W00457

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	W00457

LOCALITY

State(s):	Mississippi
General Locality:	Mississippi Sound
Sub-locality:	Port of Gulfport

2017

CHIEF OF PARTY
Alberto Neves, Hydrographic Science Program Coordinator and Instructor

LIBRARY & ARCHIVES

Date:

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00457

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

State(s):	**Mississippi**
General Locality:	**Mississippi Sound**
Sub-Locality:	**Port of Gulfport**
Scale:	**20000**
Dates of Survey:	**06/08/2017 to 06/28/2017**
Instructions Dated:	**10/25/2021**
Project Number:	**ESD-PHB-18**
Field Unit:	**University of Southern Mississippi**
Chief of Party:	**Alberto Neves, Hydrographic Science Program Coordinator and Instructor**
Soundings by:	**Teledyne RESON SeaBat 7125 SV2 (MBES)**
Imagery by:	**N/A**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 16N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

DESCRIPTIVE REPORT MEMO

October 25, 2021

MEMORANDUM FOR: Pacific Hydrographic Branch

FROM: Report prepared by PHB on behalf of field unit
Alberto Neves
Hydrographic Science Program Coordinator, University of Southern Mississippi

SUBJECT: Submission of Survey W00457

This survey was conducted in the City of Gulfport Municipal Marina, commonly known as the Bert Jones Yacht Basin, as well as in the Gulfport Sound Channel and the Port of Gulfport Commercial Small Craft Channel. The survey was planned and executed in order to meet both IHO Special Order and the National Oceanic and Atmospheric Administration (NOAA) Object Detection Survey standards. Professionalism and strict adherence to the highest levels of safety and survey specifications designated by NOAA and IHO were integral parts of the overall survey design. While the attached report includes discussion of a pole mounted Side Scan Sonar (SSS), this data was not provided to NOAA and no products were generated as a result. The survey also provided positions for the newly constructed Aids to Navigation (ATONs), for the harbor approaches, and bathymetry for these approaches

Processed data (from a portion of the surveyed extents) and a 50cm gridded surfaces were created for this survey and delivered for review

All soundings were reduced to Mean Lower Low Water using VDatum. The horizontal datum for this project is North American Datum of 1983 (NAD 83). The projection used for this project is Universal Transverse Mercator (UTM) Zone 16.

All survey systems and methods utilized during this survey were as described in ESD-PHB-18_DAPR with the exception of the pole mounted Side Scan Sonar data, which was not provided and could not be validated.

All data were reviewed for DTONs and none were identified in this survey.

USMS acquired the data outlined in this report. Additional documentation from the data provider may be attached to this report.

See attached report for details on acquisition, processing, and results. Note that while the attached report includes discussion of a pole mounted Side Scan Sonar (SSS), this data was not provided to NOAA and no products were generated as a result.

This survey does meet charting specifications and is adequate to supersede prior data. This survey resulted in two distinct M_QUAL evaluations. Where processed data was available and able to be reviewed in CARIS, the data quality earned CATZOC A1. Where the surface has no supporting HDCS and where obvious vertical errors were extracted, the survey meets CATZOC B.

17USM01
Descriptive Report

Gulfport Summer Survey

University of Southern Mississippi Class of 2017

Prepared By:

James Fritz

Johnson Oguntuase

Lauren Quas

Gabriel Ridgeway

Austin West

Maxwell Williamson

Short Details

Type of Survey:	Ellipsoid Referenced Hydrographic Survey
Locality:	Gulfport, Mississippi, Northern Gulf Coast Region
Date:	08 June – 28 June 2017
Vessel Used:	University of Southern Mississippi's R/V GCGC
Registry Number:	17USM01
Team Members:	James Fritz Johnson Oguntuase Lauren Quas Gabriel Ridgeway Austin West Maxwell Williamson
Chart No. and Scale:	NOAA Chart 11371, 1:80,000 NOAA Chart 11372, 1:40,000 NOAA Chart 11373, 1:80,000
Product Scale:	Bathymetric Sheet 1:5,000 ENC 1:5,000
Positional Accuracy:	IHO Special Order NOAA Full Coverage
Horizontal Datum:	NAD83 (2011/MA11/PA11) epoch 2010.00 (Bathymetric Sheet) WGS84 (G1762) (ENC)
Sounding Datum:	MLLW (NTDE 1983-2001)

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A. Area Surveyed

A.1 Purpose and Description

The University of Southern Mississippi's (USM) Hydrographic Science Master's Program requires the completion of a full hydrographic survey meeting the International Hydrographic Organization's (IHO) 1A Survey specifications to fulfill graduation requirements. This includes meeting all of the necessary requirements and standards specified by the IHO S-44 in order to obtain a Category-A certification. This survey met IHO Special Order and NOAA Object Detection requirements as will be explained in the following report.

The 17USM01 survey was conducted in the City of Gulfport Municipal Marina, commonly known as the Bert Jones Yacht Basin, as well as in the Gulfport Sound Channel and the Port of Gulfport Commercial Small Craft Channel. The survey was planned and executed in order to meet both IHO Special Order and the National Oceanic and Atmospheric Administration (NOAA) Object Detection Survey standards. Professionalism and strict adherence to the highest levels of safety and survey specifications designated by NOAA and IHO were integral parts of the overall survey design. Deliverables include, but are not limited to, updates to applicable nautical charts, Electronic Navigation Charts (ENCs), Coast Pilot, and Notice to Mariners.

A.2 Survey Area Limits

The Port of Gulfport is a world-class maritime terminal that allows for domestic and international trade into the Mississippi Gulf Coast region. The port brings in larger commercial traffic via the dredged Gulfport Sound Channel, which is an 18 km long dredged channel that leads into the Gulfport Bar Channel and then out into the Gulf of Mexico. The Port of Gulfport is located between the Gulfport Municipal Marina, the Commercial Small Craft Channel, and the Gulfport Sound Channel, which were the three Priority Areas (PA) surveyed for this project as seen in Figure 1.

Figure 2. Priority Areas overlaid on Google Earth imagery (WGS84)

The three survey areas were then named in order of their priority, as seen in Figure 2, with Priority Area 1 (PA01) being the highest priority, Priority Area 2 (PA02) of next highest importance, and Priority Area 3 (PA03) being the lowest priority. The original goal was to survey each of the PAs in order; as the survey began however, plans changed in order to complete PA03. As this area was the most exposed, it became necessary to conduct survey operations whenever the weather would support due to volatile handling of the R/V GCGC. The survey areas were focused on the main channels that have the most use by commercial and recreational boating traffic and not necessarily on the geographic constraints of the area. Navigable depths were a continuous concern for the vessel and the safety of the survey equipment and personnel were paramount. The PAs can be seen in greater detail in Figures 3-5, with the coordinates of the areas listed in Tables 1-3.

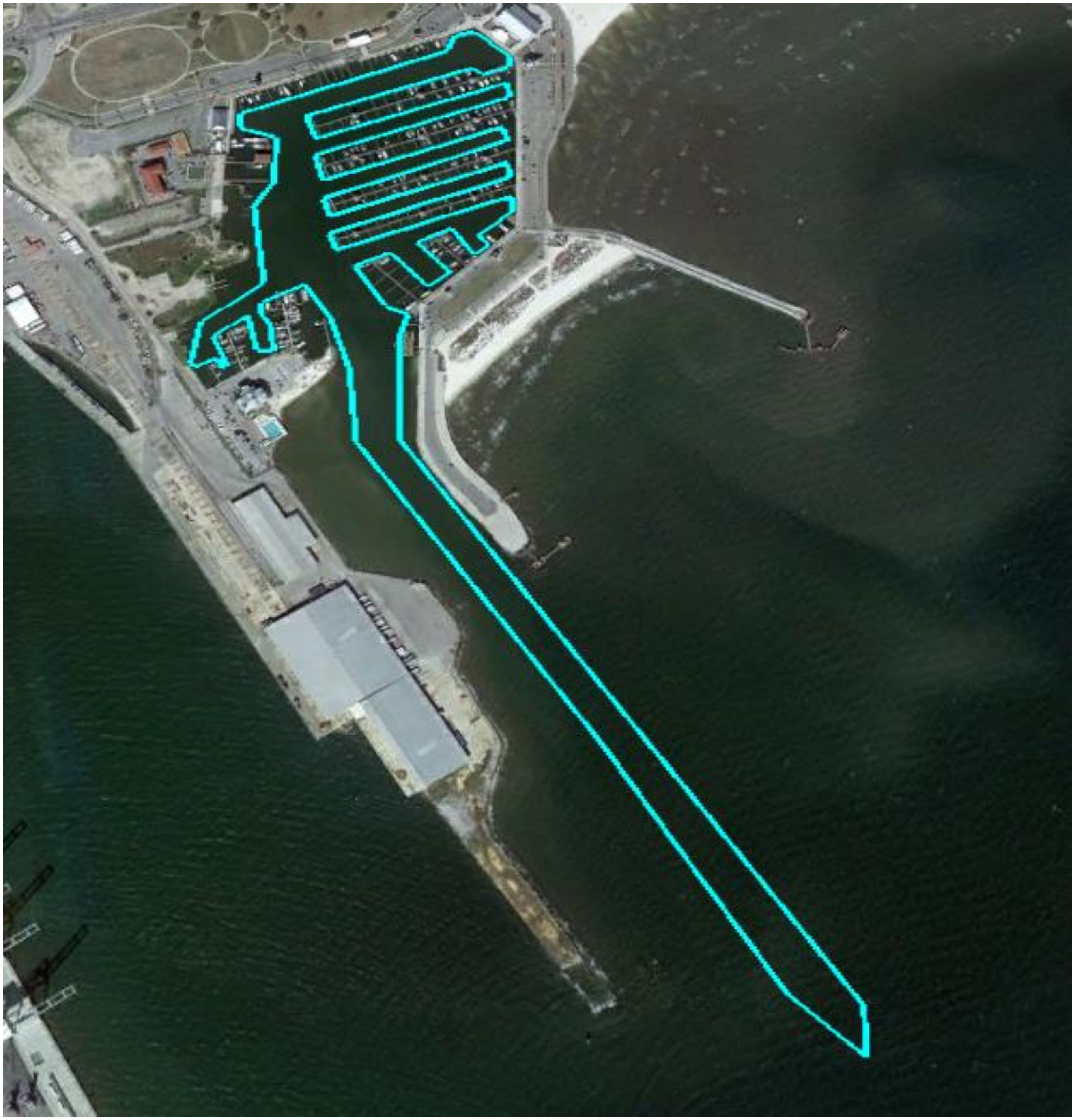

Figure 3. Priority Area 1 overlaid on Google Earth imagery (WGS84)

Table 1. Priority Area 1 bounding polygon coordinates (WGS84)

Priority Area 1					
Point	**Latitude**	**Longitude**	**Point**	**Latitude**	**Longitude**
1	30.36431944	-89.08986111	**34**	30.36431944	-89.08986111
2	30.36418333	-89.08936944	**35**	30.36418333	-89.08936944
3	30.363525	-89.08935833	**36**	30.36352500	-89.08935833
4	30.36317222	-89.08960000	**37**	30.36317222	-89.08960000
5	30.36208889	-89.08940000	**38**	30.36208889	-89.08940000
6	30.36155833	-89.09017222	**39**	30.36155833	-89.09017222
7	30.36102500	-89.09025556	**40**	30.36102500	-89.09025556
8	30.36095833	-89.09021389	**41**	30.36095833	-89.09021389
9	30.36107222	-89.08993056	**42**	30.36107222	-89.08993056
10	30.36093889	-89.08985000	**43**	30.36093889	-89.08985000
11	30.36096944	-89.08978611	**44**	30.36096944	-89.08978611
12	30.36136944	-89.09000556	**45**	30.36136944	-89.09000556
13	30.36164444	-89.08958333	**46**	30.36164444	-89.08958333
14	30.36117500	-89.08943333	**47**	30.36117500	-89.08943333
15	30.36117778	-89.08922222	**48**	30.36117778	-89.08922222
16	30.36153056	-89.08929444	**49**	30.36153056	-89.08929444
17	30.36168333	-89.08943056	**50**	30.36168333	-89.08943056
18	30.36182222	-89.08942222	**51**	30.36182222	-89.08942222
19	30.36206944	-89.08887778	**52**	30.36206944	-89.08887778
20	30.36160556	-89.08852778	**53**	30.36160556	-89.08852778
21	30.36093056	-89.08826667	**54**	30.36093056	-89.08826667
22	30.35998611	-89.08813889	**55**	30.35998611	-89.08813889
23	30.35641944	-89.08520000	**56**	30.35641944	-89.08520000
24	30.35531111	-89.08437778	**57**	30.35531111	-89.08437778
25	30.35428611	-89.08364722	**58**	30.35428611	-89.08364722
26	30.35461111	-89.08317222	**59**	30.35461111	-89.08317222
27	30.36000556	-89.08760000	**60**	30.36000556	-89.08760000
28	30.36139722	-89.08763611	**61**	30.36139722	-89.08763611
29	30.36166111	-89.08755000	**62**	30.36166111	-89.08755000
30	30.36176944	-89.08784444	**63**	30.36176944	-89.08784444
31	30.36232222	-89.08826111	**64**	30.36232222	-89.08826111
32	30.36251111	-89.08780000	**65**	30.36251111	-89.08780000
33	30.36203333	-89.08730000	**66**	30.36203333	-89.08730000

Figure 4. Priority Area 2 overlaid on Google Earth imagery (WGS84)

Table 2. Priority area 2 bounding polygon coordinates (WGS84)

Priority Area 2					
Point	**Latitude**	**Longitude**	**Point**	**Latitude**	**Longitude**
1	30.36103889	-89.10036111	**22**	30.36028333	-89.09773056
2	30.35848611	-89.09846111	**23**	30.36018056	-89.09833333
3	30.35794722	-89.09840833	**24**	30.36041389	-89.09848889
4	30.35754167	-89.09862778	**25**	30.36065556	-89.09783889
5	30.35551667	-89.10119722	**26**	30.36076667	-89.09778889
6	30.35018889	-89.09742500	**27**	30.36138611	-89.09808611
7	30.34646667	-89.09471667	**28**	30.36151667	-89.09830556
8	30.34538056	-89.09263611	**29**	30.36140000	-89.09871667
9	30.3432	-89.08810278	**30**	30.36148056	-89.09875000
10	30.34578056	-89.07972500	**31**	30.36164722	-89.09826111
11	30.34614167	-89.08002778	**32**	30.36173333	-89.09820556
12	30.34379167	-89.08762778	**33**	30.36256111	-89.09859444
13	30.34721667	-89.09428889	**34**	30.36268056	-89.09880556
14	30.35221944	-89.09799167	**35**	30.36244722	-89.09933611
15	30.35531667	-89.10017778	**36**	30.36234722	-89.09936111
16	30.35746944	-89.09816111	**37**	30.36222500	-89.09958889
17	30.35803611	-89.09785278	**38**	30.36228056	-89.09970833
18	30.358125	-89.09776944	**39**	30.36180556	-89.10086111
19	30.35839167	-89.09706944	**40**	30.36162222	-89.10086389
20	30.35868889	-89.09691667	**41**	30.36103889	-89.10036111
21	30.360225	-89.09755278	**42**	30.36103889	-89.10036111

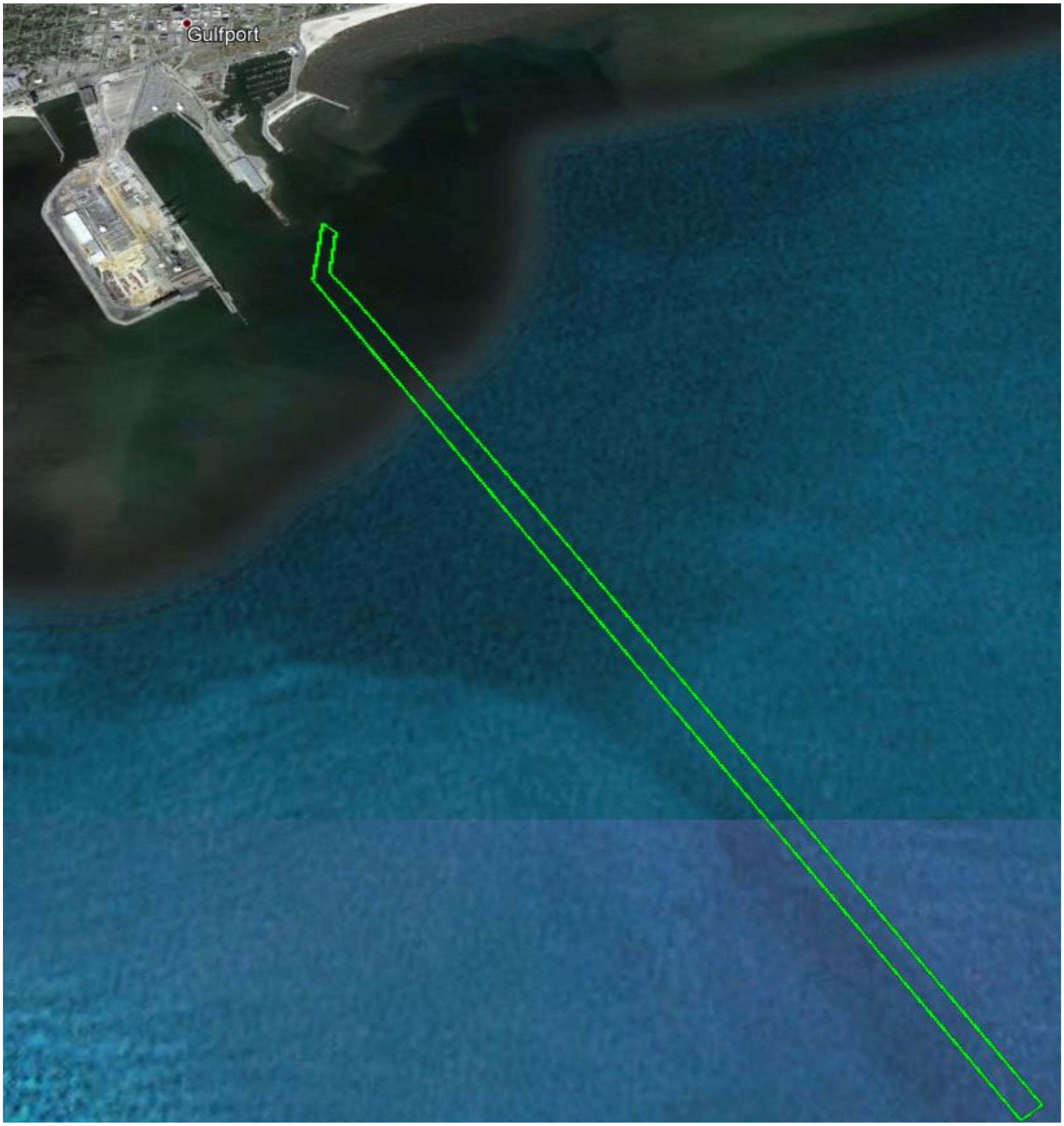

Figure 5. Priority Area 3 overlaid on Google Earth imagery (WGS84)

