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

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey	**Hydrographic**
Project Number	**OPR-J348-KR-17**
Contract Number	**EA-133C-14-CQ-0037**
Task Order Number	**T0004**
Time Frame	**August 2017**

LOCALITY

State	**Mississippi, Alabama and Texas**
General Locality	**Mississippi Sound and Vicinity**

2017

CHIEF OF PARTY

Jonathan L. Dasler, David Evans and Associates, Inc.

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TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

Data Acquisition and Processing Report
Project OPR-J348-KR-17
Locality: Mississippi Sound and Vicinity
August 2017
S/V *Blake* and R/V *John B. Preston*
David Evans and Associates, Inc.
Chief of Party: Jonathan L. Dasler, PE, PLS, CH

INTRODUCTION

This report applies to surveys H13059, H13060, H13061, H13062, H13063, H13064, H13065, H13066, H13067, H13068, F00698 and F00699. Surveys H13059 through H13068 are located within the OPR-J348-KR-17 project area in Mississippi Sound. Surveys F00698 and F00699 were Hurricane Harvey response surveys assigned to David Evans and Associates, Inc. (DEA) after OPR-J348-KR-17 began. Surveys H13059 through H13064 cover parts of the Mississippi Sound north of Ship, Horn, and Petit Bois Islands. Surveys H13065 through H13068 cover areas in the Gulf of Mexico south of Petit Bois and Dauphin Islands. These surveys meet requirements defined in the *Statement of Work* (July 21, 2017), *Hydrographic Survey Project Instructions Mod2* (November 3, 2017), and National Ocean Service (NOS) *Hydrographic Surveys Specifications and Deliverables* (HSSD) (April 2017).

Hurricane Harvey response surveys F00698 and F00699 cover portions of the Houston- Galveston Ship Channel and Sabine Pass. Two revisions to the Project Instructions were required to address the addition of these surveys to the OPR-J348-KR-17 Project with specific instructions relating to these surveys such as a Descriptive Report memo and other deviations from the original instructions to expedite the survey and data turn around. These surveys were conducted as an emergency response to open shipping lanes following Hurricane Harvey. Data acquisition and products were time critical for the safety of maritime commerce. Quality assurance checks in the field were abbreviated to focus on time sensitive deliverables. The response surveys were generally acquired in accordance with the requirements defined in the OPR-J348-KR-17 Project Instructions as well as guidance provided by National Oceanic Atmospheric Administration (NOAA) Hydrographic Survey Division (HSD) Operations (OPS) branch staff during emergency survey operations.

The revisions to the Project Instructions also added a waiver to the Set Line Spacing surveys; allowing the acquisition of bathymetric spits for the development of significant shoals in lieu of the HSSD requirement to develop with complete multibeam coverage. Additional time saved through this waiver was devoted to the development of contours falling at intervals included on NOS charts.

The project's survey purpose for the H surveys, which was defined in the Project Instructions, is "to provide contemporary surveys to update National Ocean Service (NOS) nautical charting products. This hydrographic survey will support the dense vessel traffic transiting the Intracoastal Waterway extending Biloxi to Pascagoula, Mississippi as well as the local fishing vessels and recreational boaters transiting further inshore. The area has been inundated by eight major tropical storms and hurricanes since it was last surveyed, including Hurricane Katrina. This survey will update the regional bathymetry and address over 50 charted discrepancies. In addition, this survey data will support the State of Mississippi and United States Army Corps of Engineers Mobile District as they plan a large barrier island restoration project in the vicinity of Ship Island. Survey data from this project is intended to supersede all prior survey data in the common area."

All references to equipment, software or data acquisition and processing methods were accurate at the time of document preparation. All changes to data acquisition and processing methods will be specifically addressed in the Descriptive Report for each project survey.

A. EQUIPMENT

For this project, David Evans and Associates, Inc. (DEA) implemented state-of-the-art data acquisition systems on board the Survey Vessel (S/V) *Blake* and Research Vessel (R/V) *John B. Preston* in accordance with National Oceanic and Atmospheric Administration (NOAA) standards and modern remote sensing techniques. Operational systems used to acquire survey data and redundant systems that provided confidence checks are described in detail in this section and are listed in Tables 1 and Table 2.

Table 1. R/V *John B. Preston* Hardware

Instrument	Manufacturer	Model	Serial No.	Function
Side Scan Sonar				
Deck Unit	**EdgeTech**	2000 Topside 2000- DL	51574	Topside side scan interface and digital sensors
Towfish	**EdgeTech**	4200-HF	42627	300/600 kHz side scan towfish for seafloor imaging
Multibeam Echosounder				
Deck Unit	**Teledyne RESON**	T50-P FP4 V4.2.019	95771416138	Starboard multibeam sonar processor
Sonar	**Teledyne RESON**	Projector TC2181 Receiver EM7218	TX 5015065 RX 5113012	Starboard multibeam sonar RX (until 1/04/2018)
Sonar	**Teledyne RESON**	Receiver EM7218	RX 4816020	Starboard multibeam sonar RX (installed 1/04/2018)
Deck Unit	**Teledyne RESON**	T50-P FP4 V4.2.019	95772416169	Port multibeam sonar processor (installed 11/1/2017)
Sonar	**Teledyne RESON**	Projector TC2181 Receiver EM7218	TX 5015068 RX 2714147	Port multibeam sonar (installed 11/1/2017)
Sound Speed				
Sound Speed Profiler	**AML Oceanographic**	SmartX	Sensor: 20142 SV: 204912 P: 304506 T: 404148	Primary sound speed profiler (until 11/1/2017)
Sound Speed Profiler	**AML Oceanographic**	SmartX	Sensor: 20142 SV: 204678 P: 304610 T: 404001	Primary sound speed profiler (installed 11/1/2017)
Surface Sound Speed	**AML Oceanographic**	Micro SV Xchange	Housing: 7561 Sensor: 204871	Sound speed at MBES
Sound Speed Profiler	**AML Oceanographic**	SV Plus V2	Sensor: 3591	Secondary sound speed profiler
Navigation				
Deck Unit IMU Port Antenna Starboard Antenna	**Applanix** **Applanix** **AeroAntenna** **AeroAntenna**	POS MV 320 V5, Firmware: 5.03 LN200 AT1675-540 AT1675-540	7343 898 8574 8570	Integrated Differential Global Positioning System (DGPS) and inertial reference system for position, heading, heave, roll, and pitch data
RTK Receiver RTK Antenna	**Trimble** **Trimble**	SPS 851 Zephyr Model II	5005K65406 3121170598	Secondary RTK positioning system
Intuicom	**Intuicom**	RTK Bridge	X151467	RTK corrections via NTRIP
DGPS Receiver DGPS Antenna	**Trimble** **Trimble**	Pro Beacon Pro Beacon	220014495 220094426	Primary DGPS positioning system

