W00458

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	W00458

LOCALITY

State(s):	Mississippi
General Locality:	South Mississippi Gulf Coast Region
Sub-locality:	Long Beach Harbor

2017

CHIEF OF PARTY
Maxim Van Norden

LIBRARY & ARCHIVES

Date:

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00458

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:	**South Mississippi Gulf Coast Region**
Sub-Locality:	**Long Beach Harbor**
Scale:	**40000**
Dates of Survey:	**06/13/2017 to 06/19/2017**
Instructions Dated:	**N/A**
Project Number:	**ESD-PHB-18**
Field Unit:	**University of Southern Mississippi**
Chief of Party:	**Maxim Van Norden**
Soundings by:	**Kongsberg Maritime EM 2040C (MBES)**
Imagery by:	**EdgeTech Unknown (SSS)**
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

August 25, 2021

MEMORANDUM FOR: Pacific Hydrographic Branch

FROM: Report prepared by PHB on behalf of field unit
Maxim Van Norden
Chief of Party, University of Southern Mississippi

SUBJECT: Submission of Survey W00458

In accordance with the University of Southern Mississippi (USM) Division of Marine Science requirements for the IHO category 'A' hydrographic certification program, students planned and executed this hydrographic survey.

Survey products were submitted by the field unit and verified by the hydrographic branch.

All soundings were reduced to Mean Lower Low Water using Constant Separation. 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 vertical and horizontal control methods utilized during this survey are described in the ESD-PHB-18 HVCR report.

All survey systems and processing methods utilized during this survey are described in the ESD-PHB-18 DAPR report.

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

University of Southern Mississippi acquired the data outlined in this report. Additional documentation from the data provider may be attached to this report.

This survey does meet charting specifications and is adequate to supersede prior data.

Long Beach Harbor and Approach (MS)

17USM02 Hydrographic Survey
Descriptive Report

CAO: 28JUL17

Prepared By:

Gilbert Alviola | Ryan Beets | Joshua Bergeron

Kyle Kaszynski | Halim Nordin | Dennis Wilson

NOAA FORM 77-28 (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY No 17USM02
HYDROGRAPHIC TITLE SHEET	
INSTRUCTIONS - The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.	FIELD No N/A

State	Mississippi		
General Locality	South Mississippi Gulf Coast Region		
Sub-Locality	Long Beach Harbor		
Scale	1:40,000	**Date of Survey**	June 7 to June 20, 2017
Instructions dated	N/A	**Project No.**	N/A
Vessel	R/V LeMoyne		
Chief of Party			
Surveyed by	University of Southern Mississippi (R. Beets, G. Alviola, J. Bergeron, K. Kaszynski, H. Nordin, D. Wilson)		
Soundings by echo sounder, hand lead, pole	ECHOSOUNDER (POLE MOUNTED)		
Graphic record scaled by	N/A		
Graphic record checked by	N/A	**Automated Plot**	N/A
Verification by	N/A		
Soundings in fathoms feet at MLW MLLW	METERS at MLLW		

REMARKS All times are in UTC. Projection is in UTM ZONE 16N

NOAA FORM 77-28 SUPERSEDES FORM C&GS-537

U.S GOVERNMENT PRINTING OFFICE: 1978-886-881/1222 REGION NO.6

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Short Details

Table 1. Short Details for proposed survey of Long Beach Harbor and Approach.

Survey Title	Long Beach Harbor & Approach, MS
Region	USA, Central Mississippi Gulf Coast
HSS Number	17USM02
Survey Dates	12-19 June 2017 (JD 163-170)
Team Members	Gilbert Alviola, Ryan Beets, Joshua Bergeron Kyle Kaszynski, Halim Nordin, Dennis Wilson
Locality	Long Beach, MS
Positional Accuracy	IHO Special Order NOAA 1m Object Detection Coverage Survey
NOAA Nautical Charts (Datum: NAD83)	DNC 11371 (41st Ed.) Scale: 1:80,000 Soundings: ft. @ MLLW DNC 11372 (35th Ed.) Scale: 1:40,000 Soundings: ft. @ MLLW
NOAA ENCs (Datum: WGS84)	ENC US5MS11M.00 (50.1 Ed.) Soundings: m @ MLLW ENC US4MS10M.00 (18.2 Ed.) Soundings: m @ MLLW
Horizontal Datum (S-57 Compliance)	NAD83 (2011/MA11/PA11) Epoch 2010.0 WGS84 (G1674) 2005.0
Vertical Datums	MLLW (NTDE 1983-2001) NAVD88 (Geoid12B)
Product Scale	1:5,000
Prior Survey	H11618

A. Area Surveyed

A.1 Purpose and Objectives

In accordance with the University of Southern Mississippi (USM) Division of Marine Science requirements for the IHO category 'A' hydrographic certification program, students are required to plan and execute a hydrographic survey to the standards specified by IHO Order 1A [IHO, 2008]. 17USM02 was designed to exceed these standards, meeting IHO Special Order and NOAA Object Detection Coverage Survey (ODCS) outlined in the National Ocean Service (NOS) Hydrographic Survey Specifications and Deliverables (HSSD) [NOS, 2017].

Long Beach Harbor and Approach was selected for survey based on several factors, including safety to navigation, date of previous survey, and importance to interested parties. As a result of these dynamics, the selected study area was divided into two priority areas. The first is a full seafloor coverage of the interior of Long Beach Harbor and associated marked approach (priority area 1). This includes positioning all features of interest such as aids to navigation (ATONs) and delineation of the shoreline to affirm position of harbor piers and jetties. Priority area 2 includes the outer approach and surrounding shallows, as well as determining the validity of charted dangers to navigation (DTONs).

17USM02 was designed and carried out in consultation with several government agencies including the Mississippi Department of Marine Resources (DMR), City of Long Beach, and the National Oceanic and Atmospheric Administration (NOAA). DMR is responsible for several artificial fishing reefs along the Mississippi Gulf Coast, three of which are located in proximity to Long Beach Harbor. They have expressed an interest in any bathymetric and imaging data relating to the accessibility and condition of these reefs. The City of Long Beach is planning an expansion project at the harbor. The results of this survey have been requested as ancillary data for possible construction, as well as for the Harbormaster's office to aid in assessing harbor seafloor condition and determining under keel clearance within the harbor and approach. Mr. Tim Osborn, Navigation Manager, Central Gulf Region was consulted during the survey planning and recommended that USM focus survey efforts on maintaining up to date nautical charts of small craft facilities along the Mississippi Gulf Coast. There are few NOAA resources available for allocation to these projects and represent survey areas that are of particular interest to the local community. In addition the aforementioned clients, this data will be provided to NOAA Office of Coast Survey to assist in updating existing nautical charts.

A.2 Area Surveyed

This Hydrographic survey was completed as specified by the 17USM02 Long Beach Harbor Survey Specifications and Deliverables, dated May 29th, 2017, with exceptions described within this report, and the NOS HSSD [HSSD, 2017].

The final survey coverage achieved by 17USM02 was limited by survey time spent with calibration difficulties and a weather event towards the end of the survey. However, the coverage was significant enough to achieve the goals described in the 17USM02 HSSD. The extent of our Kongsberg multibeam bathymetry coverage is depicted in figure 1 and 2. The extent of our EdgeTech bathymetry coverage is depicted in figure 3 and 4.

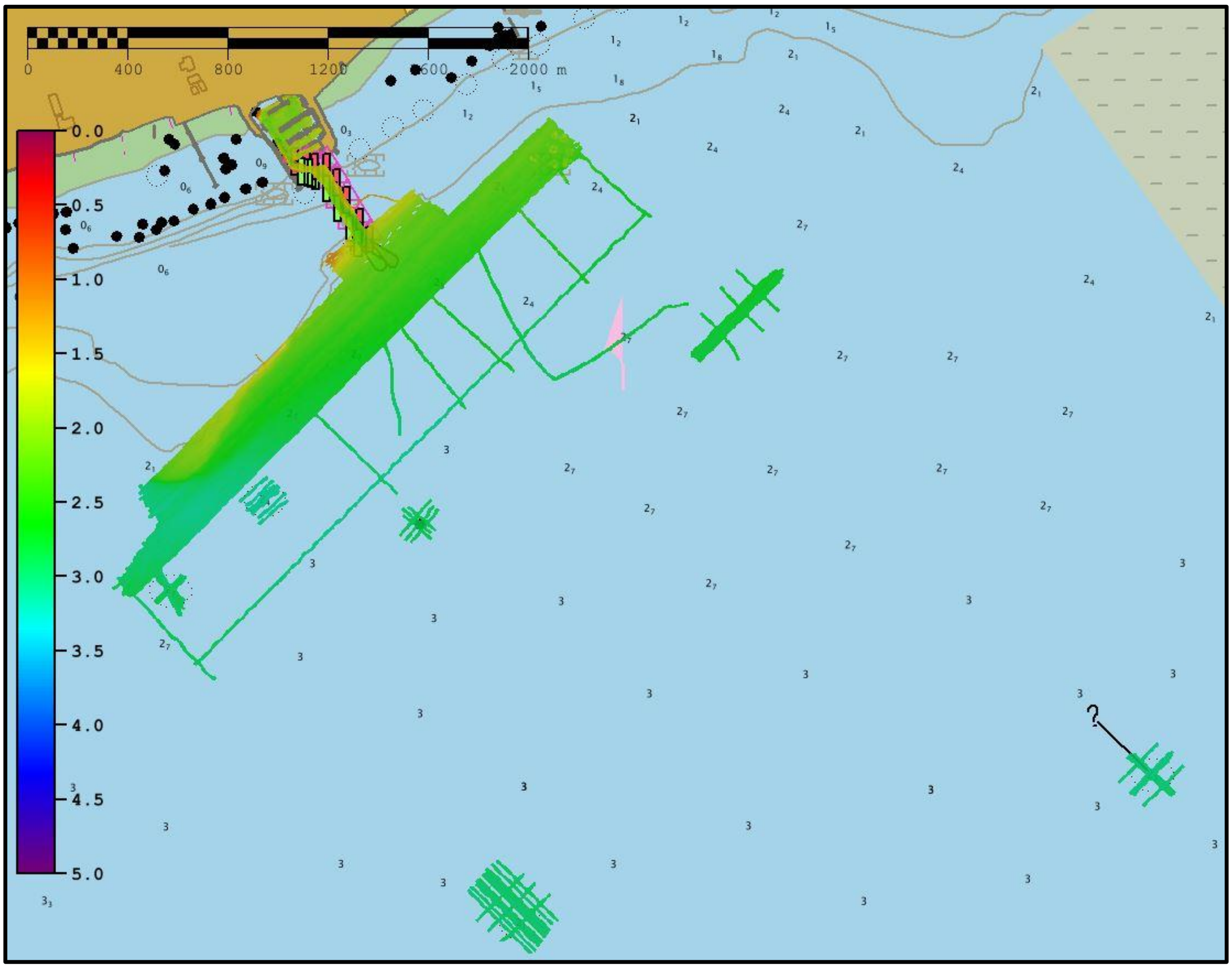


Figure 1. Kongsberg MBES bathymetry coverage with colored depth in meters.

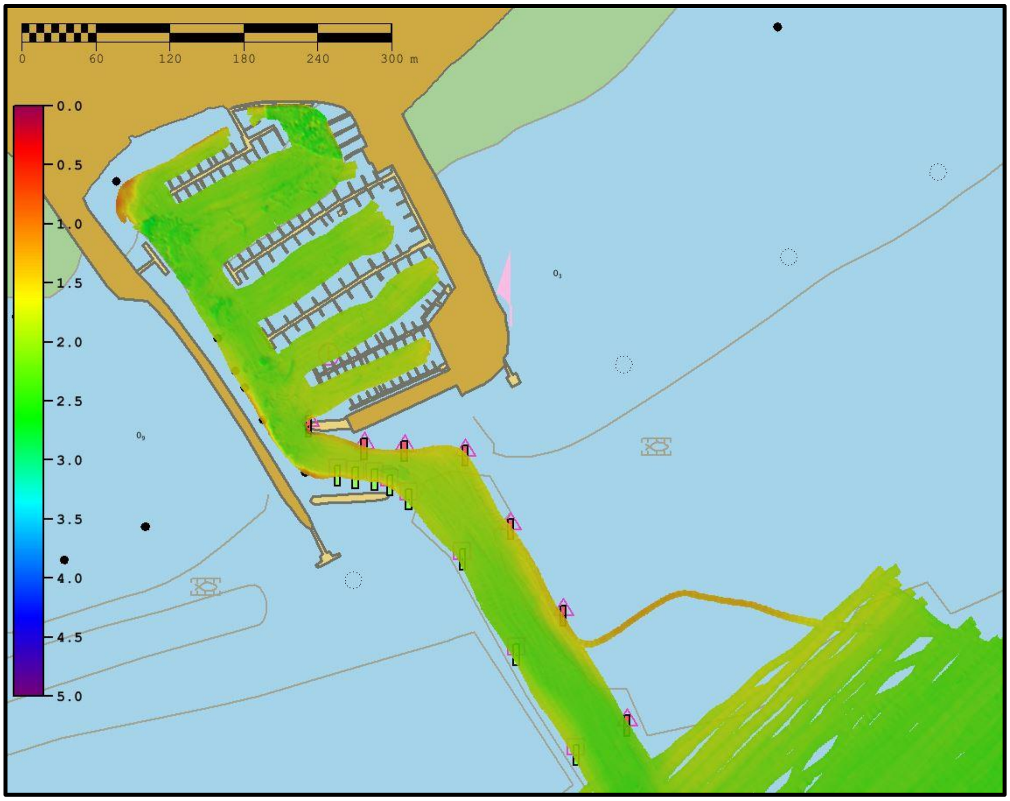


Figure 2. Kongsberg multibeam bathymetry coverage within the harbor with colored depth in meters.

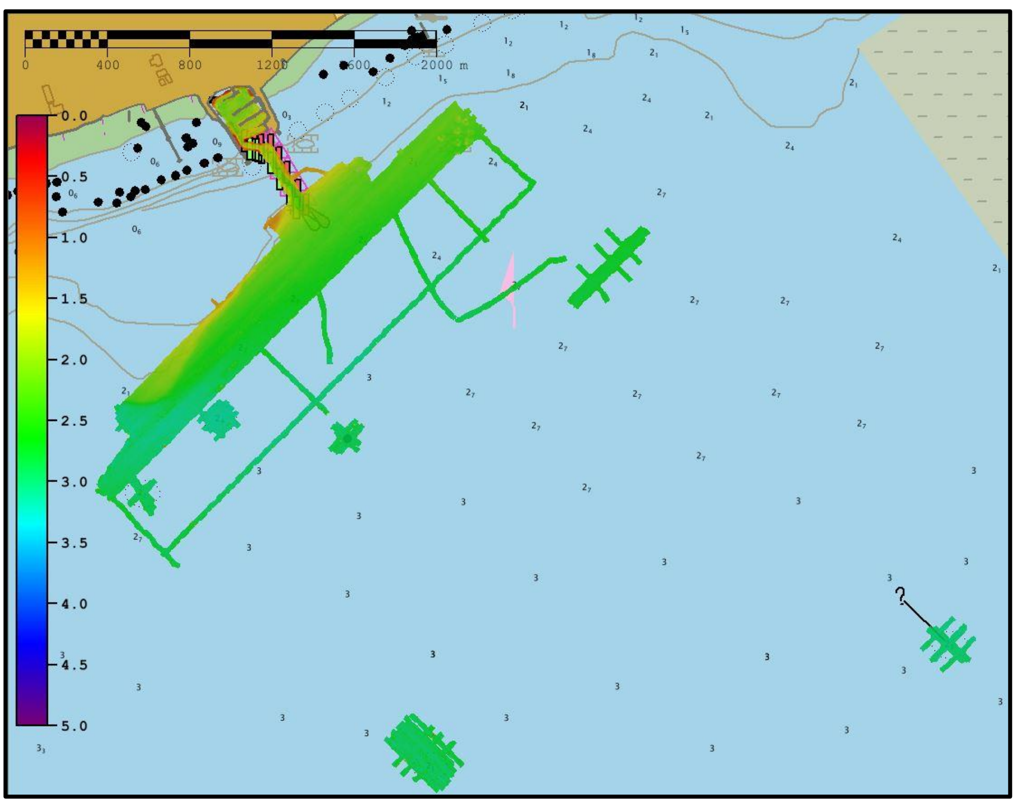


Figure 3. EdgeTech multibeam bathymetry coverage with colored depth in meters.

Figure 4. EdgeTech bathymetry coverage within the harbor with colored depth in meters.

A.3 Survey Quality

All survey planning, practices, and final product production were performed to the standards of an Object Detection (Option B) Survey as defined in section 5.2.2 of the HSSD [HSSD, 2017]. 200% side scan sonar coverage with concurrent MBES bathymetry was collected with object detection MBES developments of contacts and features. Concurrent EdgeTech 6205 bathymetry was also collected for further comparison and validation. This data will be made available to NOAA and USM by request. Line spacing was such that greater than 200% of the seafloor was covered with side scan (Figure 5). This figure shows side scan coverage for the low frequency channel (550 kHz). High frequency (1600 kHz) data was also recorded with the same coverage percentages.

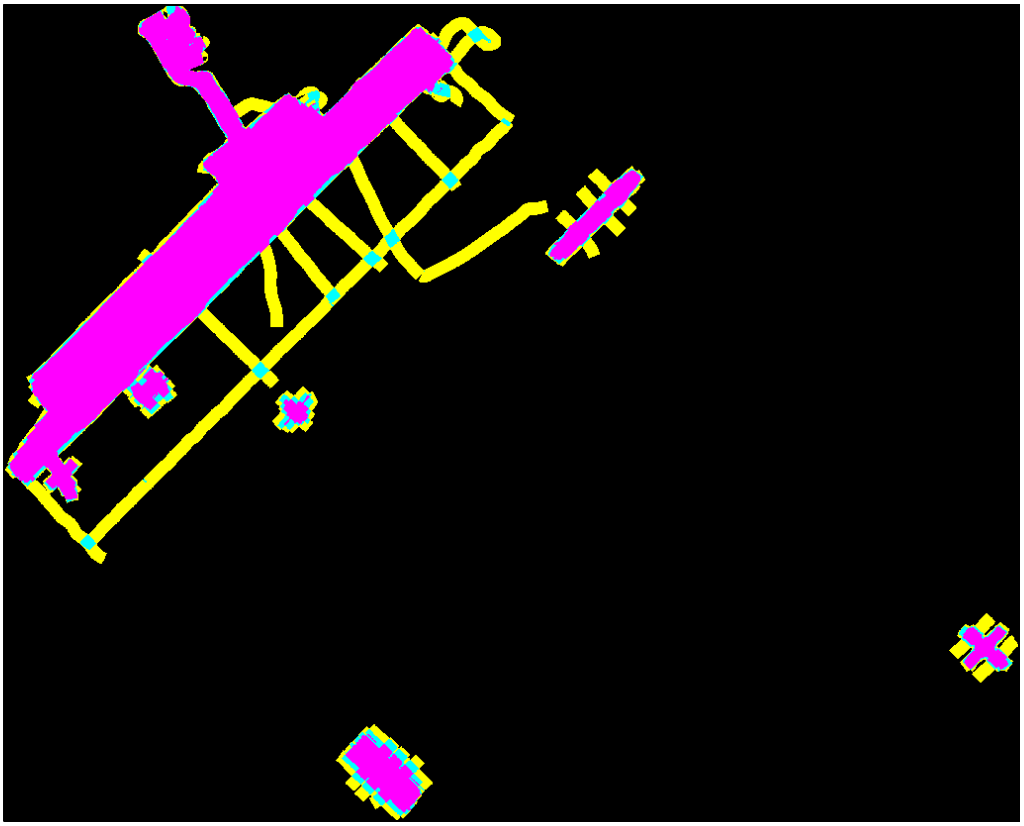


Figure 5: Side scan coverage during 17USM02. Yellow = 100%, Blue = 200%, Pink = 300%

In addition, this survey successfully met Special Order standards as set forth in the IHO S-44 standards [IHO, 2008]. Uncertainties were obtained by calculating both total vertical and horizontal uncertainty (TVU and THU), and survey coverage. By adhering to the NOS HSSD and IHO specifications, this survey is recommended for consideration to supersede previous survey data for the area.

The number of sounding per node exceeds that required by specifications. This is further discussed in the 17USM02 DAPR section B.1.2.

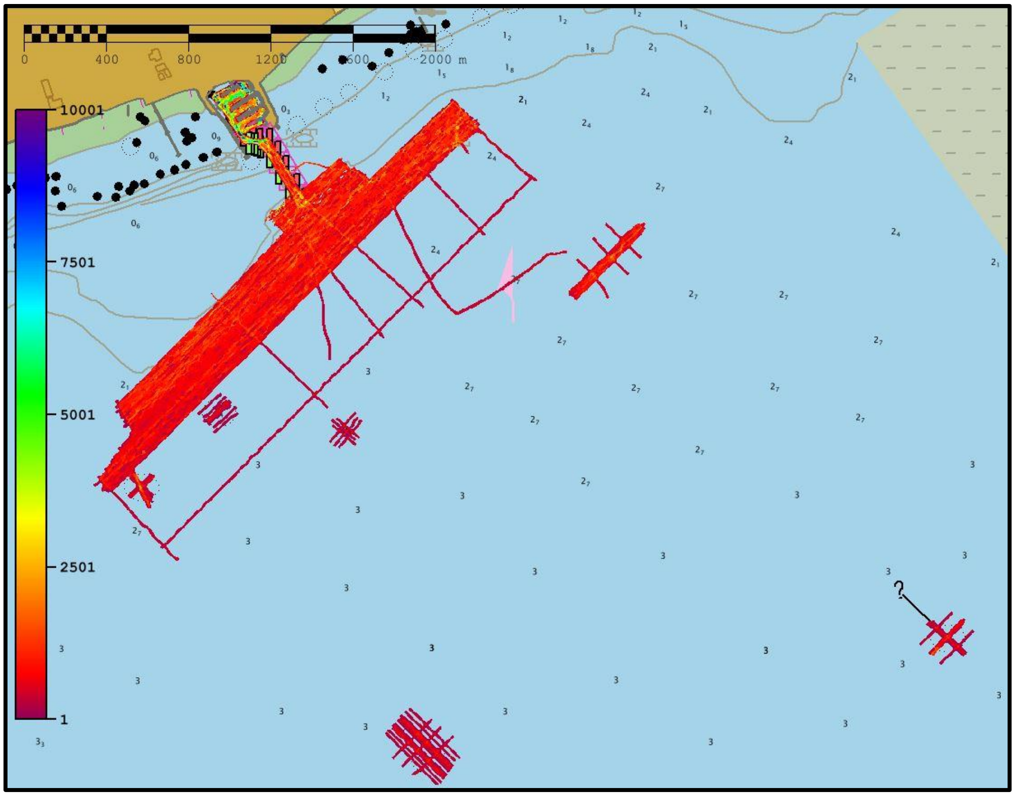


Figure 6. Density of multibeam soundings per node overview.

