia	29-Jun-2017	10-Jul-2017
	Mitchell Kennedy	10-Jul-2017	11-Aug-2017
Field Processor	Matthew Gudger	21-Jun -2017	21-Jul-2017
	Mary Eaton	21-Jun-2017	29-Jun-2017
	Amanda Bittinger	29-Jun-2017	10-Jul-2017
	Mary Eaton	10-Jul-2017	21-Jul-2017

5. SURVEY PROCEDURES

5.1 General

The offshore New York area includes four separate blocks with a total of approximately 2679 survey km and 300 SPI/PV Camera sites.

All data was acquired in accordance to Alpine standard operating procedures and in line with good industry standard practices.

5.2 Project Survey Parameters

Table 5.1 Project geodetics

Datum and projection parameters for all surveys:		
Geodetic datum	NAD83 (2011)	
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	Universal Transverse Mercator (UTM)	
	Projection method	Transverse Mercator
	Zone	18 North
	Central Meridian	75°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)
	EPSG code	26918

5.3 Vertical Datum

Multibeam Echosounder (MBE) data was collected by Alpine during the survey. Bathymetry data were water level corrected using the Post Processing Kinematic (PPK) method and subsequently adjusted from water depths to Mean Lower Low Water (MLLW) elevations in meters using a datum model. The vertical shifts in seafloor elevation from NAD83 to MLLW of locations surrounding the survey area were calculated using NOAA's North American Vertical Datum Transformation (VDATUM). The datum model was generated to interpolate the vertical shift between them to estimate the dynamic elevation of the seafloor relative to MLLW across the survey area. This area datum method is more accurate than performing a single point shift of all the vertical data.

The PPK method uses 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 MBE 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 differential corrections from 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.

5.4 Summary of Survey Design

The offshore New York area includes four separate blocks with a total of approximately 2679 survey km. The line spacing for the survey was 3.5 km spaced throughout each survey block. Transit lines were also recorded between lines in order to provide a larger coverage area.

In addition to the survey lines, 300 SPI/PV Camera sites we spread throughout the survey blocks in order to identify variable bottom types as well as possible environmental habitats.

5.5 Survey Equipment and Methods

5.5.1 Vessel Configuration

The *RV Shearwater* provided the survey platform to conduct the bathymetric and environmental investigation. The vessel provides an aft deck, winches, and lab space for topside survey electronics. The MBE transducers were mounted in the bow moonpool 2.56 meters below the vessel's waterline. The SPI/PV camera rig was deployed of the starboard A-frame via the onboard hydraulic winch. The equipment offsets are presented below.

Table 5.2: Vessel Offsets and Equipment

VESSEL :	**RV Shearwater**				
	☑ meter	☐ feet	+ forward/ - backward	+ right/ - left	+ up/ - down
Reference Point			0.000	0.000	0.000
Primary GPS Antenna			-1.661	-0.729	5.246
Secondary GPS Antenna			1.744	-0.691	5.251
IMU (Inertial Measurement Unit)			0.000	0.000	-0.115
CNAV GPS Antenna			-1.277	-0.513	4.966
Waterline					-3.565
Port Multibeam Echosounder (MBE)			-0.848	2.836	-6.125
Stb Multibeam Echosounder (MBE)			-0.392	2.857	-6.125
Rapid Cast SVP (RC)			-5.599	-13.751	0.831
A-Frame			6.946	-12.634	5.806

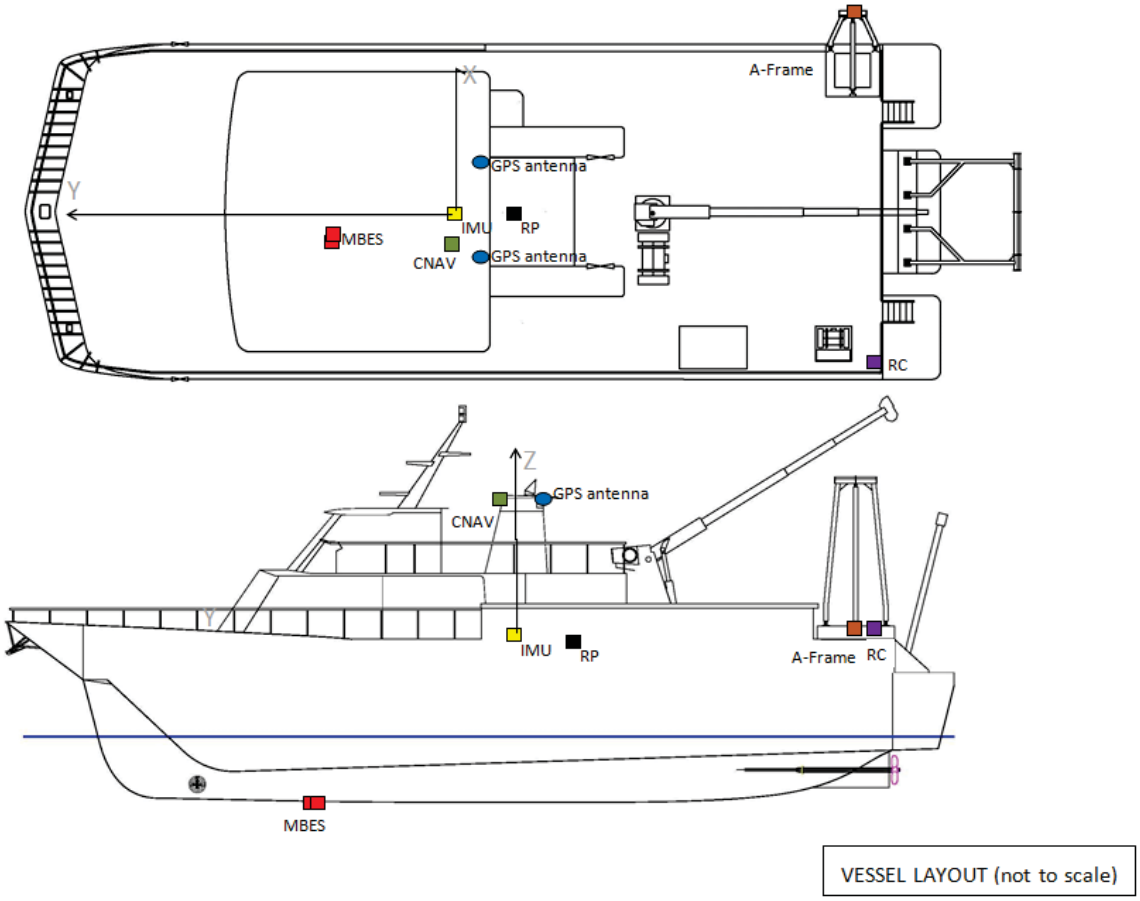

Figure 5.1: Survey equipment configuration

Table 5.3 Marine Bathymetric Survey Equipment

System	Make/Model
Positioning and orientation system	Applanix POS MV Oceanmaster with Trimble Nav-Beacon XL
Echo Sounder (MBE system)	Dual R2Sonic 2024
Sound Velocity Profiler	Sonardyne Rapid Cast, AML PlusX

5.5.2 Vessel and Equipment Navigation

The Applanix POS MV Oceanmaster was used for navigation control during the survey. Differential corrections were received from USCG stations offshore New York. 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 floor of the lab near the vessel's center of rotation/gravity. The GPS antennas were mounted above and aft of the vessel's bridge, aligned normal to the longitudinal axis of the vessel. Offsets between the GPS antennas, IMU and all other fixed mounting points for sensors were precisely measured before conducting onsite calibrations.