Table 2. S/V *Blake* Hardware

Instrument	Manufacturer	Model	Serial No.	Function
Side Scan Sonar				
Deck Unit	**EdgeTech**	701-DL	35323	Topside side scan interface and digital sensors
Towfish	**EdgeTech**	4200-HF	42627	300/600 kHz side scan towfish for seafloor imaging (until 9/04/2017)
Towfish	**EdgeTech**	4200-HF	43188	300/600 kHz side scan towfish for seafloor imaging (installed 9/04/2017)
Side Scan Sonar Cable Counter				
Cable Counter	**Measurement Technology Northwest**	LCI-90	0350	Continuous digital output of deployed side scan tow cable length for layback calculations
Multibeam Echosounder				
Deck Unit	**Teledyne RESON**	T50-R FP4 V4.2.019	3716029	Multibeam sonar processor (until 8/28/2017)
Sonar	**Teledyne RESON**	Projector TC2181 Receiver EM7218	TX 4516115 RX 4816020	Multibeam sonar (until 8/28/2017)
Deck Unit	**Teledyne RESON**	T50-P FP4 V4.2.019	95772016148	Multibeam sonar processor (installed 8/28/2017)
Sonar	**Teledyne RESON**	Projector TC2181 Receiver EM7218	TX 5015057 RX 2714140	Multibeam sonar RX (installed 8/28/2017 until 9/7/2017)
Sonar	**Teledyne RESON**	Receiver EM7218	RX 2714147	Multibeam sonar RX (installed 9/7/2017 until 9/29/2017)
Sonar	**Teledyne RESON**	Receiver EM7218	RX 2714149	Multibeam sonar RX (installed 9/29/2017)
Sound Speed				
MVP30-350 Sound Speed Profiler	**Rolls Royce/AML Oceanographic**	Micro SV&P	Sensor: 8704 SV: 204796 P: 304616 T: 404176	Primary sound speed profiler
Surface Sound Speed	**AML Oceanographic**	Micro SV Xchange	Housing: 10992 Sensor: 204914	Sound speed at MBES
Sound Speed Profiler	**Sea-Bird Electronics, Inc.**	SBE 19+ SeaCAT	4962	Secondary sound speed profiler
Navigation				
Deck Unit IMU Port Antenna Starboard Antenna	**Applanix** **Applanix** **Trimble** **Trimble**	POS MV 320 V5, Firmware: 5.03 LN200 GA830 GA830	7342 750 7337 7235	Integrated Differential Global Positioning System (DGPS) and inertial reference system for position, heading, heave, roll, and pitch data
RTK Receiver RTK Antenna	**Trimble** **Trimble**	SPS 751 Zephyr	4706K04156 60078651	Secondary RTK positioning system
Intuicom	**Intuicom**	RTK Bridge	X151418	RTK corrections via NTRIP
DGPS Receiver DGPS Antenna	**CSI Wireless MBX** **CSI Wireless MBX**	MBX-3S MD MGL-3	0647-32351-0026 0716-3582-0008	Primary DGPS positioning system

A1. Survey Vessels

The S/V *Blake*, owned and operated by DEA (Figure 1), was a survey vessel for the project.
The S/V *Blake* is a 92-ton United States Coast Guard (USCG) Subchapter T inspected vessel, Official Number 1256966, and Hull Number 213. She is an 83-foot aluminum catamaran with a 27-foot beam and a draft of 4.5 feet. The vessel is equipped with wave-piercing bows, Tier-3 diesel engines, twin 55-kilowatt generators, centerline moon pool with a hydraulic multibeam strut, stern mounted A-frame, bow mounted knuckle boom crane, climate-controlled equipment and server closet, two data acquisition stations, and two data processing stations. The S/V *Blake* supports a hydrographic crew of six and is supported by four ship crew for 24-hour survey operations.

Figure 1. S/V *Blake*

For shallow water near the islands in the Gulf Islands National Seashore, a smaller survey launch running day operations was utilized. The R/V *John B. Preston*, owned and operated by DEA (Figure 2) is a 33-foot monohull with a beam of 8.5 feet and is powered by a Yanmar diesel engine with a Hamilton jet drive. The vessel has integrated hydraulics and an articulated A-frame and two side arm davits for multibeam or side scan deployment and is equipped with radar and an autopilot for safe and efficient operations. The R/V *John B. Preston* supports a vessel operator and a hydrographer while running multibeam surveys, with a second hydrographer added when operating side scan sonar with concurrent multibeam.

Figure 2. R/V *John B. Preston*

A2. Side Scan Sonar Systems

Side scan sonar imagery was acquired with an Edgetech 4200-HF (300/600 kHz) dual frequency side scan sonar. The sonar was operated at 600 kHz in high-speed mode using 50-meter and 75-meter range scales.

Side scan sonar imagery was logged as eXtended Triton Format (XTF) (16 bit, 2048 pixels/channel) in Triton Isis SS-Logger. In addition to the imagery, vessel heading, pitch, roll, position, towfish depth and altitude, and computed towfish position from layback calculations were also recorded to the XTF.

The side scan sonar towfish was either deployed from the bow, port side davit, or stern of the vessels. For each configuration, the horizontal offset of the tow point relative to the vessel reference point was entered into Hypack. The tow point position calculated in Hypack was sent to SS-Logger and used as the raw towfish position. During stern tow an LCI-90 cable payout interface was used to measure cable-out. The cable-out, along with the measured tow point height above the waterline and towfish depth, was used by SS-Logger to compute layback. A fixed cable-out method was used for towing from the bow and side arm davit. When using the fixed layback method, the cable-out on the bow or port side davit was set at a fixed distance and the horizontal distance from the tow point to the towfish was measured. This horizontal layback was entered into SS-Logger as a positive value as the towfish was always aft of the tow point. Vessel tow points are denoted on the vessel offset drawings included in Appendix I. This appendix also includes a discussion on layback computation methodology.

To confirm adequate target resolution at the outer limits of the selected range, confidence checks were conducted on a daily basis during acquisition and noted in the acquisition logs. In deteriorating conditions, confidence checks were performed more frequently to confirm detection of features at the outer range limits.

A3. Multibeam System

The S/V *Blake* and R/V *John B. Preston* were equipped with Teledyne/Reson SeaBat T50-P multibeam sonars capable of operating at 190-420 kHz and integrated AML Micro SV Xchange sound velocity sensors. The multibeam sonars were deployed with a center lift-mount through a moon pool on the S/V *Blake* and a custom fabricated mount on the starboard and port side of the R/V *John B. Preston*, although originally deployed with a single head on the starboard side. For all surveys, the sonar was operated with FP4 V4.2.019 in Continuous Wave (CW), Equi-Angle Beam mode at 350 kHz using a 140-degree swath width. Mainscheme acquisition typically used 256 beams per sonar while investigations were acquired with 512 beams. In some instances, 512 beams were acquired during mainscheme when node density was of concern.

All multibeam data were acquired with the Reson T50-P normal standard bracket selected in the hardware configuration. Range adjustments were made during acquisition as dictated by changes in water depth. HYPACK HYSWEEP was used to acquire multibeam data in HYSWEEP HSX file format and snippets in 7K file format.

On November 1, 2017 (DN305), the R/V *John B. Preston* was equipped with a second T50-P multibeam sonar on the port side of the vessel to allow dual head operation with an expanded swath width for shallow water mapping. The two systems were installed with a 15° outboard tilt using a custom designed mount. This configuration increased the survey efficiency of shallow water investigations and developments. The sonars were operated concurrently in Full Rate Dual Head (FRDH) mode which enabled the multibeam sonars to ping simultaneously using Frequency Modulated (FM) transmissions. The port sonar was configured as a slave to the starboard (master) sonar, meaning that the master system controls power, gain, ping rate, range scale, absorption, spreading and surface sound speed. HYPACK HYSWEEP was used to trigger the Teledyne/Reson systems to begin logging a Teledyne S7K file per sonar. The single S7K file per system contains all navigation, attitude, bathymetric and backscatter records needed for processing.

A4. Position, Heading and Motion Reference Systems

The S/V *Blake* and R/V *John B. Preston* were outfitted with a POS/MV 320 version 5 with GNSS and inertial reference system, which was used to measure attitude, heading, heave, and position. The system was comprised of an Inertial Motion Unit (IMU), dual frequency (L1/L2) GNSS antennas, and a data processor.

On each vessel, a DGPS receiver acquired corrections from a nearby USCG beacon and provided these corrections to the POS/MV for all horizontal positioning. In addition, each vessel was equipped with a real-time kinematic (RTK) receiver for vertical positioning and for a redundant system in case of DGPS outages. RTK correctors were received from state network systems via cellular modem and Networked Transport of RTCM via Internet Protocol (NTRIP). RTK heights were reduced to Mean Lower Low Water in Hypack by using VDatum. The addition of the redundant RTK GNSS system gave the hydrographer the ability to compare the positions of the two systems during acquisition and allowed for real-time monitoring of the limits of hydrography when based on depth requirements. Sheet specific state networks and configurations will be further

discussed in the survey's accompanying Descriptive Report and project wide Horizontal and Vertical Control Report.
Positions from all systems were displayed in real-time using Hypack and continuously compared during survey operations. A weekly position comparison between the primary and secondary positioning system was observed and documented while the vessel was either secured in port or within the extents of the survey area. Logged position data were extracted from the Hypack RAW file and entered into an Excel file for comparison. Position check reports can be found in Separate I *Acquisition and Processing Logs* of each survey's Descriptive Report.

Position, timing, heading, and motion data were output to the Hypack acquisition system using the POS/MV real-time Ethernet option at 50 Hz.

