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National Ocean Service

Data Acquisition & Processing Report

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State(s): Maryland

General Locality: Patapsco River

2020

CHIEF OF PARTY
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Date:

Table of Contents

A. System Equipment and Software	1
A.1 Survey Vessels.....	1
A.1.1 EchoBoat.....	1
A.2 Echo Sounding Equipment.....	2
A.2.1 Multibeam Echosounders.....	2
A.2.1.1 Picotech, LTD PicoMBES.....	2
A.2.2 Single Beam Echosounders.....	4
A.2.3 Side Scan Sonars.....	4
A.2.3.1 Tritech StarFish 453.....	4
A.2.4 Phase Measuring Bathymetric Sonars.....	4
A.2.5 Other Echosounders.....	4
A.3 Manual Sounding Equipment.....	4
A.3.1 Diver Depth Gauges.....	5
A.3.2 Lead Lines.....	5
A.3.3 Sounding Poles.....	5
A.3.4 Other Manual Sounding Equipment.....	5
A.4 Horizontal and Vertical Control Equipment.....	5
A.4.1 Base Station Equipment.....	5
A.4.2 Rover Equipment.....	5
A.4.3 Water Level Gauges.....	5
A.4.4 Levels.....	5
A.4.5 Other Horizontal and Vertical Control Equipment.....	5
A.5 Positioning and Attitude Equipment.....	6
A.5.1 Positioning and Attitude Systems.....	6
A.5.1.1 Applanix (a Trimble company) POS/MV.....	6
A.5.2 DGPS.....	7
A.5.3 GPS.....	7
A.5.4 Laser Rangefinders.....	7
A.5.5 Other Positioning and Attitude Equipment.....	8
A.6 Sound Speed Equipment.....	8
A.6.1 Moving Vessel Profilers.....	8
A.6.2 CTD Profilers.....	8
A.6.2.1 Valeport SWiFT.....	8
A.6.3 Sound Speed Sensors.....	9
A.6.3.1 Valeport miniSVS.....	9
A.6.4 TSG Sensors.....	10
A.6.5 Other Sound Speed Equipment.....	10
A.7 Computer Software.....	11
A.8 Bottom Sampling Equipment.....	11
A.8.1 Bottom Samplers.....	11
B. System Alignment and Accuracy	11
B.1 Vessel Offsets and Layback.....	11
B.1.1 Vessel Offsets.....	11
B.1.1.1 Vessel Offset Correctors.....	12
B.1.2 Layback.....	12

B.1.2.1 Layback Correctors.....	12
B.2 Static and Dynamic Draft.....	12
B.2.1 Static Draft.....	13
B.2.1.1 Static Draft Correctors.....	13
B.2.2 Dynamic Draft.....	13
B.2.2.1 Dynamic Draft Correctors.....	13
B.3 System Alignment.....	14
B.3.1 System Alignment Methods and Procedures.....	14
B.3.1.1 System Alignment Correctors.....	14
C. Data Acquisition and Processing.....	14
C.1 Bathymetry.....	15
C.1.1 Multibeam Echosounder.....	15
C.1.2 Single Beam Echosounder.....	16
C.1.3 Phase Measuring Bathymetric Sonar.....	16
C.1.4 Gridding and Surface Generation.....	16
C.1.4.1 Surface Generation Overview.....	16
C.1.4.2 Depth Derivation.....	17
C.1.4.3 Surface Computation Algorithm.....	17
C.2 Imagery.....	17
C.2.1 Multibeam Backscatter Data.....	17
C.2.2 Side Scan Sonar.....	17
C.2.3 Phase Measuring Bathymetric Sonar.....	18
C.3 Horizontal and Vertical Control.....	18
C.3.1 Horizontal Control.....	18
C.3.1.1 GNSS Base Station Data.....	18
C.3.1.2 DGPS Data.....	18
C.3.2 Vertical Control.....	20
C.3.2.1 Water Level Data.....	20
C.3.2.2 Optical Level Data.....	20
C.4 Vessel Positioning.....	20
C.5 Sound Speed.....	20
C.5.1 Sound Speed Profiles.....	21
C.5.2 Surface Sound Speed.....	21
C.6 Uncertainty.....	21
C.6.1 Total Propagated Uncertainty Computation Methods.....	22
C.6.2 Uncertainty Components.....	22
C.6.2.1 A Priori Uncertainty.....	22
C.6.2.2 Real-Time Uncertainty.....	22
C.7 Shoreline and Feature Data.....	22
C.8 Bottom Sample Data.....	23
D. Data Quality Management.....	23
D.1 Bathymetric Data Integrity and Quality Management.....	24
D.1.1 Directed Editing.....	24
D.1.2 Designated Sounding Selection.....	24
D.1.3 Holiday Identification.....	24
D.1.4 Uncertainty Assessment.....	24
D.1.5 Surface Difference Review.....	24

D.1.5.1 Crossline to Mainscheme.....	24
D.1.5.2 Junctions.....	25
D.1.5.3 Platform to Platform.....	25
D.2 Imagery data Integrity and Quality Management.....	25
D.2.1 Coverage Assessment.....	25
D.2.2 Contact Selection Methodology.....	25
E. Approval Sheet.....	26
List of Appendices:.....	27

List of Figures

Figure 1: EchoBoat ASV008.....	2
Figure 2: PicoMB-120SF mounted on ASV 008.....	3
Figure 3: POS MV SURFMASTER ONE unit aboard ASV008.....	7
Figure 4: Valeport SWiFT installed on ASV008.....	9
Figure 5: Valeport MiniSVS next to the MBES.....	10
Figure 6: MBES Data Processing Workflow.....	16
Figure 7: Real Time POS M/V monitoring interface.....	19

Data Acquisition and Processing Report

NOAA R/V *Bay Hydro II*
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A. System Equipment and Software

A.1 Survey Vessels

A.1.1 EchoBoat

<i>Vessel Name</i>	EchoBoat	
<i>Hull Number</i>	ASV008	
<i>Description</i>	The EchoBoat is a remotely controlled and autonomous surface vehicle that can be used to perform multibeam or side scan surveys in very shallow water or in remote areas where it is difficult to launch conventional survey boats. The ASV was used for hydrographic data acquisition, with an assisting vessel as a launching/hosting platform. The vessel was used for acquisition of MBES as noted in the DR. Vessel configuration and offset measurements are included in the appendix of this report.	
<i>Dimensions</i>	<i>LOA</i>	1.68 meters
	<i>Beam</i>	0.79 meters
	<i>Max Draft</i>	0.258 meters
<i>Most Recent Full Static Survey</i>	<i>Date</i>	2017-10-02
	<i>Performed By</i>	Seafloor Systems, Inc.
<i>Most Recent Partial Offset Verification</i>	<i>Date</i>	2020-03-11
	<i>Method</i>	Steel measuring tape comparison to full static survey.



