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

Data Acquisition & Processing Report

Type of Survey:	Basic Hydrographic Survey
Project Number:	OPR-Y390-KR-21
Time Frame:	June - September 2021

LOCALITY

State(s):	Wisconsin
General Locality:	Green Bay, WI

2021

CHIEF OF PARTY
David Neff, C.H.

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Date:

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Data Acquisition and Processing Report

eTrac
Chief of Party: David Neff, C.H.
Year: 2021
Version: 1
Publish Date: 2021-10-01

A. System Equipment and Software

A.1 Survey Vessels

A.1.1 R/V Endeavor

<table>
<tr><td>Vessel Name</td><td>R/V Endeavor</td></tr>
<tr><td>Hull Number</td><td>MMSI: 338342779</td></tr>
<tr><td>Description</td><td>eTrac Inc. provided the R/V Endeavor for hydrographic survey operations on OPR-Y390-KR-21. The R/V Endeavor is a 44 foot aluminum catamaran built by Armstrong Marine. The R/V Endeavor has the following specifications:</td></tr>
<tr><td>Dimensions</td><td><table><tr><td>LOA</td><td>44 ft.</td></tr><tr><td>Beam</td><td>14 ft.</td></tr><tr><td>Max Draft</td><td>2.5 ft.</td></tr></table></td></tr>
<tr><td>Most Recent Full Offset Verification</td><td><table><tr><td>Date</td><td>2021-06-01</td></tr><tr><td>Method</td><td>Precise measurements with a hand held metal tape and a long carpenters level were used to confirm and adjust the previously measured offsets during the mobilization of OPR-Y390-KR-21. The static survey data and measured data were used to establish vessel equipment offsets for all components of the hydrographic system mobilized on R/V Endeavor.
All measurements were performed a minimum of 3 times to reduce uncertainty.</td></tr></table></td></tr>
</table>

Figure 1: R/V Endeavor

A.1.2 R/V Rapid

<table>
<tr><td>Vessel Name</td><td colspan="2">R/V Rapid</td></tr>
<tr><td>Hull Number</td><td colspan="2">MMSI: 338357651</td></tr>
<tr><td>Description</td><td colspan="2">eTrac Inc. provided the R/V Rapid for hydrographic survey operations on OPR-Y390-KR-21. The R/V Rapid is a 28 foot ribbed safe boat. The R/V Rapid has the following specifications:</td></tr>
<tr><td rowspan="3">Dimensions</td><td>LOA</td><td>28</td></tr>
<tr><td>Beam</td><td>7.5</td></tr>
<tr><td>Max Draft</td><td>2</td></tr>
</table>

Most Recent Full Offset Verification	*Date*	2021-06-01
	Method	Precise measurements with a hand held metal tape and a long carpenters level were used to establish vessel equipment offsets for all components of the hydrographic system mobilized on R/V Rapid during the mobilization of OPR-Y390-KR-21. All measurements were performed a minimum of 3 times to reduce uncertainty.

Figure 2: R/V Rapid

A.1.3 R/V Voxel

Vessel Name	R/V Voxel
Hull Number	MMSI: 338394464
Description	eTrac Inc. provided the R/V Voxel for hydrographic survey operations on OPR-Y390-KR-21. The R/V Voxel is a 46 foot aluminum catamaran built by Armstrong Marine. The R/V Voxel has the following specifications:

Dimensions	*LOA*	46
	Beam	12.5
	Max Draft	2
Most Recent Full Offset Verification	*Date*	2021-06-01
	Method	Precise measurements with a hand held metal tape and a long carpenters level were used to confirm and adjust the previously measured offsets during the mobilization of OPR-R355-KR-20. The static survey data and measured data were used to establish vessel equipment offsets for all components of the hydrographic system mobilized on R/V Voxel. All measurements were performed a minimum of 3 times to reduce uncertainty.

Figure 3: R/V Voxel

A.2 Echo Sounding Equipment

A.2.1 Multibeam Echosounders

A.2.1.1 R2Sonic 2024

R/V Voxel was equipped with a single head R2Sonic 2024 Multibeam Echosounder System (MBES). R/V Endeavor and R/V Rapid were both equipped with a dual head R2Sonic 2024 MBES. The single head 2024 utilizes 256 and the dual head 2024 utilizes 512 discretely formed beams over a selectable sector up to 160° per sonar. At 400kHz the 2024 focuses an across-track and along-track beamwidth of 0.5° and 1° respectively. The 2024 operates at a maximum ping rate of 60Hz and is designed to comply with IHO standards for depth measurement to a maximum range of 400 meters.

Manufacturer	R2Sonic
Model	2024

Inventory

R/V Endeavor

Component	Deck Unit (Port)	Sonic Receiver (Port)	Sonic Projector (Port)	Deck Unit (Stbd)	Sonic Receiver (Stbd)	Sonic Projector (Stbd)
Model Number	Sonar Interface Module	2024	2024	Sonar Interface Module	2024	2024
Serial Number	103757	101004	800013	104267	101794	806829
Frequency	N/A	300	300	N/A	400	400
Calibration	2021-06-03	2021-06-03	2021-06-03	2021-06-03	2021-06-03	2021-06-03
Accuracy Check	2021-06-03	2021-06-03	2021-06-03	2021-06-03	2021-06-03	2021-06-03

R/V Rapid

Component	Deck Unit (Port)	Sonic Receiver (Port)	Sonic Projector (Port)	Deck Unit (Stbd)	Sonic Receiver (Stbd)	Sonic Projector (Stbd)
Model Number	I2NS	2024	2024	Sonar Interface Module	2024	2024
Serial Number	104685	101639	807033	100259	101838	807421
Frequency	N/A	300	300	N/A	400	400
Calibration	2021-06-03	2021-06-03	2021-06-03	2021-06-03	2021-06-03	2021-06-03
Accuracy Check	2021-06-03	2021-06-03	2021-06-03	2021-06-03	2021-06-03	2021-06-03

R/V Voxel

Component	Deck Unit	Sonic Receiver	Sonic Projector
Model Number	Sonar Interface Module	2024	2024
Serial Number	104733	101848	807481
Frequency	N/A	400	400
Calibration	2021-06-09	2021-06-09	2021-06-09
Accuracy Check	2021-06-09	2021-06-09	2021-06-09

Figure 4: R2 Sonic 2024 MBES (single head)

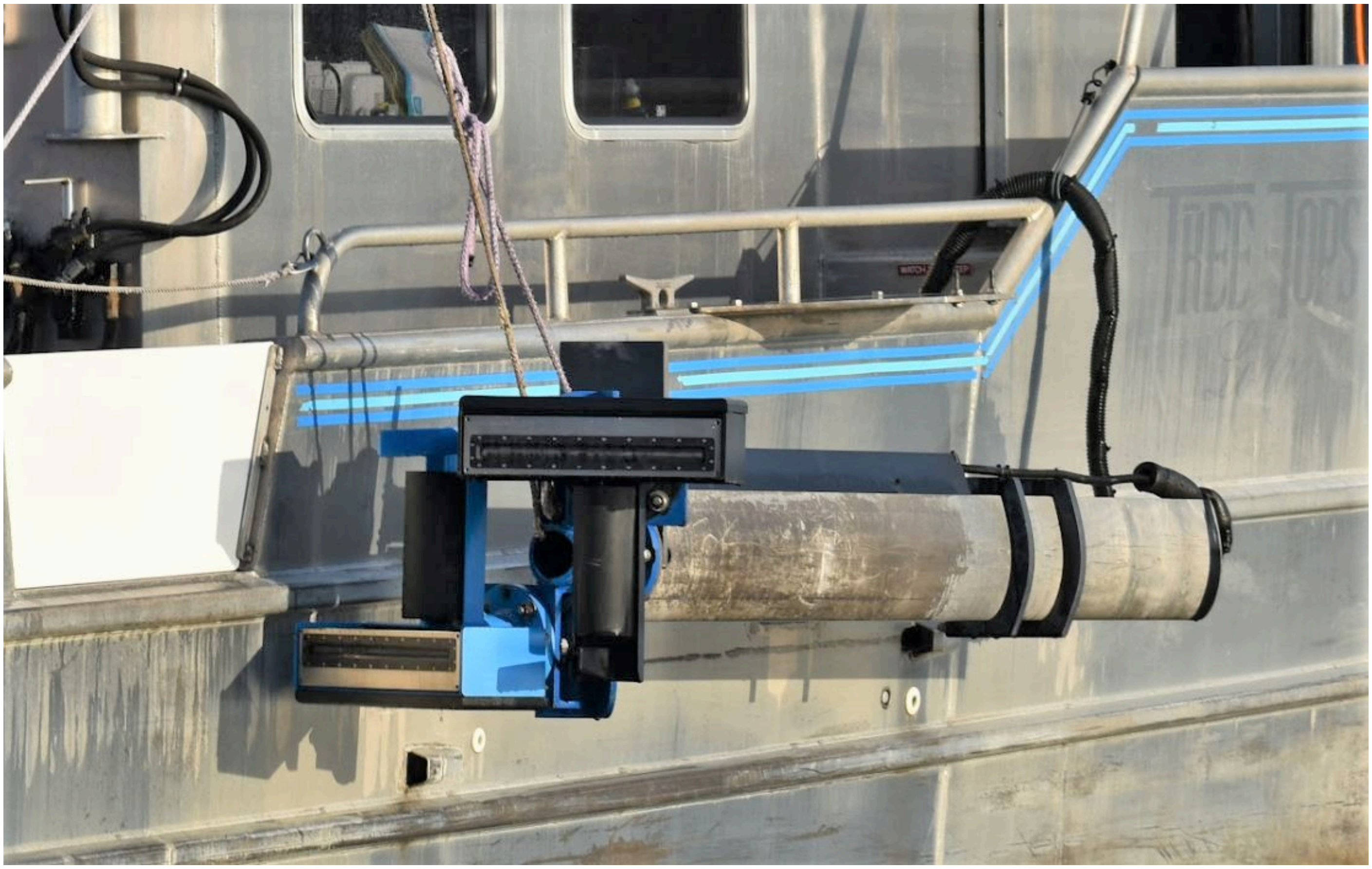

Figure 5: R2 Sonic 2024 MBES (dual head)

A.2.2 Single Beam Echosounders

No single beam echosounders were utilized for data acquisition.