Table 3. Priority area 3 bounding polygon coordinates

Priority Area 3					
Point	**Latitude**	**Longitude**	**Point**	**Latitude**	**Longitude**
1	30.35386111	-89.08328056	**7**	30.31093056	-89.04881389
2	30.35324444	-89.08247500	**8**	30.31036944	-89.04977500
3	30.35068056	-89.08258611	**9**	30.33689444	-89.07225000
4	30.34911111	-89.08110556	**10**	30.35022222	-89.08346389
5	30.34469167	-89.07730278	**11**	30.35386111	-89.08328056
6	30.33701667	-89.07071389	**12**	30.35386111	-89.08328056

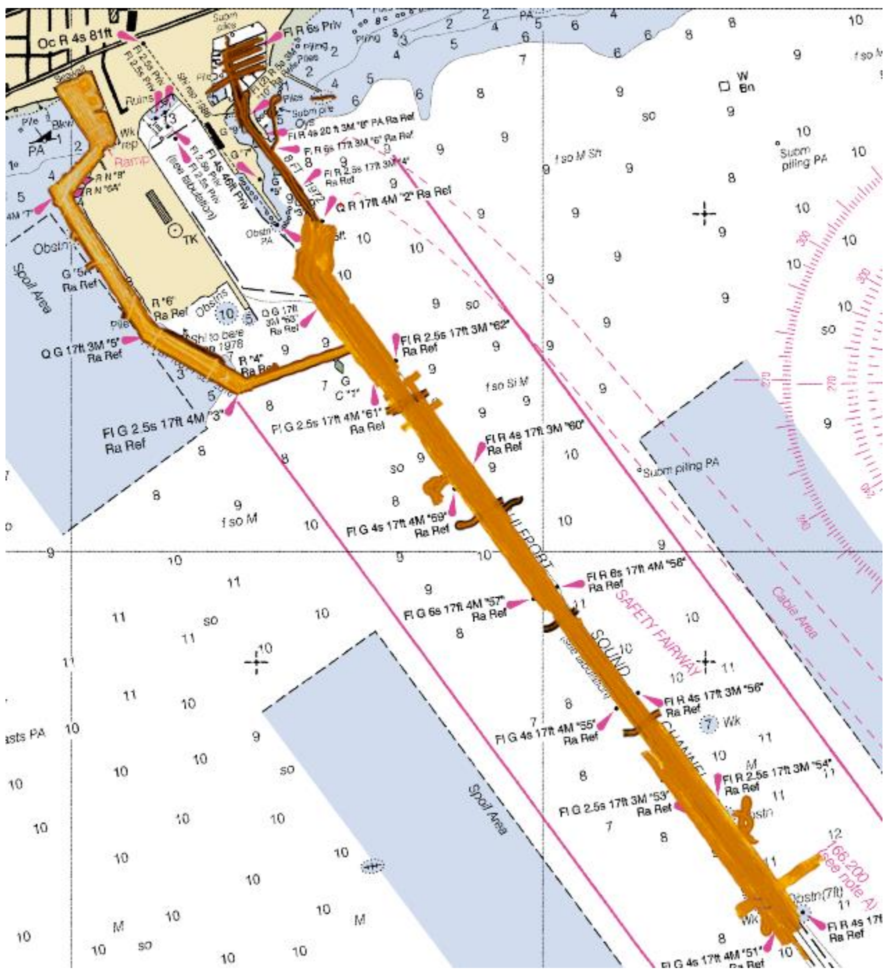

Figure 6. SSS Mosaic on RNC

A.3 Survey Statistics

The overall coverage statistics for each PA is shown in Table 4 below.

Table 4. Overall survey coverage statistics

Priority Area	Mainlines Linear m & LNM	Crosslines Linear m & LNM	SSS (200%) m^2 & SNM	Seabed Samples	ATONs
1	29338.38 15.8415	366.08 0.1977 (1.15 %)	205123 0.0597	2	10
2	66256.78 35.7758	2481.82 1.3401 (3.75%)	461604 0.1344	2	5
3	87579.61 47.2892	12993.09 7.0157 (14.84 %)	539723 0.1572	3	9
Total	183174.77	15840.99 (8.65%)	1206450	7	24

A.3 Chronology

The 17USM01 survey schedule, including all survey preparations and other relevant activities, are summarized in Table 5.

Table 5. Chronology of activities

Date	Activity
10 Mar 2017	Conducted vessel configuration survey (VCS) Processed VCS data to determine sensors offsets
18 May 2017	Reconnaissance at the Gulfport Municipal Marina Recovered benchmark BH0867 874 5557 NO 1 1969 Established four temporary benchmarks Tide gauge calibration inside USM Support Facility (Bldg. 1029) Tested CastAway CTD and Odom Digibar Pro for comparison
23 May 2017	Installed tide gauge and staff and secondary tide staff at Gulfport Municipal Marina Conducted a three-wire leveling tied to the recovered and established benchmarks, tide gauge and staff. Conducted three hours of simultaneous observation of tide Conducted four hours of static GNSS observation over BH0867 874 5557 NO 1 1969

30 May 2017	Conducted shoreline delineation using TopCon GR-3/5
05 June 2017	Set up equipment on R/V GCGC
06 June 2017	Set up equipment on R/V GCGC
07 June 2017	Trailered R/V GCGC to the Gulfport Municipal Marina Conducted one hour of simultaneous tidal observation and downloaded tidal data RTK-Positioned Aids to Navigation (ATONs) with TopCon GR-5
08 June 2015	Conducted GAMS calibration test Conducted Patch Test in Priority Area 3 Collected bottom samples in Priority Areas 1 and 2 Completed Positioning of ATONs
09 June 2017	Processed Patch Test from 08 June Conducted Patch Test in Priority Area 3 (for comparison) Collected bottom samples in Priority Area 3 Conducted LIDAR survey of marina
12 June 2017	MBES and SSS data acquisition in Priority Area 1 CARIS and SonarWiz Projects started
13 June 2017	Refueled R/V GCGC and Generator MBES and SSS data acquisition in Priority Area 3 Reconnaissance survey in Priority Area 2 Generator out of fuel, UPS failure, and system crash
14 June 2017	RESON firmware reinstalled Conducted SSS survey in Priority Area 1 Conducted MBES survey in Priority Area 3
15 June 2017	New UPS installed on R/V GCGC Conducted MBES and SSS survey in Priority Area 2
16 June 2017	Refueled R/V GCGC and Generator Conducted MBES survey in Priority Area 2 Conducted one hour of simultaneous tidal observation and downloaded tidal data

	Team meeting at USM Long Beach campus
19 June 2017	Conducted MBES and SSS survey in Priority Areas 2 and 3 Conducted holiday fill in Priority Areas 2 and 3
20 June 2017	Trailered R/V GCGC back to Stennis Space Center due to Tropical Storm Cindy
21 June 2017	R/V GCGC to remain at Bldg. 1020 due to Tropical Cindy Distributed datasets for processing Began SSS Processing of Priority Areas 1 and 3 Began CARIS data integration
23 June 2017	Redeployed R/V GCGC at Gulfport Municipal Marina Conducted Patch Test in Priority Area 3 Conducted MBES and SSS survey in Priority Areas 1 and 2 Conducted holiday fill, DTON investigation, and crosslines in Priority Areas 1 and 2
24 June 2017	Conducted Patch Test in Priority Area 3 Conducted holiday fill, DTON investigation, and crosslines in Priority Area 3 Conducted remaining DTON investigation
28 June 2017	Conducted MBES and SSS survey in Priority Area 3
29 June 2017	Trailered R/V GCGC back to Stennis Space Center
05 July 2017	Demobilized the R/V GCGC at Bldg. 1029
06 July 2017	Conducted three-wire leveling at Gulfport Municipal Marina Conducted three hours of simultaneous tidal observation and downloaded tidal data Removed tide gauge and staffs Performed tide gauge re-calibration at Bldg. 1029

B. Data Acquisition and Processing

B.1 Equipment

B.1.1 Survey Equipment

The University of Southern Mississippi Research Vessel (R/V) GCGC was used for all data collection and on-water survey support during the 17USM01 hydrographic survey. The R/V GCGC has a medium V-planning hull constructed of aluminum; it is 8m in length, 2.5m at its widest beam, and sits with a draft of 0.5m.

Vessel offsets and associated measurement uncertainties of the R/V GCGC were determined from a vessel configuration survey (VCS) conducted at the USM John C. Stennis Space Center Campus on 10 March 2017. The survey was conducted using a Leica Total Station TP S600 with observations referenced to a pre-established bolt network located behind USM Building 1029.

On 05 June 2017, the R/V GCGC was mobilized with both port and starboard side pole mounts. The pole mount on the starboard side was fitted with the Reson SeaBat 7125 SV2 multibeam echosounder (MBES), and the port side pole mount was fitted with the EdgeTech 4600 side scan sonar (SSS). The wiring diagrams or schematics of all equipment outfitted on the R/V GCGC are shown in Figures 7 and 8. The two sonars were swiveled up and out of the water at the completion of each survey day to limit the sonars exposure to biofouling and damage due to unforeseen weather or wake in the harbor at night. The vessel remained mobilized and stationed at pier 5 of the Gulfport Municipal Marina through June 19. Tropical Storm Cindy passed the survey area between the dates of 20 June through 22 June which necessitated the recovery of the vessel for safety of the vessel and equipment. The GCGC was redeployed on 22 June. The equipment utilized for the survey was installed as shown in Figures 7 and 8 with the equipment listed in Tables 6 and 7.

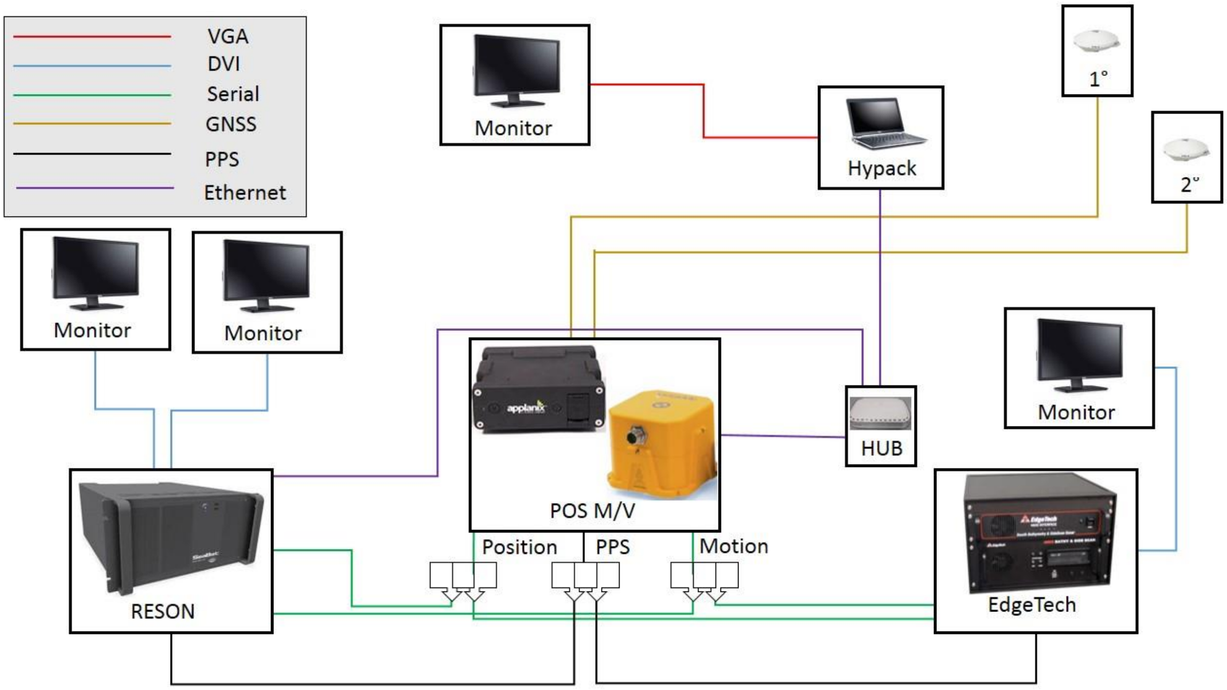

Figure 7. Data wiring schematic onboard the R/V GCGC.

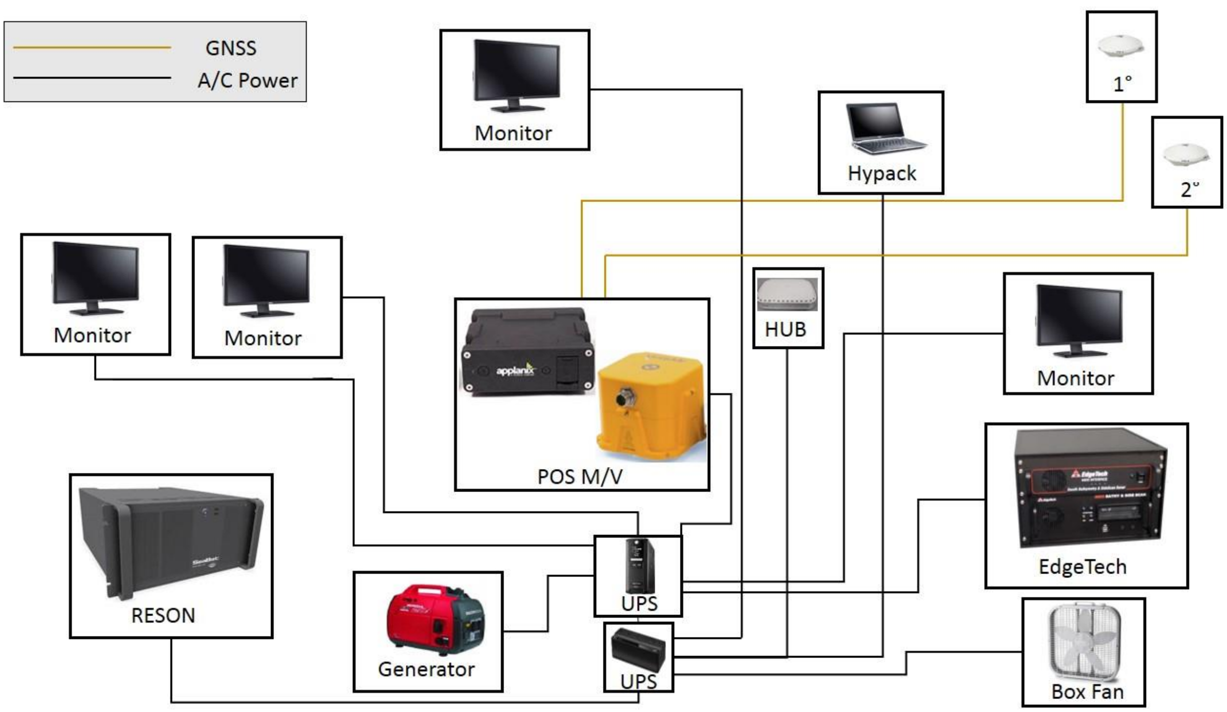

Figure 8. Power wiring schematic onboard the R/V GCGC.

Table 6. Descriptions and serial numbers of major equipment installed aboard R/V GCGC.

Equipment	Description	Serial Number
Reson Seabat 7125 SV2 Transducer and CPU	Multibeam Echosounder	Transducer: 4010148 CPU: 1006853-1
EdgeTech 4600, 540Hz EdgeTech CPU	Side Scan Sonar	Transducer: 215070 CPU: 40283
Applanix WaveMaster II POS MV PCS and IMU Trimble Zephyr 2 GNSS antennas	Attitude and Navigation	Applanix PCS-76: 5090 IMU: 2056 Primary Antenna: 1441038502 Secondary Antenna: 1441043318
Odom Digibar Pro V CastAway CTD	Sound Velocity	Digibar: 214819 CastAway: CC1519001
APC Back-UPS - 425VA CyberPower - 1500VA	Battery Back ups	9B1711A14025 QAKFZ2002759
AML Oceanography SV Sensor	Surface Sound Speed	5046
Netgear	Network Hub	IFM2043K09965

Table 7. Descriptions and serial numbers of major equipment utilized for the Shoreline Delineation.

Equipment	Description	Serial Number
Topcon GR-5 Base	Used for Shoreline manual point observations	800-21144
Topcon GR-5 Rover	Used for Shoreline manual point observations	800-21157
Topcon GR-3 Base	Used for Shoreline continuous (every 1 second) observations	433-0510
Topcon GR-3 Rover	Used for Shoreline continuous (every 1 second) observations	433-0511

B.1.2 Geodetic and Tidal Equipment

An In-Situ Level TROLL 700 tide gauge was installed within PA01 on Pier 5 at berth 68 of the Gulfport Municipal Marina, with an additional tide staff installed along the marina quay wall approximately 10m to the southeast. An In-Situ Level TROLL 700 tide gauge was installed within PA01 on Pier 5 at Berth 68 of the Gulfport Municipal Marina, with an additional tide staff installed along the marina quay wall approximately 10m to the southeast. The tide gauge and tide staff were installed and collected tide data for approximately 44 days. A dual frequency Topcon GR5

GNSS receiver was placed on a tripod over NOS benchmark 6819 B to collect data for four continuous hours. Four temporary benchmarks were established and networked to both the In-Situ Level TROLL 700 tide gauge and tide staff via geodetic leveling using a Leica NA2002 Auto Level. The C-Check and level closure met the IHO and NOAA requirements and are included in the 17USM01 Horizontal and Vertical Control Report (HVCR). Geodetic and tidal equipment used during the survey are shown in Table 8.

Table 8. Geodetic and tidal equipment for tide gauge and benchmark installation.

Equipment	Description	Serial Number
In-Situ Level TROLL 700	Water level logger	323685
Topcon GR5 GNSS Base	Used for static observation and Post Processed Kinematic solutions	800-21144
Topcon GR5 GNSS Rover	Used for static observation and Post Processed Kinematic solutions	800-21157
Leica NA2002 Auto Level	used to level tide gauge and staffs to benchmarks	283624

The In-Situ Level TROLL 700 tide gauge was calibrated using a graduated metal rod in a freshwater cylindrical plastic tank in USM Building 1029 prior to and after its deployment. The results from pre-survey and post-survey calibrations both met the NOAA 1mm accuracy specifications.

