W00271

NOAA FORM 76-35A

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

DESCRIPTIVE REPORT

Type of Survey	**Outside Source Data**
Project No.	**OSD-AHB-13**
Registry No.	**W00271**

LOCALITY

State	**Mississippi**
General Locality	**Gulf of Mexico**
Sub-locality	**Pascagoula Harbor and Bayou Casotte**

2013

CHIEF OF PARTY
Maxim van Norden
HYDROGRAPHER
Geoffrey Lawes

LIBRARY & ARCHIVES

DATE

NOAA FORM 77-28 (11-72)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET		**W00271**

State:	**Mississippi**
General Locality:	**Gulf of Mexico**
Sub-Locality:	**Pascagoula Harbor and Bayou Casotte**
Scale:	**1:5,000**
Dates of Survey:	**06/10/2013 to 06/19/2013**
Instructions Dated:	**05/27/2013**
Project Number:	**OSD-AHB-13**
Field Unit:	**University of Southern Mississippi**
Chief of Party:	**Maxim van Norden, USM**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Side Scan Sonar**
Verification by:	***Atlantic Hydrographic Branch***
Soundings Acquired in:	**meters at Mean lower low water**

Remarks:

The purpose of this survey is to provide contemporary surveys to update National Ocean Service (NOS) nautical charts. All separates are filed with the hydrographic data. Any revisions to the Descriptive Report (DR) generated during office processing are shown in bold red italic text. The processing branch maintains the DR as a field unit product, therefore, all information and recommendations within the body of the DR are considered preliminary unless otherwise noted. The final disposition of surveyed features is represented in the OCS nautical chart update products. All pertinent records for this survey, including the DR, are archived at the National Geophysical Data Center (NGDC) and can be retrieved via http://www.ngdc.noaa.gov/.

Pascagoula Harbor and Bayou Casotte

13USM01 Descriptive Report

Date: 26 July 2013

Prepared By:
Geoffrey Lawes
Ahmed Azab
Laura Casey
Kandice Gunning
Nicolas Waters

Short Details

Title	Pascagoula Harbor and Bayou Casotte
Registry Number	13USM01
Team Members	Geoffrey Lawes (HIC) Ahmed Azab Laura Casey Kandice Gunning Nicolas Waters
Locality	United States - Gulf Coast - Mississippi
Chart No. and Scale	NOAA Chart 11375, Scale 1:20,000
Product Scale	1:5000
Positional Accuracy	IHO Special Order NOAA 1m Object Detection Survey
Horizontal Datum	NAD83 (print charts), WGS84 (ENC)
Vertical Datum	MLLW (NTDE 1983-2001)
Charts Affected	NOAA Charts 11006, 1115A, 11363, 11373 11374, 11375, 11379, 411
ENC Affected	US4MS12M, US5MS21M, US5MS22M
Prior Surveys	H11384 (2005) F00516 (2005) H08645 (1962) H08649 (1962) H04021 (1917) H00365 (1853) Rowe Surveying Job 33407 (2009) Rowe Surveying Job 33409 (2009)

Contents

List of Figures

List of Tables

Acronyms and Abbreviations

ATON Aid to Navigation

CORS Continuously Operating Reference Station

CSAR Caris Spatial ARchive

CUBE Combined Uncertainty and Bathymetry Estimator

DTON Danger to Navigation

ENC Electronic Navigation Chart

FST Fleet Survey Team

GCGC Gulf Coast Geospatial Consortium

GNSS Global Navigation Satellite System

GSF Generic Sensor Format

HIC Hydrographer-In-Charge

HIPS Hydrographic Information Processing System

HSD Hydrographic Survey Division

IHO International Hydrographic Organization

IMU Inertial Motion Unit

JSF JStar Sidescan Format

MBES Multi-Beam Echo-Sounder

MLLW Mean Lower Low Water

NAD83 North American Datum of 1983

NGS National Geological Survey

NMEA National Marine Electronics Association

NOAA National Oceanic and Atmospheric Administration

NTDE National Tidal Datum Epoch

OPUS Online Positioning User Service

PPK Post Processed Kinematic

PPS Pulse Per-Second

POSMV Position and Orientation System for Marine Vehicles

QC Quality Control

SBET Smoothed Best Estimate of Trajectory

SEP Ellipsoid to Tidal Vertical Datum Separation

SSC John C. Stennis Space Center

SSS Side-Scan Sonar

SVP Sound Velocity Profiler

THU Total Horizontal Uncertainty

TPU Total Propagated Uncertainty

TVU Total Vertical Uncertainty

USACE United States Army Corps of Engineers

USM University of Southern Mississippi

UTC Coordinated Universal Time

WAAS Wide Area Augmentation System

XTF eXtensible Triton Format

A Area Surveyed

This navigable area survey was conducted to the specifications outlined in the *University of Southern Mississippi Hydrographic Survey Specification 13USM01, Pascagoula Harbor and Bayou Casotte*, dated 27 May 2013. The survey was required to meet the National Oceanic and Atmospheric Administration (NOAA) 1m object detection standards and International Hydrographic Organization (IHO) order 1a. The object detection standard was met in over 99% of the area surveyed. Due to the use of ellipsoid reference survey methods and high quality equipment, IHO special order was also achieved.

A.1 Purpose and Description

The purpose of the survey was to provide NOAA Hydrographic Survey Division (HSD) and the Jackson County Port Authority with a high resolution Multi-Beam Echo-Sounder (MBES) data set for checking existing chart information and historical data.

The survey area was divided into three sub-areas denoted A, B and C. Area A is within the harbor limits of the Port of Pascagoula and is principally concerned with the maintained channel. Area B is also within the Port of Pascagoula limits and lies between the Ingalls Shipyard south wharves and Singing River Island. Area C is within the harbor limits of Bayou Casotte and again is principally concerned with the maintained channel.

MBES coverage for both areas A and B are shown in figure A.1. Side-Scan Sonar (SSS) coverage for areas A and B is shown in figure A.2. MBES coverage for Area C is shown separately, in figure A.3 and SSS coverage for Area C is shown in figure A.4. The final survey areas vary slightly from the areas shown in the specification in order to alleviate the need for the survey vessel to venture into inadequately charted areas with depths below 4m.

The berths around the Ingalls Shipyard in Pascagoula Harbor could not be surveyed due to security related access restrictions. The areas around the bulk goods terminals (docks E, F, G and H) in Bayou Casotte could not be completely surveyed due to simultaneous hazardous material removal operations. Additionally, the area immediately south-west of the CSX railroad bridge and the area adjacent to the end of the Singing River island wharf could not be surveyed due to the presence of dilapidated oil rigs.

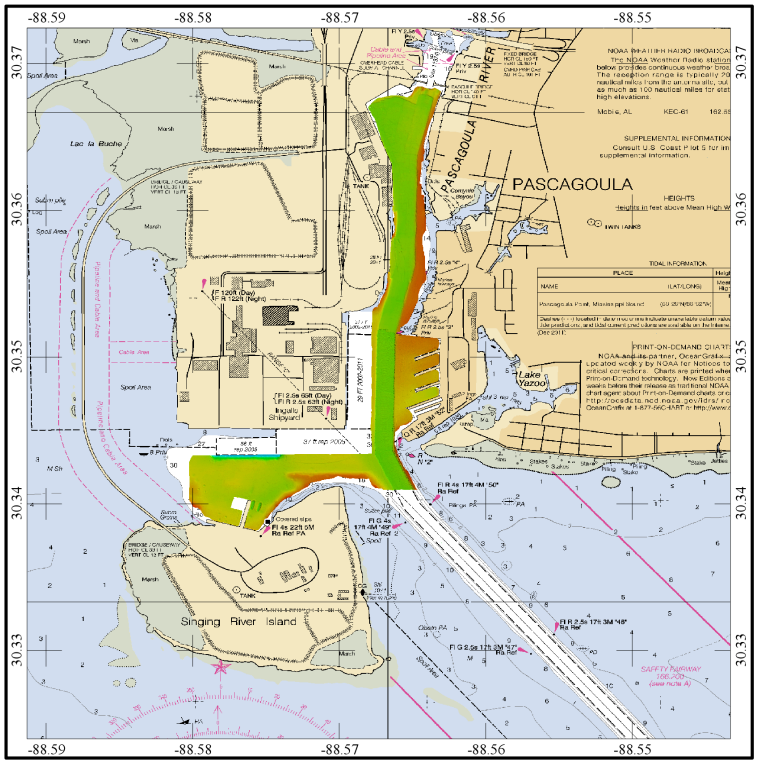

Figure A.1: Combined MBES coverage - areas A and B overlaid on chart 11375

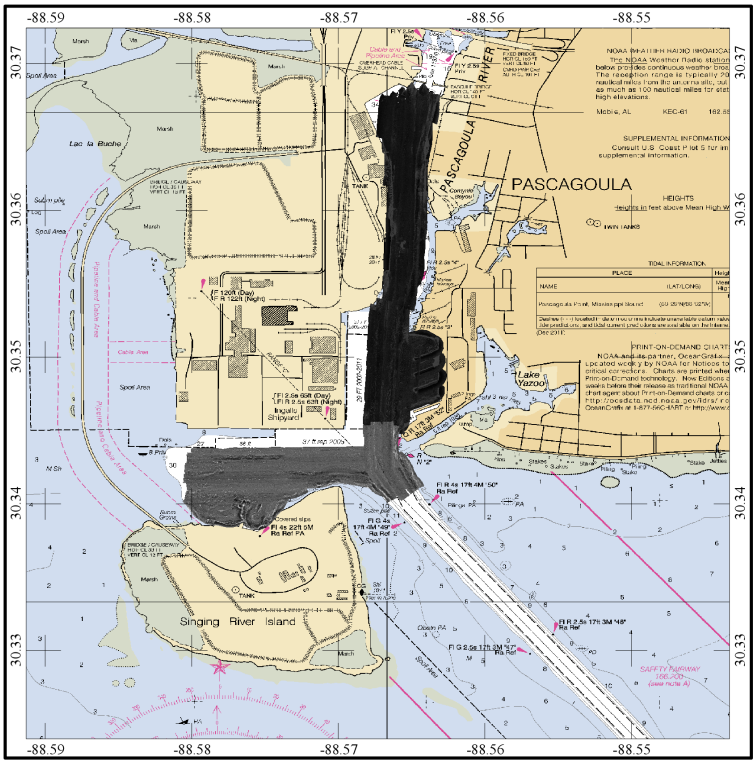

Figure A.2: Combined SSS coverage - areas A and B overlaid on chart 11375

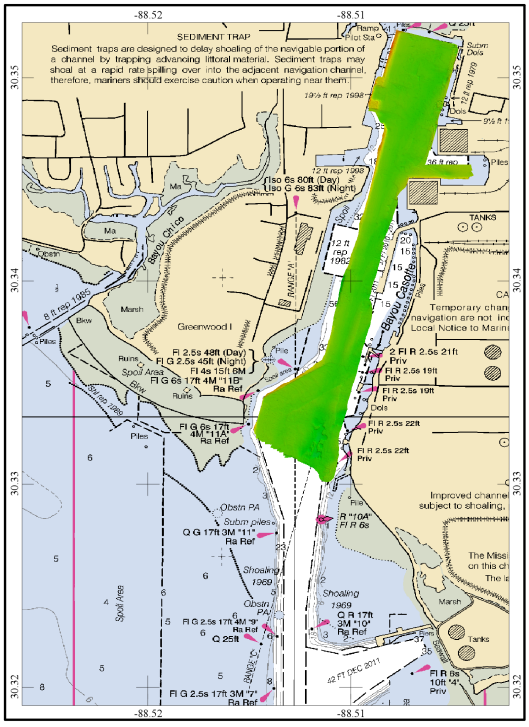

Figure A.3: MBES coverage - area C overlaid on chart 11375

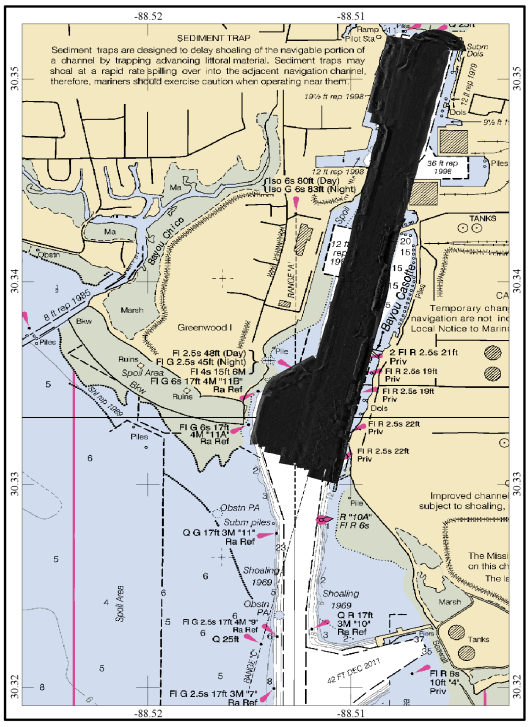

Figure A.4: SSS coverage - area C overlaid on chart 11375

A.2 Survey Statistics

Full statistics separated by area are shown in table A.1.