A.2.3 Side Scan Sonars

No side scan sonars were utilized for data acquisition.

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 POS MV Oceanmaster

R/V Endeavor and R/V Voxel were both mobilized with an Applanix POS MV Oceanmaster, also known as a POS MV 320. The POSMV was used to acquire position, attitude, and heading throughout the entire survey. The POSMV Oceanmaster integrates a dual GPS antenna baseline and an inertial motion unit. Position, attitude, and heading data were broadcast to QPS QINSy acquisition software over Ethernet/UDP at 50Hz for the vessels.

<table>
<tr><td>Manufacturer</td><td colspan="4">Applanix</td></tr>
<tr><td>Model</td><td colspan="4">POS MV Oceanmaster</td></tr>
<tr><td rowspan="8">Inventory</td><td rowspan="4">R/V Endeavor</td><td>Component</td><td>Deck Unit</td><td>IMU</td></tr>
<tr><td>Model Number</td><td>MV-320</td><td>IMU 65</td></tr>
<tr><td>Serial Number</td><td>11293</td><td>2904</td></tr>
<tr><td>Calibration</td><td>2021-06-03</td><td>2021-06-03</td></tr>
<tr><td rowspan="4">R/V Voxel</td><td>Component</td><td>Deck Unit</td><td>IMU</td></tr>
<tr><td>Model Number</td><td>MV-320</td><td>IMU 65</td></tr>
<tr><td>Serial Number</td><td>7163</td><td>5554</td></tr>
<tr><td>Calibration</td><td>2021-06-09</td><td>2021-06-09</td></tr>
</table>

Figure 6: POS MV Oceanmaster

Figure 7: IMU 65

A.5.1.2 R2Sonic Integrated Inertial Navigation System (I2NS)

R/V Rapid was mobilized with a R2Sonic Integrated Inertial Navigation System (I2NS). The I2NS is a combined Applanix Wavemaster, also know as POSMV 220, and R2Sonic topside unit. The POSMV portion of the I2NS was used to acquire position, attitude, and heading throughout the entire survey. The POSMV 220 integrates a dual GPS antenna baseline and an inertial motion unit. Position, attitude, and heading data were broadcast to QPS QINSy acquisition software over Ethernet/UDP at 50Hz for the vessel.

<table>
<tr><td>Manufacturer</td><td colspan="4">R2Sonic</td></tr>
<tr><td>Model</td><td colspan="4">Integrated Inertial Navigation System (I2NS)</td></tr>
<tr><td rowspan="4">Inventory</td><td rowspan="4">R/V Rapid</td><td>Component</td><td>Deck Unit</td><td>IMU</td></tr>
<tr><td>Model Number</td><td>I2NS Sonar Interface Module (SIM)</td><td>I2NS IMU</td></tr>
<tr><td>Serial Number</td><td>10122</td><td>501208</td></tr>
<tr><td>Calibration</td><td>2021-06-03</td><td>2021-06-03</td></tr>
</table>

Figure 8: I2NS Sonar Interface Module (SIM)

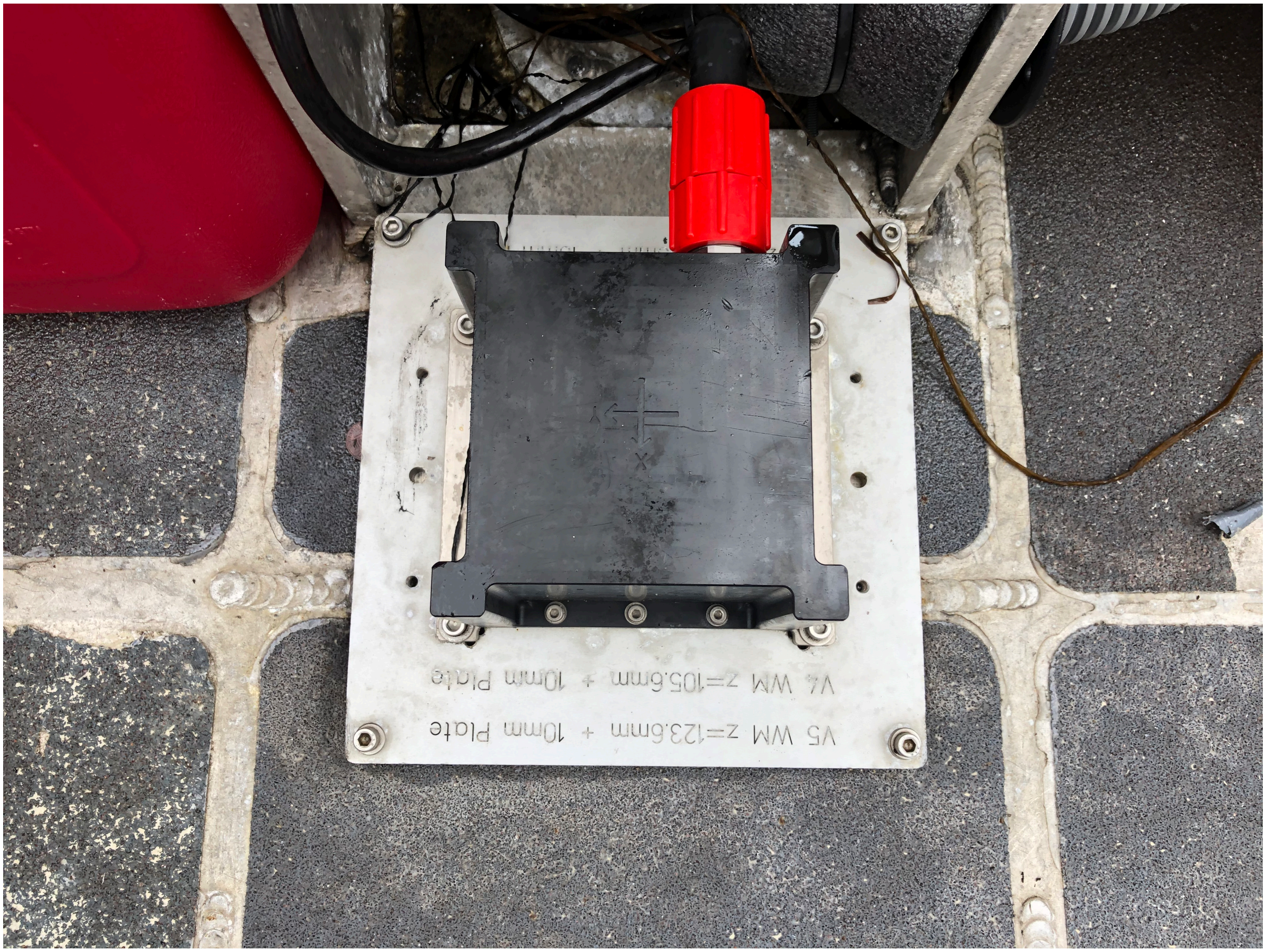

Figure 9: I2NS IMU

A.5.2 DGPS

DGPS equipment was not utilized for data acquisition.

A.5.3 GPS

Additional 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

A.5.5.1 Fugro Marinestar Global Correction System

R/V Endeavor, R/V Rapid, and R/V Voxel received GNSS satellite corrections over the POSMV G2+ carrier signal from the Marinestar Global Correction System maintained by Fugro.

The Marinestar system is a global realtime GNSS broadcast system that delivers corrections from a network of base stations around the world via geo-stationary satellites.

<table>
<tr><td>Manufacturer</td><td colspan="3">Fugro</td></tr>
<tr><td>Model</td><td colspan="3">Marinestar Global Correction System</td></tr>
<tr><td rowspan="12">Inventory</td><td rowspan="4">R/V Endeavor</td><td>Component</td><td>Marinestar Global Correction System</td></tr>
<tr><td>Model Number</td><td>N/A</td></tr>
<tr><td>Serial Number</td><td>N/A</td></tr>
<tr><td>Calibration</td><td>N/A</td></tr>
<tr><td rowspan="4">R/V Rapid</td><td>Component</td><td>Marinestar Global Correction System</td></tr>
<tr><td>Model Number</td><td>N/A</td></tr>
<tr><td>Serial Number</td><td>N/A</td></tr>
<tr><td>Calibration</td><td>N/A</td></tr>
<tr><td rowspan="4">R/V Voxel</td><td>Component</td><td>Marinestar Global Correction System</td></tr>
<tr><td>Model Number</td><td>N/A</td></tr>
<tr><td>Serial Number</td><td>N/A</td></tr>
<tr><td>Calibration</td><td>N/A</td></tr>
</table>

A.6 Sound Speed Equipment

A.6.1 Moving Vessel Profilers

A.6.1.1 AML/eTrac MVP•X

The AML/eTrac MVP•X moving vessel profiler is a high accuracy time of flight sound speed sensor capable of measuring sound speed in depths up to 80m meters. The MVP•X is towed behind the survey vessel through approximately 300m of electromechanical (0.5” cable) spooled onto a 24V oceanographic winch. The MVP•X is capable of transferring data via RS-485 serial cable. eTrac’s MVP Profiler software is run on the acquisition computer to facilitate the data monitoring, data transfer, and profile formatting.

The AML/eTrac MVP•X sound speed was used as the primary sound speed profiler on R/V Endeavor throughout the contract.