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 one meter.

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 Rapid Cast SVP. The POS MV system output was also directly interfaced to the MBE 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 vessel nodes were measured and recorded in QINSy. The QINSy navigation software converted the latitude and longitude data to Universal Transverse Mercator Zone 18N (meters), NAD83 datum, which was used for survey control.

5.5.3 Multibeam Echosounder (MBE)

Dual R2Sonic 2024 MBE systems were used to collect the bathymetric data. On the *RV Shearwater* the transducers were pole-mounted in the forward moonpool. Once appropriate settings of power and gain were determined, the system was calibrated for pitch, roll, and yaw by running a patch test. 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 MBE are included (Table 5.4).

Data were collected using signals transmitted at frequencies of 335 and 375 kHz and variable settings were used for range, pulse-length and gain for optimal data quality. Water column data was monitored live throughout the survey by onboard surveyors. This data was to be recorded in the event of visible artifacts however the only observations made were due to fish in the water column. No water column data was therefore collected. The speed of sound in water was determined using a Sonardyne Rapid Cast (SVP). The SVP sensor data was used to generate a profile of the speed of sound (Figure 5.2), which was then applied in QINSy to correct for sound velocity temporal changes. 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 2.0 hours during the MBE portions of the survey.

Some areas of the survey was completed in marginal weather to acquire as much data as possible during the campaign. Minimal if any data from outer swathes was rejected to aid in maintaining maximum coverage per single swath. Many images were vertically exaggerated 2-5x to highlight features along the routes that typically were flat bottom.

The hydrographic survey was designed to meet IHO order 1 specifications. This was accomplished through the use of high accuracy survey instruments such as the R2Sonic 2024 dual MBE, Applanix POS M/V, Teledyne RapidCast SVP, and QPS QINSy. Post processing and data reduction of bathymetric data to MLLW datum was completed using Caris HIPS 10, Applanix POSPac, and NOAA VDATUM.

Total Propagated Uncertainty was computed within Caris HIPS using manufacturer's accuracy values, VDATUM uncertainties, and NOAA Field Procedures Manual guidelines. Crossline comparisons yielded typical resultant differences of 0.05 to 0.10 meters, in water depths ranging from 30 to 70 meters.

All final processed and accepted bathymetric data met IHO order 1 specifications.

Table 5.4 MBE calibration values (Note that each MBE Transducer is tilted an additional 20° outboard)

Attitude	Correction
MBE1 Pitch	-0.190°
MBE1 Roll	1.190°
MBE1 Heading	0.210°
MBE2 Pitch	-0.020°
MBE2 Roll	0.230°
MBE2 Heading	0.590°

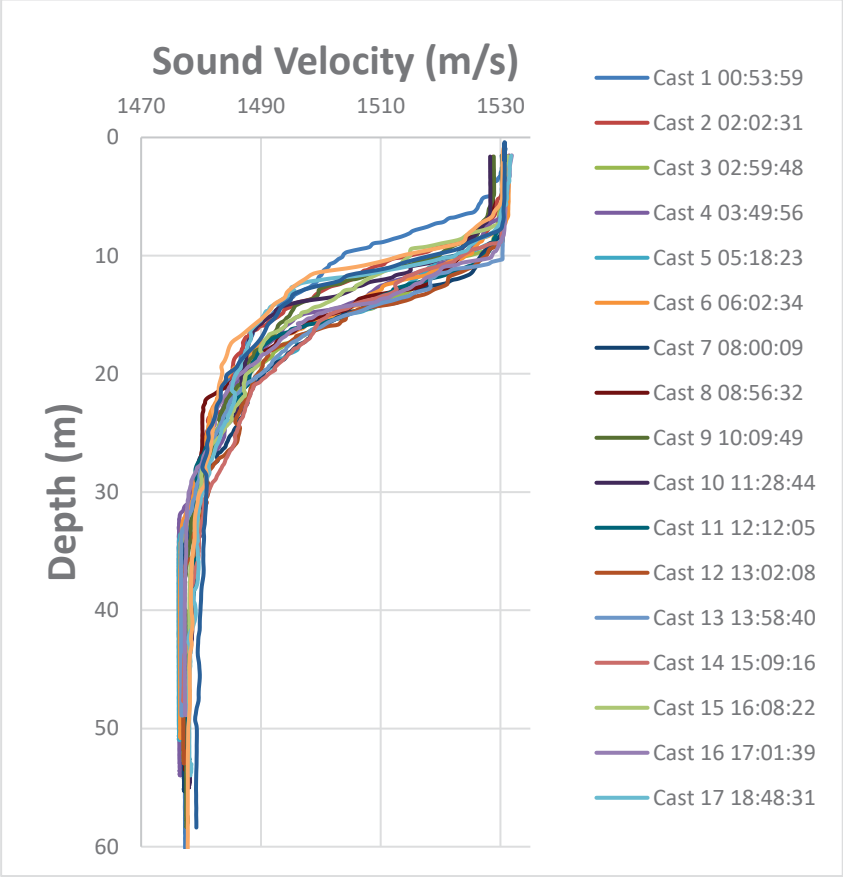

Figure 5.2: Example of SVP profiles collected

6. ACOUSTIC SURVEY RESULTS

6.1 Introduction

From June to August 2017, a dual sonar multibeam acoustic survey was conducted to provide planning-level characterization of the geological (sediment size and type), geotechnical (density of bottom) and benthic (animal habitat) characteristics of all potential offshore wind energy areas within previously identified water depth zones offshore New York. Survey areas were provided by INSPIRE and NYSERDA and are displayed within the Figure 1.1 of this report. Section 6 of this report summarizes the data processing and analysis of the survey results, and includes a general data discussion.

The overall survey design was atypical of multibeam surveys due to the lack of adjacent swathes of bathymetry. Multibeam sonar tuning was done to optimize the backscatter data as the highest priority.

6.2 Bathymetry

6.2.1 Bathymetry Processing and Analysis

The MBE data collected with the dual R2Sonic systems were processed using QINSy and Caris HIPS 10.3.1 software. The data were loaded into Caris HIPS, applied SVP corrections, loaded POSPac SBET for GNSS tides, and applied Delayed Heave. Data were de-spiked, water level and datum corrected and exported as 1.0 meter binned ASCII XYZ sounding files (DTM). These DTMs were used to generate shaded relief images of seafloor elevations across the four survey blocks.

6.2.2 Bathymetry Discussion

Seafloor elevations across the survey area ranged between approximately -25 m and -65 m relative to MLLW. A large amount of the survey area shows sections heavily marked with trawl scars (Figure 6.1).