Table A.1: Survey statistics

Area	Mainlines Linear NM	Crosslines Linear NM	SSS Lines Linear NM	NM^2	Seabed Samples	Items Investigated	ATONs Positioned	DTONs Generated
A	25.12	1.37 (5.4%)	8.65	0.21	4	1	3	5
B	24.18	1.22 (5.0%)	7.13	0.15	3	0	3	1
C	19.15	1.01 (5.3%)	6.16	0.18	6	0	1	1
Total	68.45	3.60 (5.3%)	21.94	0.54	13	1	7	7

A.3 Chronology

The timeline of survey related activites, including geodetic and tidal infrastructure deployment is shown in table A.2

Table A.2: Chronology

Date	Activity
20 April 13	Conducted vessel configuration survey
29 May 13	Conducted University of Southern Mississippi (USM) tide gauge calibration Rigged tide staff for deployment at Pascagoula Point
30 May 13	Installed tide gauge and tide staff at Pascagoula Point public jetty Installed tidal benchmark at Pascagoula Point Recovered National Geological Survey (NGS) benchmarks at Pascagoula Point Recovered NGS/NOAA benchmarks at NOAA Lab, Pascagoula Conducted 6 hours static Global Navigation Satellite System (GNSS) observation at NOAA Lab primary tidal benchmark
31 May 13	Configured and tested vessel equipment
04 June 13	Conducted SSS wet-test and confidence check Conducted on-water MBES test Discovered vessel motor defect and timing circuit defect
05 June 13	Motor repairs to vessel Timing circuit rectified Rigged tide staff for use in NOAA tide gauge leveling
06 June 13	Conducted pre-deployment MBES calibration survey in the Pearl River Processed calibration survey and established initial calibration values Conducted 3 hours simultaneous tidal observations for Pascagoula Point tide staff and USM tide gauge Conducted 6 hours static GNSS observation at Pascagoula Point USM tidal benchmark

07 June 13	Recovered benchmarks at Dock E, Bayou Casotte Completed 6 hours static GNSS observation at Bayou Casotte Dock E primary tidal benchmark Installed tide staff adjacent to NOAA Lab tide gauge Conducted leveling traverse at NOAA Lab - discovered one mobile benchmark which invalidated traverse Fuelled and transported vessel to Pascagoula
10 June 13	Completed 100% area A MBES perimeter soundings and crosslines Completed 75% area A MBES mainlines Completed leveling run at NOAA lab - excluding the mobile benchmark
11 June 13	Completed remaining Area A mainlines Completed 50% area A SSS lines Completed 3 hours simultaneous tidal observations at NOAA Lab tide gauge
12 June 13	Completed remaining area A SSS lines Completed 100% area B MBES perimeter soundings and crosslines Digibar Pro became defective - replaced with new probe from FST Damaged MBES housing during vessel slipping - returned to USM for repair
13 June 13	Repaired and refitted MBES to vessel Conducted calibration survey in Pascagoula Harbor Establish new MBES calibration values Installed tide staff adjacent to Dock E NOAA tide gauge
14 June 13	Completed 100% area B MBES mainlines
17 June 13	Completed 100% area B SSS lines Positioned accessible navigation aids in areas A and B Conducted leveling traverse to tide-staff at Dock E NOAA tide gauge Conducted 3 hours simultaneous observations at Dock E NOAA tide gauge
18 June 13	Completed 100% area C MBES perimeter soundings and crosslines Complete 85% MBES area C mainlines - remaining 15% unachievable due to berthed shipping and dredging operations
19 June 13	Completed 90% area C SSS lines - remaining 10% unachievable due to berthed shipping and dredging operations Collected seabed samples in areas A, B and C Assessed navigation aids in area C - none positioned due to extensive construction activities, or located within secure areas Conducted additional 3 hour simultaneous observations at Dock E NOAA tide-gauge to achieve lower residuals Returned vessel to USM
03 July 13	Conducted level-out of USM tide-gauge at Pascagoula Point Removed Pascagoula Point tide gauge Attempted additional static GNSS observation at USM benchmark - observation window shortened to 3.5 hours by inclement weather

B Data Acquisition and Processing

This section contains an overview of the equipment, processes and results of the data acquisition and processing conducted during the survey. For more detailed information, refer to the supplementary *13USM01 Data Acquisition and Processing Report*.

B.1 Equipment

B.1.1 Survey Vessel *R/V GCGC* Equipment

The soundings for this survey were collected using the USM research vessel *R/V GCGC*. The *R/V GCGC* is a 10m medium-V planing hull vessel constructed in aluminum. It has an 3m beam and 1m draft. It is equipped with an over-the-side pole mounted Reson 7125-400 MBES and EdgeTech 4125-D SSS, further supplemented by the equipment shown in table B.1. For laybacks and configuration see section B.3.1.

Table B.1: *R/V GCGC* equipment

Item	Description	Serial Numbers
MBES	Reson 7125 - 400 kHz (over-the-side pole mounted)	4010148
SSS	EdgeTech 4125-D 900kHz (towed)	Towfish: 6230681322 Topside: 6230680806 Controller: 623068605
Attitude Reference and Navigation	Applanix Position and Orientation System for Marine Vehicles (POSMV) Wavemaster v5 fitted with two Trimble Zephyr 2 GNSS antennas	POSMV: 0214808 Antennas: 1441038502 1441043318
Secondary Navigation	TopCon GR3 Geodetic GNSS (PPK)	433-0511, 433-0510
Sound Velocity Profiler (SVP)	Odom Digibar Pro	98571, 003947

B.1.2 Geodetic and Tidal Equipment

Benchmark leveling, geodetic observations and tidal observations were conducted using the equipment detailed in table B.2.

Table B.2: Geodetic and tidal equipment

Item	Description	Serial Numbers
Tide Gauge	In-Situ LevelTroll 700	134960
Optical Level	Leica NA2002	283627
Geodetic GNSS	TopCon GR3	433-0511
		433-0510

Prior to each use, the Leica NA2002 level was checked for collimation error by multiple observations over 100m/10m baselines. The largest collimation error observed was 0.002m/100m.

The LevelTroll 700 tide gauge was user calibrated against a graduated staff on 29 May 13 in a 1.5m test tank. The results of the calibration confirmed that the gauge measurement accuracy was within the $\pm$0.001m requirement stipulated in NOAA Specifications and Deliverables [NOAA, 2013, §4.2.2, p. 15].

B.1.3 Data Processing Software

Data processing software versions utilized throughout the survey are shown in table B.3.

Table B.3: Data processing software versions

Software	Version
Applanix POSView	6.05
Applanix POSPac MMS	6.2
EdgeTech Discover	7.15
QPS QINSy	8
NovAtel GrafNav	8.30.2105
Chesapeake SonarWiz	5.05.0023
Caris HIPS & SIPS	7.1.2 SP 2
In-Situ WinSitu	5.6.21.0
Leica GeoOffice	8.3.0.0
NAVOTAS	3.0.0
Geospatial Data Abstraction Library	1.10.0-1
Tide Analyst	3.1.8

B.2 Quality Control

B.2.1 Data Consistency

The internal consistency of the sounding data was generally good. However, the MBES experienced low signal-to-noise ratio in waters deeper than 12m. The impact of this was mitigated with IHO special order 0.5m Combined Uncertainty and Bathymetry Estimator (CUBE) surface generation, 100% subset checking in *Caris Hydrographic Information Processing System (HIPS)* and filtering of soundings to 2σ from the CUBE surface.

The resulting cleaned dataset is highly consistent and shows CUBE node densities typically around 50 soundings. In addition, beams from 1-37 were removed from the data set in area B and beams from 470-512 were removed from the data set in area C due to low signal-to-noise ratio. See the section B.2.2 for further details.

All GNSS data was processed against the Gulf Coast Geospatial Consortium (GCGC) Gautier Continuously Operating Reference Station (CORS) (designation "MSGA") [GCGC, 2013]. This is a 1Hz reference station. Post Processed Kinematic (PPK) navigation data were consistently resolved to fixed integer ambiguity (quality 1) with rare short periods of floating ambiguity solutions (quality 2). All standard deviations remained at or below 0.10m. All navigation coordinates were generated using the North American Datum of 1983 (NAD83) (2011/PA11/MA11) epoch 2010.0 datum.

However, some changes in GNSS constellation visibility and hence, solution quality, near large ships, oil rigs and onshore structures resulted in some short term vertical reference shifts. These shifts were readily identified in the CUBE surface. In most cases, the shifts were rectified by switching between navigation sources or rejecting the erroneous data.

Due to the presence of several vertical shifts in the POSMV Smoothed Best Estimate of Trajectory (SBET) data for area A, all navigation data in area A has been sourced from the TopCon GR3 GNSS receiver's 1Hz data, PPK, and augmented with 50Hz SBET attitude-only data. All navigation and attitude data for areas B and C were sourced from post-processed SBET data.

B.2.2 Crossline Comparison

Crossline comparisons were performed using the *Caris HIPS Quality Control (QC) Report* tool. Each finalized CUBE surface was assessed independently. Any beams showing performance below the IHO special order 95% confidence interval were excluded from the CUBE surface using a beam reject filter. The surface was then rebuilt and the coverage reassessed.

For area B, beams from 1-37 were excluded from the surface. For area C, beams from 470-512 were exluded from the surface. Subsequently, all crossline comparisons meet the requirements of Special Order. IHO order 1a was met without any requirement for beam rejection. For a summary of results see table B.4. Results are also shown graphically for area A (figure B.1), area B (figure B.2) and area C (figure B.3).

Table B.4: Crossline comparison results

Area	No. Beams Order 1a	No. Beams Special Order	Order 1a Met?	Special Order Met?	Highest Mean Difference (m) (Included beams only)
A	512 (100%)	512 (100%)	Yes	Yes	0.128
B	512 (100%)	475 (93%)	Yes	Yes (after filtering)	0.033
C	512 (100%)	469 (92%)	Yes	Yes (after filtering)	0.012

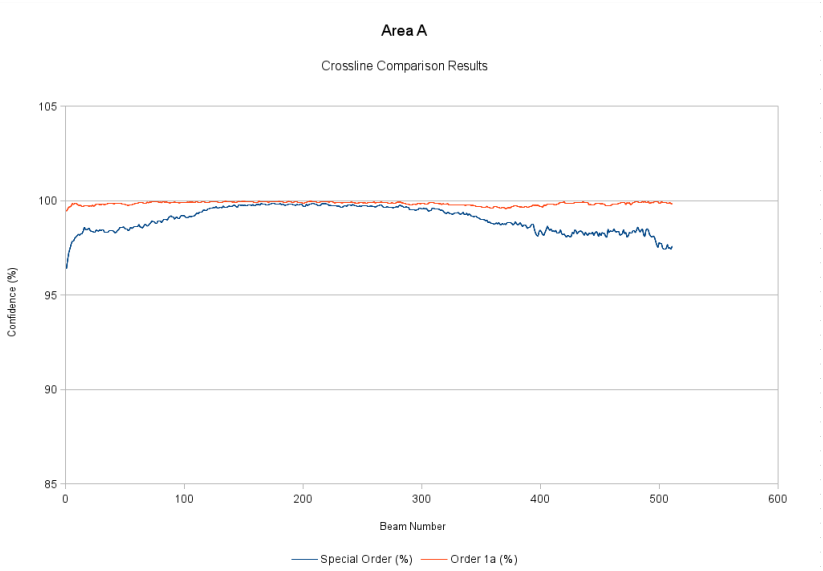

Figure B.1: Crossline comparison results - area A

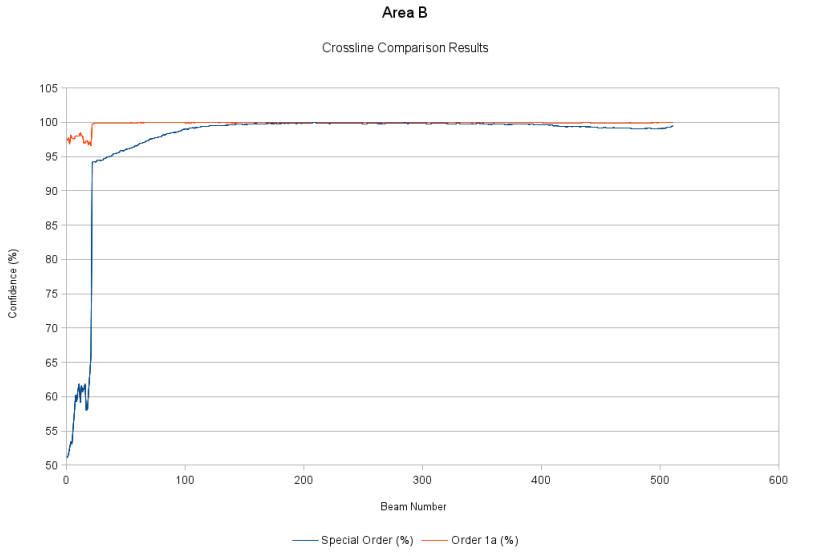

Figure B.2: Crossline comparison results - area B

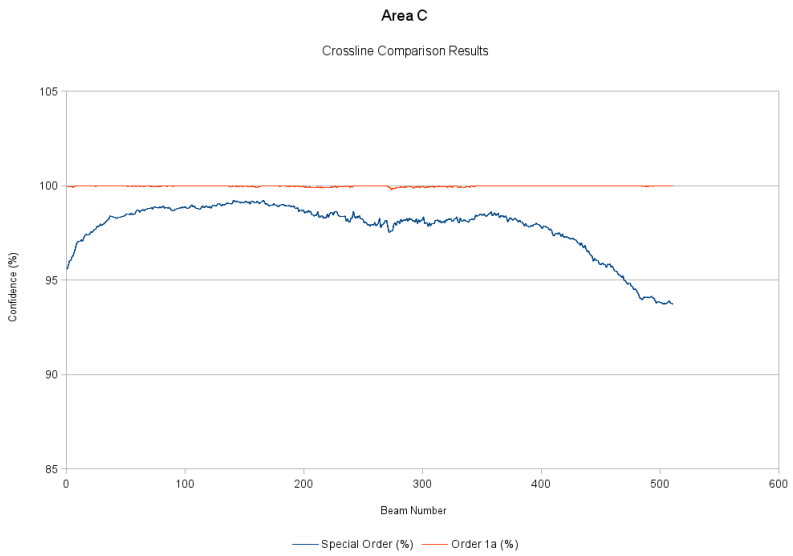

Figure B.3: Crossline comparison results - area C

B.2.3 Surface Uncertainty

0.5m CUBE surfaces for each area were generated using the IHO Special Order [IHO, 2008] CUBE settings in conjunction with the NOAA 0.5m CUBE parameters embedded in the NOAA Field Procedures Manual [NOAA, 2012]. See section B.5.1 for further details of CUBE generation.