<table>
<tr><td>Manufacturer</td><td colspan="6">AML/eTrac</td></tr>
<tr><td>Model</td><td colspan="6">MVP•X</td></tr>
<tr><td rowspan="4">Inventory</td><td rowspan="4">R/V Endeavor</td><td>Component</td><td>Sound Speed Profiler</td><td>SV Sensor</td><td>Pressure Sensor</td><td>Temperature Sensor</td></tr>
<tr><td>Model Number</td><td>MVP•X</td><td>SV•Xchange</td><td>P•Xchange</td><td>T•Xchange</td></tr>
<tr><td>Serial Number</td><td>37191</td><td>209670</td><td>304556</td><td>404449</td></tr>
<tr><td>Calibration</td><td>N/A</td><td>2021-03-06</td><td>2021-03-18</td><td>2021-03-18</td></tr>
</table>

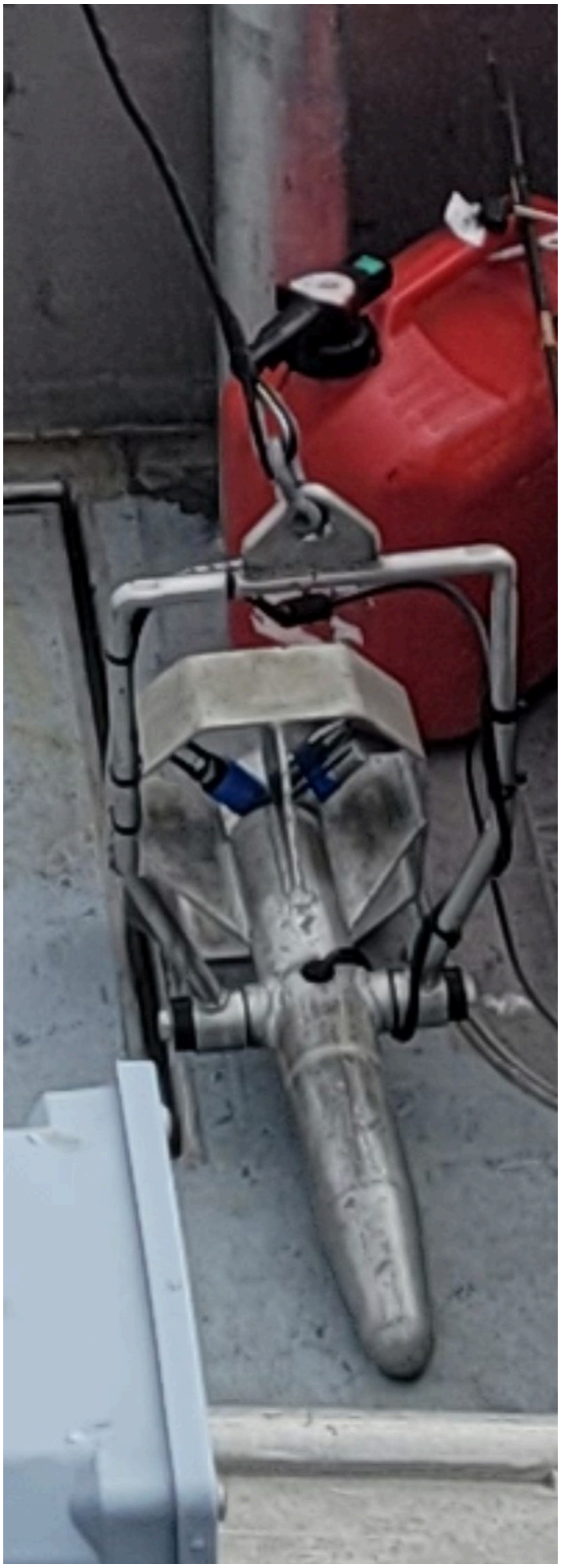

Figure 10: AML/eTrac MVP•X

Figure 11: R/V Endeavor MVP•X Winch

A.6.2 CTD Profilers

No CTD profilers were utilized for data acquisition.

A.6.3 Sound Speed Sensors

A.6.3.1 AML Micro•X

The R2Sonic 2024 MBES utilizes an AML Micro•X located at the sonar head for surface sound speed measurement. The AML Micro•X is a time of flight SV sensor and is powered through the R2Sonic topside or powered directly from a 12 volt power source via RS232 serial cable connection. Sound speed measurements (measured in meters per second) are output through the same serial connection at 1Hz.

<table>
<tr><td>Manufacturer</td><td colspan="4">AML</td></tr>
<tr><td>Model</td><td colspan="4">Micro•X</td></tr>
<tr><td rowspan="12">Inventory</td><td rowspan="4">R/V Endeavor</td><td>Component</td><td>Surface Sound Speed</td><td>SV Sensor</td></tr>
<tr><td>Model Number</td><td>Micro•X</td><td>SV•Xchange</td></tr>
<tr><td>Serial Number</td><td>11274</td><td>208950</td></tr>
<tr><td>Calibration</td><td>N/A</td><td>2021-03-06</td></tr>
<tr><td rowspan="4">R/V Rapid</td><td>Component</td><td>Surface Sound Speed</td><td>SV Sensor</td></tr>
<tr><td>Model Number</td><td>Micro•X</td><td>SV•Xchange</td></tr>
<tr><td>Serial Number</td><td>12749</td><td>209674</td></tr>
<tr><td>Calibration</td><td>N/A</td><td>2021-03-06</td></tr>
<tr><td rowspan="4">R/V Voxel</td><td>Component</td><td>Surface Sound Speed</td><td>SV Sensor</td></tr>
<tr><td>Model Number</td><td>Micro•X</td><td>SV•Xchange</td></tr>
<tr><td>Serial Number</td><td>10858</td><td>205954</td></tr>
<tr><td>Calibration</td><td>N/A</td><td>2021-03-06</td></tr>
</table>

Figure 12: AML Micro•X installed on a dual head R2Sonic 2024 custom mount

A.6.3.2 AML Base•X2

The AML Base•X2 sound speed profiler is a high accuracy time of flight sound speed sensor capable of measuring sound speed in depths up to 500 meters. The Base•X2 is capable of transferring data via RS-232 serial cable. AML SeaCast software is run on the acquisition computer to facilitate the data transfer and profile formatting.

The AML Baset•X2 sound speed profiler were used as the primary sound speed profiler on R/V Rapid and as the spare sound speed profiler on R/V Endeavor throughout the contract.

Manufacturer	AML				
Model	Base•X2				
Inventory	*R/V Endeavor*	*Component*	Sound Speed Profiler (Spare)	SV Sensor (Spare)	Pressure Sensor (Spare)
		Model Number	Base•X2	SV•Xchange	P•Xchange
		Serial Number	25004	205623	305433
		Calibration	N/A	2021-03-06	2021-03-18
	R/V Rapid	*Component*	Sound Speed Profiler	SV Sensor	Pressure Sensor
		Model Number	Base•X2	SV•Xchange	P•Xchange
		Serial Number	26216	209672	305446
		Calibration	N/A	2021-03-06	2021-03-18

Figure 13: AML Base•X2

A.6.3.3 AML Smart•X

The AML Smart•X sound speed profiler is a high accuracy time of flight sound speed sensor capable of measuring sound speed in depths up to 500 meters. The Smart•X is deployed behind the survey vessel through approximately 300m of electromechanical (0.5” cable) spooled onto a 24V oceanographic winch. The Smart•X is capable of transferring data via RS-232 serial cable or RS-485 serial cable connection. eTrac's internal SVP Profiler software is run on the acquisition computer to facilitate the data transfer and profile formatting.

The AML Smart•X sound speed profiler was used as the primary sound speed profiler on R/V Voxel throughout the contract.

<table>
<tr><td>Manufacturer</td><td colspan="5">AML</td></tr>
<tr><td>Model</td><td colspan="5">Smart•X</td></tr>
<tr><td rowspan="4">Inventory</td><td rowspan="4">R/V Voxel</td><td>Component</td><td>Sound Speed Profiler</td><td>SV Sensor</td><td>Pressure Sensor</td></tr>
<tr><td>Model Number</td><td>Smart•X</td><td>SV•Xchange</td><td>P•Xchange</td></tr>
<tr><td>Serial Number</td><td>20218</td><td>209289</td><td>305423</td></tr>
<tr><td>Calibration</td><td>N/A</td><td>2021-03-06</td><td>2021-03-18</td></tr>
</table>

