H12907

NOAA FORM 76-35A

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Project Number:	OPR-K354-KR-16
Registry Number:	H12907

LOCALITY

State(s):	Louisiana
General Locality:	Gulf of Mexico
Sub-locality:	25 NM SSE of Marsh Island

2016

CHIEF OF PARTY
George G. Reynolds

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Date:

NOAA FORM 77-28

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

H12907

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:	**Louisiana**
General Locality:	**Gulf of Mexico**
Sub-Locality:	**25 NM SSE of Marsh Island**
Scale:	**1:40000**
Dates of Survey:	**Aug 18, 2016 to Sep 30, 2016**
Instructions Dated:	**Jul 26, 2016**
Project No.:	**OPR-K354-KR-16**
Field Unit:	**Ocean Surveys, Inc.**
Chief of Party:	**George G. Reynolds**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Side Scan Sonar Multibeam Echo Sounder Backscatter**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

The purpose of this project is to provide contemporary surveys to update National Ocean Service (NOS) nautical charting products. All times are recorded in UTC. Data recorded and presented relative to UTM Zone 15 North. THE INFORMATION PRESENTED IN THIS REPORT AND THE ACCOMPANYING BASE SURFACES REPRESENTS THE RESULTS OF SURVEYS PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 16 AUGUST 2016 TO 30 SEPTEMBER 2016 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

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 Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/.

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Descriptive Report to Accompany Survey H12907

Project: OPR-K354-KR-16

Locality: Gulf of Mexico

Sublocality: 25 NM SSE of Marsh Island

Scale: 1:40000

August 2016 - September 2016

Ocean Surveys, Inc.

Chief of Party: George G. Reynolds

A. Area Surveyed

This survey provides hydrographic data for the Gulf of Mexico waters approaching Atchafalaya Bay. The general locations of the survey limits are presented in Table 1.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
29° 13" 47.07' N 91° 51" 23.96' W	29° 5" 10.1' N 91° 41" 15.4' W

Table 1: Survey Limits

Survey limits were acquired in accordance with the requirements in the Project Instructions and the HSSD.

A.2 Survey Purpose

Per the hydrographic project instructions, the purpose of this project is to provide contemporary surveys to update National Ocean Service (NOS) nautical charting products. This project area is located within the vicinity of the Atchafalaya River Delta and the Port of Morgan City. The proposed project will cover both nearshore and offshore areas in the vicinity of the Atchafalaya River Basin and will update the nautical chart where depth contours have migrated. The project will cover approximately 130 square nautical miles of critical survey area in the Approaches to Atchafalaya Bay as designated in NOAA Hydrographic Survey Priorities, 2012 edition. Survey data from this project are intended to supersede all prior survey data in the common area.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

A.4 Survey Coverage

The following table lists the coverage requirements for this survey as assigned in the project instructions:

Water Depth	Coverage Required
All waters in survey area	Complete Coverage accomplished using either: A) Complete coverage MBES depth and backscatter data or B) 100% SSS coverage with concurrent set line spacing MBES depth and backscatter data.

Survey Coverage is in accordance with the requirements in the Hydrographic Survey Project Instructions (July 26, 2016), the Statement of Work, [May 2016 (SOW)], and the Hydrographic Surveys Specifications and Deliverables, [March 2016 (HSSD)]. In all waters, Complete Coverage was accomplished by acquiring one hundred percent (100%) side scan sonar (SSS) coverage with concurrent multibeam echosounder (MBES) with backscatter. Data were acquired on a set line spacing plan.

Additional SSS and MBES coverage was obtained as necessary to fill gaps in coverage, to provide a least depth for all significant SSS contacts and for charted feature disprovals. Gaps in the 100% SSS coverage were addressed with SSS fill-in lines or covered with complete MBES data. Bathymetric splits were also acquired to verify or disprove charted depths that fell between two MBES survey lines when the charted depth was shallower than the adjacent survey soundings.

The final survey area covers 35.92 square nautical miles (Figure 1).

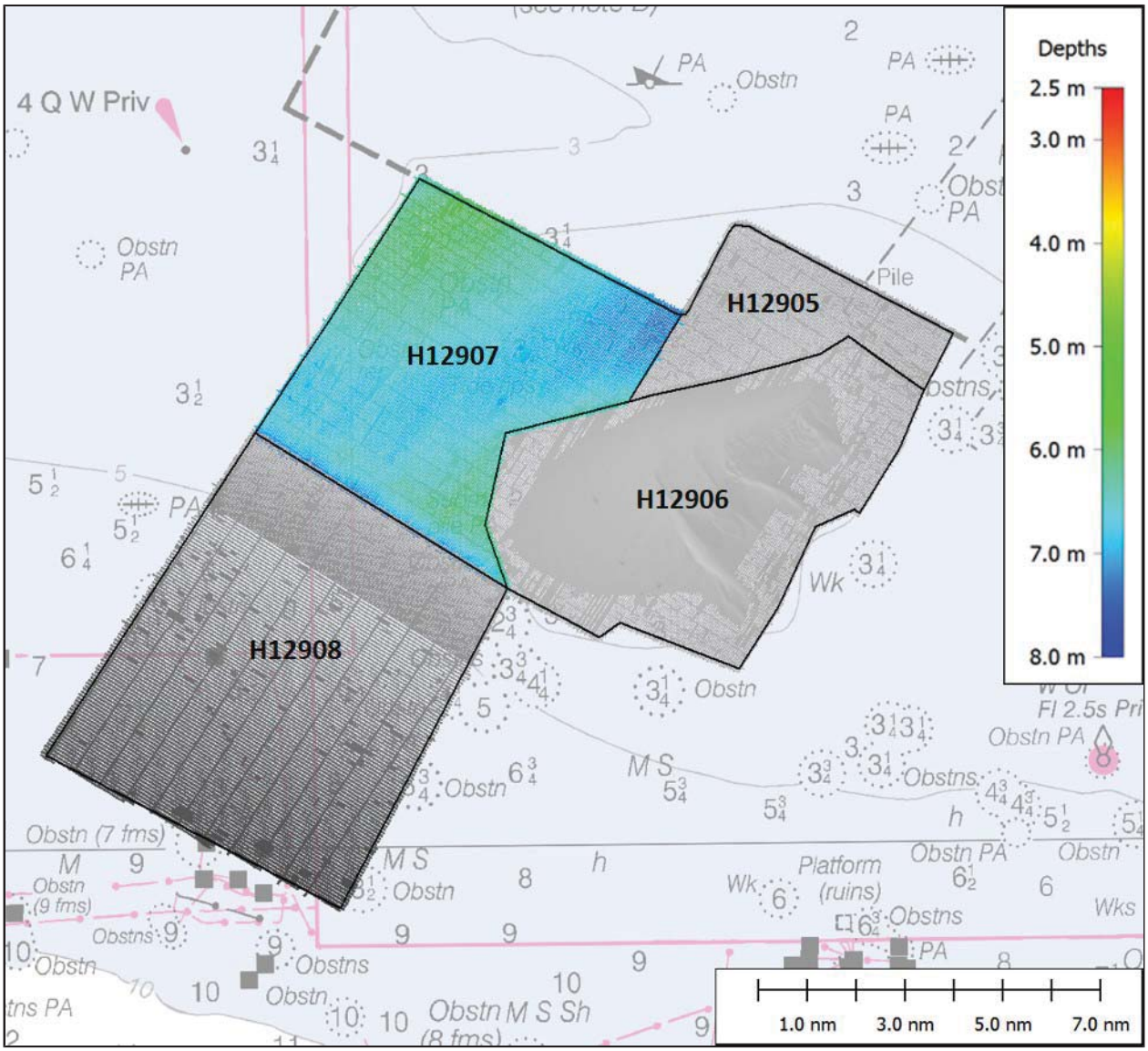


Figure 1: Survey H12907 MBES coverage overlaid on RNC 11340.

A.5 Survey Statistics

The following tables list the survey statistics (Table 2) and the dates of hydrography (Table 3).

	Hull ID	***R/V Ocean Explorer***	***Total***
LNM	**SBES Mainscheme**	0	0
	MBES Mainscheme	14.97	14.97
	Lidar Mainscheme	0	0
	SSS Mainscheme	135.31	135.31
	SBES/MBES Mainscheme	0	0
	SBES/SSS Mainscheme	0	0
	MBES/SSS Mainscheme	875.62	875.62
	SBES/MBES Cross Lines	96.49	96.49
	Lidar Cross Lines	0	0
Number of Bottom Samples			4
Number of Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total Number of SNM			35.92

Table 2: Hydrographic Survey Statistics

Survey Dates	Julian Day Number
08/18/2016	231
08/23/2016	236
08/31/2016	244
09/01/2016	245
09/02/2016	246
09/03/2016	247
09/04/2016	248
09/05/2016	249
09/10/2016	254
09/11/2016	255
09/21/2016	265
09/22/2016	266
09/23/2016	267
09/30/2016	274

Table 3: Dates of Hydrography

The lineal nautical miles (LNM) for MBES only development and fill in lines were included under the heading "Mainscheme MBES" and the LNM for SSS only fill in lines were included under the heading "Mainscheme SSS" in Table 2. Hydrographic Survey Statistics.

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the OPR-K354-KR-16 Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessel, quality control procedures and data processing methods. Additional information to supplement sounding and survey data, and any deviations from the DAPR are discussed in the following sections.

B.1.1 Vessels

Survey operations were conducted from the R/V Ocean Explorer. The R/V Ocean Explorer, O.N. 905425, is an 18-meter aluminum vessel, with a 5.1-meter beam and nominally 2-meter draft, powered by two 1,000 HP Iveco diesel engines.

Hull ID	***R/V Ocean Explorer***
LOA	18 meters
Draft	2 meters

Table 4: Vessel Used

B.1.2 Equipment

Table 5 summarizes the primary equipment used to acquire MBES and SSS data. All equipment was installed, calibrated and operated in accordance with the DAPR.

Manufacturer	Model	Type
Reson	7125	MBES
EdgeTech	4125	SSS
ODIM	MVP30 w/AML SVPT	Sound Speed System
AML	Micro-X	Sound Speed System
Applanix	POS MV 320 V.4	Positioning and Attitude System
Trimble	ProBeacon	Positioning System
Trimble	SPS 461	Positioning System

Table 5: Primary Survey Equipment

B.2 Quality Control

B.2.1 Cross Lines

A total of 96.49 nm of cross line data were acquired August 18, 2016 (DN 231). Cross line mileage equaled 11.1% of the 875.62 nm of mainscheme MBES lines. Cross lines were run nominally perpendicular to mainscheme lines (Figure 2).

Soundings from mainscheme lines and cross lines were compared periodically throughout survey operations reviewing preliminary MBES surfaces and using CARIS HIPS Subset Editor. Cross line comparisons provided confirmation that the system offsets and biases were entered correctly and verified the accuracy of sounding correctors (i.e. tide, sound speed, TrueHeave).

Statistical quality control information was compiled from a difference surface, generated in CARIS HIPS, between the depth layer of a 1-meter CUBE surface composed only of cross line data and the depth layer of a 1-meter CUBE surface composed only of mainscheme data. The cross line analysis results demonstrate excellent agreement between cross line soundings and mainscheme soundings, with the depth differences less than or equal to 0.30 meters with an average difference of 0.04 meters. The allowable TVU for the range of water depths within Survey H12907 is greater than 0.50 meters.

Figure 3 is a histogram showing the distribution of depth differences for all comparison grid cells considered. The total number of 1-meter comparison cells equaled 1,210,147. Of 1,210,147 possible comparison cells, 1,181,669 or 97.65% of the cells include cross line and mainscheme soundings that match within +/- 20 centimeters.

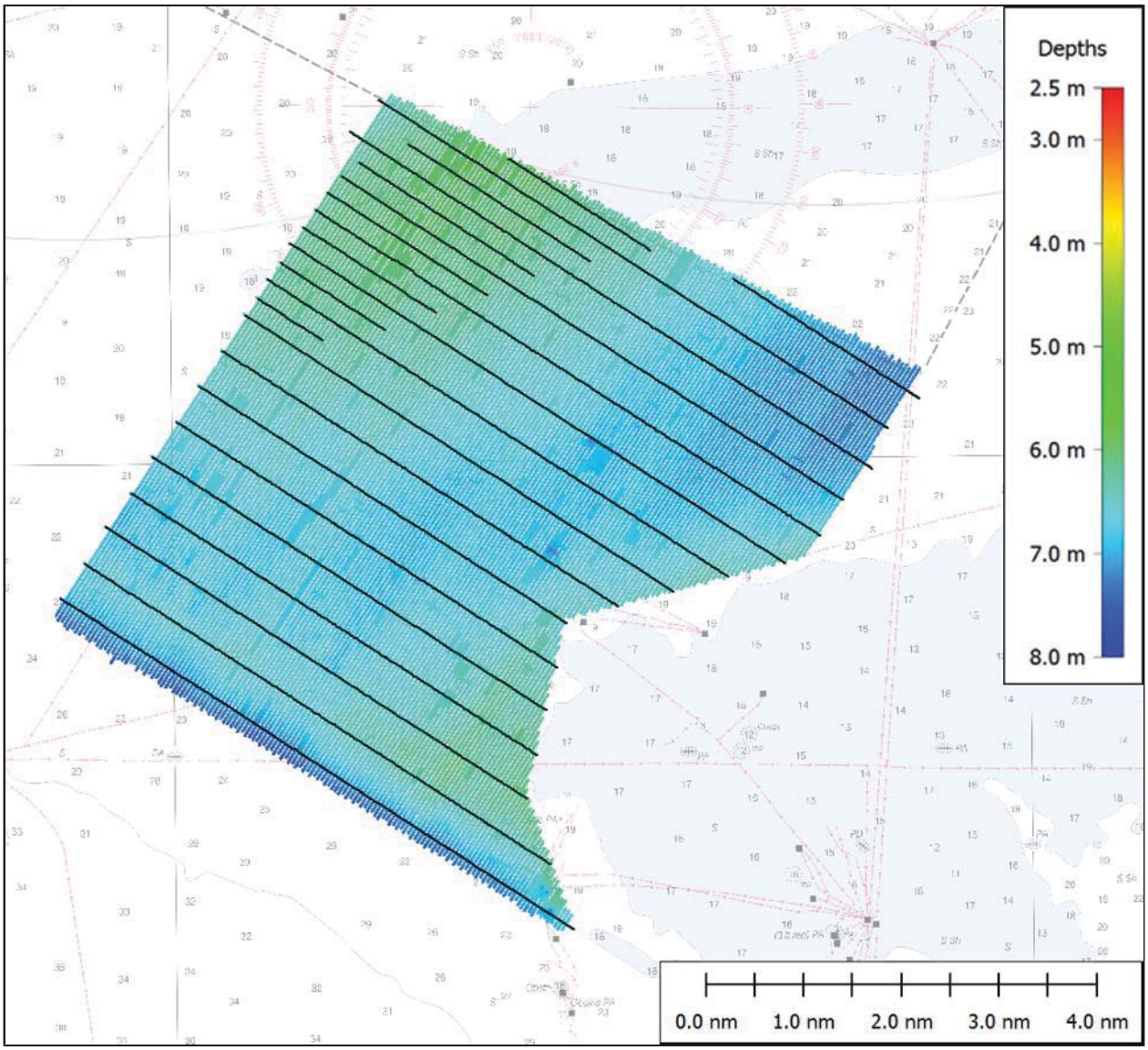


Figure 2: An overview of the cross line layout on a 1-meter surface created from mainscheme MBES data and colored by depth. RNCs 11351 and 11349 are visible in the background.

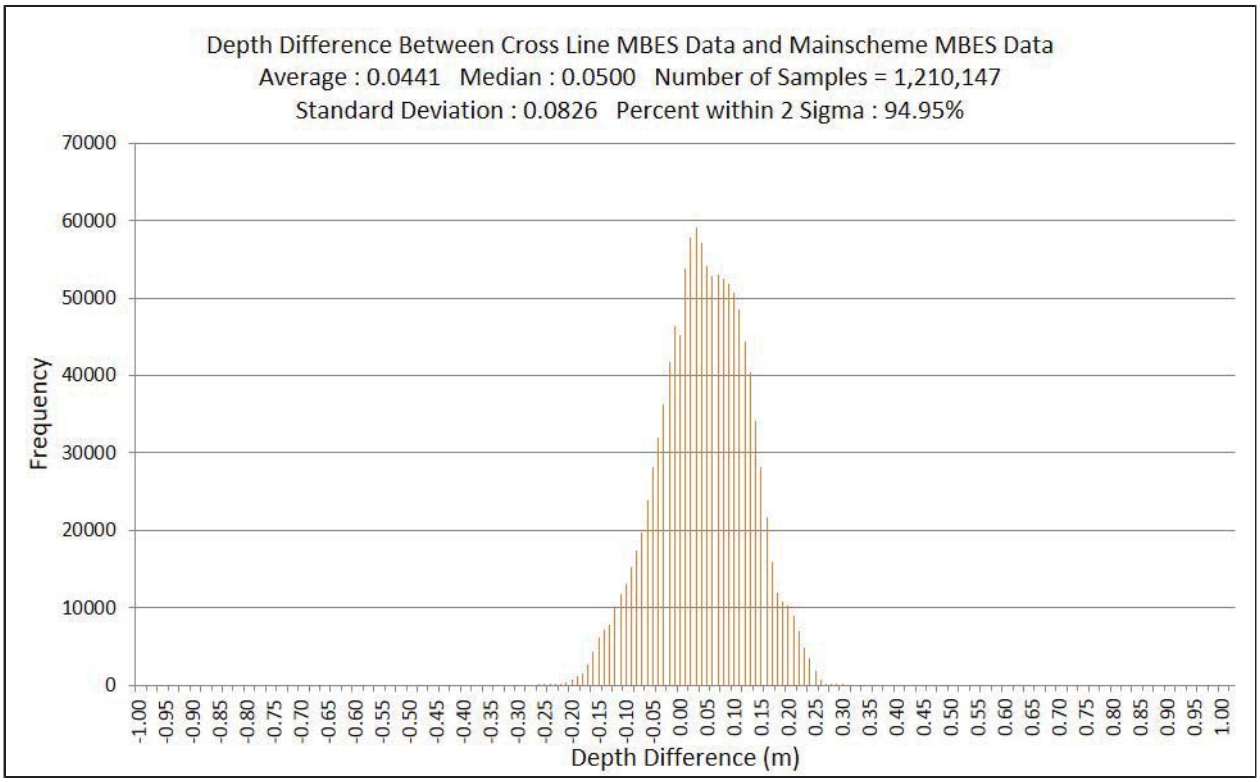


Figure 3: The graph shows a frequency distribution of the depth differences between the H12907 cross line data and the H12907 mainscheme MBES data. Statistics from the depth difference sample set are displayed above the graph.

B.2.2 Uncertainty

The following two tables list the tide and sound speed uncertainty parameters that were used to compute Total Propagated Uncertainty (TPU) for this survey.

Measured	Zoning	Method
0.03 meters	0.09 meters	Discrete Zoning

Table 6: Survey Specific Tide TPU Values

Hull ID	Measured - CTD	Measured - MVP	Surface
R/V Ocean Explorer		1 meters/second	1 meters/second

Table 7: Survey Specific Sound Speed TPU Values

The methods used to minimize the uncertainty in the corrections to echo soundings are described in detail in Section B. Processing and Quality Control of the project DAPR. Survey H12907 did not deviate from the methods documented in the DAPR.

The Total Vertical Uncertainty Quality Check (TVU QC) "Ratio Method" was used to evaluate IHO uncertainty for all finalized surfaces. The TVU QC "Ratio Method" is described in the Chapter 4 Appendices of the NOAA OCS Field Procedures Manual (FPM) dated April 2014. Per the FPM TVU QC section, "The hydrographer should use the finalized surface because this surface will identify areas where either the uncertainty or the standard deviation exceeded the maximum allowable error and the greater of these two values is used in addition to having the uncertainty scaled to a 95% CI, whereas unfinalized surface uncertainties are reported at the 68% CI." The FPM TVU QC section also states that, "[ratio] values which do not require further examination are from -1 to 0 and the values which do require further examination are from -100 to -1." Finalized surfaces were used in this analysis. Surfaces were finalized using the “greater of the two” option as the basis for calculating “Final Uncertainty” in the CARIS “Finalize Base Surface” utility.

Five (5) MBES CUBE (Combined Uncertainty and Bathymetric Estimator) surfaces were delivered along with Survey H12907 including "H12907_MB_1m_MLLW_Final" and four (4) 50-centimeter item investigation surfaces. The 1-meter surface is intended to satisfy coverage and sounding density requirements for Complete Coverage, Option B: 100% side scan sonar coverage with concurrent multibeam. The remaining 0.5-meter surfaces are intended to satisfy Object Detection Coverage and sounding density requirements over significant features.

Results from the TVU QC indicate that 99.9997% of the nodes from all submitted surfaces meet IHO Order 1 uncertainty specifications, i.e. the ratio values of nearly all the nodes are less than -1. Of the 40,794,968 nodes considered, 105 had a ratio value below -1. Upon examination it was found that the nodes with ratio values below -1 were located over the various features covered by the investigation surfaces resulting in higher standard deviation values and finalized uncertainty values, which is to be expected over discrete features.

B.2.3 Junctions

Two (2) prior surveys and three (3) contemporary surveys junction with Survey H12907. Figure 4 displays the location of the prior and contemporary junction surveys for Project OPR-K354-KR-16.

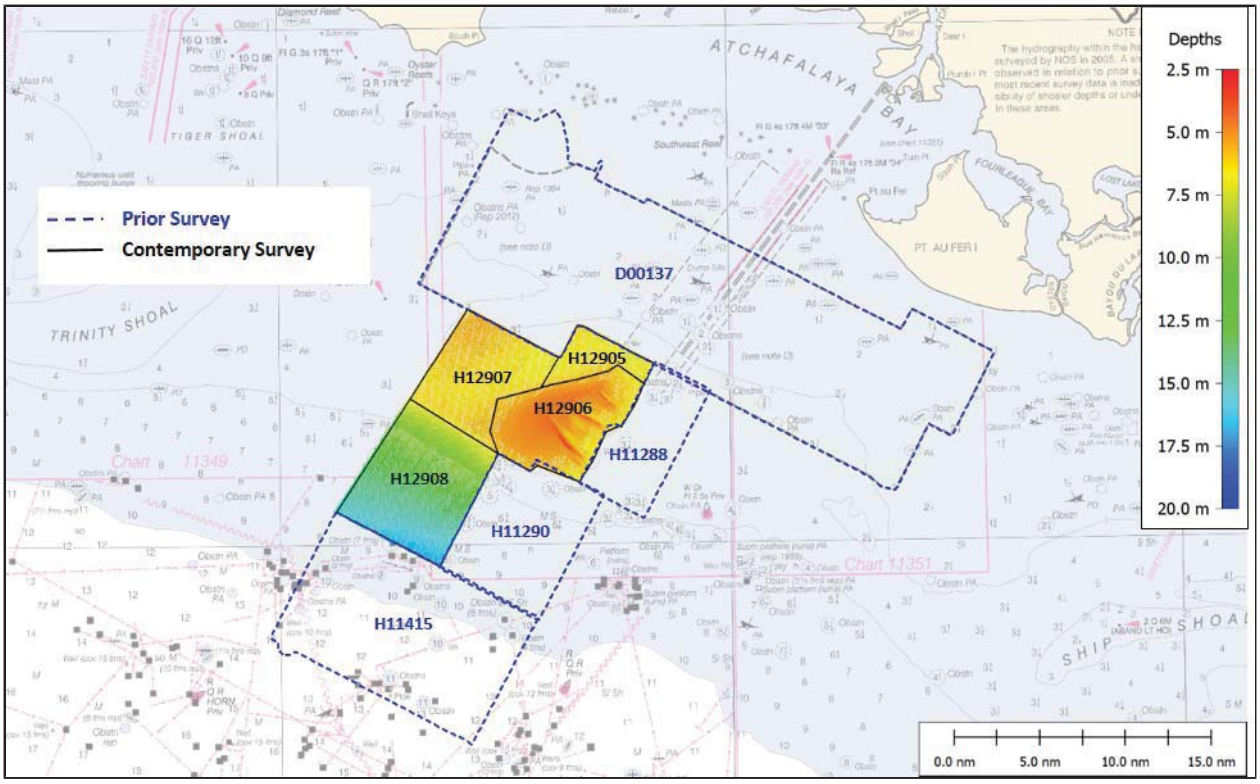


Figure 4: Survey junctions for Project OPR-K354-KR-16. RNC 11340 is displayed in the background.