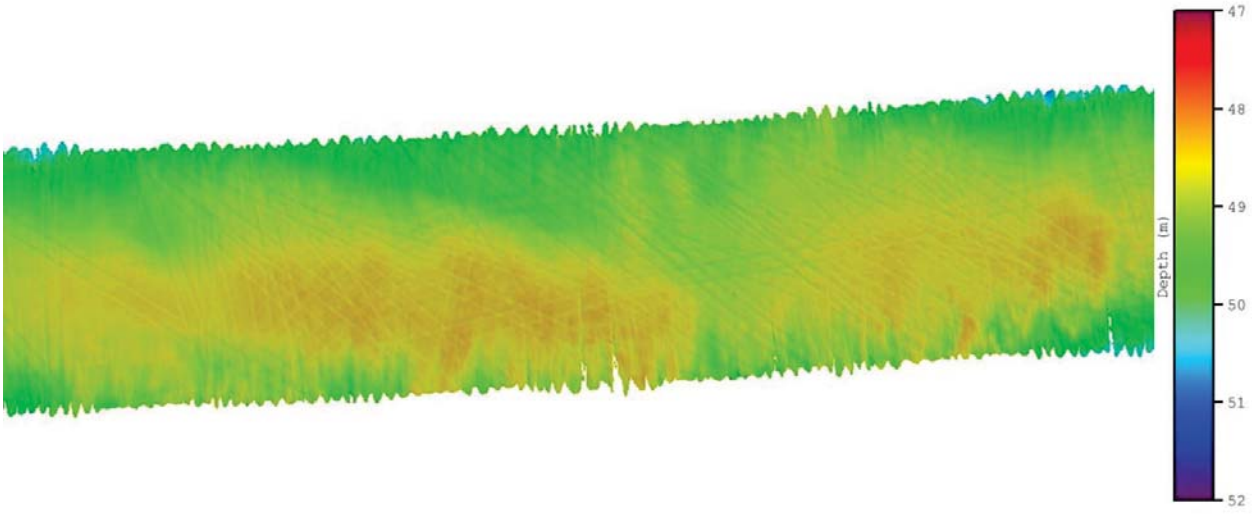

Figure 6.1: Example of trawl scars observed on Line 403

In addition, the northern section of Block 400 appears to have potential pock marks specifically along the eastern side of lines 407, 408 and 409 (Figure 6.2).

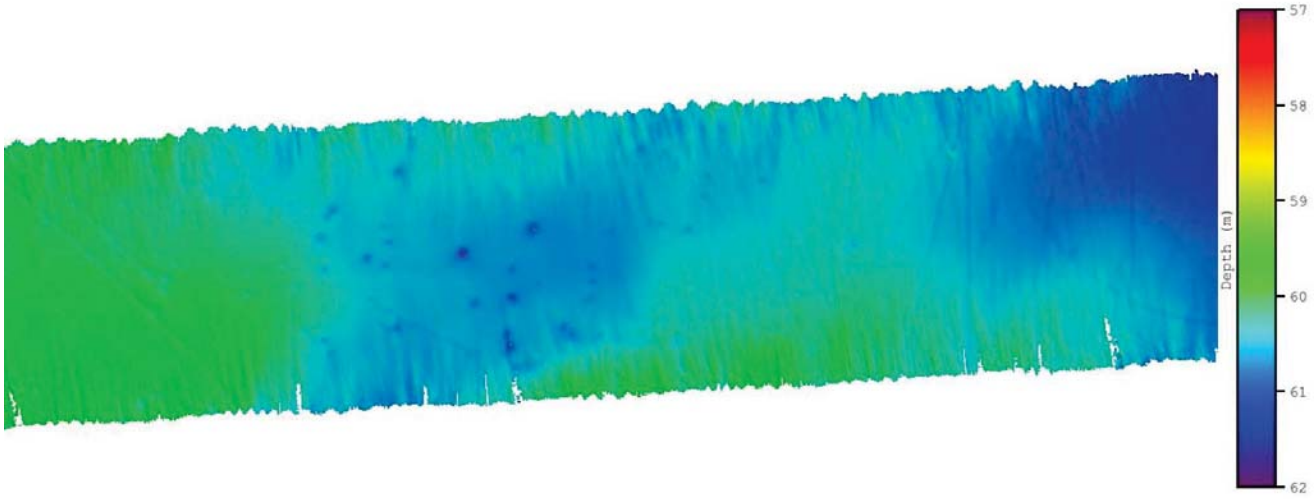

Figure 6.2: Potential pockmarks along Line 407

There were a total of two shipwrecks observed throughout the survey. The first of which is located on the southern end of Block 300 just north of line 301 (Figure 6.3). The second is located in the northern quarter of line 111.

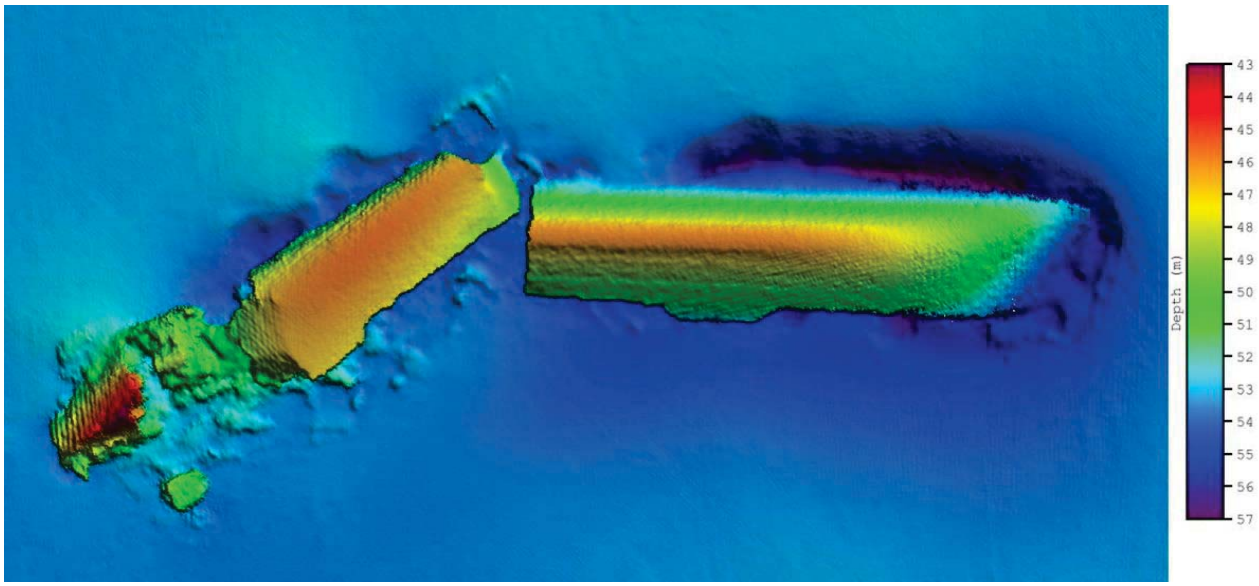

Figure 6.3: Block 300 shipwreck

6.3 Backscatter

6.3.1 Backscatter Processing and Analysis

Backscatter post processing was completed in QPS Fledermaus Geocoder Toolbox (FMGT). This entails bringing in the raw sonar files and cleaned bathymetry files to perform backscatter processing. Backscatter processing included application of AVG corrections and custom processing parameters specific to the dual head R2Sonic system. Due to the size of the area covered by the survey, mosaics were generated for each survey line individually. After mosaic generation, the survey lines were inspected for any anomalies or features of interest. The de-spiked backscatter data were then tiled and exported as 0.25m binned ASCII XYI and Floating Point GeoTiff files.