B.1.3 Data Acquisition and Processing Software

Data processing software used throughout this survey are shown in Table 9 below.

Table 9. Data acquisition and processing software versions

Software	Use	Version
Chesapeake SonarWiz	SSS processing, target Classification and mosaicking	V6 64bit
CARIS HIPS & SIPS	Bathymetric data processing	9.1.1
CARIS BASE Editor	Source Bathymetry Data management system	4.2.8
CARIS S-57 Composer	Electronic Navigation Product production software	3.0.6
HYPACK/HYSWEEP	Collect bathymetric data	2016
SeaBat 7k	Collect bathymetric data	SeaBat FP4 V.6 1.0.3 - 7125 SV2
EdgeTech Discover Bathymetric	Real time collection of SSS data	4600 1.08
MV-POSView	POS View real-time monitoring and configuration of POS MV	7.00
GrafNet	Post-processing of Topcon GR5	8.7

Online Positioner User Service (OPUS)	high-accuracy National Spatial Reference System (NSRS) coordinates calculations	2.3
Leica Geo Office	Post-processing of TP S300 Total Station data	8.3
Win-Situ	Tide collection and extraction	5.6.21.0
MATLAB (Developed Code from Tide Class)	Tide analysis	R2016a, R2016b
Topcon Magnet field	Single SEP verification	June, 2015

B.1.4 Data Consistency

Data consistency was maintained throughout the survey by allowing minimal changes to the MBES settings; changes were made primarily when surveying in PAO3, the deepest region of the survey. During preliminary data collection tests on JD159, it was noticed that the physical settings on the Reson 7K Controller Ocean Menu were all set to 0. This was rectified using standard values listed in the Reson Operator's Manual, and are further explained in Section B.1.1 of the 17USM01 Data Acquisition and Processing Report (DAPR).

In total, four MBES calibration tests were run for the 17USM01 survey. Two patch tests were run before survey began: one on 08 June 2017 and another on 09 June 2017; these were conducted as a consistency check on initial patch test values. Multiple team members processed the patch test datasets before final values were designated in the CARIS HIPS and SIPS vessel file (*.HVF). At the end of 12 June 2017, the MBES pole made contact with a pier. Another patch test was performed at the start of 13 June 2017 to verify the angular offsets of the MBES mounting. Due to the tropical storm event "Cindy", the vessel was removed from the marina, with MBES pole disassembled for transit, and redeployed on 22 June 2017. This warranted a fourth patch test performed on 23 June 2017 to identify any changes in the MBES calibration offsets. See Section C.1.2 of the 17USM01 DAPR for complete detail on MBES calibration.

To maintain consistency in MBES coverage, line plans were created in HYPACK prior to survey in accordance National Ocean Service's (NOS) Hydrographic Survey Specifications and Deliverables (HSSD). Specifications required line spacing to provide 100% MBES coverage with 20% overlap. Using the formula for swath width of $2 \times D \times \tan(\theta \div 2)$, (where D is depth and θ is swath angle) and accounting for at least 20% additional overlap, the line spacing for each priority area was calculated as seen in Table 10 below. Swath Angle was estimated to be less than the maximum 140° in order to provide ample line spacing, especially for extremely shallow water depths in PAO1 and PAO2.

Table 10. 17USM01 Calculated Line Spacing

Reson SeaBat 7125 MBES Calculated Line Spacing by Priority Area				
Priority Area	**Average Depth (m)**	**Swath Angle (°)**	**Swath Width (m)**	**Line Spacing (m)**
1	2	130	8.6	6
2	2.5	130	10.7	8

3	10	130	42.9	34

Real-time coverage was assessed during survey operations using matrix files in HYSWEEP. This coverage display allowed for the survey team to quickly identify holidays and/or adjust line spacing. In PA01 and PA02, line spacing was often decreased to 5m due to extremely shallow depths and difficult maneuverability of the R/V GCGC. The line spacing for PA03 listed in the table above was utilized in the center of the channel at the maximum depths. On either side of the channel, the line spacing for PA02 was implemented. Split lines were run between planned survey lines to fill in holidays. Daily surfaces were exported from CARIS and provided to the field team for further guidance in holiday fill.

For the duration of the survey, the IHO recommendation of 6 knots was utilized as the maximum survey speed of the R/V GCGC in PA02 and PA03. When operating at a 100 m range scale with SSS, survey speeds were kept under 4 knots in accordance with calculations shown in the 17USM01 DAPR, Section B.2.1. In PA01 and the "no wake" portion of PA02, 2-3 knots was adhered to as maximum survey speed.

The POS MV had two malfunctioning COM ports during survey; therefore, we were unable to connect an auxiliary GPS to the POS MV. Improper import of auxiliary data into CARIS HIPS & SIPS caused problems with delayed heave and navigation sources. Initially, it was suspected that CARIS was unable to overwrite the raw POS MV (*.000) files with the Post Processed Kinematic (PPK) solution Smoothed Best Estimate of Trajectory (SBET) files (*.OUT). Processing output logs also showed that no delayed heave was found in the data. After deleting the raw index files from the project, reloading the *.000 files, and importing only the delayed heave, CARIS was able to apply this to the MBES data. The *.OUT files were found to be imported without selecting a reference week, which is required when using SBET solutions from POSPac MMS. Once this data was imported with the appropriate reference week selected, the navigation sources could be properly implemented.

B.2 Quality Control

B.2.1 Crossline Comparison

In accordance with NOS HSSD (2017), crosslines were surveyed within each PA in order to assess MBES data quality. These lines were run perpendicular to development lines and spaced no more than 1 km apart. In total, the 17USM01 survey collected 8.55 LNM, which was 8.65% of the development line length. This also satisfies the minimum 4% crossline length needed according to NOS HSSD (2017). The CARIS HIPS & SIPS Line Quality Control (QC) Report tool was used to perform crossline analysis. A CUBE surface was created from only the crosslines and then differenced with a CUBE surface derived from only the development line. This difference surface was then segmented by PA and run through the QC Report tool according to IHO TVU specifications (±0.25 m). Table 11 shows the summarized crossline results for each PA and the

Total Survey Area. The combined surfaces fell short of the specifications for NOAA Object Detection.

Table 11. Crossline Difference QC Report results for each Priority Area and the Total Survey Area

Statistical Information:	Priority Area 1	Priority Area 2	Priority Area 3	Total
Minimum	-0.2 m	-1.2 m	-1.2 m	-1.2 m
Maximum	0.6 m	0.3 m	1.8 m	1.8 m
Mean	0.1 m	0 m	0 m	0 m
Standard Deviation	0.1 m	0.1 m	0.1 m	0.1 m
Total Count	17597	127680	330461	475738
Order 1A 95% Confidence Interval	99.994% (17596/17597 nodes)	99.996% (127675/127680 nodes)	**98.623% (325909/330461 nodes)**	**99.042% (471180/475738 nodes)**
Special Order 95% Confidence Interval	**99.864% (17573/17597 nodes)**	**99.976% (127650/127680 nodes)**	92.003% (304033/330461 nodes)	**94.433% (449256/475738 nodes)**

In addition to the difference surface, the CARIS HIPS & SIPS Line QC Tool was utilized to create an analysis of crossline to development line data quality based on beam number. The three analysis reports, one for each PA, are shown in Appendix A.1. In summary, PA01 and PA02 both meet requirements in accordance with IHO Special Order TVU. PA03 fails to meet IHO Special Order, but does meet IHO Order 1A.

B.2.2 Coverage and Junctions

Quality assurance of MBES coverage was performed in CARIS HIPS & SIPS. In total 69 holidays were detected by CARIS in the finalized CUBE surface. Any holidays which are not a result of gaps around harbor infrastructure, are covered by at least 200% SSS coverage and therefore do not bust the requirements for IHO Special Order Survey as seen in Figure 9.

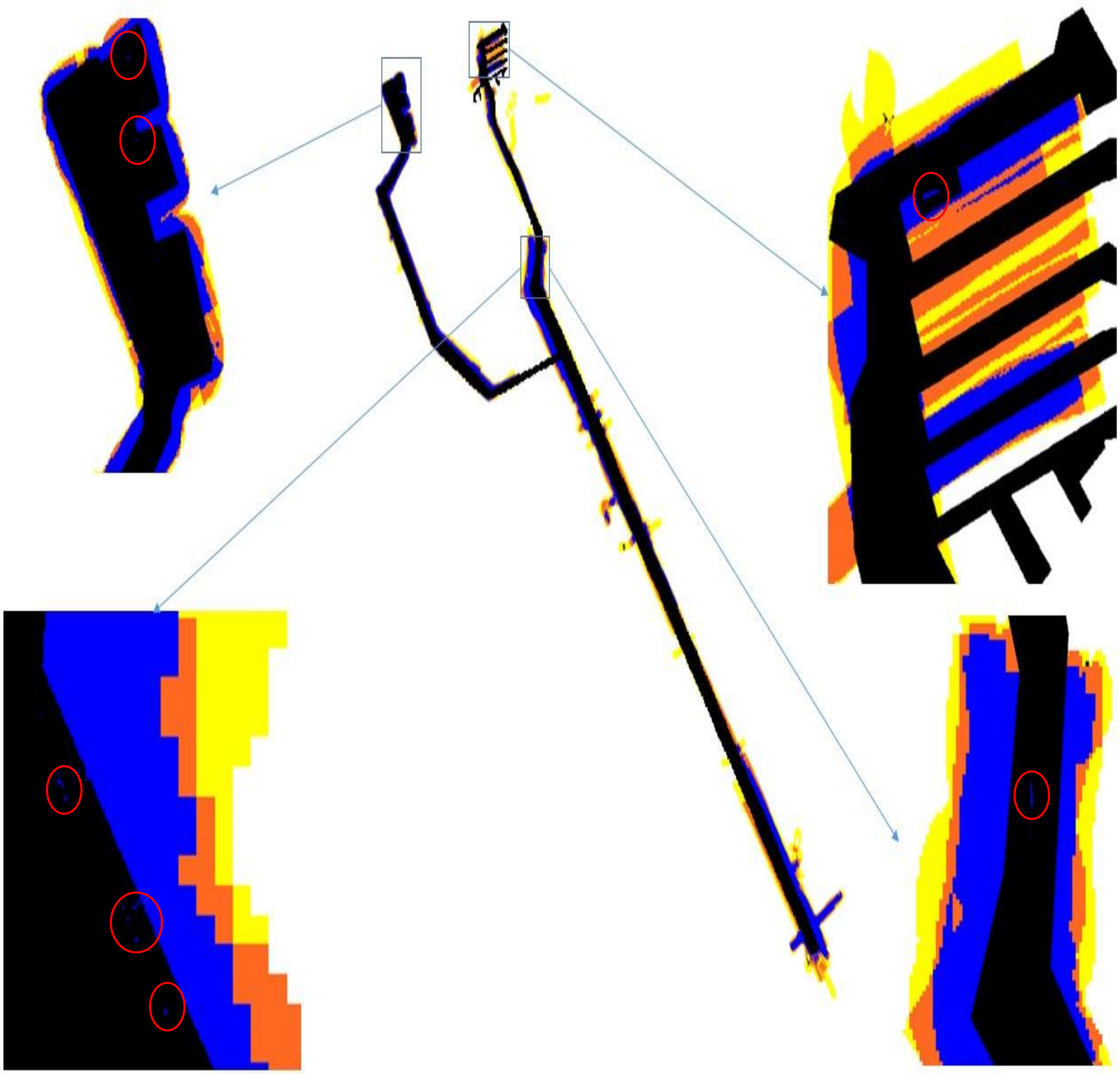

Figure 9. MBES overlay in black, 300% SSS in blue, 200% SSS orange, and 100% SSS in yellow. This figure shows that that gabs in MBES were in areas of greater than 200% SSS as circled in red.

There were also no MBES or SSS holidays over significant target features, so NOAA Object Detection Survey requirements are met in regards to holidays. In terms of sounding density, NOAA requires 5 pings per node in order to meet Object Detection specifications. Analyzing the Density layer of the finalized CUBE surface provided the number of pings per node. The 17USM01 survey had 99.99% of nodes with over 5 pings as shown in Table 12.

Table 12. Density Analysis of Final 0.5 m CUBE surface

Minimum	1
Maximum	28060
Mean	450.6
Standard Deviation	572.4
Total Count	4458621
95% Confidence Interval	**99.99% (4458130/4458621 nodes)**

The 17USM01 survey has a Current Junction overlap with the 17USM02 survey operated in Long Beach, Mississippi. The 17USM02 survey collected MBES data over a portion of the Gulfport Sound Channel using a Kongsberg 2040C MBES. The 0.5m CUBE surface of the junction area provided by 17USM02 was differenced with the 17USM01 surface, and statistical analysis was performed to ensure relative agreement of depths within appropriate TVU standards. For IHO Special Order survey, the difference surface must comply with less than √2 * TVU on a 95% CI basis. Figure 10 below shows the Junction of 17USM02 perpendicular to the 17USM01 CUBE surface in PA03 and Figure 11 shows the difference surface. All surfaces were analyzed using a 0.5m resolution.

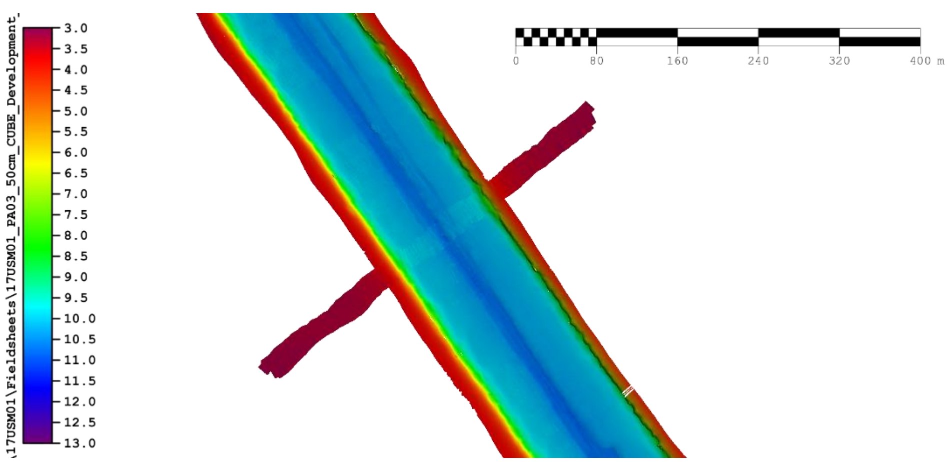

Figure 10. Single 17USM02 survey line at junction with 17USM01 PA03 at 0.5 m resolution

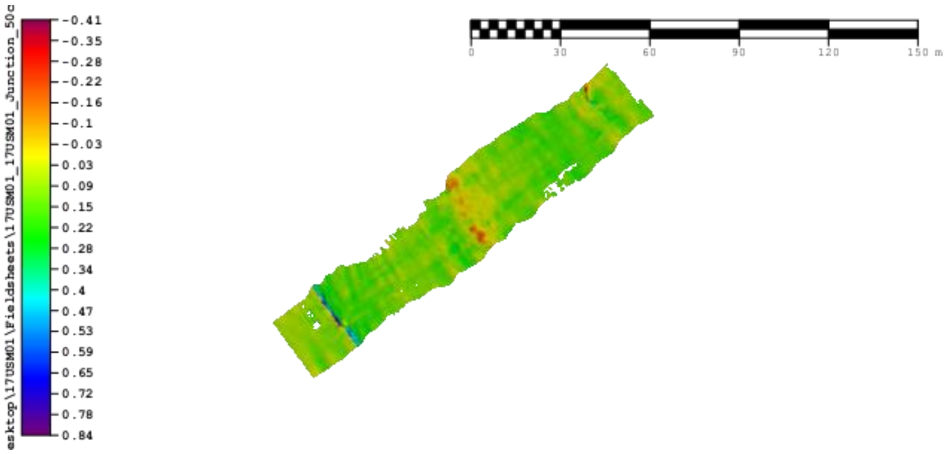

Figure 11. 17USM01 and 17USM02 junction difference surface at 0.5m resolution

A statistical analysis was performed in CARIS HIPS & SIPS on the difference surface. Using the maximum TVU of 0.25m for IHO Special Order survey, the junction surface should have 95% of its differences within ±0.35m. Table 13 and Figure 12 show the difference distribution and statistics, which comply with the 95% CI for Special Order.

Table 13. Results of 17USM01 and 17USM02 junction analysis in CARIS HIPS & SIPS 9.1

Minimum	-0.4 m
Maximum	0.8 m
Mean	0.1 m
Standard Deviation	0.1 m
95% Confidence Interval	**99.03% nodes pass (13726/13860)**

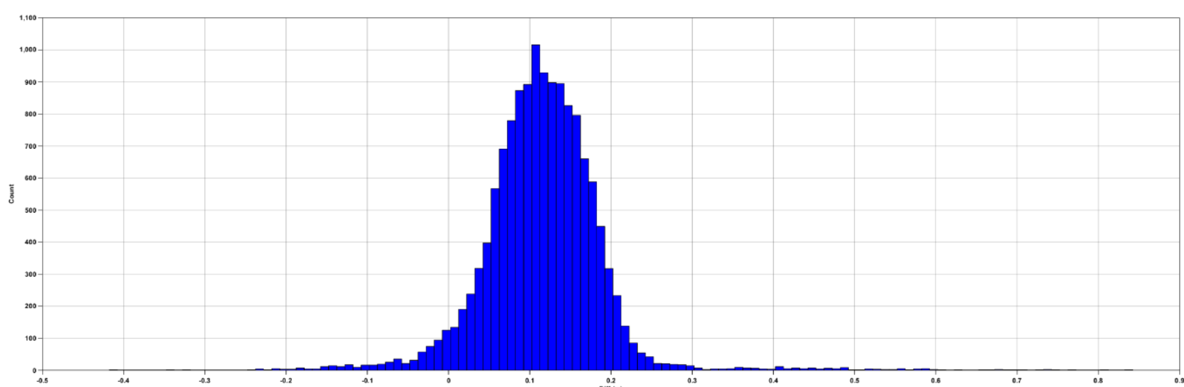

Figure 12. Difference analysis of junction surfaces

B.2.3 Sonar Quality Control Checks

The performance of the MBES and SSS was checked prior to development line data acquisition. On 08 June and 09 June 2017, patch test lines were run over the same area within PA03. Following calibration, these surfaces were differenced and analyzed using the CARIS HIPS & SIPS QC Tool.

As mentioned in Section B.2.2, a MBES confidence check was done by performing a junction comparison with a surface collected during the 17USM02 survey which overlapped a portion of 17USM01 PA03. This quality check indicated that the sonars were capable of resolving objects to the NOAA and IHO specifications designated for this survey. 99.03% of nodes fell within the 95% CI.