Registry Number	Scale	Year	Field Unit	Relative Location
D00137	1:40000	2005	NOAA Time Charter	N
H11290	1:20000	2005	NOAA Time Charter	SE
H12905	1:40000	2016	Ocean Surveys, Inc.	NE
H12906	1:40000	2016	Ocean Surveys, Inc.	E
H12908	1:40000	2016	Ocean Surveys, Inc.	S

Table 8: Junctioning Surveys

D00137

The NOAA Time Charter's Survey D00137, a reconnaissance survey conducted in 2005, overlapped the northern border of H12907. Given that both Survey H12907 and Survey D00137 were acquired to meet Set Line Spacing with the MBES systems, the junction area between the two surveys was sparse. Depth data for Survey D00137 were downloaded from the National Geophysical Data Center (NGDC) website (http://www.ngdc.noaa.gov) in the form of a 5-meter resolution Bathymetric Attributed Grid (BAG), "D00137_5m_MLLW_1of1".

To conduct the junction comparison a 5-meter CUBE surface was generated from the entire MBES data set for Survey H12907, "H12907_MB_5m_MLLW". In CARIS HIPS, depths from the "D00137_5m_MLLW_1of1" BAG were subtracted from the depths in the "H12907_MB_5m_MLLW" CUBE surface using the CARIS HIPS Difference Surface function. A histogram of the differences is shown in Figure 5. Depths from the H12907 survey show reasonable agreement with depths from the D00137 survey. Depth discrepancies equaled 37 centimeters or less with a mean difference of 19 centimeters.

On average, Survey D00137 depths were shallower than H12907 depths. The largest discrepancy grouping between H12907 and D00137 survey depths (37 centimeters) and another discrepancy grouping of around 34 centimeters, occurred on only two of the seven instances where there was overlapping data. The reason for the relatively small bias is not clear. One possible reason for the bias is tide. The Descriptive Report for Survey D00137 is not available on the NGDC website. However, assuming that Survey D00137 was conducted around the same time as the other assigned junction surveys (H11288, H11290, H11415) it is noted that these surveys used a different tide source than the contemporary survey. The assigned junction surveys used either the Eugene Island, LA (876-4311) tide gauge or a gauge located in Galveston, TX (877-1510).

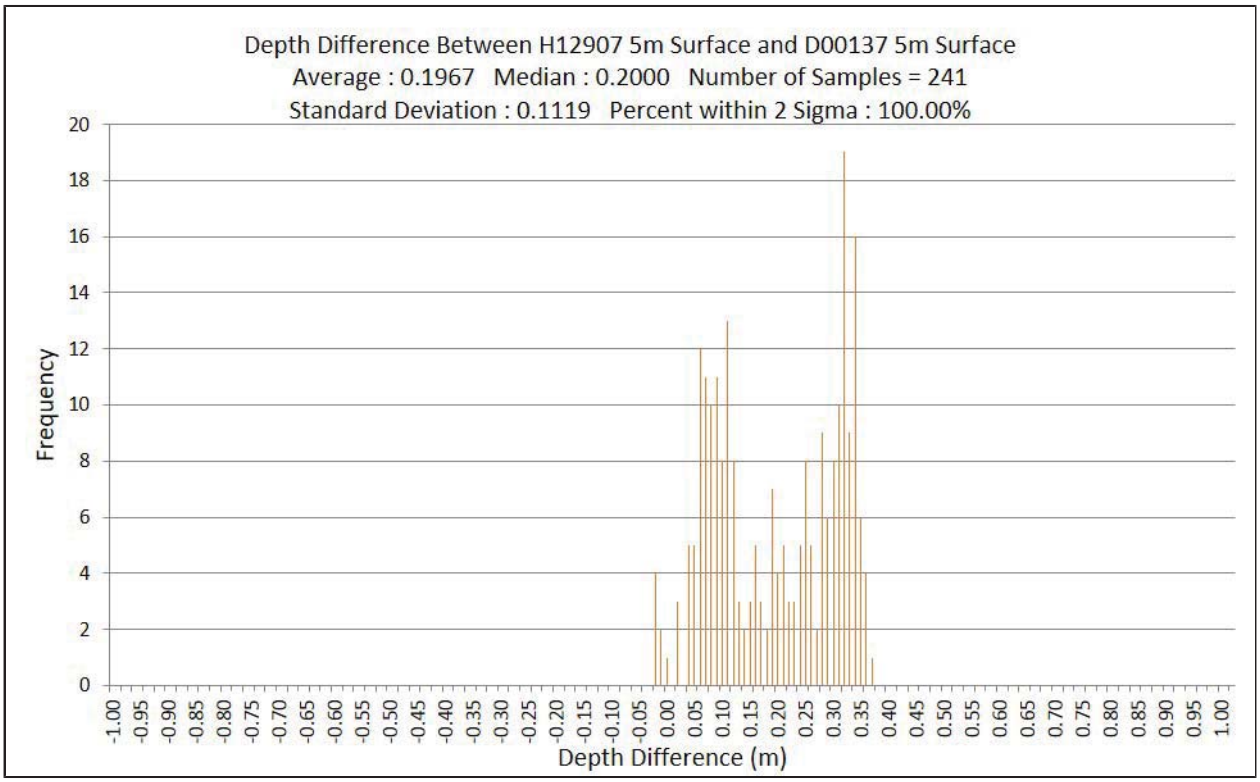


Figure 5: *Surface-to-surface difference histogram comparing Survey H12907 to D00137.*

H11290

NOAA Time Charter's Survey H11290, a hydrographic survey conducted in 2005, overlapped the far southeastern corner of H12907. Depth data for Survey H11290 were downloaded from the NGDC website in the form of a 1-meter resolution BAG, "H11290_1m_MLLW_2 of 4." Both MBES surfaces were acquired for 100 or 200% SSS coverage with Set Line Spacing; therefore, the horizontal overlap between the two surveys was sparse with an approximate overlap of 250 meters found in the small wedge shaped southeastern extent of Survey H12907.

To conduct the junction comparison a 1-meter CUBE surface was generated from the MBES data set for Survey H12907, "H12907_MB_1m_MLLW." In CARIS HIPS, depths from the "H11290_1m_MLLW_2of4" BAG were subtracted from the depths in the "H12907_MB_1m_MLLW" CUBE surface using the CARIS HIPS Difference Surface function. A histogram of the differences is shown in Figure 6. Depths from the H12907 survey were deeper than depths from the H11290 survey, with a maximum depth discrepancy of 78 centimeters and an average difference of 54 centimeters.

The mean and maximum vertical offset is relatively large. The reason for this bias could include the different tide sources employed in reducing the comparative datasets (see discussion for Junction D00137 above). Another potential cause of the discrepancy is depth changes due to sediment transport that occurred between survey times of acquisition. For example, in Survey H12906 (immediately east of Survey H12907) large bedforms (assumed to be mobile) are apparent. The bedforms are suggestive that this region could be prone to

depth changes due to sediment transport. Furthermore, it is noted that Survey H11290 was completed on July 31, 2005. Less than a month later Hurricane Katrina made landfall in south Louisiana. Given the relatively shallow water depths in this area it is possible that this massive storm and subsequent storm events could be responsible for some depth change between surveys.

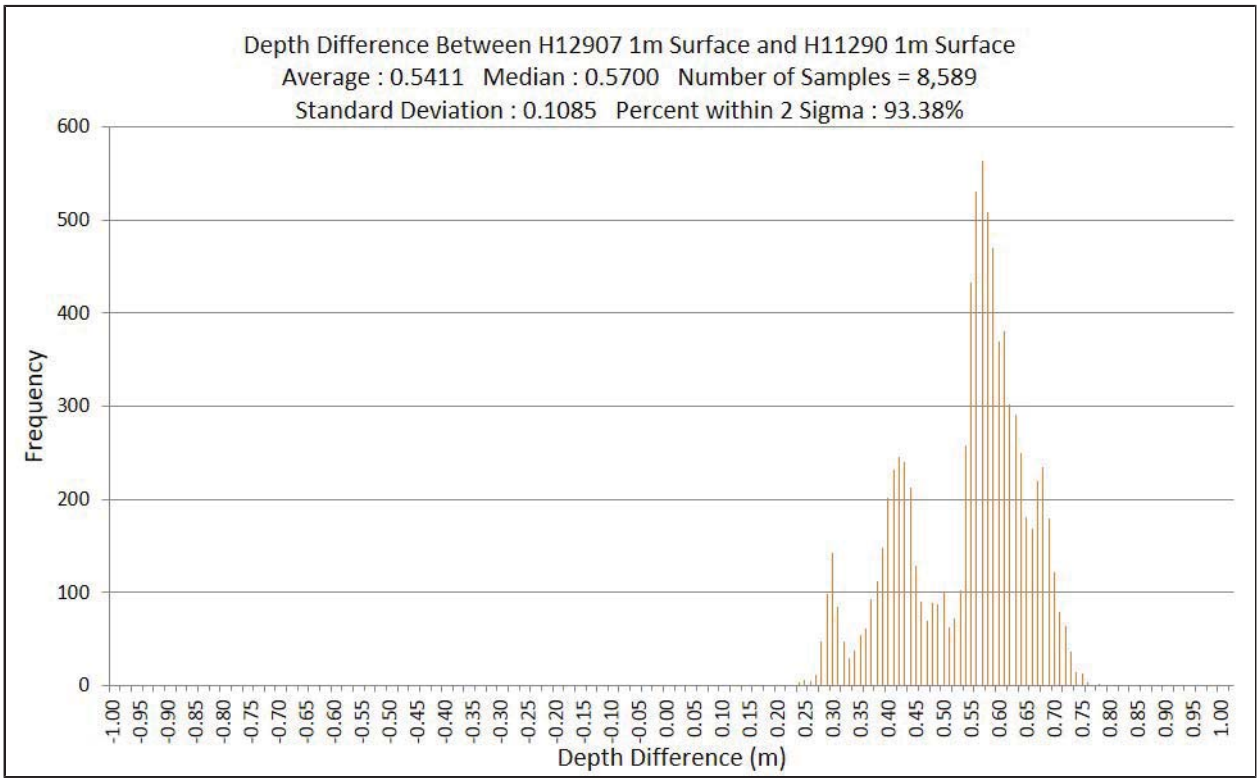


Figure 6: *Surface-to-surface difference histogram comparing Survey H12907to H11290.*

H12905

The approximate overlap between the bathymetric data from contemporary Surveys H12905 and H12907 was approximately 200 meters. Given that both surveys were acquired to meet 100% SSS Coverage, not complete MBES coverage, the junction area between the two surveys consists largely of the ends of three semi-coincidental, parallel track lines.

Depths from 1-meter BASE surfaces compiled from the MBES data from each survey, "H12907_MB_1m_MLLW" and "H12905_MB_1m_MLLW," were compared using the CARIS HIPS Difference Surface function. A histogram of the differences is shown in Figure 7. Depths from the H12907 survey show good agreement with the depths from the H12905 survey. Depth discrepancies generally equaled 20 centimeters or less with a mean difference of 14 centimeters.

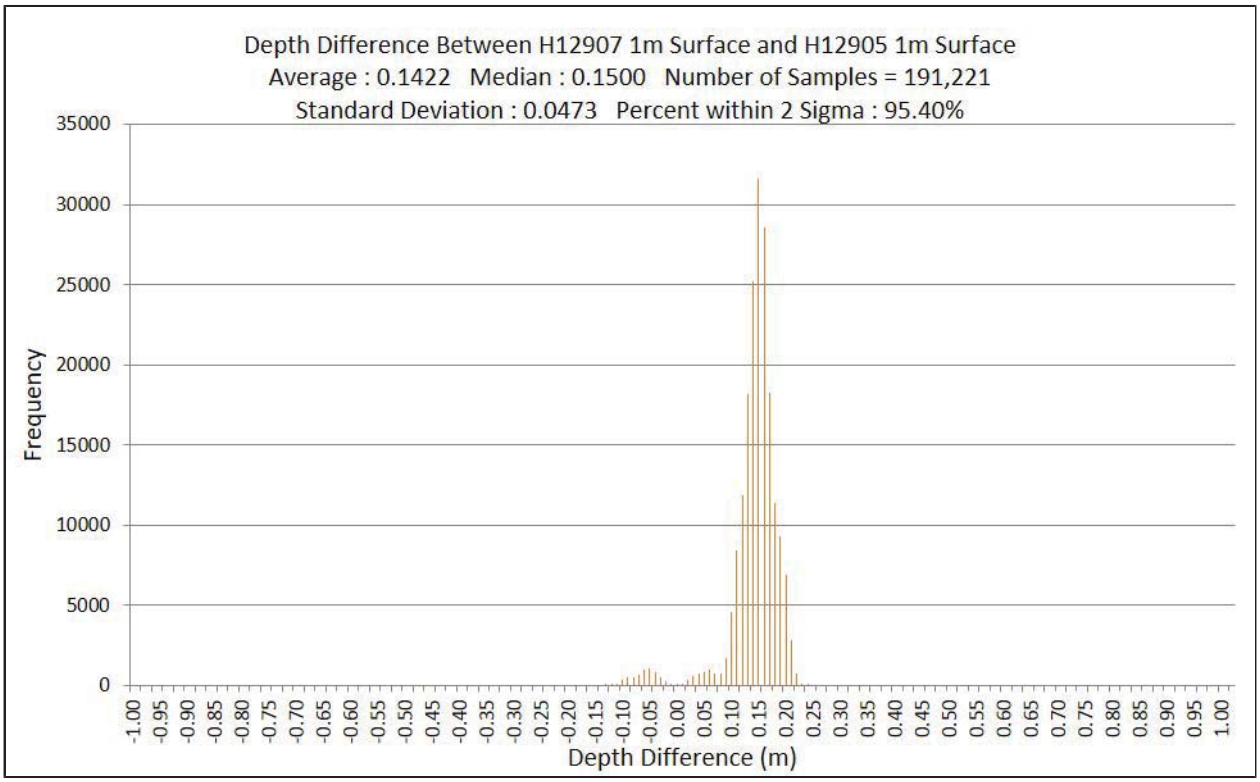


Figure 7: Surface-to-surface difference histogram comparing Survey H12907 to Survey H12905.

H12906

The overlap between the bathymetric data from contemporary Surveys H12907 and H12906 is approximately 400 meters. Given that both surveys were acquired to meet 100% SSS Coverage, not complete MBES coverage, the junction area between the two surveys occurs at trackline ends that are generally overlapping.

Depths from 1-meter BASE surfaces compiled from the MBES data from each survey, "H12907_MB_1m_MLLW" and "H12906_MB_1m_MLLW," were compared using the CARIS HIPS Difference Surface function. A histogram of the differences is shown in Figure 8. Depths from the H12907 survey show good agreement with the depths from the H12906 survey. Depth discrepancies generally equaled 25 centimeters or less with a mean difference of 10 centimeters. The minor biases between surveyed depths appear to be tide related, as the agreement between survey depths from H12907 and H12906 vary with survey day. Where a difference between Survey depths is present, the offset is noted across the full swath of coincident lines from the same survey day, without any modification to system configuration, which is indicative of a tidal offset.

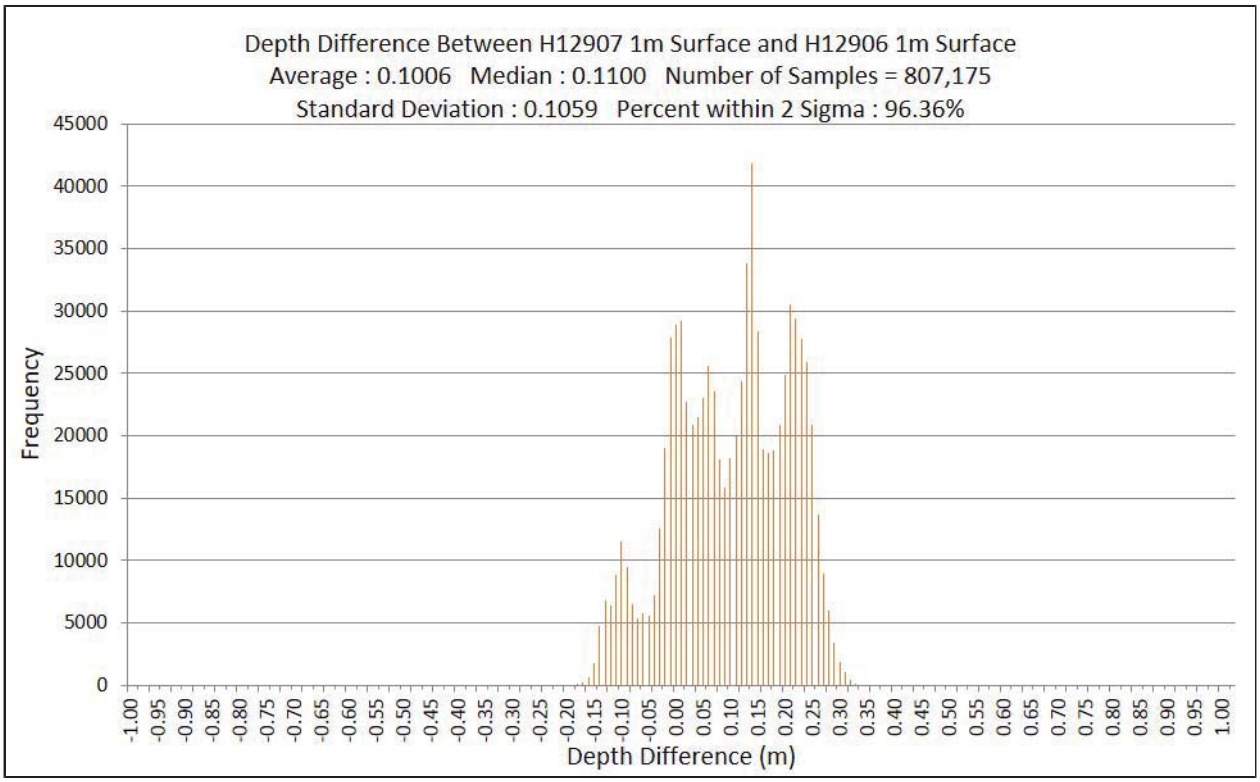


Figure 8: *Surface-to-surface difference histogram comparing Survey H12907 to H12906.*

H12908

The overlap between the bathymetric data from contemporary Surveys H12907 and H12908 is approximately 270 meters. Both surveys were acquired to meet 100% SSS Coverage, not complete MBES coverage. The mainscheme line plans for H12907 and H12908 were oriented perpendicular to one another, a layout based on the charted depths and contours for the survey area indicating a very flat gradient in H12907 and a gradual deepening in H12908, with H12908 lines oriented parallel to the charted contour. The result generally is that the four northernmost NW-SE lines from Survey H12908 overlap the southern ends of the lines from Survey H12907.

Depths from 1-meter BASE surfaces compiled from the MBES data from each survey, "H12907_MB_1m_MLLW" and "H12908_MB_1m_MLLW," were compared using the CARIS HIPS Difference Surface function. A histogram of the differences is shown in Figure 9. Depths from the H12907 survey show good agreement with the depths from the H12908 survey. Depth discrepancies generally equaled 20 centimeters or less with a mean difference of 3 centimeters. The minor biases between surveyed depths appear to be tide related, as the agreement between survey depths from H12907 and H12908 vary with survey day. Where a difference between Survey depths is present, the offset is noted across the full swath of coincident lines from the same survey day, without any modification to system configuration, which is indicative of a tidal offset.

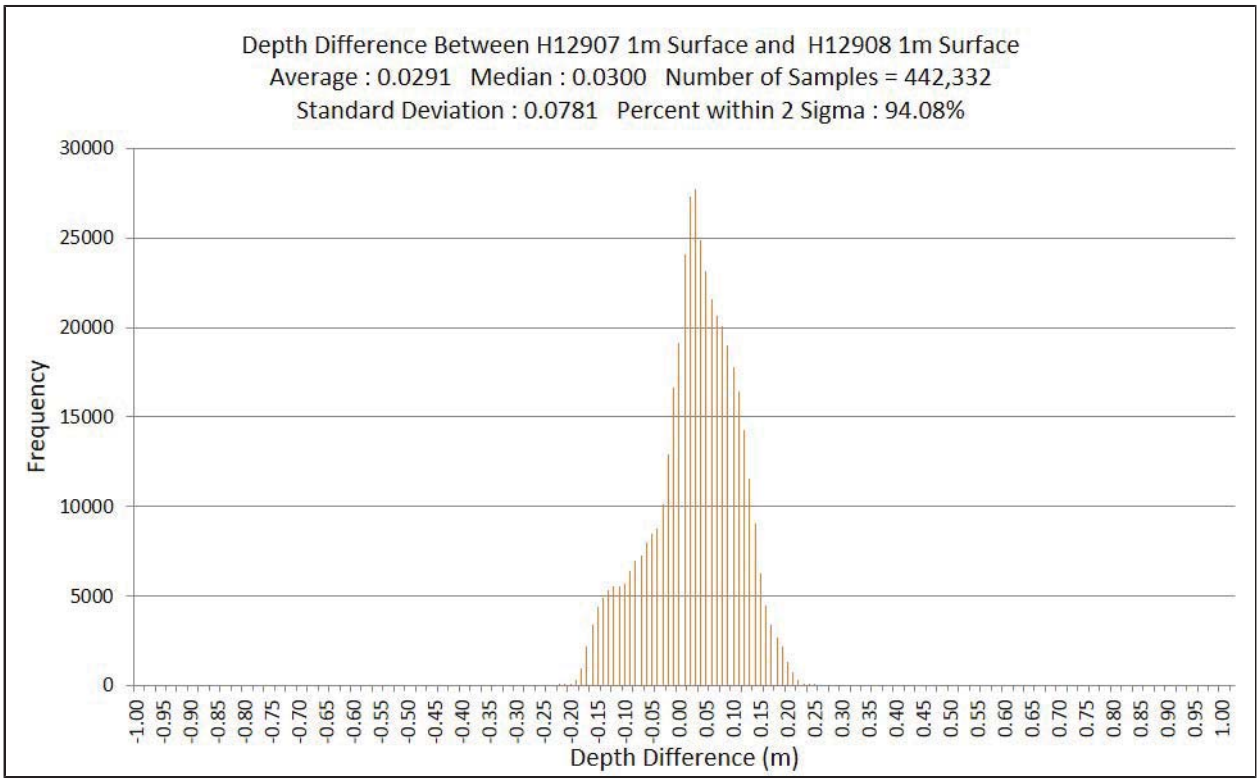


Figure 9: *Surface-to-surface difference histogram comparing Survey H12907 to H12908.*

B.2.4 Sonar QC Checks

Sonar system quality control checks were conducted as detailed in the Quality Control section of the DAPR. Results from the weekly MBES bar checks are included in Appendix II of the DAPR.