Due to the high density of soundings at each CUBE node and the high spatial variation of surface sound velocity, a minimum uncertainty value was entered when generating the finalized CUBE surface for each area. This mimimum value was used to prevent unrealistically low uncertainty values propagating to the finalized surface. The minimum value was calculated in accordance with the model by Hare [Hare, 1995], supplemented with values for ellipsoid referenced datum separation. For full calculations, see section B.5.4. A summary of values is shown in table B.5.

Table B.5: Minimum vertical uncertainty (95% confidence) for CUBE nodes

Area A (m)	Area B (m)	Area C (m)
0.124	0.124	0.158

All CUBE nodes in the finalized surfaces (except those with designated soundings) exhibit uncertainty values equal to those shown in table B.5. This suggests that the Total Propagated Uncertainty (TPU) values calculated by *Caris HIPS* for each node in the preliminary CUBE surfaces were unrealistically low due to the high data redundancy. Therefore, the values shown in table B.5 were accepted and retained in the finalized surfaces. They are also supported by the crossline comparison results in section B.2.2.

Although the initial survey requirement was for IHO order 1a, the uncertainty values for all three surfaces meet the requirements for IHO Special Order [IHO, 2008]. The *Caris HIPS* surface QC

reports also support this conclusion and are detailed in table B.6.

Table B.6: *Caris HIPS* surface QC results

Surface	Area_A_Main_50cm_SO_Final.csar	Area_B_Main_50cm_Final.csar	Area_C_Main_50cm_Final.csar
Holiday search radius	1	1	1
Holiday minimum nodes	7	7	7
Holiday layer created	Yes	Yes	Yes
Error values from	Uncertainty	Uncertainty	Uncertainty
Number of Nodes Processed	2851339	2014717	9092679
Number of Nodes Populated	2851194 (99.99%)	2014533 (99.9%)	9092545 (100.0%)
Number of Holidays Detected	17	24	3
Nodes within IHO Special Order	100%	100%	100.0%
Residual Mean (m)	-0.138	-0.139	-0.111

B.2.4 Coverage and Junctions

The *Caris HIPS* surface QC results in table B.6 indicate the existence of some holidays greater than two nodes in CUBE surfaces of all three areas. 17 holiday nodes exist in area A, 24 in area B and 3 in area C. These holiday areas are stored as holiday layers in the Caris Spatial ARchive (CSAR) files submitted with this survey.

Despite the small holidays in the MBES data, 200% SSS coverage was also achieved throughout all survey areas and all targets identified have been fully investigated using MBES to establish the least depth. No SSS holidays exist within the bathymetry area and no MBES holidays exist over the tops of significant features. Consequently, the NOAA object detection standard has been met for the area surveyed.

One junction exists within the survey area. This is the junction between areas A and B. In this area, the two finalized CUBE surfaces are in agreement. The mean vertical difference between the two finalized CUBE surfaces is 0m with a standard deviation of 0.07m. Horizontal positioning differences are within one node (less than 0.5m). As areas A and B were processed with different navigation sources and were acquired on different days, this junction area serves to validate the navigation solutions against one another and also to validate the GNSS tide approach.

B.2.5 SEP/GNSS Tide Validation

In order to formally validate the use of GNSS tide data and the associated Ellipsoid to Tidal Vertical Datum Separation (SEP) values, the crosslines for each area were re-processed with verified traditional tide data from the NOAA stations at the NOAA Lab, Pascagoula and Dock E, Bayou Casotte. 0.5m CUBE surfaces were then calculated from the traditional tide crosslines and differenced with the finalized CUBE surfaces for each area.

Separations between the traditional tide and GNSS tide surfaces are shown in table B.7. The values are within the 95% confidence interval for each surface. This suggests that the final SEP values used were valid and that survey data has been appropriately reduced to the tidal datum, Mean Lower Low Water (MLLW) (National Tidal Datum Epoch (NTDE) 1983-2001), using ellipsoid referenced positioning.

Table B.7: SEP/GNSS tide validation

Area	NOAA Station	NOAA tide vs GNSS tide mean surface difference (m)	σ (m)
Area A	NOAA Lab (8741533)	0.04	0.11
Area B	NOAA Lab (8741533)	0.11	0.06
Area C	Dock E (8741041)	-0.02	0.08

B.2.6 Sonar Confidence Checks

The SSS was checked on an opportunity basis on multiple occasions throughout each period of use. Checks were conducted using man-made objects including tires and pylons with less than 0.5m diameter, at or near the full 75m range scale used. All confidence checks demonstrated that the sonar was capable of resolving objects smaller than the 1m requirement at the edge of the range scale.

B.2.7 Other Factors Affecting Quality

MBES Signal-to-Noise

The MBES was reporting very low signal strength in water deeper than 12m. This may be indicative of failing elements within the receiver array. This effect was most apparent in the deep north-western edge of area B. Nevertheless, the saturation of soundings allowed for effective filtering. All contacts greater than 1m in any dimension identified as targets by SSS were readily found within the filtered MBES data and least depths could be determined.

Sound Velocity

Sound Velocity Profiles were collected at intervals between 1-2.5 hours depending on the surface sound velocity change observed. In some areas, particularly in the south-western section of area B, the surface sound velocity was highly variable. This was captured by the hull sound velocity probe built-in to the MBES head. Even with highly variable sound velocity in the upper 1m of water, the sound speed profiles deeper than 1m were typically consistent with predictable variation. A complete georeferenced *Caris HIPS* SVP file is included with the survey data.

The adjusted minimum uncertainty values applied to the finalized CUBE surfaces account for this by allowing for a spatial sound velocity variation of 4m/s - approximately 0.06m at a depth of 12m. See section B.5.4 for details.

B.2.8 Specification Deviations

One major deviation from the specifications was made during the course of the survey. This was the selection of the 75m SSS range scale, instead of the 50m range scale. Due to the lack of a depressor wing on the SSS towfish, the SSS was flown at a higher altitude than planned - approximately 7.5-10m. Consequently, the range scale was adjusted to 75m. Line spacing was kept to 40m and the

vessel speed was reduced to approximately 3-4kt. Confidence checks confirmed the theoretical 1m object detection capability at the adjusted range scale and vessel speed:

$$Max\ Speed(ms^{-1}) = \frac{Target\ Size(m) \times PRF(s^{-1})}{3} = \frac{1m \times \left(\frac{1502ms^{-1}}{75m \times 2}\right)}{3} = 3.34ms^{-1} \approx 6.5knots$$

B.3 Corrections to Echo Soundings

B.3.1 Vessel Configuration

A vessel configuration survey was conducted using a Leica TPS300 TotalStation on 20 April 13. The GNSS and Inertial Motion Unit (IMU) sensor positions were observed from multiple stations. Additional reference marks were also observed to aid in positioning other devices. Observations were least squares adjusted using Leica GeoOffice. Sensor positions and adjustment derived standard deviations are shown in table B.8. These positions are relative to the approximate center of rotation at coordinate (0,0,0). The MBES acoustic center location and the SSS tow point were measured with a tape-measure relative to reference marks positioned with the TotalStation. Hence, the uncertainty is higher for these positions.

Laybacks were applied by the POSMV unit such that all attitude and navigation data (including SBET) sourced from the POSMV is referenced to the vessel center of rotation. TopCon GR3 navigation is referenced to the antenna reference mark. The *Caris HIPS* vessel file contains appropriate sections to reflect the navigation source used for each day.

Table B.8: Vessel configuration (X=bow+, Y=starboard+, Z=down+)

Sensor	X (m)	Y (m)	Z (m)	σ_X (m)	σ_Y (m)	σ_Z (m)
POSMV IMU	0.6152	0.7014	-0.1623	0.0028	0.0013	0.0021
POSMV GNSS 1	-0.2823	-0.9265	-2.0712	0.0037	0.0017	0.0028
POSMV GNSS 2	-0.2947	0.9099	-2.0889	0.0028	0.0013	0.0021
TopCon GR3	-1.6647	0.9079	-2.0872	0.0030	0.0013	0.0022
MBES	-1.6673	1.6343	0.8893	0.0278	0.0137	0.0111
SSS Towpoint	-2.01	-1.430	-1.580	0.0300	0.0300	0.0300

B.3.2 Initial Calibration

An initial calibration survey (patch test) was conducted 6 June 13 in the Pearl River under benign conditions. Calibration values were obtained via the *Caris HIPS* calibration tool in the order prescribed by NOAA [NOAA, 2013, §5.2.4.1]. Initial calibration values are applied to the *Caris HIPS* vessel file SVP data section for data collected on 6-12 June 13 (Julian days 157-163). Calibration values are shown in table B.9.

B.3.3 Additional Calibration

While slipping the vessel on 12 June 13 the MBES housing collided with a pylon. This caused the housing to tilt, requiring realignment and invalidating the initial calibration. After realignment of the housing, a second calibration survey was conducted in the Pascagoula River on 13 June 13. Values obtained during the second calibration were applied to all data collected from 13 June 13 until survey completion. Adjusted calibration values are also shown in table B.9.

Table B.9: Vessel calibration values

Date	Roll (°)	Pitch (°)	Azimuth (°)	Timing (s)
6-12 June 13	1.00	-2.50	1.40	0.00
13-21 June 13	1.66	-2.50	2.60	0.00

B.3.4 Navigation Data

Both the TopCon GR3 and POSMV systems logged raw dual frequency GNSS data for post-processing. All navigation data in the final survey data set is sourced from PPK GNSS solutions. All positions were reported with standard deviations typically less than ±0.05m (horizontal) and ±0.07m (vertical). The highest observed position standard deviations during MBES sounding, after PPK processing of GNSS data, are shown in table B.10.

Table B.10: Highest observed position standard deviations during MBES sounding

Date	Source	North σ (m)	East σ(m)	Up σ (m)
10 June 13	TopCon GR3 PPK	0.063	0.063	0.091
11 June 13	POSMV PPK SBET	0.033	0.027	0.064
12 June 13	POSMV PPK SBET	0.095	0.113	0.093
13 June 13	POSMV PPK SBET	0.033	0.034	0.067
14 June 13	POSMV PPK SBET	0.039	0.025	0.057
17 June 13	POSMV PPK SBET	0.044	0.029	0.101

TopCon GR3

The TopCon GR3 1 Hz data was post-processed in *GrafNav* software using the GCGC CORS located at Gautier (designation: "MSGA") [GCGC, 2013]. The base station data was sourced at 1Hz in the NAD83 (CORS 2011/MA11/PA11) epoch 2010.0 datum. The TopCon GR3 navigation data was used only to position MBES soundings within area A.

POSMV

The POSMV unit was configured to log all raw ethernet *POSPac* packet data at a 50Hz rate, including all attitude, heave and position records. This data was post-processed using *POSPac* to form SBET data. The SBET navigation data was used to position the MBES soundings within areas B and C.

SSS data was positioned using Wide Area Augmentation System (WAAS) enabled real-time POSMV navigation only.

For more information, refer to section C.

B.3.5 Attitude Data

The navigation component of the SBET data was processed PPK against the Gautier "MSGA" CORS 1Hz data and supplemented with inertial data to form a 10Hz SBET navigation solution. Post processed attitude and heave data were output at 50Hz. The 50Hz SBET attitude data was applied to all MBES soundings in all areas using *Caris HIPS*. The highest observed standard deviations of attitude data during MBES sounding are shown in table B.11.

Table B.11: Highest observed attitude standard deviations during MBES sounding

Date	Source	Pitch σ (°)	Roll σ(°)	Heading σ (°)
10 June 13	POSMV PPK SBET	0.030	0.030	0.053
11 June 13	POSMV PPK SBET	0.026	0.026	0.065
12 June 13	POSMV PPK SBET	0.028	0.027	0.120
13 June 13	POSMV PPK SBET	0.023	0.023	0.046
14 June 13	POSMV PPK SBET	0.029	0.029	0.054
17 June 13	POSMV PPK SBET	0.029	0.029	0.050

B.3.6 GNSS Tide Application

All soundings were reduced to MLLW (NTDE 1983-2001) datum via calculation of GNSS tide. GNSS tide was applied using a zoned single SEP value model with two zones. Areas A and B exist within one zone and area C exists within another zone. For zone determination and SEP calculation details, see section C.

SEP values and uncertainties used are shown in table C.5.

Table B.12: SEP values and uncertainty at 95% confidence

Area	SEP (m)	Uncertainty (95%) (m)
A and B	-28.1819	0.0268
C	-28.1543	0.0294

B.3.7 Sound Velocity Correction

A single *Caris HIPS* sound velocity file was generated containing all profiles, complete with time-stamp and position, collected during the survey. Due to the small survey area sizes, raytracing of soundings was performed using the *Caris HIPS nearest in time* method.