Figure 1: EchoBoat ASV008

A.2 Echo Sounding Equipment

A.2.1 Multibeam Echosounders

A.2.1.1 Picotech, LTD PicoMBES

The PicoMBES-120SF is a miniature CHIRP FM multibeam echo sounder (MBES) manufactured by Picotech Ltd, customized to fit inside the transducer well of the ASV008. All beam forming and digital signal processing are performed within the sonar, allowing a direct connection from the sonar to a control computer via WiFi. The PicoMBES-120SF interfaces directly with the EchoBoat's onboard industrial PC. From a shore laptop using Remote Desktop Connection, the User accesses the onboard PC via a WiFi bridge to control the sonar settings, data logging, as well as the ASV's AutoNav™ autonomous mission planner.

<i>Manufacturer</i>	Picotech, LTD		
<i>Model</i>	PicoMBES		
<i>Inventory</i>	ASV008	<i>Component</i>	MBES
		<i>Model Number</i>	120SF
		<i>Serial Number</i>	389
		<i>Frequency</i>	300-400kHz
		<i>Calibration</i>	2020-03-09
		<i>Accuracy Check</i>	2020-03-11



Figure 2: PicoMB-120SF mounted on ASV 008.

A.2.2 Single Beam Echosounders

No single beam echosounders were utilized for data acquisition.

A.2.3 Side Scan Sonars

A.2.3.1 Tritech StarFish 453

The Tritech StarFish 453 side scan sonar system is an acoustic imagery device that is mounted to the hull of ASV008. The Tritech StarFish has an operational frequency of 450kHz CHIRP with a vertical beam width of 60°. The integrated system includes two mounted transducers and a power control unit. Acquisition is controlled via WiFi interface and the ASV internal CPU. Positioning of the towfish is calculated using CARIS SIPS and found using the POS M/V IMU, GPS locations, and the measured offsets of the Tritech. Altitude is maintained between 8% and 20% of the range scale, in accordance with the FPM Section 2.5.3.1.2. Confidence checks are performed daily in accordance with the HSSD Section 6.1.3.1. More information can be found in Section C.2.2 of this document.

<i>Manufacturer</i>	Tritech		
<i>Model</i>	StarFish 453		
<i>Inventory</i>	ASV008	<i>Component</i>	SSS
		<i>Model Number</i>	453
		<i>Serial Number</i>	ASV008
		<i>Frequency</i>	450kHz CHIRP
		<i>Calibration</i>	2020-03-09
		<i>Accuracy Check</i>	2020-03-09

A.2.4 Phase Measuring Bathymetric Sonars

No phase measuring bathymetric sonars were utilized for data acquisition.

A.2.5 Other Echosounders

No additional echosounders were utilized for data acquisition.

A.3 Manual Sounding Equipment

A.3.1 Diver Depth Gauges

No diver depth gauges were utilized for data acquisition.

A.3.2 Lead Lines

No lead lines were utilized for data acquisition.

A.3.3 Sounding Poles

No sounding poles were utilized for data acquisition.

A.3.4 Other Manual Sounding Equipment

No additional manual sounding equipment was utilized for data acquisition.

A.4 Horizontal and Vertical Control Equipment

A.4.1 Base Station Equipment

No base station equipment was utilized for data acquisition.

A.4.2 Rover Equipment

No rover equipment was utilized for data acquisition.

A.4.3 Water Level Gauges

No water level gauges were utilized for data acquisition.

A.4.4 Levels

No levels were utilized for data acquisition.

A.4.5 Other Horizontal and Vertical Control Equipment

No other equipment were utilized for data acquisition.

A.5 Positioning and Attitude Equipment

A.5.1 Positioning and Attitude Systems

A.5.1.1 Applanix (a Trimble company) POS/MV

The POS MV SURFMASTER ONE system used on the EchoBoat is a userfriendly, turnkey system designed and built to provide accurate attitude, heading, heave, position, and velocity data of the marine vessel and onboard sensors. MV blends GNSS data with angular rate and acceleration data from an IMU and heading from the GPS Azimuth Measurement System (GAMS) to produce a robust and accurate full six degrees-of-freedom position and orientation solution. GAMS Calibration performed on 19FEB2020.

ASV008 used the wide area augmentation service (WAAS) for realtime positioning and POS Pac generated Smoothed Best Estimates of Trajectory for post processed navigation data.

<i>Manufacturer</i>	Applanix (a Trimble company)				
<i>Model</i>	POS/MV				
<i>Inventory</i>	ASV008	<i>Component</i>	IMU/POS	Antenna	Antenna
		<i>Model Number</i>	MV-120	GA830	GA830
		<i>Serial Number</i>	10227	14185	44830
		<i>Calibration</i>	2020-02-19	2020-02-19	2020-02-19



Figure 3: POS MV SURFMASTER ONE unit aboard ASV008.

A.5.2 DGPS

DGPS equipment was not utilized for data acquisition.

A.5.3 GPS

GPS equipment was not utilized for data acquisition.

A.5.4 Laser Rangefinders

Laser rangefinders were not utilized for data acquisition.

A.5.5 Other Positioning and Attitude Equipment

No additional positioning and attitude equipment was utilized for data acquisition.

A.6 Sound Speed Equipment

A.6.1 Moving Vessel Profilers

No moving vessel profilers were utilized for data acquisition.

A.6.2 CTD Profilers

A.6.2.1 Valeport SWiFT

ASV008 is equipped with a Valeport SWiFT SVP profiler and uses it as the primary CTD device. Temperature and electrical conductivity (to calculate salinity) are measured directly, while depth is calculated from strain gauge pressure. Using the Chen-Millero Equations, CTD data is used to calculate sound velocity profiles. As part of the annual HSRR, the CTD profiler is sent to the manufacturer for factory calibration. A Calibration Report can be found in the Appendix of this report.