B.2.5 Equipment Effectiveness

MBES Time Sync Errors and Gaps

Occasional time sync alarms were observed during acquisition on the Reson 7125 Seabat display. The field personnel noted that along with the time sync alarm a brief gap may be observed in the real time display of the Seabat waterfall window. A few small along track data gaps associated with the Reson time sync error were noted in CARIS HIPS Subset Editor during processing of the MBES data wherein there is a short break in recorded profiles (Figure 10). Larger gaps were "filled" with additional MBES coverage. Remaining gaps do not exceed 3x3 nodes in the 1-meter Complete Coverage surface.

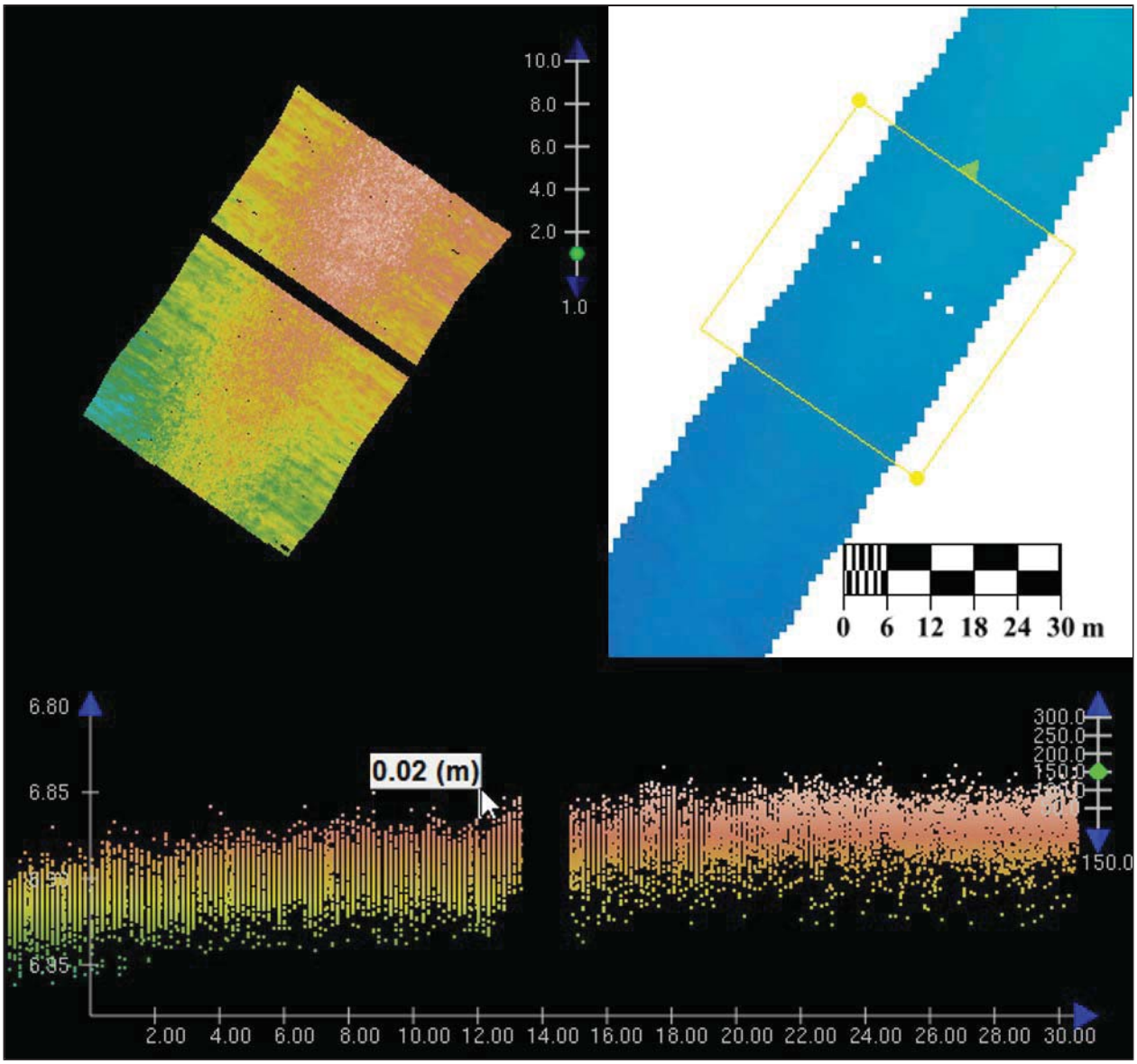


Figure 10: *Example of a small gap in MBES data associated with the Reson time sync error as it appears in CARIS Subset Editor (top left and bottom) and the same gap as it appears in a 1-meter CUBE surface (top right).*

B.2.6 Factors Affecting Soundings

Tide Offset

Review of surface data indicates that there were a number of minor tide-related offsets between MBES data collected on different days scattered throughout Survey H12907. There were no noteworthy tide events that affected this survey. However, for the period of the survey, a nearly consistent offset with a magnitude averaging about 17 centimeters was apparent between the predicted and verified tides at the LAWMA, Amerada Pass

LA tide station. Overall, the tide correctors were modeled well for Survey H12907, showing good agreement between survey days. Tide offsets generally equaled 20 cm or less and are likely associated with local environmental effects, i.e. wind setup.

Figure 11 highlights a portion of the survey area where the tidal offset varied with survey day. In Figure 11 a standard deviation surface depicts cross lines (oriented NW-SE) along with a number of mainscheme lines and tightly spaced investigation lines. The standard deviation surface and the subset cross section show a minor tide offset (< 0.2 m) which was prevalent between the cross line and the mainscheme/investigation lines. In two cases where investigation lines overlapped coincidental mainscheme lines the standard deviation surface appears bright green due to the opposing tide offset in the various lines contributing to the stacked coverage (blue over yellow over purple in the cross section display). Investigation lines run on DN 254 (purple) coincided with mainscheme lines run early on day DN 255 (blue) soon after passage of a squall. It is surmised that the squall, having a different wind direction and magnitude than before/after squall weather pattern, contributed to the tide offset highlighted in Figure 11.

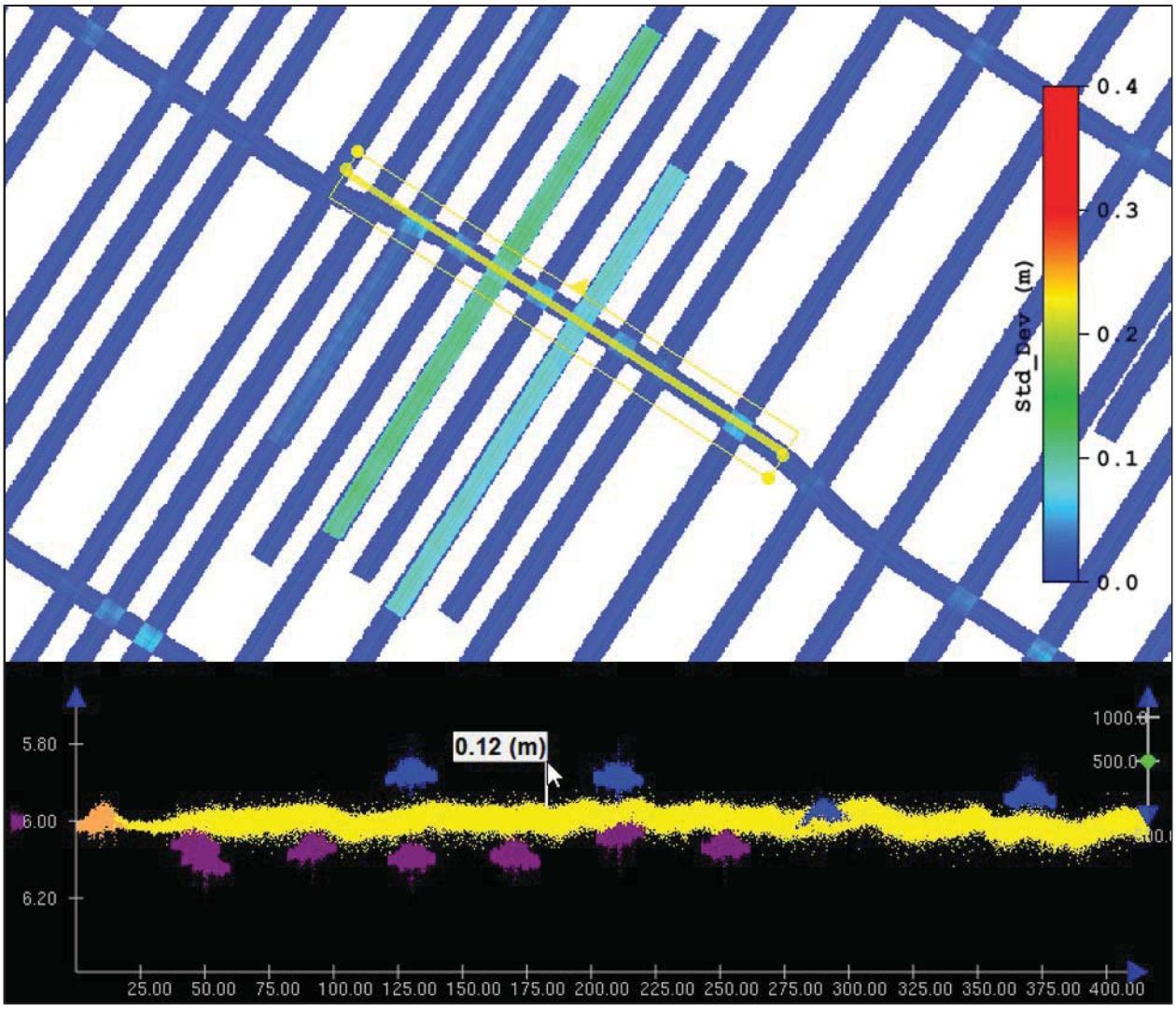


Figure 11: *The top image shows a portion of the Standard Deviation layer from the H12907 1-meter CUBE surface. In the Standard Deviation layer the cyan and green colors indicate areas of higher standard deviation in the surface due to minor tide offsets. The bottom image displays MBES data loaded into CARIS Subset Editor with a tide-related vertical offset noted between investigation soundings collected on DN 254 (purple), a cross line collected on DN 231 (yellow), and mainscheme soundings collected on DN 255 (blue) and DN 267 (orange). Depths and distances are in meters.*

SSS Refraction

Dynamic sound speed changes affected the SSS imagery at times, causing refraction in the outer ranges of the SSS swath (Figure 12). To ensure that 100% coverage of high quality SSS data was acquired, SSS lines with excessive refraction were rejected or the portion of the line with severe refraction was re-run.

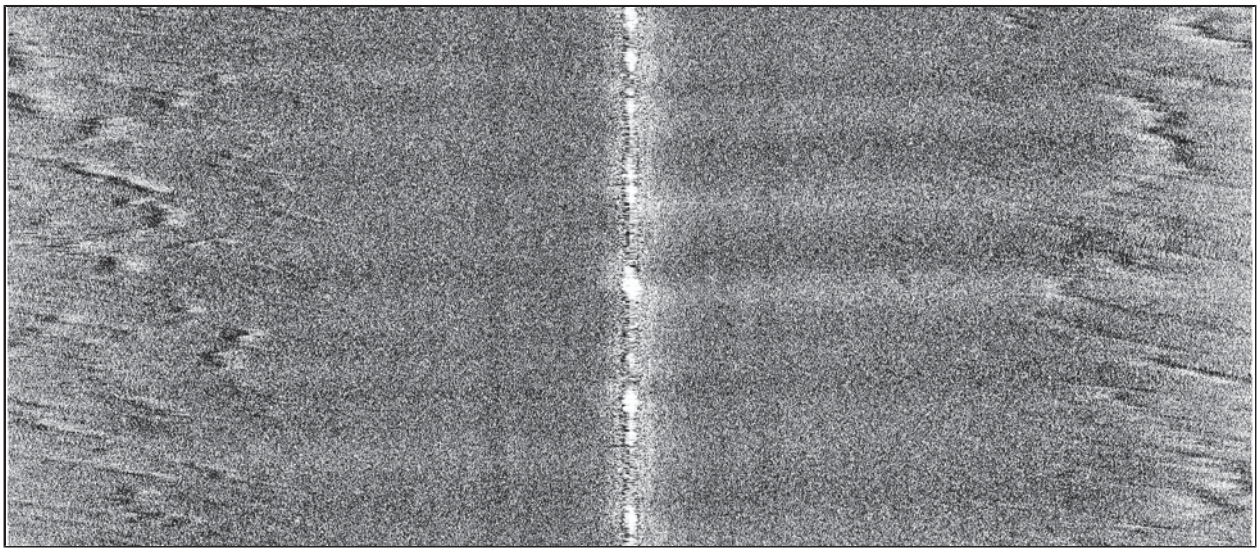


Figure 12: *Refraction in the SSS imagery is visible in the outer range of both channels of a survey line acquired with the fixed-mount 4125 SSS.*

Sea State Induced White Streaks in SSS Imagery and MBES "Blowouts"

The Reson 7125 system experienced periodic bursts of motion-induced noise or “blowouts,” typically affecting between 1 and 4 sequential profiles. Efforts were made to reduce this noise during acquisition, including adjustments to system gain and power, in addition to the multibeam pole fairing that was installed to reduce cavitation effects. The noise bursts were infrequent and were encountered when sea state worsened. Accepted data effected by blowouts did not show any coverage gaps in excess of 3 x 3 nodes in the 1-meter MBES coverage surface.

The fixed mount SSS data were also impacted by sea state conditions, such that when the wave frequency and height increased more cavitation effects were observed near the transducer head with a dark return noted at the top of the water column in the raw SSS record. The cavitation noise at the transducer head resulted in intermittent "white streaks" across the SSS record, which occasionally coincided with blowouts in the MBES data (Figure 13). To ensure that 100% coverage was attained where the white streaks occurred, holiday fill-in lines were acquired over the location of the streaks with either MBES or SSS coverage.

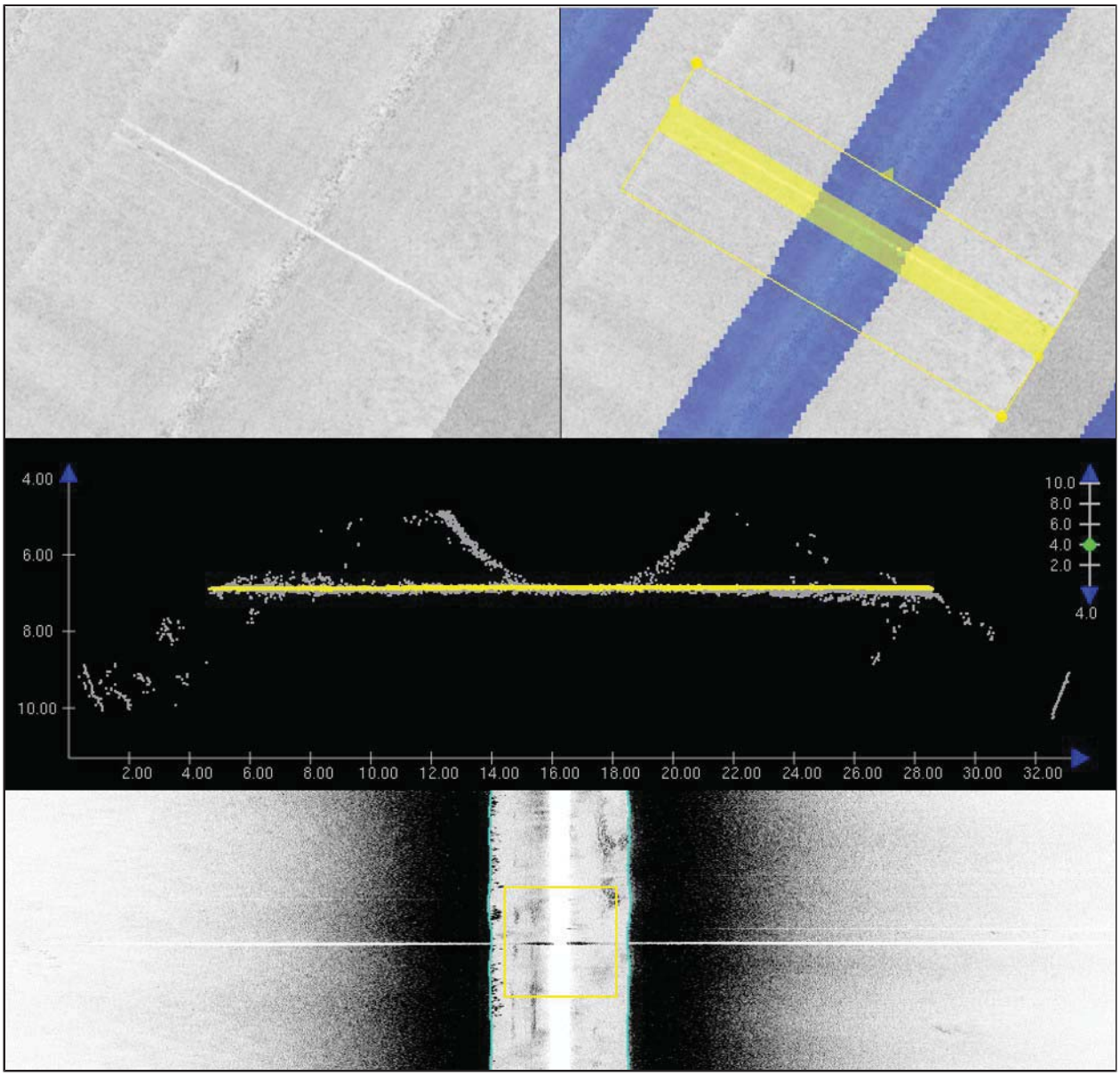


Figure 13: *This figure shows how cavitation noise at the SSS and MBES transducer heads presented in the converted data. Noise at the 4125 TX head is visible as a dark return at the top of the water column in the raw SSS imagery (bottom), which presented as white streaks across the processed SSS record (top left). In this instance, the SSS white streak coincided with an MBES blowout (top right and middle image).*

Fish in SSS Imagery and MBES data

Occasional fish and marine sea life were seen in the SSS and MBES data, either as lone swimmers or in schools (Figures 14 - 15). Fish and dolphins were noted in the acquisition log by the field team, and these areas were carefully reviewed during data processing. Shadows in the SSS, usually detached from a dark return, were typically associated with fish either in the water column or at a position closer to nadir. In the cases where a

visible shadow was recorded in the SSS, the contact was designated as a fish, for two reasons: 1) the possibility that the assumed fish was actually a feature and 2) to assist processors in rejecting fish-related noise from the MBES data.

Dolphin pods were a presence within the survey area, as well as large schools of fish or shrimp, which at times created large shadows in the SSS imagery and gaps in the MBES data where acoustic returns on fish and dolphins were rejected from the data. To ensure that possible significant features were not located in the fish and dolphin shadows, fish/dolphin related coverage gaps were developed with 200% SSS coverage or object detection MBES coverage.

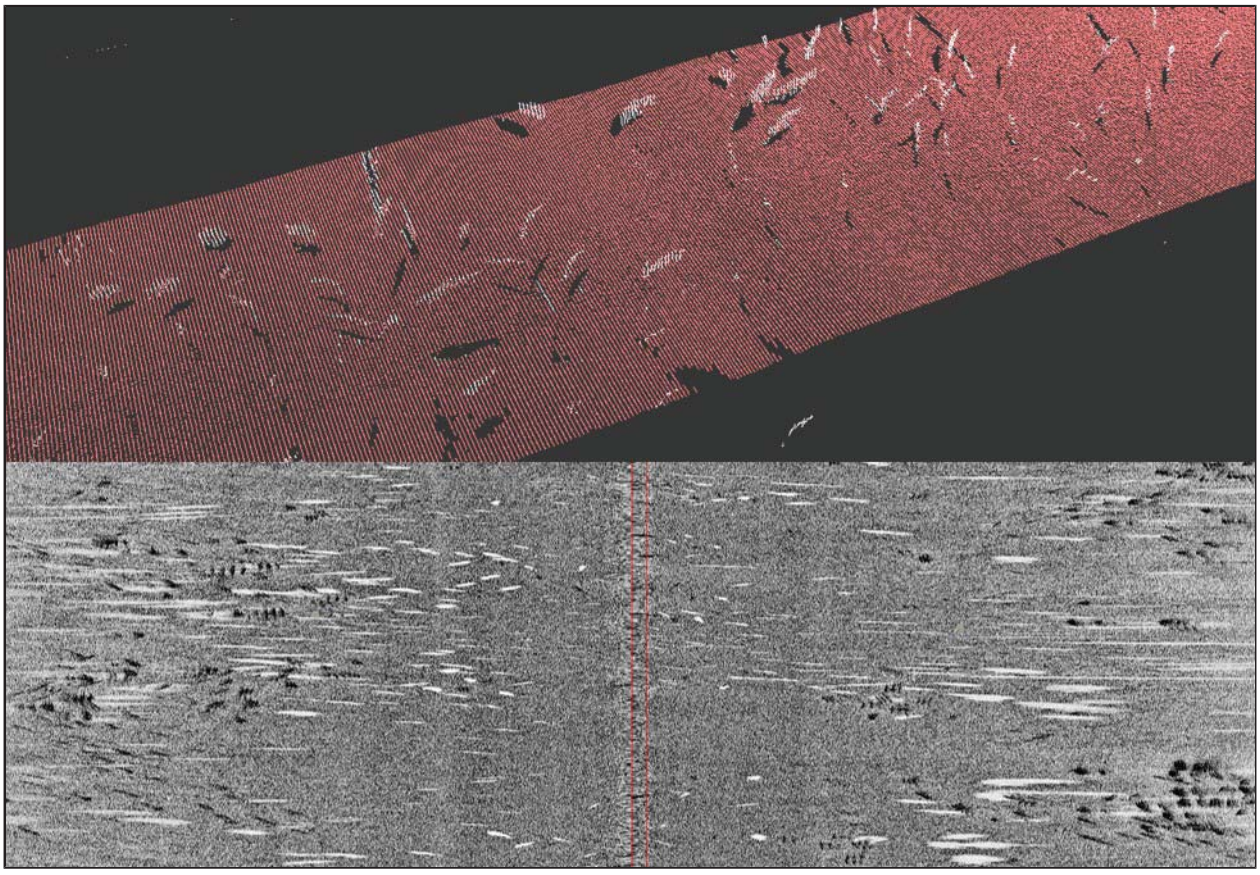


Figure 14: *A large school of fish as it appears in the MBES data and in the water column of the slant range corrected SSS imagery. The top image was taken in CARIS Subset Editor 3D with rejected soundings colored grey. The bottom image of the same fish school was taken in the CARIS SIPS waterfall display window.*

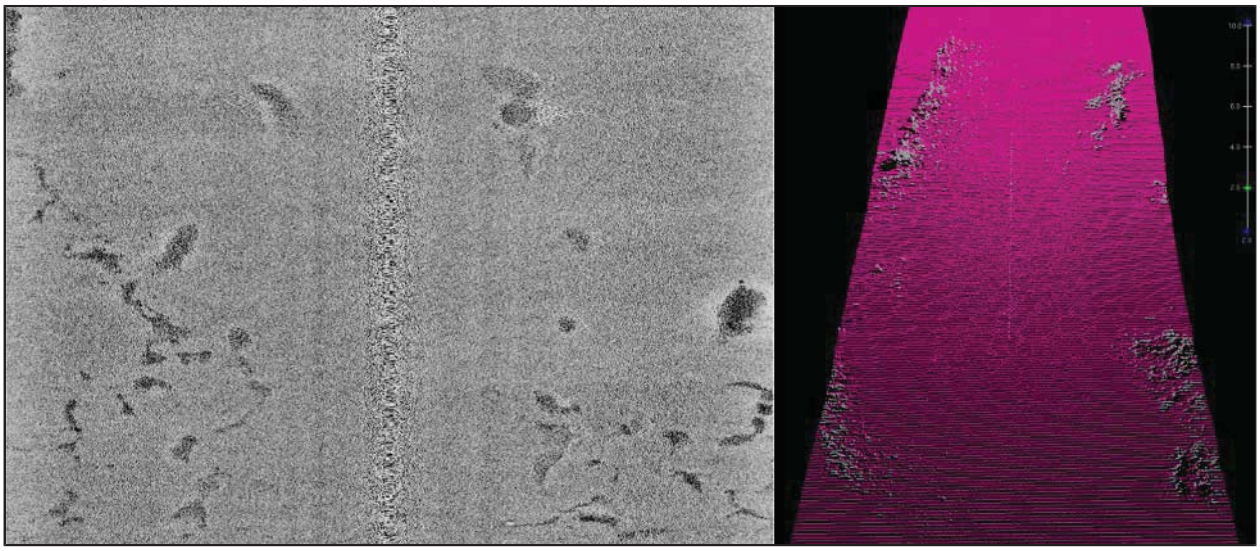


Figure 15: *Fish or shrimp "balls" as they appeared in the slant range corrected SSS imagery (left) and in the MBES data (right). The dense fish or shrimp balls had dark returns in the SSS record and were often clustered close to the seafloor as noted in the MBES data in CARIS HIPS Subset Editor 3D, with the rejected fish soundings colored grey.*

B.2.7 Sound Speed Methods

Sound speed profile data were acquired with the ODIM MVP30 approximately every 15 minutes as documented in the DAPR.