B.3.8 TPU Calculation

The *Caris HIPS* vessel file TPU section was populated with manufacturer quoted uncertainties at $1\times\sigma$, in conjunction with measurement uncertainty values derived from the vessel configuration survey also at $1\times\sigma$. Uncertainty at $1\times\sigma$ derived from GNSS tide values was included in the *Caris HIPS* TPU calculation tool as "Zoning" uncertainty. This is in accordance with the method stipulated in the NOAA Field Procedures Manual [NOAA, 2012, §4.2.3.8]. TPU values used in the *Caris HIPS* vessel file are shown in table B.13. These values reflect the change in TPU values due to switching navigation source from the TopCon GR3 PPK to the POSMV PPK/SBET data.

Table B.13: *Caris HIPS* vessel file TPU entries

Entry		Julian Day	
		JD 157/13	**JD 163/13**
Offsets	MRU to Transducer X (m)	0.933	0.933
	MRU to Transducer Y (m)	-2.283	-2.283
	MRU to Transducer Z (m)	1.052	1.052
	Nav to Transducer X (m)	0.726	1.634
	Nav to Transducer Y (m)	0.026	-1.667
	Nav to Transducer Z (m)	2.978	0.889
	Transducer Roll (°)	0.000	0.000
Standard Deviations	Motion Gyro (°)	0.030	0.030
	Heave % Amplitude	5.000	5.000
	Heave (m)	0.050	0.050
	Roll (°)	0.030	0.030
	Pitch (°)	0.030	0.030
	Position Navigation (m)	0.100	0.100
	Timing Transducer (s)	0.010	0.010
	Navigation Timing (s)	0.010	0.010
	Gyro Timing (s)	0.010	0.010
	Heave Timing (s)	0.001	0.001
	Pitch Timing (s)	0.001	0.001
	Roll Timing (s)	0.001	0.001
	Offset X (m)	0.014	0.014
	Offset Y (m)	0.028	0.028
	Offset Z (m)	0.011	0.011
	Vessel Speed (m/s)	0.010	0.010
	Loading (m)	0.000 (N/A for ERS Survey)	
	Draft (m)	0.000 (N/A for ERS Survey)	
	Delta Draft (m)	0.000 (N/A for ERS Survey)	
	MRU Gyro Alignment	0.030	0.030
	MRU Roll/Pitch Alignment	0.030	0.030

B.4 Backscatter

Beam averaged amplitude data was collected during the survey. However, inspection of the data revealed excessive water column noise that rendered this data unusable. Therefore, no backscatter was processed. The seabed texture information was instead prepared using the EdgeTech 4125-D

900Khz towed SSS mosaics.

B.5 Data Processing

B.5.1 Preliminary CUBE Surfaces

Three preliminary CUBE surfaces were generated from the corrected soundings. One surface was generated for each of the three survey areas. All CUBE surfaces were generated at 0.5m resolution, using IHO special order conditions and CUBE parameters embedded in the NOAA Field Procedures Manual [NOAA, 2012]. These parameters are detailed in table B.14.

Table B.14: NOAA object detection and IHO Order requirements

Criteria	Requirement
Object detection size	1m × 1m × 1m (in waters shoaler than 22m otherwise 5% of depth)
CUBE grid resolution	0.5m
Node density	At least 95% of nodes with 5 or more soundings
Maximum propagation distance	0.35m
Special Order TVU	For a given depth, d, $TVU = \sqrt{a^2 + (b \times d)^2}$ where a = 0.25m and b = 0.0075
Special Order THU	2m

B.5.2 Subset Editing

All preliminary CUBE surfaces were 100% inspected using the *Caris HIPS* subset editor. 40m × 40m subset tiles were used to track inspection status. All significant bathymetric features identified were inspected to determine the least depth over the object. Shoal soundings were flagged as *designated* to prevent filtering and to ensure inclusion in the finalized surface.

B.5.3 Filtering

After the CUBE surface had been 100% inspected and all identified features had been flagged, the entire sounding set was filtered to remove unflagged soundings with distances greater than two standard deviations from the CUBE surface. This filtering was performed to remove water column noise from the sounding set. CUBE surfaces were then recalculated to ensure that the filtering had not adversely affected any part of the surface.

B.5.4 CUBE Finalization

On completion of CUBE surface subset editing and filtering, each surface was finalized. Due to the high density of soundings at each CUBE node, a minimum uncertainty value was entered when generating the finalized CUBE surface for each area. This mimimum value was used to

prevent unrealistically low uncertainty values propagating to the finalized surface due to the high data redundancy. The mimimum value also takes into account a higher spatial variation of sound velocity of 4m/s (0.06m at 12m depth) rather than the measurement accuracy value of 0.1m/s. The minimum value was calculated in accordance with the TPU model by Hare [Hare, 1995], supplemented with values for ellipsoid referenced datum separation shown in table B.15.

Table B.15: Minimum vertical uncertainty values

Factor		$1\times\sigma$ value (meters)		
		Area A	**Area B**	**Area C**
Sounding Uncertainty	σ_1 Vessel GNSS	0.007	0.007	0.007
	σ_2 Vessel Configuration	0.011	0.011	0.011
	σ_3 Sounder Measurement	0.005	0.005	0.005
	σ_4 Refraction	0.060	0.060	0.060
SEP Uncertainty	σ_5 Leveling Misclosure	0.001	0.001	0.000
	σ_6 Benchmark GNSS Uncertainty	0.008	0.008	0.010
	σ_7 Simultaneous Tide Observations	0.011	0.011	0.004
	σ_8 Single SEP Zone Uncertainty	0.010	0.010	0.010
Minimum Vertical Uncertainty (95% Confidence) $1.96\times\sqrt{\sum_{n=1}^{8}\sigma_n^2}$		0.124	0.124	0.158

B.5.5 SSS Mosaics

All 900kHz data from the EdgeTech 4125-D SSS was imported from JStar Sidescan Format (JSF) using *Chesapeake SonarWiz*. The files were checked for altitude tracking inconsistencies and corrected manually as required. Altitude varying gain and time varying gain were applied with user gain control used to ensure consistent beam pattern and intensity in overlapping lines. The final corrected lines were stitched using the *shine through* approach to ensure contact visibility and exported to GeoTIFF mosaics at 0.5m resolution. Mosaic coverage is shown in figures A.2 and A.4 (see section A).

B.5.6 SSS Features

Side-scan sonar feature selection was conducted by manually inspecting all gain corrected side-scan lines. Each feature was digitized with measured shadow lengths, dimensions, and estimated least depth. PDF target reports are included as appendices to the supplementary *13USM01 Data Acquisition and Processing Report*. An S-57 final feature file was also generated using the standard NOAA descriptors listed in the Specifications and Deliverables [NOAA, 2013].

C Vertical and Horizontal Control

This section contains an overview of the horizontal and vertical control methods employed during the survey. For more detailed information, refer to the supplementary *13USM01 Horizontal and Vertical Control Report*.

C.1 Vertical Control

C.1.1 Vertical Datum

The vertical datum used for depth information generated during the survey is MLLW NTDE 1983-2001. All horizontal and vertical position information obtained during the survey was referenced to NAD83 (CORS11/MA11/PA11) epoch 2010.0. In order to transform sounding data from NAD83 to MLLW datum, accurate determination of the values for and spatial variation of SEP was required. This was achieved through a combination of:

- traditional tidal observations at:
  - NOAA Fisheries Lab tide station, Pascagoula (No. 8741533);
  - NOAA Dock E tide station, Bayou Casotte (No. 8741041); and
  - USM installed LevelTroll 700 tide gauge located at Pascagoula Point;
- geodetic GNSS observations at:
  - NOAA benchmark "RM 1 Tidal 1970";
  - NOAA benchmark "1429 B 1980"; and
  - USM benchmark "13USM01" installed for this purpose;
- geodetic leveling between three benchmarks (including the primary benchmark) and a tide staff at each tide station;
- simultaneous observation of tide-staffs and adjacent tide gauges;
- spatial tidal range and phase modeling in *NAVOTAS* software to establish tidal/SEP zones; and
- diurnal tidal datum transfer to the USM tide gauge.

C.1.2 Tidal Infrastructure

The tidal infrastructure used to assist in SEP determination and zoning consisted of two NOAA tide gauges: NOAA Lab (No. 8741533) and Dock E (No. 8741041); and one LevelTroll 700 tide gauge installed by the survey team at Pascagoula Point. For more information on installation and datum determination at each gauge, see the supplementary *13USM01 Horizontal and Vertical Control Report*.

Summaries of relevant details determined for each gauge are included in tables C.1, C.2 and C.3.

Table C.1: NOAA Lab (No. 8741533) tide gauge details

Type	Stilling well acoustic with pressure backup
Latitude	30° 22’ 02” N
Longitude	88° 33’ 46” W
MLLW datum	2.471m below 1533 B 2005
	2.425m below 1533 A 2005
	3.972m below 1533 B 2005
	2.427m below 1429 B 1980 (primary benchmark)
	3.547m below 1429 D 1980 (benchmark disturbed)
GNSS observation	6 hours processed by OPUS
Primary benchmark NAD83 elevation	-25.754m ±0.008m (peak-to-peak)
SEP determined at gauge	-28.1819m ±0.0268m (95%)

Table C.2: Dock E (No. 8741041) tide gauge details

Type	Stilling well acoustic with pressure backup
Latitude	30° 20’ 52” N
Longitude	88° 30’ 19” W
MLLW datum	3.404m below RM 1 TIDAL 1970 (primary benchmark)
	3.322m below 1041 A 2008
	3.334m below 1041 B 2008
	3.263m below 1041 C 2008
	3.499m below 1041 D 2008
	3.356m below 1041 E 2008
GNSS observation	6 hours processed by OPUS
Primary benchmark NAD83 elevation	-24.751m ±0.010m (peak-to-peak)
SEP determined at gauge	-28.1543m ±0.0294m (95%)

Table C.3: USM Pascagoula Point tide gauge details

Type	In-situ LevelTroll 700
Latitude	30° 20' 24"N
Longitude	88° 32' 00"W
Primary Benchmark	13USM01
Secondary Benchmarks	1196 G 2004
	E234 RESET 2000
Logging	6 minute logging
	2 second measurements averaged over 4 minutes
	(2 minutes either side of even 10ths of the hour)
Start time	1700 (UTC) 30 May 2013
Stop time	1836 (UTC) 03 July 2013
Total Data	34.1 days
MLLW datum	2.101m below 13USM01 (primary benchmark)
	2.050m below 1196 G 2004
	1.431m below E234 RESET 2000
GNSS observation	6 hours processed by OPUS
	4 hours processed against GCGC CORS station "MSGA"
Primary benchmark NAD83 elevation	-26.007m ±0.008m (95%)
SEP determined at gauge	-28.108m ±0.158m (95%)

C.1.3 Tidal Zoning

A *NAVOTAS* comparison of verified data from the existing NOAA tide gauges was used to establish traditional tide zones. These traditional tide zones were then used as the basis for determining appropriate SEP sampling intervals.

The normal requirement for tide zoning is stipulated in the NOAA Specifications and Deliverables [NOAA, 2013] which states that tidal correctors may not be applied over zones spanning more than 6cm range difference or 18 minutes of phase difference. The results of the *NAVOTAS* comparison are shown in table C.4 indicated that all survey areas could be treated as a single tide zone. However, as there were multiple tide stations available, areas A and B were treated as one zone with the NOAA Lab station (No. 8741533) as the controlling station, while area C was treated as a separate zone with the Dock E station (No. 8741041) as the controlling station.

Table C.4: *NAVOTAS* derived phase and range offsets from NOAA Lab

Station	Range (m)	Range Difference (m)	Phase difference (minutes)
NOAA Lab	0.332	0.00	0.0
Dock E	0.328	-0.004	-9.0
Pascagoula Point (USM installed)	0.333	+0.001	-13.0

C.1.4 SEP Values

NAVOTAS modelling showed very little tidal variation across the whole survey area. Furthermore, at all times, the survey vessel was within 1.5 NM from a NOAA tide gauge. Subsequently, a single SEP value was considered sufficient for accurate reduction of soundings in each zone. These SEP values were derived for each NOAA gauge site and were applied to all soundings obtained within the zone controlled by that gauge. The values calculated are shown in table C.5. The uncertainty figures account for leveling misclosure, GNSS benchmark observation uncertainty, simultaneous tidal observation uncertainty and the spatial variation of the SEP across each controlled survey area.

Table C.5: SEP values and uncertainty at 95% confidence

Area	SEP (m)	Uncertainty (95%) (m)
A and B	-28.1819	0.0268
C	-28.1543	0.0294

C.2 Horizontal Control

C.2.1 Positioning Methodology

Data from both GNSS sources was post processed to form a PPK navigation solution. The TopCon GR3 data was processed at 1Hz using *GrafNav*. The POSMV data was processed at 10Hz using *POSPac*. The best quality solution was used for each area which resulted in the TopCon GR3 PPK solution being applied to Area A data and the POSMV PPK and full SBET solution applied to the area B and C data. SBET attitude-only data was also applied in area A.

The GCGC CORS station located at Gautier, MS (station ID: "MSGA") was used as the base station for all PPK processing. 1Hz data was used. This was sourced from the GCGC website [GCGC, 2013]. The closest extent of the survey area is 7.8km to this base station. The furthest extent of the survey area is 14.8km to the base station. This is in accordance with the NOAA requirements for PPK baseline length [NOAA, 2013].