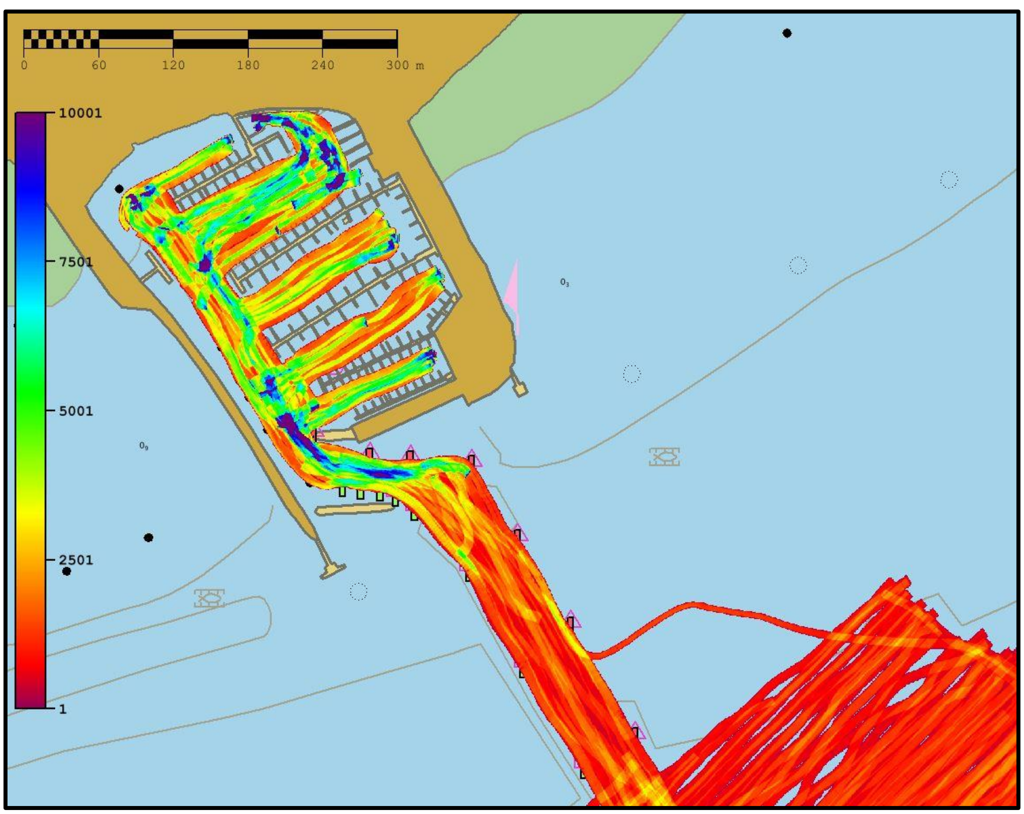


Figure 7. Density of multibeam soundings per node within harbor.

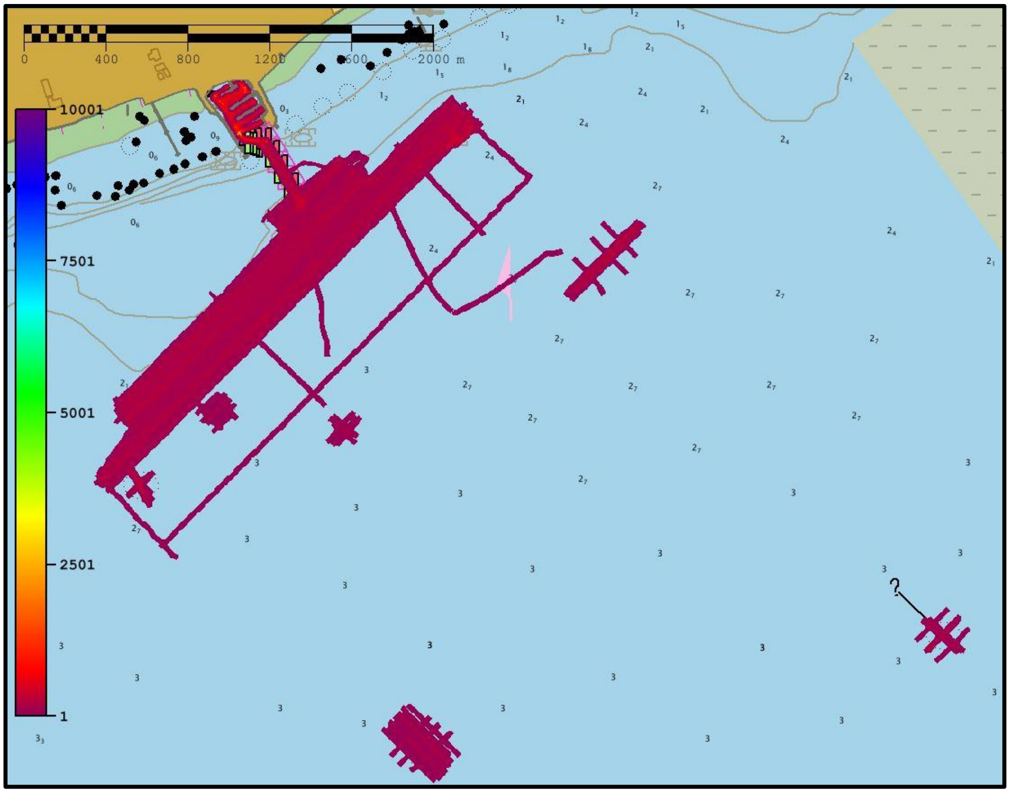


Figure 8. Density of EdgeTech 6205 soundings per node overview.

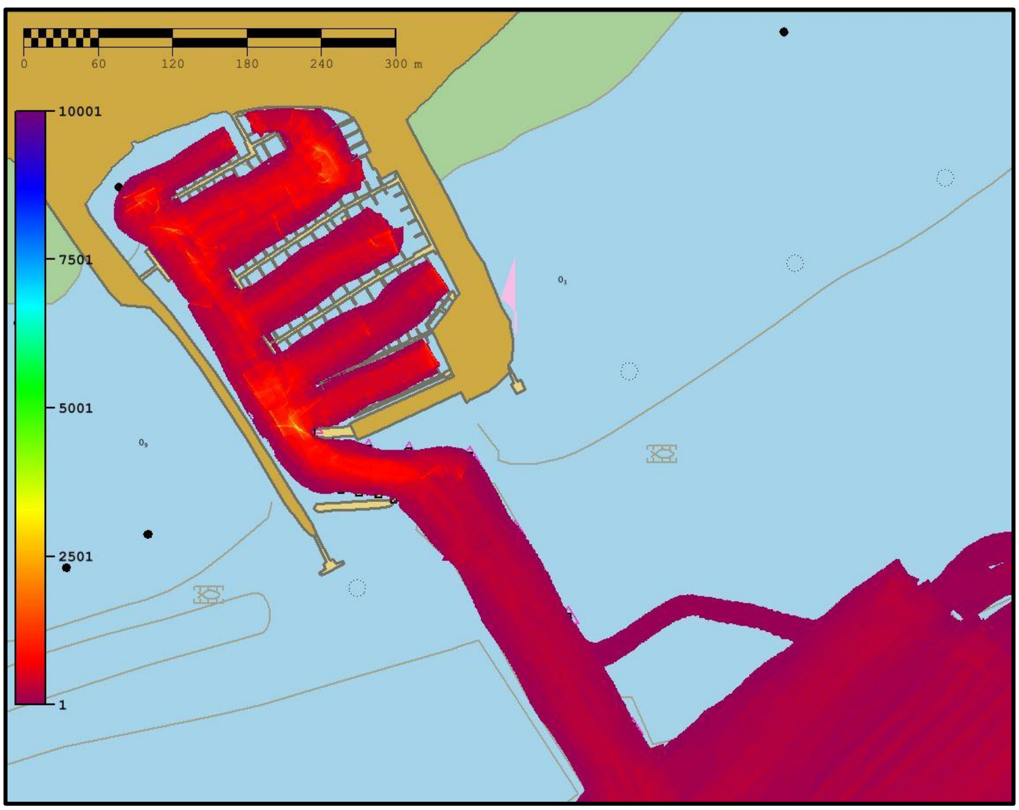


Figure 9. Density of EdgeTech 6205 soundings per node overview.

A.4 Survey Statistics

Data acquisition was conducted from June 8 to June 19, 2017 (Julian Day 159-170).

Table 2. 17USM02 Survey Line Statistics.

17USM02	
Linear Nautical Miles of Multibeam Lines	87.27
Linear Nautical Miles of Multibeam Crosslines	9.38
Percentage of Linear Multibeam Crosslines to Multibeam Survey Lines	10.75 %
Linear Nautical Miles of Side Scan Bathymetry (SSB) Lines	93.75
Linear Nautical Miles of SSB Crosslines	8.86
Percentage of Linear SSB Crosslines to SSB Survey Lines	9.45 %
Linear Nautical Miles of Side Scan Sonar Imagery Lines	93.75
Total Square Nautical Miles of Bathymetry Coverage	0.216

B. Data Acquisition and Processing

B.1 Equipment

B.1.1 *R/V LeMoyne* Equipment

The R/V *LeMoyne* was used for the 17USM02 survey. The *LeMoyne* is a 29-foot aluminum hull research vessel owned by the University of the Southern Mississippi. The vessel was outfitted with port and starboard pole mounts and two Suzuki 150 HP outboard engines. It was docked at the Long Beach Harbor for the duration of the survey.

A Kongsberg EM2040C multibeam echo sounder (MBES) was mounted on the starboard side pole of the *LeMoyne* and an EdgeTech 6205 side scan sonar (SSS) was mounted on the Port side (Figure 9). The poles were bolted in the down position for the duration of the survey and only removed for out of the water transit to and from storage at Stennis Space Center.

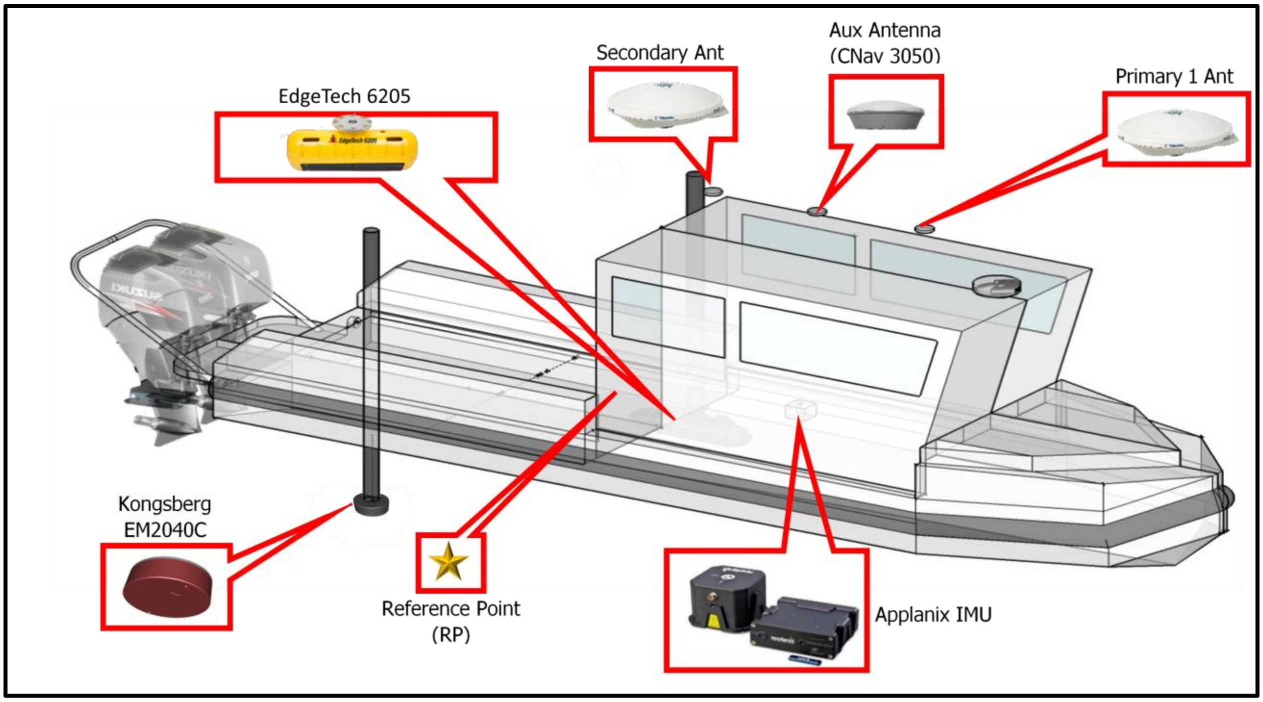


Figure 10. Equipment configuration aboard R/V LeMoyne for 17USM02.

All equipment incorporated with data collection and post-processing procedures involving the two major sonar systems are detailed in the 17USM02 DAPR section A.

Table 3. 17USM02 Survey Equipment.

Item	Description	Serial Number
MBES	Kongsberg 2040C – Topside Kongsberg EM2040C – Transducer	10142 1361
SSS	EdgeTech 6205 – Topside EdgeTech 6205 – Transducer	46159 87921
Auxiliary GNSS	CNav 3050	5906
Primary POS/MV Antenna	Trimble Aero540AP	30939221
Secondary POS/MV Antenna	Trimble Aero540AP	1440912441
POS/MV	Applanix POS/MV	7312
Inertial Motion Unit	Applanix POS/MV	3219
Sound Velocity Sensor	AML Micro SV X	227804
Sound Velocity Profiler	Xylem Castaway CTD	CC1642004
Auxiliary Sound Velocity Profiler	ODOM Digibar Pro	3947
Bottom Sampler	Wildco Ponar	805
Field Laptop 1	Dell (HYPACK & Castaway)	230180
Field Laptop 2	Dell Precision (SIS, POS/MV, CNav)	J9L4XV1
Field Laptop 3	Hewlett-Packard (EdgeTech Discover)	N/A

B.1.2 Geodetic and Tidal Equipment

Vertical and horizontal control was established with third order leveling, geodetic positioning, and tidal observations. Further discussion on leveling procedures and results can be found in 17USM02 HVCR Section A and B. Supplemental information on geodetic and tidal equipment is listed in the 17USM02 DAPR section A.5.

B.1.3 Data Processing Software

Data processing software utilized during survey are detailed in Table 4, section A.6, of the 17USM02 DAPR.

Table 4. 17USM02 survey data processing software.

17USM02 Survey Data Processing Software		
Software	Purpose	Version
Applanix MV-POSView	Control/Configure POS/MV	9.12
Applanix POSPac MMS	Post-processing Raw POS/MV data	8.0.6264.23143
C-Setup	Control/Configure C-Nav 3050	7.2.0
Topcon Receiver Utility	Configure Topcon GR5	3.0.2
Kongsberg SIS	Control/Configure EM2040C	4.3.0
EdgeTech Discover	Control/Configure 6205	7.15
HYPACK/HYSWEEP	Data Acquisition & Navigation	2016
MAGNET Field	Control/Configure Topcon GR5 RTK	4.0
CARIS HIPS and SIPS	Post Processing Bathymetric Data	9.1.1
Chesapeake Technology SonarWiz	Post Processing Side Scan Sonar Imagery	6.05.0003
Leica GeoOffice	Processing VCS	8.3
CARIS BASE Editor	Post Processing Bathymetric Data	4.2
CARIS S-57 Composer	Chart Comparison and ENC Generation	3.0.6
RiSCAN PRO	Lidar Control/Configuration	2.4
Riegl GeoSys Manager	Lidar Data Conversion	2.0.6

B.2 Quality Control

B.2.1 Crosslines

Crosslines were primarily run toward the beginning of the survey with additional lines ran in areas of charted wreck/obstruction investigations. Additionally north-south facing lines in the harbor area were used as crosslines to ensure adequate crossline analysis in the harbor could be achieved. Per the HSSD requirements for object detection survey, lineal mileage of the crosslines should be minimum 4% of development lines, and no crosschecks greater than 1 km apart [HSSD, 2017].

Table 5. Crossline Coverage Requirement values for 17USM02.

17USM02 Crosscheck Mileage	
Development Lines	161.6 km
Crosslines	17.4
Percentage of Total Survey	10.75%
HSSD Specifications (4%)	Achieved

According to NOAA, "the hydrographer shall evaluate each area of overlapping crossline and main-scheme coverage to ensure that the depth values from the two datasets do not differ more than the maximum allowable TVU for the depth of the comparison area" [HSSD, 2017]. To ensure we met this requirement, a difference was developed between our development and crosslines and statistics were computed. A depth difference distribution of 99.7% of the depth differences were within the IHO Special Order TVU of 0.25 m for the Kongsberg EM2040C.

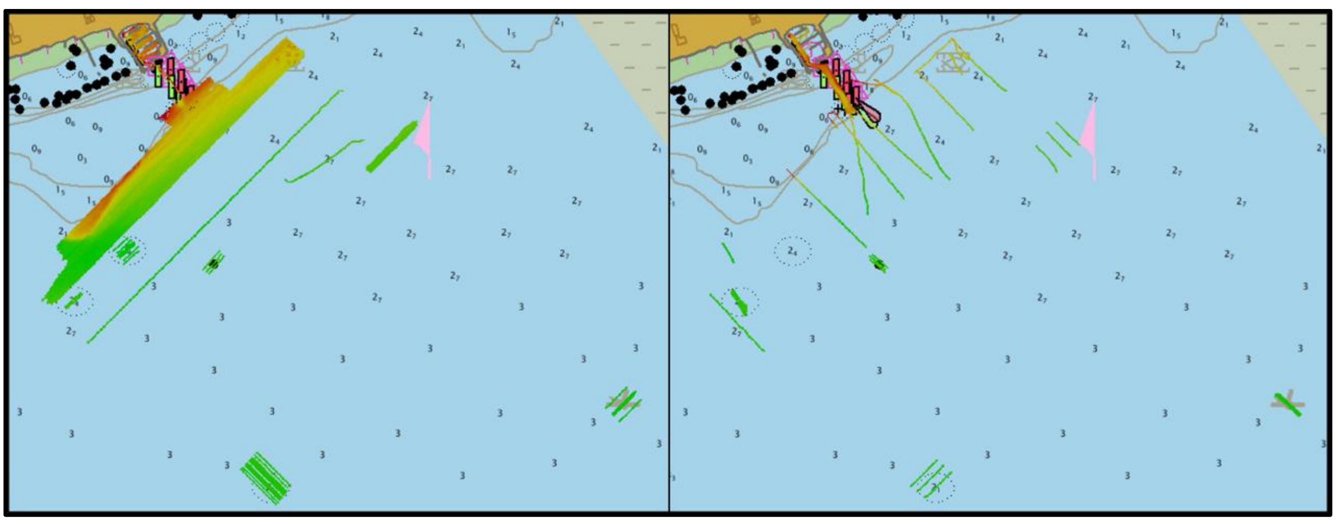


Figure 11. All MBES development lines (left and crosslines (right) for 17USM02.

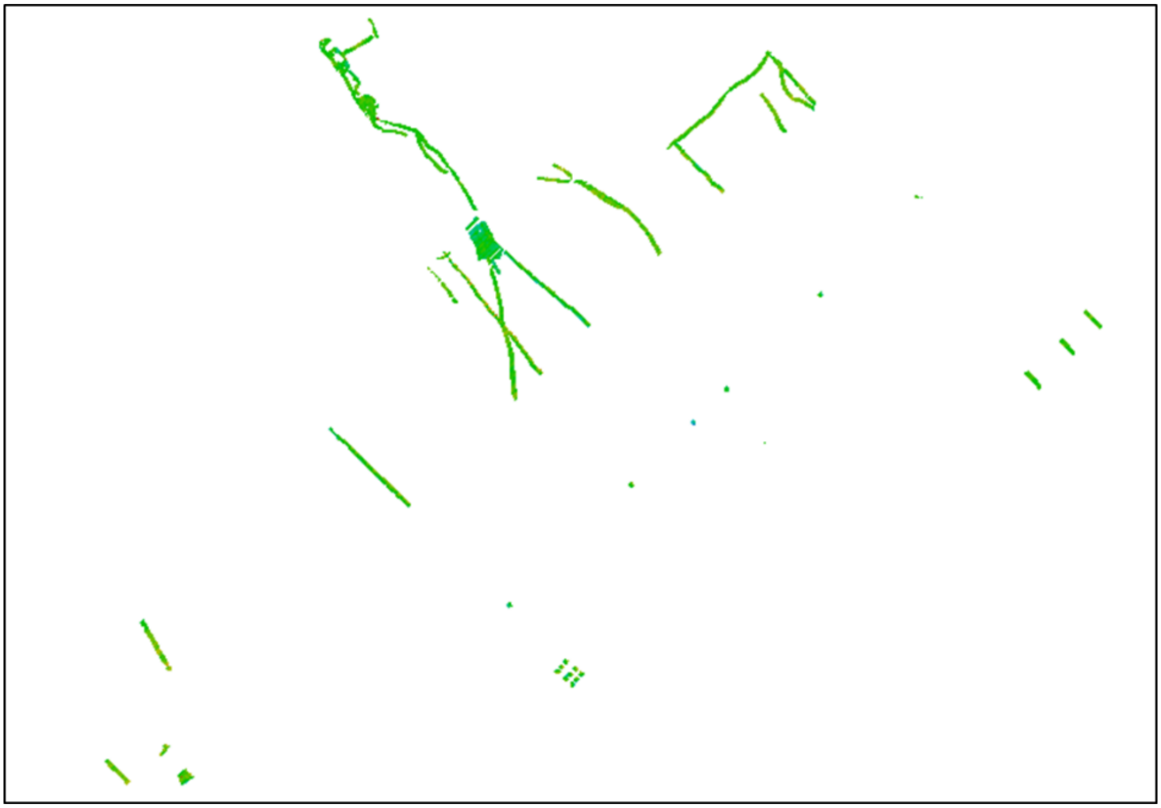
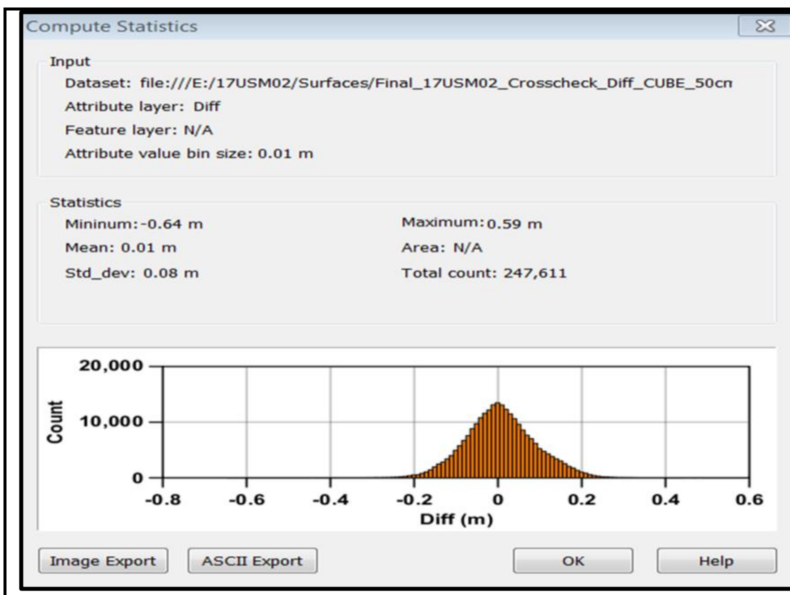


Figure 12. All intersections between development lines and crosslines for 17USM02



Total Count	247611
<0.25cm TVU	246874
Percentage Passed	99.7%

Figure 13. Distribution of MBES depth differences in the crosscheck analysis for 17USM02 (left) and percentage of nodes passing IHO Special Order (right).