Quality control checks of the EdgeTech 4600 were conducted prior to and throughout SSS operations. Before deploying the SSS each day, a rub test and full system integration test was conducted to check position, motion and recording of data. Additionally, daily QC checks were performed using submerged dock pilings, key walls within the marina, and fixed daymarks in the overall survey area. The SSS system passed all quality control checks.

B.2.4 Factors Affecting Quality

The R/V GCGC is known to have a high center of gravity; therefore, vessel stability was a concern during preparations for survey. Referencing previous surveys aboard the R/V GCGC, it was decided to add approximately 700 pounds of ballast within the vessel to increase its stability and maneuverability offshore. Even with the additional weight, roll instability in even moderate seas caused high signal to noise ratios within the PAO3 as well as data gaps in the MBES coverage within PA01 and PA02. This was remedied by reducing line spacing and compensated with adequate SSS coverage. However, motion artifacts were significantly reduced and general handling characteristics improved by the additional weight.

B.2.5 Sound Speed Methods

Sound Velocity Profiles (SVP) were collected during survey using a CastAway CTD. The CastAway was tested in the USM Support Facility Building 1029 along with an Odom Digibar Pro to verify data accuracy; these test casts are shown in the 17USM01 DAPR Appendices section D. With a valid comparison check performed, the CastAway was the sole SV profiler used during field operations. Profiles were taken at the start and end of each survey day, as well as when more than a ±2m/s difference between the sound velocity at the transducer face and the previous SVP was observed on the 7K Controller. In order to adequately compensate for refraction errors that are caused by spatial and temporal water column sound speed variations, casts were taken approximately every two hours. The SVP files were accessed over Bluetooth connection on the same field laptop running HYPACK. HYPACK's drop-down menu allows connection to the CastAway for streamlined download and review of the data. These files were saved within the HYPACK project folder as *.VEL files and downloaded at the end of the survey day. The *.VEL SV casts were converted into *.SVP files for each year-day and applied in CARIS following data import. For detailed SVP cast information see 17USM01 DAPR Appendices section D.

B.2.6 Coverage Equipment and Methods

All equipment and survey methods adhere to the methods detailed in the 17USM01 DAPR.

B.3 Corrections to Echo Sounding

B.3.1 Vessel Configuration

To accurately survey the instrument mounting nodes on the R/V GCGC, the vessel was positioned within a pre-established 8-bolt reference network, and all nodes were surveyed with a Total Station. The sensors' nodes, vessel hull, and other points of interest were observed from seven stations. An intersection survey of all sensor nodes was performed from at least two different stations, and a minimum of two sets of observations were recorded at each station. The final computation and least squares adjustment of the coordinate system transformation was performed using LGO software. The vessel reference point was translated in 3D to a new origin (0.000mE, 0.000mN, 0.000mH), and all points in the x-y plane were rotated about the z-axis of the boat, with its longitudinal axis coincident with the zero azimuth. Additionally, more rudimentary offset measurements were made via tape measure for comparison and verification with the Total Station survey. For more details, see Appendix A.2 in the 17USM01 DAPR.

B.3.2 Multibeam Calibration

In total, four calibration tests were performed during the 17USM01 survey. Two initial patch tests were conducted on 08 June 2017 and 09 June 2017 across the Gulfport Shipping Channel. A third patch test was conducted on 13 June 2017 to account for any changes in the angular offsets of the MBES following a strike of the mounting pole. A fourth patch test was conducted on 23 June 2017 after the reassembly of the R/V GCGC following a sortie associated with Tropical Storm Cindy necessitating removal of the vessel from the marina. Calibration tests were performed in CARIS HIPS & SIPS Subset Editor by four individuals; the results from the four iterations of each test were averaged into a final set of patch values and applied to the vessel configuration file. The offsets from the two initial patch tests results were within less than 0.1°, and were conducted prior to any developmental line data recording, therefore averages were used for the initial patch test values in the CARIS vessel file (*.HVF). The final values used in the *.HVF are shown in Table 14. As an example, Figure 13 shows the pre- and post-calibrated surfaces for the averaged 13 June 2017 acquired patch test data; this data was not cleaned until full data processing had commenced, so some noise is evident in the surface images. The 17USM01 DAPR, Section C.1.2 and Appendix B, has further detailed calibration information and surface images.

Table 14. Calibration results used for 17USM01 CARIS HIPS & SIPS Vessel File

Day	Pitch	Roll	Yaw
06/08/17	-1.60	2.53	3.58
06/13/15	-2.42	2.54	4.23
06/23/15	-1.65	2.64	3.54

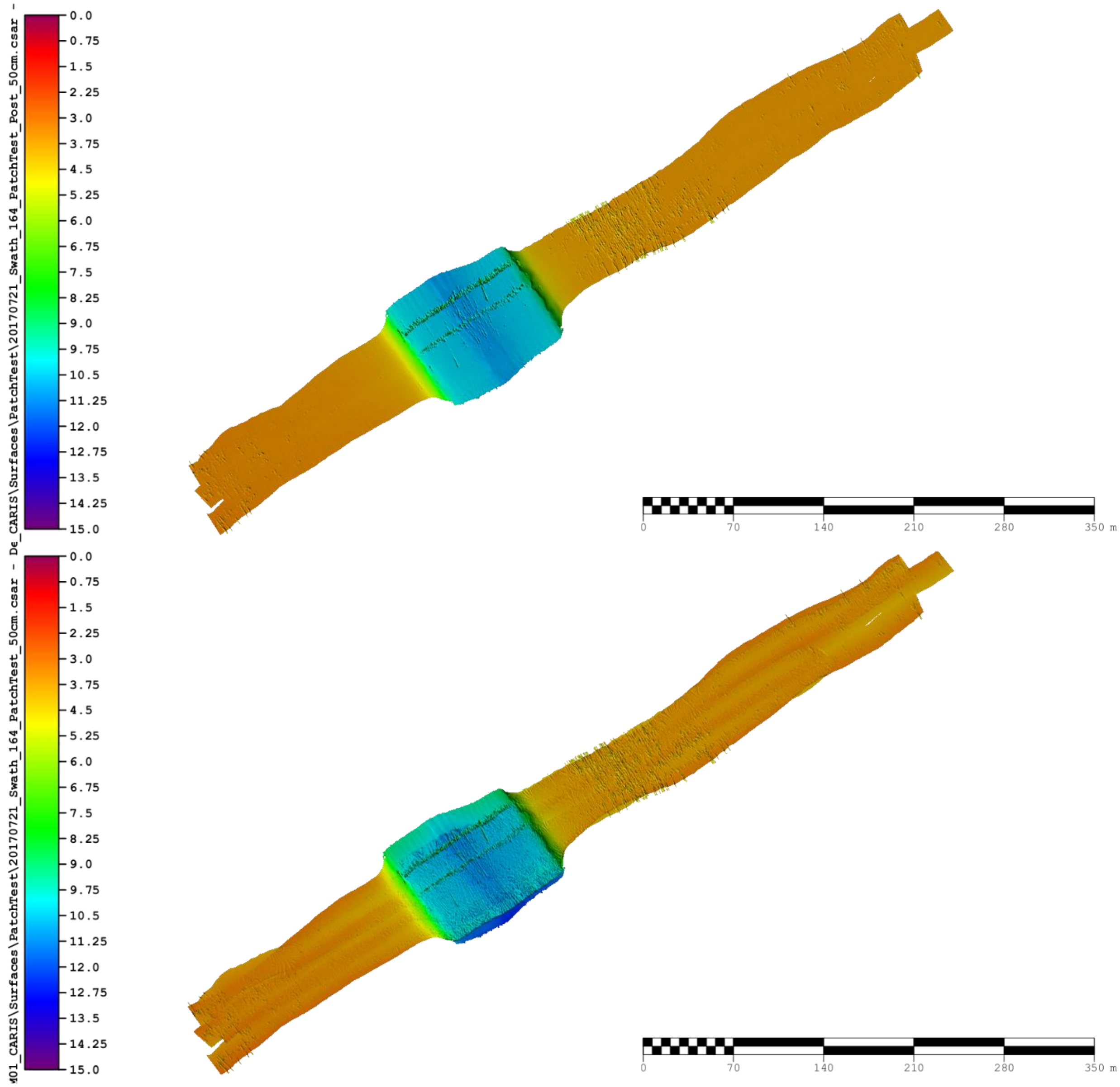

Figure 13. 13 June 2017 pre-processed (above) and post-processed (below) patch test surfaces.

B.4 Backscatter

MBES backscatter mosaics were not listed as deliverables for the 17USM01 survey.

B.5 Data Processing

Brief descriptions of data processing procedures are described in the sections below. For more details, see the 17USM01 DAPR, Section B.1.3.

B.5.1 Software Updates

All software versions listed in the 17USM01 DAPR are accurate; there are no version updates or changes.

B.5.1 Project Setup and Preliminary Data Import

To begin data processing, the six total survey team members were split into three processing teams. Each processing team was responsible for the MBES and SSS data for one of the three PAs. Once each team had all of the necessary datasets, SonarWiz was utilized for SSS data analysis, and CARIS HIPS & SIPS was utilized for MBES data analysis. A singular *.HVF was created for use by each processing team. HYPACK files (*.HSX) were imported according to Year-Day for post-processing in CARIS HIPS & SIPS. Auxiliary data in the form of raw POS MV files (*.000) and post-processed PPK Smoothed Best Estimate of Trajectory (SBET) solutions from POSPac MMS (*.OUT) were applied to the data along with the Root-Mean-Square (RMS) solutions for each SBET file. Next, sound velocity corrections were applied by importing the formatted SVP casts (*.SVP) from the CastAway CTD using “nearest in distance within time” option, and delayed heave was applied. Finally, GPS tides were applied using a single calculated separation value of -27.97587m. Data was merged along with GPS Tides and Delayed Heave. Before creating surfaces, TPU was calculated and both the navigation and attitude datasets were inspected for each line.

B.5.2 Surface Generation and Data Cleaning

Once all attitude and navigation data were examined and cleaned, preliminary Swath Angle and CUBE surfaces were created using a 0.5 m resolution in accordance with NOS’s HSSD’s requirement for Object Detection. Each line was first cleaned using Swath Editor, with progress tracked using a shared processing log. Upon completion of swath editing, surfaces were recomputed to update any changes made during cleaning. Subset tiles were generated to track completeness while conducting cleaning using the CUBE surface in Subset Editor, as there was no practical way to track this using the processing log. Following cleaning, surfaces were recomputed and finalized prior to export and merger with the other Priority Area surfaces. Separate CUBE surfaces were exported for developmental lines and cross lines of each PA. Two separate combined surfaces were created for the entire survey area: one surface for all developmental lines and one surface for all crosscheck lines.

B.5.3 CUBE Surface Finalization

Following the completion of data cleaning, the exported surfaces from each PA were merged into a finalized CUBE surface. This allowed for statistical analysis of the entire survey area in CARIS HIPS & SIPS in regards to TPU, holiday analysis, cross line analysis, etc. The finalized CUBE surface is shown below in Figure 12 with CARIS QC Analysis results in Table 14. The exported QC Report is shown in Appendix A.2.

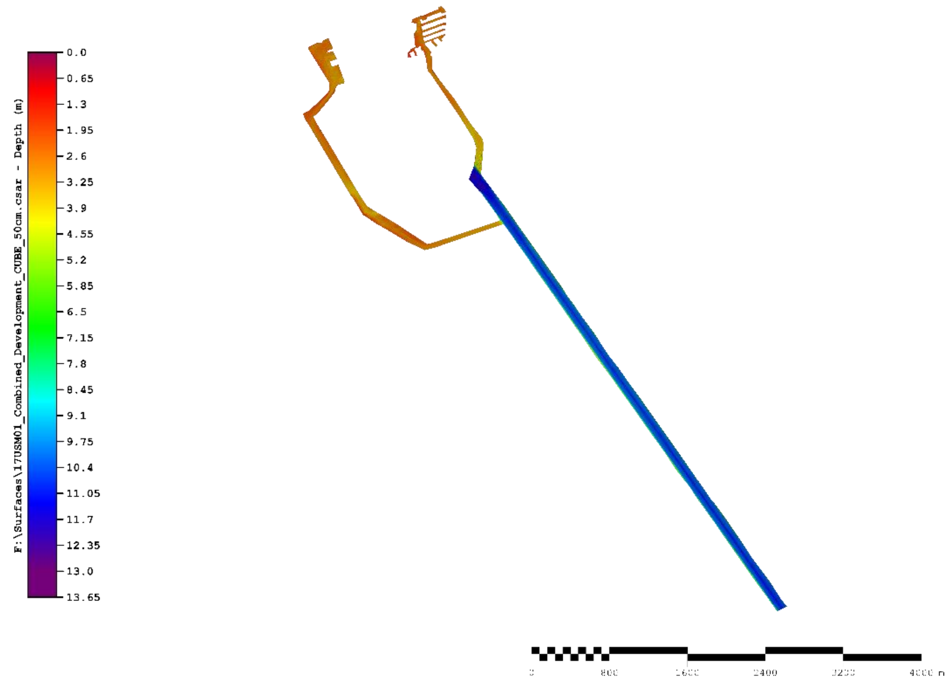

Figure 14. 17USM01 Finalized 0.5m CUBE surface

Table 15. BASE QC Report results from the finalized CUBE surface for all Priority Areas.

All Areas		
Holidays Detected	69	
Range	0 to 100.00	
Number of Nodes Considered	4460745	
Number of Nodes within	IHO S-44 Special Order	4404565 (98.76%)
	S-44 Order 1A	4460037 (99.99%)
Residual Mean (m)	IHO S-44 Special Order	-0.166
	S-44 Order 1A	-0.420

Once TPU results were calculated, finalized MBES surfaces (*.CSAR) were exported and saved in the HSS-specified file structure.

B.5.4 SSS Mosaics

SSS data processing was performed using Chesapeake Technologies SonarWiz V6.05.0003. All data collected by SSS was logged in *.JSF file format. Files were imported into SonarWiz, where bottom tracking, sheave offsets, and gain settings were adjusted (*Automatic Gain Control)* to maximize image quality. Geo-referenced SSS mosaics (gray scale) *.TIFF files were then created for the whole 17USM01 survey area, as well as each of the three PAs (Figures 13-16, respectively). Resolution was set at 1m, allowing for shadows of small objects to be distinctive. For further details on SSS data processing and mosaic creation, see the 17USM01 DAPR, Section B.2.2.

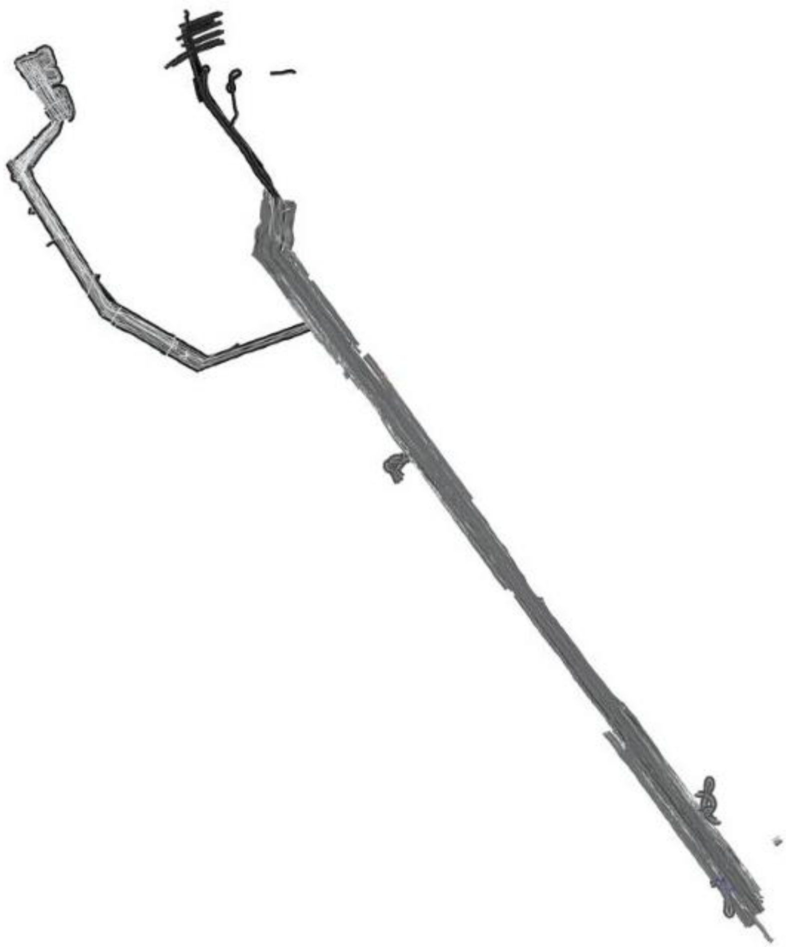

Figure 15. SSS mosaic of all Priority Areas

Figure *16*. SSS mosaic of Priority Area 1

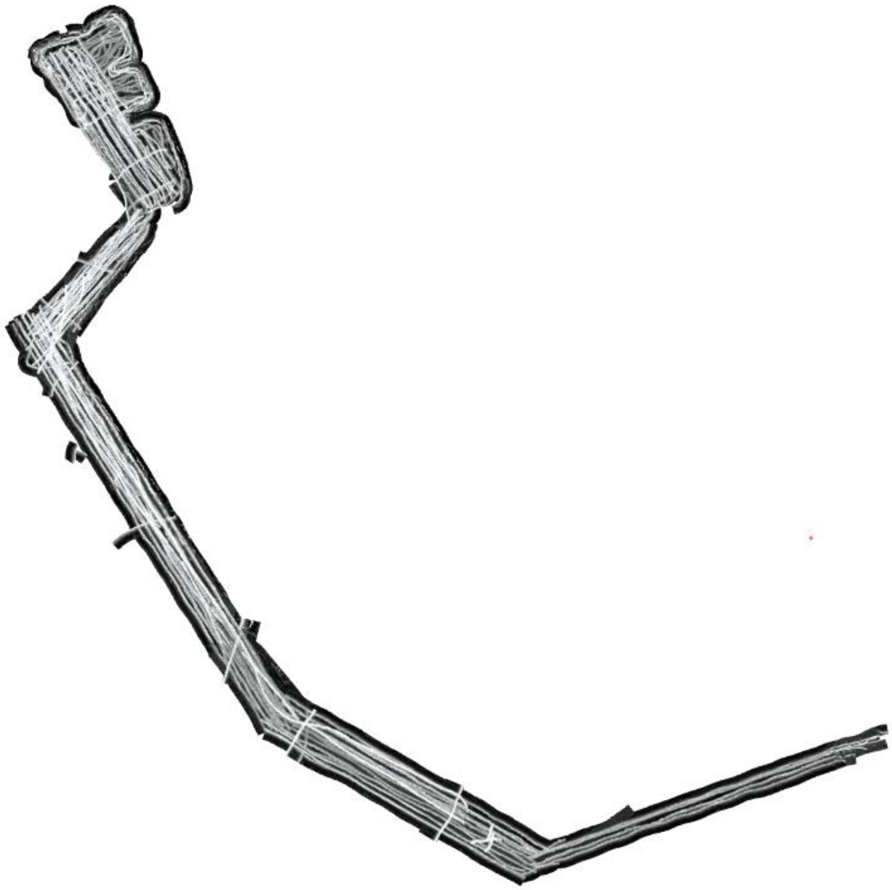

Figure *17*. **SSS mosaic of Priority Area 2**

Figure *18*. SSS mosaic of Priority Area *3*

B.5.5 Feature selections

Based on NOAA's NOS HSSD, detection of objects with a height of 1 m or greater or a demotion of 1 m^3 or greater must be identified. Since the entirety of this survey was conducted in water depths of less than 20 m, this was the requirement for meeting object detection with SSS. All SSS survey data was thoroughly examined for significant contacts. All significant contacts were analyzed and digitized with a precise position, height off of sea floor, width, length, shadow length, and a general classification. Further investigation of all significant contacts and potential DTONs was conducted using the MBES bathymetry data. In total four significant contacts were identified in the 17USM01 survey area and are listed in Appendix B.