<i>Manufacturer</i>	Valeport	
<i>Model</i>	SWiFT	
<i>Inventory</i>	<i>Component</i>	CTD
	<i>Model Number</i>	N/A
	<i>Serial Number</i>	68630
	<i>Calibration</i>	2018-10-17

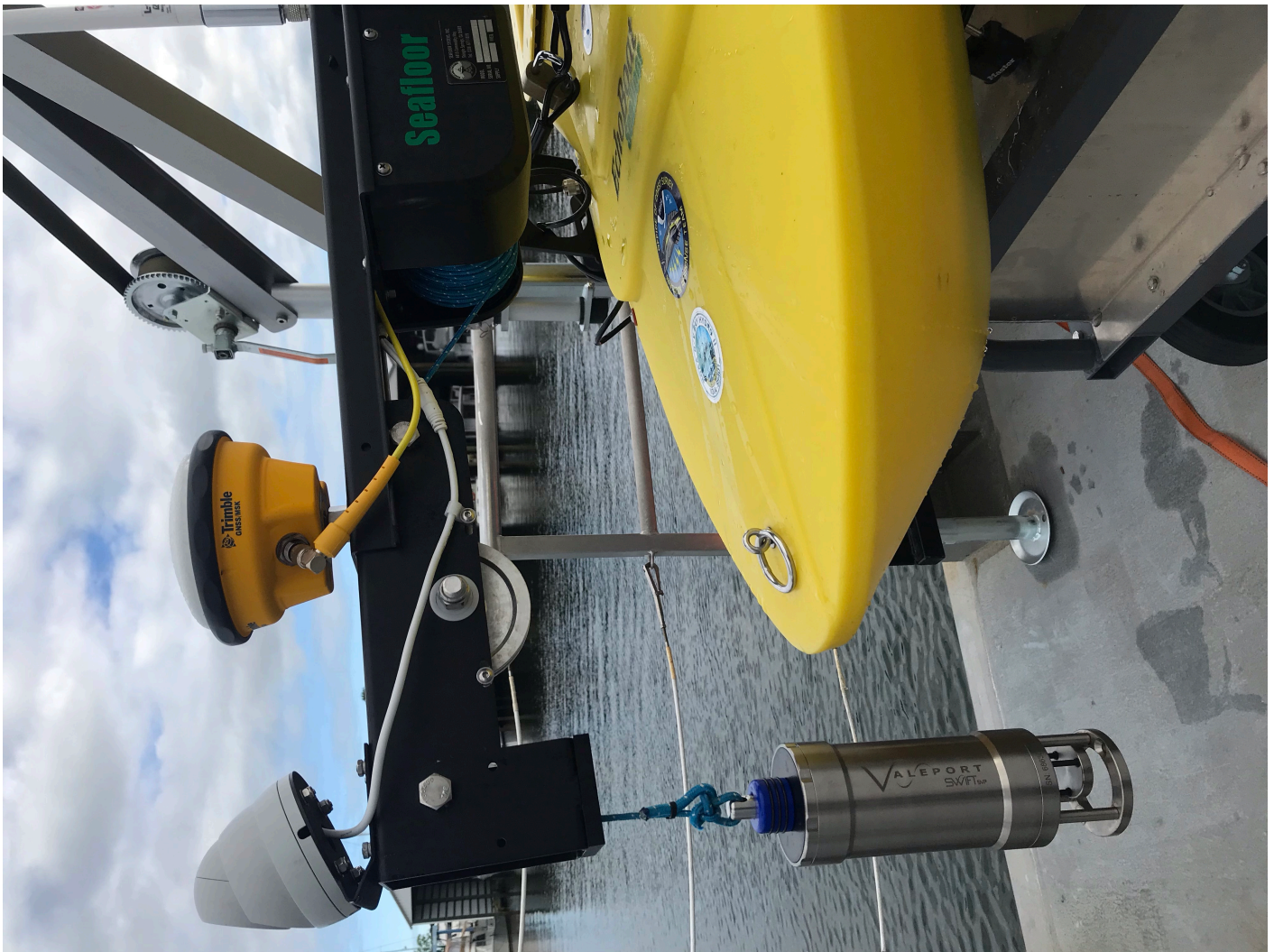


Figure 4: Valeport SWiFT installed on ASV008.

A.6.3 Sound Speed Sensors

A.6.3.1 Valeport miniSVS

The Valeport miniSVS is a sing-around transducer that determines the sound velocity by measuring the time needed for a ping of sound to travel a known distance. This unit was used to determine the speed of sound at the head of the Kongsberg EM2040 MBES on R/V BAY HYDRO II and alongside the PicoMBES on the EchoBoat. As part of the annual HSRR, BHII's miniSVS is sent to the manufacturer for factory calibration. A Calibration Report can be found in the Appendix of this report.

<i>Manufacturer</i>	Valeport		
<i>Model</i>	miniSVS		
<i>Inventory</i>	ASV008	<i>Component</i>	ultraSV-TTL
		<i>Model Number</i>	N/A
		<i>Serial Number</i>	65881
		<i>Calibration</i>	2018-04-10