6.3.2 Backscatter Discussion

The backscatter data was of very good quality and yielded high resolution across the survey area. Mosaics were generated at a quarter of the bathymetric bin size, identifying a vast number of seafloor geological changes and features.

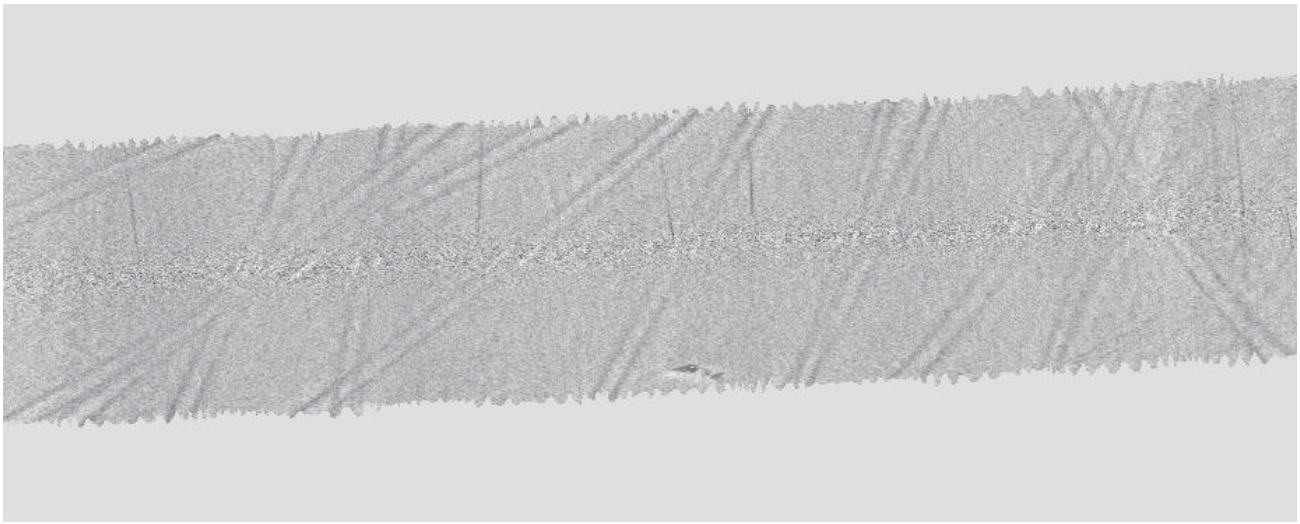

Figure 6.4: Line 403 trawl marks in backscatter

Report for

Project:

Multibeam Echo Sounder and Sediment Profile and Plan View Imaging Survey in Support of the New York Offshore Wind Master Plan

Description:

Mobilization Report

Report Date:

23 June 2017

Project Number:

1815

Revision Number:

1.0

REPORT AUTHORIZATION AND DISTRIBUTION

Compilation Alpine Ocean Seismic Survey, Inc.

Compiled by S. MacDonald

Approved by S. MacDonald

Revision	Date	Comment
0	23-June-2017	Alpine 1815 Mobilization Report
1.0	25-June-2017	Approved for use

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1. PROJECT SUMMARY

1.1 Mobilization Summary

The following report discusses the mobilization of the RV *Shearwater* by Alpine Ocean Seismic Survey Inc. for Inspire Environmental. The mobilization included two parts, a series of checks along the quayside, and calibrations and sea trials performed at a calibration site. The quayside mobilization and calibrations were carried out 21-June-2017. The quayside mobilization was conducted at the Marine Commerce Terminal in New Bedford, MA. The following report contains details of all checks and calibrations that were carried out as part of this mobilization.

1.2 Field Personnel

The following key contractor personnel and client representatives were present on board the survey vessel during mobilization:

Personnel	Name
Senior Project Manager / Surveyor	Steve MacDonald
Field Project Manager / Surveyor	Marcus Kwasek
Hydrographer / Data Processor	Mary Eaton
Data Processor	Matthew Gudger
E&E Environmental Oversight	Nicole Jeter
Inspire Chief Scientist	Dave Browning
Inspire Project Manager	Daniel Doolittle
Inspire Scientist	Marisa Guarinello
Inspire Scientist / GIS Analyst	BenTaylor
Vessel Captain	Michael Porter
Vessel 2nd Captain	Ron Worley
Vessel 3rd Captain	Eric Houtary
A/B	Kris Kliensmith
A/B	Aleck Brown
Cook	Thakechan Singh

Table 1 Field Personnel

1.3 Main Survey Equipment

Equipment Type	Equipment Model
Primary Navigation	Applanix POSMV
Secondary Navigation	C-Nav 3050
Primary Motion Sensor	Applanix POSMV
Primary Heading Sensor	Applanix POSMV
Multibeam Echosounder	R2Sonic 2024 dual head
Sound Velocity Probe	Teledyne-Oceanscience Rapidcast SVP
SPI/PV Camera System	Inspire Environmental system

Table 2 Main Survey Equipment

1.4 Mobilization and Trials Program

Trials No	Equipment	Plan
1	GAMS	Conduct 3x verifications at sea
2	GNSS	Alongside check
3	Node Offset	Alongside check
4	Position Comparison	Alongside check
5	Heading	Alongside check
6	Draft Check	Alongside check
7	MBES	Patch test
8	SVP	Alongside check

Table 3 Mobilization and Trials Program

2. VESSEL CONFIGURATION, OFFSETS AND INTERFACING

2.1 Offsets

All equipment offsets have been surveyed in using land survey techniques, full documentation of the process can be found in RV-Shearwater_Vessel Installation Report 09June2017.pdf. The vessel coordinate frame follows in-house convention and is in accordance with industry standards. The x-axis is positive to starboard; y is the vessel's longitudinal center-line, positive forward and z is positive upwards. Survey monuments are located around the vessel for easy measurement of towed sensors and for use in heading sensor calibrations.

2.2 QINSy Interfacing

All interface cabling was checked and inputs / outputs from the survey online equipment were checked as detailed below:

Navigation / Fix Outputs from QINSy	Baud Rate
Teledyne RapidCast SVP	9600/8/n/1

Table 4 Outputs from QINSy

Inputs to QINSy	Baud Rate
POS MV Position Primary	N/A UDP
POS MV Attitude Primary	N/A UDP
ZDA/PPS	9600/8/n/1
CNAV	19200/8/n/1
MBES Depth in	N/A UDP

Table 5 Inputs to QINSy

3. GEODETIC REFERENCE SYSTEM

Geodetic Datum	
Geodetic Datum	NAD83 – North American Datum 1983

Ellipsoid	
Ellipsoid	GRS1980
EPSG Code	7019
Semi-major Axis (a)	6 378 137.000m
Semi-minor Axis (b)	6 356 752.314m
Inverse Flattening (1/f)	298.257 222 101
Eccentricity sq. (e2)	0.006 694 380 023
Eccentricity (e)	0.081 819 191 043

Projection	
Projection	UTM Zone 18N
Projection Type	Transverse Mercator
Origin Latitude	00° 00' 00.000" North
Origin Longitude	075° 00' 00.000" West
Origin False Easting	500 000.000
Origin False Northing	0.000
Scale Factor	0.9996
Grid Unit	Meter
EPSG Code	16019

Table 6 Geodetic Information

4. POSITIONING CONTROL

The vessel's reference point (X=0, Y=0, Z=0) was the top of the primary Applanix POSMV IMU. All equipment offsets, towpoints and laybacks can be found in RV-Shearwater_Vessel Installation Report 09June2017.pdf.