C. Vertical and Horizontal Control

Summaries of the 17USM01 Vertical and Horizontal Controls are listed in the sections below. See the 17USM01 HVCR for further details.

C.1 Vertical Control

C.1.1 Vertical Datum

The 17USM01 Gulfport Survey used Mean Lower Low Water (MLLW) National Tidal Datum Epoch (NTDE) 1983-2001 as the sounding datum. All vertical and horizontal positions were referenced to North American Datum of 1983 (NAD83) (2011/MA11/PA11) Epoch 2010.00. This excludes any updates to ENCs, which utilized the WGS-84 datum and ellipsoid.

C.1.2 Existing Tidal Infrastructure

Three primary benchmarks were utilized for various tidal analyses: Bay Waveland Yacht Club (ID 874737, about 25 km from Gulfport survey area), Pascagoula (ID 8471533, about 50 km from Gulfport survey area), and Shell Beach (ID 8761305, about 75 km from Gulfport Survey Area). These primary tide gauges have 19-year accepted datum and are maintained by NOS.

An established bench mark (ID 8745557) was available at the Gulfport Municipal Marina whose datum were published on 03 September 2015 and whose data span from 2006-2007 and 2009-2010. A MLLW datum and separation value between the benchmark and ellipsoid allows for an existing SEP value to be determined.

C.1.3 Tide Gauge Calibration

The In-Situ Level TROLL 700 tide gauge was calibrated in a three meter tall cylindrical tube filled with freshwater at John C. Stennis Space Center both before and after tide gauge deployment at Gulfport. The resulting calibration revealed a resolution that met NOAA's 1-mm resolution specification. A linear least-squares fit designed by York et al. 2004 was utilized to compare simultaneous observations as well as calibration data. Since the Level TROLL 700 does not record salinity, data from a USGS buoy was utilized to correct the pressure readings to an appropriate depth value. The buoy was located 12 km away from the site, so a comparison between the salinity from the buoy and some sparse salinity profiles from the 17USM01 SVP casts was performed. See the 17USM01 HVCR Sec. B for more information on uncertainties and calibration.

C.1.4 Tidal Zoning

The Gulfport survey area covers a small area but has an extensive length offshore for PA03. The established tide gauge in Gulfport is 25 km from Bay Waveland, MS, 50 km from Pascagoula, MS, and 75 km from Shell Beach, LA tide gauges. These three stations have NOAA-published datums for water levels referenced to the NTDE Epoch 1983-2001 as seen in Table 16. These three stations were utilized to triangulate a cotidal zoning scheme. However, High Water Interval (HWI) and Low Water Interval (LWI) accepted values are not available for these primary tide stations; relative HWI and LWI values were determined by pairing extrema values between a primary tide station and the 17USM01 subordinate tide gauge. In turn, a cotidal phase model was developed for the region with timing with respect to 17USM01 tides (Figure 12). The model assumes a linear interpolation relationship between the stations, which may be an erroneous assumption as the contours approach Shell Beach and the embayment of southeast Louisiana. The cotidal model suggests that the 17USM01 survey only needs 1 SEP value since the survey area is within each of the sets of cotidal curves as defined by NOAA (Figure 19). For more information on the cotidal analysis, see the 17USM01 HVCR .

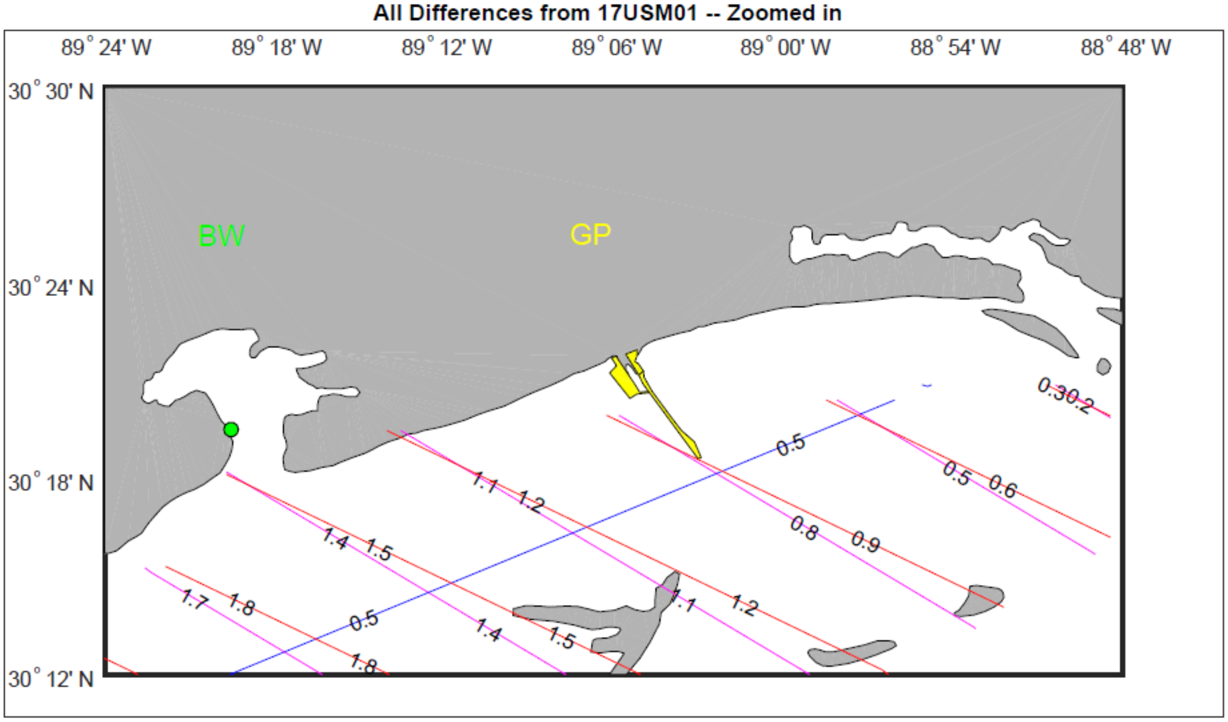

Figure *19. Combined Cotidal model zoning scheme, zoomed into the 17USM01 survey area depicted in yellow. High Water Cotidal Phase contours (magenta) at regular intervals of 0.3 hours as specified by NOAA. Low Water Cotidal Phase contours (magenta) at regular intervals of 0.3 hours as specified by NOAA. Cotidal Range contours (magenta) at regular intervals of 0.06 meters as specified by NOAA. Green circles and text correspond to the three primary gauges established by NOAA (BW is Bay Waveland (ID 8747437)).*

Table 16. NOAA published great diurnal range (Gt) values for tide stations surrounding the survey.

Status	Station	Great Diurnal Range (Gt) NTDE Epoch 1983-2001 (m)
Accepted (22 May 2017)	8747437, Bay Waveland Yacht Club, MS	0.538
Accepted (23 Aug 2012)	8741533, Pascagoula NOAA Lab, MS	0.468
Accepted (25 Sep 2012)	8761305, Shell Beach, LA	0.437

Calculated (11 Jul 2017)	17USM01, Gulfport, MS	0.547

C.1.5 SEP Values

To determine if multiple SEP values would have to be used, a geoid undulation calculator from GeographicLib (Karney, 2015) was used to determine geoid – ellipsoid separation at the extents of the survey area to within 1 mm (RMS error). Point calculations were made at four corners of the survey area, and changes in elevation were calculated between them (Figure 20). The largest slope in ellipsoid height across the survey area was 4.15 cm, which was determined to not be significant enough to require more than a single SEP value to be applied for sounding reduction.

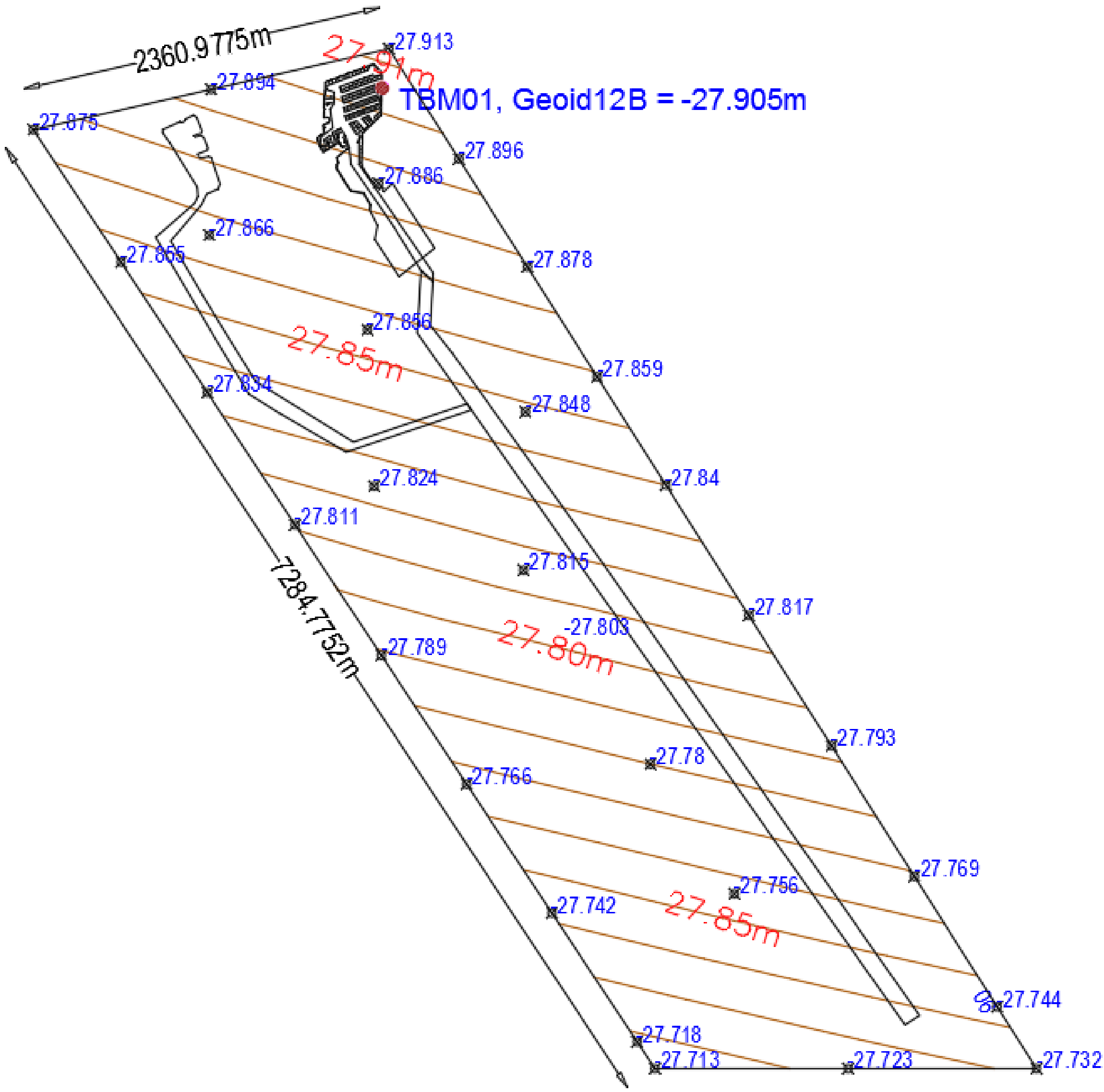

Figure 20. Height undulations between the WGS84 ellipsoid and EGM2008 geoid. Values obtained from http://geographiclib.sourceforge.net/cgi-bin/GeoidEval.

By using the derived ellipsoidal height from the GNSS static observation, benchmark elevations (from three-wire leveling), and MLLW/MSL values from the tidal datum transfer, an SEP value can be calculated (Method 1). Another Method (2) was derived by using the established chart datum/tidal relationships for the NOS BM 6819 B data and ellipsoidal height from the GNSS static survey. Method 3 utilized NOAA's VDatum Vertical Datum Transformation (v3.4) program to determine a SEP value by providing the datum, coordinates, and zero height over the primary benchmark. SEP values for each method are summarized in Figure 21. Uncertainty values were calculated to a 95% confidence and are shown in Table 17.

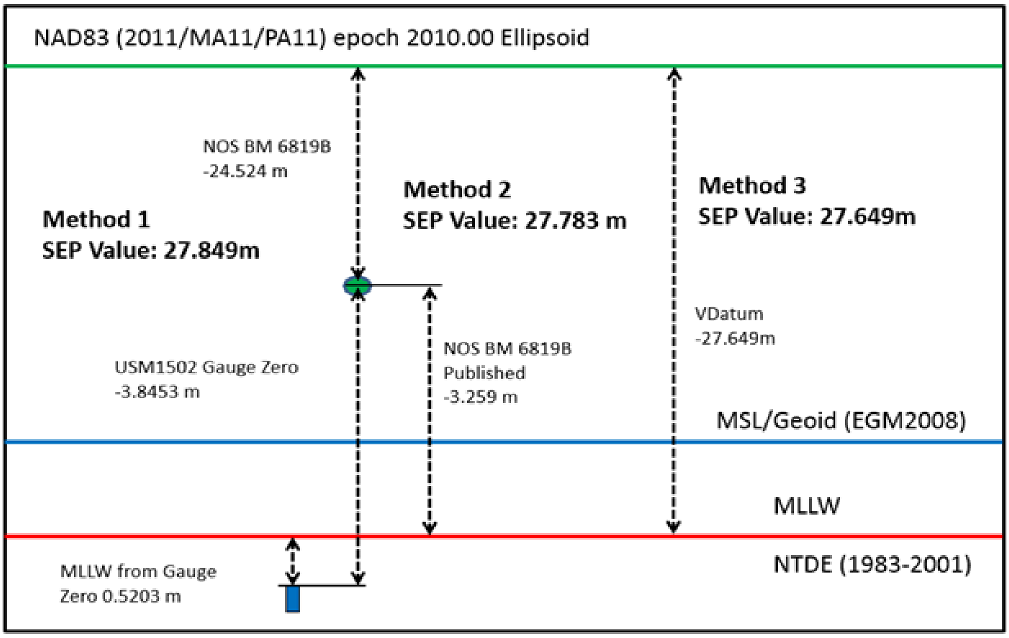

Figure 21. SEP value from four different methods.

Table 17. SEP values with uncertainties at 95% confidence interval.

	Method 1			Method 2			Method 3
SEP (m)	**27.849**			**27.783**			**27.649**
Uncertainty Components (m)							
Gauge Uncertainty	0.0005		GNSS Observation	0.011		ITRF to NAD83	0.020
Leveling Misclosure	0.00225		Datum Uncertainty (published)	0.011		NAD83 to NAVD88	0.050
Datum Transfer	0.0548					NAVD88 to MSL	0.148
GNSS Observation	0.011					MSL to MLLW	0.029
Σ (σ²ⁿ)	0.003129			0.000242			0.025645
Total Uncertainty at 95% C.I. (m)	**0.110**			**0.030**			**0.314**

C.2. Horizontal Control

C.2.1 Positioning Methods

The R/V GCGC was equipped with an Applanix POS MV WaveMaster II as the primary navigation system. The POS MV was operated with two Trimble Zephyr Model 2 antennas. The POS MV was logged in compliance with datagram requirements for post-processing in POSPac MMS 8.0. Due to malfunctions with the POS MV PCS, two COM ports were inaccessible for the duration of the survey. Therefore, the other two COM ports were needed to send data to the MBES and SSS and could not obtain auxiliary GPS inputs. The data was also accessible on the HYPACK field laptop via ethernet connection. The two GPS antennas were used as the primary and secondary antenna systems to determine an inertially-aided PPK positioning. A Topcon GR-5 was used to determine positions of some of the ATONs through a Real-Time Kinematic solution but had a limited range. Finally, a Garmin handheld receiver was utilized to obtain positions of the ATONs that were outside the radio signal propagation range offshore for the Base Station to send corrections to the Rover Topcon unit.

An RTK survey was also performed to obtain shoreline data, which utilized both GR-3 and GR-5 variants of Topcon pairs of receivers. Radio Technical Commission for Maritime services (RTCM) corrections were transmitted from the GR-3 and GR-5 base stations to the respective rovers to obtain accurate positions.

Finally, the GR-3 and GR-5 Topcon units were utilized to perform a GNSS station positioning method which determined accurate positioning of the tidal benchmarks.

See the 17USM01 HVCR for more information on positioning methods.

C.2.2 Positional Uncertainty

Using GrafNet, statistics were computed and estimated for all survey days. All estimated uncertainty values were well within survey requirements for IHO Special Order and NOAA's 1 m Object Detection Surveys. RTN and PPK data were also compared. This was done in CARIS HIPs and SIPs by creating new line files with the PPK data and overlaying them with the RTN ship track lines. Horizontal differences of up to 1.7 m can be seen between the two track lines. This is thought to be caused by the RTN solution switching between a fixed and float solution. The PPK data consistently produced low uncertainty solutions and was determined to be used as the primary positional source.