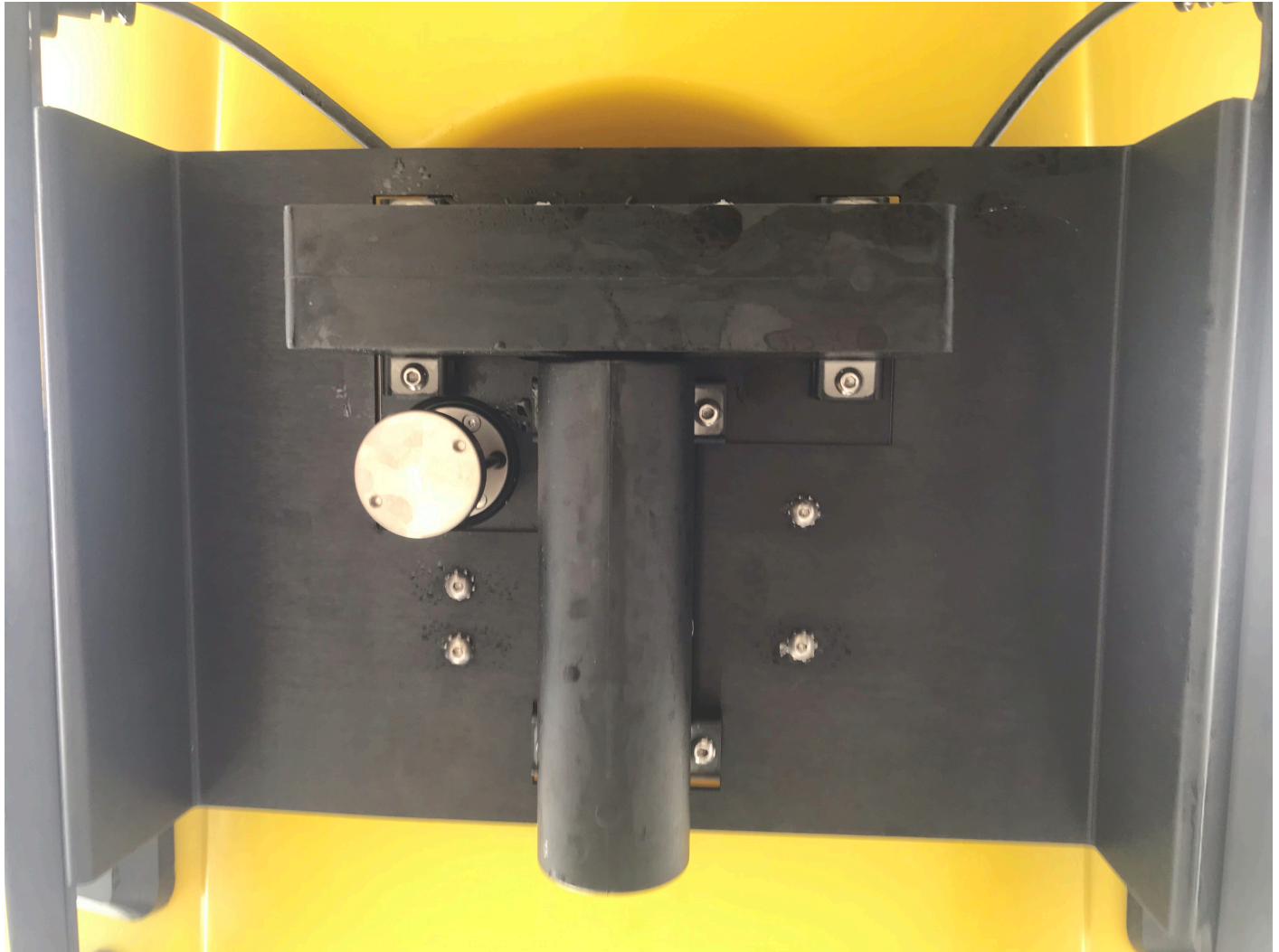


Figure 5: Valeport MiniSVS next to the MBES.

A.6.4 TSG Sensors

No surface sound speed sensors were utilized for data acquisition.

A.6.5 Other Sound Speed Equipment

No surface sound speed sensors were utilized for data acquisition.

A.7 Computer Software

<i>Manufacturer</i>	<i>Software Name</i>	<i>Version</i>	<i>Use</i>
HYPACK, Inc	HYPACK 2018	2018+	Acquisition
Applanix	POSVIEW	10.11	Acquisition
Applanix	POSPac MMS	8.5	Processing
Teledyne Caris	HIPS and SIPS	11.3.5	Processing
NOAA OCS HSTB	PydroExplorer	19.4	Processing
Teledyne Caris	BASE Editor	5.4.5	Processing
Hydroffice	Sound Speed Manager	2019.2.6	Processing

A.8 Bottom Sampling Equipment

A.8.1 Bottom Samplers

No bottom sampling equipment was utilized for data acquisition.

B. System Alignment and Accuracy

B.1 Vessel Offsets and Layback

B.1.1 Vessel Offsets

A survey of the EchoBoat was completed by SeaFloor Systems and provided to the user. The survey established a vessel Reference Point (RP), then found the X, Y, and Z distances for the GNSS antennas and multibeam sonar. These offsets were verified by NOAA representatives at the vessel acceptance testing. All physical offsets are located in the Caris HVF because the reference point is at the MRU. The MRU and Nav to Transducer offsets are shown in the tables below. It should be noted that the sonars and IMU are mounted on a rigid frame with precise manufacturing. This keeps the lever arms very small and the roll, pitch, and yaw measurements near zero.

B.1.1.1 Vessel Offset Correctors

<i>Vessel</i>	ASV008			
<i>Echosounder</i>	Picotech, LTD. PicoMBES-120SF			
<i>Date</i>	2020-03-11			
<i>Offsets</i>	<i>MRU to Transducer</i>		<i>Measurement</i>	<i>Uncertainty</i>
		<i>x</i>	0.000 meters	0.020 meters
		<i>y</i>	0.061 meters	0.020 meters
		<i>z</i>	0.399 meters	0.020 meters
	<i>Nav to Transducer</i>	<i>x</i>	0.000 meters	0.020 meters
		<i>y</i>	0.456 meters	0.020 meters
		<i>z</i>	0.768 meters	0.020 meters
	<i>Transducer Roll</i>	<i>Roll</i>	0.000 degrees	

B.1.2 Layback

A survey of the EchoBoat was completed by SeaFloor Systems and provided to the user. The survey established a vessel Reference Point (RP), then found the X, Y, and Z distances for the sidescan sonar. These offsets were verified by NOAA representatives at the vessel acceptance testing. All physical offsets are located in the Caris HVF because the reference point is at the MRU. The MRU and Nav to Transducer offsets are shown in the tables below.

B.1.2.1 Layback Correctors

<i>Vessel</i>	ASV008		
<i>Echosounder</i>	Tritech StarFish 453		
<i>Frequency</i>	450 kHz		
<i>Date</i>	2020-03-11		
<i>Layback</i>	<i>Towpoint</i>	<i>x</i>	0.000 meters
		<i>y</i>	0.043 meters
		<i>z</i>	0.676 feet
	<i>Layback Error</i>	0.000 meters	

B.2 Static and Dynamic Draft

B.2.1 Static Draft

Static draft for EchoBoat was calculated using manufacturer provided measurements. The calculated value is entered directly into the HVF for use by Charlene for processing.

B.2.1.1 Static Draft Correctors

<i>Vessel</i>	ASV008	
<i>Date</i>	2020-03-11	
<i>Loading</i>	0.001 meters	
<i>Static Draft</i>	<i>Measurement</i>	0.170 meters
	<i>Uncertainty</i>	0.001 meters

B.2.2 Dynamic Draft

Dynamic draft for ASV008 was measured using the Post Processed Kinematic GPS method outlined in section 1.4.2.1.2.1 of NOAA's FPM. To reduce the effect of any potential current, reciprocal lines were run at each RPM step in order to get an average speed over ground for each RPM. This average speed was used to estimate the vessel's speed through the water. Dynamic draft and vessel offsets corrector values are stored in the HVF.

In ERS surveys, those that use recorded GPS heights corrected via a VDatum SEP model to achieve tidal datum, the dynamic draft correction is not applied to the soundings.