All MBES lines were sound speed corrected using CARIS HIPS' "Nearest in Distance Within Time" method with the time set to two (2) hours. Based on prior survey experience in the northern Gulf of Mexico, OSI expected to encounter high variability in the speed of sound with abrupt gradient changes linked to dynamic salinity and temperature conditions. Fortunately, with the exception of the last day of survey for Project OPR-K354-KR-16, the water column was relatively well-mixed, which reduced the incidence of refraction in the SSS and MBES data sets as compared to OSI's recent Gulf of Mexico experience.

OSI submitted H12907 sound speed data in NetCDF format to the National Centers for Environmental Information (NCEI) on December 14, 2016 (DN 349) via the S2N tool. NCEI assigned the sound speed submission Accession Number 0157605. Correspondence regarding the NCEI data submission is included in Appendix II.

B.2.8 Coverage Equipment and Methods

This survey was conducted to develop 100% SSS coverage along with concurrent MBES with backscatter to a depth of 20 meters, i.e. Complete Coverage, Option B as defined in Section 5.2.2.3 of the HSSD 2016. All depths within Survey H12907 were shallower than 20 meters. Per the HSSD which states "Gaps in SSS coverage should be treated as gaps in MBES coverage and addressed accordingly," gaps in SSS coverage and

holidays caused by fish, dolphins, or white line noise were developed with Complete Multibeam or a second SSS coverage. All potentially significant features located with mainscheme SSS or MBES were developed with high density multibeam sonar data to meet the HSSD requirement of Object Detection coverage.

The survey methods used to meet coverage requirements did not deviate from those described in the DAPR.

B.2.9 Density

To confirm the HSSD Density coverage requirements, the Compute Statistics tool was utilized within CARIS HIPS and SIPS to generate statistics for the Density layer for each finalized BASE surface. The HSSD states that at least 80% of the surface nodes shall be populated with at least 5 soundings for the Complete Coverage (Option B) 1-meter surface, and that at least 95% of the nodes shall be populated with at least 5 soundings for the 50 cm Object Detection surfaces. For the purpose of obtaining the most accurate surface density statistics, the unfinalized surfaces were used for the Density QC check as it was discovered that during surface finalization a density value of one (1) was assigned to all nodes containing a designated sounding, regardless of the node's sounding density value pre-finalization.

The Compute Statistics tool generates an ASCII export containing two columns: 1) sounding density value and 2) the number of nodes that returned that value. This export was used to determine the percentage of nodes with a sounding density ≥ 5 for every submitted CUBE surface.

The percentage of nodes with density greater than or equal to 5 soundings for the 1-meter Complete Coverage surface was as follows: H12907_MB_1m_MLLW = 99.44%.

All four (4) of the Object Detection surfaces had 100% of the nodes populated with a density far in excess of 5 soundings.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

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

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

Backscatter data were acquired concurrent with bathymetry data for Survey H12907. Backscatter data were recorded with HYSWEEP SURVEY in .7K format. These data were periodically reviewed to ensure function of the backscatter acquisition process. No specific instructions were made in the Project Instructions regarding

coverage, ground truthing or processing for the Backscatter data, as such, these data are delivered in raw format in the “Backscatter” directory per the HSSD, Section 8.3.4 Backscatter Deliverables.

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following software program was the primary program used for bathymetric data processing:

Manufacturer	Name	Version
CARIS	HIPS/SIPS	7.1.2

Table 9: Primary bathymetric data processing software

The following software program was the primary program used for imagery data processing:

Manufacturer	Name	Version
CARIS	HIPS/SIPS	7.1.2

Table 10: Primary imagery data processing software

The following Feature Object Catalog was used: NOAA Profile V_5_4.

Software versions described in Section A of the DAPR were used throughout acquisition and processing of data for Project OPR-K354-KR-16.

B.5.2 Surfaces

The following CUBE surfaces and mosaics were submitted to the Processing Branch:

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H12907_MB_1m_MLLW_Final	CUBE	1 meters	4.06 meters - 8 meters	NOAA_1m	Complete Coverage (Option B)
H12907_MB_50cm_MLLW_7-082_Final	CUBE	0.5 meters	5.95 meters - 7.26 meters	NOAA_0.5m	Object Detection

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H12907_MB_50cm_MLLW_7-083_Final	CUBE	0.5 meters	4.06 meters - 6.58 meters	NOAA_0.5m	Object Detection
H12907_MB_50cm_MLLW_7-093_Final	CUBE	0.5 meters	6.36 meters - 7.99 meters	NOAA_0.5m	Object Detection
H12907_MB_50cm_MLLW_7-097_Final	CUBE	0.5 meters	5.71 meters - 7.55 meters	NOAA_0.5m	Object Detection
H12907_SSS_1m_100	SSS Mosaic GeoTiff	1 meters	-	N/A	100% SSS
H12907_SSS_1m_200	SSS Mosaic GeoTiff	1 meters	-	N/A	200% SSS

Table 11: Submitted MBES and SSS Coverage Surfaces

Five (5) MBES CUBE surfaces and two (2) SSS mosaics comprise the total surfaces delivered with Survey H12907. To demonstrate MBES coverage requirements were met for Complete Coverage (Option B), a 1-meter CUBE surface was generated for the entire survey area. Four (4) small field sheets were generated over significant features and populated with 50-centimeter CUBE surfaces to demonstrate Object Detection coverage.

Two 1-meter SSS mosaics were submitted as GeoTIFFs to satisfy the SSS coverage requirements of 100% coverage and 200% coverage over charted feature disprovals and SSS fill-ins. In addition, a higher resolution, 25-centimeter SSS mosaic image composed of all SSS lines was submitted in the ECW (Enhanced Compressed Wavelet) format to assist with the survey review.

C. Vertical and Horizontal Control

Additional information regarding the vertical or horizontal control for this survey can be found in the accompanying Horizontal and Vertical Control Report (HVCR) for Project OPR-K354-KR-16.

C.1 Vertical Control

The vertical datum for this project is Mean Lower Low Water.

Traditional Methods Used: Discrete Zoning

The following National Water Level Observation Network (NWLON) stations served as datum control for this survey:

Station Name	Station ID
LAWMA, Amerada Pass, LA	876-4227
Eugene Island, LA	876-4314

*Table 12: NWLON Tide Station*s

The following subordinate water level station was established for this survey:

Station Name	Station ID
Offshore Bottom Mounted Pressure Gauge	N/A

Table 13: Subordinate Tide Station

A final verified tide file was created from verified water level data from the primary tide station LAWMA, Amerada Pass, LA (876-4227) obtained from the CO-OPS website upon completion of survey operations. The Eugene Island gauge data were used only for tide zone refinement analysis not for reducing soundings to MLLW. Discrete zoning methods were utilized to apply tide correctors in CARIS HIPS. The survey area is located within Zones WGM283, WGM282, and WGM281 as provided in the preliminary tidal zoning scheme included with the project SOW.

Pursuant to the "strong recommendation" in the Tides and Water Levels Statement of Work provided with the Project Instructions, two Bottom Mounted Pressure Gauges (BMPGs) were installed in the southwestern end of the project area in order to better understand the tidal propagation and zoning error for the discrete zones. The BMPG water level data were not used for tide correction of soundings; the gauges served as a "zoning station" acquiring data used to update the tidal range and phase correctors and to derive a tide zoning error estimate for the project area. Two BMPGs, one primary gauge and a back-up, were deployed for over 30 days from August 17 (DN 230) to September 24 (DN 268), logging data continuously for the entire deployment.

OSI's subcontractor, JOA Surveys, processed the downloaded pressure data to calculate water levels and to compute the tidal datum for the BMPG zoning station. Water levels from the BMPG station were used along with data from the LAWMA and Eugene Island NWLON stations to refine the phase and range correctors provided in CO-OPS preliminary zoning scheme. The final zoning scheme, K354KR2016 Revised Zoning 20161103.zdf, includes new time and range correctors for each preliminary zone, but the preliminary zone geometry was retained along with the CO-OPS provided names. Based on the results of cross line analysis, the time and range factors as provided in the final zoning scheme are adequate.

Please refer to JOA's OPR-K354-KR2016 Zoning Report.pdf included with the Tide deliverables. Tide station deliverables required in Section 4.7.5 of the HSSD were submitted to CO-OPS on November 9, 2016, as documented in an email included with Correspondence in Appendix II, OPR-K354-KR-16_BMPG_Transmittal.pdf. As of this time, OSI has not received and does not anticipate receiving a station name or ID number for the BMPG Gauges.

File Name	Status
8764227.tid	Verified Observed

Table 14: Water Level File (.tid)

File Name	Status
K354KR2016 Revised Zoning 20161103.zdf	Final

Table 15: Tide Corrector (.zdf or .tc)

C.2 Horizontal Control

The horizontal datum for this project is North American Datum of 1983 (NAD83).

The projection used for this project is UTM Zone 15 North.

All data products, except the S-57 Final Feature File (FFF) are referenced to Latitude/Longitude, UTM Zone 15 North. The S-57 Final Feature File, H12907.FFF.000, is referenced to the World Geodetic System Datum of 1984 (WGS 84) as specified in HTD 2016-03, which revised the HSSD 2016 Section 2.1 Horizontal Datum such that all positions will be referenced to NAD 83 and "the only exception for the NAD 83 datum requirement is that the S-57 feature file will be in the WGS 84 datum".

All MBES and SSS line and item investigation position data were acquired using an Applanix POS-MV operating in Differential GPS (DGPS) mode. The unit was configured to receive USCG Differential beacon correctors from the English Turn, LA station. A secondary GPS, used to facilitate real-time horizontal control confidence checks, was supplied with correctors from the Marinestar subscription service.

Prior to and during the course of the survey the accuracy of the primary positioning system was verified by means of a physical measurement to a horizontal control point established at the vessel's base of operation, a dock at the Port of Morgan City. Position confidence checks were accomplished, when possible, during fuel or weather stops. Refer to the DAPR and HVCR for additional details.

The following DGPS stations were used for horizontal control:

DGPS Stations
English Turn, LA, 293 kHz

Table 16: USCG DGPS Station used for Horizontal Control

C.3 Additional Horizontal or Vertical Control Issues

C.3.1 Horizontal Offset in DGPS Positioning

A horizontal offset of less than 1 meter was noted between the MBES survey lines collected over significant features developed to meet object detection coverage (Figure 16). The shift in horizontal position between lines can be attributed to the use of DGPS correctors for positioning with the survey area located over 150 kilometers from the English Turn station. The horizontal positional shift was well within the limits of horizontal accuracy as defined in Section 3.1.1 Horizontal Position Uncertainty of the HSSD 2016.

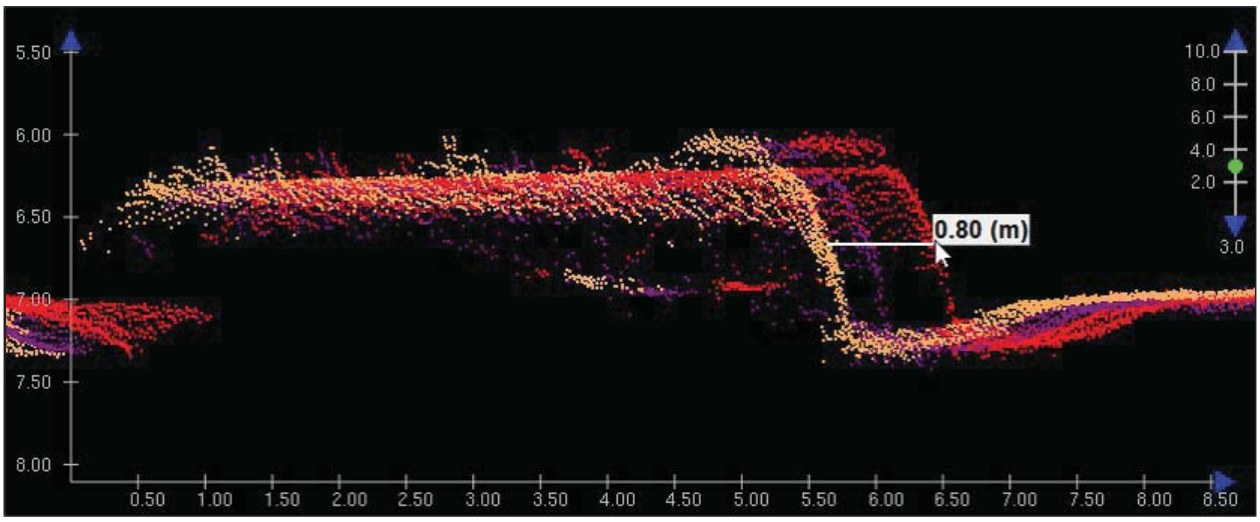


Figure 16: *Example of a feature developed with object detection MBES coverage that exhibited a horizontal positioning shift between survey lines. The image shows an unknown obstruction with soundings colored by line in CARIS Subset Editor 2D Window.*

D. Results and Recommendations

D.1 Chart Comparison

Chart comparisons were performed in CARIS HIPS/SIPS and Notebook using finalized BASE surfaces and contours and selected soundings. The latest editions of the NOAA NOS Raster Nautical Charts (RNC) and Electronic Nautical Charts (ENC) were downloaded from the NOAA Office of Coast Survey website http://www.nauticalcharts.noaa.gov/) regularly during survey operations, and after the survey was completed for final comparisons. The RNCs and ENCs used for final comparisons were downloaded on December 19, 2016 and are submitted with the survey deliverables.

Local Notice to Mariners (LNM) and Notice to Mariners (NM) spanning the period beginning at the date of issuance of the preliminary Hydrographic Project Instructions (June 28, 2016) and ending on December 14, 2016 were consulted in conjunction with the chart comparison.

The following sections adhere to the Descriptive Report sounding rounding system as described in Section 5.1.2 of the HSSD. Specifically, features described below having “precision” depths are presented along with the sounding's TPU. Depth and TPU are rounded to the nearest centimeter by standard arithmetic rounding ("round half up").

During the chart comparison it was found that the least depth soundings for charted regions were on obstruction features; however, the chart comparisons documented below will discuss general seafloor changes, shoaling and deepening trends. All new or charted features identified, updated or disproved within Survey H12907 were addressed and attributed in the S-57 Final Feature File. For more information on the methodology that was used to build the FFF see Section B.2.5 Feature Verification in the DAPR.

An overview of the areas of change between charted depths and H12907 surveyed soundings is shown in Figure 17. The figure displays a difference surface made by subtracting a 10-meter resolution depth surface generated from the H12907 MBES data from a 250-meter resolution depth surface interpolated from the charted ENC soundings within the project area. Regions of shoaling are represented by positive depth differences and regions of deepening are represented by negative depth differences. This analysis indicates a general deepening trend across the survey area (green/blue shading) with isolated regions having essentially no change (grey shading) . A detailed description of each chart comparison follows.

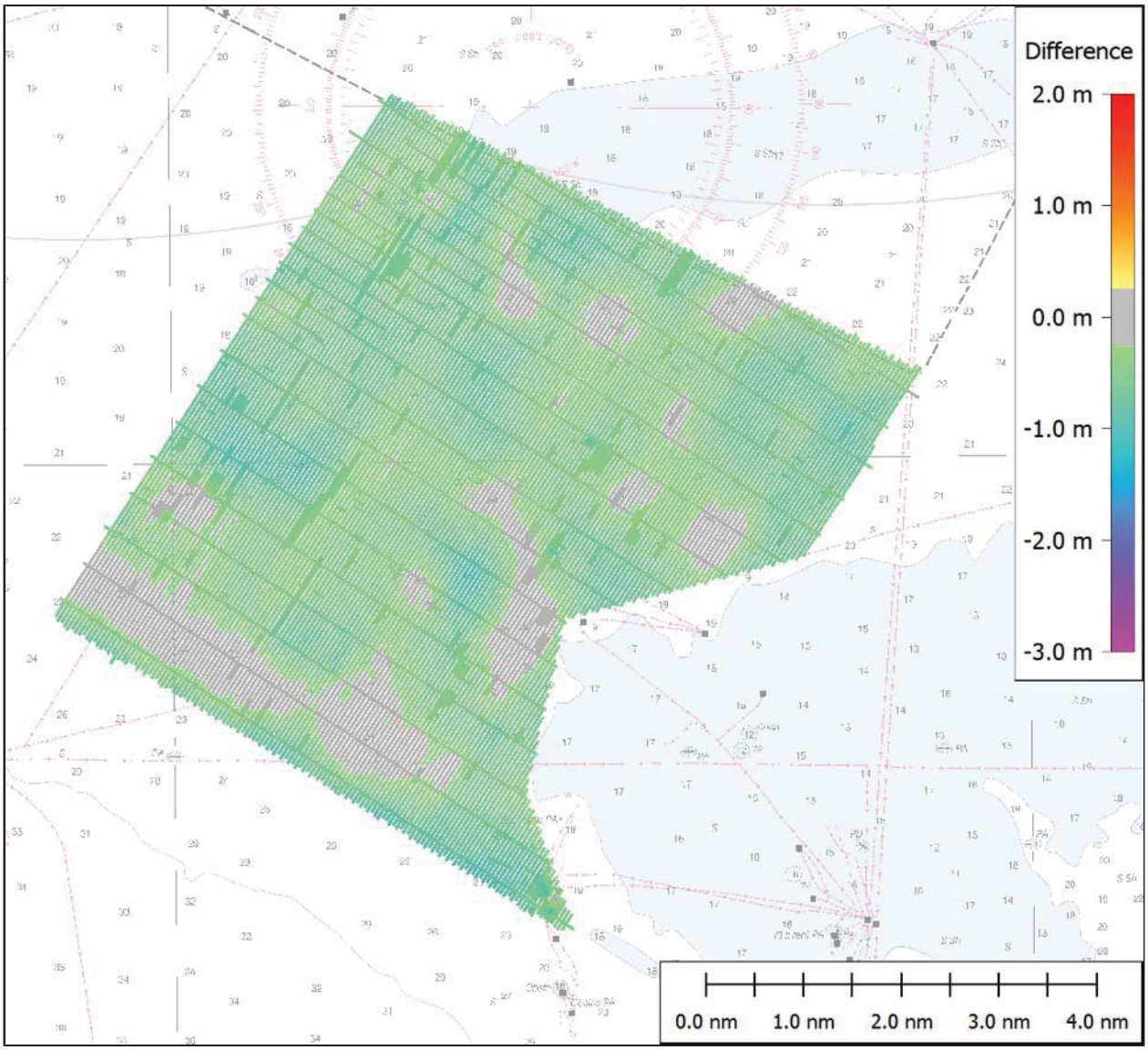


Figure 17: *A depth difference surface overlaid on RNCs 11351 and 11349 provides an overview of the areas of change between charted depths and H12907 surveyed soundings.*

D.1.1 Raster Charts

The following table summarizes pertinent epoch details about the largest scale RNCs assigned for the survey area.

Chart	Scale	Edition	Edition Date	LNM Date	NM Date
11349	1:80000	46	03/2014	11/15/2016	10/29/2016
11351	1:80000	43	03/2012	11/29/2016	10/29/2016
11340	1:458596	79	02/2016	11/29/2016	10/29/2016

*Table 17: Largest Scale Raster Chart*s

11349

The west side of Survey H12907 intersects with a small portion of RNC 11349. The soundings from survey H12907 agreed well with the charted depths, with soundings differing from charted depths by approximately 0 to 2 feet (0.6 meters). No charted contours coincide with the H12907 survey area.

11351

There is good agreement between the H12907 surveyed soundings and the RNC 11351 charted depths, with soundings differing from the charted depths by approximately 0 to 3 feet (0.9 meters). Surveyed depths overall were slightly deeper than charted depths with all charted 18-foot contours being disproved; the surveyed soundings over the charted 18-foot contours ranged between 19 to 21 feet. With the exception of a new obstruction having a least depth of 13 feet (4.06 m, +/- 0.23 TPU) (reported as a DtoN), the existence of the charted 18-foot contour, as drawn within the H12907 survey area, is not supported by the MBES data (Figure 18). In fact, the majority of surveyed soundings are deeper than 19 feet.