Crosscheck analysis was performed for the Edgetech 6205 bathymetry data. Edgetech crossline lineal mileage is 9.5% of development line mileage (See Section A.5 for details). Final processed Edgetech data met requirements for IHO Order 1A, so the appropriate TVU value of 0.5m was used when making crossline comparisons. By looking at the distribution of depth differences, it was determined that 99.9% of them fall within the TVU value for Order 1A and 99.5% of them fall within the TVU value for Special Order. See the following figures for more details:

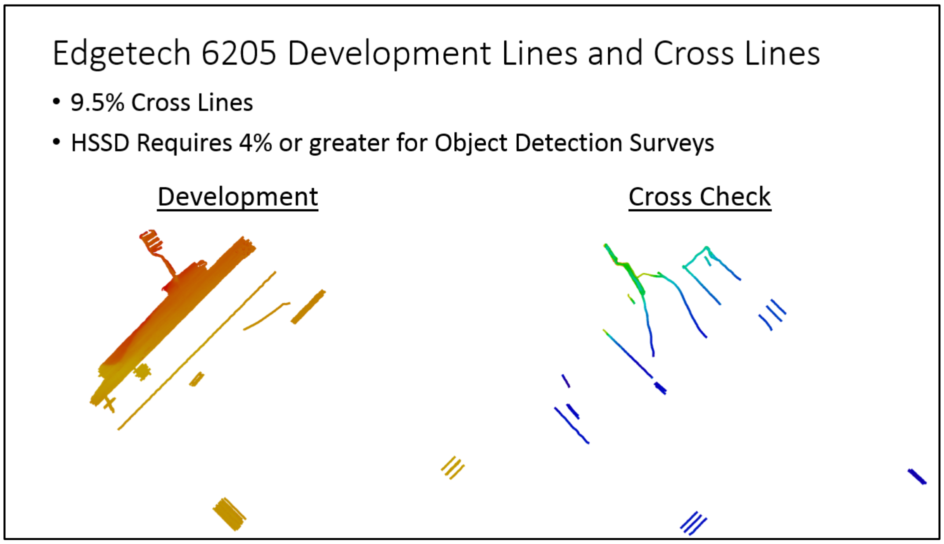


Figure 14. Development lines and crosslines for 17USM02 (Edgetech 6205 data).

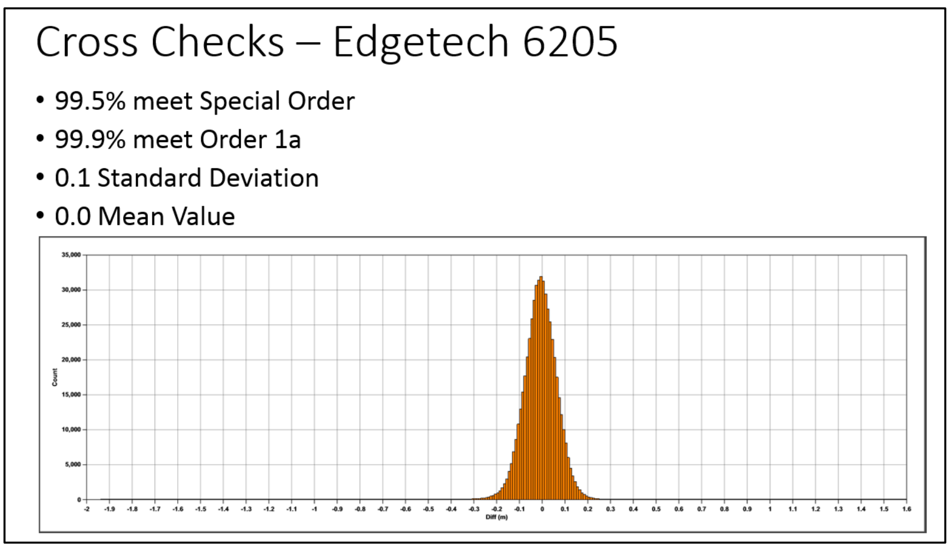


Figure 15. Crosscheck statistics for 17USM02 (Edgetech 6205 data).

An additional crossline analysis was performed using the Line QC Tool in CARIS HIPS for the Kongsberg EM2040C. All beams of all development lines were compared to a crossline surface to determine how many soundings from each beam are within the allowable TVU value of 0.25m (compared to crossline line nodes). The results are shown in Figure 15. It can be seen that most beams have 99.4% or more soundings that achieve the Special Order TVU values when compared to development lines. The worst beam is 400 with 98.6%. The same check was done with the EdgeTech 6205 data with 96% or greater meeting Special Order TVU values.

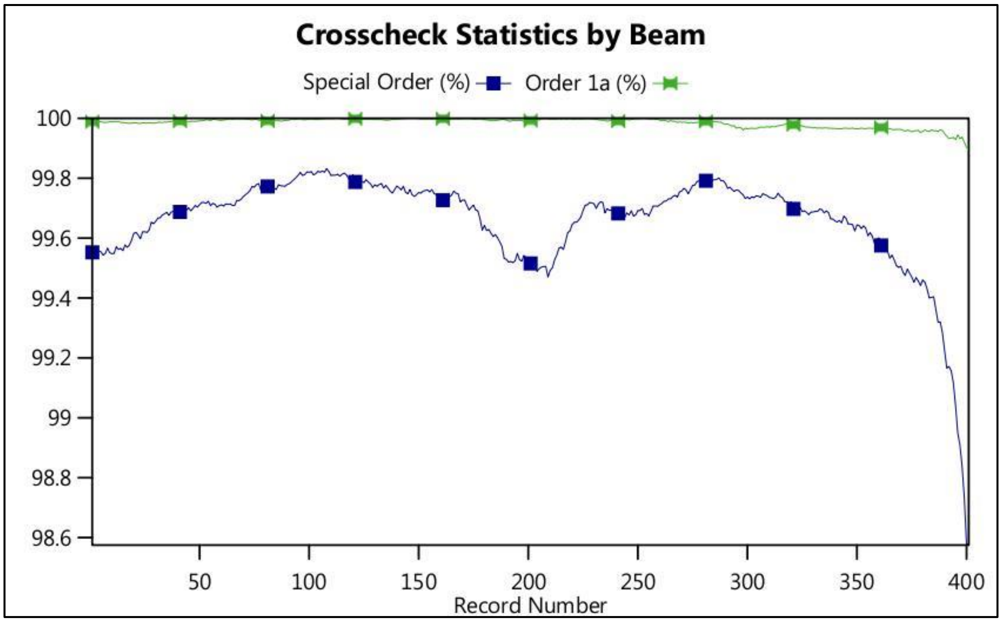


Figure 16: Crosscheck statistics from using CARIS Line QC Tool (EM2040C Data)

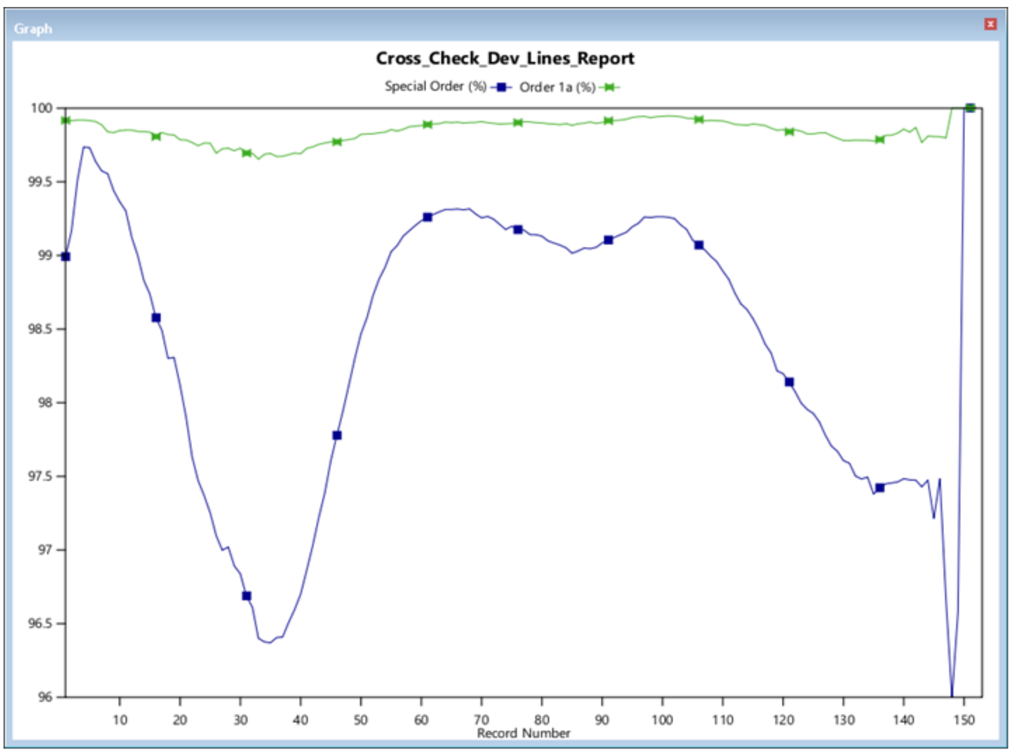


Figure 17: Crosscheck statistics from using CARIS Line QC Tool (EdgeTech 6205 Data)

B.2.2 Uncertainty

The following survey specific parameters were used for 17USM02 are included in Table 6 and 7.

Table 6. Survey Specific Tide TPU Values.

Measured	Zoning	Method

0.072 meters	0 meters	ERS via Constant Separation Model

Table 7. Survey Specific Sound Speed TPU Values.

Hull ID	Measured - CTD	Measured - Surface
R/V Le Moyne	4 meters/second	2 meters/second

Uncertainty values reported are to 1σ as practiced by the values used for CARIS HVF parameter fields and TPU calculations.

Tide gauge calibration uncertainty yielded 0.001 m. Leveling error of closure yielded 0.002 m. Datum transfer from nearby NOAA Waveland-Bay Saint Louis Tide Station (ID: 8747437) yielded 0.055 m. Three OPUS solutions were conducted over the primary benchmark, and the solution with the least uncertainty yielded 0.010 m. Two tape measure measurements were taken in the generation of the Constant Separation Model, one at the extended GNSS observation and another on the tide gauge measuring the gauge to the bolt. The uncertainty for both of these measurements are 0.002 m.

SVP casts were completed every 4 hours producing a 4.0 m/s uncertainty as recommended by the NOAA [FPM, 2014]. Sound speed did not vary significantly temporally or spatially in the survey environment, but the last calibration date for the transducer SS probes were unknown. We chose the conservative value of 2.0 m/s, the maximum recommended value for surface SS uncertainty in the NOAA [FPM, 2014].

Real time TPU calculations for navigation were attributed to our sounding data through use of RMS files generated by POSPAC. Further TPU values were contained in the CARIS HIPS vessel configuration file. See the DAPR Section B.1.4 for further details on how TPU was calculated.

After TPU was assigned to all soundings through use of the CARIS HIPS TPU Calculator Tool, a final CUBE surface was developed and statistics were generated for the uncertainty layer of this surface. The distribution of TVU was analyzed and it was determined that 94.5% of soundings had a TVU of less than 0.25m which is very close to meeting Special Order. A TPU filter was run to remove soundings with a TVU value higher than 0.28m. This resulted in a few more small holidays, but we deemed this acceptable since we are striving to meet NOAA Object Detection Coverage Survey Option B with 200% Side Scan Coverage. After running this filter, 96.4% of TVU values were within 0.25m and 100% of THU values were within 2m. These values for TPU meet IHO Special Order. QC Reports were generated from our built surfaces for both TVU and THU. The results are shown in the below figures. Notice that that 100% of the THU values are below 0.57m in the distribution, well below the 2m horizontal limit for Special Order.

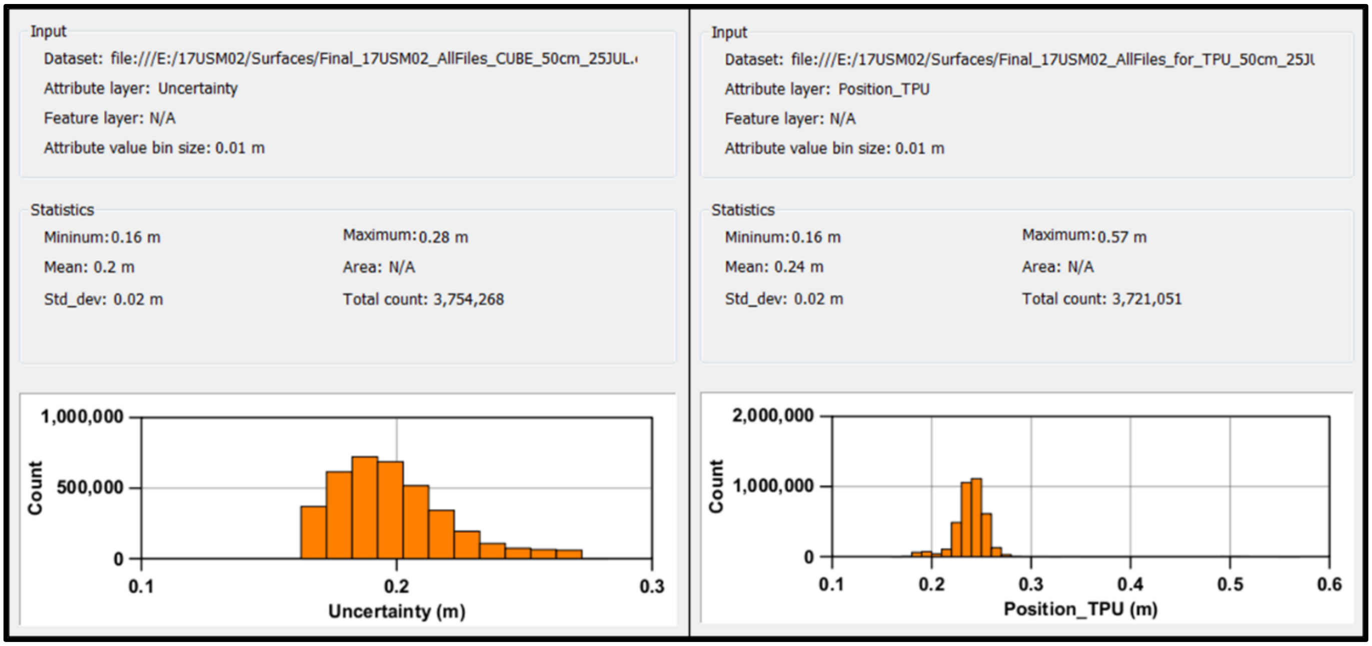


Figure 18. Distributions for TVU (Left) and THU (Right) for EM2040C data.

```
IHO S-44 Special Order:
     Range:  0.000 to 100.000
     Number of nodes considered: 3754385
     Number of nodes within: 3619672 (96.41%)
     Residual mean: -0.052
S-44 Order 1a:
     Range:  0.000 to 100.000
     Number of nodes considered: 3754385
     Number of nodes within: 3754385 (100.00%)
     Residual mean: -0.303
S-44 Order 1b:
     Range:  0.000 to 100.000
     Number of nodes considered: 3754385
     Number of nodes within: 3754385 (100.00%)
     Residual mean: -0.303
S-44 Order 2:
     Range: 100.000 to 5000.000
     No depths within the specified range
```

Figure 19. QC Report for EM2040C TVU showing that Special Order has been met.

A similar method was used to determine TVU and THU for the Edgetech 6205. Because the Edgetech data had a much larger swath width, and cleaning methods were only cursory, it was not able to meet Special Order standards. Instead, IHO Order 1A was achieved with this data. We determined that 100% of values for THU and TVU meet IHO Order 1A (Figure 17).

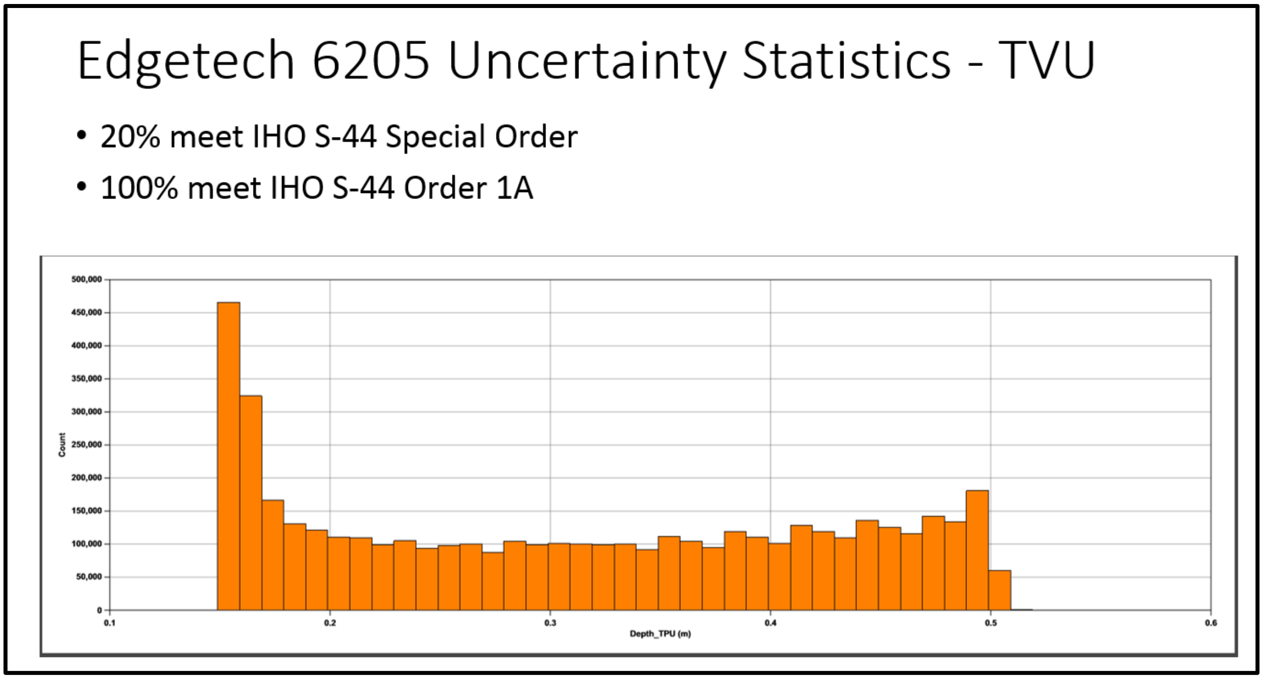


Figure 20. TVU distribution for Edgetech 6205. IHO Order 1A met.

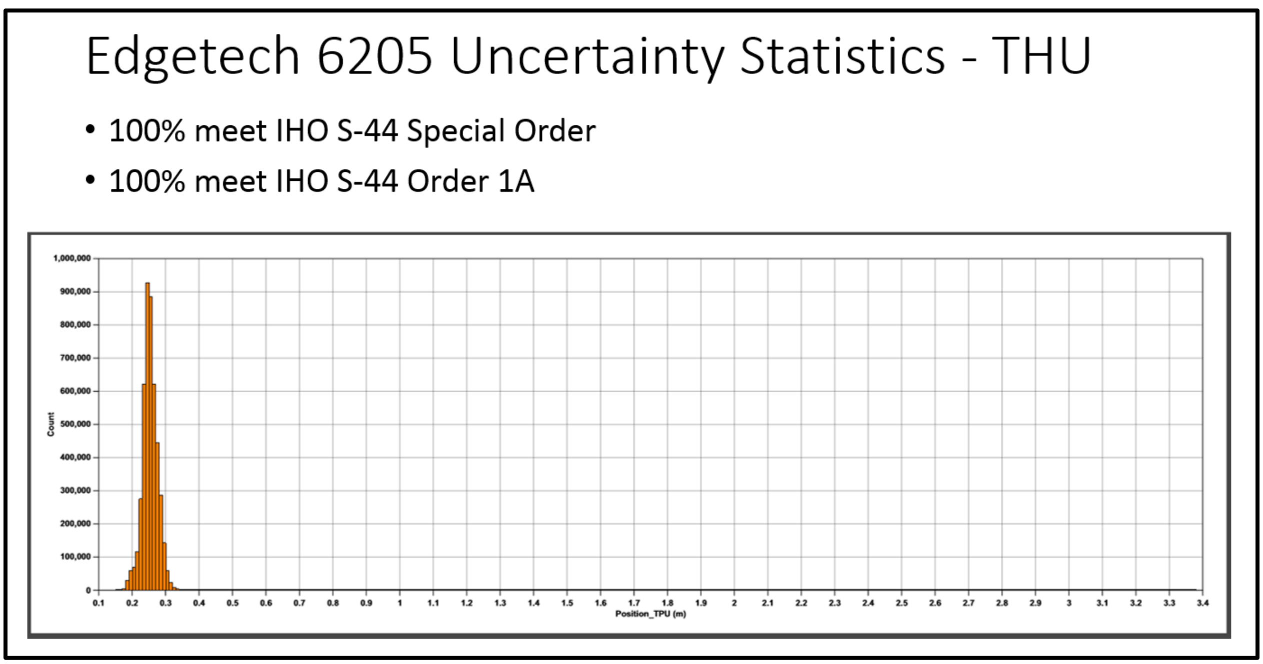


Figure 21. THU distribution for Edgetech 6205. IHO Order 1A (and Special Order) met.