B.2.2.1 Dynamic Draft Correctors

<i>Vessel</i>	ASV008	
<i>Date</i>	2020-03-04	
<i>Dynamic Draft</i>	<i>Speed (m/s)</i>	<i>Draft (m)</i>
	0.00	0.00
	0.50	0.04
	1.00	0.04
	1.50	0.07
<i>Uncertainty</i>	<i>Vessel Speed (m/s)</i>	<i>Delta Draft (m)</i>
	0.40	0.01

B.3 System Alignment

B.3.1 System Alignment Methods and Procedures

The 2018 field season patch test was conducted as part of the HSRR (see the Appendix for full report). The patch test determined any roll, pitch, and yaw biases (X, Y, and Z axis) and the time offset between the MBES reference frame and the navigational reference frame. All patch tests are conducted in accordance with the HSSD Section 5.2.4.1. The lines are post-processed and the CARIS Calibration Utility is performed by all ASV008 crew members. The results of the trials are averaged and the result is recorded in the Caris HVF. The standard deviation of several calibration iterations for pitch and roll are averaged to produce the HVF associated value.

B.3.1.1 System Alignment Correctors

<i>Vessel</i>	ASV008		
<i>Echosounder</i>	Picotech, LTD PicoMBES		
<i>Date</i>	2020-03-09		
<i>Patch Test Values</i>		<i>Corrector</i>	<i>Uncertainty</i>
	<i>Transducer Time Correction</i>	0.000 seconds	0.010 seconds
	<i>Navigation Time Correction</i>	0.000 seconds	0.010 seconds
	<i>Pitch</i>	-0.290 degrees	0.120 degrees
	<i>Roll</i>	-0.110 degrees	0.120 degrees
	<i>Yaw</i>	0.610 degrees	0.060 degrees
	<i>Pitch Time Correction</i>	0.000 seconds	0.010 seconds
	<i>Roll Time Correction</i>	0.000 seconds	0.010 seconds
	<i>Yaw Time Correction</i>	0.000 seconds	0.010 seconds
	<i>Heave Time Correction</i>	0.000 seconds	0.010 seconds

C. Data Acquisition and Processing

C.1 Bathymetry

C.1.1 Multibeam Echosounder

Data Acquisition Methods and Procedures

PicoMB multibeam data is logged using HYPACK and HYSWEEP in the ".HSX" and ".RAW" formats. The hydrographer scans the real time data for system wide errors, anomalies, and dropouts. Display windows such as Intensity Waterfall, Matrix Maps, and Beam Profile aid in this task. This system is controlled via remote desktop over Wifi connection. Using this Wifi interface, data is viewed real-time from the parent platform but is collected on the ASV internal computer. During acquisition, the hydrographer reviews the real time data and provides feedback to the coxswain in order to ensure acquired data will meet coverage requirements set forth in the Project Instructions and HSSD Section 5.2.2.

Data Processing Methods and Procedures

Once data acquisition is complete, raw MBES data is converted in CARIS HIPS to provide a visual examination of the data points collected. Corrections and offsets are then applied to the MBES data to produce high resolution depth profiles of the seafloor. These conversions, corrections, and offsets are performed via the automated processing and data transfer tool, Charlene.

The process starts by converting the Kongsberg .all or Hypack .hsx files using CARIS HIPS. Converted files are saved in the CARIS HDCS file format. Navigation and attitude data are visually inspected for gross errors. Data files are corrected for delayed heave, tides, and sound velocity profiles, and then merged. After the merge, the Total Propagated Uncertainty (TPU) is computed (See Section C.6.1).

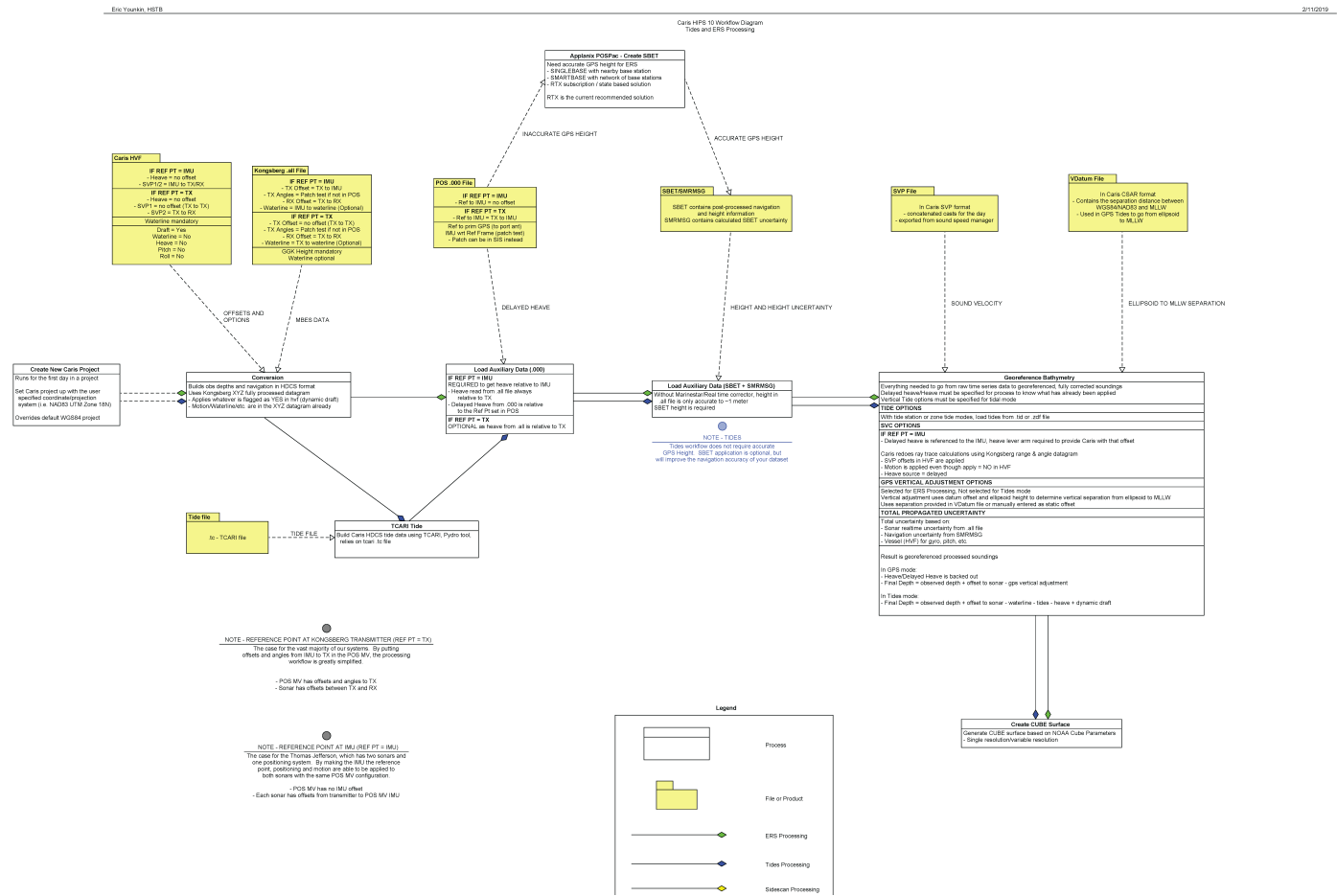


Figure 6: MBES Data Processing Workflow

C.1.2 Single Beam Echosounder

Single beam echosounder bathymetry was not acquired.