The POS/MV provided time synchronization of sonar instruments and data acquisition computers using a combination of outputs. The Reson processors and Hypack acquisition computers were provided a Pulse Per Second (PPS) and National Marine Electronics Association (NMEA) Global Positioning System Timing Message (ZDA) to achieve synchronization with the POS/MV. The Isis SS-Logger acquisition computer synchronized its time using the proprietary Trimble Universal Time Coordinated (UTC) message provided by the POS/MV. All messages contained time strings that enabled the acquisition computers and sonars to synchronize to the time contained within the message. Time offsets between the instruments and computers, relative to the times contained in POS/MV network packets, were typically sub-millisecond.

The POS/MV was configured to log all the raw observable groups needed to post-process the real-time sensor data. The POS/MV logged 64-megabyte .000 files, which resulted in multiple files created per day. The TrueHeave™ data group was also logged to these files.

A5. Sound Speed Measurement Systems

Sound speed sensors were calibrated prior to the start of acquisition. Factory calibration results are included in Appendix IV *Sound Speed Sensor Report* of this report.

AML Micro Xchange SV sensors mounted on the Reson T50 sonar heads were input into the Reson processors and sound speed from the sensors were used in real-time during acquisition for beam forming on the T50s' flat arrays. The primary sound speed sensors for the S/V *Blake* was a Rolls Royce MVP 30-350 and for the R/V *John B. Preston* an AML Oceanographic SmartX system was used. Both were equipped with AML Oceanographic Micro SV&P sensors.

A Seabird SBE 19+ SeaCAT and an AML Oceanographic SV Plus V2 were used as the secondary sound speed sensors. All sound speed calculations from the Sea-Bird Conductivity, Temperature, and Depth (CTD) profiler used the Chen-Millero equation. These profiles were used solely for confidence checks with the primary sensor.

A6. Acquisition and Processing System

The acquisition stations were custom-installed and integrated on the S/V *Blake* and R/V *John B. Preston* by DEA and consisted of a HYPACK HYSWEEP multibeam acquisition and navigation computer, a Triton Isis SS-Logger side scan sonar data acquisition computer, and a computer for digital logs and general administration. The S/V *Blake* had an additional MVP computer and two processing computers.

Data collected from the S/V *Blake* were logged locally on each acquisition computer and continuously backed up to a QNAP network attached storage (NAS) device. A secondary QNAP NAS was used to perform backups of the primary QNAP. At each vessel port call, acquisition and processing data from the primary QNAP were transferred to the Gulfport, MS and Vancouver, WA offices via two external USB 3.0 hard drives.

Data collected from the R/V *John B. Preston* were logged locally on each acquisition computer and backed up nightly to a QNAP in the Gulfport, Mississippi office. An external USB 3.0 hard drive was shipped to the Vancouver, WA office every two to three days of acquisition.

The software and version numbers used throughout the survey are listed in Table 3.

Table 3. Acquisition and Processing Software

Name	Manufacturer	Version
Acquisition		
Hypack	Hypack, Inc.	17.0.34.0
Hypack Survey	Hypack, Inc.	17.0.26.1
Hysweep	Hypack, Inc.	17.0.26.1
SeaBat	Reson	V5.0.0.2 (S/V *Blake)* V4.2.0.19 (R/V *Preston*)
Isis SS-Logger	Triton Imaging, Inc.	7.3.623.51
Discover 4200-MP	Edgetech	33.0.1.109
LineLog	David Evans and Associates, Inc. Marine Services Division	2.0.7 (S/V *Blake)* 2.0.3 (R/V *Preston*)
MV-POSView	Applanix Corporation	8.32
ODIM MVP Controller	ODIM Brooke Ocean	V2.450
SeaTerm	Sea-Bird Electronics, Inc.	1.59
SBE Processing	Sea-Bird Electronics, Inc.	7.23.1
Intuicom Bridge Pro	Intuicom	V2.3 (S/V *Blake)* V2.2 (R/V *Preston*)
Processing		
HIPS	CARIS 64-bit	10.3.1
Base Editor	CARIS 64-bit	4.4.13.1
ArcGIS	ESRI	10.2.2.3552
Triton SS-Logger (ISIS)	Triton Imaging, Inc.	7.3.623.51
SonarWiz	Chesapeake Technology, Inc. 64-bit	V6.04.0006 64-bit
POSPac MMS	Applanix	8.0.6169.27588
Photoshop CS3	Adobe	10.0
ODIM MVP Controller	ODIM Brooke Ocean	V2.450
TCARI	NOAA Office of Coast Survey	16.8

Name	Manufacturer	Version
Other		
Microsoft Office Suite	Microsoft	2016
Beyond Compare	Beyond Compare	4.1.1
Oxygen XML Editor	Syncro Soft	17.0
XML DR	NOAA Office of Coast Survey	18.1

A7. Survey Methodology

A7.a Mobilization

Mobilization of the S/V *Blake* occurred from August 16-18, 2017. System calibrations and a start of the project patch test were performed in Mississippi Sound on August 16, 2017 (DN228). An end of survey comparison patch test was performed on October 27, 2017 (DN300) overlaying DN228 data to evaluate quality assurance through time of survey. A squat confirmation test was performed in Mississippi Sound on August 18 (DN230). Results from the squat test were consistent with results from the prior test which was performed on November 14, 2014, in support of NOAA project OPR-J311-KR-14. The prior values were held and used for this project. Vessel offsets and associated measurement uncertainties for the S/V *Blake* were calculated from a vessel offset survey performed at Geo Shipyard in New Iberia, LA on September 23-24, 2014. All survey points were positioned using a terrestrial land survey total station, from a minimum of two locations, which allowed a position uncertainty to be determined. Vessel offsets and uncertainties were used in the HIPS Vessel File (HVF). Changes to the hardware offsets since the initial vessel offset survey were necessary to account for new equipment installation.

Mobilization of the R/V *John B. Preston* occurred on September 13, 2017 (DN256) and again on November 1, 2017 (DN305) for installation of the dual-head configuration. System calibrations and a start of the project patch test were performed in Mississippi Sound on September 13, 2017 (DN256). End of survey comparisons were performed on January 22, 2018 (DN022) overlapping initial data for quality assurance. A squat confirmation test was performed in Mississippi Sound on January 22, 2018 (DN022). Values from DN022 were used for the duration of the project. Vessel offsets and associated measurement uncertainties for the R/V *John B. Preston* were calculated from a vessel offset survey performed at DEA's Vancouver, WA warehouse on August 3, 2016. Similar to the S/V Blake survey, all survey points were positioned using a total station, from a minimum of two locations, allowing the determination of a position uncertainty. Vessel offsets and uncertainties were used in the HVF.

A7.b Survey Coverage

Survey coverage requirements varied by survey area. Hurricane Harvey response surveys F00698 and F00699 required Object Detection Coverage. F00698 achieved this by using 200% side scan sonar coverage with concurrent multibeam bathymetry or 100% multibeam bathymetry and F00699 used 100% multibeam bathymetric coverage exclusively. Survey H13059 required Complete Coverage using 100% side scan sonar coverage with concurrent multibeam bathymetry in water depths greater than 4 meters. In water depths less than 4 meters the requirement was 50-meter Set Line Spacing Multibeam. Surveys H13060, H13061, H13062, H13063, and H13064 required 200-meter Set Line Spacing Multibeam to the 2-meter contour. Surveys H13060 and H13061 also contained charted anchorage areas with complete coverage requirements. Survey H13065 required Complete Coverage using 100% side scan sonar coverage with concurrent multibeam bathymetry in water depths greater than 4 meters and 200-meter Set Line Spacing in water depths less than 4 meters. The remaining areas (H13066, H13067, and H13068) required Complete Coverage using 100% side scan sonar with concurrent multibeam bathymetry in water depths greater than 4 meters. All survey areas with set line spacing coverage required charted depths that were shallower than adjacent surveyed soundings by two feet or greater to be investigated with 3 independent survey lines for verification or disproval. All multibeam acquisition included time series backscatter.

The disproval radii of all assigned charted features falling seaward of the Navigable Area Limit Line (NALL) were investigated using either 100% multibeam or a second 100% side scan sonar coverage. Multibeam data was acquired during feature and side scan contact developments as required by the HSSD.