C.2.2 Navigation Validation

Navigation was validated by using a junction area between survey areas A and B. In this area there was significant overlap. Area A was processed using the TopCon GR3 PPK data. Area B was processed using the POSMV SBET data. The mean vertical difference between each surface was 0m $\pm$0.07m. Horizontal differences were within 1 node (0.5m $\times$ 0.5m). This result is within both the vertical and horizontal accuracy requirement for IHO Special Order surveys, and within the expected accuracy of the two units compared.

D Results and Recommendations

As the survey data was obtained to IHO special order and NOAA 1m object detection standards, it is suitable to update existing charted data.

D.1 Chart Comparison

Comparison of soundings obtained during this survey with those published on NOAA chart 11375 was generally good. Depths obtained within USACE maintained channels showed very good agreement with the controlling depths published in the chart annotations and remarks. However, there were several areas outside the maintained channels where variations from the charted depths occurred.

Area A

Survey depths in the area A United States Army Corps of Engineers (USACE) maintained channel are as expected, with depths generally at the charted/tabulated channel depth or within 1 foot of the expected depth. Depths outside the channel in the northern part of area A also agree well (see figure D.1). However, significant deviations from charted depths occur outside the maintained channel in the south-eastern part of area A (see figure D.2). In these areas, the NOAA US5MS22M S-57 Electronic Navigation Chart (ENC) which covers the area includes an annotation within the DEPARE object to say that it is "not regularly maintained". The raster chart 11375 makes no such representation. The depths obtained during the survey were in some cases several feet shoaler than charted. Two objects within this area with depths 12 feet shoaler and 10 feet shoaler than charted have been reported separately as dangers to navigation.

The charted obstruction within area A was not located exactly where charted. However, due to the charted obstruction being adjacent to a foul area of sunken wharfs, a full disproving search could not be safely conducted.

Area B

The survey depths in the area B maintained channel also agree well with the charted annotations. However, outside the maintained channel, in the area west of the Singing River Island wharf, depths are generally shoaler than charted by 4-6 feet. A Danger to Navigation (DTON) has been submitted separately for a rock/shoal in the south-western part of the area. The charted coastlined

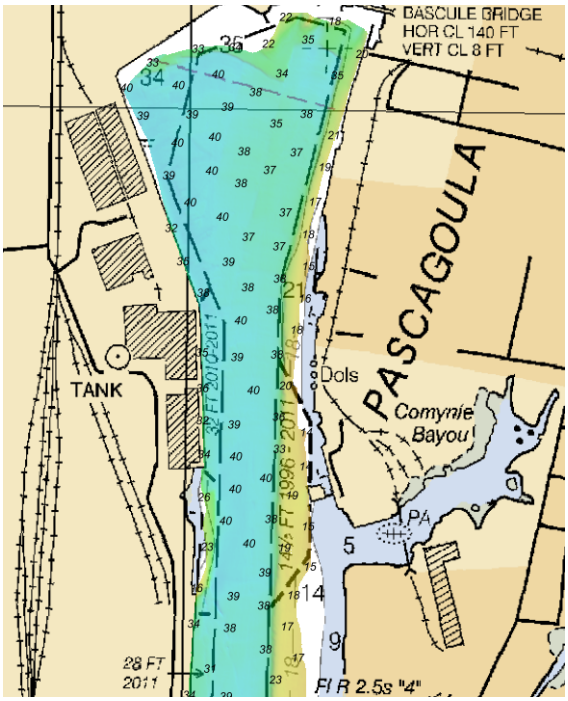

Figure D.1: Area A depths in feet overlaid on chart 11375 (northern part)

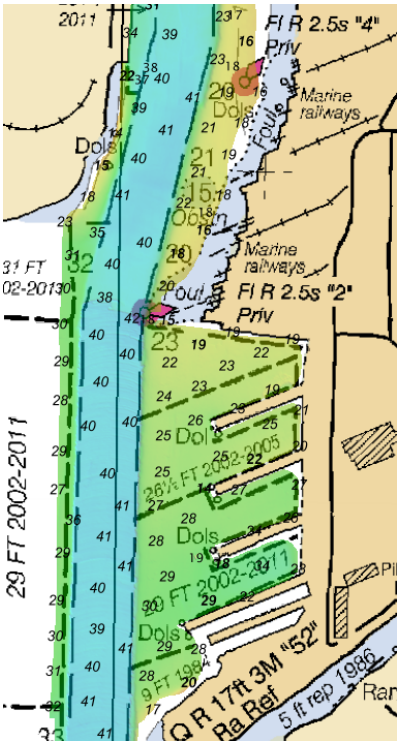

Figure D.2: Area A depths in feet overlaid on chart 11375 (southern part)

at the north-east of Singing River Island was observed visually to be incorrect. However, due to restricted access to the island the updated coastline could not be surveyed. Significant terraforming from dredge and spoil dumping on the eastern side of Singing River island may have contributed to this variation and this is likely to continue to be an unstable coastline for some time. The comparison with chart 11375 is shown in figure D.3.

Area C

The survey depths in area C agree very well (generally within 1 foot) with with those charted on chart 11375. There is one exception to this for which a DTON was submitted separately. This occurred within the south-western corner of area C, within the USACE maintained channel. It is shown in red as 36 feet. The controlling channel depth in this area is 37.5 feet. The danger is clearly identifiable in the bathymetry and the SSS trace as a man-made object protruding from the seabed. The comparison is shown in figure D.4 (northern part) and figure D.5 (southern part).

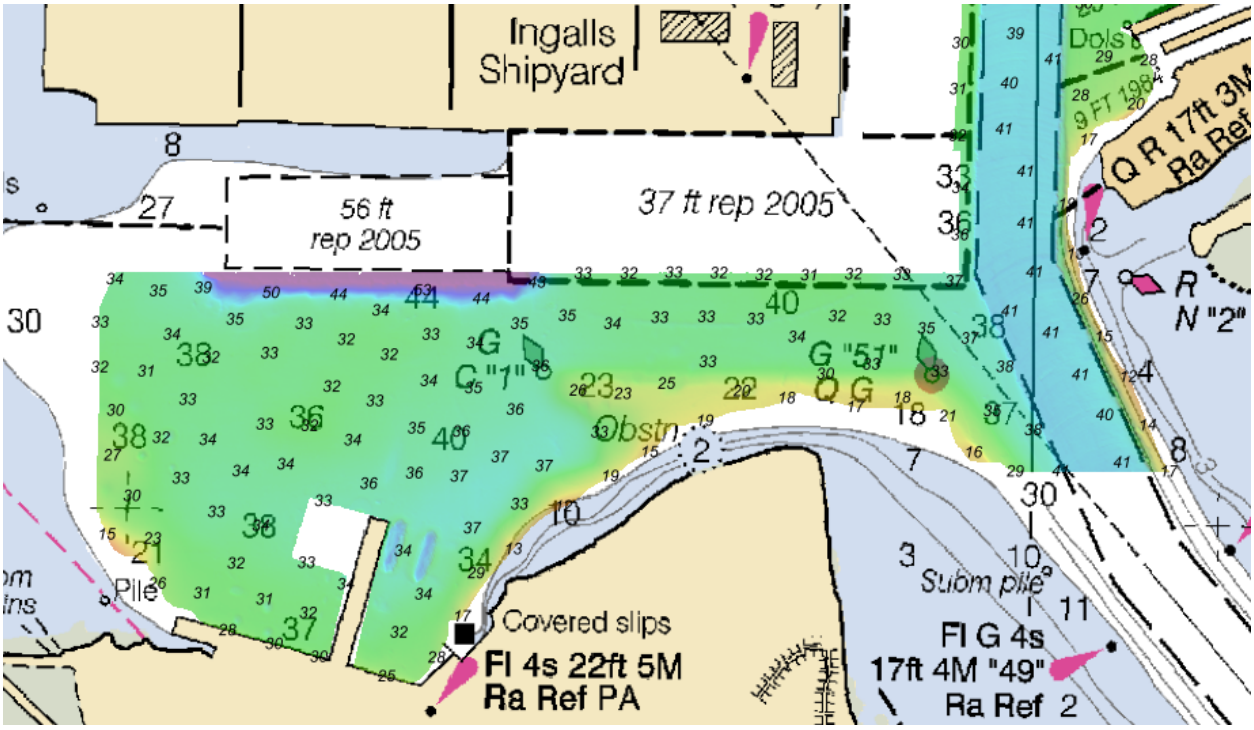

Figure D.3: Area B depths in feet overlaid on chart 11375

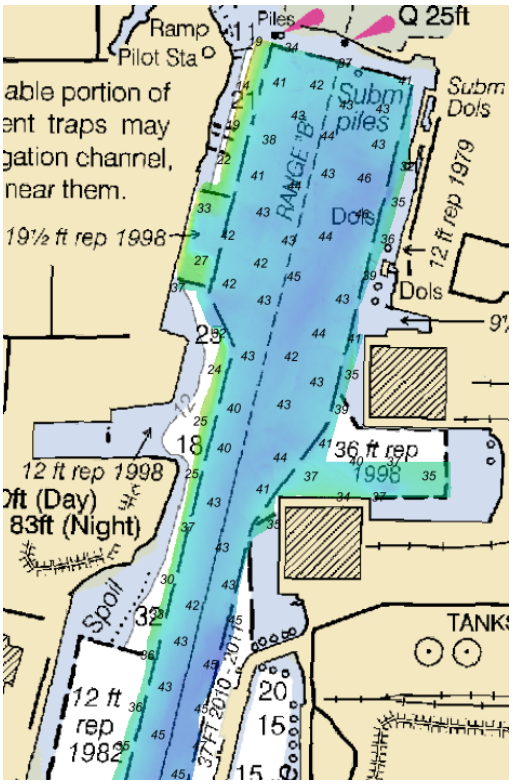

Figure D.4: Area C depths in feet overlaid on chart 11375 (northern part)

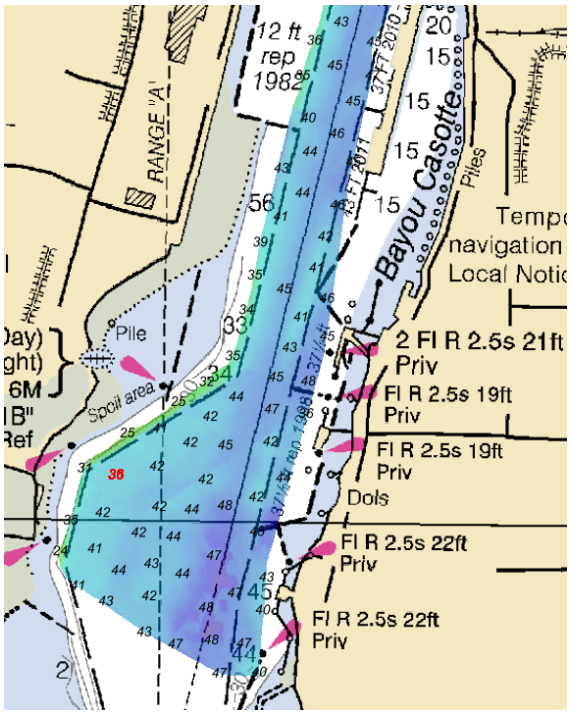

Figure D.5: Area C depths in feet overlaid on chart 11375 (southern part)

D.2 Additional Results

D.2.1 Seabed Samples

Seabed sampling was completed on 19 June 2013. A Petite Ponar Grab was used to sample the top 5-10cm of seabed sediment in several locations distributed throughout each area. The locations sampled were selected by assessing possible texture boundaries from return intensity variation observed in the gain corrected SSS mosaics. The full list of samples is shown in table D.1.

Table D.1: Seabed samples collected 19 June 2013 with S-57 encoding values

Time (UTC)	Latitude	Longitude	NATSUR	NATQUA	COLOUR
1546	30° 19'58.135"N	88° 30'41.491"W	Clay (2)	Stiff (7)	Grey (7)
1555	30° 19 56.592"N	88° 30'42.198"W	Clay, Silt (2,3)	Sticky, Fine (5,1)	Grey, Grey (7,7)
1603	30° 20 01.759"N	88° 30'45.022"W	Silt (3)	Fine (1)	Grey (7)
1611	30° 20'16.015"N	88° 30'36.409"W	Silt (3)	Fine (1)	Grey (7)
1621	30° 20 58.481"N	88° 30'27.109"W	Silt (3)	Fine (1)	Grey (7)
1654	30° 20'22.511"N	88° 34'42.107"W	Silt (3)	Fine (1)	Grey (7)
1701	30° 20'23.870"N	88° 34'32.278"W	Silt (3)	Fine (1)	Grey (7)
1707	30° 20'34.408"N	88° 34'22.150"W	Silt (3)	Fine (1)	Grey (7)
1715	30° 20'35.752"N	88° 34'00.576"W	Silt (3)	Fine (1)	Grey (7)
1721	30° 20'54.328"N	88° 33'55.827"W	Silt (3)	Fine (1)	Grey (7)
1728	30° 21'29.543"N	88° 33'52.965"W	Silt (3)	Fine (1)	Grey (7)
1733	30° 21'53.892"N	88° 33'54.499"W	Silt (3)	Fine (1)	Grey (7)

D.2.2 Seabed Texture

Beam averaged backscatter data was generated from the MBES eXtensible Triton Format (XTF) packets. However, this data was low quality due to significant water column noise. Consequently, processed SSS mosaics sourced from the EdgeTech 4125-D 900Khz data were used in place of backscatter to infer seabed texture distribution. The general intensity variation across all mosaics was minimal, suggesting little variation in seabed texture across the survey area. The only exceptions observed occured at the southern end of area C where a naturally deeper part of the maintained channel contained sticky clay sediment in addition to the fine silt found elsewhere in the area. Seabed sample data is recorded in the Final Feature File submitted with this dataset.