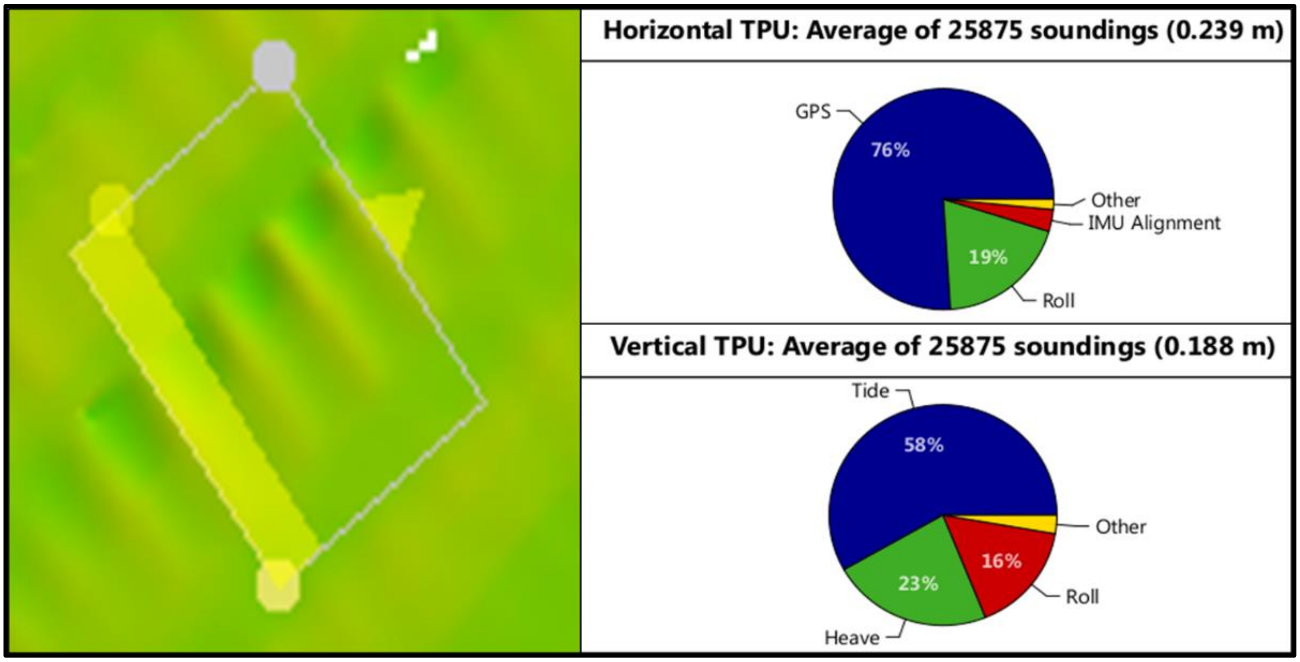


Figure 22. THU and TVU charts in a particularly rough looking area of our surface.

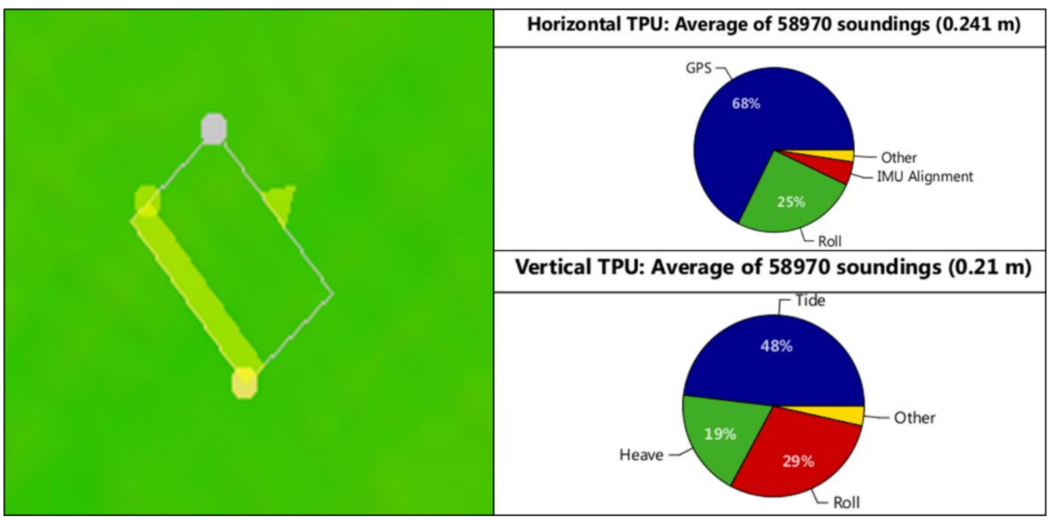


Figure 23. THU and TVU charts in a smoother area of our surface.

B.2.3 Junctions

Junction comparisons were made in accordance with NOAA HSSD 2017. Three comparisons were made for the EM2040C data. One comparison was made with past NOAA survey H11618, a second with the Edgetech 6205 bathymetric data, and finally with data collected during 17USM01 in the Gulfport Channel with the Reson Seabat 7125.

For the first comparison, the only useable data from past surveys coincident with 17USM02 was from NOAA survey H11618 conducted in 2007. The area for this survey spanned from Long Beach, MS to Biloxi, MS. This survey data was collected using an Odom Hydrotrac single beam echosounder and the final BAG has vertical/horizontal datums matching ours (MLLW and

NAD83). A difference surface was developed between the soundings of both surveys and statistics were computed. NOAA's rule for junction comparisons requires that "the difference between the two data sets are less than √2 * TVU on a 95% CI basis" [HSSD, 2017]. Using this rule and our desired IHO Special Order TVU of 0.25, a tolerance can be computed.

$$\sqrt{2} * 0.25\ m = 0.35\ m\ @\ 95\%\ Confidence\ Interval$$

Using a spreadsheet to calculate the percentage of bins that meet this tolerance, it was determined that 97.7% of the depth differences are within tolerance and the NOAA Junction requirement is met.

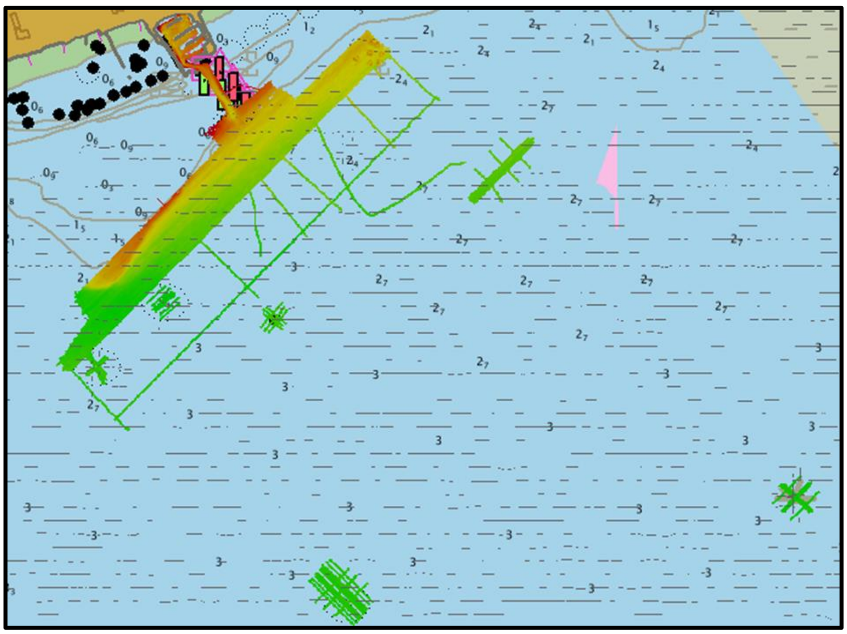


Figure 24. Differencing 17USM02 (MBES) with H11618 (SBES) for a junction comparison

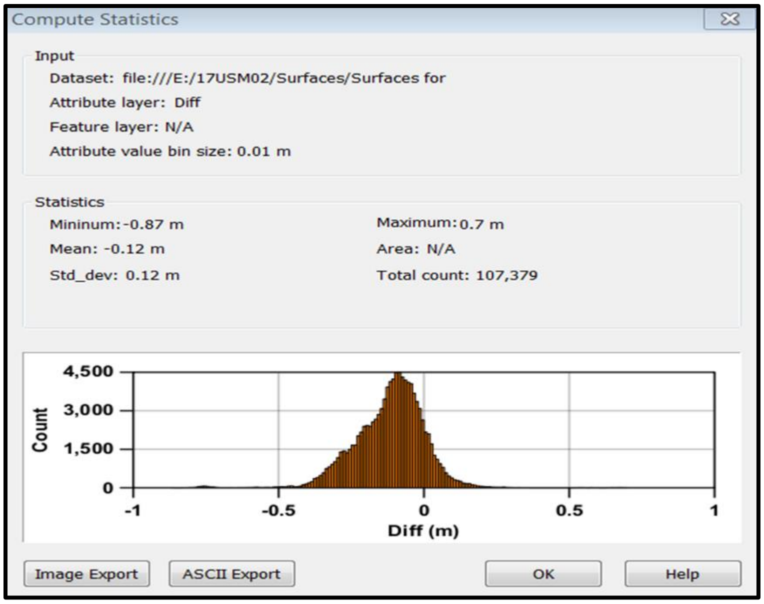


Figure 25. Histogram of junction difference distribution between 17USM02 (EM2040C data) and NOAA H11618 (Odom Hydrotrac data).

Total samples	within .35	within .25
107379	105007	95,021
	0.97791002	0.8849123

Figure 26. Statistics of samples in the above distribution. 97.7% of junction differences are within the NOAA required √(2)*TVU = 0.35m.

The following junction comparison used the Reson Seabat 7125 data collected during 17USM01 over the Gulfport Channel. The same process from the H11618 comparison was used. 99.0% of the depth differences are within tolerance here which meets the NOAA requirements [HSSD, 2017].

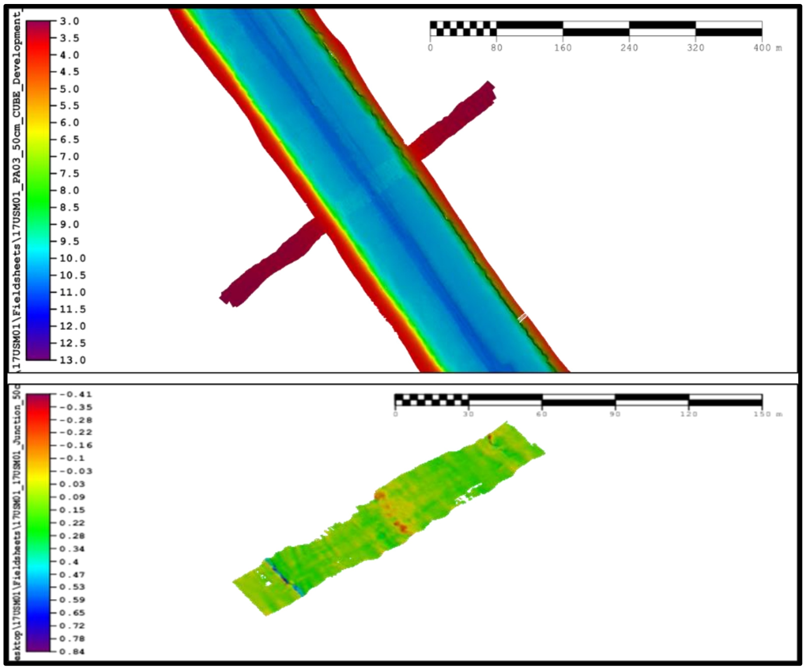


Figure 27. Final surfaces for 17USM01 and 17USM02 in Gulfport Channel (Top) and surface differenced (Bottom).

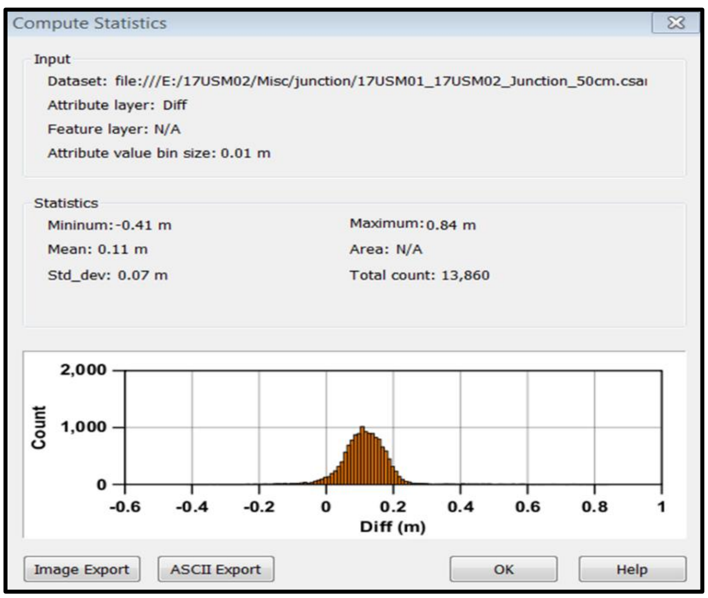


Figure 28. Histogram of junction difference distribution between 17USM02 (EM2040C) and 17USM01 (Reson Seabat 7125).

Total Samples	Within .35	Within .25
13860	13726	13612
	0.99033189	0.98210678

Figure 29. Statistics of samples in the above distribution. 99.0% of junction differences are within the NOAA required √(2)*TVU = 0.35m

Junction analysis was also performed using the Edgetech 6205 bathymetry data starting with a comparison to the EM2040C. 99.98% of the depth differences are within tolerance specified in the HSSD (Figure 27) [HSSD, 2017].

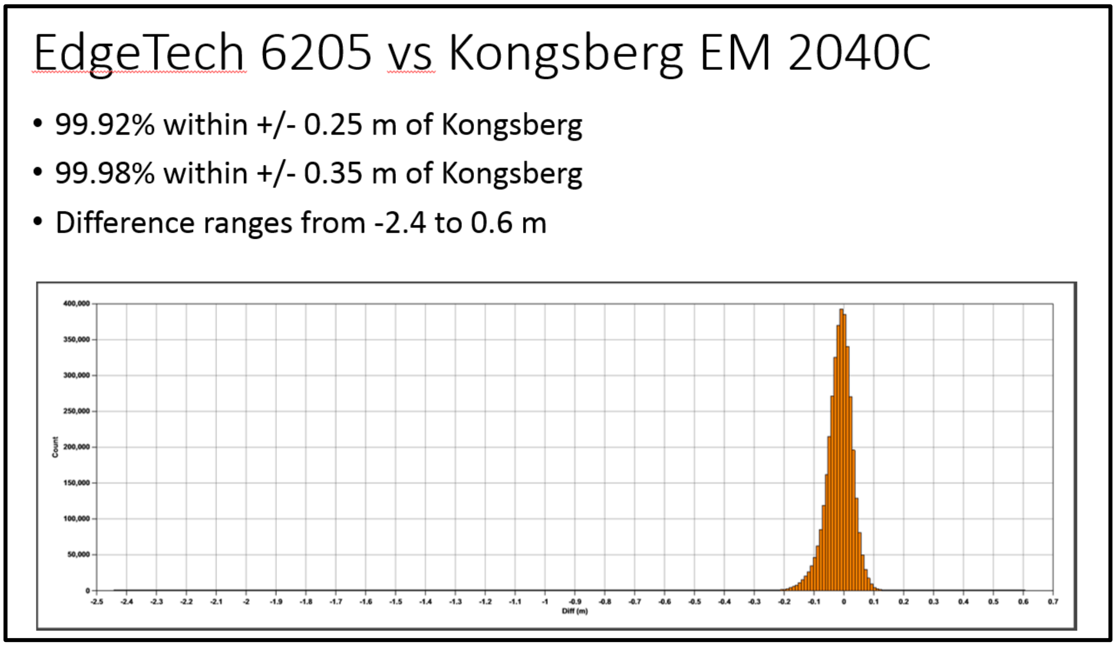


Figure 30. 99.98% of junction differences are within the NOAA required SQRT(2)*TVU = 0.35m.

Further comparisons of the Edgetech 6205 with the NOAA survey H11618 and with 17USM01 Reson 7125 Seabat data were also analyzed as a validation check (Figure 28).

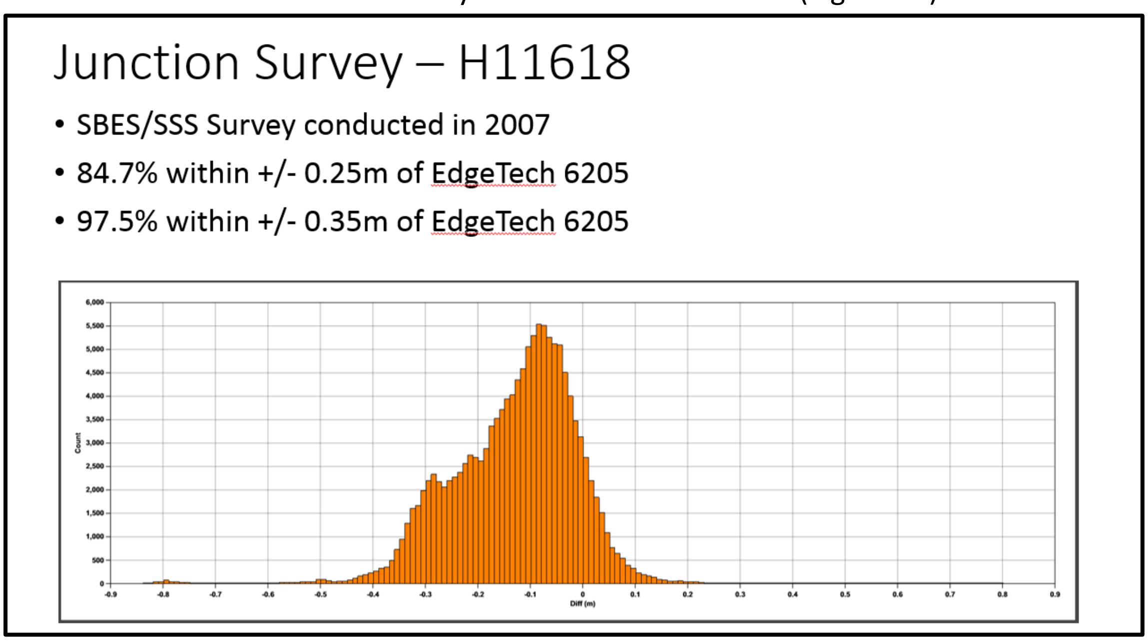


Figure 31: 97.5% of junction differences are within the NOAA required SQRT(2)*TVU = 0.35m.

The comparison between Edgetech 6205 and Reson 7125 data did not meet the SQRT(2)*TVU = 0.35m using TVU for Special Order. However, our Edgetech 6205 uncertainty as a whole only meets the requirements for IHO Order 1A so it is safe to use the Order 1A TVU for this comparison. SQRT(2)*TVU = 0.70m for Order 1A and 99.6% of the depth differences meet this requirement (Figure 29).

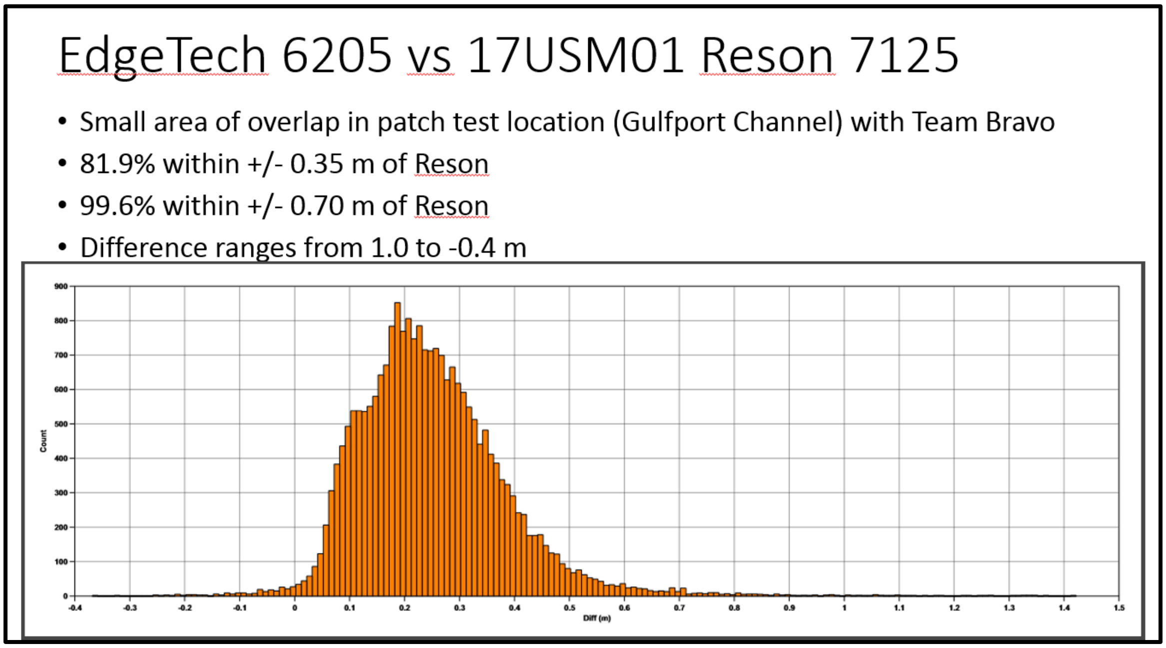


Figure 32: 99.6% of junction differences are within the NOAA required SQRT(2)*TVU = 0.70m (Order 1A TVU).