C.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not acquired.

C.1.4 Gridding and Surface Generation

C.1.4.1 Surface Generation Overview

MBES data are gridded using CARIS HIPS Combined Uncertainty and Bathymetric Estimator (CUBE) algorithm and is processed as described in FPM Section 4.2.1.1, using methods described above in Section C.1.1. The CUBE surface is also created using a grid resolution determined by coverage type and depth, as required by the Project Instructions and specified in the HSSD, Section 5.2.2. The "Depth" layer is reviewed for holidays (gaps in coverage) or erroneous soundings. Any erroneous soundings, known as fliers, are flagged as rejected and removed from the surface so the surface more accurately represents the seafloor. Any

least depth on a feature that is not accurately reflected in the surface is flagged as “designated” in order to force the surface to reflect that shoaler depth in accordance with HSSD Section 5.2.1.2.3.

C.1.4.2 Depth Derivation

See above

C.1.4.3 Surface Computation Algorithm

See above

C.2 Imagery

C.2.1 Multibeam Backscatter Data

Multibeam backscatter imagery was not acquired.

C.2.2 Side Scan Sonar

Data Acquisition Methods and Procedures

All side scan sonar data is logged using HYPACK, in the ".hsx" and ".RAW" formats. The hydrographer sets the range scale to maximize coverage, while providing sufficient resolution to easily identify contacts in post-processing. During acquisition, the hydrographer ensures the range scale meets the HSSD specifications based on the depth of the water set forth in Section 6.1.2.3. This is accomplished by adjusting the range scale settings in HYPACK realtime. The hydrographer monitors the sonar's health and function via realtime data displays of the Side Scan Intensity Waterfall as well as the ASV's position, speed, course, and altitude, making sure that they correspond with data coming from the vessel's positioning software.

During acquisition of SSS data, lines are acquired so approximately 20% of the swath will overlap the swath from an adjacent line. This overlap is used to ensure continuous coverage over the survey area without creating holidays.

The hydrographic team conducts confidence checks on survey days to ensure the SSS system is functioning properly by passing by a known object; this object is typically within the survey area and is visually conspicuous at the surface. An example is using a navigation buoy and its associated buoy block on the seafloor to verify. Once the vessel passes the object, the hydrographer reviews the real time data for the object's presence in the appropriate channel and at the offset from nadir. Once the object is confirmed in the data, the confidence check is complete.

Data Processing Methods and Procedures

SSS processing work flow begins with converting Tritech SSS .hsx file using CARIS SIPS via Charlene. The towfish navigation and gyro are examined for gross errors, and the towfish altitude is inspected and corrected as needed to accurately track the seafloor.

The individual lines are stitched together to create a mosaic of the SSS data. As per the Project Instructions, the hydrographer creates mosaics for each percentage of coverage required (i.e.: one mosaic for the first set of data and a second mosaic for the second set of data of the project area). If holidays are found, a holiday line plan is created and the gaps are acquired by either SSS or MBES.

The hydrographer reviews each SSS line for contacts by visually inspecting the imagery record for contacts on the seafloor with a shadow height that meets or exceeds the specifications for a significant contact as stated in HSSD 6.1.3.2. The hydrographer has the ability to adjust the color histogram, zoom in and out on the image record, and switch between the processed and unprocessed view of the imagery to make locating contacts and measuring associated shadows easier. An additional hydrographer reviews the data using the same processes, verifies contacts found by the first hydrographer, and inspects all lines to ensure no possible contacts were missed.

Once the data has been scanned by two hydrographers, all identified contacts are treated as features and fully investigated with MBES, as explained in section C.7.

C.2.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar imagery was not acquired.

C.3 Horizontal and Vertical Control

C.3.1 Horizontal Control

C.3.1.1 GNSS Base Station Data

GNSS base station data was not acquired.

C.3.1.2 DGPS Data

Data Acquisition Methods and Procedures

For WAAS surveys, the POS/MV is optionally configured to receive correctors from the Wide Area Augmentation System (WAAS). The WAAS is a Satellite Based Augmentation System (SBAS) for North America, developed by the Federal Aviation Administration and the Department of Transportation as an aid to air navigation. Usable by any WAAS-enabled GPS receiver, WAAS corrects for GPS signal errors caused

by ionospheric disturbances, timing and satellite orbit errors, and it provides vital integrity information regarding the health of each GPS satellite.

WAAS consists of multiple widely-spaced Wide Area Reference Stations (WRS) sites that monitor GPS satellite data. The WRS locations are precisely surveyed so that any errors in the received GPS signals can be detected. Two master stations, located on either coast, collect data from the reference stations via a terrestrial communications network and create a GPS correction message. This correction accounts for GPS satellite orbit and clock drift plus signal delays caused by the atmosphere and ionosphere. The corrected differential message is then broadcast through geostationary satellites with a fixed position over the equator. The information is compatible with the basic GPS signal structure, which means any WAAS-enabled GPS receiver can read the signal.

The WAAS specification requires it to provide a position accuracy of 7.6 meters (25 ft) or better (for both horizontal and vertical measurements), at least 95% of the time. Actual performance measurements of the system at specific locations have shown it typically provides better than 1.0 meter horizontally and 1.5 meters vertically throughout most of the contiguous United States and large parts of Canada and Alaska. In more remote regions of Alaska, values range between 2 and 6 meters horizontally.

Data Processing Methods and Procedures

Position accuracy and quality were monitored using the POSView Controller software to ensure positioning accuracy requirements in the HSSD Section 3.2 were met.