Figure 14: AML Smart•X

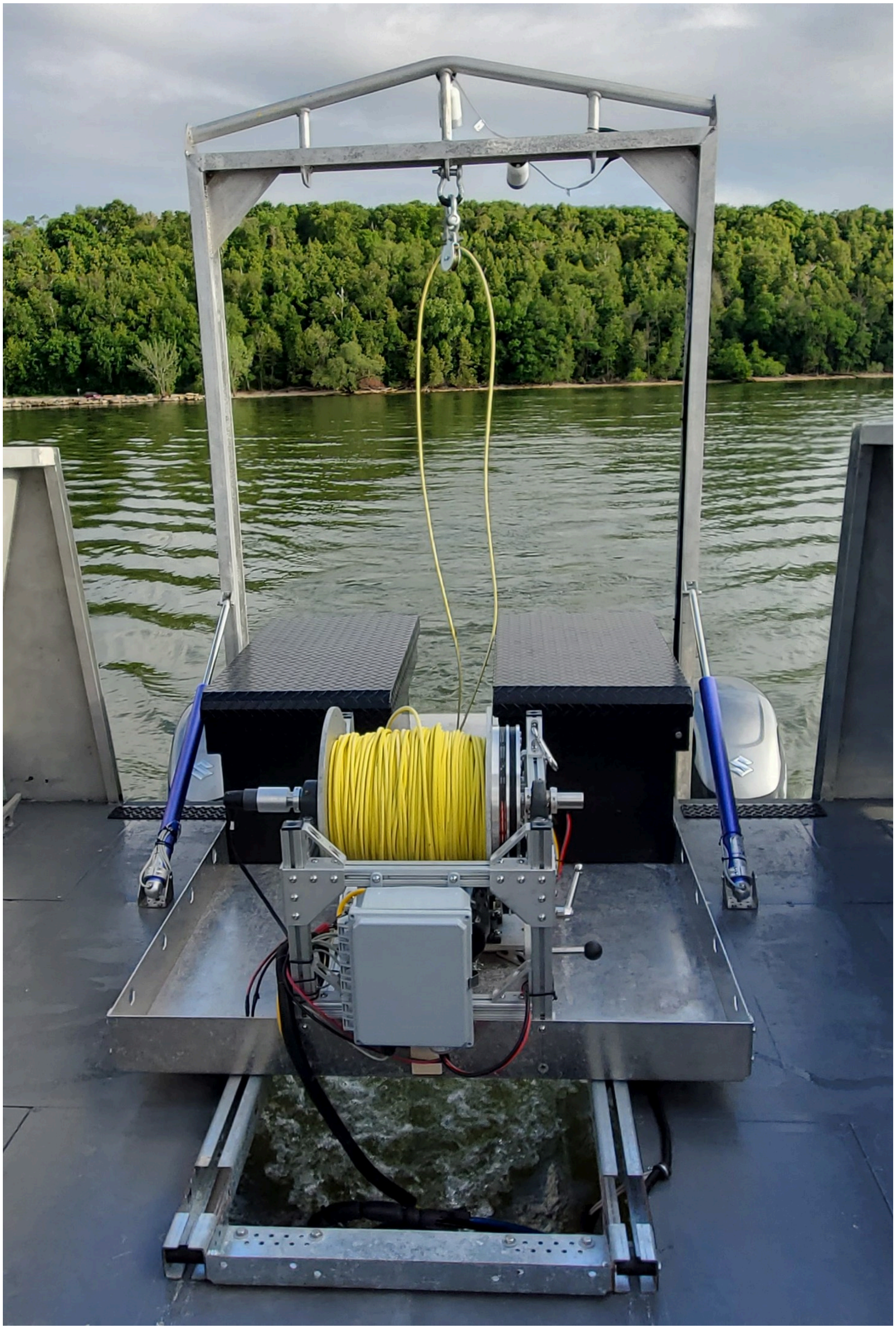

Figure 15: R/V Voxel SVP Winch

A.6.4 TSG Sensors

No TSG sensors were utilized for data acquisition.

A.6.5 Other Sound Speed Equipment

No other surface sound speed sensors were utilized for data acquisition.

A.7 Computer Software

Manufacturer	*Software Name*	*Version*	*Use*
QPS	Qinsy	9.3.1.333	Acquisition
R2Sonic, LLC	R2Sonic Sonic Control	02/09/2019	Acquisition
R2Sonic, LLC	R2Sonic 2024 Firmware (Head)	03/28/2019	Acquisition
R2Sonic, LLC	R2Sonic 2024 Firmware (SIM)	04/03/2017	Acquisition
AML Oceanographic	Seacast	4.4.0	Acquisition
eTrac Inc.	SVP Profiler	1.0.12	Acquisition
Applanix	MV-POSView	10.20	Acquisition
Applanix	PosMV 220 Firmware	10.30	Acquisition
Microsoft	Microsoft Excel	2007	Acquisition
QPS	Qimera	2.3.5	Processing
QPS	FMGeocoder Toolbox (FMGT)	7.9.6	Processing
Applanix	POSPac MMS	8.6	Processing
eTrac Inc.	Amitrac - Density Trac	1.0.0.20	Processing
eTrac Inc.	DiffTrac	1.0.0.9	Processing
eTrac Inc.	JunctionTrac	1.0.0.9	Processing
Blue Marble Geographics	Global Mapper	20.0	Processing
NOAA	Pydro Explorer	19.4	Processing
NOAA	QC Tools	3.4.5	Processing
CARIS	HIPS and SIPS	10.2.2	Processing
Google	Google Drive	n/a	Processing

A.8 Bottom Sampling Equipment

A.8.1 Bottom Samplers

A.8.1.1 Wildco Shipek Grab

The Shipek Grab is a center pivot stainless steel sampler designed for sampling unconsolidated sediments from soft ooze to hard packed sand. When the Shipek Grab makes contact with the bottom, inertia from a self-contained weight releases a catch and helical springs rotate the inner half cylinder by 180°. After turning, the scoop remains closed by the residual torque of the scoop spring. Because the rotation of the bucket is very rapid, its shear strength is far greater than the sediment strength, thus cutting cleanly, particularly in soft clays, muds, silts and sands. After closing, the sample is protected from washout during retrieval by the cylindrical design. The system was mobilized on R/V Endeavor for bottom sample collection on OPR-Y390-KR-21.

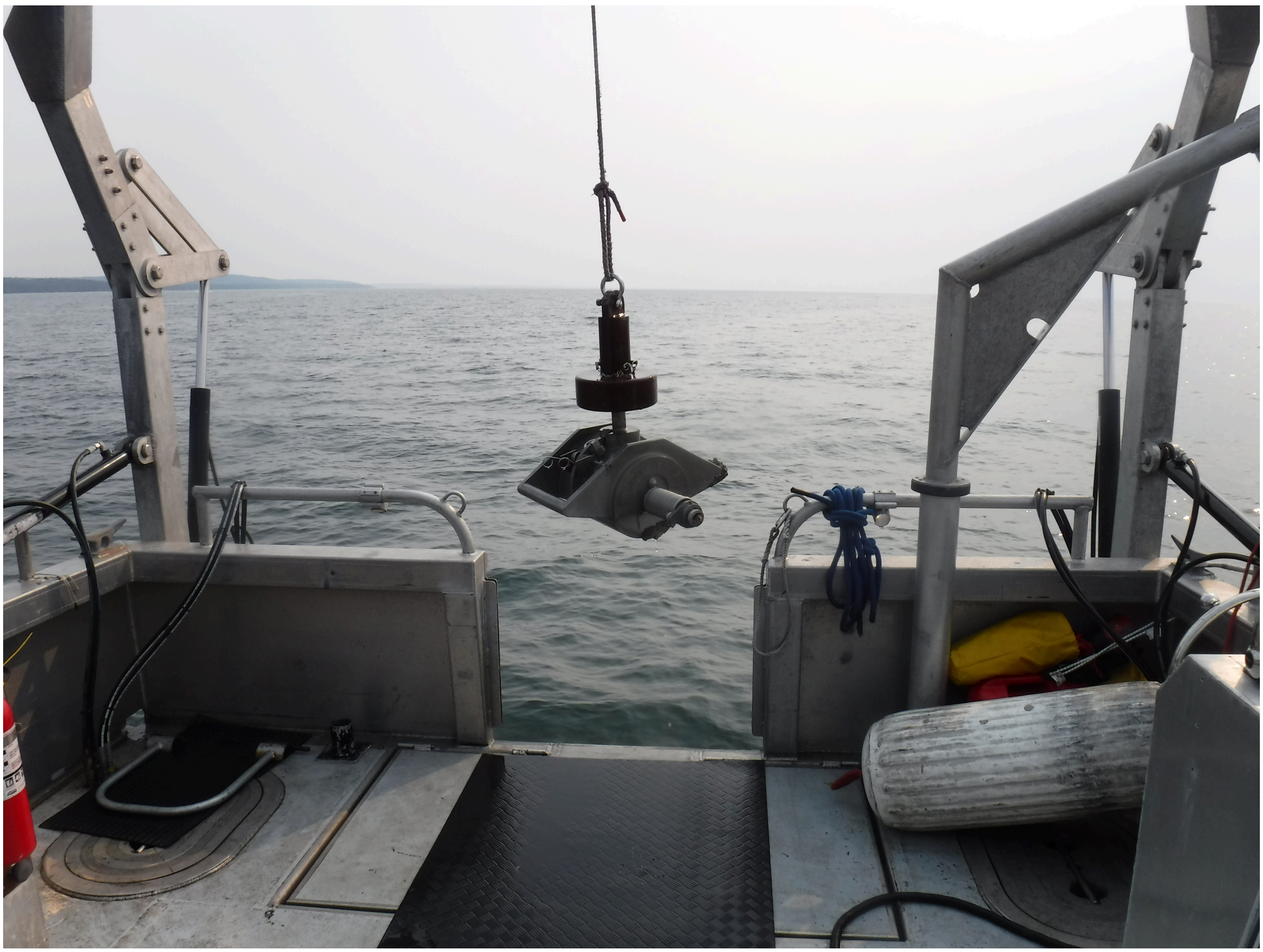

Figure 16: Shipek Grab

B. System Alignment and Accuracy

B.1 Vessel Offsets and Layback

B.1.1 Vessel Offsets

Prior to survey operations, offsets on all vessels were determined from the static vessel surveys performed at varying times and were verified using a metal hand tape. For R/V Rapid, offsets from the I2NS POSMV reference point to the acoustic center of each sonar were determined, measured, and confirmed using a metal hand tape. For R/V Endeavor and R/V Voxel, offsets from the Applanix Oceanmaster POSMV 320, reference point to the acoustic center of each sonar were determined, measured, and confirmed using a metal hand tape. These offsets were entered into Qinsy for use during data acquisition on all vessels.

A QPS Vessel Template Database file (DB) was created for each vessel. The vessel files contain sensor offsets and biases, static and dynamic draft corrections, and uncertainty values to aid in Total Propagated Uncertainty (TPU) calculations.

The I2NS POSMV on R/V Rapid was configured to output position and motion data at the IMU. The Applanix Oceanmaster POSMV 320 on R/V Endeavor and R/V Voxel was configured to output position and motion data at the IMU. Offsets to the acoustic centers of the Port and Starboard echosounders were input in the Qinsy Vessel DB.

B.1.1.1 Vessel Offset Correctors

Vessel offset correctors were not applied.

B.1.2 Layback

N/A

Layback correctors were not applied.

B.2 Static and Dynamic Draft

B.2.1 Static Draft

As this project utilized an ERS workflow, static draft was not utilized in final sounding computations.

B.2.1.1 Static Draft Correctors

Static draft correctors were not applied.

B.2.2 Dynamic Draft

As this project utilized an ERS workflow, dynamic draft was not utilized in final sounding computations.

B.2.2.1 Dynamic Draft Correctors

Dynamic draft correctors were not applied.

B.3 System Alignment

B.3.1 System Alignment Methods and Procedures

Multibeam patch tests were performed on each vessel prior to commencing data collection. A multibeam patch test is performed in order to measure the mounting/alignment biases between the MBES sensor and the inertial motion unit (IMU). In addition to mounting/alignment biases, a patch test is also performed to determine latency between MBES and position sensor data.

Latency patch tests were performed by running reciprocal survey lines at varying speeds over a prominent geological feature.
Roll patch tests were performed by running reciprocal survey lines at equal speeds over a flat bottom.
Pitch patch tests were performed by running reciprocal survey lines at equal speed over a prominent geological feature and an obstruction.
Yaw patch tests were performed by running parallel survey lines at equal speeds over a prominent geological feature and an obstruction.