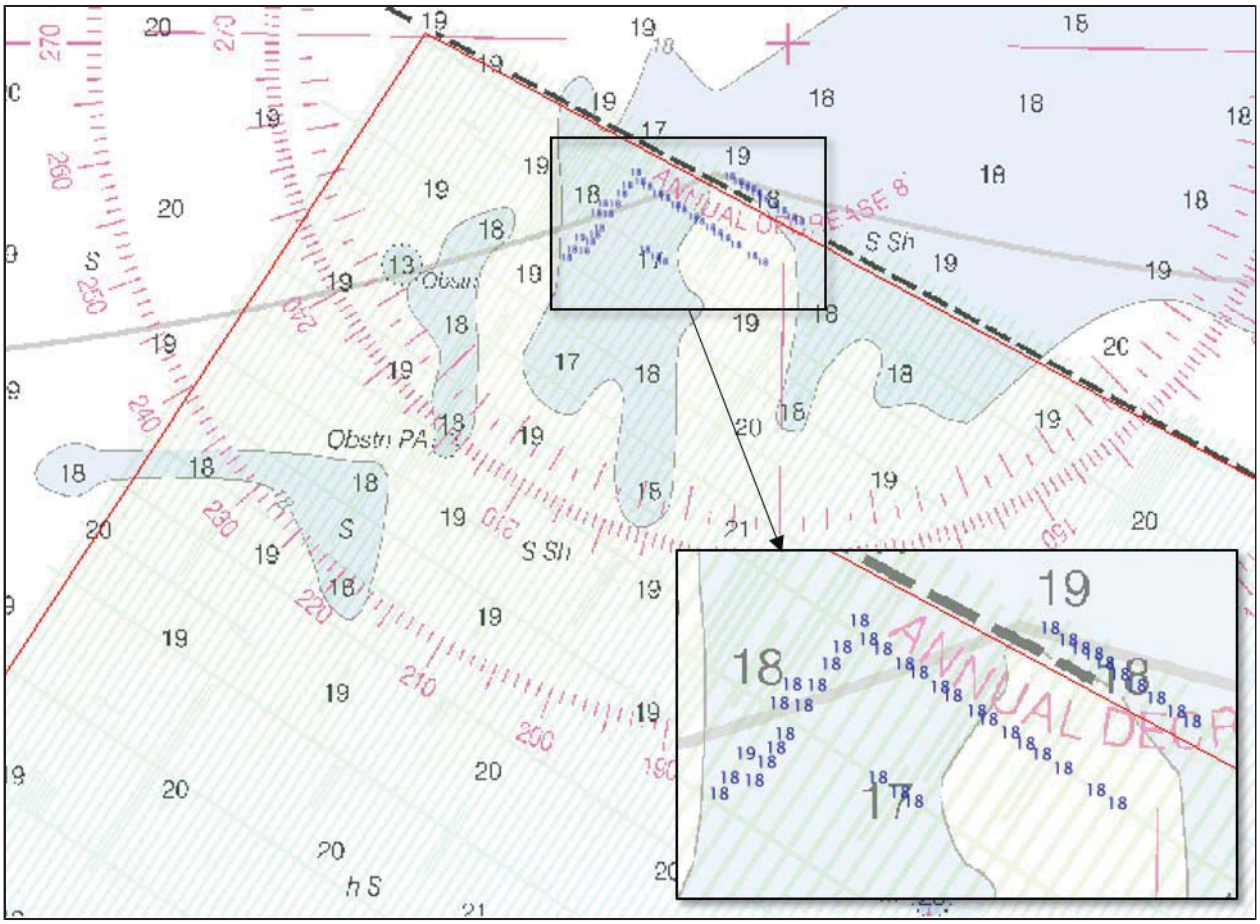


Figure 18: *Soundings less than or equal to 18 feet within Survey H12907 (aside from new features) are highlighted in blue and shown in comparison to the charted 18-foot contour on RNC 11351. All depths are in feet.*

<u>11340</u>

Other than least depths on obstructions, no soundings from RNC 11340 exist within the H12907 survey area. The 3-fathom contour intersects the northwest and southeast portions of H12907. The location of the 3-fathom contour was disproved by the surveyed soundings, with surveyed depths being 0.2 to 0.5 fathoms (1.2 to 3 feet) deeper than the charted 3-fathom contour.

D.1.2 Electronic Navigational Charts

The following table summarizes pertinent epoch details about the largest scale ENCs assigned for the survey area.

ENC	Scale	Edition	Update Application Date	Issue Date	Preliminary?
US4LA15M	1:80000	23	11/06/2014	10/24/2016	NO
US4LA21M	1:80000	27	03/25/2015	12/08/2016	NO
US3GC03M	1:459596	47	02/20/2015	12/12/2016	NO

*Table 18: Largest Scale Electronic Navigational Chart*s

US4LA15M

RNC 11349 is the source for ENC US4LA15M; therefore, the positions and values of the soundings and contours included in ENC US4LA15M are identical to those charted on RNC 11349. All chart comparison notes entered under the RNC 11349 apply to US5LA15M.

US4LA21M

RNC 11351 is the source for ENC US4LA21M; therefore, the positions and values of the soundings and contours included in ENC US4LA21M are identical to those charted on RNC 11351. All chart comparison notes entered under the RNC 11351 apply to US5LA21M.

US3GC03M

RNC 11340 is the source for ENC US3GC03M; therefore, the positions and values of the soundings and contours included in ENC US3GC03M are identical to those charted on RNC 11340. All chart comparison notes entered under the RNC 11340 apply to US3GC03M.

D.1.3 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.1.4 Charted Features

The following features were assigned for investigation within the Composite Source File (CSF) provided with the OPR-K354-KR-16 Project Instructions:

Eight (8) charted platforms (OFSPLF) of which one is described as submerged and charted as "Platform PA (ruins)".

- 21 BSSE well head obstructions (OBSTRN)
- Two (2) Obstruction PA (OBSTRN)
- One (1) wreck (WRECKS)

Of the assigned platforms only three of the eight were found to exist. The remaining assigned platforms, including the submerged platform, were disproved visually and with 200% SSS coverage and partial MBES coverage within a search area centered on the CSF provided position and defined by a 50-meter or 80-meter (PA feature) radius. Platforms are discussed further in Section D.2.

The BSSE well head obstructions were not charted but were submitted to be verified or disproved by OSI. Investigation requirements for the BSSE well heads were provided to OSI in an email dated April 22, 2016 which is submitted with the Correspondence in the DR Appendix II. The well head investigation requirements were as follows:

- If obstruction is found and considered a danger to navigation, develop the feature (7.3.3), designate the feature (7.4), submit it as a DtoN (1.5), and include it in the FFF (7.3).

- If obstruction is found and merits individual cartographic representation, develop the feature (7.3.3), designate it (7.4), and submit in FFF (7.3).

- If obstruction is found and does not merit cartographic representation, do not investigate it as a feature. Include it in the FFF with “descrp = delete” and “remrks=obstruction addressed as represented in the surface”

- If the obstruction is not found, in cases where 100% SSS with concurrent multibeam is being used as the primary coverage technique, a 50m disproval search radius using a technique described in Section 7.3.4 is necessary.

Of the assigned BSSE well head features. it is recommended that all 21 BSSE well heads remain uncharted. Multiple BSSE well heads were correlated either with another BSSE well head assignment (one case) or with a charted platform. All but one BSSE well head was disproved with 200% SSS and partial MBES. For one BSSE well head located at 29-09-41.47 N, 91-49-31.47 W, a small sliver of bottom within the 50-meter search radius was not ensonified with the 200% SSS coverage but the 100% coverage clearly depicted a seafloor devoid of features. See the FFF for additional information regarding the investigated BSSE well head obstructions. The source date (SORDAT) and source indication (SORIND) attribute fields were blank for the BSSE well head features submitted in the CSF; therefore, the SORDAT and SORIND fields are blank for the disproved well heads attributed with a description (descrp) of "Delete" in the FFF.

A charted Obstn PA located at 29-09-47.11 N, 91-49-31.54 W, "a 15ft by 10ft diameter tank" per the AWOIS database description, was disproved with 200% SSS and partial MBES coverage within a search area defined by an 80 m radius. A new tank like obstruction that is included in the FFF was developed with object detection MBES coverage approximately 2.5 kilometers SW of the Obstn PA, possibly the actual position of the Obstn PA (see DR Section D.1.5 Uncharted Features).

An Obstn PA located at 29-12-00.81 N, 91-47-18.43 W, "a submerged obstruction" that "snagged an unknown amount of cable" per the AWOIS database description, was disproved with 200% SSS and partial MBES coverage within a search area defined by an 80 m radius. A new obstruction, most likely the actual position of the charted Obstn PA, was developed approximately 1.3 kilometers NNW of the charted Obstn PA and submitted as a Danger to Navigation (see DR Section D.1.6 Dangers to Navigation).

The charted Wreck PA at the CSF defined location of 29-10-00.81 N, 91-45-00.43 W was disproved at it's charted location with 200% SSS and partial MBES coverage within a search area defined by an 80 m radius. A new 60-foot wreck was developed with object detection MBES coverage approximately 380 meters NNW of the charted wreck position and was submitted as a Danger to Navigation (see DR Section D.1.6 Dangers to Navigation). As of December 19, 2016, the date the RNCs and ENCs were downloaded for chart comparison, the original Wreck PA had been deleted from the chart and replaced with the new H12907 position (Figure 19).

The Platform PA (ruins) feature charted on RNC 11351 and ENC US4LA21M at 29-05-37.81 N, 91-45-47.80 W was charted as an Obstn PA on RNC 11340 and ENC US3GC03M. The Platform PA (ruins) as charted on RNC 11351/ENC US4LA21M was submitted for investigation in the CSF. The platform ruins were disproved with 200% SSS and partial MBES at its charted location within the search area defined by an 80 meter radius. A new obstruction, most likely the actual position of the platform ruins, was developed approximately 125 meters east of the charted Platform PA (ruins)/Obstn PA and is included in the H12907 FFF (see DR Section D.1.5 Uncharted Features).

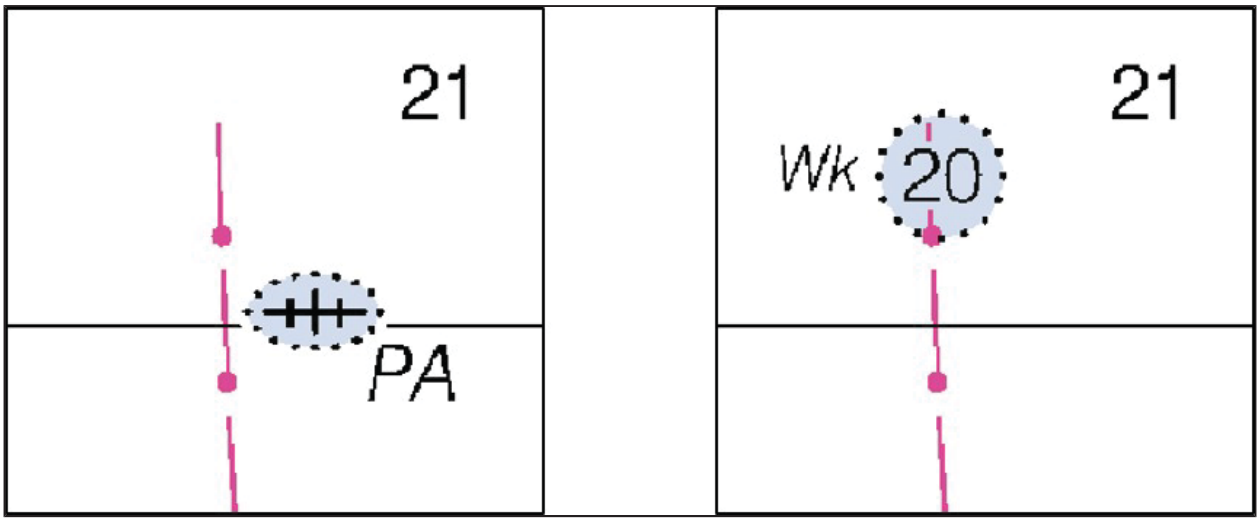


Figure 19: The left image is the Wreck PA as charted on RNC 11351 on August 26, 2016 and the right image is the H12907 surveyed position and depth of the wreck as charted on RNC 11351 December 19, 2016.

D.1.5 Uncharted Features

A large tank like feature with a least depth of 19 feet (5.95 m, ±0.23 TPU) was developed with object detection MBES coverage at position 29-08-43.78 N, 91-50-28.88 W, most likely the actual position of the "15ft by 10ft diameter tank" charted Obstn PA discussed above. The feature appears to be embedded in the seafloor and protrudes less than 1 meter above the seafloor (Figure 20).

Two significant features were positioned within the footprint of a disproved charted platform at position 29-05-38.32 N, 091-45-43.21 W. Two pipe like obstructions over 1 meter tall and one with an insignificant height of 0.65 meters tall were developed with object detection MBES coverage with a least depth of 18 feet (5.71 m, ±0.23 TPU) and were possible evidence of a ruined or removed platform (Figure 21).

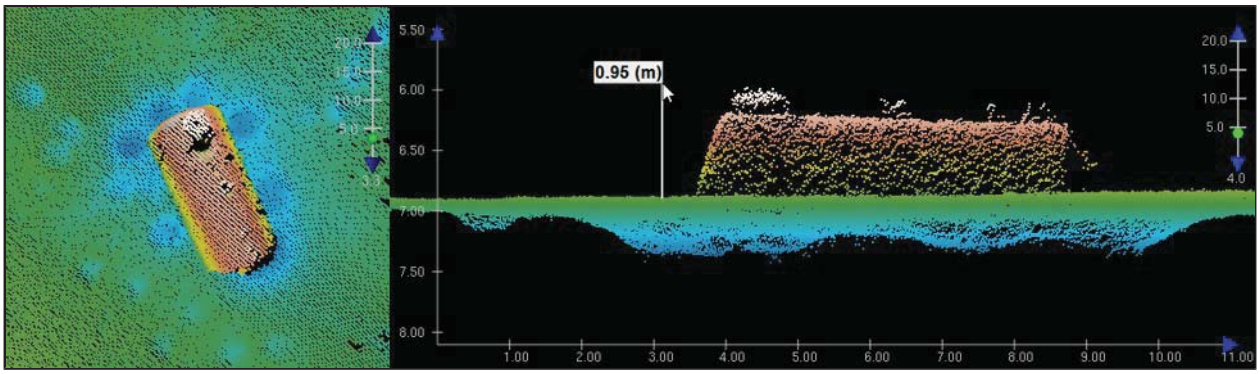


Figure 20: *A 19-foot, tank like obstruction is represented in CARIS HIPS Subset Editor 3D and 2D views with the soundings colored by depth and depths and units in meters.*

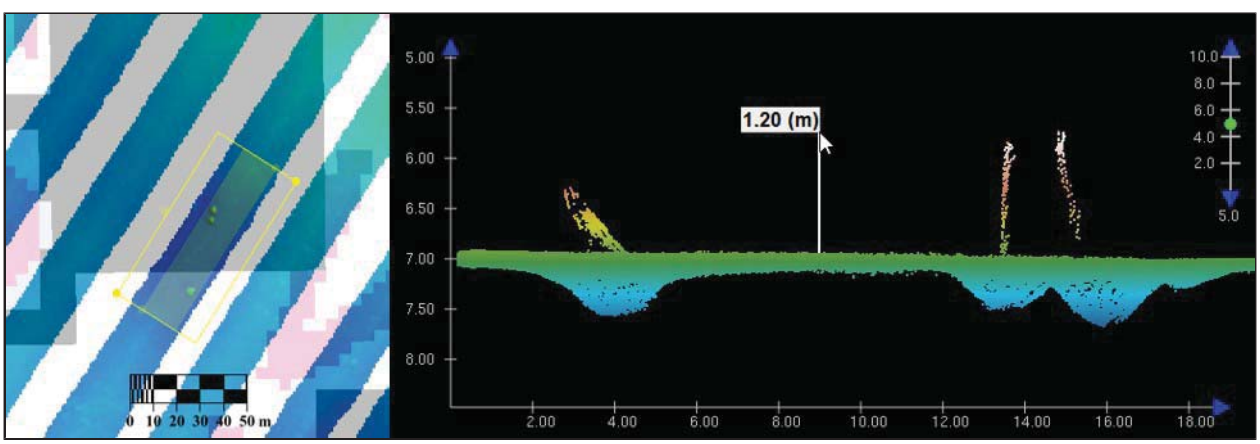


Figure 21: *Several pipe like features were developed in the vicinity of a disproved charted platform as shown in the left image with a 1-meter CUBE surface overlaid on RNC 11351. On the right, the obstructions are shown in Subset Editor 2D view with depths and units in meters.*

D.1.6 Dangers to Navigation

The following DTON reports were submitted to the processing branch:

DTON Report Name	Date Submitted
H12907_DtoN_1_Wk.000	2016-10-04
H12907_DtoN_1_Obstn.000	2016-10-04

Table 19: DTON Reports

Two (2) Danger to Navigation (DtoN) S-57 files (.000) were submitted to the Atlantic Hydrographic Branch (AHB) for Survey H12907.

The DtoN #1 submission describes a wreck approximately 380 meters NNW of a charted wreck PA which was disproved. The new wreck's surveyed position is 29-10-12.05 N, 91-45-06.83 W. The wreck DtoN was submitted by AHB to the Nautical Data Branch (NDB) and Marine Chart Division (MCD) on October 5, 2016 and has since been updated on RNCs 11351 and 11340 and ENCs US4LA21M and US3GC03M. The Local Notice to Mariners (LNM) Edition 44 for District 8 (44/16) included chart updates for RNC 11351 and 11340 to add the new wreck at the following position: 29-10-12.10 N, 91-45-06.80 W.

The DtoN #2 submission describes an obstruction located approximately 1.3 kilometers NW of a charted obstruction PA which was disproved. The position of the new obstruction is 29-12-44.22 N, 91-47-32.44 W. The obstruction DtoN was submitted by AHB to the Nautical Data Branch (NDB) and Marine Chart Division (MCD) on October 5, 2016 and has since been updated on RNCs 11351 and 11340 and ENCs US4LA21M and US3GC03M. The Local Notice to Mariners (LNM) Edition 44 for District 8 (44/16) included chart updates for RNC 11351 and 11340 to add the new obstruction at the following position: 29-12-44.20 N, 91-47-32.40 W.

The DtoNs are included in the H12907 S-57 FFF, H12907.FFF.000. The value of sounding (VALSOU) depths for the obstruction and wreck submitted as DtoNs have been updated in the FFF following the application of final tides to the MBES data set. Danger to Navigation Reports as well as correspondence regarding the DtoN submissions are included in Appendix II of this report.

D.1.7 Shoal and Hazardous Features

A caution area (CTNARE) note encompasses the entirety of the intersection of the H12907 survey area and RNC 11340 and ENC US3GC03M stating the following: "Gas and Oil Well Structures. Platforms, gas and oil well structures, some of which are submerged and capped, and submarine pipelines and cables are charted."

Similarly, a Caution Note for RNC 11351 and ENC US4LA21M stated: "Additional uncharted submarine pipelines and submarine cables may exist within the area of this chart. Not all submarine pipelines and submarine cables are required to be buried, and those that were originally buried may have become exposed. Mariners should use extreme caution when operating vessels in depths of water comparable to their draft in areas where pipelines and cables may exist, and when anchoring, dragging, or trawling. Covered wells may be marked by lighted or unlighted buoys." The caution note was included in the text files referenced

in the Textual description (TXTDSC) fields of the PIPSOL (pipeline) and M_NPUB (nautical publication information) features.

The Caution Notes are warranted given the abundance of charted platforms, pipelines and possible well heads within the project area. No exposed pipelines were located within H12907; however, many segments of exposed pipeline were developed within the contemporary survey areas of project OPR-K354-KR-16.

A Tide Rips/Water Turbulence (WATTUR) feature was positioned at 29-09-47.82 N, 91-46-34.09 W on RNC 11351 and ENC US4LA21M and at 29-09-28.68 N, 91-45-43.71 W on RNC 11340 and ENC US3GC03M. While not specifically confirmed at the charted location, tide rips were documented by the field crew in the acquisition log and photographically within the project area (Figure 22).

Figure 22: *Photograph of tide rip taken in the southeast corner of Survey H12906 on September 29, 2016 (DN 272).*

D.1.8 Channels

No channels exist for this survey. There are no designated anchorages, precautionary areas, safety fairways, traffic separation schemes, pilot boarding areas, or channel and range lines within the survey limits.

D.1.9 Bottom Samples

Four (4) bottom samples were acquired to determine bottom characteristics. Bottom samples were assigned in the PRF provided with the Hydrographic Survey Project Instructions. There were no deviations from the assigned bottom sampling plan. A position and description of each sample are provided as attributed SBDARE

objects in the FFF. Digital images with identification reference numbers are submitted with the survey data and referenced in the NOAA extended attributes 'images' field.

D.2 Additional Results

D.2.1 Shoreline

No shoreline exists within this survey.

D.2.2 Prior Surveys

Prior survey data exists for this survey area. However, with the exception of the assigned junction surveys, prior data were not investigated.

D.2.3 Aids to Navigation

No Aids to navigation (ATONs) exist for this survey.

D.2.4 Overhead Features

Overhead features do not exist for this survey.

D.2.5 Submarine Features

Compared to the contemporary surveys in Project OPR-K354-KR-16, relatively few charted pipelines are located within Survey H12907. Pipes colored magenta represent supply pipelines for oil, gas, chemicals, or water, according to Chart No. 1: Nautical Chart Symbols, Abbreviations and Terms downloaded from the Office of Coast Survey (OCS) website. None of the charted pipelines have a buried depth value (BURDEP); however, no unburied charted pipelines were visible in the SSS or MBES data.

Review of information contained in a shape file (.SHP) downloaded from the Bureau of Ocean Energy Management (BOEM) on April 25, 2016 suggests that there may be two uncharted pipelines within Survey H12907. The BOEM pipeline shape file that intersects with the OPR-K354-KR-16 project area was reprojected to UTM Zone 15N, NAD83 and saved as a .DXF file and converted to a .HOB file. In CARIS Notebook, the BOEM pipeline HOB file was then visually compared to the charted pipelines within the project area to identify any potentially uncharted BOEM pipelines. While the majority of the pipelines in the BOEM file corresponded with charted pipelines, two BOEM reported pipelines were not charted. There was no visible evidence in the MBES or SSS data of the existence of the uncharted pipelines. An overview of the uncharted BOEM-defined pipelines that intersect Survey H112907 is provided in Figure 23.

The shape file, "ppl_arcs.shp" and re-projected .DXF file, "Pipelines_UTM_15N_NAD83_Meters.dxf" are included with the digital deliverables along with the RNC/ENC charts considered in the chart comparison.

BOEM pipeline data were obtained at the following web address: http://www.data.boem.gov/homepg/data_center/mapping/geographic_mapping.asp.

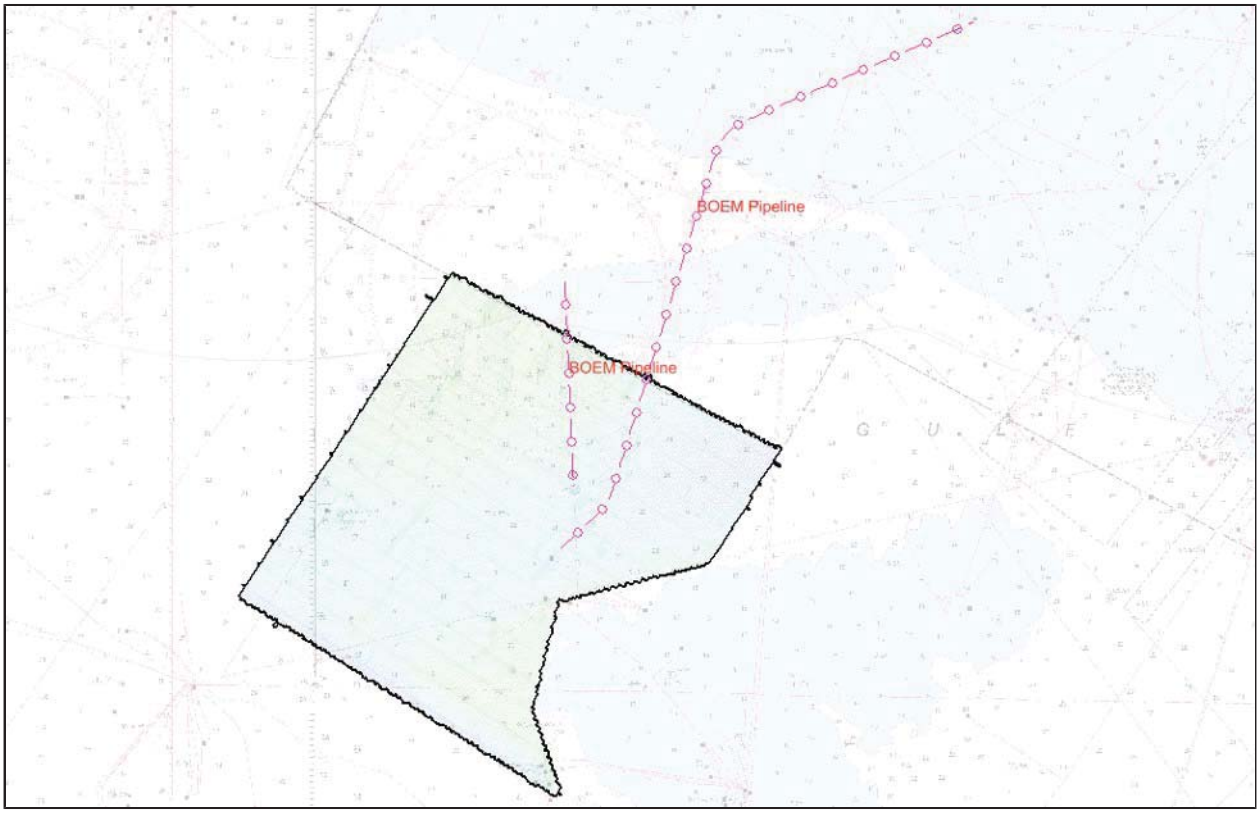


Figure 23: *Two reported BOEM-defined pipelines that are not charted are highlighted in pink in reference to RNCs 11351 and 11349 with the H12907 survey outline shown in orange.*

D.2.6 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.7 Platforms

Eight (8) "assigned" platforms were included for investigation in the CSF. Of the eight assigned platforms, five were disproved with 200% SSS and partial MBES coverage within a search area defined by a 50-meter radius centered on the CSF position. The remaining three platforms were positioned close enough to the CSF-provided positions to be attributed with the "retain" value, i.e. the surveyed platform positions were within 2 mm at the survey scale (80 m at 1:40000) to the charted platform positions.