4.1 GNSS System

Primary navigation for this project was the Applanix POSMV OceanMaster system and used the USCG Differential GPS Correction service. The secondary GNSS system was a C-Nav3050.

The vessel operates with two GNSS receivers:

DGNSS Receivers		
1	Applanix POSMV Oceanmaster 1	USCG DGPS Correction
2	C-Nav3050	USCG DGPS Correction

Table 7 GNSS System

4.2 GNSS System Verification

A number of alongside checks were performed in accordance with Alpine requirements. This included a comparison of the Primary and Secondary GNSS systems at a node on the vessel, monitoring GNSS signal to noise ratio's, number of satellites observed, and observing differential correction update rates. All systems were found to be operating normally.

4.3 Heading Control

4.3.1 Heading Sensor System

The Applanix POSMV system provides motion, heading and position information by integrating data from both inertial and GNSS sensors. The system comprises an Applanix inertial measurement unit and two Trimble GNSS carrier phase receivers mounted on an antenna platform with a nominal 3.4 metre separation perpendicular to the centre-line of the vessel.

4.3.2 Heading Validation Check

To perform the Heading Validation Check the vessel heading derived from the POSMV was recorded while secured at the quayside and compared to the quayside baseline vector established by RTK GPS methods by Alpine previously.

Heading Verification		
	Value	Std Dev
Quayside Grid Vector	347.21	N/A
POSMV Gyro Grid HDT	346.80	0.039
Delta HDT	0.41	N/A

Table 8 Heading Check Results

As the results of this verification tie in well with those obtained during the calibration undertaken at the system installation, the installation values were retained in the system.

4.3.3 GNSS Azimuth Measurement System (GAMS) Calibration

A GAMS calibration was carried out as part of heading comparison against the calibration value derived from land survey in May 2017 during drydock. Summary of the results are shown below:

Calibration	Antenna Separation	Baseline X component	Baseline Y component	Baseline Z component
DIMCON Values	3.405	3.405	0.038	-0.006
GAMS Mean Values	3.401	3.401	0.011	0.005
Difference	0.004	0.004	0.027	0.011

Table 9 GAMS Calibration Results

*The GAMS values were derived from calibrations completed in May 2017. It is standard practice to maintain GAMS values for up to one year when the system remains installed, and no physical or software changes have been made.

5. ECHO SOUNDER – MULTIBEAM SYSTEM

A R2Sonic dual head multi-beam echo sounder is hull-mounted on RV *Shearwater* and was used to provide swathe bathymetry data. Main instrumental and operating parameters are as follows:

Instrumentation	
Multi-beam echo sounder	R2Sonic 2024
Transducer mount	Hull-mounted
Motion reference unit	POSMV
Surface sound velocity	Valeport Mini SVS
Sound velocity profiler	Teledyne RapidCast SVP

Table 10 MBES Equipment List

Operating Parameters	
Transducer Frequency	200-400 kHz
Snippets	Enabled
Water Column	Enabled
Acquisition software	QINSy
Velocity Sensor at Td	On
Installation angles	-20° / 20°
General water depth	5 - 200 m
Average ship's speed	5 knots (Expected to be 4 - 6 knots)
Angular coverage	120/120 (however varies based on WD)
No of beams	512

Table 11 R2Sonic 2024 MBES Configuration

5.1 Patch Test Results

A patch test was performed on 21-June-2017 as part of the acceptance tests to establish the correct motion sensor offset angles for the system. The patch test consisted of setting the motion sensor offset values in the acquisition software to 0.00, and running the standard set of patch test lines. These lines were run across a steep seafloor feature and a shipwreck in Buzzards Bay, MA. This test is to monitor the three dimensional position of a clearly defined, but easily detectable feature on the seabed.

Multi-beam Patch Test				
Head / Sensor	**Roll**	**Pitch**	**Alignment**	**Time Delay**
Transducer 1 (Port)	-1.26°	-0.32°	0.80°	00:00s
Transducer 2 (Stbd)	-0.17°	-0.32°	0.80°	00:00s

Table 12 Patch Test Calibration Values

The following figures highlight the Patch Test Calibration Results.