B.2.4 Sonar Quality Control Checks

Sonar system quality control checks were conducted as detailed in the quality control section 17USM02 DAPR Section B.

B.2.5 Equipment Effectiveness

During post-processing of the MBES data, obvious offset problems were encountered. Several lines over one object placed it in different positions up to 2-3 meters offset horizontally. After troubleshooting, we determined the problem to be a bad GAMS calibration. A GAMS calibration was performed for the POS/MV system on JD159 and values saved in the POS/MV settings for the remainder of the survey. The PosView display indicated “GAMS OK” throughout the survey so the error was not immediately apparent. After inspection during post-processing, an error in the current GAMS values was identified and corrected with values obtained from the vessel configuration survey using POSPac MMS. Please see 17USM02 DAPR Sections A.3 and B.1.3 for more details on the GAMS problem and solution. Erroneous GAMs values and the replacement values from our VCS are included (Table 8).

Table 8. Original GAMS values (left) and corrected values (right).

GAMS Calibration Value Differences 17USM02			
GAMS Calibration Results		VCS Correction Values	
X	-1.947	X	-2.00
Y	-0.486	Y	-0.029
Z	0.021	Z	0.027

After the GAMS offset problem was corrected, an accurate set of patch values was consistently obtained. These values are outlined in the 17USM02 DAPR Section C.4. Once these values were applied to the entire dataset, roll artifact between subsequent days became apparent, and sometimes between subsequent lines, in the data. We eventually used two different roll bias values in our vessel file, one for JD164 and one for everyday thereafter. The roll bias differences were attributed to a slightly unstable pole mount. Wooden shims were used during the survey in an attempt to stabilize the mounted transducer poles, but the drag on the poles while underway and the changing sea state each day may have had an adverse effect on the data introducing roll artifacts. After comparing several areas of data throughout the survey, it was determined that the roll bias for the EM2040C varied between -1.05 and 0.00. This variation was reflected this value in the vessel configuration file and ingested it into our TPU calculations.
A third issue to highlight for the survey is heave artifacts that can be seen in various areas in the data. In some cases, this was because delayed heave would apply to a few lines. In other cases, delayed heave was applied, but visible errors are still present in the data. We chose the option to read RMS values from our delayed heave data when computing TPU, so this and all other errors described above, should be accounted for in our uncertainty calculations.

B.2.6 Factors Affecting Soundings

Using the Douglas Scale, the sea state each day varied between 2 (Smooth) to 3 (Slight) with light swells. This corresponds to wave heights of 0.1-1.25 meters. This may have contributed to errors in the data considering our visible heave artifacts and the possible movement of our mounted poles.
Surface sound speed seemed to be stable within 2 m/s for most of the survey, but outside of the harbor on JD165, it was difficult to obtain a sensor-to-profile bias at the surface of less than 2 m/s even after multiple casts. Sound speed issues on that day seem slightly worse than other days in the data which probably means there was a sound speed gradient moving through the area on that day. Other than these two noted issues, and all other noted issues in the DAPR Section B, there were no other factors that affected corrections to soundings.

B.2.7 Sound Speed Methods

All methods of correcting soundings for sound speed error are described in the DAPR Section C.2 and C.5.

B.2.8 Coverage Equipment and Methods

All equipment and survey methods were used as detailed in the DAPR.

B.3 Corrections to Echo Soundings

B.3.1 Corrections

All data reduction procedures conform to those detailed in the DAPR Section C.

B.3.2 Calibrations

All data reduction procedures conform to those detailed in the DAPR. See DAPR Section C.4 for a detailed procedure and results for the MBES calibration.

B.4 Backscatter

Backscatter data was recorded in the Kongsberg EM2040C *.all files using Seafloor Information System software. Backscatter data was not processed nor used in any of our deliverables. We instead used SSS data from the Edgetech 6205 to obtain bottom imagery.

B.5 MBES Data Processing

B.5.1 Processing Software and Method

MBES data was post-processed with CARIS HIPS and SIPS v9.1.1. Data was imported into HIPS and all initial correctors applied before making a final surface and coverage geotiff for each day. Final surfaces were created once all data had been post-processed and final correctors applied. These surfaces are detailed in the next section. For an in depth explanation of all MBES data processing, see the DAPR Section B.1.3.

B.5.2 Surfaces

Since our data was contained in a fairly small area, we decided to make one surface with all of our data. One final CUBE surface was generated once all correctors and TPU calculations had been applied. The surface was made at a resolution of 50cm to match NOAA specifications and several surface layers were attributed including depth, uncertainty, density, hypothesis count &

strength, standard deviation, and more. The surface was then exported to a BAG with the following metadata:

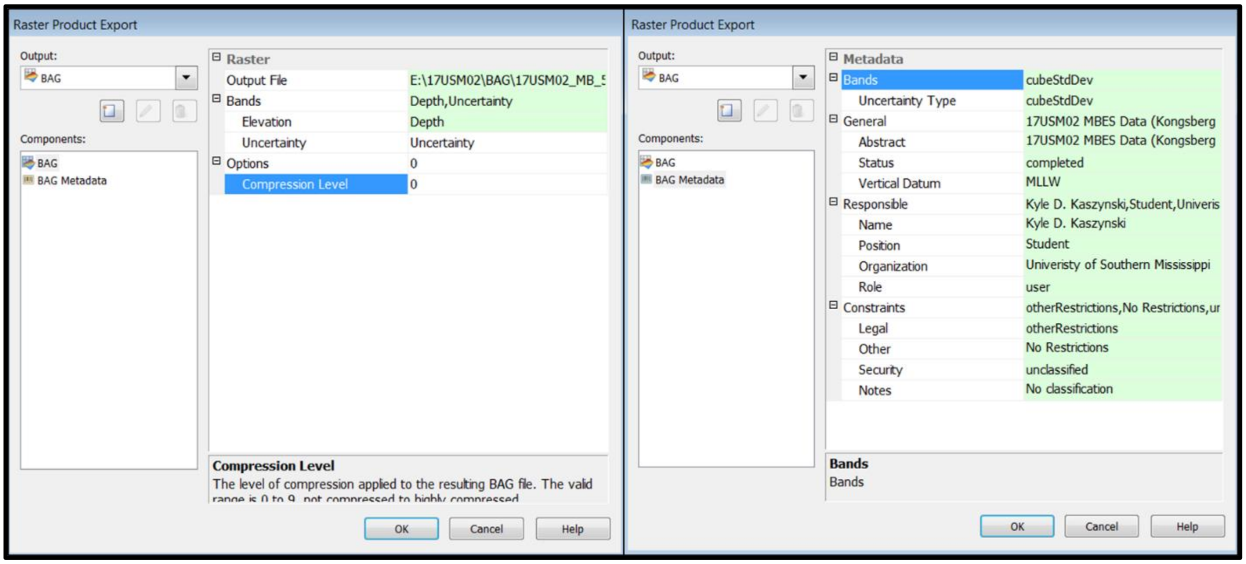


Figure 33. Metadata for our final BAG product.

The final surface and BAG were both named according to NOAA specifications:
17USM02_MB_50cm_MLLW_Final.bag (.csar)
Similarly, a final surface and BAG were developed for the Edgetech 6205 data named:
17USM02_MP_50cm_MLLW_Final.bag (.csar)

The following shows our final generated BAG in a few areas of our survey:

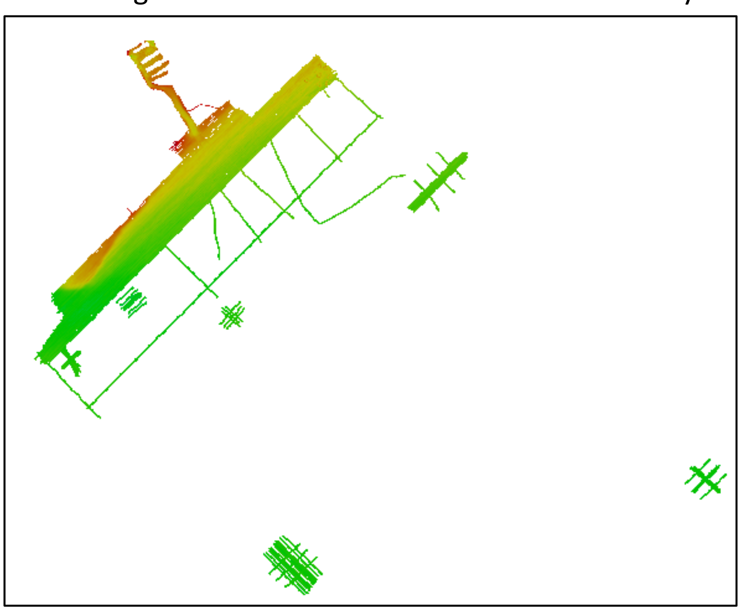


Figure 34: Image of BAG file 17USM02_MB_50cm_MLLW_Final.bag displayed in CARIS HIPS.

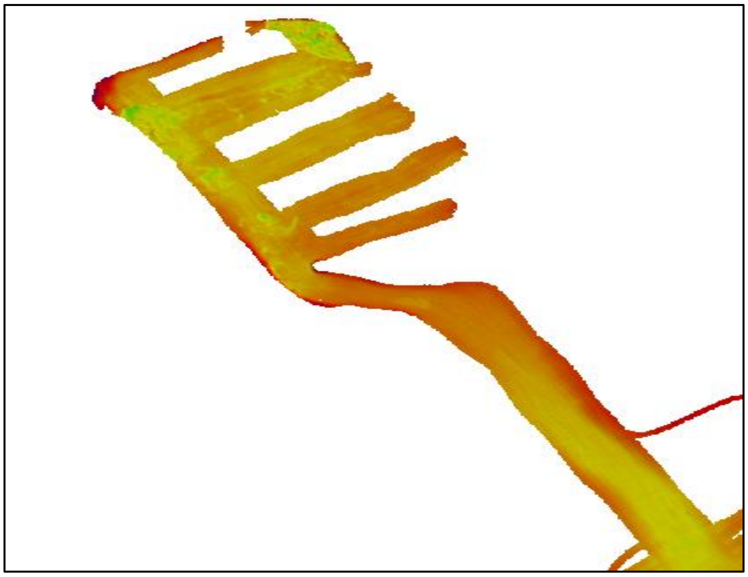


Figure 35: Close up of final BAG to show Priority Area 1 (Long Beach Harbor and Approach).

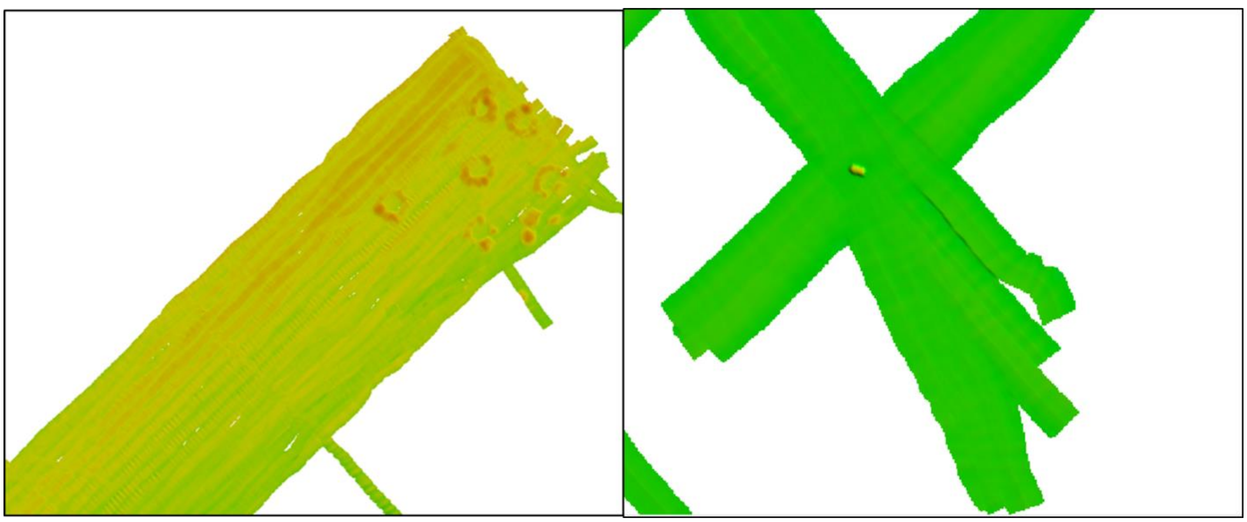


Figure 36: Area with artificial reefs to the east of the harbor (Left) and the charted obstruction to the west (Right).

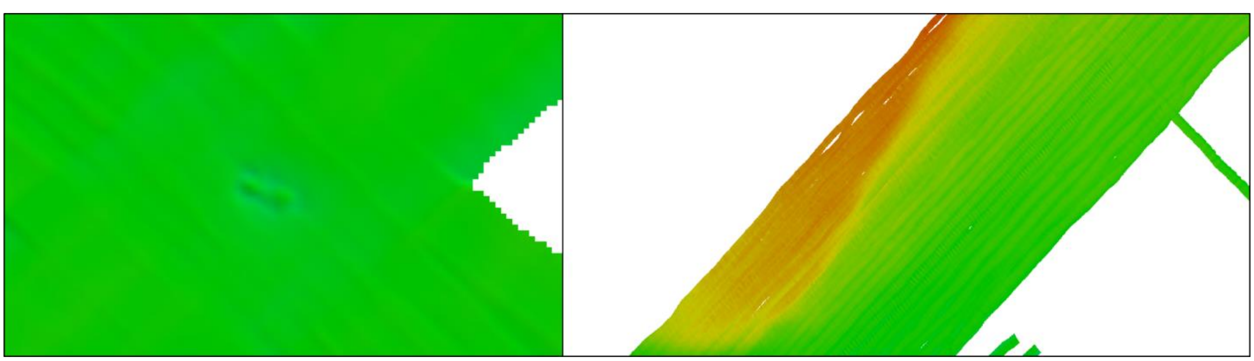


Figure 37: Charted wreck (Left) and west side of Priority Area 2 (Right)

B.6 SSS Data Processing

SSS processing was completed at the end of each survey day in order to assess image quality and identify significant features that would require MBES investigation the following survey day. For detailed information on SSS processing refer to the 15USM01 DAPR section B.2.3 and Appendix B.4.

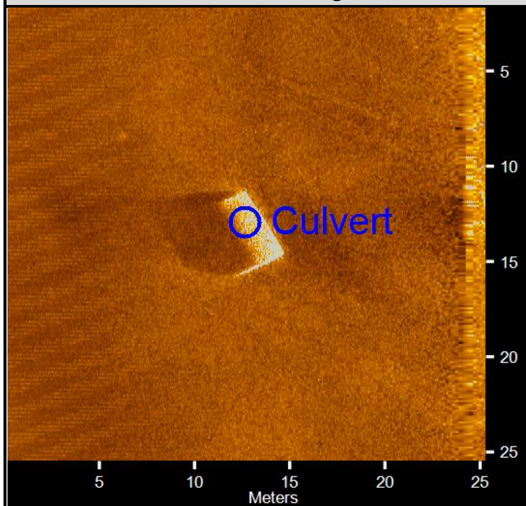
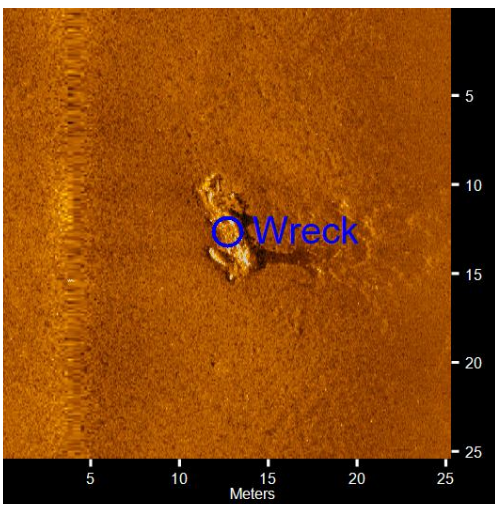
B.6.1 SSS Mosaic Production

A geo-referenced SSS mosaic (in gray scale) was created for each individual 100% coverage survey line, each priority area, and the entire 17USM02 survey area. For further details refer to the 17USM02 DAPR section B.2.3.

B.6.2 Significant Contact Selection

In accordance with the NOS HSSD, a significant contact is required to have dimensions greater than or equal to 1 m^3 in waters less than or equal to 20 m and located in the vicinity of critical navigation depths [NOS, 2017]. Contacts were identified by manual inspection of SSS data, with independent reviews of the high frequency and low frequency SSS mosaics conducted to ensure validity of targets. Particular attention was given to the confirmation of existing features on the current ENC US5MS11M, which were investigated as an objective of 17USM02. All significant contacts were digitized to determine position, shadow length, horizontal dimensions, and general classification when possible (Table 9). Significant contacts were then compared with bathymetry to ascertain a least depth and horizontal position. Contacts were then compared to MBES bathymetry to determine position and least depth, these values are included in section D.2.4.

Table 9. SSS Contact Report.

17USM02 SSS Contact Report	
Contact Image	**Contact Information**
	**Name:** Culvert **Date and Time:** 17-Jun-17 3:18:56 PM **Position:** (X) 293528.34 (Y) 3357031.26 (Projected Coordinates) **Line Name:** 20170617151829_Binned **Map Projection:** UTM83-16 **Ping Number:** 359529 **Range to Target:** 11.57 Meters **Fish Height:** 3.50 Meters **Target Width:** 1.70 Meters **Target Height:** 1.01 Meters **Target Length:** 4.04 Meters **Target Shadow:** 4.04 Meters **Classification:** boulders **Description:** Charted concrete cylinder culvert
	**Name: Wreck** **Date and Time:** 17-Jun-17 12:39:02 PM **Position:** (X) 297455.07 (Y) 3356296.21 (Projected Coordinates) **Line Name:** 20170617123826_Binned **Map Projection:** UTM83-16 **Ping Number:** 88179 **Range to Target:** 8.59 Meters **Fish Height**: 3.70 Meters **Target Height:** 1.00 Meters **Target Width:** 1.78 Meters **Target Length:** 5.95 Meters **Target Shadow:** 3.44 Meters **Classification**: Wreck **Description:** Charted wreck

C. Vertical and Horizontal Control

C.1 Vertical Datum

The survey data was collected in reference to the North American Datum of 1983 or NAD 83 (2011/PA11/MA11) Epoch 2010.00. The sounding data was reduced to the vertical datum of Mean Lower Low Water (MLLW) in the present National Tidal Datum Epoch (NTDE) of 1983-2001.

A single ellipsoid-chart datum value or SEP was applied to the sounding data to reduce it to MLLW. This was accomplished using Ellipsoid-Referenced Surveying (ERS). The process is explained in detail in 17USM02 HVCR Section A: Vertical Control.

C.2 Datum Transfer

To determine the Mean Lower Low Water (MLLW) datum at the survey site, a tidal datum transfer was conducted using Modified Range-Ratio method. The water level datums in the nearest primary station, Bay Waveland Yacht Club (Station ID: 8747437), was transferred to the water level data obtained from the tide gauge. The datum transfer process is explained in further detail on 17USM02 HVCR Section A.10. The results are shown in Table 10.

Table 10. Transferred datums from Bay Waveland station.

Transferred Datums	Description	Height (m)
DTL	Mean Diurnal Tide Level	1.2663
Gt	Great Diurnal Range	0.5648
MLLW	Mean Lower Low Water	0.9840
MHHW	Mean Higher High Water	1.5487

C.3 SEP Value

A single separation or SEP value between the ellipsoid and MLLW was determined by subtracting the transferred MLLW datum to the sum of the ellipsoidal height of the primary bench mark (PBM) and its distance from tide gauge zero, obtained in geodetic leveling (Figure 38). A single SEP value was deemed sufficient for the relatively small area of the Long Beach Harbor survey. Refer to 17USM02 HVCR Section A.12 for further discussion on the determination of the SEP value.

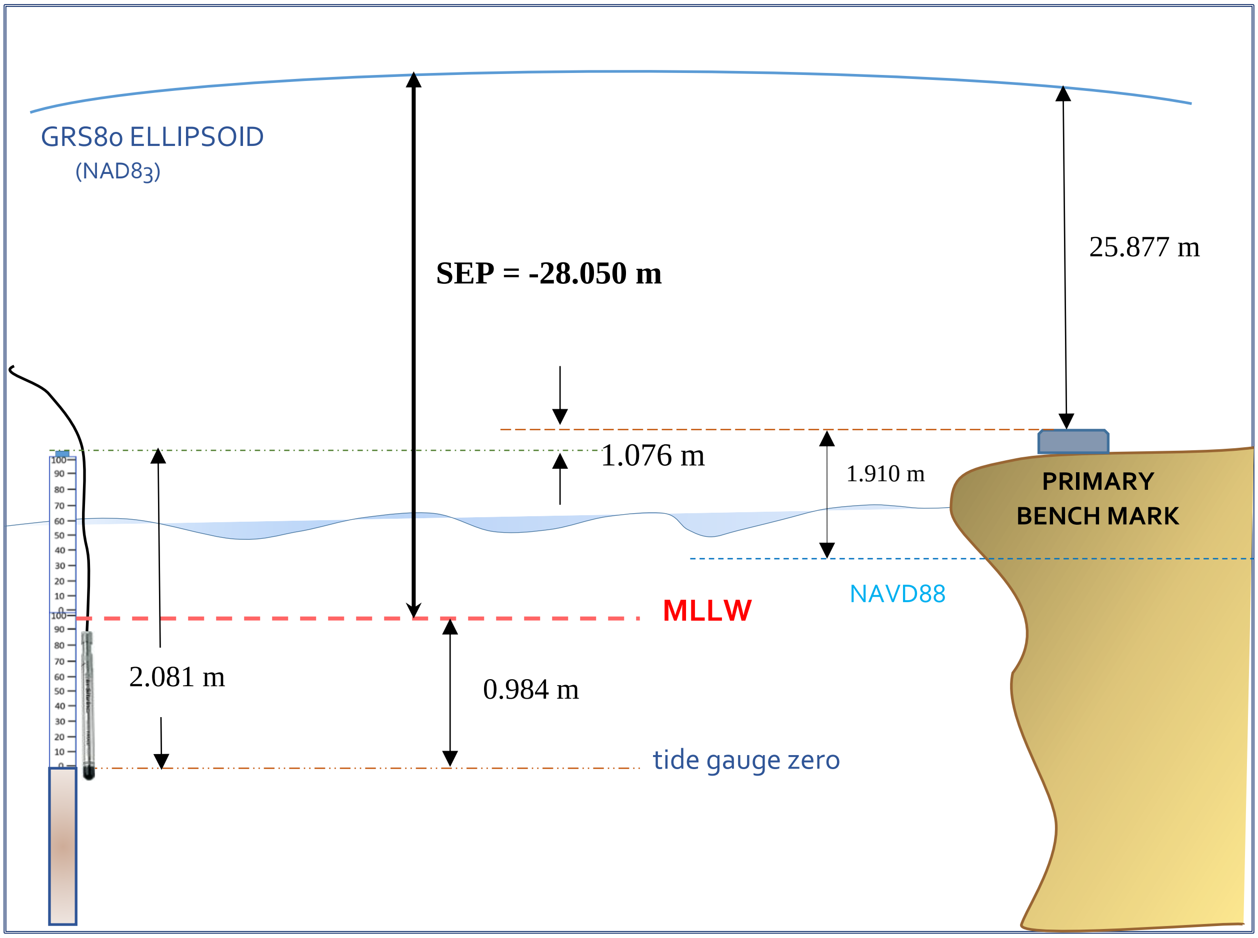


Figure 38. Determination of SEP value.