The effective range of the side scan sonar was reduced to 12.5 times the towfish height when height was less than 8% of range scale. Additional coverage was acquired to fill any associated holidays created by reducing the range.

The NOAA provided Project Reference File (PRF) OPR-J348-KR-17_PRF_FINAL.000 (sent to DEA on August 4, 2017) and Composite Source File (CSF) OPR-J348-KR-17_CSF_FINAL_08092017.000 (sent to DEA on August 9, 2017) were used during the project.

A7.c Side Scan Sonar Operations

The side scan sonar was operated at 50-meter and 75-meter range scales at survey speeds and ping rates that enabled the sonar to detect 1-meter targets in the along track direction. All data were acquired in the 600 kHz high-speed mode.

The EdgeTech 4200 series sonar has a ping rate of 30 Hz at the 50-meter range and 20 Hz at the 75-meter range while operating in the high-speed mode. High-speed mode makes use of the optional Multi-Pulse (MP) technology, which places two sound pulses in the water at a time rather than the traditional one pulse, and allows for tow speeds upwards of 8 knots. In accordance with the 2017 HSSD, vessel speed was monitored to allow for the acquisition of a minimum of three pings per meter. During acquisition, the side scan was towed from either the bow or stern of the S/V *Blake* and from the port side davit of the R/V *John B. Preston*.

The side scan sonar operator was assigned the task of analyzing the digital sonogram and keeping the towfish height within specification by adjusting cable-out. The operator also called out contacts and daily confidence checks, which were entered into the digital acquisition log. When weather or sea conditions degraded side scan sonar imagery, operations were suspended.

The OPR-J348-KR-17 Project Instructions included a waiver which reduced the minimum towfish height off bottom allowance from 8 percent of the range scale to 6 percent when operating at the 50-meter range scale.

A7.d Multibeam Sonar Operations

The multibeam sonar was operated at different range scales throughout the survey by adjusting the depth range to obtain the best coverage in varying depths of water. Gain and power were adjusted to record a strong bottom return capable of supporting quality depth and backscatter data.

Multibeam investigations occurred over significant features after examining parameters such as coverage, density, feature or contact height, depth, and navigational significance.

Table 4 lists the typical T50-P sonar settings for the survey.

Table 4. Typical Reson T50-P Sonar Settings

T50-P Parameter	Pulse Type: CW or FM
Frequency	350 kHz
Operation Depth	>20m
Range	Variable, depth dependent
Receive Gain	10-40
Transmit Power	205-220 dB
Spreading	30 dB
Absorption	120 dB/km
Ping Rate	20 p/s max
Pulse Width	300-700 µs

A8. Quality Assurance

Acquisition and processing methods followed systematic and standardized workflows established by DEA. These systems include, but are not limited to, staff training and mentoring, a formalized project management program, record and log keeping standards, software version management, and a multilevel review process.

Multibeam survey data were converted and processed in CARIS HIPS version 10.3.1. Data processing methodologies followed standard CARIS HIPS workflows for multibeam data.

The default *CUBE Parameters.XML* was replaced with *CUBEParams_NOAA_2017.xml* which was issued by the Hydrographic Surveys Division (HSD) prior to the start of the project with version 5.6 of the CARIS support files. This updated XML file uses the resolution dependent maximum propagation distance values required in the NOS HSSD.

Side scan contacts, which were created on items with measured target heights of at least 0.75 meters, were developed with multibeam according to coverage requirements for each survey sheet. In order to streamline the process, contact investigations were typically performed to meet feature development requirements. This technique is shown in Figure 3.

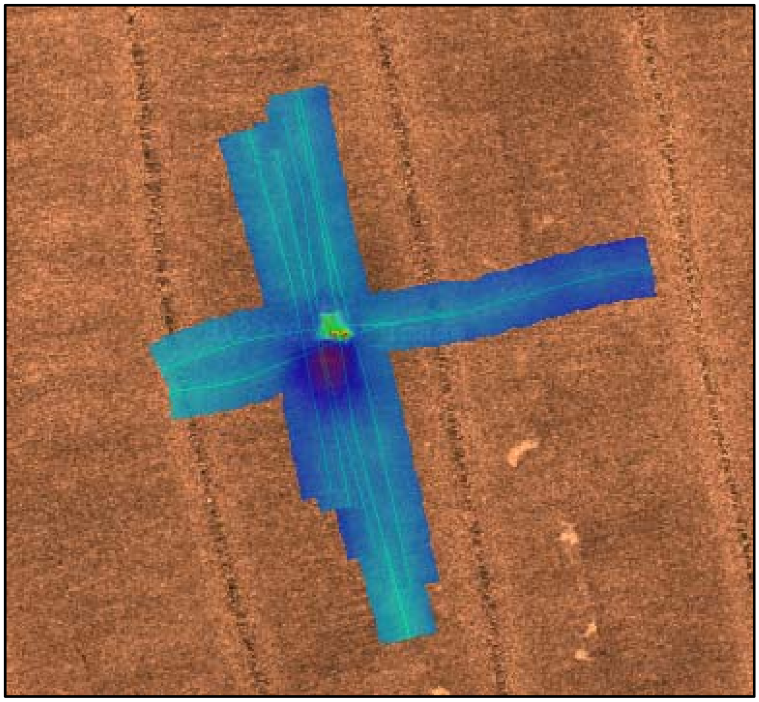

Figure 3. Example of Multibeam Development of Side Scan Contact

B. QUALITY CONTROL

B1. Data Acquisition

B1.a Side Scan Sonar

Triton Isis SS-Logger acquisition software was used to record side scan sonar data in XTF format. Adjustments to towfish height were made during stern tow data acquisition as necessary and logged in Isis SS-Logger to meet specifications and provide the best image quality possible. Changes to cable-out values, sensor settings, offset configurations, data quality, and contacts were recorded in the daily acquisition log. Typical windows for monitoring raw sensor information included a waterfall display for the sonar imagery, tow fish motions, cable-out and layback, sonar signal voltage display, and I/O port monitor. Data were displayed on a 30-inch LCD flat panel monitor mounted vertically at the acquisition station. The large format display allowed for increased time to analyze online contacts. Contacts were selected in real-time and during post-processing.

To aid in the consistency of contact identification, a table was posted at the side scan acquisition station listing slant range and towfish altitude to determine minimum shadow heights for 0.75-meter contacts at range. Contacts were created on bottom features if their estimated height was 0.75 meters or greater. The 0.75-meter height threshold was used to allow for measurement uncertainty around the 1-meter HSSD requirement.

When towing the side scan sonar from the stern of the vessel and using the cable-out method for layback calculation, efforts to maintain towfish altitude at 8% to 20% of the range was tasked to the side scan operator, who also controlled the winch operation. The operator could view the towfish altitude above the seafloor on the Isis SS-Logger display and adjust cable-out accordingly to maintain the towfish at the required height. When towing the side scan sonar in shallow regions of the survey area, the towfish was deployed with a fixed cable-out with the layback value from the tow point entered into SS-Logger.

The digital cable-out value was confirmed by stopping pay out of the tow cable when the 5-meter mark on the cable was at the top of the block sheave. Using this method, the cable-out meter was calibrated during each deployment and continuously during tow operations.

B1.b Multibeam

Multibeam data were acquired in HYPACK HYSWEEP file format (HSX). Adjustments to the sonar, including changes in range, power, and gain, were made as necessary in order to acquire the best bathymetric data quality. Additionally, vessel speed was adjusted in accordance with the HSSD to meet the required along track coverage. Typical windows for monitoring raw sensor information included timing synchronization, vessel motion, number of satellites, HDOP, and PDOP. Raw attitude and nadir depth were also recorded in HYPACK RAW format, as a supplementary backup. Multibeam snippets were logged in Hypack 7K format.

The HYPACK acquisition station operator monitored and tuned the multibeam sonar, tracked vessel navigation, and maintained the digital line log. Operators monitored primary and secondary navigation systems to verify quality position data were acquired.

The R/V *John B. Preston* was equipped with FRDH multibeam systems on November 1, 2017. Due to limitations with acquisition and processing software, all FRDH data were collected in Teledyne/Reson’s S7K format. The S7K files contain all data necessary for processing of bathymetric and backscatter products.