D. Results and recommendation

D.1 Chart Comparison

All chart comparisons were conducted in CARIS S-57 Composer 3.0.6 utilizing the most current, largest scale resources: ENC US5MS11M and Chart 11372, details found below in Table 17. Comparison analysis utilized the ENC format and appropriate transformations to WGS-84 as performed by the software. All applicable features from US5MS11M were imported into the new 17USM01 ENC, which was clipped to the new boundaries. Any features that were newly created or modified from the existing ENC had their source date (SORDAT) set to "20170628", the last day of survey, and their source indication (SORIND) set to "US,0_,Surfc, 17USM01_20170720_Combined_50cm" or "US,0_,reprt,17USM01" as appropriate. Sounding data collected via this survey was rendered in CARIS HIPS and SIPS 9.1 from the finalized, generalized surface and imported as S-57 objects. Soundings were grouped with those from NOAA ENC US5MS11M for areas outside of the three Pas, and contours were manually integrated where necessary.

Average depth changes were less than 0.6 m and predominantly occurred in and around the 10 m dredged channel in PA03. This minimal difference is most likely associated with accretion of silts from the nearby river deltas and the adjacent dumping sites for dredging operations in close proximity. As all three Pas contained some section of dredged waters, there were few soundings and contours on ENC US5MS11M and Chart 11372 with which to compare. Most information regarding depth is captured in metadata and chart notes. An overview of the survey boundary can be seen in Figure 20.

Table 18. Charts used for 17USM01 comparison.

Chart	Type	Scale	Edition	Date	LL bound	UR bound
US5MS11M	ENC	1:40000	50 update 1	20170502	30-07-31.909440, -089-24-39.792600	30-28-25.980600, -088-44-41.295840
11372	Chart	1:40000	35 LNM 2417	20170613	30-10-08, -089-21-20	30-28-05, -088-48-40
17USM01	ENC	1:5000	1	20170628	30-18-37.670400, -089-06-07.261200	30-21-58.953960, -089-02-47.796000

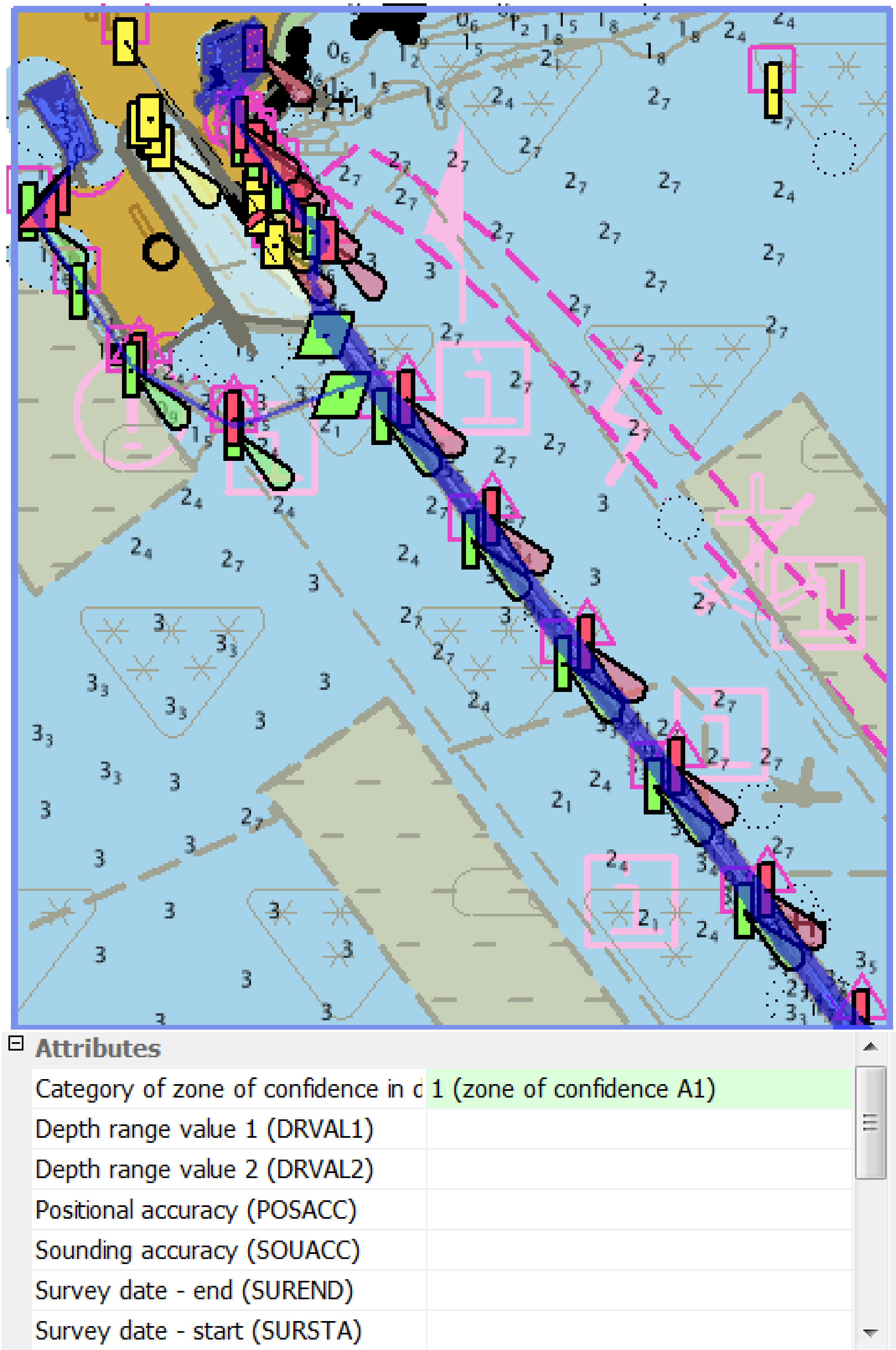

Figure 22. M_QUAL CATZOC set to 1 capturing all 3 Priority Areas.

Priority Area 1 (PA01)

ENC US5MS11M only lists one sounding within PA01 but notes the marina as a dredged area down to 2.4 m as referenced to NOAA Chart 11372. Multibeam coverage in PA01 confirms this depth throughout much of the marina, which was expected based on the relative frequency of dredging and public use. However, there are a few navigable areas around the Yacht club piers that are as shoal as 1.2 m. The most significant chart update was from the shoreline data collected. Based on the larger scale chart produced, there has been a significant update to the facilities to include 200+ finger piers. As such, the noted obstructions and wreck in PA01 listed on the original ENC have all been displaced by pier construction, but were left on the chart pending removal by NOAA. Additionally, ATON marker 63 is charted as a day marker vice buoy.

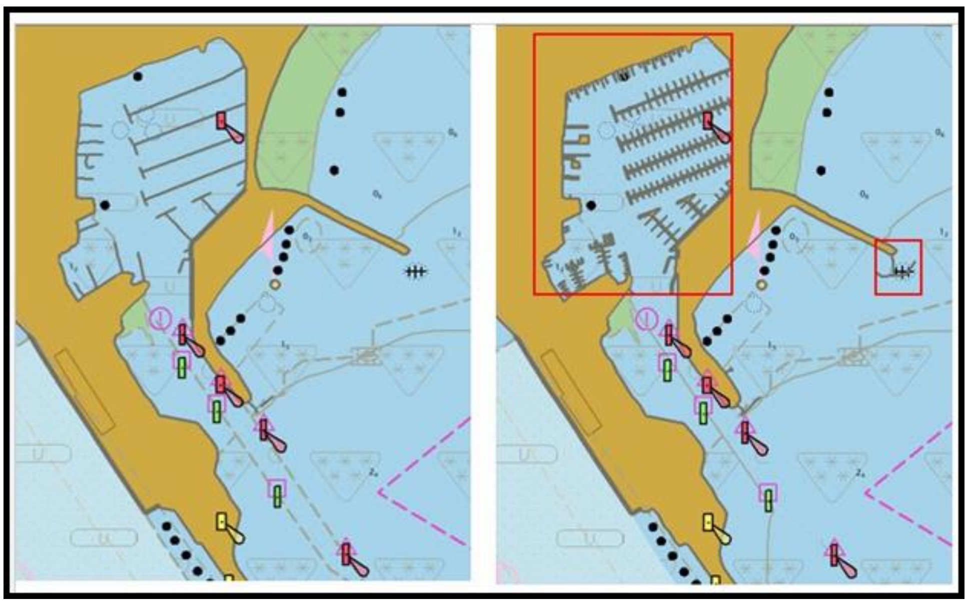

Figure 9. PA01 subsets of ENC US5MS11 (before) and 17USM01 (after).

Priority Area 2 (PA02)

Similar to PA01, there were few soundings listed on the chart for PA02. Likewise, this was due to much of the area being maintained in a dredged status of 1.2 m within the basin and 2.1 m along the approach channel. Of particular note, there is a 2 m contour that crosses the dredged channel immediately after day markers 3 and 4. Shoreline data were evaluated and used to update the status of the pier construction within the basin; however, it appears to be an active construction site. Once construction is complete, a revisit of shoreline data is recommended. MBES and SSS analysis showed two shoal areas. Comparison with the current ENC and chart shows that they are collocated within projected pier construction.

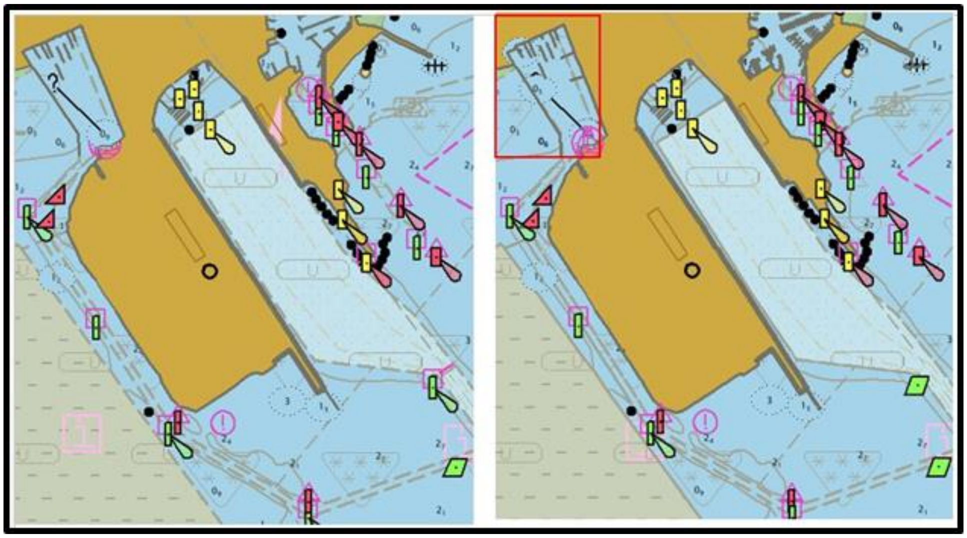

Figure 10. PA02 subsets of ENC US5MS11 (before) and 17USM01 (after).

Priority Area 3 (PA03)

Average sounding values throughout PA03 were adjusted by 0.6 m and were the most significant of all sounding adjustments. A significant change in PA03 involved the wreck described as being located at 30.311934 N -089.05162 W. SSS confirmed that although a fraction of wreck is located at the charted position, the majority of debris is actually 80m to the southeast as seen in both MBES and SSS in Figure 11-13 below. No other significant changes were made in PA03.

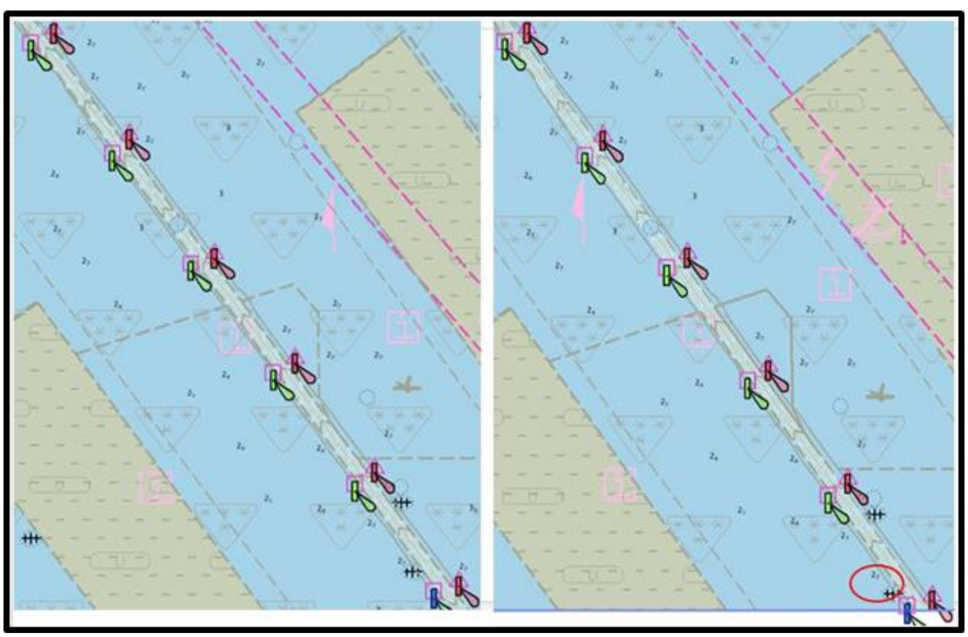

Figure 11. PA03 subsets of ENC US5MS11 (before) and 17USM01 (after).

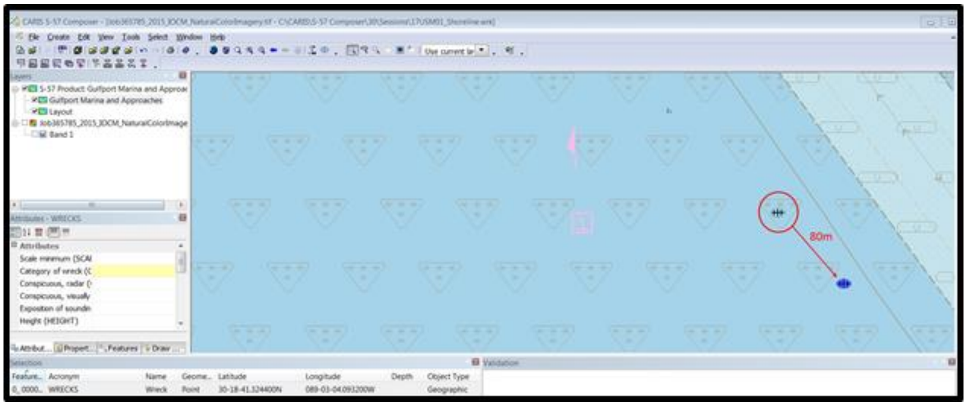

Figure 12. Inclusion of additional wreck debris to the SE.

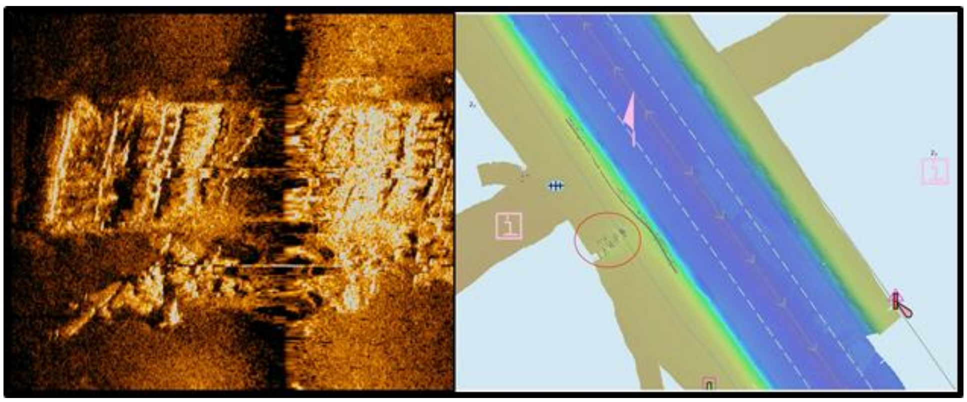

Figure 13. SSS/MBES image of wreck in PA03.

D.2 Additional Results

D.2.1 Seabed Samples

Seabed sampling was conducted on 08 June – 12 June 2017. A Wildco Petite Ponar Grab bottom sampler was used to collect seabed samples throughout the survey areas. GPS time and position were recorded during each sample via concurrent CTD casts. All seven samples were evaluated on site to be sticky mud of similar consistency across all three PAs. The samples were bagged in zip-lock sealing bags and brought to USM's geology lab for further analysis.

Two sediment samples were collected in each priority area with a 3rd sample taken in PA03 due to the more dynamic nature of the deeper channel. The positions of each sample and final classifications are listed in Table 11. Seabed characteristics were classified IAW the Wentworth grain size scale, see Appendix C, and listed in the ENC 17USM01.000 IAW S-57 standards. Visuals of the sediment analysis and classification process can be seen in Figures 21-24. Final lab results displayed more diversity that originally identified during field collection.

Table 19. Seabed samples with their corresponding S-57 encoding values.

Sample Number	Date/ Time UTC	Priority Area	Latitude	Longitude	Sediment Description/NATSU	NATQUA
A1_01	20170609 /2052	1	30.3596	-89.088	Mud, sand	Soft, soft
A1_02	20170608 /1805	1	30.3634	-89.0892	Mud, sand	Soft, soft
A2_01	20170609 /1937	2	30.3457	-89.0932	Sand, shells	Coarse, broken
A2_02	20170609 /1925	2	30.3557	-89.1004	Mud, sand	Soft, soft
A3_01	20170609 /2000	3	30.3169	-89.0541	Silt, clay	Fine, sticky
A3_02	20170608 /1830	3	30.3168	-89.0546	Silt, clay	Fine, sticky
A3_03	20170612 /1805	3	30.3351	-89.0705	Silt, clay	Soft, soft

Figure 23. Bottom sample from PA03 (10m channel).