D.2.3 Aids to Navigation

While many Aids to Navigation (ATONs) existed in the vicinity of the survey area, only those accessible by boat could be investigated due to security requirements and construction at the shore sites. Two ranges were investigated for their bearing accuracy. These were Bayou Casotte Range "C" and Pascagoula River Range "C" and both were correct. Five floating navigational aids were also positioned using PPK GNSS (see table D.2). As all survey activities were conducted during daylight hours, light characteristics were not assessed. Several floating navigation aids were found to be off station and one floating aid had not yet been charted. However, none of the off station navigation aids were displaced to the degree that they could not serve their purpose.

Table D.2: Floating aids to navigation positioned on 17 June 2013

Time	Area	Name	Feature No.	Verified Position	Charted Position	Distance off station (m)	Bearing from station (°)
1557.32	B	Pascagoula Navy Channel Buoy No. 1	8230	30° 20' 31.30434"N 88° 34 25.42717"W	30° 20' 31.574"N 88° 34' 25.252"W	7	146
1604.38	B	Lighted Buoy No. 51	8215	30° 20' 31.38903"N 88° 34' 05.23274"W	30° 20' 31.684"N 88° 34' 25.546"W	7	164
1610.43	A	*Uncharted* Red can buoy	-	30° 20' 53.99064"N 88° 33' 53.10713"W	-	-	-
1615.25	A	Spoil Bank Day Bn No. 2	8165	30° 21' 05.56792"N 88° 33' 57.90609"W	30° 21' 05.976"N 88° 33' 58.248"W	12	149
1621.09	A	Spoil Bank Day Bn No. 4	8150	30° 21' 19.40770"N 88° 33' 52.94808"W	30° 21' 19.728"N 88° 33' 51.660"W	37	263

For imagery of all aids to navigation positioned during the survey, refer to the supplementary *13USM01 Data Acquisition and Processing Report*.

D.2.4 Dangers to Navigation

Seven DTONs were found during data processing. All were prepared and submitted in an S-57 file, accompanied by written reports, to the NOAA Atlantic Hydrographic Branch. The correspondence is included with the dataset in the standard NOAA format. A concise summary of the dangers is shown in table D.3. Any least depths were also set as designated soundings in the accompanying CSAR surfaces for each area. Full reports are included in appendix II.

Table D.3: Summary of dangers to navigation

Area	Latitude	Longitude	Depth (m)	Description
A	30° 21'54.33"N	088° 33'51.56"W	9.6	Object is atypical in surrounding seabed, in a depth area of 8.5m, close to the edge of a USACE maintained channel with a controlling depth of 11.2m
A	30° 21'04.17"N	088° 33'54.45"W	5.9	Object is in a dredged area (not regularly maintained) with a controlling depth of 8.2m
A	30° 20'55.64"N	088° 33'53.91"W	4.3	Object appears to be a fallen dolphin structure protruding into navigable waters in a dredged area with controlling depth of 8.2m
A	30° 20'51.48"N	088° 33'54.41"W	5.9	Object appears to be a large man-made structure adjacent to a dilapidated wharf, protruding into a navigable area with a controlling depth of 8.2m
A	30° 21'14.74"N	088° 34'00.75"W	5.4	Object does not conform to the general trend of the seabed and may pose a hazard to navigation
B	30° 20'23.83"N	088° 34'45.82"W	7.1	Surrounding depth triangle suggests depths should be greater than 10.6m in this location
C	30° 20'02.90"N	088° 30'49.17"W	11.1	Object is within the USACE maintained channel and protrudes above the controlling depth of 11.5m

D.2.5 Platforms

Two platforms were located within the survey area. One platform was undergoing repairs, moored at the northern end of area A (figure D.6). The second platform was also undergoing repairs, moored at the Singing River Island wharf in area B (figure D.7). These platforms are not permanent structures. However, they did interfere with the collection of MBES and SSS data. Both platforms are visible in Google Earth imagery as at 15 July 2013.

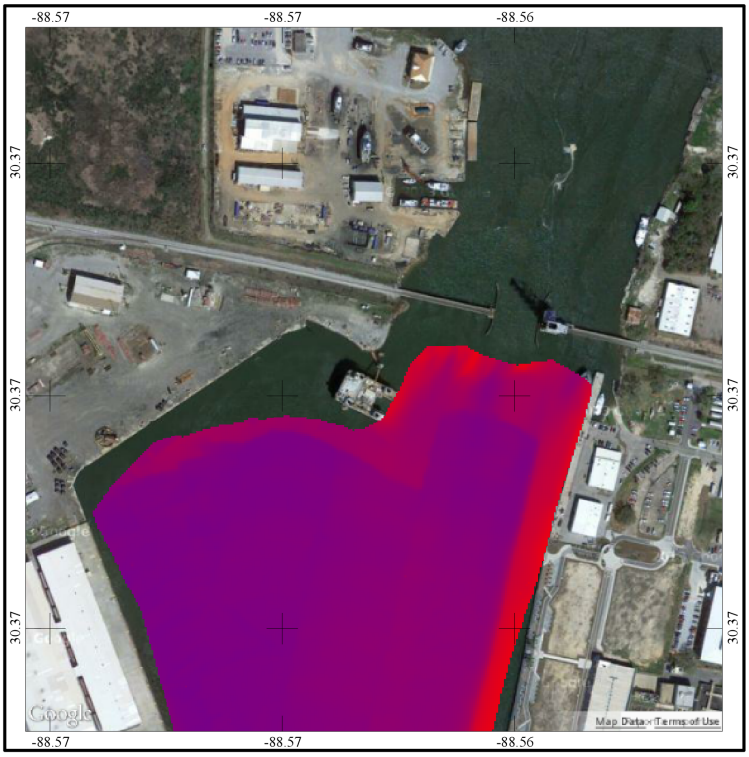

Figure D.6: Impact on bathymetry collection due to platform located in area A - Google Earth imagery sourced 15 July 2013

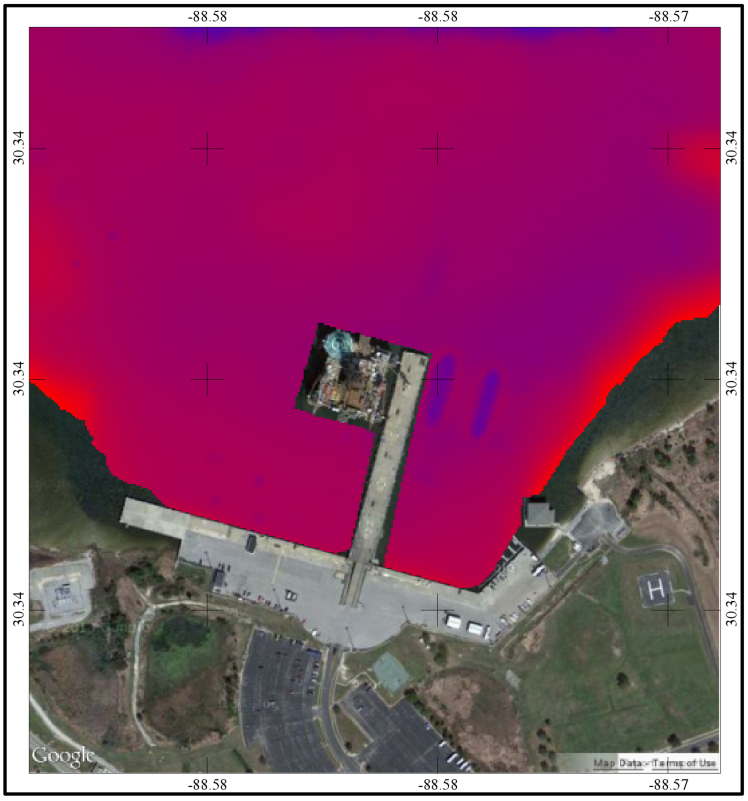

Figure D.7: Impact on bathymetry collection due to platform located in area B - Google Earth imagery sourced 15 July 2013

D.2.6 Construction

Significant construction activities were occurring at the Chevron terminal, Bayou Casotte, at the south-eastern end of area C during the survey. The construction activities included wharf refurbishment and building of new wharf facilities. The survey vessel avoided this area due to the dynamic environment and risk of interfering in the construction activity. The south-eastern wharf area in Bayou Casotte will require future survey attention to adequately assess changed bathymetry and coastline features as a result of the construction.

D.2.7 Dredging

Bayou Casotte bulk terminals (terminals E, F, G and H) in area C could not be fully surveyed due to hazardous material removal dredging being conducted by contractor C. F. Bean LLC. These areas will also require resurvey on completion of the dredging.

D.2.8 Ammendments to Sailing Directions/Coast Pilot

Both the port of Pascagoula and Bayou Casotte are covered by NOAA Coast Pilot 5, chapter 7 [NOAA, 2013]. This section was fully reviewed and during the survey no discrepancies were found in the existing information.

However, one addition to the text is suggested:

> (182) The area bounded by Singing River Island and the Ingalls Shipbuilding floating dock is not maintained and is subject to silting. Depths between 3-10 feet shoaler than those charted may be expected.

E Approval Sheet

PLACEHOLDER - INTENTIONALLY LEFT BLANK

Bibliography

[GCGC, 2013] Gulf Coast Geospatial Center/University of Southern Mississippi (2013), *GCGC Real Time Network, NAD 83(2011) epoch 2010.00*, retrieved from: http://vrsnet.gcgcusm.org/

[Hare, 1995] Hare, R. (1995), "Depth and position error budgets for multibeam echosounding", *International Hydrographic Review*, Monaco, 72(1), March, pp. 33

[IHO, 2005] International Hydrographic Organization (2005), *IHO Manual on Hydrography*, Publication C-13, 1st Edition, May 2005, corrected to February 2011, International Hydrographic Bureau, Monaco.

[IHO, 2008] International Hydrographic Organization (2008), *IHO Standards for Hydrographic Surveys*, 5th Edition, February, International Hydrographic Bureau, Monaco.

[NOAA, 2012] National Oceanic and Atmospheric Administration (2012), *NOAA OCS Field Procedures Manual*, April, US Department of Commerce.

[NOAA, 2013] National Oceanic and Atmospheric Administration (2013), *Coast Pilot 5*, chapter 7, pp. 308-314.

[NOAA, 2013] National Oceanic and Atmospheric Administration (2013), *NOS Hydrographic Specifications and Deliverables*, April, US Department of Commerce.

APPENDIX I

TIDES AND WATER LEVELS

I Tides and Water Levels

This survey was reduced to MLLW (NTDE 1983-2001) datum using an ellipsoid referenced method. No final smoothed tide data was requested from NOAA. Therefore this appendix does not contain the typical NOAA correspondence. For details of vertical control see section C or the supplementary *13USM01 Horizontal and Vertical Control Report*.

Abstract of times of Hydrography

If applying smooth tides to the dataset, the dates and times of bathymetric data collection detailed in table I.1 should be used. All times and dates are referred to Coordinated Universal Time (UTC) and have been extracted from the acquisition logfile included with the dataset.

Table I.1: Dates and times (UTC) of bathymetric data collection

Date	Time
6 June 2013	1428-1450
10 June 2013	1444-2005
11 June 2013	1307-1509
12 June 2013	1538-1718
13 June 2013	1811-1826
14 June 2013	1301-1908
18 June 2013	1301-1844

APPENDIX II

SUPPLEMENTAL SURVEY RECORDS AND CORRESPONDENCE

Castle Parker - NOAA Federal

From: Castle Parker - NOAA Federal
Sent: Tuesday, March 25, 2014 1:41 PM
To: Patrick Fink - NOAA Affiliate; Vanessa Miller - NOAA Federal; Abigail Higgins - NOAA Federal
Cc: Tim Osborn - NOAA Federal
Subject: RE: [EXTERNAL] Fwd: W00271 DtoN #3: Obstruction in USACE channel (UNCLASSIFIED)

Thanks! Was thinking about this a day or so ago. Appreciate the update. Since the USACE will "dredge" and remove the obstruction, AHB is not going to submit this feature to NDB.
We appreciate your support, efforts, and assistance with this charting situation.

Regards,
Gene

From: Patrick Fink - NOAA Affiliate [mailto:patrick.fink@noaa.gov]
Sent: Tuesday, March 25, 2014 1:33 PM
To: Gene Parker; Vanessa Miller - NOAA Federal; Abigail Higgins - NOAA Federal
Cc: Tim Osborn
Subject: Fwd: [EXTERNAL] Fwd: W00271 DtoN #3: Obstruction in USACE channel (UNCLASSIFIED)

Hi Gene,

See below from the Mobile Corps of Engineers regarding this "DTON". Nothing more than a porta potty.....

---------- Forwarded message ----------
From: **Poiroux, Duane B SAM** <Duane.B.Poiroux@usace.army.mil>
Date: Tue, Mar 25, 2014 at 10:21 AM
Subject: RE: [EXTERNAL] Fwd: W00271 DtoN #3: Obstruction in USACE channel (UNCLASSIFIED)
To: Patrick Fink - NOAA Affiliate <patrick.fink@noaa.gov>

Classification: UNCLASSIFIED
Caveats: NONE

It turns out the obstruction is a fiberglass/plastic porta potty that probably fell off a barge. Divers went down yesterday. We will probably just dredge it up when we dredge Bayou Casotte this year.