B2. Methodology Used to Maintain Data Integrity

The acquisition systems and survey protocols were designed with some redundancy to demonstrate that the required accuracy was being achieved during the survey and provide a backup to the primary systems. Data integrity was monitored throughout the survey through system comparisons. Two positioning systems were used to provide real-time monitoring of position data. Position confidence checks, multibeam bar checks, and sound speed comparison checks were conducted regularly to confirm required accuracy was being maintained. Regular comparison checks were performed by comparing profiles from the primary and secondary sound speed sensors that were acquired concurrently. Sound speed profiles were computed for each of the sensors and compared to confirm instrumentation was functioning within required tolerances.

A flow diagram of the data acquisition and processing pipeline is presented in Figure 3. This diagram graphically illustrates the data pipeline and processing workflow from acquisition to delivery.

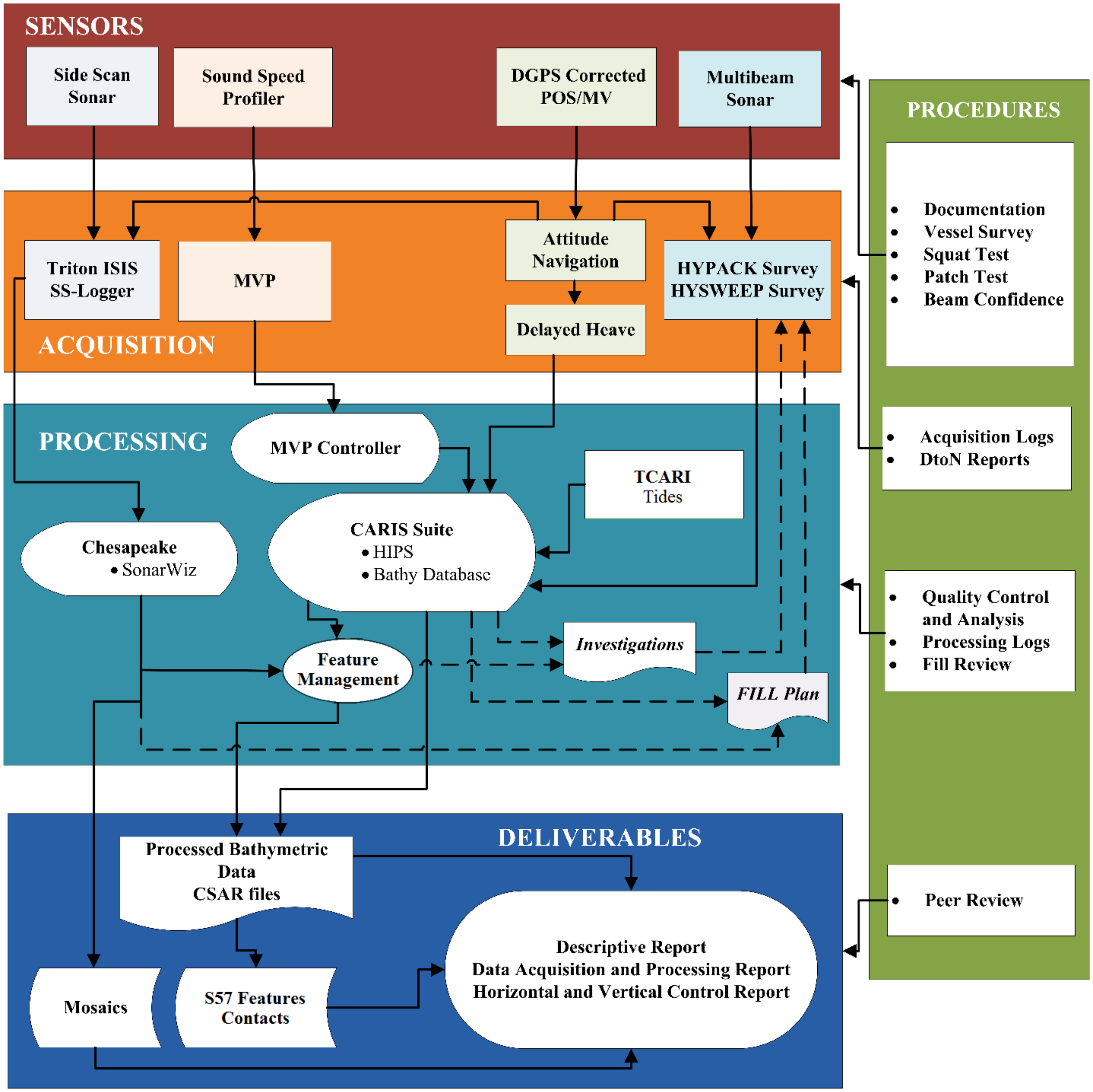

Figure 4. Flowchart of Data Acquisition and Processing Pipeline

B2.a HIPS Conversion

Multibeam data were converted from RAW and HSX format to CARIS HDCS format using the Hypack RAW, HSX conversion wizard. When converting HSX multibeam data, the device numbers fields were left blank since there were no duplicate sensors logged in the HSX files.

Teledyne S7K formatted multibeam data were converted to CARIS HDCS format using the Teledyne S7K conversion wizard. The following records were specified: Position (1003), Heading (1013), R/P/H (1012), and Raw Detection (7027).

HIPS ground coordinates (UTM NAD 83 Zone 16N) were selected in the Conversion Wizard dialogue for both formats. No data were rejected based on quality flags during conversion. The CARIS output window was reviewed for failures during conversion.

B2.b Vessel Files

The HIPS vessel file listed in Table 5 contains all offsets and system biases for the survey vessels and thier systems, as well as error estimates for latency, sensor offset measurements, attitude and navigation measurements, and draft measurements. The *Blake* vessel file was designated with BL and the *Preston* vessel files with PR.

Table 5. HIPS Vessel Files

HIPS Vessel File	HIPS Converter
OPR-J348-KR-17_MBES_BL	Hypack 10.3.1
OPR-J348-KR-17_MBES_PR	Hypack 10.3.1
OPR-J348-KR-17_S7K_MBES_PR_MASTER	Teledyne S7K 10.3.1
OPR-J348-KR-17_S7K_MBES_PR_SLAVE	Teledyne S7K 10.3.1

Sensor offsets for the S/V *Blake* and R/V *John B. Preston* were calculated from the vessel survey and dynamic draft values were calculated through the use of post-processed GNSS observations. The S/V *Blake* draft (waterline) was measured and entered daily from draft sight tubes located in the port and starboard sponsons, abeam of the multibeam sonar and vessel reference point. Daily measure down values were taken from a known point on the R/V *John B. Preston* that allowed for draft calculations. Draft changes, relative to the vessel reference point, were entered into the multibeam vessel configuration file. These corrections are listed in tabular and graphical format in Appendix I *Vessel Reports*.

Separate vessel files were required for the conversion and processing of the dual head T50P configuration on the R/V *John B. Preston*. The HVFs were named to easily differentiate the master and slave sonars. The vessel files were configured with sensor offsets for SVP1 and SVP2 in order to manage sonar specific bistatic offsets following guidance set in the *CARIS HIPS TechNote on SV Corrections for Reson 7k Data*.

Best estimates for Total Propagated Uncertainty (TPU) values were entered into the vessel files based on current knowledge of the TPU/CUBE processing model. The manufacturers' published values were entered in the static sensor accuracy fields. Other values were either calculated or estimated.

Navigation and transducer separation distances from the motion sensor were computed relative to the phase center, vice the top hat, of the motion sensor; therefore, the vessel file standard deviation offsets will not exactly match the sensor offset values. TPU values for each individual HVF are listed in Table 6.