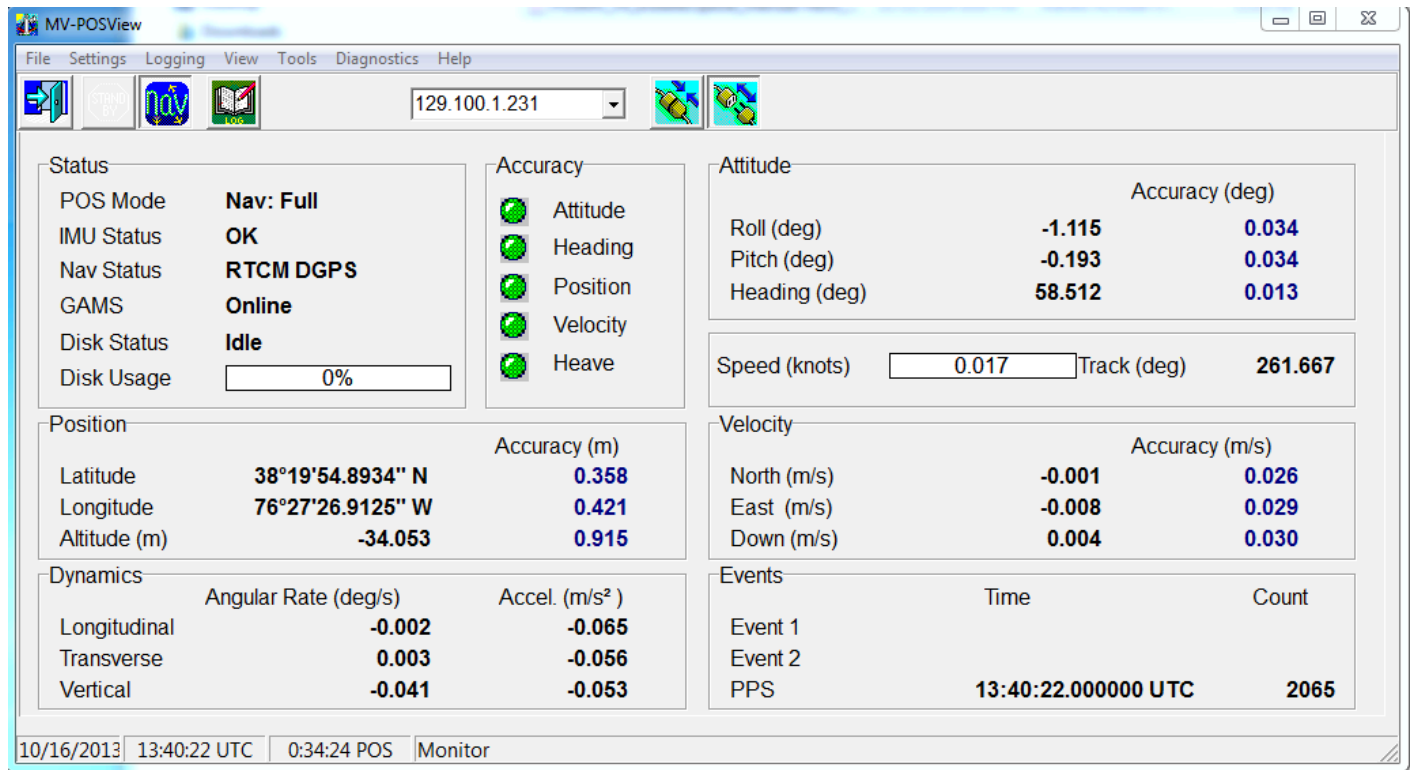


Figure 7: Real Time POS M/V monitoring interface.

C.3.2 Vertical Control

C.3.2.1 Water Level Data

Data Acquisition Methods and Procedures

ASV008 performs Ellipsoidally Referenced Surveys (ERS) or VDatum surveys.

Data Processing Methods and Procedures

The raw POSpac file is processed using reference stations (usually CORS Stations) and a Smooth Best Estimate of Trajectory (SBET) is produced via Charlene and POSpac MMS. This SBET is used in CARIS via "Input Auxiliary Data" to calculate the GPS tide, and then merged to generate a surface at the ellipsoid. The separation model provided by the Project Manager is applied to the data to reduce it to the local MLLW datum.

C.3.2.2 Optical Level Data

Optical level data was not acquired.

C.4 Vessel Positioning

Data Acquisition Methods and Procedures

POS/MV positioning and attitude data are logged and the ZDA (day, month, year, and local time zone offset), GGK (time, position, and fix), and attitude packets are applied in real time to the raw sonar data.

Data Processing Methods and Procedures

The POS/MV file is recorded during acquisition and saved to the network RAW drive. The POS/MV file is loaded, applied to, and merged with the raw sonar data in CARIS via Charlene, using the "Import Auxiliary Data" utility as part of the standard processing flow.

C.5 Sound Speed

C.5.1 Sound Speed Profiles

Data Acquisition Methods and Procedures

The Valeport SWiFT is the primary instrument to acquire sound velocity profiles, unless otherwise stated in the Descriptive Report. CARIS HIPS then utilizes the concatenated sound velocity data as a corrector. Casts are acquired every 2-4 hours during MBES acquisition. Profiles are collected more frequently when current and weather conditions warrant.

Data Processing Methods and Procedures

For the ASV, all SVP casts are processed using HydrOffice's Sound Speed Manager. In CARIS, the "Nearest in Distance Within Time of Four Hours" option is used when correcting the data for sound speed unless otherwise noted in the DR.

C.5.2 Surface Sound Speed

Data Acquisition Methods and Procedures

Surface sound speed data is directly measured by the Valeport miniSVS for use by the MBES during acquisition.

Data Processing Methods and Procedures

The PicoMBES-120SF uses the surface sound speed for its beam forming equation and only depends on the CTD sound speed profile for post-processing only. An accuracy check is performed by comparing the continuous reading from the surface sound speed profiler to a CTD reading at the same depth. The hydrographer monitors the surface sound speed readings and frequently performs casts to ensure proper representation of the water column sound speed profile. All surface sound speed is internal to the PicoMBES and stored in the .HSX file.

C.6 Uncertainty

C.6.1 Total Propagated Uncertainty Computation Methods

TPU is computed using CARIS HIPS. Compute TPU and the CUBE surface Uncertainty child layer is reviewed to ensure all depth measurement uncertainties meet the uncertainty standard in HSSD Section 5.1.3. Uncertainty standards are also confirmed using Pydro QC Tools.

In the CARIS TPU calculation, real time uncertainty values are used, where possible. Real time calculated uncertainties found in the .all file are used for position, sonar, heading, pitch, and roll. The vertical real time uncertainty is from the SBET's RMS file and the tidal uncertainty is derived from the ERS Separation Model.

When real time uncertainty data is not available, the uncertainty values recorded in the HVF are used. These uncertainties come directly from the manufacturers and are typically found in the systems operators manual's specification section.