Bubba

-----Original Message-----
From: Patrick Fink - NOAA Affiliate [mailto:patrick.fink@noaa.gov]
Sent: Tuesday, March 25, 2014 10:10 AM
To: Poiroux, Duane B SAM
Subject: Re: [EXTERNAL] Fwd: W00271 DtoN #3: Obstruction in USACE channel (UNCLASSIFIED)

Hi Bubba,

Any update on this?

On Wed, Mar 5, 2014 at 11:07 AM, Poiroux, Duane B SAM <Duane.B.Poiroux@usace.army.mil> wrote:

Classification: UNCLASSIFIED
Caveats: NONE

We are actually putting together our diving contract as we email. I will let you know what we find.

Bubba

-----Original Message-----
From: Patrick Fink - NOAA Affiliate [mailto:patrick.fink@noaa.gov]
Sent: Wednesday, March 05, 2014 10:58 AM
To: Poiroux, Duane B SAM
Subject: Re: [EXTERNAL] Fwd: W00271 DtoN #3: Obstruction in USACE channel (UNCLASSIFIED)

Hi Bubba,

Did the diver find anything?

On Wed, Jan 22, 2014 at 3:04 PM, Poiroux, Duane B SAM <Duane.B.Poiroux@usace.army.mil> wrote:

We have surveyed but still can't tell what the object is so we are planning on diving on it soon. Will keep you posted.

Bubba

From: Patrick Fink - NOAA Affiliate [mailto:patrick.fink@noaa.gov]
Sent: Wednesday, January 22, 2014 03:00 PM
To: Poiroux, Duane B SAM
Subject: Re: [EXTERNAL] Fwd: W00271 DtoN #3: Obstruction in USACE channel (UNCLASSIFIED)

Hi Bubba,

Any news on this survey?

Patrick

On Mon, Jan 6, 2014 at 2:33 PM, Poiroux, Duane B SAM <Duane.B.Poiroux@usace.army.mil> wrote:

Classification: UNCLASSIFIED

Caveats: NONE

We will be surveying it later this week or next week. Will let you know when it is complete.

Bubba

-----Original Message-----
From: Patrick Fink - NOAA Affiliate [mailto:patrick.fink@noaa.gov]
Sent: Monday, January 06, 2014 2:23 PM
To: Poiroux, Duane B SAM
Subject: Re: [EXTERNAL] Fwd: W00271 DtoN #3: Obstruction in USACE channel (UNCLASSIFIED)

Hi Bubba,

What kind of survey schedule are your guys looking at for this part of the Pascagoula nav channel?

On Fri, Dec 20, 2013 at 1:47 PM, Poiroux, Duane B SAM <Duane.B.Poiroux@usace.army.mil> wrote:

Classification: UNCLASSIFIED
Caveats: NONE

Patrick,

We will sidescan the obstruction and try to determine what it is and see if it warrants removal.

Bubba

-----Original Message-----
From: Patrick Fink - NOAA Affiliate [mailto:patrick.fink@noaa.gov]
Sent: Friday, December 20, 2013 1:24 PM
To: Poiroux, Duane B SAM; Dyess, Carl E SAM
Subject: [EXTERNAL] Fwd: W00271 DtoN #3: Obstruction in USACE channel

Hi Bubba and Carl,

Attached and below is documentation from a June 2013 survey in Bayou Casotte of a University of Southern Mississippi survey boat as part of their summer capstone project. After review of the multibeam data, NOAA's Atlantic Hydrographic Branch prepared a preliminary "Danger to Navigation" Report for a feature in the left outside quarter of the Bayou Casotte turning basin.

Before any action is taken on our part I wanted to share this information with the Corps for your review. Can you take a look at this information and let me know what actions you might take?

Thanks,

Patrick

Inline image 1<https://mail.google.com/mail/u/0/?ui=2&ik=dfe7bc9ee2&view=att&th=1431173bae56b67b&attid=0.1&disp=safe&realattid=ii_14311732be05539f&zw>

---------- Forwarded message ----------
From: Castle Parker - NOAA Federal <castle.e.parker@noaa.gov>
Date: Fri, Dec 20, 2013 at 12:54 PM
Subject: RE: W00271 DtoN #3: Obstruction in USACE channel
To: Patrick Fink - NOAA Affiliate <patrick.fink@noaa.gov>, Tim Osborn - NOAA Federal <tim.osborn@noaa.gov>
Cc: Abigail Higgins - NOAA Federal <abigail.higgins@noaa.gov>, Jon Swallow <Jon.Swallow@noaa.gov>

Hello Patrick,

What echo-sounder did the USACE use with the survey below? IF VBES, the target location may be offset from the track line and would not have ensonified the reported feature. The reported location is 30-20-02.9N 088-30-49.2W; the actual data point location of the least depth is 30-20-02.901N 088-30-49.174W. The distance between the two locations is 0.71m. Pydro tends to round the decimal seconds in lat/lon.

The foot print of a VBES transducer if it were 8° beam width is 1.557m (5.11ft) coverage on the sea floor. That being said, the VBES footprint is smaller than the object's size. So, if VBES echo sounder was used, the location were the feature is located was missed. Usually, the sounding that is plotted is based upon the center centroid or center of the digits. The survey could have missed the exact location of the feature as submitted; or the data could have been rejected. I don't have the USACE survey data for review, nor do I have a spatial file to compare. I do know the feature submitted is contained within W271 and is well supported. The feature's dimensions measures approximately 3m X 5m. The feature is supported within W271 by two data types, SSS and SWMB.

directly over the feature

Adjacent SS line to the east:

. and by three MB lines

The intent of this submission was to provide information to USACE. They can act on it and investigate if the feature still exists. AHB's actions are based upon the data content of the USM survey. If the USACE is not going to investigate this feature then AHB may submit as a Danger and have it applied to the chart. Normal OCS and HSD data supersession rules is for MB data to supersede VBES data.

AHB is following protocol so that we allow USACE to investigate and either confirm the existence, then remove the object. If USACE is not going to act on this information, then the prudent thing to do is to warn the mariner via chart application. The liability does point to USACE, but OCS would be negligent as well, knowing that current survey data at AHB contains this object and is shoaler than the charted tabulated depth limits.

From my perspective, the prudent thing to do is to contact the USACE with this information.

Regards,

Gene

Castle Eugene Parker

Atlantic Hydrographic Branch

Hydrographic Team Lead

Physical Scientist, NOAA Office of Coast Survey

castle. <mailto:matthew.wilson@noaa.gov> e.parker@noaa.gov

office (757) 441-6746 x115 <tel:%28757%29%20441-6746%20x115> <tel:%28757%29%20441-6746%20x115> <tel:%28757%29%20441-6746%20x115> <tel:%28757%29%20441-6746%20x115>

From: Patrick Fink - NOAA Affiliate [mailto:patrick.fink@noaa.gov]
Sent: Friday, December 20, 2013 12:39 PM
To: Tim Osborn - NOAA Federal

Cc: Castle Parker - NOAA Federal; Abigail Higgins
Subject: Re: W00271 DtoN #3: Obstruction in USACE channel

Gene,

The USACE surveyed this area on August 6, two months after USM did their survey. The attached JPEG shows depths of ~41ft around the data point. Advise?

Inline image 2

On Fri, Dec 20, 2013 at 11:24 AM, Tim Osborn - NOAA Federal <tim.osborn@noaa.gov> wrote:

Gene

Thank you and to Vanessa. Patrick helped coordinate with USM on the work in this area. This will be very valuable to have USACE be aware of this issue.

Tim

On Dec 20, 2013, at 8:58 AM, Castle Parker - NOAA Federal <castle.e.parker@noaa.gov> wrote:

Tim,

It should have been mentioned in the email or the feature report that the intent is to contact the USACE. This feature is located in the USACE domain based upon the location within the turning basing and federally maintained channel area; Bayou Casotte - left outside quarter tabulated depth is 37.7ft. Contact the USACE and notify them of the feature object and see if you can get them to remove the feature. If the USACE has no plans on removing the object, then AHB will submit the feature to Nautical Data Branch for application to the chart.

Thanks for your assistance.

Gene Parker

From: Vanessa Miller - NOAA Federal [mailto:vanessa.miller@noaa.gov]
Sent: Friday, December 20, 2013 9:42 AM
To: Tim Osborn - NOAA Federal; Patrick Fink - NOAA Affiliate
Cc: Castle Parker - NOAA Federal; Abigail Higgins - NOAA Federal; Michael Gonsalves - NOAA Federal
Subject: W00271 DtoN #3: Obstruction in USACE channel

Good day,

Attached is a Danger to Navigation (DtoN) found in a USACE controlled channel. This report is to be submitted to Gulf Coast Navigation Managers. This danger was found by the University of Southern Mississippi and verified at the Atlantic Hydrographic Branch during office processing. The data has not been submitted to the Nautical Charting Branch for compilation.

If you have any further questions regarding this issue, please contact me. (757-441-6746 <tel:%28757-441-6746> <tel:%28757-441-6746> <tel:%28757-441-6746> <tel:%28757-441-6746>)

Vanessa Self Miller

Hydrographer/Physical Scientist

Atlantic Hydrographic Branch

439 West York St.

Norfolk, VA 23435

<W00271_AHB_DtoN_3.pdf>

--

APPENDIX III

SURVEY FEATURES REPORT

AWOIS	0
DTONs	2
Maritime Boundary Items	0
Wrecks	0

W00271 Feature Report

Registry Number: W00271
State: Mississippi
Locality: Gulf of Mexico
Sub-locality: Pascagoula Harbor and Bayou Casotte
Project Number: OSD-AHB-13
Survey Dates: 06/10/2013 - 06/19/2013

Charts Affected

Number	Edition	Date	Scale (RNC)	RNC Correction(s)*
11375	38th	01/01/2012	1:20,000 (11375_1)	USCG LNM: 4/15/2014 (4/15/2014) NGA NTM: 4/9/2011 (4/26/2014)
11374	34th	10/01/2007	1:40,000 (11374_2)	[L]NTM: ?
11373	47th	10/01/2008	1:80,000 (11373_1)	[L]NTM: ?
11360	43rd	11/01/2008	1:456,394 (11360_1)	[L]NTM: ?
1115A	43rd	11/01/2008	1:456,394 (1115A_1)	[L]NTM: ?
11006	32nd	08/01/2005	1:875,000 (11006_1)	[L]NTM: ?
411	52nd	09/01/2007	1:2,160,000 (411_1)	[L]NTM: ?

* Correction(s) - *source: last correction applied (last correction reviewed--"cleared date")*

Features

No.	Name	Feature Type	Survey Depth	Survey Latitude	Survey Longitude	AWOIS Item
1.1	DTON 1	Obstruction	5.95 m	30° 21' 04.2" N	088° 33' 54.4" W	---
1.2	DTON 2	Obstruction	5.93 m	30° 20' 51.5" N	088° 33' 54.4" W	---

1 - Dangers to Navigation

1.1) DTON 1

DANGER TO NAVIGATION

Survey Summary

Survey Position:	30° 21' 04.2" N, 088° 33' 54.4" W
Least Depth:	5.95 m (= 19.52 ft = 3.253 fm = 3 fm 1.52 ft)
TPU (±1.96σ):	**THU (TPEh)** [None] ; **TVU (TPEv)** [None]
Timestamp:	2013-170.00:00:00.000 (06/19/2013)
Dataset:	W00271_Features.000
FOID:	US 0000730341 00001(0226000B24E50001)
Charts Affected:	11375_1, 11374_2, 11373_1, 1115A_1, 11360_1, 11006_1, 411_1

Remarks:

Object sits approximately 0.9m proud of the surrounding seabed.

Feature Correlation

Source	Feature	Range	Azimuth	Status
W00271_Features.000	US 0000730341 00001	0.00	000.0	Primary

Hydrographer Recommendations

[None]

Cartographically-Rounded Depth (Affected Charts):

19ft (11375_1, 11374_2, 11373_1)

3 ¼fm (1115A_1, 11360_1, 11006_1, 411_1)

S-57 Data

Geo object 1:	Obstruction (OBSTRN)
Attributes:	NINFOM - Add obstruction
	QUASOU - 6:least depth known
	SORDAT - 20130619
	SORIND - US,US,graph,W00271
	VALSOU - 5.949 m

WATLEV - 3:always under water/submerged

Office Notes

SAR: This feature is hydrographically significant. The feature was observed in MBES data. This feature was submitted to MCD by AHB as DTON #1. Compile: Concur, add obstruction.