For all vessels, each pair of specific survey lines were analyzed in Qimera Patch Test Tool.

Patch test data were analyzed independently by multiple hydrographers for crosscheck and also to determine an accurate uncertainty value for the mounting/alignment biases.

Daily roll lines were collected and adjusted during processing if necessary. The full patch test values are listed below. Adjusted daily roll values can be found within the Vessel Configuration of Qimera.

All calibration data is included in the digital data deliverable.

B.3.1.1 System Alignment Correctors

<table>
<tr><td>Vessel</td><td>R/V Endeavor</td></tr>
<tr><td>Echosounder</td><td>R2Sonic 2024 (Dualhead) Note: Transducer 1 is starboard and Transducer 2 is port for R/V Endeavor.</td></tr>
<tr><td>Date</td><td>2020-06-03</td></tr>
<tr><td>Patch Test Values</td><td><table>
<tr><td></td><td>Corrector</td><td>Uncertainty</td></tr>
<tr><td>Transducer Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Navigation Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Pitch</td><td>0.348 degrees</td><td>0.063 degrees</td></tr>
<tr><td>Roll</td><td>-19.260 degrees</td><td>0.045 degrees</td></tr>
<tr><td>Yaw</td><td>-1.494 degrees</td><td>0.173 degrees</td></tr>
<tr><td>Pitch Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Roll Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Yaw Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Heave Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
</table></td></tr>
<tr><td>Date</td><td>2021-06-03</td></tr>
<tr><td>Patch Test Values (Transducer 2)</td><td><table>
<tr><td></td><td>Corrector</td><td>Uncertainty</td></tr>
<tr><td>Transducer Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Navigation Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Pitch</td><td>-1.296 degrees</td><td>0.190 degrees</td></tr>
<tr><td>Roll</td><td>19.730 degrees</td><td>0.020 degrees</td></tr>
<tr><td>Yaw</td><td>-1.487 degrees</td><td>0.140 degrees</td></tr>
<tr><td>Pitch Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Roll Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Yaw Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Heave Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>Vessel</td><td>R/V Rapid</td></tr>
<tr><td>Echosounder</td><td>R2Sonic 2024 (Dualhead) Note: Transducer 1 is port and Transducer 2 is starboard for R/V Rapid.</td></tr>
<tr><td>Date</td><td>2021-06-03</td></tr>
<tr><td>Patch Test Values</td><td>
<table>
<tr><td></td><td>Corrector</td><td>Uncertainty</td></tr>
<tr><td>Transducer Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Navigation Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Pitch</td><td>-0.380 degrees</td><td>0.400 degrees</td></tr>
<tr><td>Roll</td><td>12.590 degrees</td><td>0.100 degrees</td></tr>
<tr><td>Yaw</td><td>-1.830 degrees</td><td>0.320 degrees</td></tr>
<tr><td>Pitch Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Roll Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Yaw Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Heave Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
</table>
</td></tr>
<tr><td>Date</td><td>2021-06-03</td></tr>
<tr><td>Patch Test Values</td><td>
<table>
<tr><td></td><td>Corrector</td><td>Uncertainty</td></tr>
<tr><td>Transducer Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Navigation Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Pitch</td><td>1.070 degrees</td><td>0.440 degrees</td></tr>
<tr><td>Roll</td><td>-13.350 degrees</td><td>0.080 degrees</td></tr>
<tr><td>Yaw</td><td>1.490 degrees</td><td>0.310 degrees</td></tr>
<tr><td>Pitch Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Roll Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Yaw Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Heave Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
</table>
</td></tr>
<tr><td>Date</td><td>2021-06-26</td></tr>
<tr><td>Patch Test Values</td><td>
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<tr><td></td><td>Corrector</td><td>Uncertainty</td></tr>
<tr><td>Transducer Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Navigation Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Pitch</td><td>-0.608 degrees</td><td>0.150 degrees</td></tr>
<tr><td>Roll</td><td>11.808 degrees</td><td>0.060 degrees</td></tr>
<tr><td>Yaw</td><td>-1.198 degrees</td><td>0.080 degrees</td></tr>
<tr><td>Pitch Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Roll Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Yaw Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
<tr><td>Heave Time Correction</td><td>0.000 seconds</td><td>0.000 seconds</td></tr>
</table>
</td></tr>
</table>

Date	2021-06-26
Patch Test Values (Transducer 2)	

	Corrector	*Uncertainty*
Transducer Time Correction	0.000 seconds	0.000 seconds
Navigation Time Correction	0.000 seconds	0.000 seconds
Pitch	1.215 degrees	0.280 degrees
Roll	-13.305 degrees	0.070 degrees
Yaw	1.057 degrees	0.100 degrees
Pitch Time Correction	0.000 seconds	0.000 seconds
Roll Time Correction	0.000 seconds	0.000 seconds
Yaw Time Correction	0.000 seconds	0.000 seconds
Heave Time Correction	0.000 seconds	0.000 seconds

Date	2021-07-04
Patch Test Values	

	Corrector	*Uncertainty*
Transducer Time Correction	0.000 seconds	0.000 seconds
Navigation Time Correction	0.000 seconds	0.000 seconds
Pitch	-0.116 degrees	0.070 degrees
Roll	13.320 degrees	0.040 degrees
Yaw	2.460 degrees	0.260 degrees
Pitch Time Correction	0.000 seconds	0.000 seconds
Roll Time Correction	0.000 seconds	0.000 seconds
Yaw Time Correction	0.000 seconds	0.000 seconds
Heave Time Correction	0.000 seconds	0.000 seconds

Date	2021-07-04
Patch Test Values (Transducer 2)	

	Corrector	*Uncertainty*
Transducer Time Correction	0.000 seconds	0.000 seconds
Navigation Time Correction	0.000 seconds	0.000 seconds
Pitch	0.487 degrees	0.010 degrees
Roll	-13.399 degrees	0.040 degrees
Yaw	1.102 degrees	0.160 degrees
Pitch Time Correction	0.000 seconds	0.000 seconds
Roll Time Correction	0.000 seconds	0.000 seconds
Yaw Time Correction	0.000 seconds	0.000 seconds
Heave Time Correction	0.000 seconds	0.000 seconds

Date	2021-08-03
Patch Test Values	

	Corrector	*Uncertainty*
Transducer Time Correction	0.000 seconds	0.000 seconds
Navigation Time Correction	0.000 seconds	0.000 seconds
Pitch	-0.428 degrees	0.130 degrees
Roll	12.982 degrees	0.120 degrees
Yaw	2.360 degrees	0.190 degrees
Pitch Time Correction	0.000 seconds	0.000 seconds
Roll Time Correction	0.000 seconds	0.000 seconds
Yaw Time Correction	0.000 seconds	0.000 seconds
Heave Time Correction	0.000 seconds	0.000 seconds

Date	2021-08-03
Patch Test Values (Transducer 2)	

	Corrector	*Uncertainty*
Transducer Time Correction	0.000 seconds	0.000 seconds
Navigation Time Correction	0.000 seconds	0.000 seconds
Pitch	0.566 degrees	0.150 degrees
Roll	12.982 degrees	0.120 degrees
Yaw	1.335 degrees	0.260 degrees
Pitch Time Correction	0.000 seconds	0.000 seconds
Roll Time Correction	0.000 seconds	0.000 seconds
Yaw Time Correction	0.000 seconds	0.000 seconds
Heave Time Correction	0.000 seconds	0.000 seconds

Vessel	R/V Voxel
Echosounder	R2Sonic 2024
Date	2021-06-03
Patch Test Values	

	Corrector	*Uncertainty*
Transducer Time Correction	0.000 seconds	0.000 seconds
Navigation Time Correction	0.000 seconds	0.000 seconds
Pitch	0.297 degrees	0.080 degrees
Roll	-0.266 degrees	0.020 degrees
Yaw	0.617 degrees	0.200 degrees
Pitch Time Correction	0.000 seconds	0.000 seconds
Roll Time Correction	0.000 seconds	0.000 seconds
Yaw Time Correction	0.000 seconds	0.000 seconds
Heave Time Correction	0.000 seconds	0.000 seconds

C. Data Acquisition and Processing

C.1 Bathymetry

C.1.1 Multibeam Echosounder

Data Acquisition Methods and Procedures

Data acquisition and processing throughout the entire project was overseen by the Chief of Party. Field acquisition was performed under the direct, on site, supervision of a Lead Hydrographer and a Senior Hydrographer, both with well over 10 years of experience conducting hydrographic survey operations.

MBES line spacing for Complete Coverage survey operations was based upon charted depths as well as coverage requirements set forth in the Project Instructions and the HSSD 2021. MBES line spacing for Set Line Spacing survey operations was based upon requirements set forth the in the Project Instructions and the HSSD 2021.

For the R2Sonic, incremental adjustments to the range, gain, and pulse width were made during the survey and were dependent on water depth and seabed composition (bottom type). The main adjustment made by the hydrographer was the adjustment of swath width based on environmental conditions and sea state.

Every effort was made to tune the sonars to provide the highest quality of both bathymetric and backscatter data, with bathymetry being the primary focus. The R2Sonic 2024 MBES systems were monitored realtime during all MBES acquisition efforts. Raw MBES information, including intensity, surface sound velocity, time synchronization, and ping rate, were displayed and monitored in the R2Sonic Sonic Controller Interface during acquisition.

Prior to survey operations, offsets on all vessels were determined from the static vessel surveys performed at varying times and were verified using a metal hand tape. For all vessels, offsets from the IMU reference points to the acoustic center of each sonar were determined, measured, and confirmed using a metal hand tape. These offsets were entered into QINSy for use during data acquisition on all vessels.

The R2Sonic's roll stabilization and precise timing were achieved through a combination of outputs from the I2NS POSMV or Applanix Oceanmaster. The 1PPS pulse from the I2NS POSMV or Applanix Oceanmaster is sent via BNC cable to the PPS input of the R2Sonic SIM. Additionally, a NMEA ZDA message at 1Hz is transferred from a I2NS POSMV or Applanix Oceanmaster serial port to the R2Sonic SIM via standard DB9 serial cable. For roll stabilization, the TSS1 binary motion string is transferred from the I2NS POSMV or Applanix Oceanmaster to the R2Sonic SIM via DB9 Serial connection at 200Hz.