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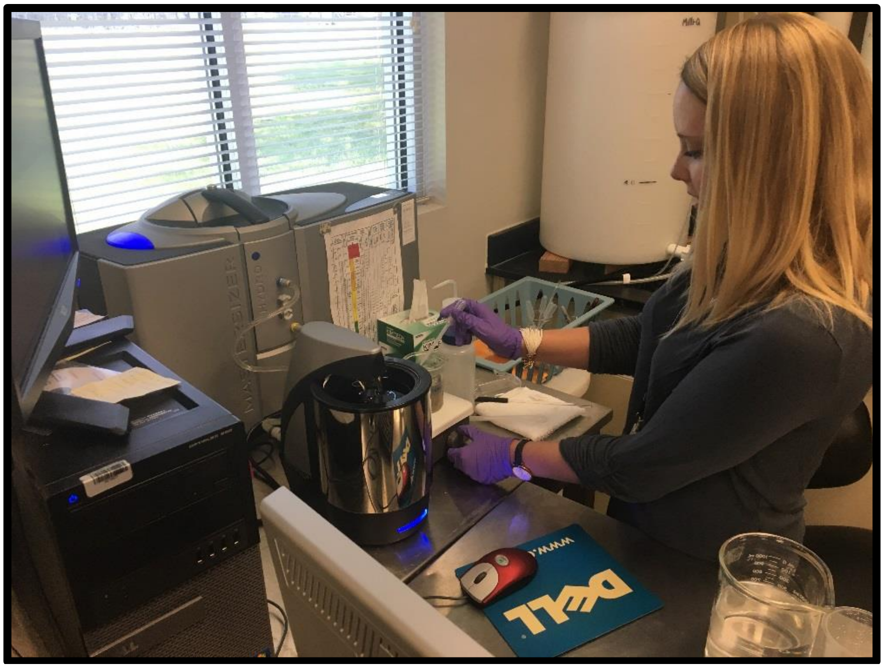

Figure 24. Bottom samples being prepared in the lab.

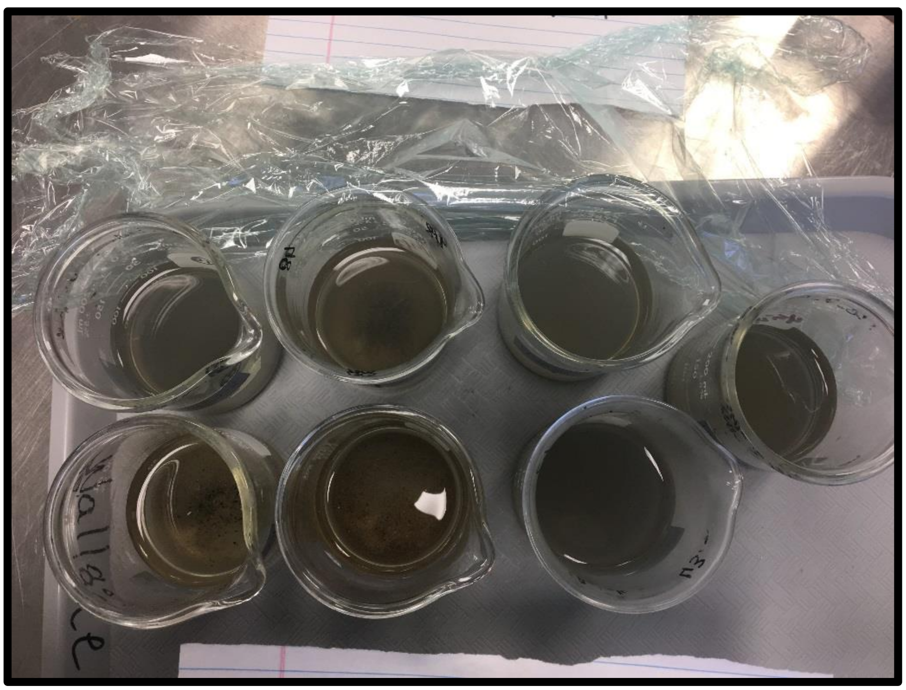

Figure 25. Samples settling for insertion to spectrometer.

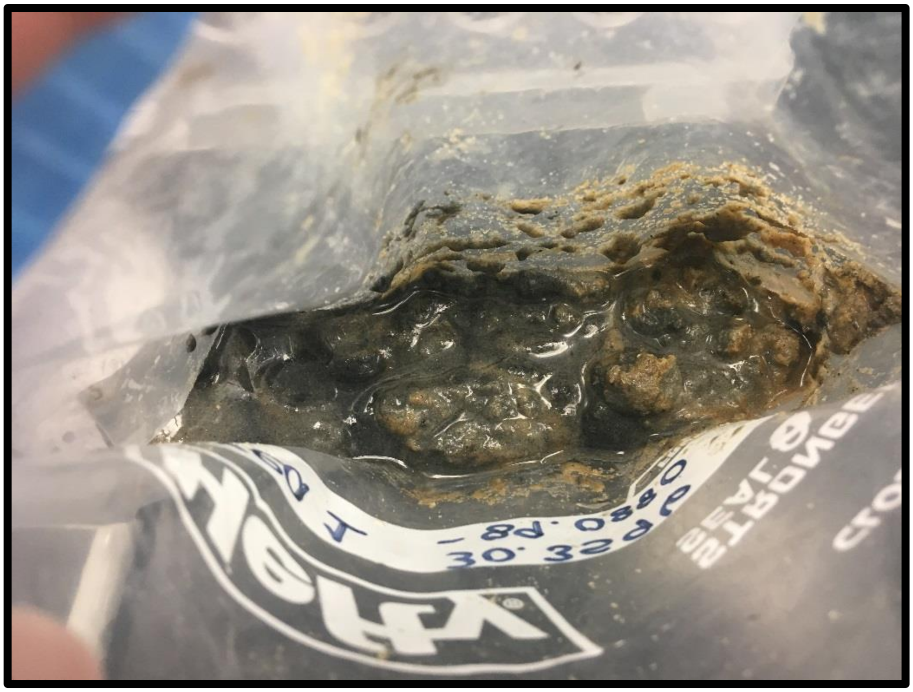

Figure 26. Bottom sample from PA01.

D.2.2 Aids to Navigation

Twenty four aids to navigation (ATONs) were investigated IAW NOS HSSD. A TopCon GR-5 base station was established over TBM-01. The bow of the R/V GCGC was then brought alongside each ATON, and its respective position was recorded using a separate GR-5 rover receiver mounted on a pole and held over the ATON. The radio signal propagation range of the TopCon precluded 4 of the ATONs from utilizing an RTK solution and therefore a handheld Garmin GPS employing WAAS corrections was used on a later date to measure their positions in similar fashion. Day marker 62 was photographed missing the identifying placard, however it was noted during processing that the Coast Guard was observed making repairs following the Tropical Storm that passed through the area. Marker 63 is annotated as a day marker on ENC US5MS11M, however as can be clearly seen in Table 18, it is a buoy. All ATONs investigated are listed in Table 12 below; those annotated in **green** fell within the NOAA FPM's 10m distance for 1:5000 scale chart, those in **red** exceeded this distance for fixed ATONs at this scale chart, but are within tolerance of the published 1:40000 chart. Buoys are annotated in **black** as their scope of chain was unknown and their positions seem to be roughly on position.

Table 20. Aids to navigation.

Imagery	Area	Name	Verified Position (NAD83)	Charted Position (NAD83)	Distance off Charted position (m)	Bearing from Charted position (˚)
	1	Red 10	30.359940 -089.087529	30.359989 -089.087600	8	130
	1	Green 9	30.359289 -089.087627	30.359337 - 089.087610	5	200
	1	Red 8	30.359001 -089.086731	30.359003 -089.086732	-	-
	1	Green 7	30.358444 -089.086814	30.358471 -089.086817	3	175
	1	Red 6	30.358065 -089.085871	30.358113 -089.085750	13	245

	1	Green 5	30.356727 -089.085334	30.356792 -089.085441	13	125
	1	Red 4	30.355656 -089.083849	30.355664 -089.083879	3	110
	1	Green 3	30.354145 -089.083134	30.353977 -089.083117	18	355
	1	Red 2	30.353615 -089.082179	30.353624 -089.082233	5	100
	1	Green Can 1	30.345228 -089.081274	30.345236 -089.08133	6	100
	2	Green 3	30.343193 -089.088024	30.343220 -089.088096	8	290

	2	Red 4	30.343861 -089.088049	30.343869 -089.088104	5	100
	2	Green 5A	30.350830 -089.097876	30.346557 -089.094547	3	335
	2	Red Nun 6A	30.355018 -089.099973	30.35503 -089.100031	6	105
	2	Red 8	30.355930 -089.099368	30.356013 -089.099566	42	150
	3	Green 63	30.348480 -089.082263	30.348408 -089.082382	14	060
	3*	Red 58	30.33153 -089.06572	30.331211 -089.065705	35	000

	3*	Green 57	30.3304 -089.06717	30.330467 -089.067361	18	090
	3*	Red 56	30.32478 -089.06000	30.324763 -089.059989	2	330
	3*	Green 55	30.32375 -089.06144	30.323737 -089.061512	7	080
	3	Red 62	30.344942 -089.077098	30.345061 -089.077099	13	180
	3	Green 61	30.343989 -089.078647	30.344027 -089.078694	6	130
	3	Red 60	30.338523 -089.071715	30.338540 -089.071739	3	130

	3	Green 59	30.33721 -089.072989	30.337225 -089.072933	5	260

* Garmin hand held GPS w/WAAS enabled

D.2.3 Dangers to Navigation

No previously uncharted DTONs were noted during this survey.

No DTONs were identified in PA01. The four charted obstructions and one wreck found on ENC US5MS11M and NOAA Chart 11372 have been consumed by construction projects and/or artificial shoreline reinforcement. As such they are recommended to be removed from future ENC/Chart production.

In PA02, two DTONs referred to in this report as 2A_001 (Figure 25) and 2A_002 (Figure 26) are identified as obstructions, most likely associated with construction debris. They are concurrent with previously annotated submerged shoreline construction projects on the ENC and are not visible at the scale of chart 11372. A shoaling area is noted just outside the straight line definition of the dredged channel in the southern portion of PA02 as seen in Figure 27. Proximity to the dumping site for dredging operations and an easterly current could cause encroachment into the channel. The three other obstructions were investigated, however could not be identified in MBES nor SSS imagery, but due to time constraints inadequate data was collected to thoroughly disprove their existence.

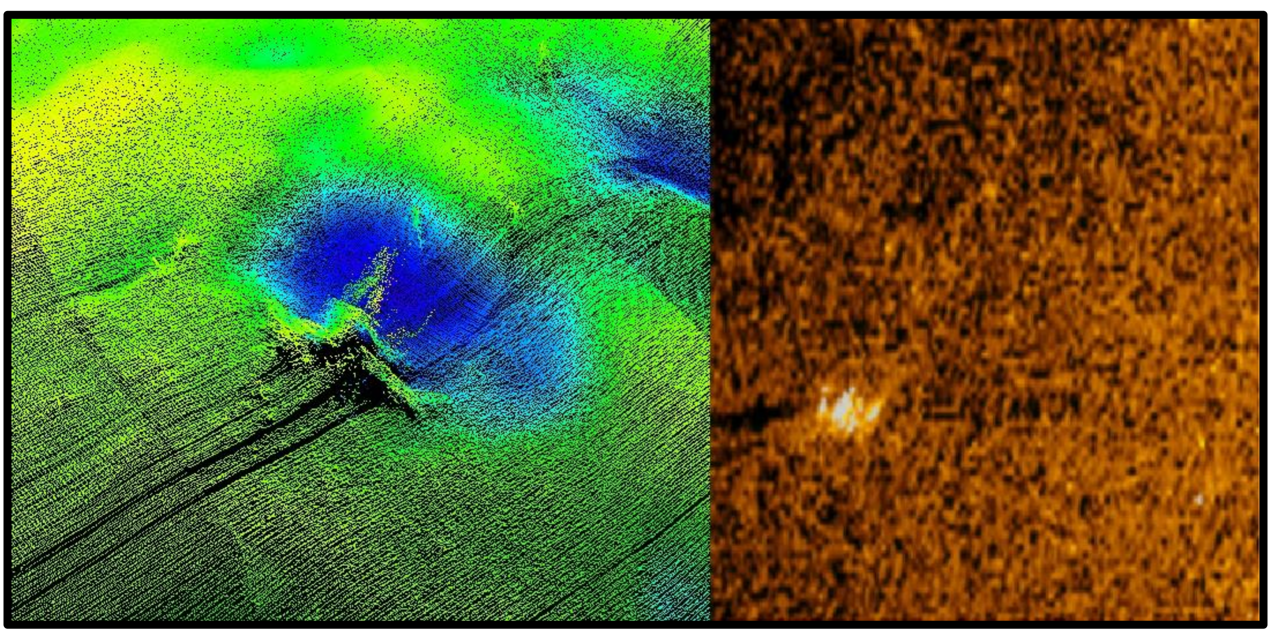

Figure 27 PA02 Contact 001 (MBES/SSS).

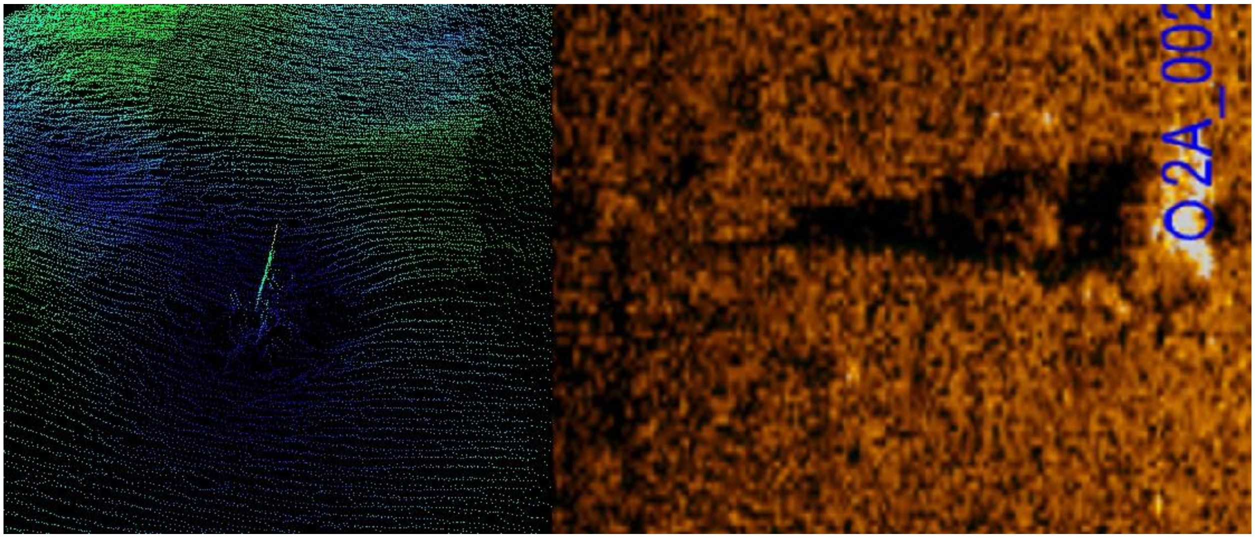

Figure 28 PA02 Contact 002 (MBES/SSS).

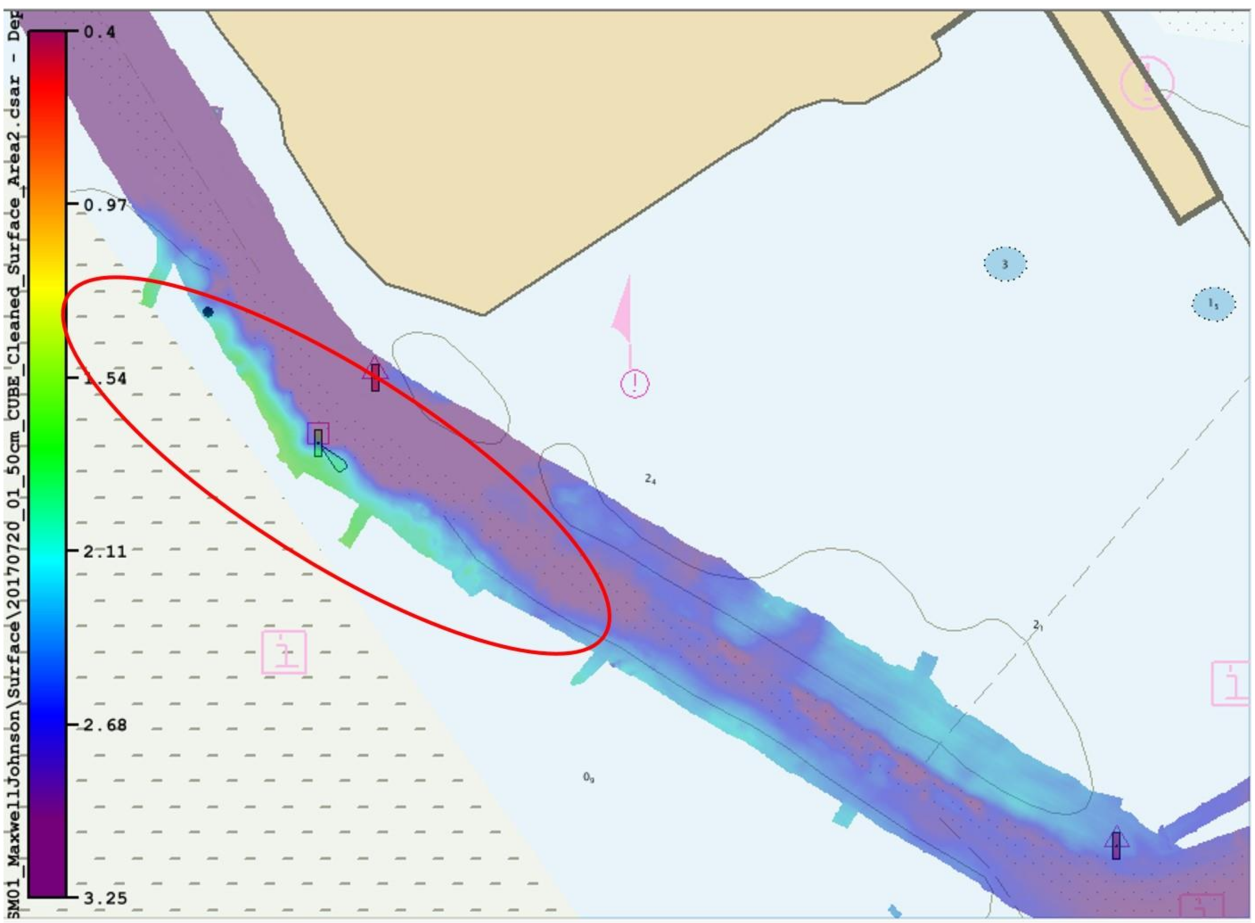

Figure 29 Encroaching 1.5m shoal area outside dredged channel.