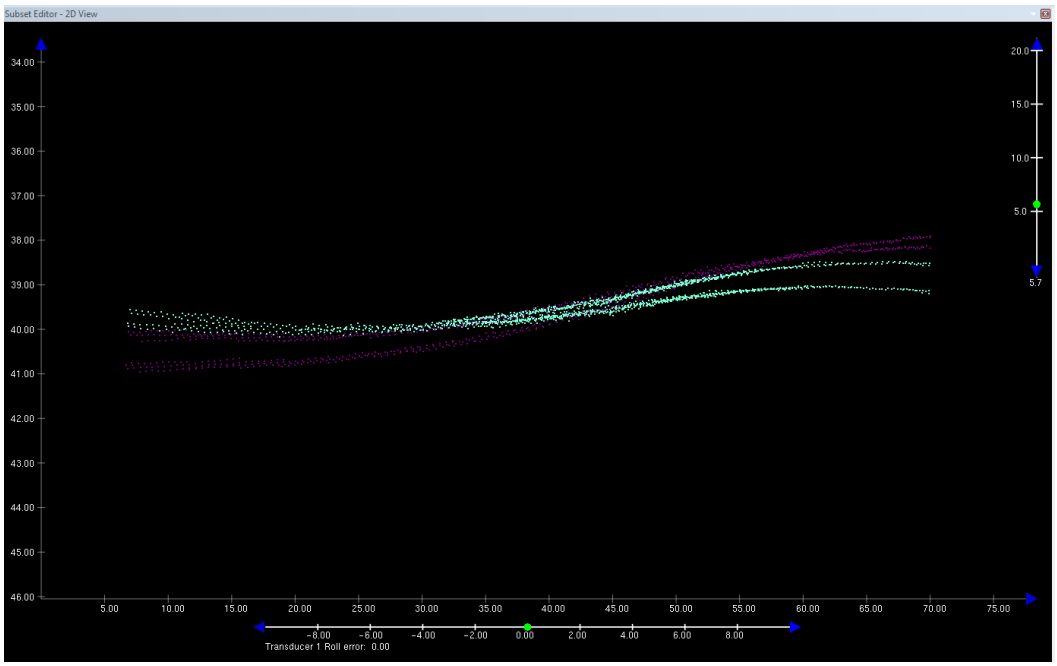

Figure 1 - No Roll Correction

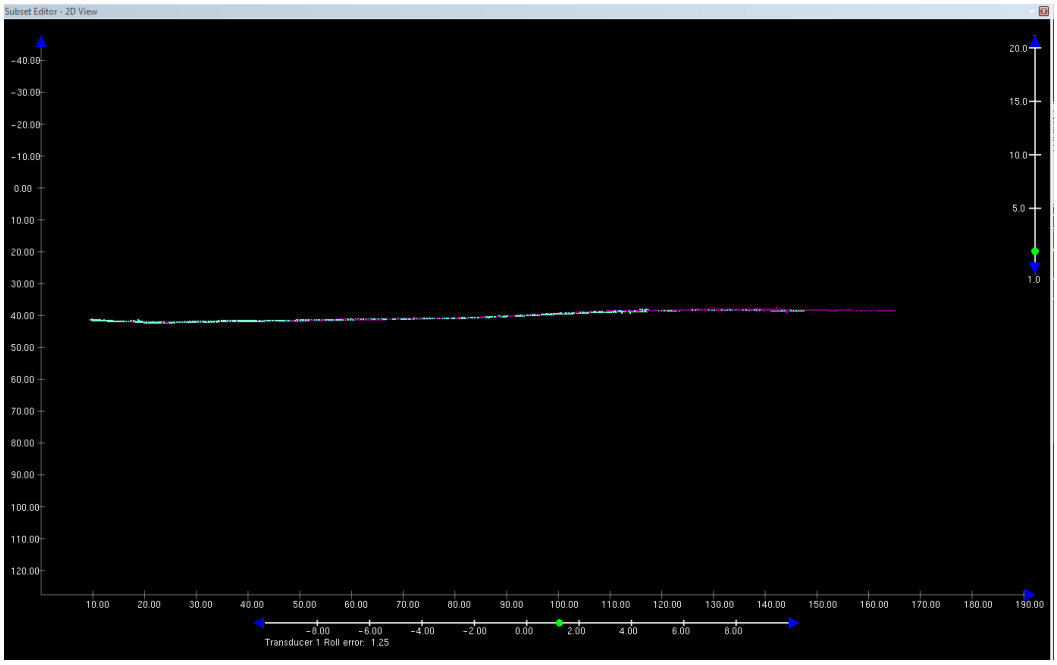

Figure 2 - Roll Correction Applied

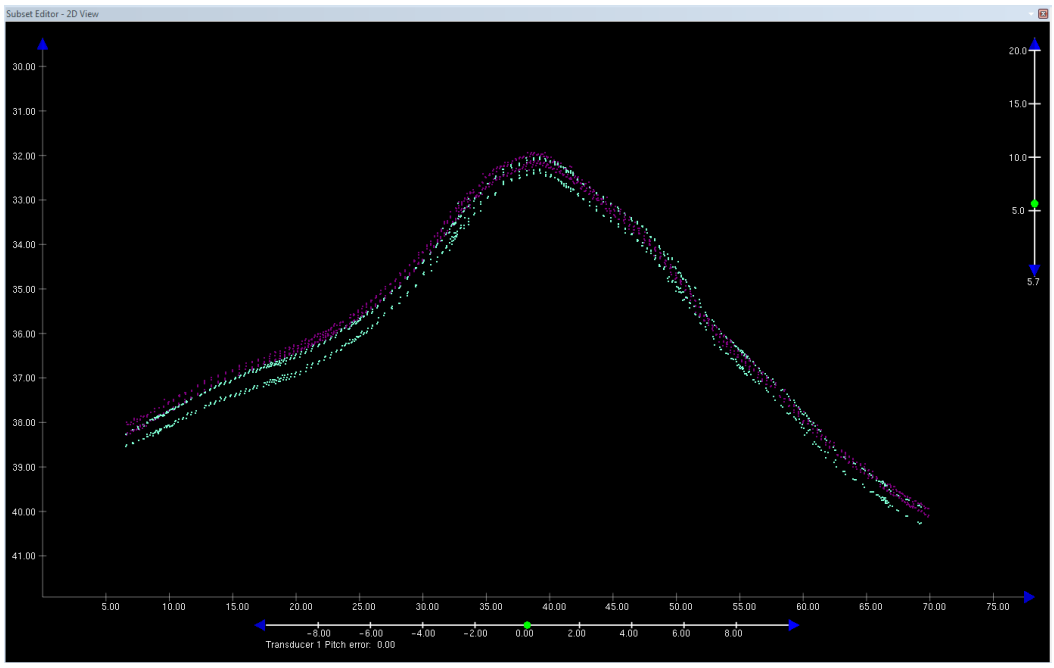

Figure 3 - No Pitch Correction

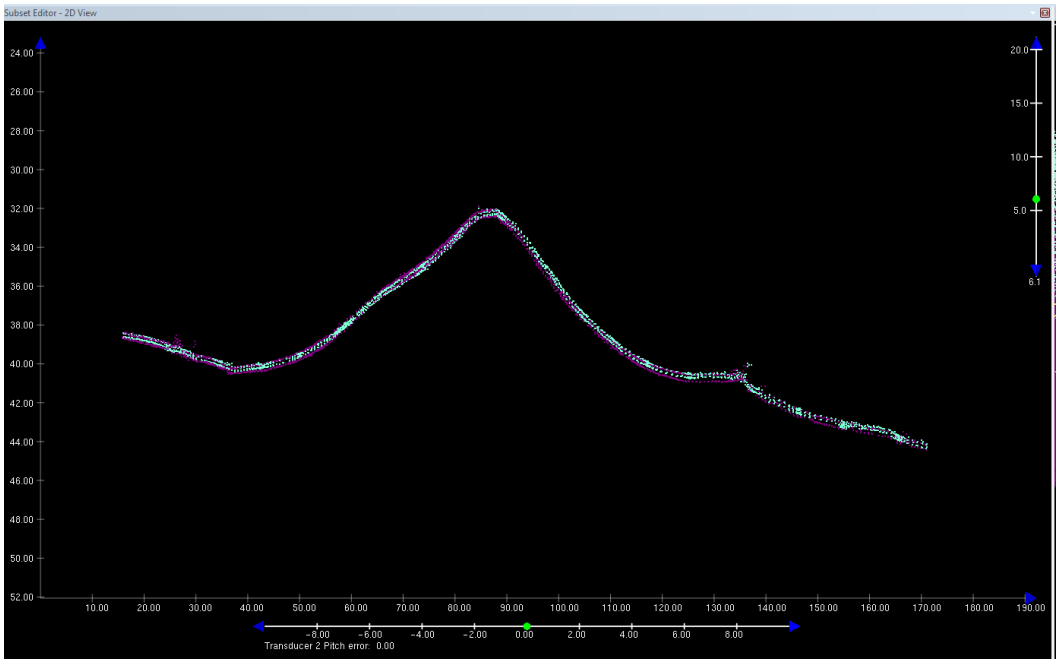

Figure 4 - Pitch Correction Applied

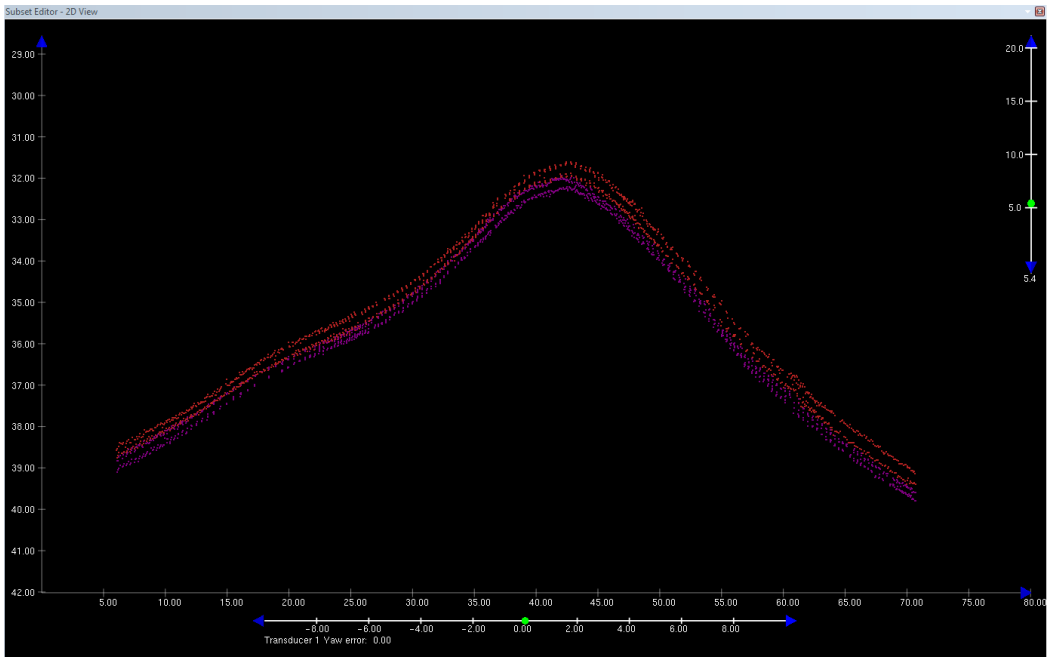

Figure 5 - No Yaw Correction

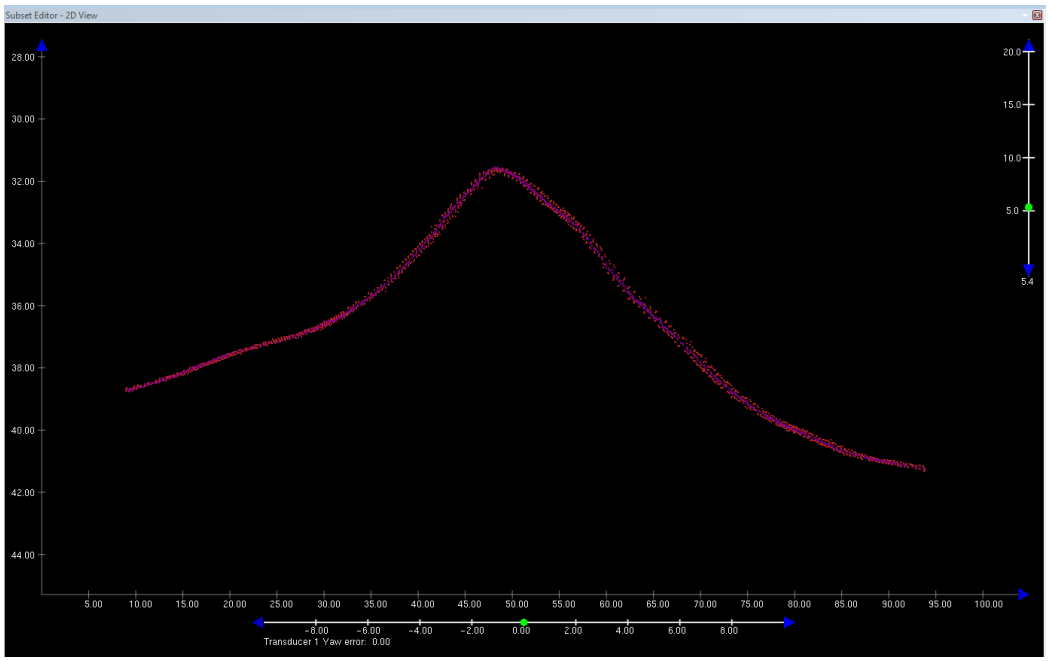

Figure 6 - Yaw Correction Applied

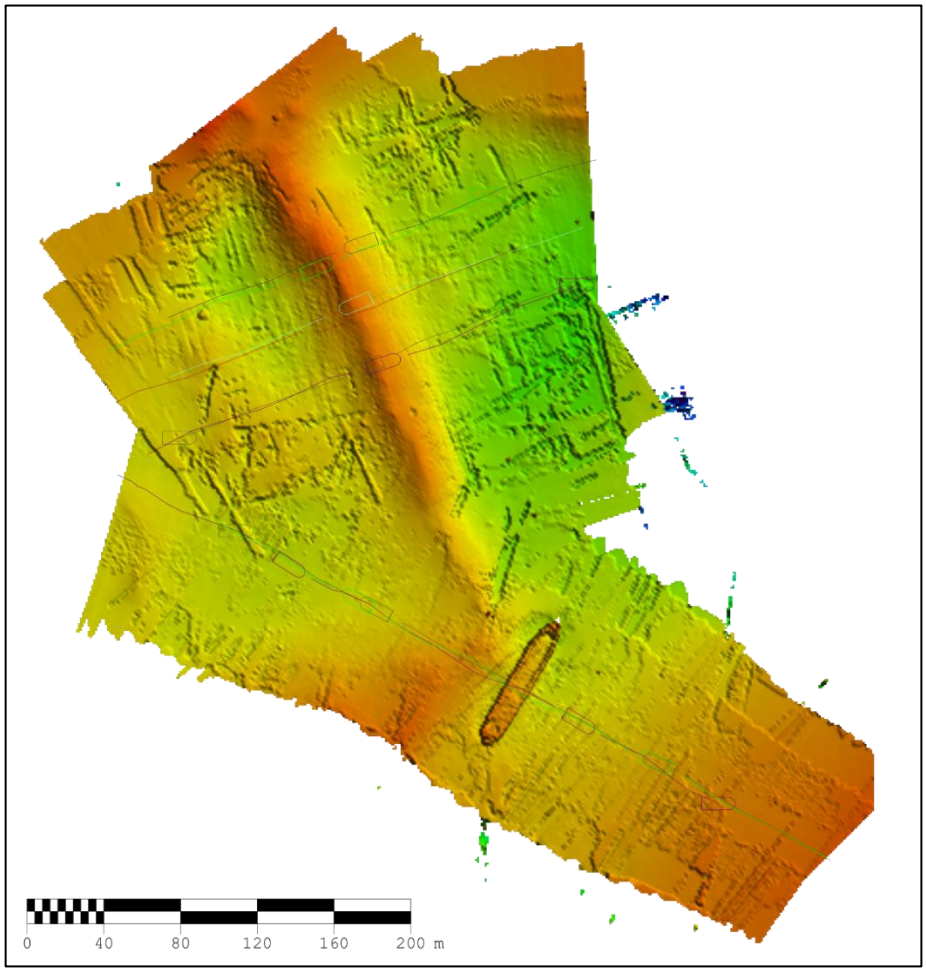

Figure 7 - Patch Site No Calibration Values

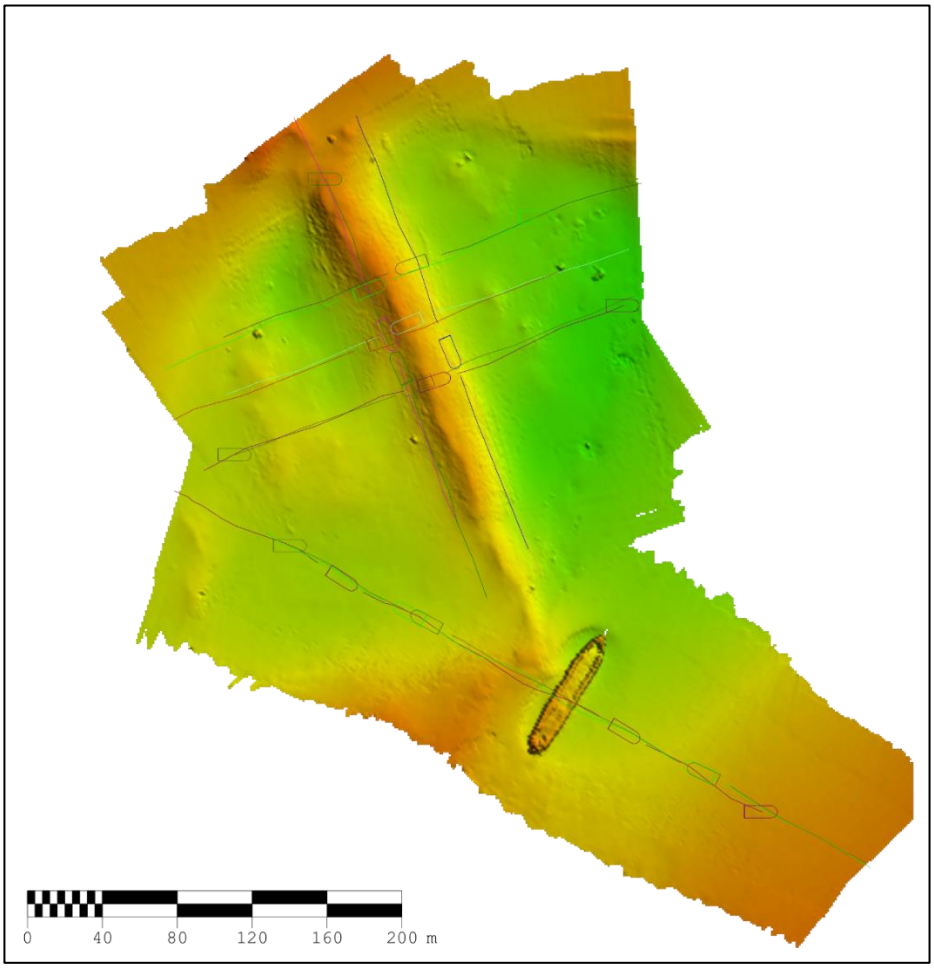

Figure 8 - Patch Site Post Calibration Values

5.2 MBES Draft Check