C.4 Horizontal Control

C.4.1 Datums and Projections

The horizontal components of the survey is referenced to the North American Datum of 1983 or NAD 83 (2011/PA11/MA11) Epoch 2010.00. The projection used is UTM Zone 16 (90°W to 84°W) of the Northern Hemisphere. The submitted S-57, in compliance with IHO standards, was referenced to WGS84 (G1674) epoch 2005.0.

C.4.2 Positioning Methodology

The inertial navigation system (INS) provided by the Applanix POS/MV, complemented by the CNav3050 positioning system, was utilized to acquire sub-decimeter horizontal accuracy. The inertially-aided kinematic data from the POS/MV was post-processed using the IN-Fusion SmartBase PPK method available in POSPac MMS 8.0.

The post-processing output is the Smoothed Best Estimate of Trajectory (SBET) data, where it contains horizontal and vertical components, integrated with velocity and orientation data. The SBET was applied to the survey files in CARIS HIPS.

D. Results

D.1 Chart Comparison

Data collected during 17USM02 was compared with NOAA ENC cell US5MS11M in order to update, remove or retain charted features as needed. Concurrent USM courses required the production of an updated ENC cell of the study area depicting changes to features identified during survey. This chart was produced at a 1:5,000 scale with feature attribution assigned as per course requirements, and it meant to be a best representation of a NOAA product. Modifications to features primarily adhered to NOAA standards, however exceptions were made due to the academic nature of the production. The resulting ENC cell contains a metadata attribute quality of data (M_QUAL) of A1, and it considered the best representation of a final NOAA ENC (Figure 37). The HSSD standards were considered when altering or creating features, and all modified objects were assigned a source date of “20170713”, and a source indication of “US, US, graphic, 17USM02”. Details of the 17USM02 cell and US5MS11M are included in table 11 and 12.

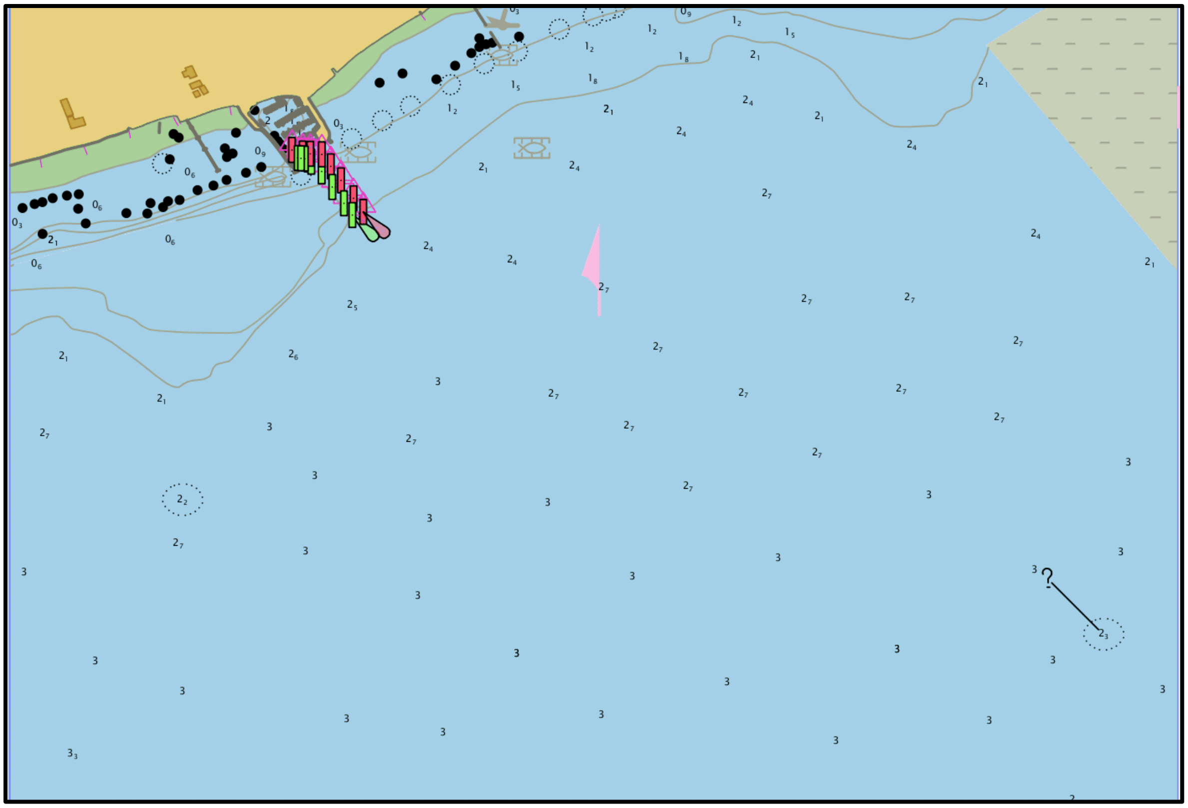


Figure 39. Overview of final feature file with bathymetry included.

Table 11. Statistics for ENCs used in chart comparison.

15USM01 Comparison Charts						
Chart	**Type**	**Scale**	**Edition**	**Date**	**LNM Date**	**NM Date**
17USM02	ENC	1:5000	N/A	28 July 2017	N/A	N/A
US5MS11M	ENC	1:40000	3.1	17 May 2017	Week 23/17	N/A

Table 12. 17USM02 M_COVR extents.

17USM02 M_COVR Extents	
Parallels	30° 17’ 50.55’’N to 30° 57’ 57.53’’N
Meridians	89° 06’ 22.97’’W to 89° 09’ 18.66’’W

In accordance with HSSD requirements, a final feature file (FFF) ENC cell was created and submitted with this project. The FFF includes all features within the study area that cannot be adequately represented in the bathymetric data. Similar to the production of USM course specific ENC, modified features have an updated date and indication source, however no features within the survey area were removed from the FFF. Instead, all investigated features have a 'descrp' included in their textual description identifying whether the feature is new, updated, retained, or recommended for removal. This methodology was adopted in an attempt to adhere to HSSD specifications, however the nature of this survey required adjustment to feature development practices. All required attribute fields in new and updated features were completed, with conditional attributes included where possible. Features recommended for removal received no further edits, original attribute assignment was maintained and no changes to date or source indications were included.

17USM02 was divided into two priority areas, generally identified as the existing harbor and approach (priority area 1), and seafloor and charted features in the surrounding area (priority 2). Changes to the ENC cell in these areas are discussed separately in sections D.1.1 and D.1.2 below.

D.1.1 Priority Area 1

Priority Area 1 was updated using bathymetry and imaging resulting from a full seafloor survey within the existing harbor and approach, shoreline delineation survey of all harbor structures and adjacent shoreline, and GNSS positioning of existing ATONs. An overview of these edits in the comparison of images presented in Figure 38.

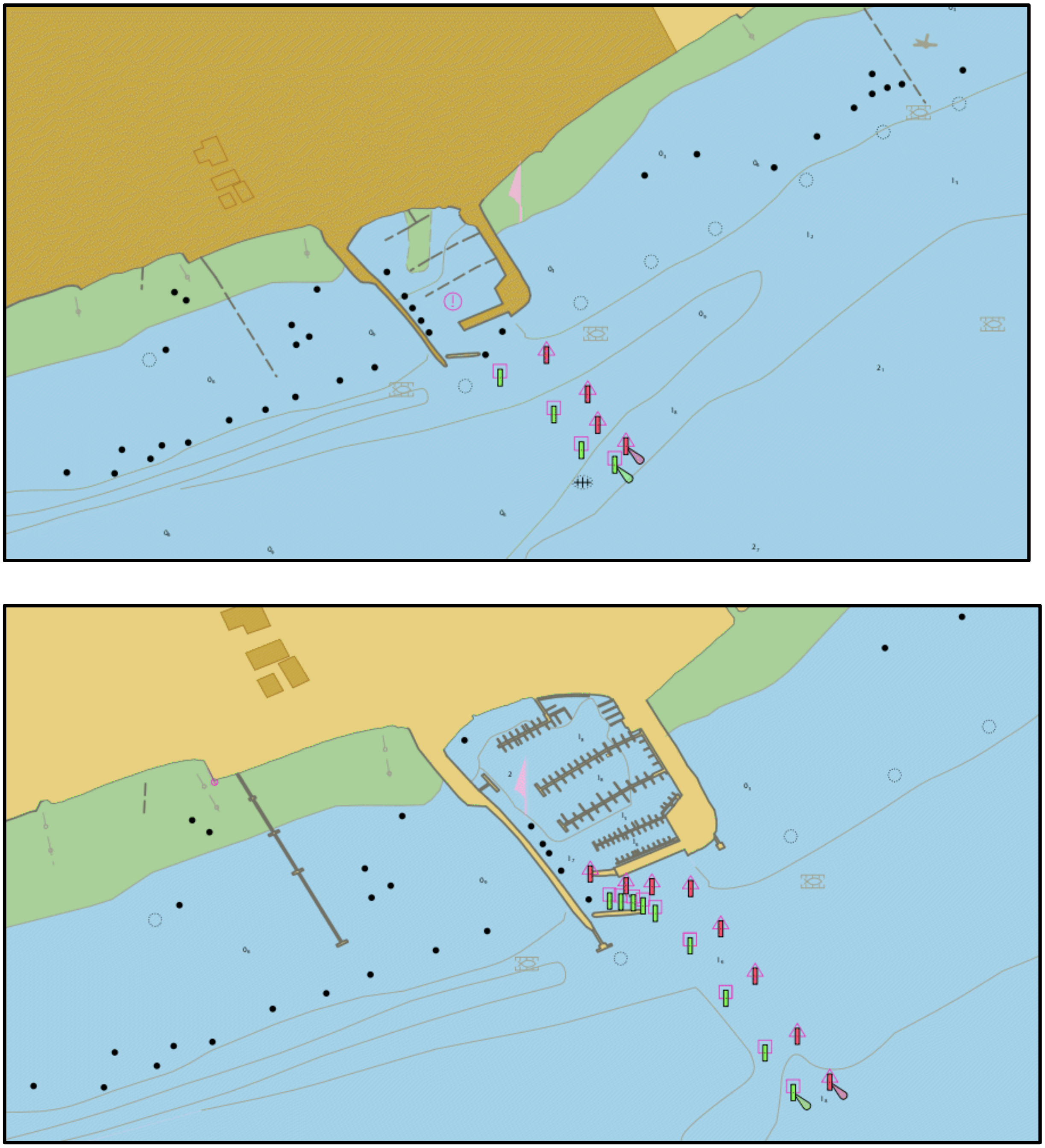


Figure 40. Priority Area 1 depicted by US5MS11M (left) and newly produced ENC 17USM02 (right).

The shoreline delineation survey resulted in updates to Group 1 features including land areas (LNDARE), coastline (COALNE) and shoreline construction (SLCONS) in proximity to Long Beach Harbor. These areas were updated or created as necessary, resulting in a detailed representation of the Harbor. Additions include the delineation of seven interior piers and associated finger piers, boat ramp facilities, three fishing pier structures, an uncharted breakwater, and updates to adjacent coastline (Figure 39). Further details of the shoreline delineation are available in section D.2.3 of this report and the FFF.

A generalized (2.5 m^2 resolution) shoal biased CUBE Caris surface (.csar) was used to update the seafloor within the harbor. As a result, the caution was removed from the harbor, soundings were added to the interior of the harbor and approach, and depth areas (DEPARE) were adjusted to conform to the altered depth contours (DEPCNT). Contours were first generated in Caris Base Editor 4.2, smoothed and converged in accordance with a 1:5,000 scale map. These contours were then imported into S-57 composer, but the disjointed nature of the generation made them best suited to guiding contour updates, which were subsequently completed by hand and checked against the generalized bathymetric surface.

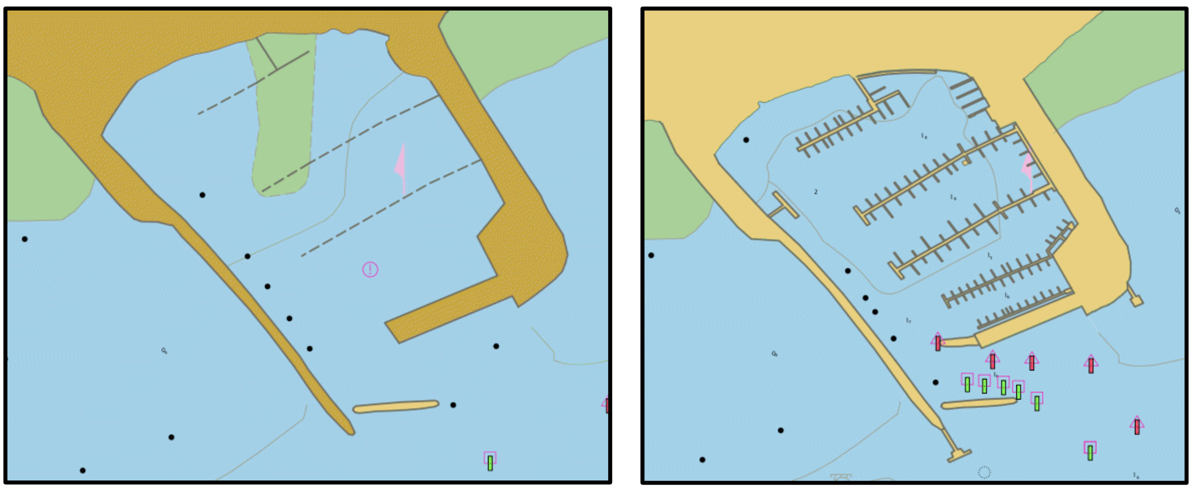


Figure 41. Comparison of interior harbor Land Area (LNDARE) from US5MS11M (left) and 17USM02 (right).

Alterations were made to the number and position of lateral beacons (BCNLAT) and associated day markers (DAYMAR) identifying the approach to the Harbor. In total, nine beacons were added to 17USM02 in addition to updating the position of the previously existing six (Figure 40). No changes were made to existing light (LIGHTS) as function was not observed. A detailed description of channel marker updates is included in section D.2.2 of this report and finalized attribute fields are included in the FFF.

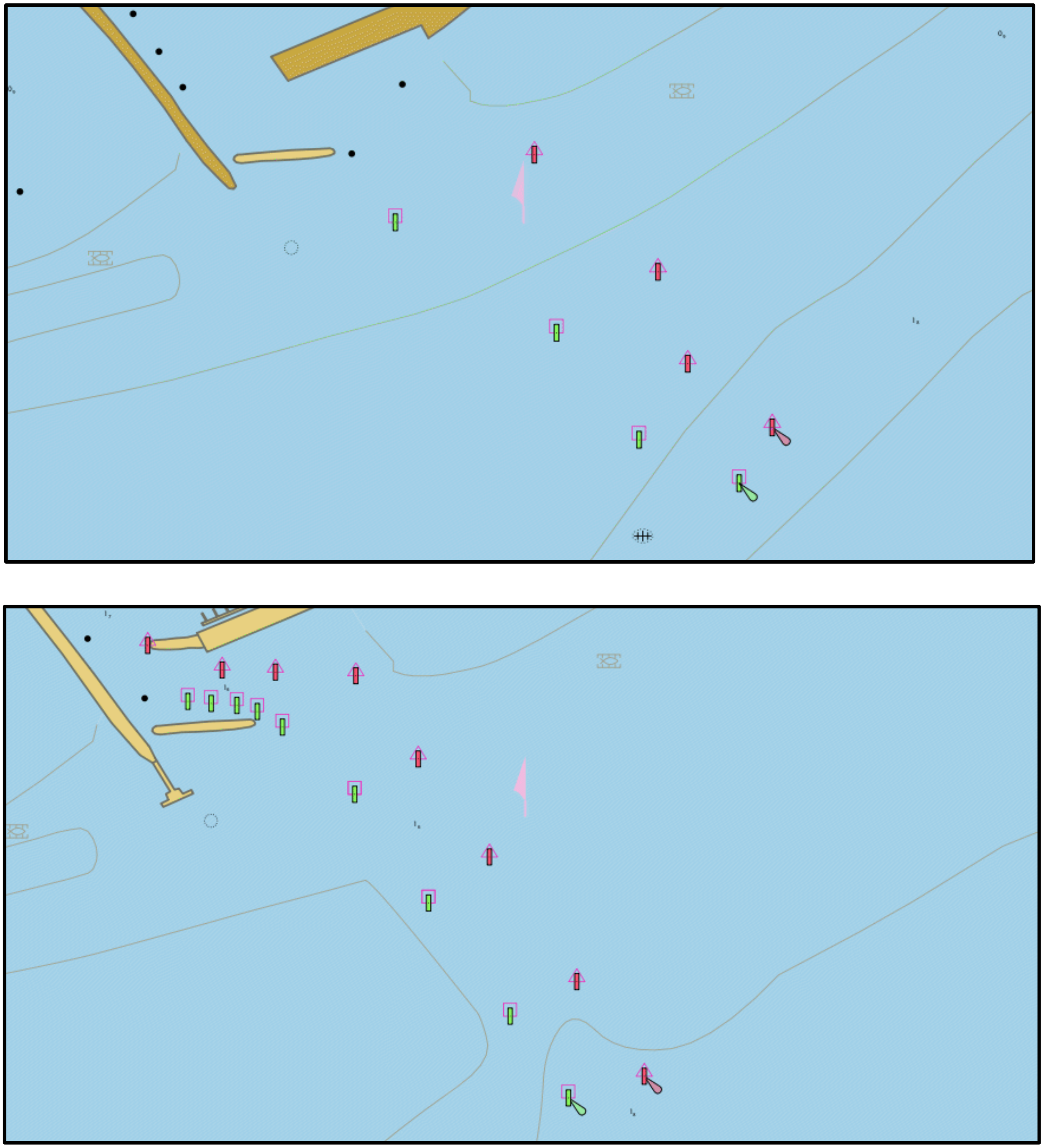


Figure 42. Lateral Beacons and Day marker positions in US5MS11M (above) and 17USM02 (below).

D.1.2 Priority Area 2

Priority Area 2 includes the comparison of areas outside of the existing harbor and approach. Determining the underkeel clearance in the vicinity of the approach and investigating charted DTONs were the primary objectives for the area. As such, updates to the existing nautical chart included alterations to depth contours (DEPCNT), depth areas (DEPARE), and updates to all investigated charted features was performed. Note that these group objects that will be derived from finalized surfaces during chart compilation (DEPARE, DEPCNT, SOUNDG) were not included in the FFF in accordance with HSSD requirements [HSSD, 2017].

The shoal-biased Caris surface referred do in section D.1.1 was used to determine the extent of bathymetric differences between observed and charted values (Figure 41). Differences between charted and surveyed depths were most apparent in the approach, where previous dredging operations were noted by the Long Beach Harbor Master. As a result, adjustments were made to the 0.9 m and 1.8 m depth contours in that area as needed. 17USM02 survey soundings also showed no depths shallower than the 0.9 m depth contour. Therefore, portions of the 0.9 m contour coincident with 17USM02 were repositioned to the boundary of the survey to reflect the depths in the surveyed area (Figure 41). The vast majority of Priority Area 2 is situated between the 1.8 m and 3.6 m contour lines present on US5MS11M chart and required no alterations. Charted soundings were updated where coincident with 17USM02, however differences were no greater than 0.3 m. Since shoreline survey was conducted at high tide only, no adjustments to the charted intertidal area were applied on the seaward side.

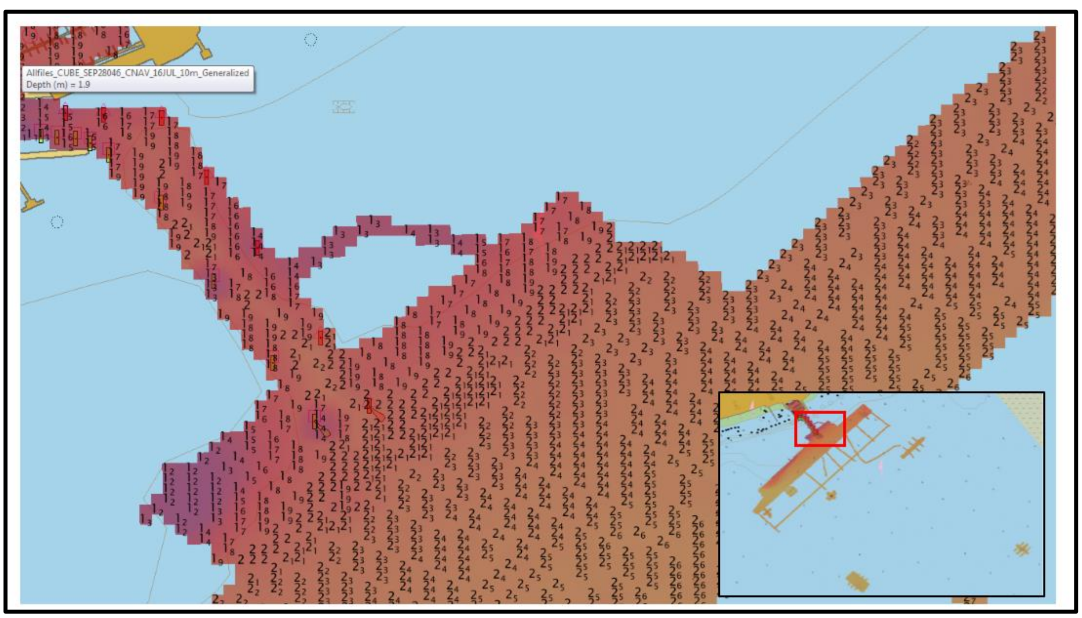


Figure 43. Bathymetry overlaid onto ENC cell 17USM02.