Two DTONs referred to in this report as 3A_001 (Figure 28) and 3A_002 (Figure 29) were able to be identified in PA03 and classified as the debris of a ship wreck. Although listed as a single feature IAW NOAA's HSSD requirement for features within 4mm on the 1:40,000 scale chart, the features are approximately 8mm apart at 1:5,000 scale ENC and therefore warrant charting as separate features. AWOIS confirms that the sunken shipwreck is known to be scattered, therefore this is not a new DTON. The smaller portion is located at the original coordinates listed on the ENC, and measures 1.77m proud in 2.7 m of water but was only captured by SSS as seen in Figure 29. However the majority of the wreck is located 80m south east of its charted position with a maximum height of 1.58m in similar water depth and can be seen in Figure 28 in both MBES and SSS. Due to the relatively shallow depths of the wreck, it is listed as dangerous. All other obstructions and wrecks charted in this area were investigated, but could not be identified in MBES nor SSS imagery. All DTON images can be found in Appendix B of this report to include all identifiable attributes; length, width, and height derived from shadow size via SSS.

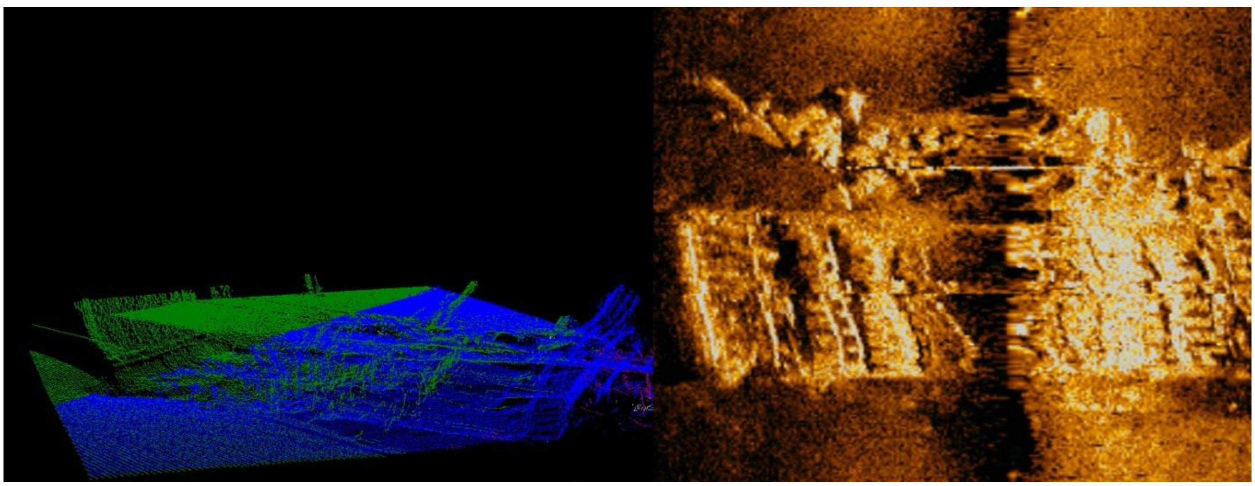

Figure 30 PA03 Contact 001 (MBES/SSS).

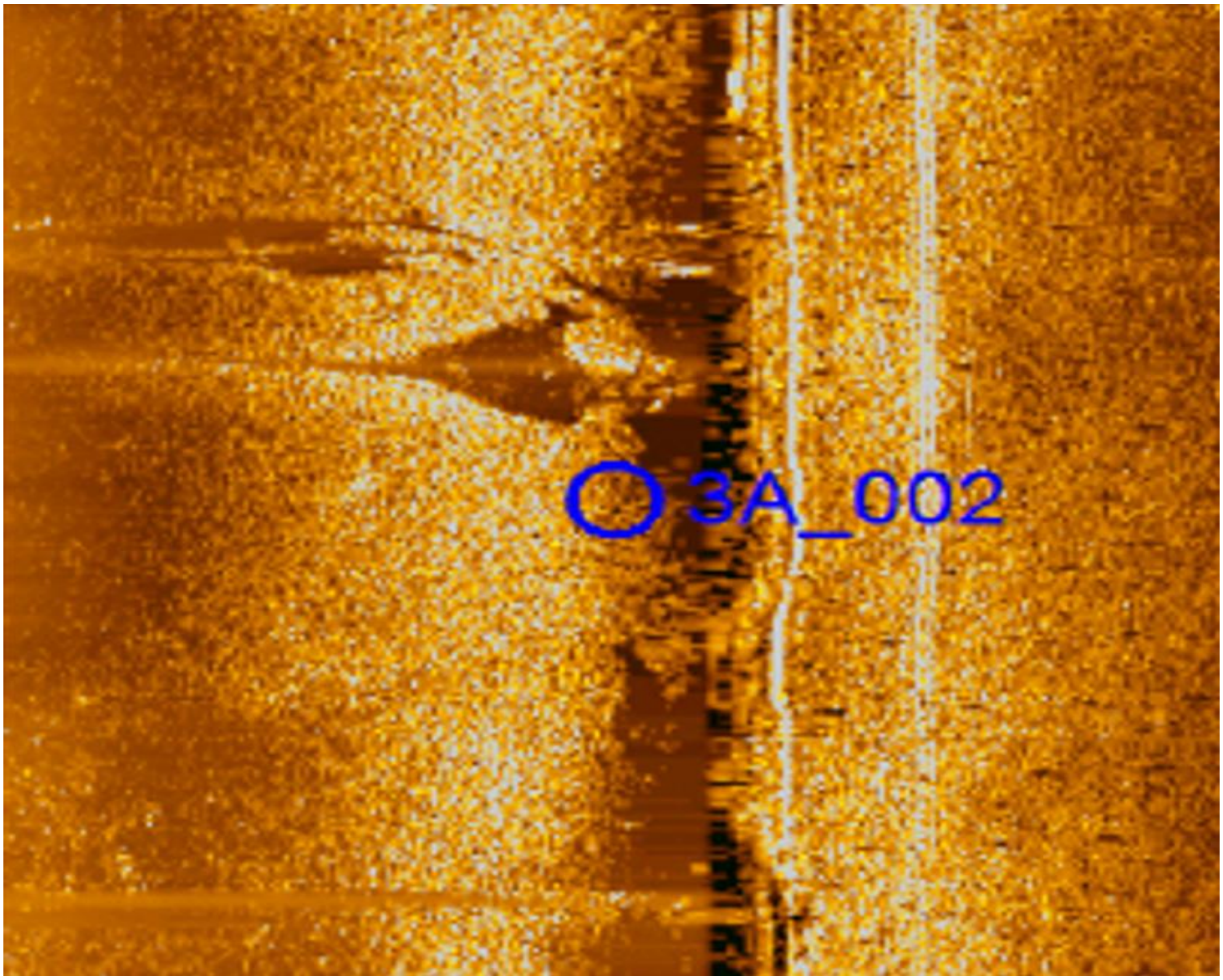

Figure 31 PA03 Contact 002 (SSS only).

D.2.4 Shoreline Delineation

Shoreline delineation was conducted on 30 May 2017 from 1530-2030 UTC using a concert of technologies to include two GNSS Topcon GR-3's two TopCon GR-5, one pole-mounted and one wheeled. On 9 June 2017, a LIDAR system on loan from the Naval Research Laboratory was employed to provide additional data confirmation. Finally, during processing both aerial and satellite photogrammetry from NOAA's OCS and the Navy's Global Eagle were utilized.

The TopCon GR-3 and GR-5 base stations were positioned over tidal BM's and programmed to serve as real-time correctors for the GR-3's and GR-5's pole-mounted/wheeled rover units to collect positioning of the shoreline. The RTK solutions were overlaid on the existing ENC data as seen in Figure 32to provide a guide for shoreline adjustments as well as modifications to recent constructions/destruction; included were several marina piers recently built, as well as storm damage throughout the area. The aerial and satellite images were collected in 2015 and 2017 respectively and were consulted alongside the terrestrial based LIDAR point cloud, Figure 33, to further develop piers with restricted access that precluded on site GNSS data collection.

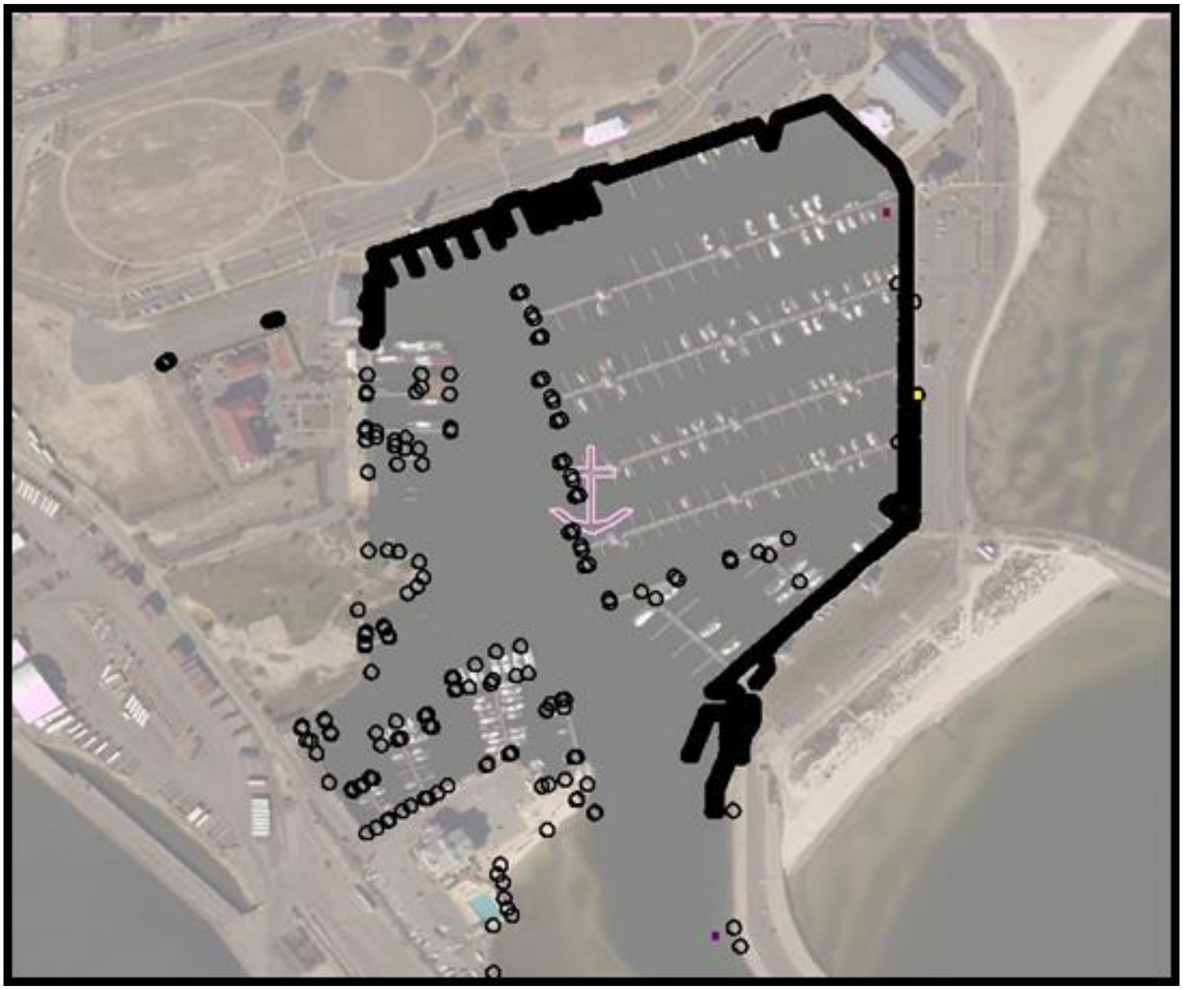

Figure* 32. *RTK data overlaid on aerial photogrammetry.

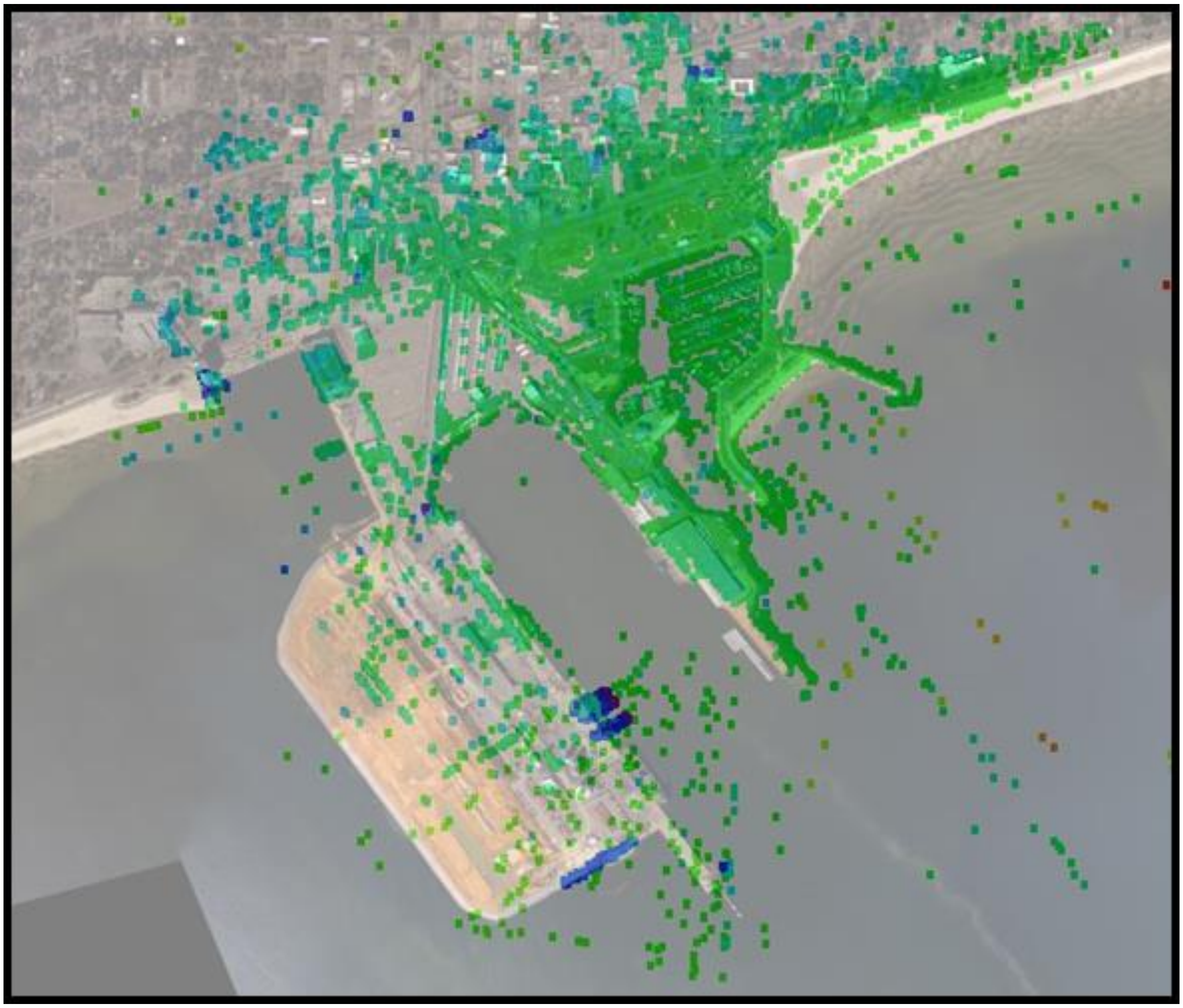

Figure **33.** ***LIDAR data overlaid on satellite photogrammetry.***

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Although the majority of shoreline in and around PA01 is manmade, shoreline data collection was timed to be within +/- 3 hr and 3ft of high tide IAW NOAA procedures as seen in Figure 34.

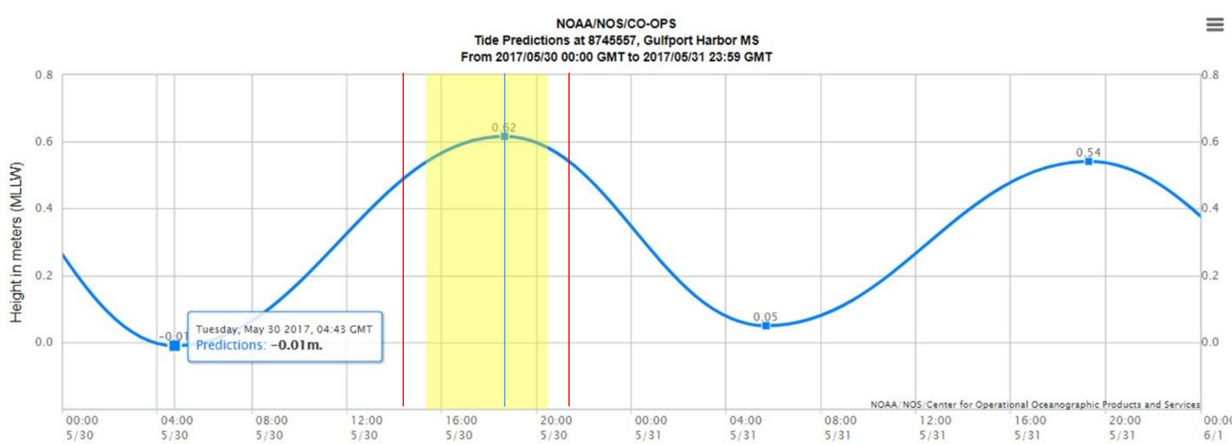

Figure **34.** ***30 May 2017 Predicted Tide***

D.2.5 Recommended Amendments to Sailing Directions/Coast Pilot

The Gulfport Municipal Marina is a new construction relative to the latest edition of the Coast Pilot 5. The facilities described for small craft are limited to those in the Bert Jones Yacht Basin, located in PA01. The water depth is listed as 7 ft (2.13m) which is appropriate for the areas of the Yacht Basin surveyed as well as the municipal marina. The additional facilities should be ascribed for small pleasure craft slippage, however no safety issues are lacking. Once the construction of pier work and facilities in PA02 are completed it would be prudent to update the Coast Pilot with that information as well. All other information appears to be factually accurate. Full review can be found in the Coast Pilot Review Report.

D.2.6 Recommended Amendments to Light List

The entirety of this survey was conducted during day light hours therefore the form, type, and functionality of lights throughout the survey area could not be confirmed. No recommendations are put forward.

E. Approval Sheet

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APPROVAL PAGE

W00457

The survey data meet or exceed the current requirements of the Office of Coast Survey hydrographic data review process and may be used to update NOAA products. The following survey products will be archived at the National Centers for Environmental Information:

- Descriptive Report
- Collection of Bathymetric Attributed Grids (BAGs)
- Geospatial PDF of survey products

Digitally signed by HOLMBERG.PETER.SCOTT.1365886101
Reason: I am approving this document
Date: 2022.01.03 09:33:46 -08'00'

Approved:____

Peter Holmberg

Products Lead, Pacific Hydrographic Branch