The remaining platforms in Survey H12907 are located at the following locations: 29-05-33.61 N, 91-45-39.85 W; 29-05-22.00 N, 91-45-36.99 W; and 29-09-03.80 N, 91-45-34.59 W.

See the FFF for additional information including images.

D.2.8 Significant Features

Many small circular depressions were visible in the MBES data throughout the survey area and were clustered in the scour area around obstructions, wrecks and platforms (Figure 24). The holes are randomly spaced, less than 50 centimeters deep, and do not appear to be associated with industrial activity.

They are more likely related to a natural phenomenon, possibly ground fish-created habitat, as some species in the Gulf of Mexico (i.e. red grouper) are known to excavate depressions in flat, sandy bottoms (See Wall, Carrie C., et al. "Spatial and temporal variability of red grouper holes within Steamboat Lumps Marine Reserve, Gulf of Mexico." Marine Ecology Progress Series (Impact Factor: 2.62). 2011. 431:243-254.)

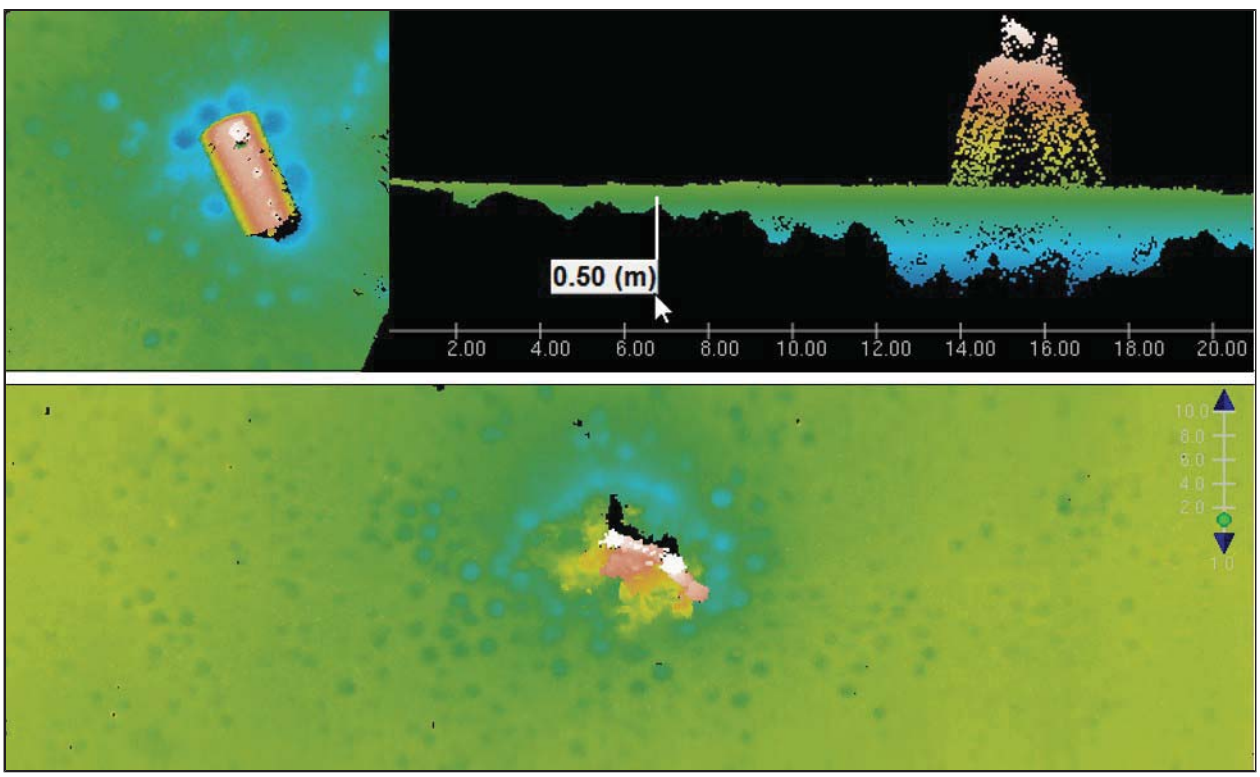


Figure 24: *Possible ground fish habitat holes as they appeared in the MBES data displayed in CARIS Subset Editor 2D and 3D windows with the soundings colored by depth.*

D.2.9 Construction and Dredging

No construction or dredging existed within the survey limits at the time of data acquisition.

D.2.10 New Survey Recommendation

No new surveys or further investigations are recommended for this area.

D.2.11 Marine Mammal Observations

Per direction in Section 1.4 and 1.4.1 of the HSSD all survey and vessel operations personnel aboard the vessel used during Project OPR-K354-KR-16 were "trained" as Marine Mammal Observers prior to commencement of the survey. Training consisted of each surveyor and vessel crew member watching the US Navy video referenced in the HSSD.

As noted multiple times in the survey acquisition log, large, mobile, water column sonar targets (assumed to be dolphins) were ensonified by either the MBES or the SSS. The dolphin-assumption is based on both the size and behavior of the sonar targets. Often times these observations did not coincide with a visual (above water) sighting. Visual observations, when noted, were recorded on NOAA/NMFS,AFSC/NMML Form 11US (POP) which is included as Appendix K of the HSSD.

As compared to past years survey work in the Gulf of Mexico, dolphin sightings during the contemporary survey were relatively sparse. This is attributed to the area of operation for the contemporary survey. During the course of Project OPR-K354-KR-16 only 13 individual visual dolphin sightings occurred.

Digital versions (.PDF format) of completed 11US (POP) forms along with the Project's marine mammal training record were compiled and transmitted to the OCS Environmental Compliance Coordinator, Jay Nunenkamp, with a CC to the Project's COR, Paul Turner. These records are also included in Descriptive Report Appendix II.

D.2.12 Coast Pilot Review

A "Coast Pilot Field Report" as described in Section 8.1.3 in the HSSD was not provided by HSD Operations. Per a June 2 email from the COR: "There are no specific items to investigate with regards to the Coast Pilot". OSI conducted a general review of relevant Coast Pilot excerpts. Specifically, pertinent paragraphs from the following Coast Pilot section were considered:

Coast Pilot 5 - 44th Edition, 2016 updated through 13-November-2016, Mississippi River to Sabine Pass.

Within the Coast Pilot Edition mentioned above there are no specific, detailed, relevant entries concerning the assigned survey area. Rather, only entries of a general nature are mentioned and are not refutable based on the observations of the OSI field team. Regarding “areas frequently transited” (as mentioned in the HSSD Section 8.1.3), there are only a few Coast Pilot paragraph descriptions that OSI's general review attempts to address.

OSI's Coast Pilot Review is included in Descriptive Report Appendix II. Correspondence between OSI and the Project COR confirming OSI's understanding of the Coast Pilot reporting requirement is included in the Correspondence directory of the Descriptive Report Appendix II.

D.2.13 New Inset Recommendation

No new insets are recommended for this area.

E. Approval Sheet

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

All field sheets, this Descriptive Report, and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch.

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

Report Name	Report Date Sent
Data Acquisition and Processing Report	2017-01-23
Horizontal and Vertical Control Report	2017-01-23

Approver Name	Approver Title	Approval Date	Signature
George G. Reynolds	Chief of Party	01/23/2017	

Digitally signed by George G. Reynolds
Date: 2017.01.23 09:39:18 -05'00'

APPENDIX I

TIDES AND WATER LEVELS

The following table summarizes the days in which data were collected that contribute to the final accepted data set.

Table 1
Abstract of Times of Hydrography

Date	Day Number	Min. Time UTC	Max. Time UTC
8/18/2016	231	00:31:52	15:24:12
8/23/2016	236	16:08:51	17:20:34
8/31/2016	244	10:18:58	23:48:58
9/01/2016	245	00:14:13	23:54:05
9/02/2016	246	00:19:08	23:47:40
9/03/2016	247	00:17:55	10:30:45
9/04/2016	248	15:33:22	23:54:12
9/05/2016	249	00:17:31	14:17:59
9/10/2016	254	12:17:56	23:54:01
9/11/2016	255	00:25:58	21:12:07
9/21/2016	265	13:47:44	23:50:58
9/22/2016	266	00:42:11	20:55:52
9/23/2016	267	7:51:50	15:57:44
9/30/2016	274	00:44:15	02:18:06

Water level data from NOS-NOAA tide station LAWMA, LA (876-4227) was used for vertical control. Predicted tide files were used during preliminary processing. Preliminary tides from the LAWMA, LA station were downloaded and reviewed for data gaps. Verified tides were downloaded and reviewed when available.

The project is located within zones indicated by preliminary tidal zoning included in the project Statement of Work (subsequently modified as described below).

According to the Tides Statement of Work (SOW), as regards the preliminary tidal zoning, "there is insufficient data with which to perform an accurate error estimation". Accordingly, NOAA CO-OPS recommended deploying a bottom mounted pressure gauge (BMPG) or GPS buoy at the southwest extent of the survey area to gain a "better understanding of tidal propagation and error associated with tidal zoning".

To this end OSI deployed a pair of BMPGs (primary and backup) near the southwest extent of the survey area. OSI's tides subcontractor, JOA Surveys, processed the recorded BMPG data, performed an instrument "settling analysis", and incorporated datum-corrected offshore tide data into an analysis of the CO-OPS provided preliminary zoning. JOA Surveys' analysis indicated that the preliminary zoning did in fact require adjustment. JOA Surveys' modification of the preliminary zoning retained the preliminary zone shapes but modified the range ratios and time correctors for each zone.

Time and range corrections were applied to LAWMA, LA (876-4227) verified data according to Table 2 which includes the modified time and range correctors.

Table 2
Modified Tide Zones Associated with Project OPR-K354-KR-16

Zone	Time Correction	Range Correction
WGM280	-108	0.85
WGM281	-102	0.85
WGM282	-90	0.91
WGM283	-84	0.97
WGM410	-72	1.04
WGM284	-60	1.10

The BMPG tide data, analysis, and report were transmitted to CO-OPS via e-mail and FTP link on November 9, 2016. The BMPG analysis and zoning modification report is included with the project deliverables, as well as with this document.

Based on the results of cross line analysis, it appears that the time and range factors as provided in the modified zoning scheme are adequate.

Coordinated Universal Time (UTC) was used to annotate the tide records and all other data obtained in this project.

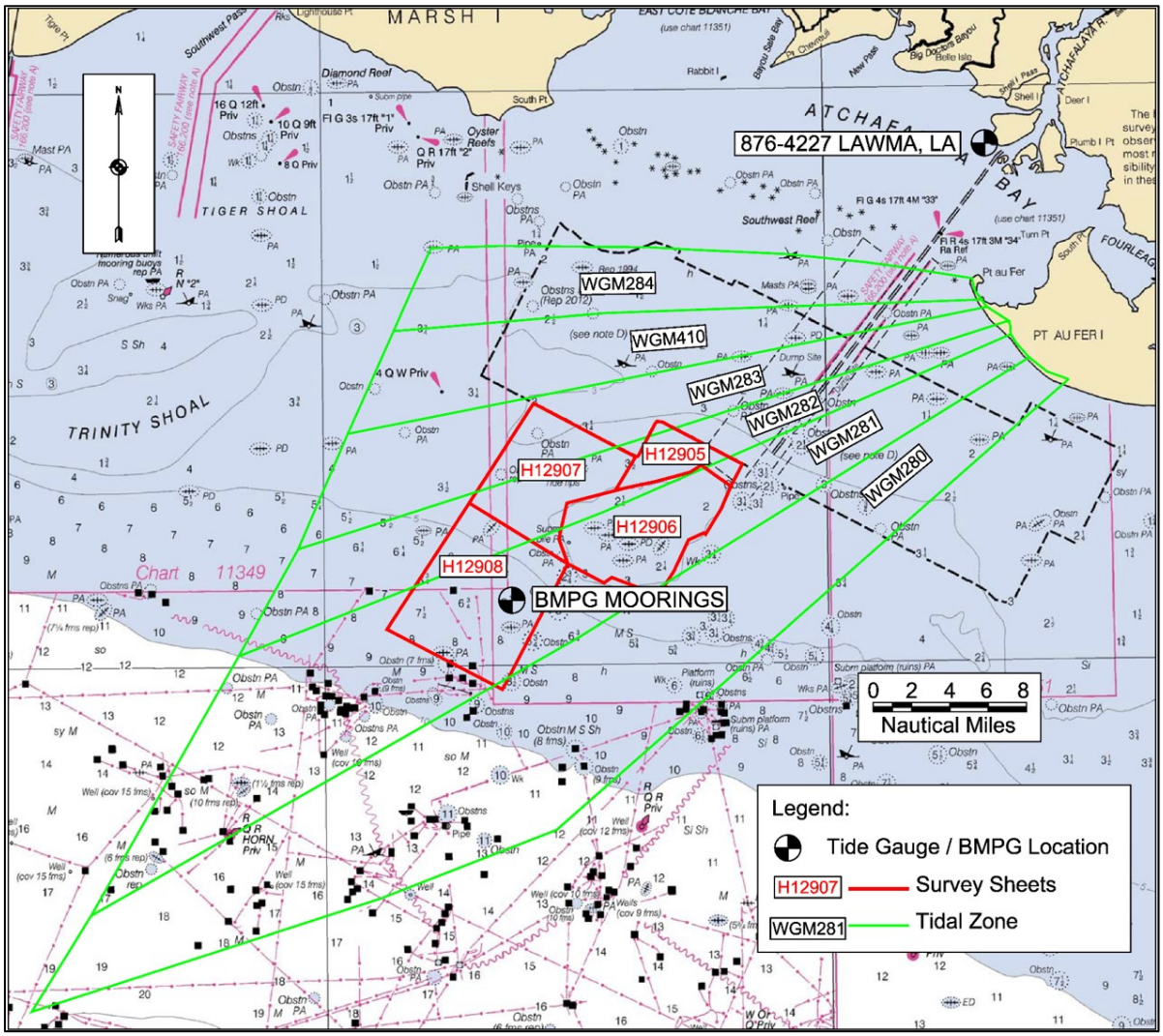


Figure 1. Project survey boundaries (red lines), tidal zone boundaries (green lines), the LAWNMA, LA tide station location and the BMPG mooring location.

E-mail Chain Regarding Modified Zoning and BMPGs

From: Paul Turner - NOAA Federal [mailto:paul.turner@noaa.gov]
Sent: Friday, September 23, 2016 10:20 PM
To: George Reynolds <ggr@oceansurveys.com>
Subject: Re: BMG Zoning Gauge Recovery
Hi George
Please continue with your plan to recover the gauge, there is no issue.
Paul

On Fri, Sep 23, 2016 at 9:10 AM, George Reynolds <ggr@oceansurveys.com> wrote:

Hi Paul,

Today is the end of the 30 day period for our bottom mounted zoning gauge deployment. We are planning to recover the gauge this week unless Co-Ops has any issues with this plan.

Thanks

George

--
Paul Turner
Physical Scientist
NOAA's National Ocean Service
Office of Coast Survey

301-713-2700 ext 106
Paul.Turner@noaa.gov

From: nathan [mailto:nathan@joasurveys.com]
Sent: Wednesday, November 9, 2016 1:17 PM
To: OET Team <nos.coops.oetteam@noaa.gov>
Cc: _NOS CO-OPS Hydro <nos.coops.hydro@noaa.gov>; George Reynolds <ggr@oceansurveys.com>; Mike Zieserl <mike@joasurveys.com>
Subject: OPr-K354-KR-2016 Zoning Station Report and Zoning Scheme

OET,

We have completed the station package for tide support on OPR-K354-KR-2016. The package has been uploaded to our FTP site. The attached transmittal letter has instructions for retrieving the package. Do not hesitate to contact me if you have any problems retrieving the report or questions about it.

Thanks,
Nathan

--
Nathan Wardwell
JOA Surveys, LLC
www.joasurveys.com
2000 E. Dowling Rd, #10
Anchorage, AK 99507
(907) 227-6635 cell
(907) 561-0136 office

JOA Surveys, LLC
SURVEYING GPS TIDES HYDROGRAPHY

2000 E. Dowling Road, Suite 10
Anchorage, AK 99507
(907) 561-0136 Phone
(907) 561-0143 Fax
www.joasurveys.com

November 9, 2016

To: CO-OPS Ocean Engineering Team

CC: CO-OPS Hydro Planning Team
George Reynolds (Ocean Surveys, Inc.)

Re: Offshore BMPG Installation and Removal Report
Louisiana Coast (JOA 352)
OPR-K354-KR-2016

The station report for the installation and removal of the bottom mounted pressure gauges offshore of the Louisiana Coast in support of OPR-K354-KR-2016 has been completed. The revised zoning scheme and report are included in this submittal. This transmittal letter was submitted via email. The report has been posted to the JOA FTP site:

Directory:	OPR-K354-KR-2016
Filename:	Offshore LA BMPG Station Report 20161109.zip
Host:	ftp.joasurveys.com
Username:	oet
Password:	1305east-west

Note: Because this is an offshore BMPG deployment, not all of the station documentation required for a tertiary tide station by the OCS HSSD is applicable. We provided all of the documentation applicable to the installation and removal of this station.

Sincerely,

Nathan Wardwell

nathan@joasurveys.com

JOA Surveys' Zoning Report

Tidal Zoning for OPR-K354-KR2016

Report by:	JOA Surveys, LLC
Processor:	Mike Zieserl
Client:	Ocean Surveys Inc.
Date:	November 3, 2016

Summary

Ocean Surveys Inc. performed a hydrographic survey of the coast of Louisiana in the Gulf of Mexico. The survey area was more than 21 km east/west and 34 km north/south. The northern extent of the survey area was 33 km SE of the NWLON station 8764226 LAWMA. The Tides Statement of Work (SOW) required the installation of one offshore bottom mounted pressure gauge (BMPG) in the open ocean near the southern end of the survey area.

The preliminary tidal zoning scheme provided by CO-OPS was based on NWLON station 8764227 LAWMA. The final scheme is based still based on LAWMA, and the geometry remains the same, but the range ratios and time corrections have been updated to reflect the data collected at the offshore BMPG location. The general tidal characteristics for this area are diurnal with a range between 0.4m to 0.6m. The tide moves from offshore to inshore.

Overall 100% of the zones in the final scheme have an uncertainty less than 18 cm at the 95% Confidence Level.

Tide Stations

As per the SOW, dated 3/28/2016, two bottom mounted pressure gauges were collocated near the southern end of the survey area to support hydrography. The BMPG's were installed 64 km SW of NWLON station 8764227 LAWMA (Figure 1). The water levels from the BMPG's at this location were used for zoning purposes only and were designated a unique station number by JOA Surveys, LLC (JOA). The pressure data collected by the BMPG were reduced to water level pressure by removing barometric pressure as measured at the LAWMA NWLON. Water depth was calculated using density measurements from the conductivity and temperature sensors deployed with the BMPG. Data from 2 NWLON stations were also used in refining the tidal zoning: 8764227 LAWMA and 8764314 Eugene Island. All of the stations are listed in Table 1 and shown in Figure 1.

Figure 1 - Overview map showing the tide stations used in the zoning analysis and the preliminary tidal zoning geometry, with the approximate survey area in the background.

Table 1 - List of tide stations used to develop the tidal zoning scheme.

Number	Name	Station Type	Active	Latitude (N)	Longitude (W)	Duration (Days)
8764227	LAWMA	NWLON	Yes	29° 27' N	91° 20.3' W	permanent
8764314	Eugene Island	NWLON	Yes	29° 22' N	91° 23' W	permanent
n/a	Offshore LA BMPG	Zoning	No	29° 03.3' N	91° 48.8' W	38 days

DATUMS

The datums for the BMPG zoning station were computed using the Tide-by-Tide (TBYT) simultaneous comparison method because they were not installed for a calendar month. They were corrected to the current National Tidal Datum Epoch (NTDE) using the Modified Method and the LAWMA NWLON station as control.

The great diurnal range, GT, increases from the offshore BMPG to the Eugene Island NWLON station, then decreases from Eugene Island to the LAWMA NWLON station. The time of the tide for the Eugene Island and LAWMA NWLON stations was derived from their harmonic constituents using the computational procedure for determining the Tropic Intervals TcHHWI and TcLLWI (as these values are not published by CO-OPS). Since harmonic constituents were not derived from the offshore BMPG water level data, the time offset from LAWMA to the BMPG location was taken from the TBYT comparison. The tide progresses from the offshore BMPG to Eugene Island and then onto LAWMA.

Table 2 - Tidal datums used to revise the zoning scheme.

Number	Name	GT	Range ratio relative to LAWMA	TcHHWI	TcLLWI	Average Time offset relative to LAWMA hrs (minutes)
8764227	LAWMA	0.487m	1.00	0.98 hrs	16.42 hrs	0 (0)
8764314	Eugene Island	0.563m	1.16	0.28 hrs	15.39 hrs	-0.86 (-52)
n/a	Offshore LA BMPG	0.416m	0.85	-1.685 (dHWI)	-1.660 (dLWI)	-1.67 (-100)

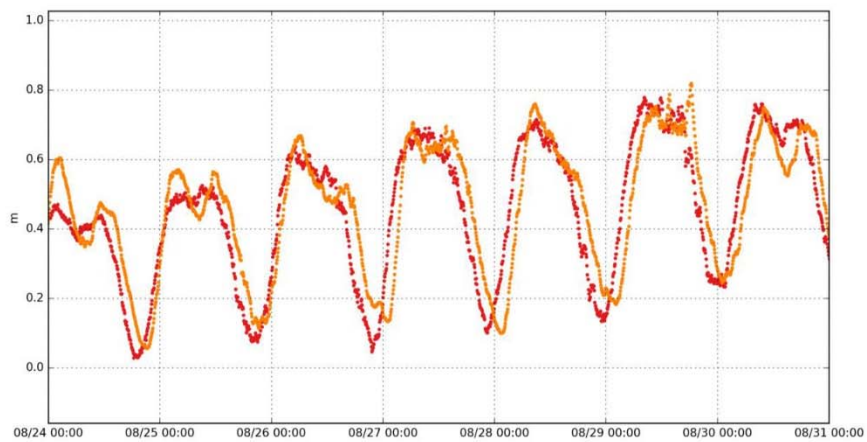


Figure 2 – Comparing Offshore LA BMPG (red) and LAWMA water level data on MLLW

Zoning Scheme

The specifications call for a new zone every 0.06 m change in range and every 0.3 hour progression in time. The range increases from the BMPG at the south end of the survey area to the Eugene Island NWLON near the north end of the survey area by 0.15 m. The range decreases from Eugene Island to LAWMA, but this is outside of the survey area and the area covered by the preliminary zoning. The tide progression from the BMPG to Eugene Island is 0.8 hours. It is another 0.9 hrs for the tide to travel from Eugene Island to LAWMA.