The 17USM02 study area included seven charted features that represent potential hazards to mariners. An additional two features identified in NOAA OCS's automated wreck and obstruction information system (AWOIS) and were included in the investigation plan for 17USM02 (Figure 42, Table 13). Each feature was investigated with a maximum search radius of 100 m to assess condition. The results of the investigation were used to update feature attributes in the 17USM02 ENC cell. As per section D of the NOS HSSD, updates to these features are detailed further in the final feature file, submitted with this report [HSSD, 2017].

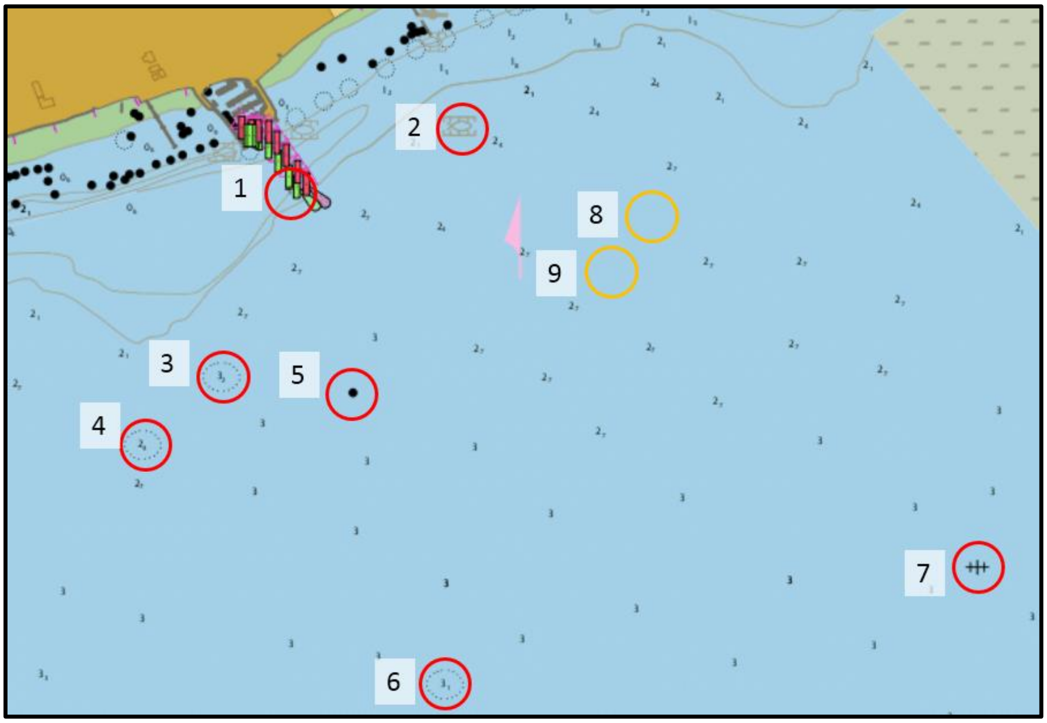


Figure 44. Locations of 9 investigated features during 17USM02 hydrographic survey.

According to NOS HSSD 7.3.3, feature disproval requires consultation with NOAA Hydrographic Surveys Division (HSD) Project Manager to determine a disproval search radius. Due to the academic nature of this survey, a radius was not clarified for investigated features, and therefore no features have been removed. However, survey results suggest that several investigated features existence is doubtful. Table 13 identifies all features investigated and mandatory attributes. Features that were not detected during survey and are recommended for removal are greyed. Attribute values for these features were not updated with the exception of a textual description added to note the recommendation for removal (descrp = Delete). Detected features include updated mandatory attribute values included in the FFF with a textual description to note the nature of update (descrp = Update/Retain). AWOIS features are highlighted in yellow, these features were not detected and have been recommended for removal from AWOIS.

Table 13. List of features investigated during 17USM02 and description of detection results.

Feature Object	Feature ID	Original Sounding (m)	New Sounding (m)	Water Level (WATLEV)	Quality (QUASOU)	Technique (TECSOU)	Category (CATWRK)
WRECK (1)	0000010908	-	-	Always Submerged	Depth Unknown	-	Unknown
MARCUL(2)	0018297495 00050	-	-	Always Submerged	Least Depth Known	SSS, MBES	-
OBSTRN (3)	0018298970 00050	2.4	-	Always Submerged	Least Depth Known	-	-
OBSTRN (4)	0018298748 00050	2.4	2.20	Always Submerged	Least Depth Known	SSS, MBES	-
PILPNT(5)	0018297625 00050	-	-	-	-	-	-
OBSTRN(6)	0018298237 00050	2.1	-	Always Submerged	-	-	-
WRECK(7)	0018298629 00050	N/A	2.33	Always Submerged	Least Depth Known	SSS, MBES	Unknown
WRECK(8)	AWOIS # 8621	-	-	Covers and Uncovers	-	-	-
WRECK(9)	AWOIS # 8664	-	-	Covers and Uncovers	-	-	-

No maritime boundaries or maintained navigation channels exist in the survey area, and thus none were investigated.

D.2 Additional Results

D.2.1 Dangers to Navigation

Dangers to Navigation (DETONs) are defined by the NOS HSSD as any natural or cultural feature which is found by the hydrographer to pose an imminent danger to the mariner or to be inadequately charted. Potential dangers shall be evaluated in the context of the largest scale nautical chart of the area and an understanding of vessel traffic in the area. As such, 17USM02 identified no uncharted features that were deemed to represent a potential danger to mariners according to DETON the selection criteria included in NOS HSSD [HSSD, 2017]. Note that least depths and positions of previously charted features and obstructions that may present as DETONs were updated on an as needed basis. These alterations are detailed in the Section B.2, listed in section D.2.4 and included in the accompanying FFF.

Concur with clarification. The correct acronym for Dangers to Navigation is DTON

D.2.2 Aids to Navigation

Positioning of all aids to navigation (ATONs) was performed in accordance with NOS HSSD [NOS, 2017]. Prior to survey, multiple sources presented conflicting information regarding the number and position of harbor lights and day markers. Specifically, the positioning and descriptions of day markers provided by the U.S. Coast Guard (USCG) with regard to the most up to date ENC (US5MS11M). The USCG list of lights provides estimated positions for 14 channel markers in the approach [USCG, 2017]. These positions are given in Table 14 and illustrated in Figure 43.

Table 14. U.S. Coast Guard List of Lights for Long Beach Harbor [USCG, 2017].

No.	Name	Latitude	Longitude	Structure
10075	Entrance Light 1	30° 20’ 25.000” N	89° 08’ 22.000” W	SG on pile
10080	Entrance Light 2	30-20-26.000N	089-08-21.000W	TR on pile
10085	Day beacon 3	30-20-27.000N	089-08-24.000W	SG on pile
10090	Day beacon 4	30-20-28.000N	089-08-23.000W	TR on pile
10095	Day beacon 5	30-20-29.000N	089-08-26.000W	SG on pile
10100	Day beacon 6	30-20-30.000N	089-08-24.000W	TR on pile
10105	Day beacon 7	30-20-30.000N	089-08-27.000W	SG on pile
10110	Day beacon 8	30-20-31.000N	089-08-28.000W	TR on pile
10115	Day beacon 9	30-20-32.000N	089-08-28.000W	SG on pile
10220	Day beacon 10	30-20-33.000N	089-08-27.000W	TR on pile
10225	Day beacon 11	30-20-32.000N	089-08-29.000W	SG on pile
10230	Day beacon 12	30-20-33.000N	089-08-29.000W	TR on pile
10235	Day beacon 13	30-20-32.000N	089-08-30.000W	SG on pile

10240	Day beacon 14	30-20-33.000N	089-08-31.000W	TR on pile

US5MS11M contains day marker information sourced from March 2004, depicting 8 channel markers along the approach and two unmarked piling near the harbor entrance (Figure 43). Initial field assessments of the approach suggested the total number of ATONs in the approach is 17, and current positions were inaccurate.

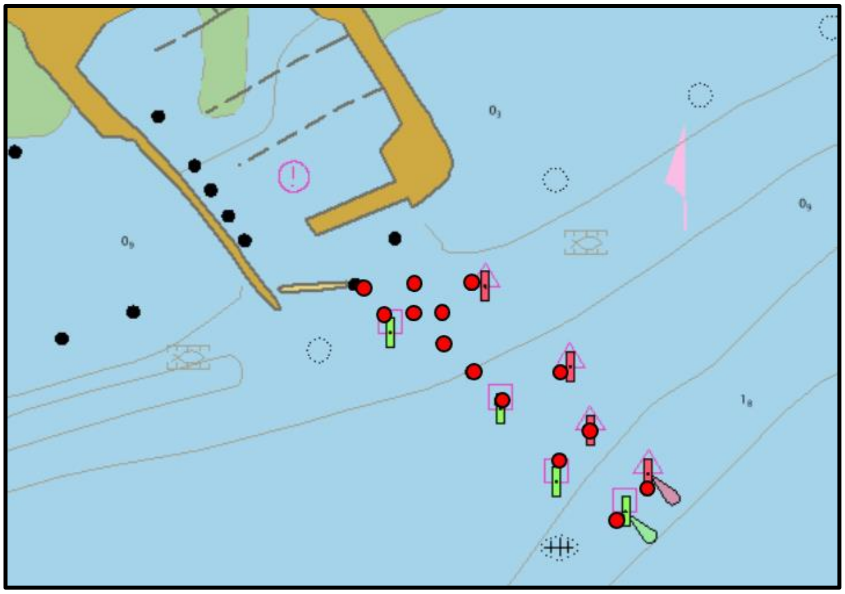
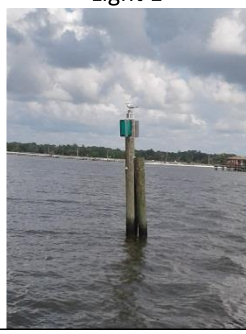


Figure 45. ENC US5MS11M with USCG lights overlaid in red circles.

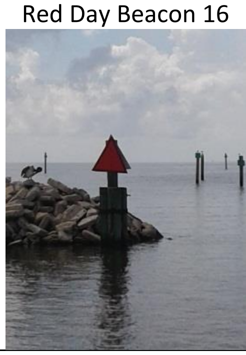
As a result of these discrepancies, the positioning of all ATONs in the vicinity of Long Beach Harbor was a priority objective for 17USM02. Positioning of all ATONs was conducted using an RTK solution and 1 Hz observations averaged over 5 seconds, results of the survey resulted in the development of new positions for all published ATONS and 6 pilings within the harbor, images of each ATON and positions are included in Table 15. Updated positions were conveyed to USCG via the ATON discrepancy report form (Figure 44).

Table 15. ATONs positioned during 17USM02 survey.

17USM02 Survey Area ATONs	
Name	**Information**
Long Beach Harbor Entrance Light 1 	**USCG Feature No.:** 10075 **US5MS11M ENC Charted Position:** 30° 20’ 25.235” N, 089° 08’ 21.746” W **17USM02 ENC Corrected Position:** 30° 20’ 24.384” N, 089° 08’ 24.019” W **Comments:** Functionality of Light Unconfirmed.
Long Beach Harbor Entrance Light 2 	**USCG Feature No.:** 10080 **US5MS11M ENC Charted Position:** 30° 20’ 26.542” N, 089° 08’ 20.972” W **17USM02 ENC Corrected Position:** 30° 20’ 24.882” N, 089° 08’ 22.279” W **Comments:** Functionality of Light Unconfirmed.
Green Day Beacon 3 	**USCG Feature No.:** 10085 **US5MS11M ENC Charted Position:** 30° 20’ 26.254” N, 089° 08’ 24.090” W **17USM02 ENC Corrected Position:** 30° 20’ 26.263” N, 089° 08’ 25.358” W **Comments:** Good working condition.
Red Day Beacon 4 	**USCG Feature No.:** 10090 **US5MS11M ENC Charted Position:** 30° 20’ 28.032” N, 089° 08’ 22.949” W **17USM02 ENC Corrected Position:** 30° 20’ 27.056” N, 089° 08’ 23.826” W **Comments:** Good working condition.

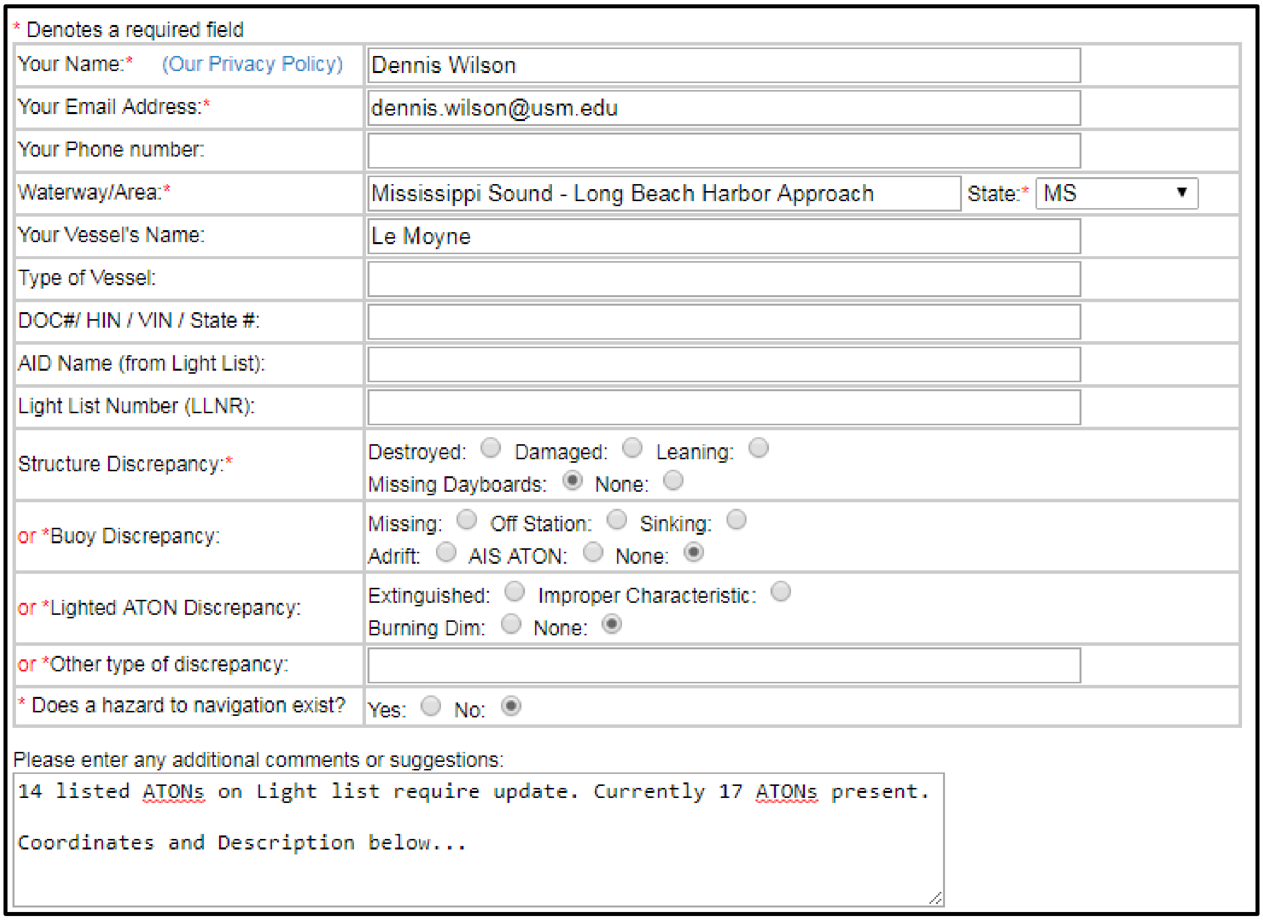
Green Day Beacon 5 	**USCG Feature No.:** 10095 **US5MS11M ENC Charted Position:** 30° 20’ 28.759” N, 089° 08’ 26.020” W **17USM02 ENC Corrected Position:** 30° 20’ 28.861” N, 089° 08’ 27.229” W **Comments:** Good working condition.
Red Day Beacon 6 	**USCG Feature No.:** 10100 **US5MS11M ENC Charted Position:** 30° 20’ 30.185” N, 089° 08’ 23.647” W **17USM02 ENC Corrected Position:** 30° 20’ 29.920” N, 089° 08’ 25.833” W **Comments:** Good working condition.
Green Day Beacon 7 	**USCG Feature No.:** 10105 **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20’ 31.358” N, 089° 08’ 28.924” W **Comments:** Good working condition.
Red Day Beacon 8 	**USCG Feature No.:** 10110 **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20’ 232.170” N, 089° 08’ 27.468” W **Comments:** Good working condition.

Green Day Beacon 9 	**USCG Feature No.:** 10115 **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20’ 32.901” N, 089° 08’ 30.585” W **Comments:** Day Marker Signage Missing. Unconfirmed light functionality.
Red Day Beacon 10 	**USCG Feature No.:** 10120 **US5MS11M ENC Charted Position:** 30° 20’ 32.928” N, 089° 08’ 26.538” W **17USM02 ENC Corrected Position:** 30° 20’ 34.083” N, 089° 08’ 28.899” W **Comments:** Good working condition.
Green Day Beacon 11 	**USCG Feature No.:** 10125 **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20’ 33.260” N, 089° 08’ 31.162” W **Comments:** Good working condition.
Red Day Beacon 12 	**USCG Feature No.:** 10130 **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20’ 34.167” N, 089° 08’ 30.745” W **Comments:** Good working condition.

Green Day Beacon 13 	**USCG Feature No.:** 10135 **US5MS11M ENC Charted Position:** 30° 20' 31.344" N, 089° 08' 29.792" W **17USM02 ENC Corrected Position:** 30° 20' 33.400" N, 089° 08' 31.630" W **Comments:** Good working condition.
Red Day Beacon 14 	**USCG Feature No.:** 10140 **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20' 34.214" N, 089° 08' 31.969" W **Comments:** Good working condition.
Green Day Beacon 15 	**USCG Feature No.:** N/A **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20' 33.445" N, 089° 08' 32.221" W **Comments:** Good working condition.
Red Day Beacon 16 	**USCG Feature No.:** N/A **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20' 34.778" N, 089° 08' 33.676" W **Comments:** Good working condition.

Green Day Beacon 17 	**USCG Feature No.:** N/A **US5MS11M ENC Charted Position:** N/A **17USM02 ENC Corrected Position:** 30° 20' 33.493" N, 089° 08' 32.755" W **Comments:** Good working condition.

Positioning methods and uncertainties of ATON investigations are discussed further in the DAPR Appendix E.



* Denotes a required field

Your Name:* (Our Privacy Policy)	Dennis Wilson
Your Email Address:*	dennis.wilson@usm.edu
Your Phone number:	
Waterway/Area:*	Mississippi Sound - Long Beach Harbor Approach State:* MS
Your Vessel's Name:	Le Moyne
Type of Vessel:	
DOC#/ HIN / VIN / State #:	
AID Name (from Light List):	
Light List Number (LLNR):	
Structure Discrepancy:*	Destroyed: ○ Damaged: ○ Leaning: ○ Missing Dayboards: ◉ None: ○
or *Buoy Discrepancy:	Missing: ○ Off Station: ○ Sinking: ○ Adrift: ○ AIS ATON: ○ None: ◉
or *Lighted ATON Discrepancy:	Extinguished: ○ Improper Characteristic: ○ Burning Dim: ○ None: ◉
or *Other type of discrepancy:	
* Does a hazard to navigation exist?	Yes: ○ No: ◉

Please enter any additional comments or suggestions:

```
14 listed ATONs on Light list require update. Currently 17 ATONs present.

Coordinates and Description below...
```

Figure 46. USCG ATON discrepancy report form example submission for 17USM02.

D.2.3 Shoreline Update

Shoreline delineation of Long Beach Harbor and associated sea walls, piers and docks was completed on 9 and12 June 2017 using a TopCon GR5 GNSS receiver. An RTK solution was generated by positioning the base station over 17USM02 primary benchmark using the OPUS solution and connecting to the Rover via the built in radio connection. Reigl VC-1000 lidar data was also collected of the project area, however processing of lidar determined a horizontal uncertainty of 1.80 m. This value was considered too great to be used independently, instead was used as a spot check validation tool against the RTK solution. This solution was determined to be 0.011 m horizontal at 2σ for kinematic positioning. Total horizontal uncertainty for RTK solutions is included in 17USM02 DAPR Appendix E.

Survey operations were carried out using a combination of static and kinematic modes. Undeveloped coastline consisting of sandy shoreline was surveyed using a kinematic method sampling at a rate of 1 Hz. Points collected during kinematic survey established the shoreline adjacent to Long Beach Harbor and a small undeveloped shoreline located in the northwestern interior of the harbor itself. Static survey mode was used to collect linear harbor features (piers, jetties, sea walls, etc.) as well as features unsuitable to kinematic survey (rip rap breakwaters). Static survey was completed using a 3 measurement average collected at a rate of 1 Hz.

NOAA specifications require that shoreline delineation occur within ±0.3 ft (0.091 m) of the MHW and MLLW for an area with a tidal range of $\leq$ 5 ft [NOAA, 2014]. Prior to shoreline efforts, tidal observations from NOAA Bay Waveland Yacht Club (Station ID: 8747437) were used to forecast water levels for the study area and determine the validity of the selected survey window (Figures 45 and 46). Using the predicted data, a survey window for MHW was determined, these time intervals are listed in Table 16.

Table 16. Shoreline timing intervals based on Bay Waveland Yacht Club predicted tides.