In addition to performing the confidence checks on each vessel, a vessel-to-vessel comparison was performed as an added quality assurance measure. All vessels typically acquired sound velocity casts independently using their assigned sound velocity probe. The exception to sound casts being collected independently was during the Multi-Vessel data acquisiton. During the Multi-Vessel data acquisition, R/V Endeavor would take casts for the vessel(s) who were digitally towed behind R/V Endeavor. Data were processed though the processing pipeline and comparisons were made between the independent datasets.

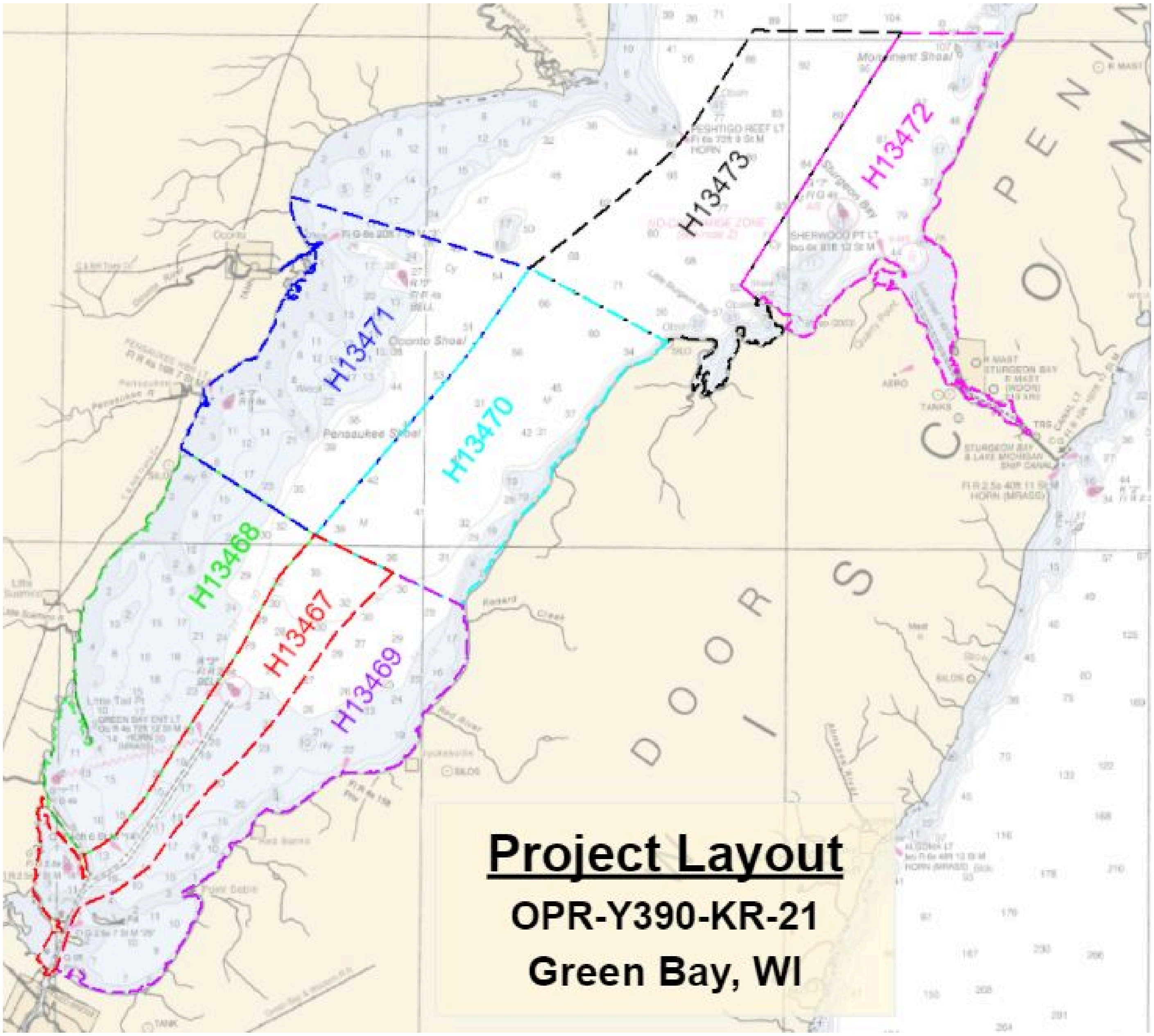

Figure 17: OPR-Y390-KR-21 Project Layout

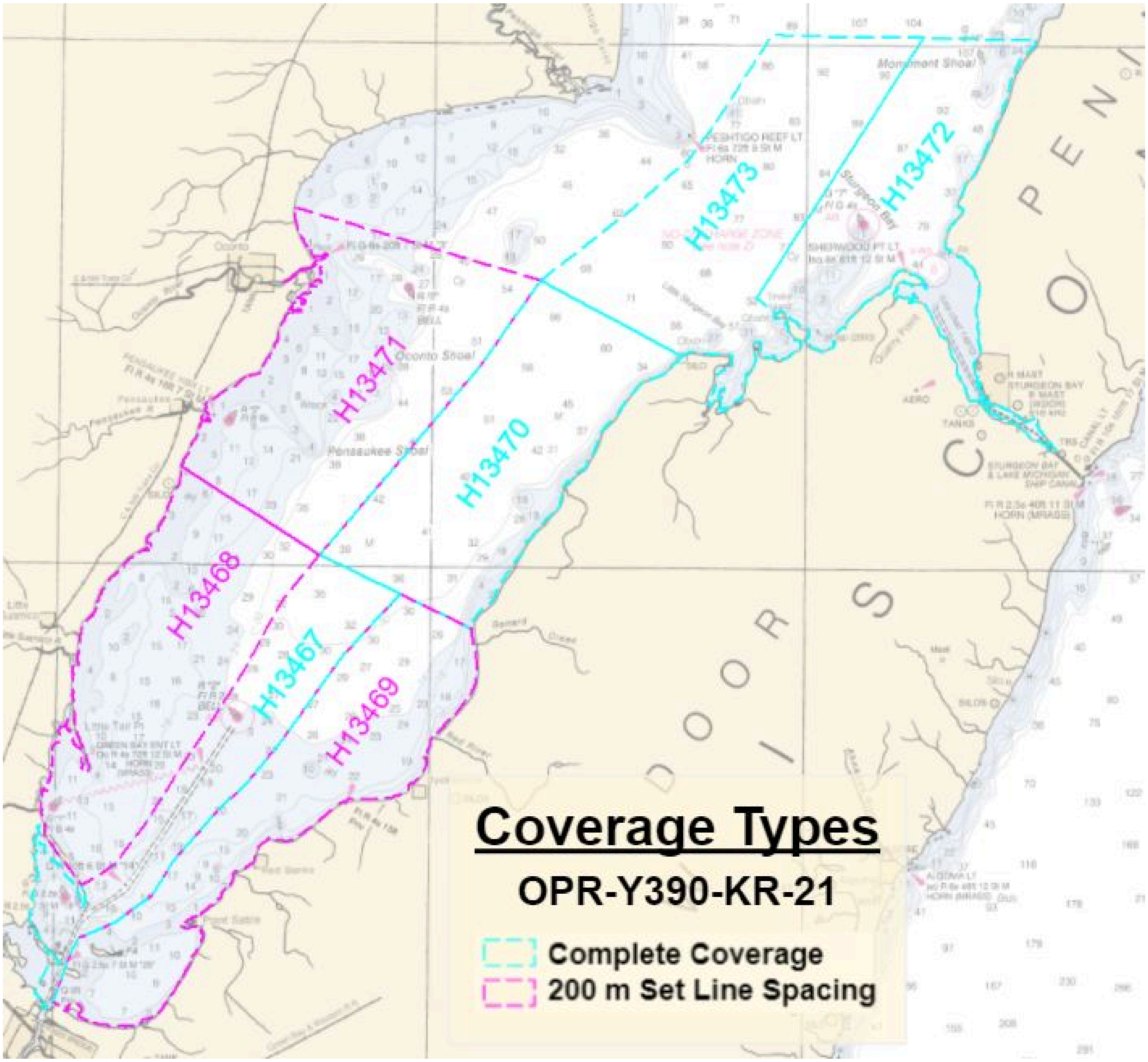

Figure 18: OPR-Y390-KR-21 Survey Coverage Types

Data Processing Methods and Procedures

Qimera was exclusively utilized for MBES processing throughout the entire project. Processing steps and procedures are detailed below in the image below.

The first part (PART 1 in the image below) of the processing pipeline consists of a series of standard Qimera processing procedures, which are completed using the Qimera process tool bar and auto processing prompts. In order to ensure each process has been completed, processes are reviewed in the output window.

The second part (PART 2 in the image below) of the Qimera processing pipeline consists of detailed review and cleaning of data, as well as project specific tasks such as investigating features or preparing DTON reports for submittal.

The third part (PART 3 in the image below) of the Qimera processing pipeline is performed once data collection has been completed for an entire H-Cell sheet. CUBE surfaces are "finalized" by choosing the option to override the CUBE hypothesis with any designated soundings. This finalized surface then represents the least depth of features and soundings worthy of a designated sounding.