Table 6. Hydrographic Vessel File TPU Values

Input Values for Total Propagation Uncertainty Computation HIPS Vessel File (HVF)*				
	OPR-J348-KR-17_ MBES_BL	**OPR-J348-KR-17_ MBES_PR**	**OPR-J348-KR-17_ S7K_MBES_PR_ MASTER**	**OPR-J348-KR-17_ S7K_MBES_PR_ SLAVE**
Motion Sensor	Applanix POS M/V Model 320 V5			
Position System 1				
Position System 2	SPS751	SPS851		
Offsets				
MRU to Trans X (m)	-0.827	1.399	1.452	-1.403
MRU to Trans2 X (m)	n/a	n/a	0.000	0.000
MRU to Trans Y (m)	0.052	-0.355	-0.355	-0.443
MRU to Trans2 Y (m)	n/a	n/a	0.000	0.000
MRU to Trans Z (m)	2.818	0.098	0.080	0.105
MRU to Trans2 (m)	n/a	n/a	0.000	0.000
Nav to Trans X (m)	-1.380	0.431	0.484	-2.371
Nav to Trans2 X (m)	n/a	n/a	0.000	0.000
Nav to Trans Y (m)	-4.646	-0.828	-0.828	-0.916
Nav to Trans2 Y (m)	n/a	n/a	0.000	0.000
Nav to Trans Z (m)	9.320	2.860	2.842	2.867
Nav to Trans2 Z (m)	n/a	n/a	0.000	0.000
Trans Roll (°)	0.000	0.000	-15.000	15.000
Trans2 Roll (°)	n/a	n/a	0.000	0.000
Gyro – Heading				
Gyro (°)	0.020	0.020	0.020	0.020
Heave				
Heave % Amplitude	5.000	5.000	5.000	5.000
Heave (m)	0.050	0.050	0.050	0.050
Roll and Pitch				
Roll (°)	0.020	0.020	0.020	0.020
Pitch (°)	0.020	0.020	0.020	0.020
Navigation				
Position Navigation (m)	1.000	1.000	1.000	1.000
Latency				
Timing Trans (s)	0.005	0.005	0.005	0.005
Nav Timing (s)	0.005	0.005	0.005	0.005
Gyro Timing (s)	0.005	0.005	0.005	0.005
Heave Timing (s)	0.005	0.005	0.005	0.005
Pitch Timing (s)	0.005	0.005	0.005	0.005
Roll Timing (s)	0.005	0.005	0.005	0.005
Measurement				
Offset X (m)	0.030	0.030	0.030	0.030
Offset Y (m)	0.030	0.030	0.030	0.030
Offset Z (m)	0.030	0.030	0.030	0.030
Speed				
Vessel Speed (m/s)	0.030	0.030	0.030	0.030
Draft and Loading				
Loading	0.059	0.011	0.009	0.018
Draft (m)	0.010	0.010	0.010	0.010
Delta Draft (m)	0.016	0.020	0.020	0.020
MRU Alignment errors*				
Gyro	0.091	0.107	0.119	0.116
Roll/Pitch	0.049	0.070	0.056	0.059
* All values given as 1 sigma				

Real-time sonar uncertainty, which was logged to the Hypack HSX and Reson S7K files for each sounding, was read into CARIS HIPS at time of conversion. Real-time navigation, delayed heave, and the associated real-time uncertainties for these data were loaded into HIPS with the Import Auxiliary Data Function. These real-time uncertainty values were applied when TPU was computed.

Tide uncertainties were loaded automatically when using the Create TCARI Waterlevels tool to import tides.

Sound speed TPU values are listed in Table 7.

Table 7. TPU Values for Sound Speed

Total Propagation Uncertainty Computation in CARIS HIPS	
Sound Speed Values	**1-Sigma Uncertainty (m/s)**
Sound Speed Measured	1.00
Surface Sound Speed	0.50

B2.c Static Draft

The S/V *Blake* was built with draft dampening tubes in each hull providing a means to monitor vessel static draft. Static draft readings from the port and starboard side draft sight tubes were recorded and averaged every 12 hours during 24-hour operations when sea conditions permitted. The R/V *John B. Preston* does not have dampening tubes or draft marks, rather the draft is calculated daily using measure down values to the waterline from known points on the port and starboard gunwales.

The average draft value best approximates the true draft value at the vessel reference point during acquisition due to loading changes from fuel consumption during transit to and from the survey area, at the start and end of each day, or from ballast changes due to water consumption. Ultimately, the daily and 12-hour draft values were used to calculate draft relative the HIPS reference point which was entered into the “Waterline Height” field in the CARIS HVF files.

B2.d Sound Speed

Sound speed profiles were applied to each line using the nearest in distance within time (one hour) option in the CARIS Sound Velocity Profiler (SVP) correct routine. During acquisition, profiles were taken at frequent intervals using the MVP30-350 on the S/V *Blake* and manually on the R/V *John B. Preston*. Final sound speed correctors were computed from the up cast portion of each profile.

B3. Bathymetric Data Processing

Multibeam data processing followed the standard HIPS workflow for CUBE editing by primarily using the hypothesis count layer to direct necessary edits to the multibeam data.

Below is the list of correctors and filters applied to the bathymetric data in HIPS. Several of the steps are interim processes (such as the water levels) and were re-applied as needed. The TPU was re-computed for the multibeam data as needed to reflect changes in the correctors.

- Convert data from Hypack HSX \ Teledyne S7K
- Import Auxiliary data (navigation, delayed heave, navigation uncertainty and delayed heave uncertainty)
- Load TCARI tide
- Review attitude
- Review navigation
- Apply daily concatenated sound speed profiles
  - "Nearest in distance within time 1 hour"
- Merge
  - "Apply delayed heave"
- Compute TPU via values listed in Tables 6 and 7
- Filter soundings with poor quality flags (0 and 1) and IHO Order 2 or greater
- Data reviewed and fliers removed in Swath Editor and/or Subset Editor
- Create CUBE surface:
  - "CUBE" weighted surface of appropriate resolution for water depth
    - International Hydrographic Organization (IHO) S-44 Order 1a
    - Density & Local Disambiguation method
    - Advanced configuration using the 2017 NOAA field unit parameters of the appropriate resolution surface
- Review CUBE surface and child layers

One surface was created to correspond to each survey. CUBE surfaces were created over the entire survey area using grid-resolution thresholds and resolution dependent maximum propagation distances for as specified in the NOS HSSD. Surfaces were reviewed for artifacts indicative of systematic errors, data fliers impacting the surface, and for consistency with the grid requirements set in the HSSD.

Node density was evaluated to verify that at least 95% of soundings were populated with at least five soundings. Multibeam investigation coverage was specifically reviewed to confirm that side scan contact and feature development criteria were met.

All the multibeam data collected were reviewed in HIPS 3D Subset Editor with the in-house defined shoal biased reference surface active.

Soundings rejected by quality filters were displayed during editing and any feature removed by a filter was manually re-accepted. Fliers making the CUBE surface shoaler than expected by more than the allowable IHO Order 1a vertical error were rejected. Designated soundings were used as necessary to force the finalized depth surface through reliable shoaler soundings. Soundings were designated when the difference between the surface and sounding met the depth based total vertical uncertainty threshold and the sounding was greater than 1 meter proud of the surrounding depths. In addition, data processors reviewed sounding data and CUBE surfaces for excessive motion artifacts or systematic biases. All cross lines were manually reviewed for high internal consistency between the datasets and comparison statistics were also computed using the HIPS QC Report tool.

Contacts exported from the side scan sonar contact database were displayed in the HIPS background as a Drawing Exchange Format (DXF) file and reviewed for multibeam coverage and significance. Designated soundings were created to denote the least depth of each submerged feature included in a survey's Final Feature File.

A large portion of the data processing, QC, and review was performed on the S/V *Blake* during survey acquisition. Data acquired by the R/V *John B. Preston* were monitored in real-time and processed and reviewed in the office shortly after acquisition. Dangers to Navigation were reported directly to the DEA project manager via a cellular modem connection to expedite submission to the processing branch. The typical data workflow for processing onboard the S/V *Blake* is shown in Figures 5.