Feature Images

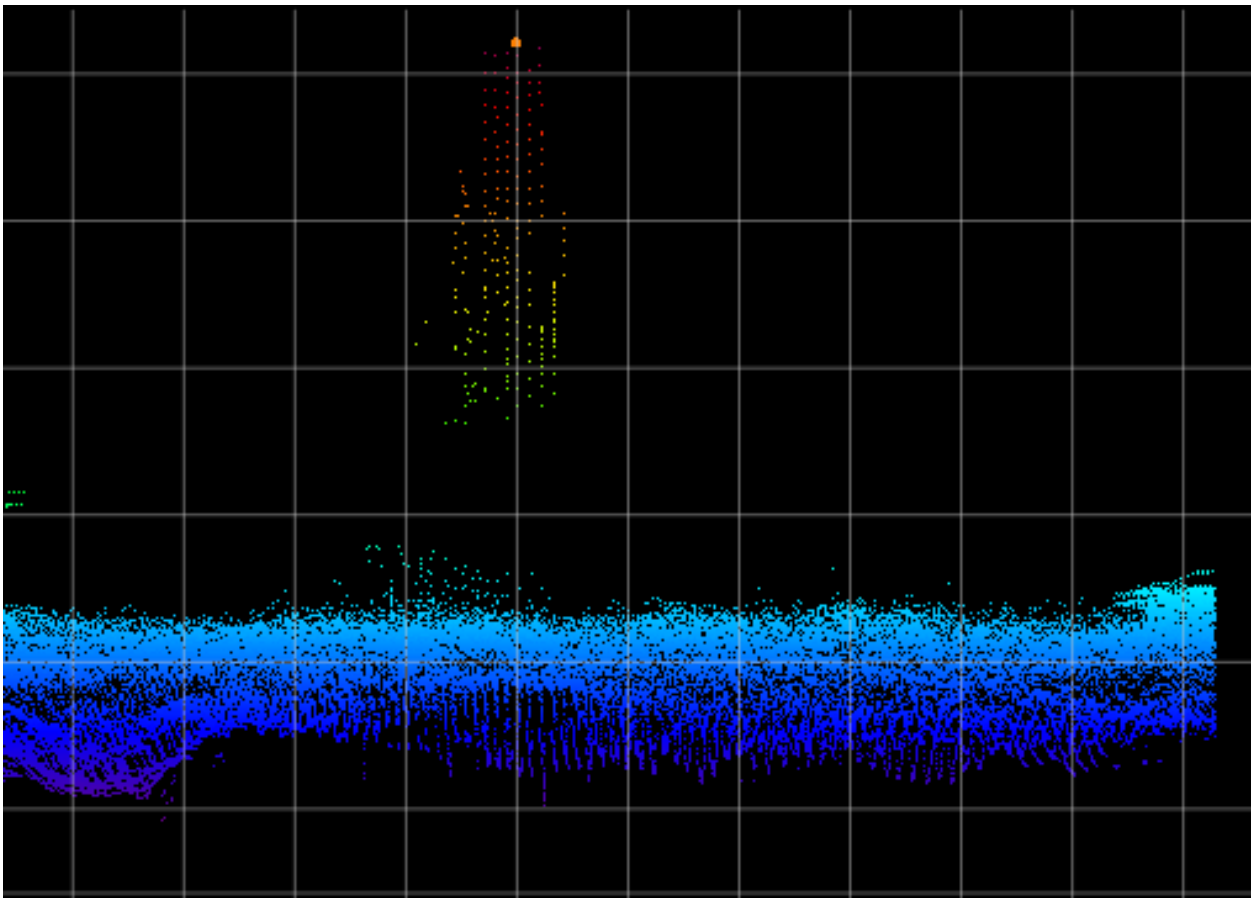

Figure 1.1.1

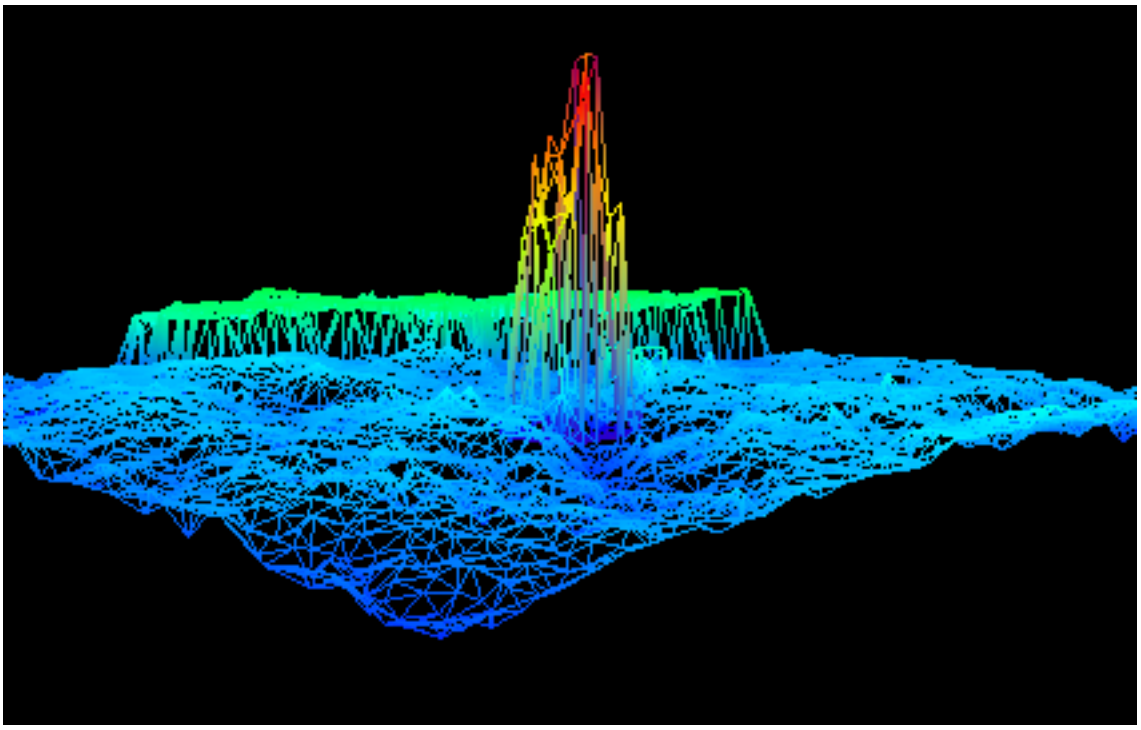

Figure 1.1.2

1.2) DTON 2

DANGER TO NAVIGATION

Survey Summary

Survey Position:	30° 20' 51.5" N, 088° 33' 54.4" W
Least Depth:	5.93 m (= 19.46 ft = 3.244 fm = 3 fm 1.46 ft)
TPU (±1.96σ):	**THU (TPEh)** [None] ; **TVU (TPEv)** [None]
Timestamp:	2013-170.00:00:00.000 (06/19/2013)
Dataset:	W00271_Features.000
FOID:	US 0000730343 00001(0226000B24E70001)
Charts Affected:	11375_1, 11374_2, 11373_1, 1115A_1, 11360_1, 11006_1, 411_1

Remarks:

Object appears to be a large man-made structure which has fallen sideways.

Feature Correlation

Source	Feature	Range	Azimuth	Status
W00271_Features.000	US 0000730343 00001	0.00	000.0	Primary

Hydrographer Recommendations

[None]

Cartographically-Rounded Depth (Affected Charts):

19ft (11375_1, 11374_2, 11373_1)

3 ¼fm (1115A_1, 11360_1, 11006_1, 411_1)

S-57 Data

Geo object 1:	Obstruction (OBSTRN)
Attributes:	NINFOM - Add obstruction
	QUASOU - 6:least depth known
	SORDAT - 20130619
	SORIND - US,US,graph,W00271
	VALSOU - 5.932 m

WATLEV - 3:always under water/submerged

Office Notes

SAR: This feature is hydrographically significant. The feature was observed in MBES data. This feature was submitted to MCD by AHB as DTON #2. Compile: Concur, add obstruction.

Feature Images

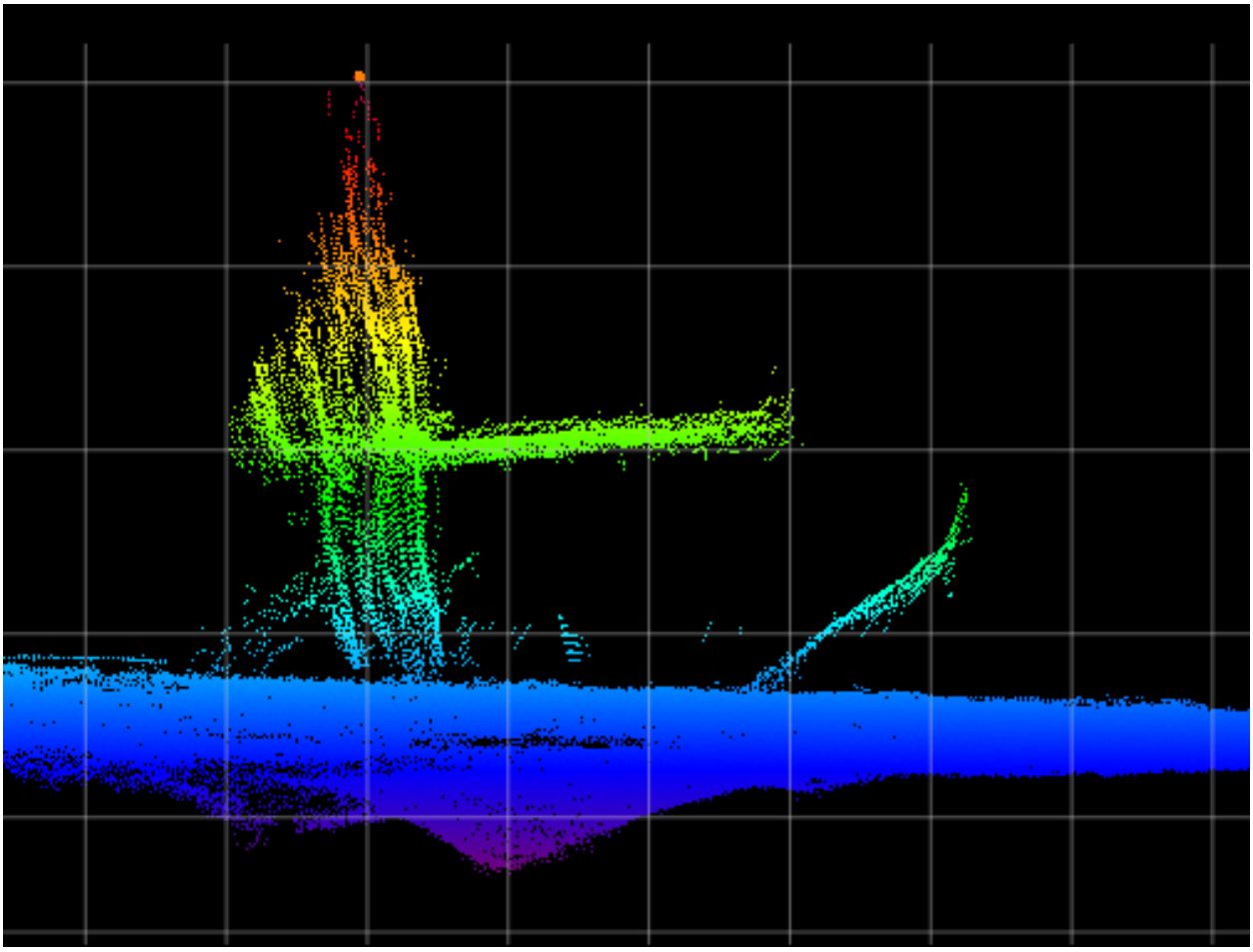

Figure 1.2.1

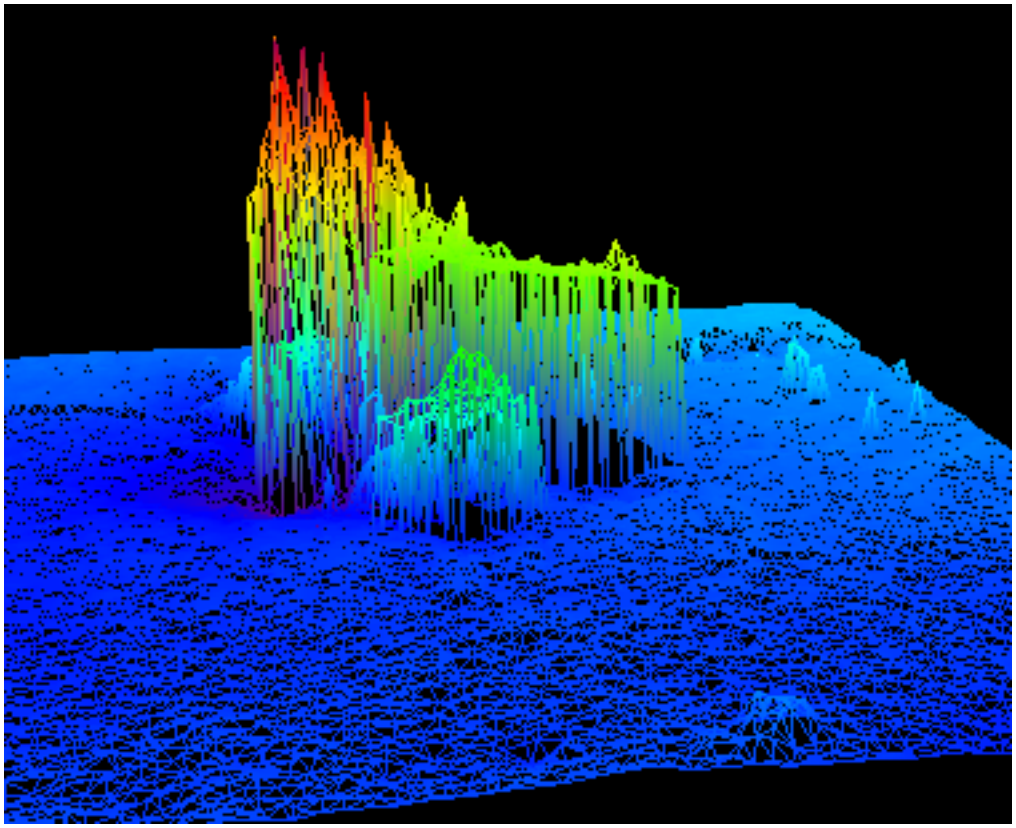

Figure 1.2.2

APPROVAL PAGE

W00271

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NGDC for archive

- W00271_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- W00271_GeoImage.pdf

The survey evaluation and verification has been conducted according current OCS Specifications, and the survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Approved:_____

LT Matthew Jaskoski, NOAA
Chief, Atlantic Hydrographic Branch