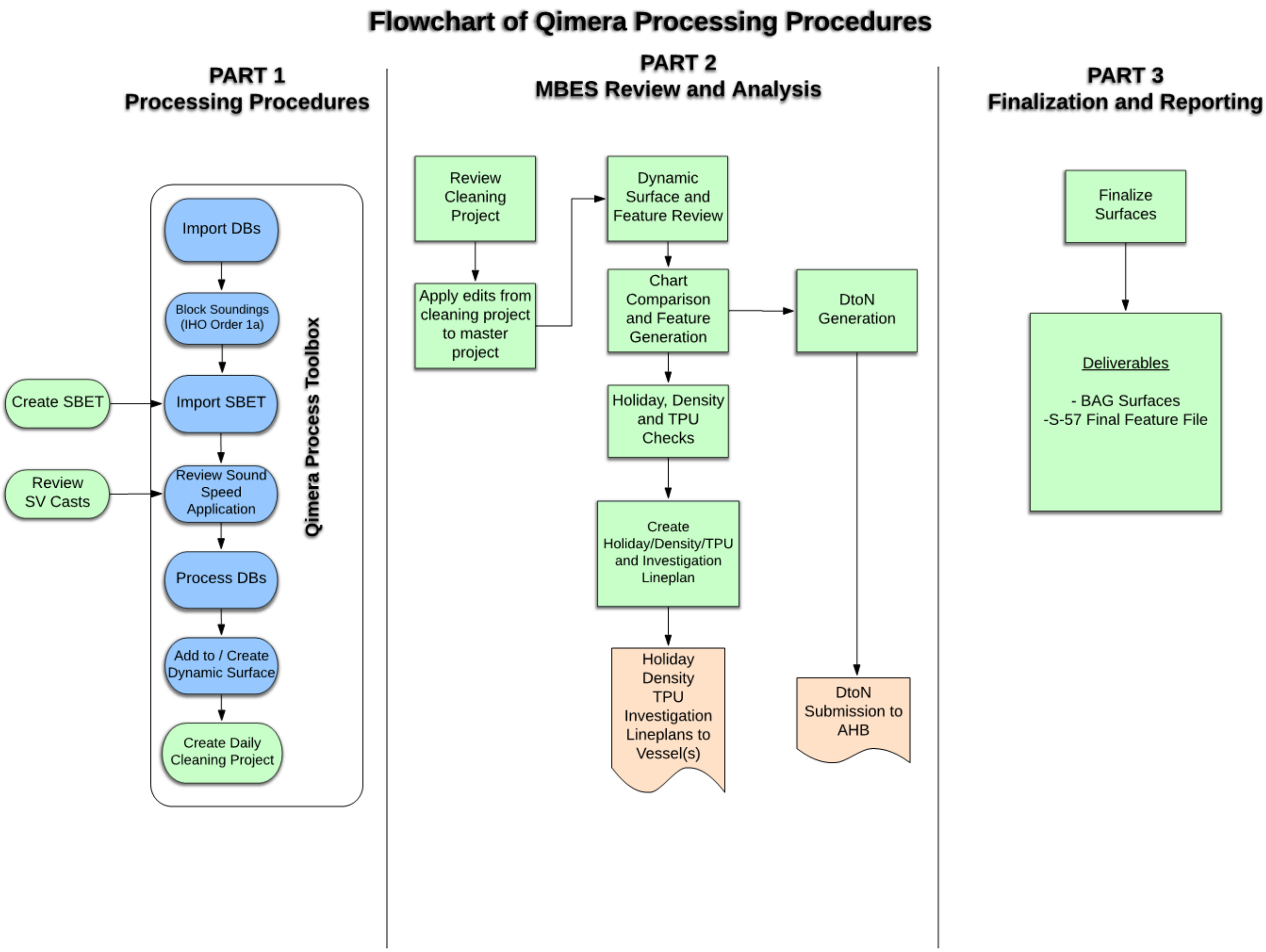

Figure 19: Qimera Processing Procedures

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

All CUBE surfaces were created in Qimera. Sheet wide parent surfaces were created in each resolution that were relevant to surveyed depths. For the complete coverage MBES H-cell projects, multiple surfaces were made due to Qimera's inability to make one surface containing all of the data.

C.1.4.2 Depth Derivation

Once data cleaning and a detailed review has been completed, finalized surfaces are created by using the "limit vertical bounds" option in the "Create Dynamic Surface" tool in Qimera. This option creates a final surface with a depth threshold. The resolution and depth ranges for each finalized surface follows the specifications in the HSSD 2021. The finalized CUBE surfaces are exported as BAG files for deliverables.

C.1.4.3 Surface Computation Algorithm

The NOAA parameters per surface resolution were imported into Qimera. These parameters were used for all surface generations throughout the duration of processing efforts.

C.2 Imagery

C.2.1 Multibeam Backscatter Data

Data Acquisition Methods and Procedures

Snippets were collected simultaneously with MBES data collection to meet Complete Coverage and Set Line Spacing requirements as specified in the HSSD 2021.

Data Processing Methods and Procedures

FMGeocoder Toolbox (FMGT) is a program designed to process, view, and analyze backscatter data. FMGT was utilized in the processing workflow as the exclusive snippets/backscatter processing software to confirm that snippets were collected during all MBES data collection to meet Complete Coverage and Set Line Spacing requirements as specified in the HSSD. Snippets data from GSF files exported from Qimera were brought into FMGT and processed into backscatter mosaics daily to confirm backscatter complete coverage. Below is an example image of the raw backscatter from H13467.

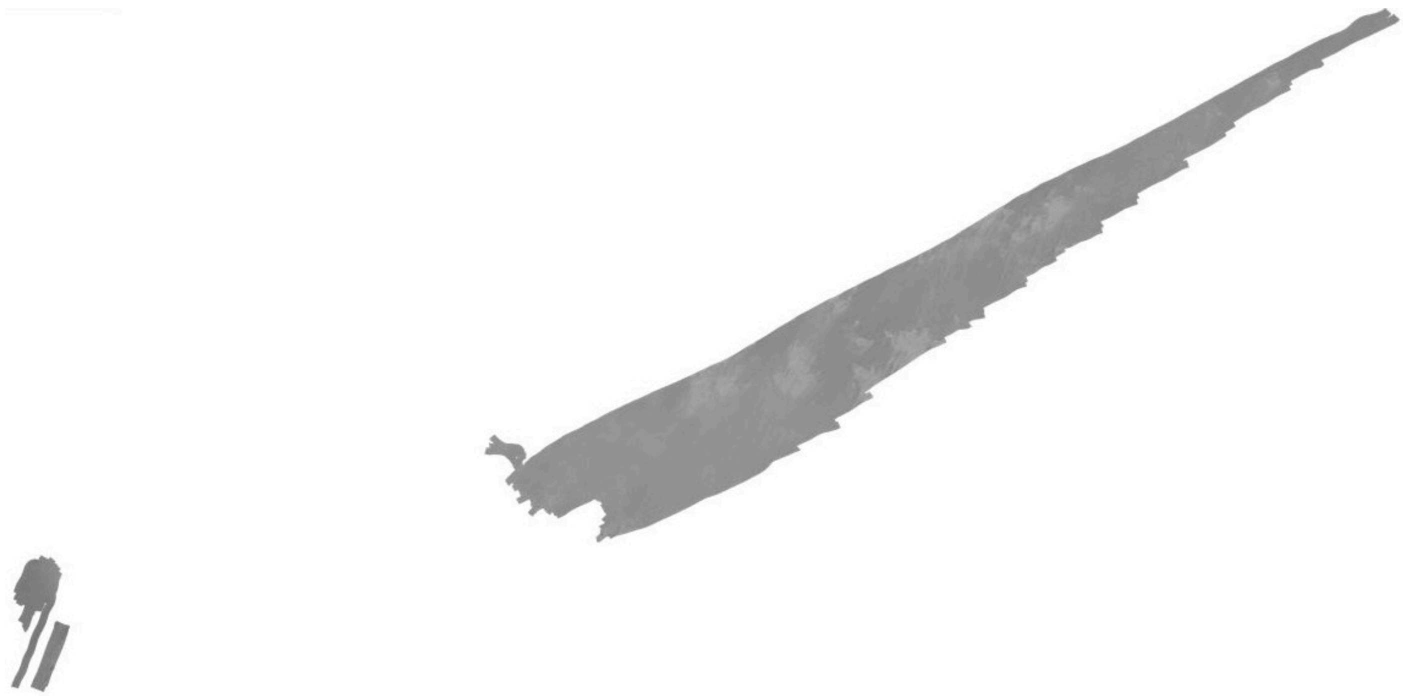

Figure 20: Raw Backscatter from R/V Rapid on DN183 in H13467

C.2.2 Side Scan Sonar

Side scan sonar imagery was not acquired.

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

DGPS data was not acquired.

C.3.1.3 Other Horizontal Control Equipment

Data Acquisition Methods and Procedures

During acquisition, R/V Endeavor, R/V Rapid and R/V Voxel received GNSS satellite corrections over the POS MV G2+ carrier signal from the Marinestar Global Correction System maintained by Fugro. Marinestar is a global real-time GNSS broadcast system that delivers corrections from a network of base stations around the world via geo-stationary satellites. Corrections were monitored during data acquisition to ensure no dropouts occurred throughout the survey.

Data Processing Methods and Procedures

During calibration procedures and throughout the project, POSMV data were logged and post-processed in POSPac MMS to output a SBET. The SBET was applied in QPS Qimera in order to reduce the THU of the data and achieve a higher accuracy.

C.3.2 Vertical Control

C.3.2.1 Water Level Data

Data Acquisition Methods and Procedures

In accordance with the Project Instructions, OPR-Y390-KR-21 was an Ellipsoidally Referenced (ERS) survey. Data were vertically referenced to the ITRF-2014 ellipsoid using Marinestar G2+ Space Based corrections. A time dependant, 7 parameter transformation from ITRF-2014 to NAD83_2011 was performed in QPS Qinsy. Using VDatum, a vertical separation model was created to transform the ellipsoidally referenced data from NAD83_2011 to Low Water Datum - International Great Lakes Datum 1985 (LWD-IGLD85). The tranformation and the separation model were applied in QPS Qinsy on the vessels in realtime to achieve LWD-IGLD85 in the field. Achieving LWD-IGLD85 in the field was extremely efficient for field operations, as the NALL was easily identified in real-time.

Data Processing Methods and Procedures

The separation model automatically carried over into QPS Qimera through the DB files during processing. The separation model generated from VDatum is noted to have an uncertainty of 4.5 cm throughout the project area.

C.3.2.2 Optical Level Data

Optical level data was not acquired.