Prior to departing the dock measurements were made from known vessel survey monuments on either side of the vessel. These measurements are repeated at the quayside upon any port call prior to taking on fuel and after, prior to departure to the survey area.

6. SOUND VELOCITY SYSTEMS

The vessel is equipped with two surface sound velocity systems at the transducers of the R2Sonic 2024 systems, and two full water column profiling systems. Prior to departure from the quayside the four systems monitored at the same depth for quality assurance. The systems were found to be operating within their expected tolerances.

The resultant values were as follows:

Instrumentation	Value
AML SV Plus	1516.4 m/s
Teledyne RapidCast SVP	1516.0 m/s
Valeport Mini SVS (Primary)	1516.3 m/s
Valeport Mini SVS (Spare)	1516.3 m/s

Table 13 Sound Velocity Comparison

The following figure is the SV profile used for the patch test.

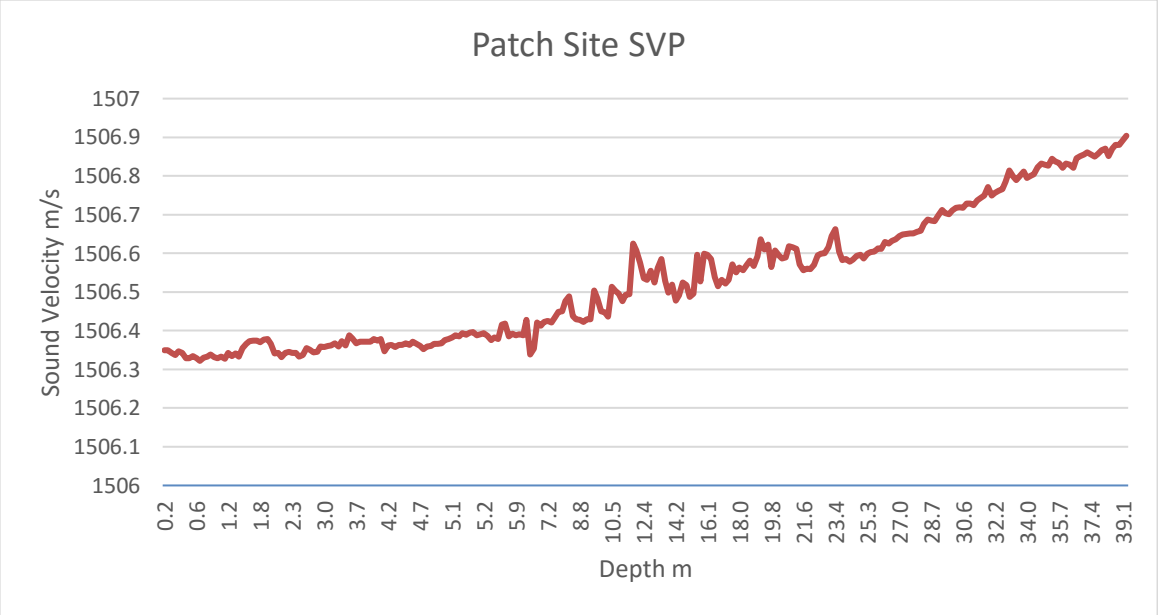

Figure 9 - Patch Site SVP

APPROVAL PAGE

W00459

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NCEI for archive

- Descriptive Report
- Collection of Bathymetric Attributed Grid (BAG)
- Processed survey data and records
- GeoPDF of survey products

The survey evaluation and verification has been conducted according to current OCS Specifications, and the survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Approved: MCGOVERN.MEGHAN.ELIZABETH.1284020495 Digitally signed by MCGOVERN.MEGHAN.ELIZABETH.1284020495 Date: 2019.11.22 07:04:58 -05'00'

Commander Meghan McGovern, NOAA
Chief, Atlantic Hydrographic Branch