C.6.2 Uncertainty Components

C.6.2.1 A Priori Uncertainty

<i>Vessel</i>		ASV008
<i>Motion Sensor</i>	<i>Gyro</i>	0.08 degrees
	<i>Heave</i>	5.00%
		0.05 meters
	<i>Roll</i>	0.04 degrees
<i>Pitch</i>	0.04 degrees	
<i>Navigation Sensor</i>		0.50 meters

C.6.2.2 Real-Time Uncertainty

<i>Vessel</i>	<i>Description</i>
ASV008	The .HSX file contains many realtime uncertainty calculations, however, when processing in Caris, the a priori uncertainty values are used.

C.7 Shoreline and Feature Data

Data Acquisition Methods and Procedures

All potentially significant features are divided into three categories. The first, features that are not safe for ASV008 to approach, are given a cursory visual inspection. If they are visible above the water line, a detached position is calculated. An azimuth and range (via compass and laser range finder, respectively) are measured along with a known vessel position, and photographed from a safe distance. This allows the feature's position to be calculated with a high degree of accuracy without placing the vessel or crew in danger. The features are imported into the Final Feature File (FFF) and S-57 attributed. For unsafe features, the feature is not addressed and referenced as such in the Descriptive Report.

The second category of features are those safe for ASV008 to investigate. For features in this category, a file is created in CARIS HIPS and SIPS identifying the position of the feature and the area around the feature that is to be ensonified by MBES, called a shape file. This shape file is exported into HYPACK and used by the coxswain during data collection. The MBES development lines are created over the suspected feature in a way that is safest for the vessel and crew, ensonify all sides of the feature, and ensonify the feature with both the port and starboard channels of the MBES. The features are created in CARIS HIPS and SIPS, are S-57 attributed and added to the FFF.

The third category is shoreline features. In the event that shoreline verification is required, or a significant/assigned feature is only accessible by shore, the Trimble GeoXH is used and a high resolution photograph of the object is taken. This hand held unit is held as high on the object as possible, for a minimum of ten minutes to achieve a positional accuracy of one meter. The data collected with the Trimble is post-processed using the Trimble Pathfinder Office software package, exported to BDB, S-57 attributed, and added to the FFF.

Data Processing Methods and Procedures

See previous section.

C.8 Bottom Sample Data

Bottom sample data was not acquired.

D. Data Quality Management

D.1 Bathymetric Data Integrity and Quality Management

D.1.1 Directed Editing

The surface's child layers are reviewed to ensure the surface meets NOAA standards as set forth in the HSSD, and is free from systematic errors. The Hypothesis Count and Hypothesis Strength child layers are reviewed to ensure that fliers are not causing confusion in determining the actual sea floor. The Density layer is reviewed to determine that all the data has the appropriate density as set by the HSSD Section 5.2.2.2. The Standard Deviation layer is reviewed to ensure that all the data lies within the 95% confidence level. The depth layer is reviewed for erroneous soundings. Any erroneous soundings, known as fliers, are flagged as rejected and removed from the surface so the surface more accurately represents the seafloor.

D.1.2 Designated Sounding Selection

Any least depth on a feature that is not accurately reflected in the surface is flagged as "designated" in order to force the surface to reflect that shoaler depth in accordance with HSSD Section 5.2.1.2.3.

D.1.3 Holiday Identification

The depth layer of each resolution grid is reviewed visually for gross holidays (gaps in coverage) by the hydrographer and then run through QC Tools "Holiday Finder" for a more thorough identification of holidays. All holidays are identified and data is later acquired to resolve the gap in data coverage to the best of the hydrographer's ability. In the unusual event that holidays are identified after the survey team has departed the survey area and are unable to return, holidays are digitized in a .HOB file and submitted with the data to the Branch.

D.1.4 Uncertainty Assessment

The uncertainty layer is viewed to ensure that the data has not exceeded specifications as set by the HSSD Section 5.2.3. Pydro's QC Tools are used to further investigate and produce statistics and graphs to whether or not the data meets uncertainty requirements.

D.1.5 Surface Difference Review

D.1.5.1 Crossline to Mainscheme

Crosslines are collected, processed, and compared in accordance with Section 5.2.4.3 of the HSSD. A CUBE surface is created at the appropriate resolution for the survey area using only mainscheme lines and a second surface is created using only crosslines. Using the two surfaces, a difference surface (mainscheme

- crosslines = difference surface) is generated. Statistics are calculated to show the mean difference between the depths derived from the mainscheme and crosslines and reported in the DR. The difference surface is also compared to the IHO allowable total vertical uncertainty (TVU) standards and reported in the DR.

D.1.5.2 Junctions

Junction surveys are performed in accordance with HSSD Section 7.2.2. The process is the same as the crossline to mainscheme review (see paragraph above). The two data set surfaces are differenced using the CARIS Differencing algorithm and difference surface statistics are generated. When the difference surface are in good agreement between the two data sets, the process is complete. If the data sets are found to be in poor agreement, the data will be reviewed to determine if a vessel bias has been introduced into the HVF, a processing error has occurred, or a significant weather event has change in the sea floor. Analyses are documented in the DR.

D.1.5.3 Platform to Platform

In the event ASV008 is assigned a survey with another vessel, data is consistently reviewed for differences and troubleshooting is performed, as necessary.

D.2 Imagery data Integrity and Quality Management

D.2.1 Coverage Assessment

See Section C.2.

D.2.2 Contact Selection Methodology

See Section C.2.

E. Approval Sheet

As Chief of Party, I acknowledge that all of the information contained in this report is complete and accurate to the best of my knowledge.

The entire survey is adequate to supersede previous data.

Approver Name	Approver Title	Date	Signature
LTJG Patrick T Lawler	Chief of Party	01/04/2021	
LTJG Kevin A Tennyson	Sheet Manager	01/04/2021	

List of Appendices:

<i>Mandatory Report</i>	<i>File</i>
<i>Vessel Wiring Diagram</i>	Echoboat ASV Wiring Diagram.pdf
<i>Sound Speed Sensor Calibration</i>	68630_CAL_181017.pdf 65881_Certificate_181004.pdf
<i>Vessel Offset</i>	EchoBoat_PicoMB_2020.pdf 2020_ASV_008_ERDDM_Report.pdf
<i>Position and Attitude Sensor Calibration</i>	POS_MV_Cal_Report_ASV2020.pdf
<i>Echosounder Confidence Check</i>	2020_Lead_Line_to_ASV_MBES_Comparison Report.pdf 2020_Lead Line Calibration_Report.pdf 2020_ASV_MBES_PatchTestValues.pdf ASV_SSS_Calibration_2020_HSRR.pdf
<i>Echosounder Acceptance Trial Results</i>	Seafloor_Systems_EchoBoat_Acceptance_Report_2019.pdf