The range correctors in the preliminary zoning scheme (Figure 3) increased from the offshore zoning cells to the inshore zoning cells, which is consistent with the trend observed between the BMPG and Eugene Island. The time corrections in the preliminary zoning showed the tide progressing from north to south, offshore. This trend was not confirmed by the BMPG water level data. Instead, the tide progresses from offshore (BMPG) to inshore (Eugene Island) over 0.8hrs, and then takes another 0.9 hrs to reach LAWMA.

For the final zoning, new range and time correctors were calculated for each tide zone (Figure 4) but the geometry was retained because the observed time and range trends support the zone orientations. The original zone names were also retained. For the sake of these computations, Eugene Island was assumed to be a zone cell directly adjacent to WGM284.

The new range ratios were calculated by first determining the overall change in the GT from Eugene Island to the BMPG location in zone cell WGM281, which was -0.15m. The step change in the GT for each zoning cell from north to south was determined to be -0.03cm. The southernmost cell, WGM280, was assigned the same GT as WGM281 where the BMPG was located, as had been done in the preliminary zoning. Finally, the calculated GT for each zone was divided by the GT at LAWMA to produce the range ratio.

The time corrections were calculated in a similar fashion. The time offset from LAWMA to Eugene Island (from comparison of TcLLHWI and TcHHWI) and from LAWMA to the BMPG (from TBYT) were subtracted to determine the time offset from Eugene Island to the BMPG, which was -48 minutes. The time step for each zone from Eugene Island to the BMPG was about -9 minutes. Beginning with Eugene Island with a time correction from LAWMA of -52 minutes, the time step of -9 minutes was applied to each zone progressing offshore, and rounding each time correction to a 6 minute interval, creating time steps of 6 minutes or 12 minutes between zones.

MLLW water level data from LAWMA was zoned to cell WGM281 using the preliminary and final zoning parameters. These zoned data sets were compared against the BMPG measured water level data on MLLW. A few of the summary statistics of for each comparison are presented in the table below.

Table 3 - Statistics for residuals when comparing preliminary and final zoning schemes to data collected at the zoning BMPG station.

Zone			Average Residual		1-Sigma Residual		RMSE Residual	
Name	NWLON	Zoning Station	Preliminary	Final	Preliminary	Final	Preliminary	Final
WGM281	LAWMA	Offshore LA BMPG	-0.061	0.058	0.133	0.060	0.092	0.083

Figure 3 - Preliminary zoning scheme.

Figure 4 - Final zoning scheme.

Zone Uncertainties

An uncertainty was estimated for each zone using the methodology outlined in a draft paper by Steve Gill dated 03/21/2006 and titled *Error Budget Considerations for Tides – CO-OPS.* The methodology estimates the uncertainty for a zone based on measurement and datum uncertainties for reference stations and RMSE of zoned water levels to a known location.

The measurement uncertainties includes uncertainties for sensor calibration, waves, currents, density, barometric pressure, staff to gauge observations, leveling and interpolation to the time of a sounding. NWLON station LAWMA provided all water level correctors for this survey, and the measurement uncertainties were assumed to be the typical values assigned in the Gill paper (see Appendix I – Reference Station Error).

The datum uncertainty for the LAWMA NWLON station was taken from the list published by CO-OPS on the datums webpage (http://tidesandcurrents.noaa.gov/pdf/Datums_error_gulf_coast.pdf). These published values are derived using Bodnar's regression equations.

The uncertainty for each zone was based on the uncertainty and MN for the reference station and the range corrector for the zone. The calculation of the uncertainty for each zone is shown in Appendix II – Zoning Error. Zone WGM281 and WGM280 have the largest uncertainty of 0.176 m at the 95% CL. Zone WGM283 has the smallest uncertainty of 0.063 m at 95% CL. Overall, 100% of the zones have an uncertainty less than 18 cm.

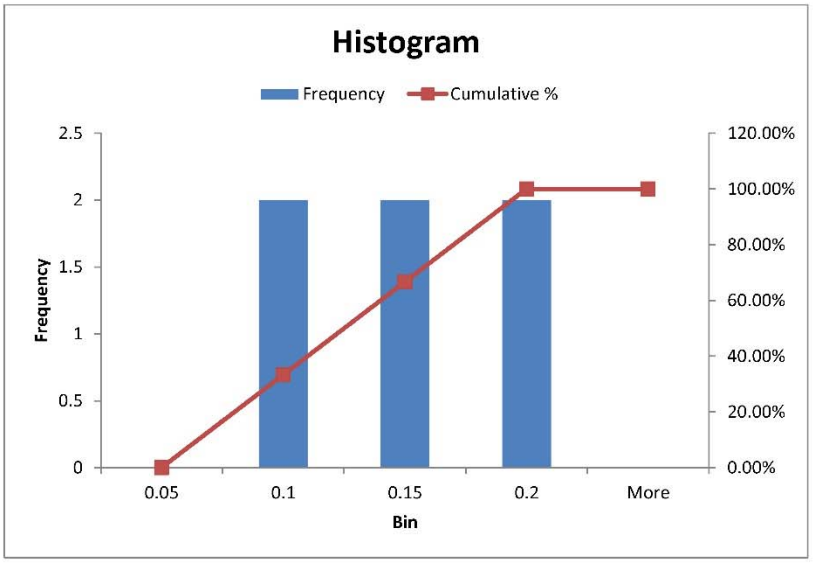


Figure 5 - Histogram of zone uncertainties at the 95% confidence level.

Appendix I – Reference Station Error

Reference Station Error

Measurement Error (S_r)	
All values typical as shown in "Error Budget Considerations for Tides - CO-OPS - skgill draft 3/21/2006"	
	8764227 LAWMA
Sensor Calibration =	0.003
Dynamic Effects	
waves =	0.000
currents =	0.000
density =	0.000
Processing to Datum	
staff to gauge =	0.020
leveling =	0.005
interpolation =	0.010
Root Sum Square =	**0.023**

Datum Computation Error at 1 Sigma (b)	
Datum error estimate as determined by CO-OPS using Bodnar's equation from "Tidal Datum Errors for Gulf Coast of the United States (Florida, Alabama, Mississippi, Louisiana, and Texas) accessed at: http://tidesandcurrents.noaa.gov/pdf/Datums_error_gulf_coast.pdf	
	8764227 LAWMA
Datum Error (FEET) =	0.02
Datum Error (METERS) =	**0.007**

Appendix II – Zoning Error

Zoning Error

Based on: Error Budget Considerations for Tides - CO-OPS, Steve Gill draft, 3/21/2006

Zone	Control Station	Range corrector	MN_c	MN_z	MNR	S_z	S	Zone	95% Confidence Interval CI = b+1.96*S
WGM284	8764227	1.100	0.344 m	0.378 m	0.100	0.055 m	0.060 m	WGM284	0.125 m
WGM410	8764227	1.040	0.344 m	0.358 m	0.040	0.022 m	0.032 m	WGM410	0.070 m
WGM283	8764227	0.970	0.344 m	0.334 m	0.030	0.017 m	0.028 m	WGM283	0.063 m
WGM282	8764227	0.910	0.344 m	0.313 m	0.090	0.050 m	0.055 m	WGM282	0.115 m
WGM281	8764227	0.850	0.344 m	0.292 m	0.150	0.083 m	0.086 m	WGM281	0.176 m
WGM280	8764227	0.850	0.344 m	0.292 m	0.150	0.083 m	0.086 m	WGM280	0.176 m

Control Station Error

Number	Name	b	S_r	MN_c	MNR_{max}	RMS_z	Zoning Station
8764227	LAWMA	0.007 m	0.023 m	0.344	0.150	0.083	Offshore LA BMPG

Notes:

1) ***b*** is the systematic datum error for the reference station estimated using Bodnar's equations.

2) S_r is the random error of measurement for a reference station and is estimated from the sensor calibration, density, waves, currents, barometric pressure, staff shots, leveling and interpolation or measurement to time of sounding.

3) MN_c is the Mean Range for the reference station.

4) MN_z is the Mean Range for the zone and equals MN_c **Range Corrector*.

5) ***MNR*** is the absolute value of the difference between mean ranges of tide between the zone and the tide station, divided by the range of tide at the control station and equals ABS(MN_c-MN_z)/MN_c.

6) MNR_{max} is the maximum *MNR* of all the zones referencing the same station.

7) RMS_z is the RMS of the differences between a reference station zoned to a zoning station.

8) S_z is the random error for zoning and equals MNR / (MNR_{max} / RMS_z)

9) Zoning Station is the station name assigned by JOA to locations throughout the project area where water levels were collected for zoning purposes only.

10) ***S*** is the total random error for a zone and includes the random error for the zone (S_z) along with the random error for measurements at the reference station (S_r). S equals the square root of the sum of S_z and S_r squared.

11) The 95% Confidence Interval for each zone is estimated as the systematic datum error for the reference station (*b*) plus 1.96 times the total random error for the zone (*S*).

Tides Statement of Work

STATEMENT OF WORK
OPR-K354-KR-2016 Louisiana Coast, LA
(03/28/2016 HY)

1.0. TIDES AND WATER LEVELS

1.1. Specifications

Tidal data acquisition, data processing, tidal datum computation and final tidal zoning shall be performed utilizing sound engineering and oceanographic practices as specified in National Ocean Service (NOS) Hydrographic Surveys Specifications and Deliverables (HSSD), dated March 2016.

1.2. Vertical Datums

The tidal datums for this project are Chart Datum, Mean Lower Low Water (MLLW) and Mean High Water (MHW). Soundings are referenced to MLLW and heights of overhead obstructions (bridges and cables) are referenced to MHW.

1.2.1. The Hydro Hot List (HHL)

Please contact CO-OPS' Hydrographic Planning Team (HPT) at nos.coops.hpt@noaa.gov and CO-OPS' Operational Engineering Team (OET) at nos.coops.oetteam@noaa.gov at least three business days before survey operations begin, and within 1 business day after survey operations are completed so that the appropriate CO-OPS National Water Level Observation Network (NWLON) control water level station(s) is/are added to or removed from the CO-OPS Hydro Hotlist (HHL) (http://tidesandcurrents.noaa.gov/hydro). Include start and end survey dates, full project number (e.g. OPR-H355-TJ-10), and control and subordinate station numbers. The notification must be sent to both teams.

Station	Station ID	Control or Subordinate	Type (e.g. NWLON, PORTS©, etc)	Comment
LAWMA, LA	8764227	Control	NWLON	

Table 1: All stations that need to be added to the HHL in support of OPR-K354-KR-2016

It is important to know that the addition of a water level station to the HHL ensures the station is monitored by CORMS and any problems are reported daily. However, platforms should view the HHL each morning of active survey operations and click on the “Plot” to double check that there are not problems with the required stations on that day. If a platform notices problems with data on their survey day of operation, please contact HPT at nos.coops.hpt@noaa.gov, CORMS at CORMS@noaa.gov, and their respective headquarters point of contact at HSD or NSD. Stations on the HHL are given priority for maintenance should a station cease normal operation during scheduled times of hydrography. CO-OPS will notify a field unit within 1 business day if a HHL water level station ceases operation during scheduled times of hydrography. This is in addition to the daily CORMS report that CORMS sends to NOAA field units, if the field unit's e-mail address is added to the CORM's daily e-mail list. To be added to the CORMS daily HHL report, the platform should

contact CO-OPS' Data Monitoring and Analysis Team (DMAT) at nos.co-ops.dmat@noaa.gov and request to be added.

If the stations are listed on HHL, then weekly priority processing will occur and, for those water level stations, verified 6-minute water level data will be made available every week on Monday or Tuesday. If Monday happens to be a federal holiday, then the 6-minute verified water level data will be made available on the following Tuesday or Wednesday. In order to ensure that verified data is correctly downloaded please **select a date that is more than 7 days prior to the day of interest** in the 'From' field on the CO-OPS website.

1.3. Tide Reducer Stations

The operating water level station at LAWMA, LA (8764227) will provide water level reducers for this project. Therefore it is critical that it remains in operation during the survey.

1.3.1. CO-OPS Long Term Water Level Station Operation and Maintenance

During periods of hydrography, CO-OPS is only responsible for the operation and maintenance of NWLON control stations and the contractor is responsible for the maintenance and operations of all contractor installed (tertiary) stations. The contractor is required to monitor the NWLON control water level data via the CO-OPS website at http://tidesandcurrents.noaa.gov/hydro.shtml or through regular communications with the OCS COTR or the OCS COTR's CO-OPS authorized point of contact (Colleen Fanelli at 301-713-2877 ext. 167 or via email: nos.coops.hpt@noaa.gov) before and during operations. The OCS COTR or the COTR's CO-OPS authorized point of contact (Colleen Fanelli) will serve as liaison between the contractor and NOS/CO-OPS to confirm operation of this station and to ensure the acquisition of NWLON control water level data during periods of hydrography. Problems or concerns regarding the acquisition of valid water level data identified by the contractor shall be communicated with the OCS COTR or the COTR's CO-OPS authorized point of contact (Colleen Fanelli) to coordinate the appropriate course of action to be taken such as gauge repair and/or developing contingency plans for hydrographic survey operations.

1.3.2. Subordinate Station Requirements

No subordinate water level stations are required for this project; however, supplemental and/or back-up water level stations may be necessary depending on the complexity of the hydrodynamics and/or the severity of the environmental conditions of the project area. The installation and continuous operation of water level measurement systems (tide gauges) at subordinate station locations are left to the discretion of the contractor, subject to the approval of the COTR. If the contractor decides to install additional water level stations, then a 30-day minimum of continuous data acquisition is required. For all subordinate stations, data must be collected throughout the entire survey period for which they are applicable, and not less than 30 continuous days. This is necessary to facilitate the computation of an accurate datum reference as per NOS standards. **A deployment of Bottom Mounted Pressure Gauge or GPS buoy at the southwest end of the survey is strongly recommended for a better understanding of tidal propagation and error associated with tidal zoning.**

1.3.3. Tide Component Error Estimation

There is insufficient data with which to perform an accurate error estimation.

1.3.4. Water Level Records: If subordinate water level stations are installed, submit water level data, such as leveling records, field reports, and any other relevant data/reports, including the data downloaded onto diskette/CD as specified in the latest version of the NOS Specifications and Deliverables document.

1.3.4.1. Water level records should be forwarded to the following address:

NOAA/National Ocean Service/CO-OPS
Chief, Engineering Division
N/OPS1 - SSMC4, Station 6531
1305 East-West Highway
Silver Spring, MD 20910

1.3.5. This section is not applicable to this project.

1.3.5.1. This section is not applicable to this project.

1.3.6. This section is not applicable to this project.

1.4. Zoning

1.4.1. The water level station at LAWMA, LA (8764227) is the reference station for predicted tides for hydrography in the Louisiana Coast, LA. The time and height correctors listed below for applicable zones should be applied to the predicted tides at the station indicated during the acquisition and preliminary processing phases of this project.
Preliminary data may be retrieved in one month increments over the Internet from CO-OPS SOAP web services at http://opendap.co-ops.nos.noaa.gov/axis/text.html. The contractor must notify the COTR or the COTR's authorized representative immediately of any problems concerning the predicted tides. Preliminary data are six-minute time series data relative to MLLW in metric units on Greenwich Mean Time. For the time corrections, a negative (-) time correction indicates that the time of tide in that zone is earlier than (before) the predicted tides at the reference station. A positive (+) time correction indicates that the time of tide in that zone is later than (after) the predicted tides at the reference station. For height corrections, the water level heights **relative to MLLW** at the reference station are multiplied by the range ratio to estimate the water level heights relative to MLLW in the applicable zone.

Zone	Time Corrector (min)	Range Ratio	Predicted Reference Station
WGM280	-36	x1.09	8764227
WGM281	-48	x1.09	8764227
WGM282	-54	x1.15	8764227
WGM283	-60	x1.18	8764227
WGM284	-72	x1.22	8764227
WGM410	-66	x1.22	8764227

1.4.2. Polygon nodes and water level corrections referencing LAWMA, LA (8764227) are provided in ASCII format denoted by a *.zdf extension file name. Zoning diagrams, created in MapInfo, are provided in both digital and hard copy format to assist with the zoning. Longitude and latitude coordinates are in decimal degrees. Negative (-) longitude is a MapInfo representation of West longitude.

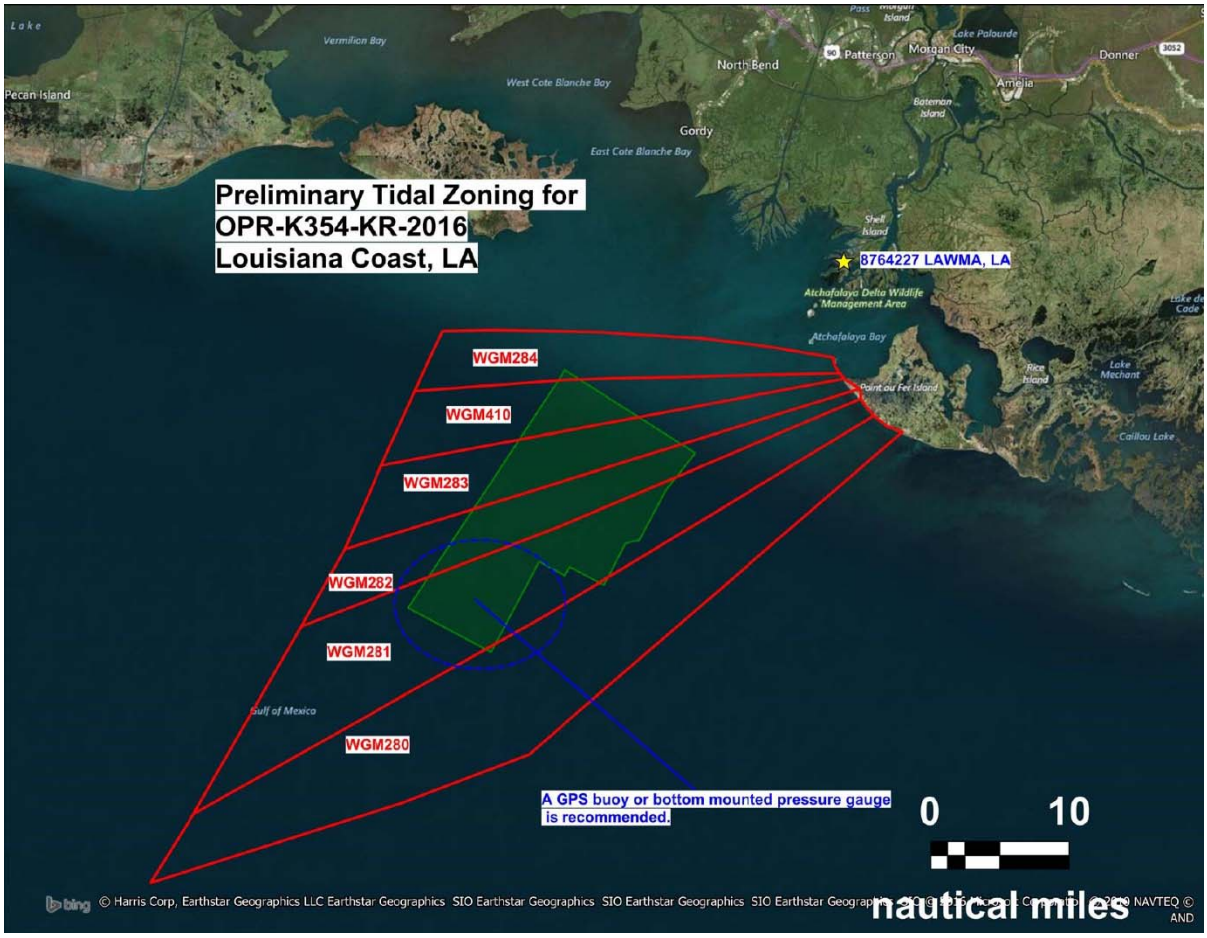
"Preliminary" data for the control water level station, LAWMA, LA (8764227), are available in near real-time and verified data will be available on a weekly basis for the previous week. **These water level data may be obtained from CO-OPS SOAP web services at http://opendap.co-ops.nos.noaa.gov/axis/text.html.**

1.4.3 Zoning Diagram(s)

Zoning diagrams, created in MapInfo® and Adobe PDF, are provided in digital format to assist with the zoning in section 1.4.1.

1.5. Final Zoning

1.5.1. For final processing, apply tidal zoning correctors to "verified" observed data of the NOS control station and/or the final processed data of the subordinate stations.



APPENDIX II

SUPPLEMENTAL SURVEY RECORDS AND CORRESPONDENCE

-----Original Message-----
From: Alexandra.Grodsky@noaa.gov [mailto:Alexandra.Grodsky@noaa.gov]
Sent: Monday, December 19, 2016 9:11 PM
To: jjd@oceansurveys.com
Subject: NCEI acceptance confirmation for Reference ID: 8RYXUH

Dear Joseph DiPalma:

Thank you for sending your data and metadata files to the NOAA National Centers for Environmental Information (NCEI). NCEI received these data, SOUND VELOCITY collected from R/V Ocean Explorer in Gulf of Mexico from 2016-08-18 to 2016-09-30, on 2016-12-14 22:05:25 via S2N.

After reviewing your submission package (metadata and data), I assigned your submission an NCEI Accession Number 0157605. This number is a tracking identifier for the NCEI Ocean Archive. Please reference this number when corresponding with NCEI about these data.

You can find information about these archived data at http://accession.nodc.noaa.gov/0157605.

After further reviewing your data, creating any additional representations of these data in a format that is more preservable in the NCEI Ocean Archive, and developing necessary tracking metadata, NCEI will publish these archived data online. You may access the archival copy of your original data via the link listed above.

In addition to creating an archival copy of these data, NCEI may include all or part of your data into one or more product databases, such as the World Ocean Database.

Please let me know if you have any questions or if you have additional data and documentation that you would like to archive with these data.

Thank you again for choosing to archive your data with the National Centers for Environmental Information (NCEI).

Regards,
Alexandra Grodsky
Alexandra.Grodsky@noaa.gov

Subject: [Send2NCEI] data submission confirmation for Reference ID: 8RYXUH

To: jjd@oceansurveys.com
From: NODC.DataOfficer@noaa.gov

Dear Joseph DiPalma,

Thank you for submitting your data collection, titled "SOUND VELOCITY collected from R/V Ocean Explorer in Gulf of Mexico from 2016-08-18 to 2016-09-30", to the NOAA National Centers for Environmental Information (NCEI). Your submission package has been assigned Reference ID: 8RYXUH. After reviewing your data and metadata, NCEI will update you about the archival status of your submission package.

You will be notified if NCEI creates an archival information package (accession) of your data, including the unique identifier for that archival information package (the NCEI Accession number). When your data are archived, NCEI keeps an exact copy of the data and metadata you sent and will develop necessary tracking and discovery metadata. In addition, NCEI may create additional versions to ensure your data are preserved for long-term access.

Upon completion of these archival ingest actions, NCEI will publish your data online (including a copy of your original files). You will receive another email once your submission package (Reference ID: 8RYXUH) is published for global access. In addition, NCEI may include all or part of your data into one or more product databases, such as the World Ocean Database.

If you have any questions about NCEI archival processes, please contact NODC.DataOfficer@noaa.gov. Also, if at any time you wish to update your submission package, please send an e-mail to NODC.DataOfficer@noaa.gov with your request. Please remember to include your submission package Reference ID.

Thank you again for choosing to archive your data with the National Centers for Environmental Information (NCEI).