Date	Range Times (UTC)	
9 June 2017	1212 - 1554	1800-2042
12 June 2017	1354 - 1750	2000 - 2230

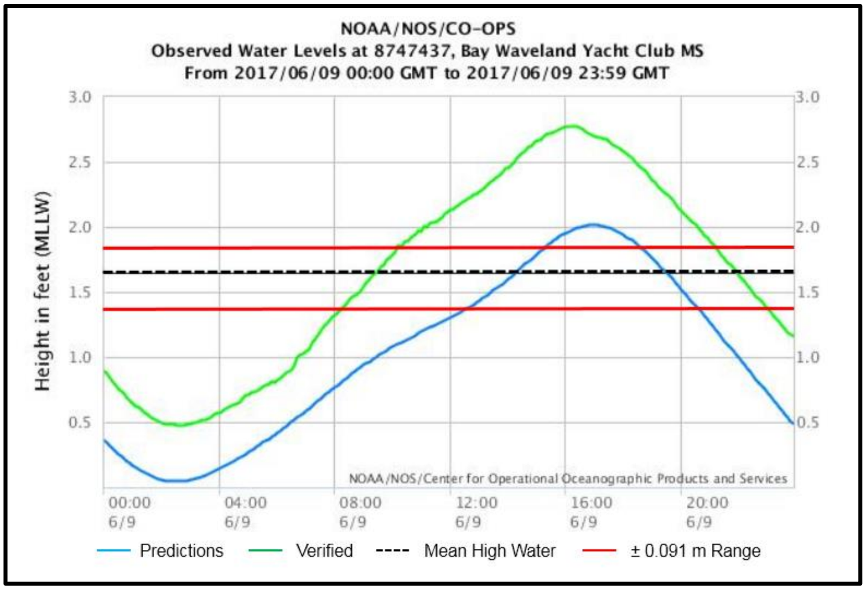


Figure 47. Tidal predictions and shoreline survey range for 9 June 2017 at Bay Waveland Yacht Club, MS.

On 9 June 2017 surveying on undeveloped coastline commenced at 1524 UTC. Shoreline delineation of these areas was completed at 1610, at which time delineation of built up harbor structures began using static point collection of prominent coastal features to delineate the harbor extent. The western extent of the coastline was therefore surveyed for approximately 16 minutes outside of NOAA specifications. However, given the minimal tidal variation in the region (Mean Tidal Range = 1.5 ft), surveyors determined that the data would still represent a shoreline within IHO special order specifications for coastline/topography less significant to navigation (10 meters).

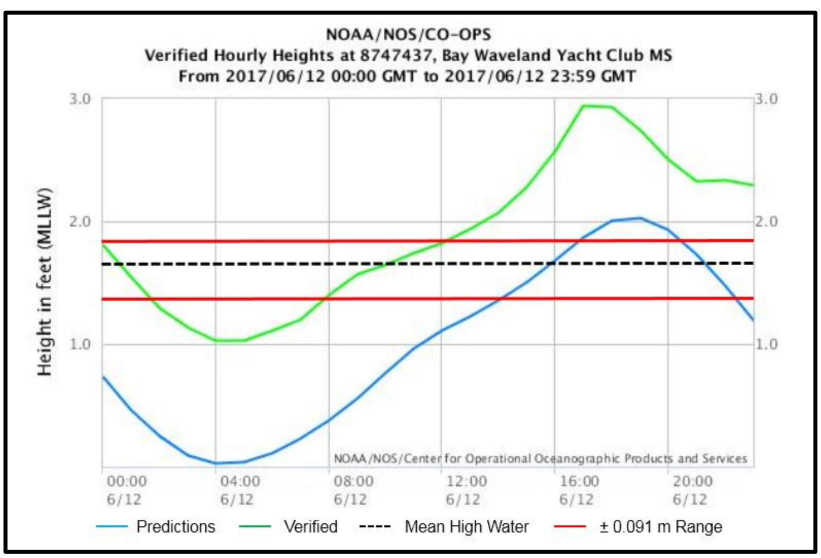


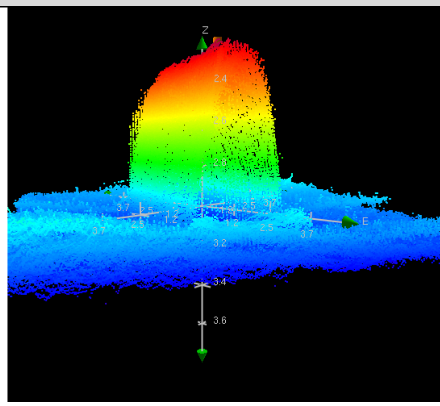
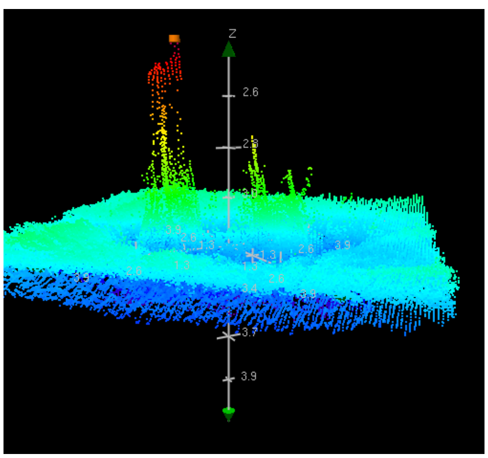
Figure 48. Tidal predictions and shoreline survey range for 12 June 2017 at Bay Waveland Yacht Club, MS.

Shoreline delineation survey conducted on 12 June 2017 was conducted between 1305 and 1700. Initial surveying was conducted along interior harbor pier structures, which are not affected by changing water levels. Survey of the shoreline commenced at approximately 1505, within NOAA specification for shoreline delineation.

D.2.4 Significant Features

Two significant features were identified during 17USM02 survey. Both were charted features that were being investigated for corroboration purposes. According to the HSSD, a significant feature is any feature measuring 1 m^2 horizontally and extending 1 m vertically in waters 22 m or less [HSSD, 2017]. Features presented here were initially identified in SSS imaging, with positions and least depths confirmed via MBES.

Table 17. Significant features with MBES point cloud imagery.

Feature	MBES Image	Position	Least Depth (m)
Submerged Obstruction		30º 19’ 38.95”N 089º 08’ 51.33”W	2.20
Submerged Wreck		30º19’17.53”N 089º06’23.92”W	2.33

D.2.5 Seabed Samples

Bottom sampling was conducted on 19 June 2017 using the Petite Ponar grab sampler detailed in 17USM02 DAPR Section A.4. Sampling locations were selected based on geographical area as well as to corroborate possible texture boundaries observed in the SSS waterfall (Figure 47). Table 18 contains the position and description of collected samples.

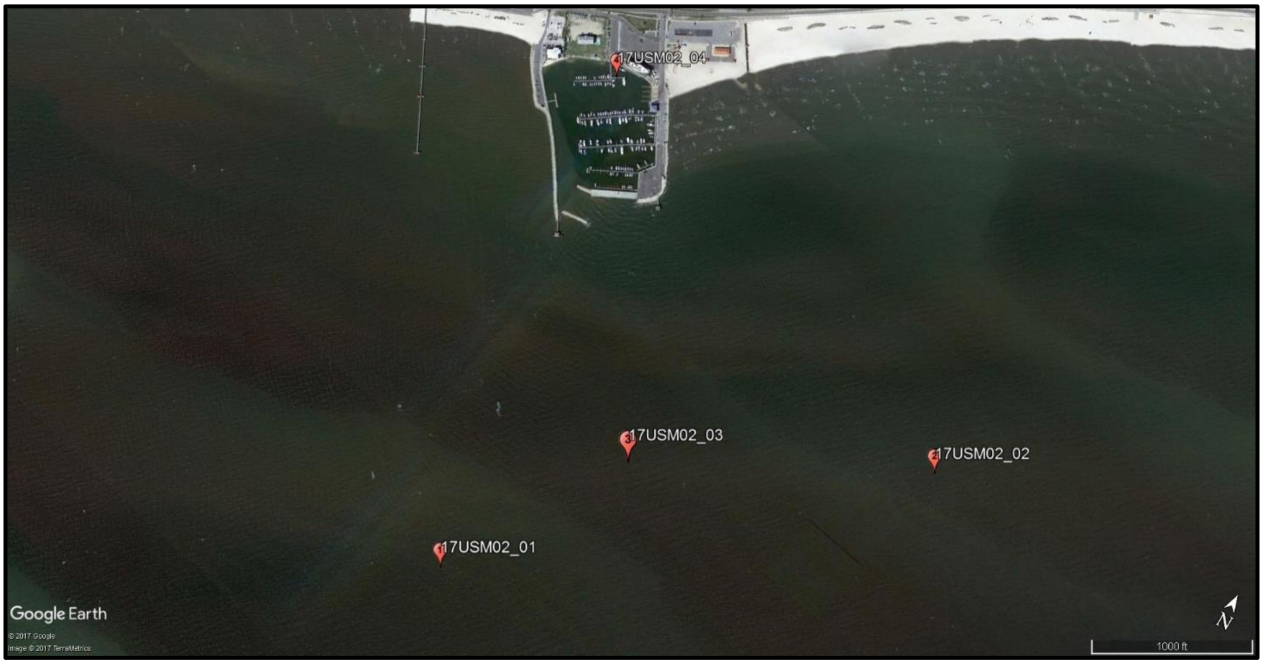


Figure 49. Seabed sample collection locations in proximity to Long Beach Harbor.

Table 18. Location of seabed sample collection.

Sample Number	Time (UTC)	Latitude	Longitude	Description
17USM02_01	1900	30 20' 09.60" N	89 08' 27.98" W	Priority Area 2 - West
17USM02_02	1919	30 20' 29.86 N	89 08' 00.32" W	Priority Area 2 - East
17USM02_03	1928	30 20' 20.96" N	89 08' 20.03" W	Priority Area 2 - Central
17USM02_04	1950	30 20’ 42.51” N	89 08’ 35.34” W	Interior Harbor - North

Analysis of collected bottom samples was conducted using the Mastersizer 3000 laser particle size analyzer. Results of sediment analysis show grain sizes exhibit a consistent clay classification on the Wentworth Scale, with an average Dx(50) of 22.1 µm across all samples. The complete results are presented in Figure 48 and Table 19.

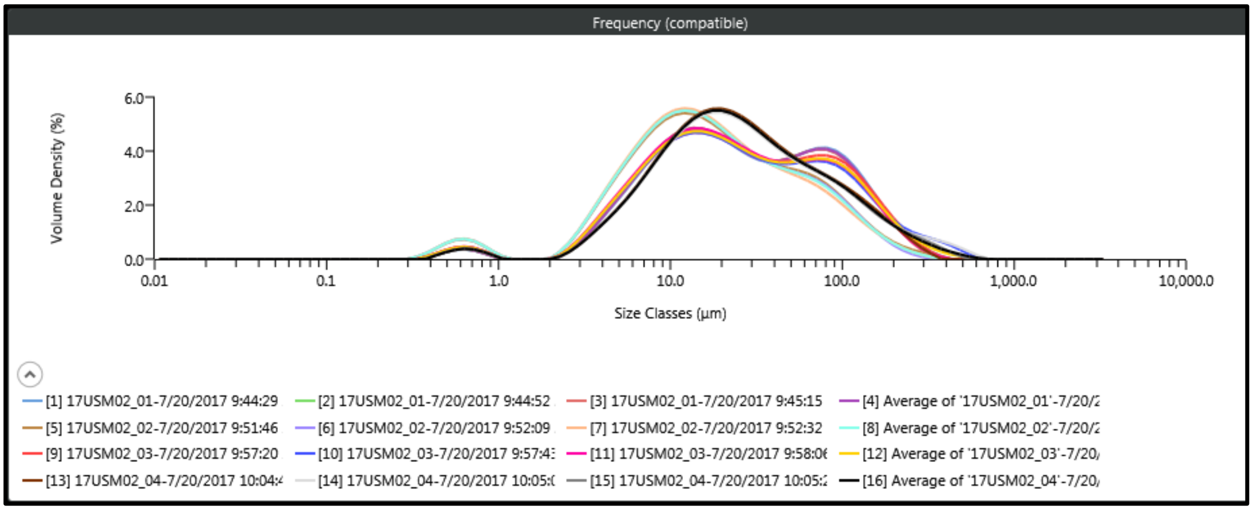


Figure 50. Grain size distribution for seabed samples collected.

Table 19. Sediment grain size analysis results.

Sample	Record Number	Grain Size (µm)			Mode
		Dx(10)	Dx(50)	Dx(90)	
17USM02_01	1	6.03	25.1	124	14
	2	5.97	24.4	120	14
	3	5.93	24.2	119	14
	Average	**5.97**	**24.6**	**121**	**14**
17USM02_02	1	4.5	16.8	85.7	12.2
	2	4.44	16.3	81.4	12.2
	3	4.41	16	79.8	12.2
	Average	**4.45**	**16.3**	**82.4**	**12.2**
17USM02_03	1	5.61	24.2	125	14.3
	2	5.6	24.2	137	14.3
	3	5.49	22.8	118	14.3
	Average	**5.57**	**23.7**	**126**	**14.3**
17USM02_03	1	6.38	23.5	110	18.8
	2	6.46	24.3	129	18.6
	3	6.41	23.8	118	18.6
	Average	**6.42**	**23.9**	**118**	**18.7**

Collected samples were then described according to NOS HSSD requirements for encoding bottom samples [NOS, 2017]. These descriptions include attribute codes for nature of the surface (NATSUR), nature of the quality (NATQUA), and color (COLOUR) (Table 20).

Table 20. Seabed samples with corresponding S-57 attribute values.

17USM02 Seabed Sampling					
Time (UTC)	**Latitude**	**Longitude**	**NATSUR**	**NATQUA**	**COLOUR**
1900	30 20' 09.60" N	89 08' 27.98" W	2,3 (Clay, Silt)	5,6 (Sticky, Soft)	7 (Grey)
1919	30 20' 29.86 N	89 08' 00.32" W	2,3 (Clay, Silt)	5,6 (Sticky, Soft)	7 (Grey)
1928	30 20' 20.96" N	89 08' 20.03" W	2,3 (Clay, Silt)	5,6 (Sticky, Soft)	7 (Grey)
1950	30 20' 45.51	89 08' 35.34" W	2,3 (Clay, Silt)	5,6 (Sticky, Soft)	2,7 (Black, Grey)

Bottom samples features were created and added to the FFF.

D.2.6 Sailing Directions &Coast Pilot Amendments

Coast Pilot 5 contains sparse information regarding the Long Beach area that includes landmarks and features that no longer exist. College Pier, a structure associated with the Gulf Park College is no longer located along the coast and the College is now a University of Southern Mississippi Campus – Gulf Park Campus.

Updates to the harbor description could include:

> Long Beach Harbor is formed by two moles, the east forming an L-shape and supporting vehicle traffic which acts as the primary breakwater for the harbor. The western mole encloses the harbor and supports a small fishing pier at its extent. The approach to the harbor is well marked and lines up with a prominent elevated restaurant located at the northern extent of the harbor and can be used to aid in lining up an approach. Vessels are required to navigate between two rip rap breakwaters before entering the harbor. The approach and harbor have a minimum depth of approximately 6 feet. The harbor master facilities are located on the eastern side of the harbor, where facilities are available.

These updates in conjunction with aspects currently existing description provide an adequate description of the Long Beach Harbor.

F. Lessons Learned and Recommendations

The following sections detail lessons we learned both during the summer survey and throughout the program. Recommendations are also made for the future of the program.

F.1 Equipment Installation / Survey Preparation

- A Kongsberg EM2040C should only be mounted on the port side of a vessel if configured with a single transducer and tilt. The Kongsberg operations manual and the Kongsberg installation manual makes no note of this limitation. However, this necessity is described in the datagram technical report. Although previous survey managed to conduct a survey with a starboard mounted tilted EM2040C, it was with significant artifacts in the data and required laborious cleaning and manipulation of the data.
- It would be a useful exercise to validate the GAMS Baseline Vectors as a post first survey day Q/C check to further confirm the values obtained during the POS/MV GAMS calibration. If the first day of POS data is processed in POSPac so that the initial GAMS calibration result could be compared to the x, y, and z GAMS lever arm report. These values should be very close and would alarm the survey of any differences should they exist; perhaps facilitating a new GAMS calibration.
- POSPac MMS was not available to 17USM02 until after the survey was complete. This prevented any alterations to lever arm offsets and GAMS values for an extended period of time.
- After consultation with Applanix technical support, it was advised that in future small boat operation survey, GAMS calibrations should be performed 3 times, compared with VCS values to prevent blunders, and averaged.
- The differences in the standard deviation between the averaged and the least square adjusted values determined by the GeoOffice LSA, demonstrates the importance of comparing the standard deviations within the processed solutions of trusted methods. The least square adjustment should have improved the standard deviation but did not. After consulting with Dr. Howden, the error in the GeoOffice processing is still not clear. However, the averaged values provided us with useful values with an acceptable standard deviation.
- Never walk away from a Windows 10 machine with any work unsaved or a CARIS project open if it can be avoided. The brand new USM rugged laptops equipped with Windows 10 frequently crashed, download 'updates' automatically and force reboots while un-attended. We found it was best to do any sort of batch processing or running programs with long processing times to operate the computer in Airplane mode. This shut down many of the background processes, and prevented any chance in downloading updates with forced reboots.

F.2 Tides and Geodesy

- Make sure that the tide gauge to be used in the survey is calibrated correctly. In the case of the In-Situ Level TROLL 700, the electronic drift in the pressure sensor can be removed by calibrating the sensor while it is in air.
- Measure the static and dynamic draft of the vessel, as similar to when performing traditional hydrographic surveys. At the end, a comparison between ERS and traditional survey processing can be performed.
- It is recommended to perform vertical offset calibration of the positioning system by locating the vessel next to the water level gauge and logging data for at least 25 hours (FIG Pub 62, 2014). Data of at least 25 hours will complete a tidal cycle and thus, a comparison between the tide gauge water levels and the ellipsoidal heights from the antenna can be compared.

F.3 SSS Operation and Data Deliverables

- EdgeTech 6205 requires “Heave Down” set in the POSMV COM port Output settings for proper heave attribution to sounding data. This setting was altered during a technical demonstration without 17USM02 survey team member’s knowledge. It resulted in heave issued that had to be addressed prior to data collection.
- When processing bathymetry data in CARIS with EdgeTech 6205 data files, we found that if you bring in all of the data and filter afterwards every processing routine take an astronomical amount of time. A simple Sound Velocity correction ran for just 6 days of data took in excess of 6 hours to complete. We deleted our old project, and started anew with performing our initial data filters on the step ingesting the data into CARIS. Rather than bring in these filtered data as “rejected” soundings, they were excluded entirely from the project. This greatly enhanced our processing run times.
- EdgeTech 6205 *.JSF Files – Are massive. Files are recorded as BIN and STAVE, where the STAVE files contain all of the effective raw data and are much greater in size. On average we collected about 200 gigabytes of EdgeTech 6205 data daily on survey. STAVE files should be archived in case a BIN file is corrupted and needs to be re-binned. We found using two external hard drives to extract data off the survey vessel daily, rather than just one, helped speed up the daily backup and extraction time.
- EdgeTech 6205 bathymetry data are extremely noisy and cumbersome for manual data cleaning. We filtered data on the ingestion to 6x water depth, as often recommended when trying to achieve Special Order uncertainty values with phase differencing sonars, but an excessive amount of noise still remained in our data. We found that running a TPU filter was an effective method to eliminate much of this noise. CUBE is also recommended to use for any surface generation of noisy sonar data.

F.4 MBES Operations and Data Deliverables

- As mentioned in the DAPR, we learned that an EM2040C single head system is only meant to be tilted to the port side which requires a port-side mount for a pole-mounted system.
- Using the pole mounts on the LeMoyne seems to introduce a varying roll artifact into the data. The poles were shimmed to prevent an unstable mount, but small roll artifacts could still be seen in our data (variance of about a degree).
- EM2040c requires "Heave Up" set in the POSMV COM port Output settings for proper heave attribution to sounding data.

F.5 Data Uncertainties and IHO/NOAA Standards

- Methods and tools for multibeam crosscheck analysis should be demonstrated during the program.
- It would be useful to show more tools available in CARIS HIPS and SIPS during the program such as the Line QC Tool, QC Report, and Detailed Line Query.

F.6 ATONs, DTONs, Shorelining, and Bottom Samples

- The 17USM02 HSSD proposal outlined a methodology for positioning ATONs based on bathymetric surfaces generated via MBES. However, after problems were encountered with horizontal positioning in bathymetric systems, it was decided that it would be best practice to collect ATONs using the most precise method available. This would ensure accurate positions, and could be used as a position to validate the horizontal accuracy of bathymetric systems.
- In the future, classes should be introduced to backscatter analysis techniques that can be applied to summer survey projects. While backscatter is not currently required for nautical charting surveys, it is an emerging technique commonly practiced in the field of Hydrographic Science. Graduating students should have a basic knowledge of backscatter analysis techniques.

F.7 ENC Production

- A self-paced CARIS S-57 production module was presented in lieu of in class sessions. Students preferred this method of learning, however there was some difficulty when assessing technical problems encountered during 17USM02 chart production. CARIS support provided by Will Edwards was helpful to some extent, however it would be beneficial to have a faculty member with an understanding of the software and expectations available as a resource. Troubleshooting Composer issues via email was time consuming and difficult to properly communicate.

- Particular attention should be given to NOAA HSSD requirements for a final feature file and attribution at some point during HYD606.

G. Acknowledgements

The 17USM02 hydrographic survey required the efforts of many individuals and organizations, without which this survey would not be possible. While it is not possible to thank everyone involved, the students of the University of Southern Mississippi (USM) Hydrographic Science Class of 2017 are grateful to the following for the assistance and guidance they provided.

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The City of Long Beach, specifically Harbormaster William Angley for providing berthing for the USM vessel throughout the survey free of charge, and patience during tide gauge installation and the establishment of geodetic benchmarks.

Abigail Hode of the Naval Research Laboratory for providing the Reigl VC-1000 infrared terrestrial lidar scanner. Ms. Hode performed all Lidar data collection and processing and provided 17USM02 with ready to use point cloud data.

H. Approval Sheet

This section was intentionally left blank.

I. References

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APPROVAL PAGE

W00458

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 Memo
- Collection of Bathymetric Attributed Grids (BAGs)
- Bottom samples
- Geospatial PDF of survey products

Approved:____

James Miller
Acting Chief, Pacific Hydrographic Branch