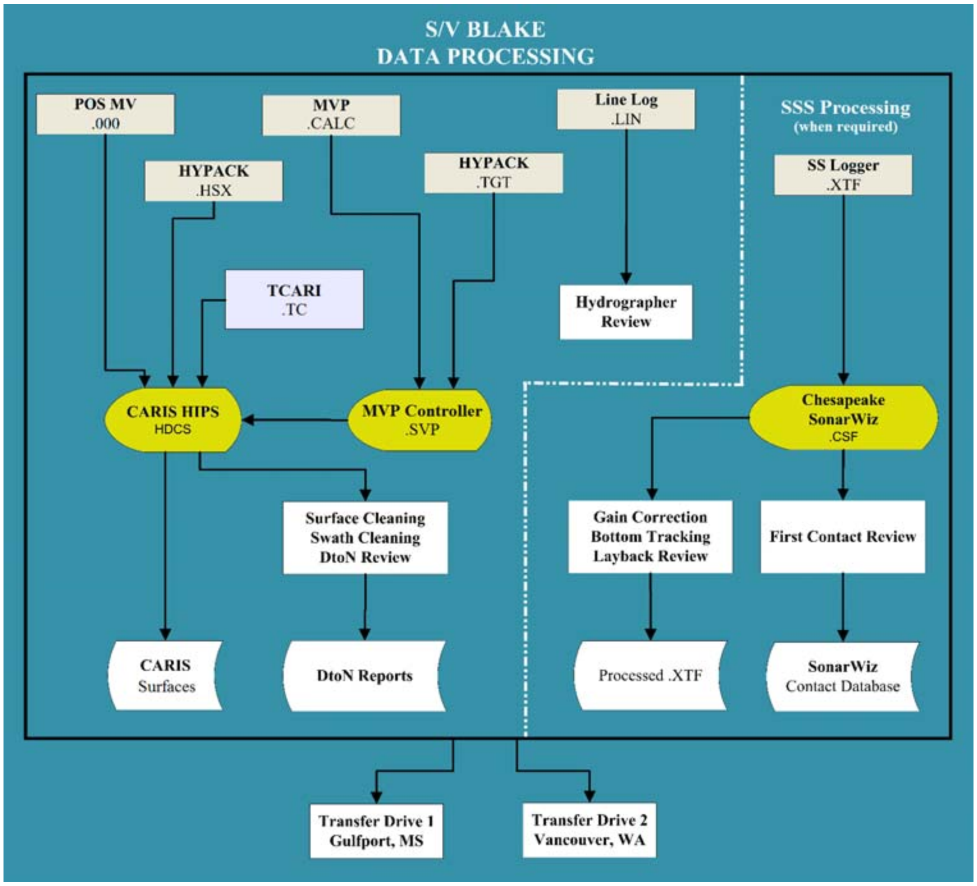

Figure 5. Flowchart of S/V *Blake* Data Processing Pipeline

B4. GNSS Post-processing

Applanix POSPac MMS software was used to create a post-processed navigation solution for all patch test lines. The post-processed solution included new position, height, heading, and attitude measurements in Smoothed Best Estimate of Trajectory (SBET) format. The SBET file was applied to the patch test data using the HIPS Import Auxiliary Data tool during patch test processing and analysis.

B5. Final Bathymetric Processing

Upon the completion of editing multibeam data in HIPS, finalized CUBE grids were generated using the "greater of the two" option for the final uncertainty value. Selected soundings and contours were generated from the surfaces and used for chart comparison purposes, but are not included with the deliverables.

Designated soundings were used as a starting point for S-57 feature creation. Designated soundings that were determined to be obstructions, rocks, wrecks, or other significant features were imported into the S-57 feature files and attributed. S-57 objects were created for all new and incorrectly charted baring features.

All features were created using the NOAA Profile object catalogue version 5.6 which references the NOAA Extended Attributes defined in the NOS HSSD. All mandatory feature attributes have been populated. In addition, the images attribute has been used to provide multibeam and side scan screen shots of features.

B6. Side Scan Processing

After acquisition the XTF files were imported into Chesapeake Technologies Inc. (CTI) SonarWiz and gain corrected. The side scan bottom track was then reviewed and losses of bottom or incorrect bottom track areas were re-digitized. Altitude, tow point offset, and cable-out were applied. The processed lines then underwent two independent reviews to identify significant contacts. In most cases, side scan contacts were determined to be significant if the measured height was within 25 centimeters of the 1-meter height requirement to allow for contact measurement error. Contacts were also created on objects with minimal shadow heights in areas deemed to be critical to navigation or if they appeared to be mounds or other geologic structures which cast little or no shadow.

Sonar contacts were processed using CTI SonarWiz software. Management of side scan sonar contacts was accomplished by utilizing CARIS feature creation tools and Hydrographic Object Binary (HOB) files, meeting the requirements of the HSSD. The use of the HOB format allowed direct geographic display of contacts within CARIS HIPS, where contacts were correlated and compared to the chart and other survey data.

Side scan mosaics were created using CTI SonarWiz. Georeferenced mosaics were generated in Tagged Image File Format (TIF) with an associated world file (TFW) at 1-meter resolution.

C. CORRECTIONS TO ECHO SOUNDINGS

C1. Static Draft

A detailed description of the static draft corrections can be found in section B2.c of this report. The daily and 12-hour draft values were used to calculate draft relative to the HIPS reference point which was entered into the "Waterline Height" field in the CARIS HVF files.

C2. Dynamic Draft

A settlement and squat test for the S/V *Blake* using post-processed GNSS height observations was performed near Gulfport, MS on November 14, 2014. Values from this test were confirmed with a squat confirmation test prior to the start of this survey. Dynamic draft values from the 2014 squat test were used in the survey's HVF and are included in Appendix I *Vessel Reports*.

A settlement and squat test for the R/V *John B. Preston* was run prior to survey operations near Gulfport, MS on September 13, 2017. This test was inconclusive and another test was run on January 22, 2018. This test was processed similar to the S/V *Blake* confirmation test. Values obtained were applied to all associated HVFs for the duration of the survey. Detailed information is included in Appendix I *Vessel Reports.*

The settlement and squat values were obtained by computing an average of GNSS height values at different ship speeds, measured in knots and revolutions per minute (RPM). Transects were run twice at each RPM interval along opposing headings. With the vessel at rest, static GNSS height observations were recorded between each RPM interval, in order to obtain a baseline GNSS height value not affected by tide changes during the test. These values were linearly interpolated to determine the baseline GNSS height at the time of the dynamic draft measurement. The difference between the GNSS height while the vessel was in motion and the interpolated static GNSS height was used to calculate the dynamic draft for each transect. An average dynamic draft corrector was then calculated from the average of the two values for each RPM interval. The average speed for each RPM interval and the average dynamic draft corrector were entered into the HIPS vessel file. Uncertainty estimates for dynamic draft were calculated by taking the average of the standard deviation for all dynamic draft calculations per transect.

C3. Bar Check Comparisons

Weekly bar checks were performed to confirm that the multibeam sonar was functioning properly and static draft was accurately documented. A Ross Laboratories Inc. Model 5150 lead target ball attached to the end of a wire cable and chain, marked at 3 meters, was used to bar check the multibeam on the S/V *Blake*. The R/V *John B. Preston* is equipped with a flat bar, spanning the width of the vessel, which is marked at 2 meters. The marks were checked periodically with a measuring tape. The bar check device was lowered to depth below the water surface, a point above the natural bottom, where it could be clearly ensonified. The depth of the bar was compared to the depth of the bar reported by the sonars. Observations were recorded in a comparison log. Tabulated bar check comparisons may be found in the Weekly Bar Check logs included in Appendix II *Echosounder Reports*.

C4. Heave, Roll, and Pitch Corrections

An Applanix POS/MV 320 V5 integrated dual frequency GNSS and inertial reference system was used for the motion sensor for this survey. The POS/MV 320 is a 6-degree of freedom motion unit, with a stated accuracy of 0.05 meters or 5% for heave, 0.02 degrees for roll, pitch, and heading. Real-time displays of the vessel motion accuracy were monitored throughout the survey with the MV-POSView controller program. If any of the vessel motion accuracy degraded to greater than 0.05 degrees RMS, survey operations would be suspended until the inertial unit was able to regain the higher degree of accuracy. The manufacturer reported accuracies, as published on the CARIS HIPS TPU website (http://www.caris.com/tpu/), were entered into the HVF and used for TPU computations for multibeam data acquired by both vessels. Schematics of the vessels and sensor set-up are located in Appendix I *Vessel Reports*.