C.4 Vessel Positioning

Data Acquisition Methods and Procedures

During acquisition, trajectory data was logged by the R2Sonic I2NS on R/V Rapid and by the Applanix Oceanmaster on R/V Endeavor and R/V Voxel. All vessels received GNSS satellite corrections over the POS MV G2+ carrier signal from the Marinestar Global Correction System maintained by Fugro. Marinestar is a global real-time GNSS broadcast system that delivers corrections from a network of base stations around the world via geo-stationary satellites. Corrections were monitored during data acquisition to ensure no dropouts occurred throughout the survey.

Data Processing Methods and Procedures

Applanix PosPac MMS was utilized for all survey data to post-process realtime positioning data utilizing Trimble's PP-RTX implementation of Trimble CenterPoint RTX. The Trimble CenterPoint RTX correction service is delivered via internet connection and integrated into Applanix PosPac MMS 8, to aid in post processed trajectories. A Smoothed Best Estimate of Trajectory (SBET) is provided by PosPac MMS and applied to survey data in Qimera.

C.5 Sound Speed

C.5.1 Sound Speed Profiles

Data Acquisition Methods and Procedures

All sound speed sensors used on the project were calibrated within 1 year of survey commencement per the HSSD 2021. Manufacturer certified calibration sheets can be referenced in Appendices of this document.

All sound speed measurements were collected in accordance with specifications set forth in the HSSD 2021.

Sound speed profiles were collected using AML Base•X2, AML Smart•X and AML/eTrac MVP profiling units. On R/V Rapid, SV profilers were lowered on a data cable by hand. On R/V Endeavor and R/V Voxel, SV profilers were lowered on a data cable by a winch while the vessel was stopped or underway depending on the sea state. SV profiles were taken immediately prior to daily survey operations, as well as approximately every 2 hours during survey operations. In addition to planning SV casts around a 2 hour time interval, positional variance was considered when suspending survey operations to perform an SV cast.

During a cast on R/V Endeavor, R/V Rapid and R/V Voxel realtime SV profiler data was collected and displayed during the downcast of the probe. The SV profiler communicated with the acquisition computer via serial data communication. The profiler data is then saved as a CSV on the MBES acquisition computer. Then, the CSV was imported to QPS QINSy acquisition software for use online and is stored in each .DB file. Once imported into the QPS QINSy software, the cast data was exported into the .SVP format for use in office processing at a later data if needed. Application of .SVP files to vessel data was not required in post processing because the applied SVP is stored in the .DB file.

Data Processing Methods and Procedures

Sound speed profiles collected in the field were applied to the MBES data. On each vessel, raw Qinsy .DB files store sound speed profile data real-time for each separate line of data. In Qimera, sound speed data is imported simultaneously with each respective raw DB file. The sound speed data was analyzed for spurious data points and cleaned if necessary. The sound speed strategy in Qimera was primarily set to “Nearest in Distance within Time” with a time set of 240 minutes. This sound speed strategy allowed for an intelligent sound speed dataset to be applied to full or partial .DB files based on time and space in order to achieve the best looking dataset. If the primary sound speed strategy was showing refraction in an area, the processor had the ability to set the sound speed strategy to "Real Time Scheduling" to individual .DB files to apply the sound cast that was used during acquisition.

Surface sound speed was collected at the R2Sonic transducer face, and sent via serial connection directly to the R2Sonic topside in order to facilitate beam steering.

C.5.2 Surface Sound Speed

Data Acquisition Methods and Procedures

The R2sonic 2024 MBES utilize an AML Micro•X located at the sonar head for surface sound speed measurement. The AML Micro•X is a time of flight SV sensor and is powered through the R2Sonic topside. Sound speed measurements (measured in meters per second) are output through the same serial connection at 1Hz.

Surface sound speed measured by the AML Micro•X, located at the sonar head, was compared in realtime against the corresponding SV from the most current cast entered into QINSy. An alarm was set to notify the operator if the difference between the two SV readings exceeded 2m/s. If the difference was ever in consistent excess of 2m/s and persisted longer than a designated time threshold, survey operations were suspended and a new sound velocity cast was performed.

Surface sound speed was measured at 1Hz during all MBES operations using the AML Micro•X. The AML Micro•X is installed using the AML or R2Sonic provided mounting bracket and installed just above the face of the MBES receiver. On R/V Endeavor, R/V Rapid and R/V Voxel, surface sound speed was transmitted at 1Hz to the R2Sonic topside SIM box and subsequently transmitted with the MBES data to

QPS QINSy, where it was permanently logged in the raw .DB files. As mentioned above, surface sound speed was additionally utilized during online operations as a QC comparison to sound speed profile data.

Data Processing Methods and Procedures

Surface sound speed was not post-processed and all values remain as realtime.

C.6 Uncertainty

C.6.1 Total Propagated Uncertainty Computation Methods

Values were determined from manufacturer's specified/suggested values and/or calibration methodology/ accuracy. CUBE surfaces were created in Qimera using the NOAA CUBE parameters based on surface resolution which determines uncertainty of each grid node. Uncertainty was cheked in NOAA QC Tools. Further dicussion of uncertainty assesment is located in section D.1.4.

C.6.2 Uncertainty Components

C.6.2.1 A Priori Uncertainty

Vessel		R/V Endeavor	R/V Rapid	R/V Voxel
Motion Sensor	*Gyro*	0.02 degrees	0.02 degrees	0.02 degrees
	Heave	5.00% 0.05 meters	5.00% 0.05 meters	5.00% 0.05 meters
	Roll	0.01 degrees	0.01 degrees	0.01 degrees
	Pitch	0.01 degrees	0.01 degrees	0.01 degrees
Navigation Sensor		0.10 meters	0.10 meters	0.10 meters

C.6.2.2 Real-Time Uncertainty

Vessel	*Description*
All vessels	The smrmsg file, containing the real time uncertainty, was applied to its relevant database files during the sbet application process within Qimera.

C.7 Shoreline and Feature Data

Shoreline and feature data was not acquired.

C.8 Bottom Sample Data

Data Acquisition Methods and Procedures

Bottom Sample locations were assigned in the CSF. The Shipek Grab was lowered to the sea floor from the A-frame of R/V Endeavor to collect bottom samples for OPR-Y390-KR-21. Below is an image of the Shipek in use during bottom sample collection.

Figure 21: Shipek Grab in use for bottom sample collection

Data Processing Methods and Procedures

All bottom samples were collected in areas designated by NOAA and results can be found in the Final Feature File of each H-cell sheet. Bottoms samples were categorized using qualitative descriptives following specifications in the HSSD 2021.

D. Data Quality Management

D.1 Bathymetric Data Integrity and Quality Management

D.1.1 Directed Editing

Within Qimera, the standard deviation layer is used to detect vertical discrepancies or spurious noise.

D.1.2 Designated Sounding Selection

Within 3D editor of Qimera, soundings and the CUBE surface were visible to analyze if the CUBE surface was incorporating natural or man-made features adequately. The determination on if a sounding should become a designated sounding follows the specifications set fourth in the HSSD 2021.

D.1.3 Holiday Identification

The CUBE surface is exported as a BAG file and loaded into QC Tools within NOAA's HydrOffice. Within QC Tools, the BAG is processed through the "detect holidays" tool. QC Tools produces a shapefile of the detected holidays, which then can be loaded into Qimera for analysis. All retrievable holidays are added to a survey line plan to be collected by the vessels. Any non-retrievable holidays were analyzed and noted in the DR.

D.1.4 Uncertainty Assessment

The CUBE surface is exported as a BAG file and loaded in QC Tools within NOAA's HydrOffice. Within QC Tools, the BAG is processed through the "Grid QA" tool. QC Tools produces a graph of the uncertainty statistics, which then states whether the data is within uncertainty specifications.

D.1.5 Surface Difference Review

D.1.5.1 Crossline to Mainscheme

A beam-to-beam statistical analysis was performed using the Cross Check tool in Qimera. A 1 meter or 4 meter Combined Uncertainty and Bathymetric Estimator (CUBE) weighted dynamic surface of each sheet was created incorporating only the mainscheme lines and excluded crosslines. The Cross Check tool was used to perform the beam-by-beam comparison of the crossline data to the mainscheme surface. Comparisons showed excellent agreement, well above 95% of the allowable TVU. Note: These surfaces were created for QC only and are not submitted as a surface deliverable.

D.1.5.2 Junctions

Depth differences between junctioning surveys were evaluated using the JunctionTrac program, developed in-house by eTrac Inc. For every junction, each CUBE weighted dynamic surface's nodes were exported to an ASCII CSV file where the fields were (Easting, Northing, Depth) for each node. A 1 meter difference surface between the junctioning datasets was also created and exported to an ASCII CSV file where the fields were (Easting, Northing, Diff) for each node. The three ASCII CSV files were then loaded into the JunctionTrac program and junction statistics were computed. A file was also created in this process to locate any nodes from the difference surface that exceed the allowable TVU, which was imported into Qimera and any identified points from JunctionTrac were analyzed. Note: the difference surfaces were created for comparison efforts only and are not submitted as surface deliverables.

D.1.5.3 Platform to Platform

A performance test between the vessels and the systems on each vessel was preformed as an additional quality assurance measure. The confidence check between all vessels can be found in Appendix V.

D.2 Imagery data Integrity and Quality Management

Imagery data integrity and quality management were not conducted for this survey.

E. Approval Sheet

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys Specifications and Deliverables, Field Procedures Manual, Letter Instructions, and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

Approver Name	Approver Title	Date	Signature
David Neff	VP Survey	09/21/2021	David Neff Digitally signed by David Neff DN: C=US, E=david@etracinc.com, O=eTrac Inc., CN=David Neff Date: 2021.09.21 13:27:54-07'00'

List of Appendices:

Mandatory Report	*File*
Vessel Wiring Diagram	Appendix 1 - VesselWiringDiagrams.pdf
Sound Speed Sensor Calibration	Appendix II - Sound Speed Sensor Calibration Reports.pdf
Vessel Offset	Appendix III - VesselOffsetReports.pdf
Position and Attitude Sensor Calibration	Appendix IV - Positioning and Attitude Sensor Calibration Reports.pdf
Echosounder Confidence Check	Appendix V - Echosounder Confidence Reports.pdf
Echosounder Acceptance Trial Results	N/A