C5. Patch Tests

Multibeam patch tests were conducted to measure alignment offsets between the IMU sensor and the multibeam transducer and to determine time delays between the time-tagged sensor data. Multiple patch tests were performed throughout the project to verify the adequacy of the system biases. Patch tests were performed periodically throughout the project including at the beginning of the project, after any system replacement, and at the end of the project. Each patch test consisted of a series of lines run in a specific pattern, which were then used in pairs to analyze roll, pitch, and heading alignment bias angles.

A precise timing latency test was performed by running a single line over a flat bottom with induced vessel motion. The line was then opened in HIPS Subset Editor (after applying tide and SVP corrections) and a small along-track slice of data was evaluated in the outer swath of the line for motion artifacts. Incremental changes to the roll time offset were made to evaluate the performance of the precise timing setup and to determine if a latency correction was needed.

Roll alignment was determined by evaluating the reciprocal lines run over a flat bottom used for the latency test. Pitch tests consisted of a set of reciprocal lines located on a steep slope or over a submerged feature. The yaw error was determined by running parallel lines over the same area as the pitch tests. All lines were run at approximately 3 knots to 6 knots. Patch tests were run in Mississippi Sound near Gulfport or Pascagoula, MS. Selected pairs of lines were then analyzed in HIPS Subset Editor to measure the angular sensor bias values. Visual inspection of the data confirmed each adjustment.

All patch test data were processed using post processed Applanix POSPac MMS SBET positions.

Sonar offsets and alignment angles computed during patch tests were entered into the HVF. Sonar roll and pitch values were entered in HVF SVP1 field rather than the Swath1 field in order for the HIPS Sound Velocity correction to work correctly. Uncertainty estimates for the MRU alignment for gyro, pitch, and roll were calculated by taking the average of the standard deviation on multiple iterations of patch test lines.

Daily roll test lines were acquired on the S/V *Blake* to monitor the stability of the multibeam sonar's pole mount. Roll values from these tests were included alongside the values from standard patch test in order to account for minor variations in roll. The R/V *John B. Preston* conducted daily roll test lines before installing the dual-head system. These roll values were not included in the HVF due to the extremely small change witnessed but were processed and documented. With the installation of the dual-head system, daily roll lines were occasionally collected for field verification but otherwise not documented. Roll for the dual head configuration was examined during processing by evaluating the overlapping beams between the two systems.

On January 4, 2018 the R/V *John B. Preston* swapped out the master sonar receiver with a spare unit. A patch test was performed on DN004 to calibrate the updated receiver. Due to environmental variables in the patch location, reliable values could not be calculated at the time of initiation. The spare unit remained in operation for the duration of the project. Values obtained from the closing patch performed on January 22, 2018 were retroactively applied to DN004 for the new transducer misalignments. These values were held for the remainder of the project.

C6. Tide and Water Level Corrections

The primary water level stations used for the surveys were Dauphin Island, Alabama (8735180) Pascagoula NOAA Lab, Mississippi (8741533) and Bay Waveland Yacht Club, Mississippi (8747437). These stations were listed on the NOAA Hydrographic Hotlist for the duration of the project, meaning National Ocean Service's Center for Operational Oceanographic Products and Services (CO-OPS) performed a rapid review and publication of the data in support of the project.

NOAA HSD provided the TCARI (Tidal Constituent and Residual Interpolation (TCARI) file J348KR2017Rev.tc which was used to apply verified tides to the bathymetric data. The primary water level stations experienced no down time during periods of hydrographic survey up to the delivery of this report.

The field unit originally planned for OPR-J348-KR-17 to be an ERS project with soundings reduced to MLLW through real-time kinematic (RTK) GNSS. The survey vessels were configured with secondary RTK GNSS receivers and acquired GNSS water levels reduced to MLLW through VDatum during survey operations. Mid-project, a vessel float was performed at the NOAA NWLON Station at Pascagoula NOAA Lab MS (8741533) for quality assurance purposes and an offset of concern was discovered between VDatum and the NWLON Station. After conferring with NOAA Operations Branch, the hydrographer switched over to TCARI water levels and used the TCARI grids provided with the project support files. Except for the Harvey Response Surveys, all surveys used TCARI water levels for sounding reduction.

C7. Sound Velocity Correction

During data acquisition, sound velocity profiles were acquired by manual or automatic deployment to obtain an adequate number of sound velocity profiles to properly correct the multibeam data during data processing. Casts were taken at approximately 15 to 30-minute intervals. The location of casts along the survey track lines were varied to ensure adequate spatial coverage. If significant cast-to-cast variability was observed, the time between casts was decreased.

Checks were completed to verify pressure sensor and sound speed instrument performance. Corrections for the speed of sound through the water column were computed for each sensor. Sound speed profiles were imported and overlaid for comparison into an Excel file. All comparisons were well within survey specification. Sound speed check results are included in Separate II *Sound Speed Data Summary* of the Descriptive Reports.

The sound speed correction was applied to each line using the nearest in distance within time (one hour) option in the HIPS SVP correct routine. All casts were concatenated into a HIPS SVP file for each survey day. Time, position, depth, and sound speed for each profile were included in the HIPS file.

D. APPROVAL SHEET

The letter of approval for this report follows on the next page.

DAVID EVANS AND ASSOCIATES INC.

LETTER OF APPROVAL

OPR-J348-KR-17
DATA ACQUISITION AND PROCESSING REPORT

This report and the accompanying data are respectfully submitted.

Field operations contributing to the accomplishment of OPR-J348-KR-17 were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and associated data have been closely reviewed and are considered complete and adequate as per the OPR-J348-KR-17 *Statement of Work* (July 21, 2017) and *Hydrographic Survey Project Instructions* (September 13, 2017).

Digitally signed by Jon L. Dasler
DN: cn=Jon L. Dasler, o=David Evans and Associates, Inc., ou, email=jld@deainc.com, c=US
Date: 2018.03.06 13:40:31 -08'00'

Jonathan L. Dasler, PE, PLS, CH
NSPS/THSOA Certified Hydrographer
Chief of Party

Digitally signed by Jason Creech
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Jason Creech, CH
NSPS/THSOA Certified Hydrographer
Charting Manager/Project Manager

Digitally signed by Callan McGriff
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Callan McGriff, EIT
IHO Cat-A Hydrographer
Lead Hydrographer

Digitally signed by Dave Moehl
DN: cn=Dave Moehl, o=David Evans and Associates, Inc., ou=Marine Services Division, email=dtm@deainc.com, c=US
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David T. Moehl, PLS, CH
NSPS/THSOA Certified Hydrographer
Lead Hydrographer

David Evans and Associates, Inc.
August 2017

E. TABLE OF ACRONYMS

AML	Applied Microsystems, Ltd
CTD	Conductivity, Temperature, Depth
CTI	Chesapeake Technologies, Inc.
CUBE	Combined Uncertainty and Bathymetry Estimator
CW	Continuous Wave
DEA	David Evans and Associates, Inc.
DGPS	Differential Global Positioning System
DXF	Drawing Exchange Format
FM	Frequency Modulated
FRDH	Full Rate Dual Head
GNSS	Global Navigation Satellite System
HIPS	Hydrographic Information Processing System
HOB	Hydrographic Object Binary
HSD	Hydrographic Surveys Division
HSSD	Hydrographic Survey Specifications and Deliverables
HSX	Hypack Hysweep File Format
HVF	HIPS Vessel File
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
MBES	Multibeam Echo Sounder
MP	Multi Pulse
MVP	Moving Vessel Profiler
NAS	Network Attached Storage
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NTRIP	Networked Transport of RTCM via Internet Protocol
POS/MV	Position and Orientation System for Marine Vessels
PPS	Pulse per Second
PRF	Project Reference File
RMS	Root Mean Square
RPM	Revolutions per Minute
RTK	Real-time Kinematic
R/V	Research Vessel
S7K	Teledyne/Reson File Format
SBET	Smoothed Best Estimate of Trajectory
S/V	Survey Vessel
SVP	Sound Velocity Profiler
SV&P	Sound Velocity & Pressure
TCARI	Tidal Constituents and Residual Interpolation
TIF	Tagged Image File Format
TPU	Total Propagated Uncertainty
TWF	World File
USCG	United States Coast Guard
UTC	Universal Time Coordinated
XTF	Extended Triton Format
ZDA	Global Positioning System Timing Message
ZDF	Zone Definition File