NCEI Data Officer Team
NOAA National Centers for Environmental Information NOAA/NESDIS
1315 East-West Highway
Silver Spring, MD 20910
USA

From: Kathryn Pridgen - NOAA Federal [mailto:kathryn.pridgen@noaa.gov]
Sent: Wednesday, November 30, 2016 1:27 PM
To: George Reynolds <ggr@oceansurveys.com>
Subject: Re: OPR-K354-KR-16 CO-OPS Tide Zoning Review
George,
I got some advice about submitting data with or without final verified tides.

"CO-OPS' approval of the Final Tide Zoning is not required prior to completion or submission of bathy deliverables. If CO-OPS finds an issue with modified zoning scheme prior to or post submission, HSD will evaluate the impact to the data and discuss a proper course of action with the KR at that time. It usually takes approximately 90 days after package submission for CO-OPS to evaluate and provide their findings, but again data submission by the KR is not contingent upon completion of this evaluation."

I think this should answer your questions. So don't wait on Co-Ops to verify the final tides to continue processing and submitting the final bathy deliverables. Let me know if you have any other questions.

Katy

Kathryn "Katy" Pridgen
Physical Scientist
NOAA-HSD OPS
301-713-2702 ext 178
kathryn.pridgen@noaa.gov

From: Kathryn Pridgen - NOAA Federal [mailto:kathryn.pridgen@noaa.gov]
Sent: Tuesday, November 29, 2016 4:44 PM
To: George Reynolds <ggr@oceansurveys.com>

Subject: Re: OPR-K354-KR-16 CO-OPS Tide Zoning Review

George,
I think I need to get some more clarification on your question. Please give me some time to discuss it here and with Co-Ops and Ill get back to you as soon as I can with an answer.

Katy

Kathryn "Katy" Pridgen
Physical Scientist
NOAA-HSD OPS
301-713-2702 ext 178
kathryn.pridgen@noaa.gov

On Tue, Nov 29, 2016 at 11:57 AM, George Reynolds <ggr@oceansurveys.com> wrote:

Hi Katy,

Thank you for your response. Per Section 4.1.1, contractors are responsible for generation of water level reducers and final tidal zoning and CO-OPS personnel are responsible for quality control check of contractor submitted data. OSI was operating under the impression that CO-OPS approval of the Final Tide Zoning was required prior to completion of bathy deliverables. However, if this is not the case, OSI will proceed with completion of the final bathy products using the final zoning submitted to CO-OPS derived by JOA from the primary NWLON gauge and subordinate BMPG zoning station and include all required documentation in the DAPR and DR.

For your file, attached is a copy of the transmittal letter for our Zoning Station Report and Zoning Scheme JOA sent to CO-OPS a few weeks ago. The transmittal letter includes a link to the Report FTP site.

Thanks,
George

From: Kathryn Pridgen - NOAA Federal [mailto:kathryn.pridgen@noaa.gov]
Sent: Tuesday, November 29, 2016 9:50 AM
To: George Reynolds <ggr@oceansurveys.com>; Paul Turner - NOAA Federal <paul.turner@noaa.gov>
Subject: Re: OPR-K354-KR-16 CO-OPS Tide Zoning Review

George,

Generally the final tide note to due at the same time as all the rest of the processed data is due. Did you install any tide gauges? Also, were any modifications made to the original tide zones provided to Co-OPS. Usually a discussion of any modifications to tide zones can just be included in the DR and Co-OPS will continue to verify this tide data once all the data is submitted to the processing branch. Please refer to the HSSD 2016 section 4.7.5 for more information on submitting final tides. I hope this answers your questions, let me know if you need any more help.
Thanks,
Katy

Kathryn "Katy" Pridgen
Physical Scientist
NOAA-HSD OPS
301-713-2702 ext 178
kathryn.pridgen@noaa.gov

On Tue, Nov 29, 2016 at 9:33 AM, Kathryn Pridgen - NOAA Federal <kathryn.pridgen@noaa.gov> wrote:

George,

I'll see what I can find out about the Tide zoning submission. Good to hear that data processing is going well. Let me know if you have any other issues I can help with!

Kathryn Pridgen

Kathryn "Katy" Pridgen
Physical Scientist
NOAA-HSD OPS
301-713-2702 ext 178
kathryn.pridgen@noaa.gov

On Mon, Nov 28, 2016 at 5:24 PM, George Reynolds <ggr@oceansurveys.com> wrote:

Hi Kathryn,

Just checking in, we have finished up our initial data processing tasks and are ready to start on the Descriptive Reports. For planning purposes, can you check with CO-OPS regarding their timeline to complete the review our Tide Zoning submittal?

Please let me know if you have any questions.

Thanks
George

George Reynolds
Vice President

OCEAN SURVEYS, INC.
129 Mill Rock Road East, Old Saybrook, CT 06475
T 860-388-4631 x112 **M** 860-395-9521 **F** 860-388-5879
ggr@oceansurveys.com | www.oceansurveys.com
Follow us: LinkedIn | Twitter | Facebook

From: George Reynolds [mailto:ggr@oceansurveys.com]
Sent: Wednesday, November 09, 2016 1:44 PM
To: 'Paul Turner - NOAA Federal' <paul.turner@noaa.gov>; 'Kathryn Pridgen - NOAA Federal' <kathryn.pridgen@noaa.gov>
Subject: OPR-K354-KR-16 Zoning Station Report and Zoning Scheme

Hi Paul, Katy

Attached for your information is a copy of the OPR-K354-KR-16 zoning station report we submitted to CO-OPS.

Please let me know if you have any questions or need additional informnaton.

Thanks
George

-----Original Message-----
From: nathan [mailto:nathan@joasurveys.com]
Sent: Wednesday, November 9, 2016 1:17 PM
To: OET Team <nos.coops.oetteam@noaa.gov>
Cc: _NOS CO-OPS Hydro <nos.coops.hydro@noaa.gov>; George Reynolds <ggr@oceansurveys.com>; Mike Zieserl <mike@joasurveys.com>
Subject: OPr-K354-KR-2016 Zoning Station Report and Zoning Scheme

OET,

We have completed the station package for tide support on OPR-K354-KR-2016. The package has been uploaded to our FTP site. The attached transmittal letter has instructions for retrieving the package. Do not hesitate to contact me if you have any problems retrieving the report or questions about it.

Thanks,
Nathan

--
Nathan Wardwell
JOA Surveys, LLC
www.joasurveys.com
2000 E. Dowling Rd, #10
Anchorage, AK 99507
(907) 227-6635 cell
(907) 561-0136 office

JOA Surveys, LLC
SURVEYING GPS TIDES HYDROGRAPHY

2000 E. Dowling Road, Suite 10
Anchorage, AK 99507
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(907) 561-0143 Fax
www.joasurveys.com

November 9, 2016

To: CO-OPS Ocean Engineering Team

CC: CO-OPS Hydro Planning Team
George Reynolds (Ocean Surveys, Inc.)

Re: Offshore BMPG Installation and Removal Report
Louisiana Coast (JOA 352)
OPR-K354-KR-2016

The station report for the installation and removal of the bottom mounted pressure gauges offshore of the Louisiana Coast in support of OPR-K354-KR-2016 has been completed. The revised zoning scheme and report are included in this submittal. This transmittal letter was submitted via email. The report has been posted to the JOA FTP site:

Directory:	OPR-K354-KR-2016
Filename:	Offshore LA BMPG Station Report 20161109.zip
Host:	ftp.joasurveys.com
Username:	oet
Password:	1305east-west

Note: Because this is an offshore BMPG deployment, not all of the station documentation required for a tertiary tide station by the OCS HSSD is applicable. We provided all of the documentation applicable to the installation and removal of this station.

Sincerely,

Nathan Washburn

_____

nathan@joasurveys.com

Tidal Zoning for OPR-K354-KR2016

Report by: JOA Surveys, LLC
Processor: Mike Zieserl
Client: Ocean Surveys Inc.
Date: November 3, 2016

Summary

Ocean Surveys Inc. performed a hydrographic survey of the coast of Louisiana in the Gulf of Mexico. The survey area was more than 21 km east/west and 34 km north/south. The northern extent of the survey area was 33 km SE of the NWLON station 8764226 LAWMA. The Tides Statement of Work (SOW) required the installation of one offshore bottom mounted pressure gauge (BMPG) in the open ocean near the southern end of the survey area.

The preliminary tidal zoning scheme provided by CO-OPS was based on NWLON station 8764227 LAWMA. The final scheme is based still based on LAWMA, and the geometry remains the same, but the range ratios and time corrections have been updated to reflect the data collected at the offshore BMPG location. The general tidal characteristics for this area are diurnal with a range between 0.4m to 0.6m. The tide moves from offshore to inshore.

Overall 100% of the zones in the final scheme have an uncertainty less than 18 cm at the 95% Confidence Level.

Tide Stations

As per the SOW, dated 3/28/2016, two bottom mounted pressure gauges were collocated near the southern end of the survey area to support hydrography. The BMPG's were installed 64 km SW of NWLON station 8764227 LAWMA (Figure 1). The water levels from the BMPG's at this location were used for zoning purposes only and were designated a unique station number by JOA Surveys, LLC (JOA). The pressure data collected by the BMPG were reduced to water level pressure by removing barometric pressure as measured at the LAWMA NWLON. Water depth was calculated using density measurements from the conductivity and temperature sensors deployed with the BMPG. Data from 2 NWLON stations were also used in refining the tidal zoning: 8764227 LAWMA and 8764314 Eugene Island. All of the stations are listed in Table 1 and shown in Figure 1.

Figure 1 - Overview map showing the tide stations used in the zoning analysis and the preliminary tidal zoning geometry, with the approximate survey area in the background.

Table 1 - List of tide stations used to develop the tidal zoning scheme.

Number	Name	Station Type	Active	Latitude (N)	Longitude (W)	Duration (Days)
8764227	LAWMA	NWLON	Yes	29° 27' N	91° 20.3' W	permanent
8764314	Eugene Island	NWLON	Yes	29° 22' N	91° 23' W	permanent
n/a	Offshore LA BMPG	Zoning	No	29° 03.3' N	91° 48.8' W	38 days

DATUMS

The datums for the BMPG zoning station were computed using the Tide-by-Tide (TBYT) simultaneous comparison method because they were not installed for a calendar month. They were corrected to the current National Tidal Datum Epoch (NTDE) using the Modified Method and the LAWMA NWLON station as control.

The great diurnal range, GT, increases from the offshore BMPG to the Eugene Island NWLON station, then decreases from Eugene Island to the LAWMA NWLON station. The time of the tide for the Eugene Island and LAWMA NWLON stations was derived from their harmonic constituents using the computational procedure for determining the Tropic Intervals TcHHWI and TcLLWI (as these values are not published by CO-OPS). Since harmonic constituents were not derived from the offshore BMPG water level data, the time offset from LAWMA to the BMPG location was taken from the TBYT comparison. The tide progresses from the offshore BMPG to Eugene Island and then onto LAWMA.

Table 2 - Tidal datums used to revise the zoning scheme.

Number	Name	GT	Range ratio relative to LAWMA	TcHHWI	TcLLWI	Average Time offset relative to LAWMA hrs (minutes)
8764227	LAWMA	0.487m	1.00	0.98 hrs	16.42 hrs	0 (0)
8764314	Eugene Island	0.563m	1.16	0.28 hrs	15.39 hrs	-0.86 (-52)
n/a	Offshore LA BMPG	0.416m	0.85	-1.685 (dHWI)	-1.660 (dLWI)	-1.67 (-100)

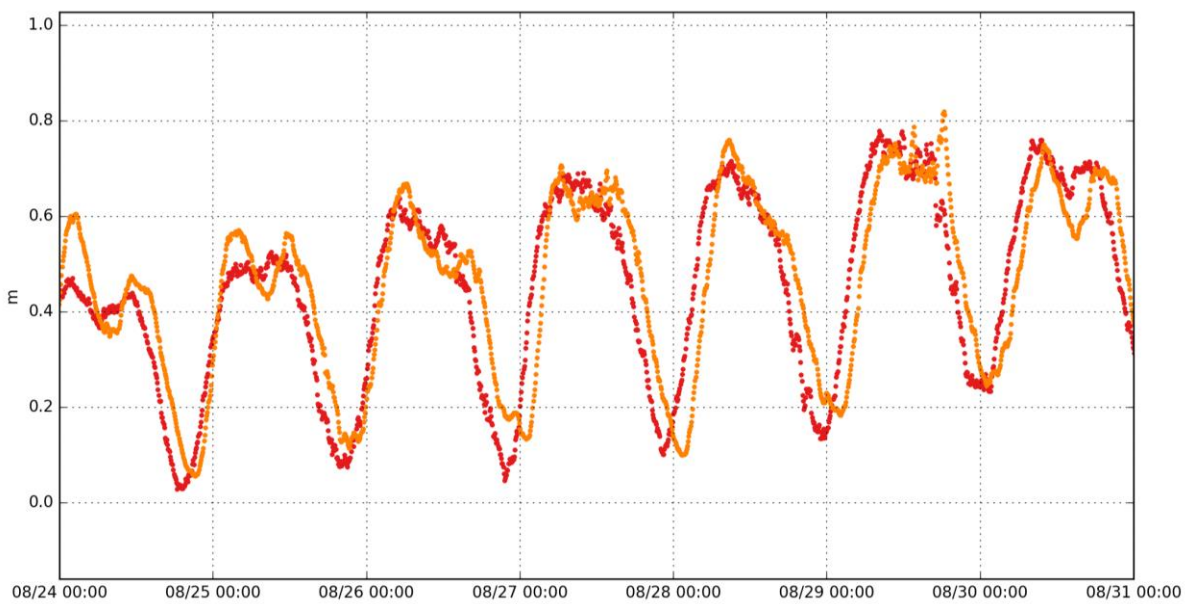

Figure 2 – Comparing Offshore LA BMPG (red) and LAWMA water level data on MLLW

Zoning Scheme

The specifications call for a new zone every 0.06 m change in range and every 0.3 hour progression in time. The range increases from the BMPG at the south end of the survey area to the Eugene Island NWLON near the north end of the survey area by 0.15 m. The range decreases from Eugene Island to LAWMA, but this is outside of the survey area and the area covered by the preliminary zoning. The tide progression from the BMPG to Eugene Island is 0.8 hours. It is another 0.9 hrs for the tide to travel from Eugene Island to LAWMA.

The range correctors in the preliminary zoning scheme (Figure 3) increased from the offshore zoning cells to the inshore zoning cells, which is consistent with the trend observed between the BMPG and Eugene Island. The time corrections in the preliminary zoning showed the tide progressing from north to south, offshore. This trend was not confirmed by the BMPG water level data. Instead, the tide progresses from offshore (BMPG) to inshore (Eugene Island) over 0.8hrs, and then takes another 0.9 hrs to reach LAWMA.

For the final zoning, new range and time correctors were calculated for each tide zone (Figure 4) but the geometry was retained because the observed time and range trends support the zone orientations. The original zone names were also retained. For the sake of these computations, Eugene Island was assumed to be a zone cell directly adjacent to WGM284.

The new range ratios were calculated by first determining the overall change in the GT from Eugene Island to the BMPG location in zone cell WGM281, which was -0.15m. The step change in the GT for each zoning cell from north to south was determined to be -0.03cm. The southernmost cell, WGM280, was assigned the same GT as WGM281 where the BMPG was located, as had been done in the preliminary zoning. Finally, the calculated GT for each zone was divided by the GT at LAWMA to produce the range ratio.

The time corrections were calculated in a similar fashion. The time offset from LAWMA to Eugene Island (from comparison of TcLLHWI and TcHHWI) and from LAWMA to the BMPG (from TBYT) were subtracted to determine the time offset from Eugene Island to the BMPG, which was -48 minutes. The time step for each zone from Eugene Island to the BMPG was about -9 minutes. Beginning with Eugene Island with a time correction from LAWMA of -52 minutes, the time step of -9 minutes was applied to each zone progressing offshore, and rounding each time correction to a 6 minute interval, creating time steps of 6 minutes or 12 minutes between zones.

MLLW water level data from LAWMA was zoned to cell WGM281 using the preliminary and final zoning parameters. These zoned data sets were compared against the BMPG measured water level data on MLLW. A few of the summary statistics of for each comparison are presented in the table below.

Table 3 - Statistics for residuals when comparing preliminary and final zoning schemes to data collected at the zoning BMPG station.

Zone			Average Residual		1-Sigma Residual		RMSE Residual	
Name	NWLON	Zoning Station	Preliminary	Final	Preliminary	Final	Preliminary	Final
WGM281	LAWMA	Offshore LA BMPG	-0.061	0.058	0.133	0.060	0.092	0.083

Figure 3 - Preliminary zoning scheme.

Figure 4 - Final zoning scheme.

Zone Uncertainties

An uncertainty was estimated for each zone using the methodology outlined in a draft paper by Steve Gill dated 03/21/2006 and titled *Error Budget Considerations for Tides – CO-OPS.* The methodology estimates the uncertainty for a zone based on measurement and datum uncertainties for reference stations and RMSE of zoned water levels to a known location.

The measurement uncertainties includes uncertainties for sensor calibration, waves, currents, density, barometric pressure, staff to gauge observations, leveling and interpolation to the time of a sounding. NWLON station LAWMA provided all water level correctors for this survey, and the measurement uncertainties were assumed to be the typical values assigned in the Gill paper (see Appendix I – Reference Station Error).

The datum uncertainty for the LAWMA NWLON station was taken from the list published by CO-OPS on the datums webpage (http://tidesandcurrents.noaa.gov/pdf/Datums_error_gulf_coast.pdf). These published values are derived using Bodnar's regression equations.

The uncertainty for each zone was based on the uncertainty and MN for the reference station and the range corrector for the zone. The calculation of the uncertainty for each zone is shown in Appendix II – Zoning Error. Zone WGM281 and WGM280 have the largest uncertainty of 0.176 m at the 95% CL. Zone WGM283 has the smallest uncertainty of 0.063 m at 95% CL. Overall, 100% of the zones have an uncertainty less than 18 cm.

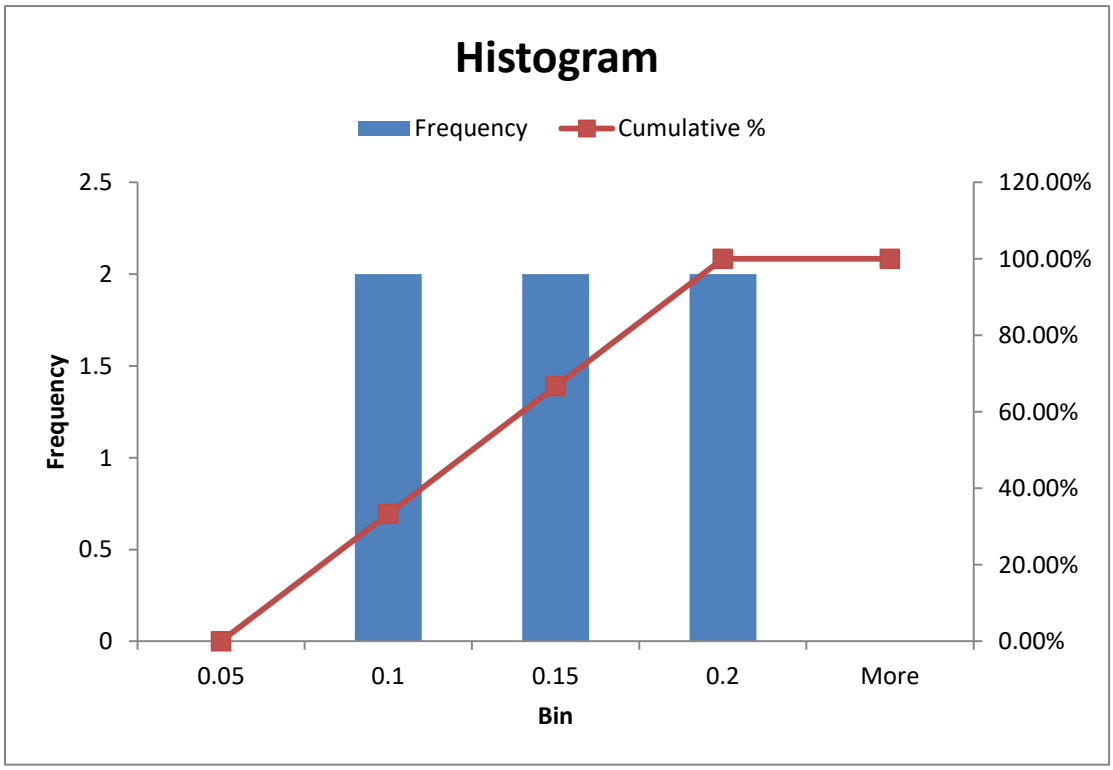

Figure 5 - Histogram of zone uncertainties at the 95% confidence level.

Appendix I – Reference Station Error

Reference Station Error

Measurement Error (S_r)

All values typical as shown in "Error Budget Considerations for Tides - CO-OPS - skgill draft 3/21/2006"

	8764227 LAWMA
Sensor Calibration =	0.003
Dynamic Effects	
waves =	0.000
currents =	0.000
density =	0.000
Processing to Datum	
staff to gauge =	0.020
leveling =	0.005
interpolation =	0.010
Root Sum Square =	**0.023**

Datum Computation Error at 1 Sigma (b)

Datum error estimate as determined by CO-OPS using Bodnar's equation from "Tidal Datum Errors for Gulf Coast of the United States (Florida, Alabama, Mississippi, Louisiana, and Texas) accessed at:
http://tidesandcurrents.noaa.gov/pdf/Datums_error_gulf_coast.pdf

	8764227 LAWMA
Datum Error (FEET) =	0.02
Datum Error (METERS) =	**0.007**

Appendix II – Zoning Error

Zoning Error

Based on: Error Budget Considerations for Tides - CO-OPS, Steve Gill draft, 3/21/2006

Zone	Control Station	Range corrector	MN_c	MN_z	MNR	S_z	S	Zone	95% Confidence Interval CI = b+1.96*S
WGM284	8764227	1.100	0.344 m	0.378 m	0.100	0.055 m	0.060 m	WGM284	0.125 m
WGM410	8764227	1.040	0.344 m	0.358 m	0.040	0.022 m	0.032 m	WGM410	0.070 m
WGM283	8764227	0.970	0.344 m	0.334 m	0.030	0.017 m	0.028 m	WGM283	0.063 m
WGM282	8764227	0.910	0.344 m	0.313 m	0.090	0.050 m	0.055 m	WGM282	0.115 m
WGM281	8764227	0.850	0.344 m	0.292 m	0.150	0.083 m	0.086 m	WGM281	0.176 m
WGM280	8764227	0.850	0.344 m	0.292 m	0.150	0.083 m	0.086 m	WGM280	0.176 m

Control Station Error

Number	Name	b	S_r	MN_c	MNR_{max}	RMS_z	Zoning Station
8764227	LAWMA	0.007 m	0.023 m	0.344	0.150	0.083	Offshore LA BMPG

Notes:

1) ***b*** is the systematic datum error for the reference station estimated using Bodnar's equations.

2) S_r is the random error of measurement for a reference station and is estimated from the sensor calibration, density, waves, currents, barometric pressure, staff shots, leveling and interpolation or measurement to time of sounding.

3) MN_c is the Mean Range for the reference station.

4) MN_z is the Mean Range for the zone and equals MN_c*Range Corrector.*

5) ***MNR*** is the absolute value of the difference between mean ranges of tide between the zone and the tide station, divided by the range of tide at the control station and equals ABS(MN_c-MN_z)/MN_c.

6) MNR_{max} is the maximum *MNR* of all the zones referencing the same station.

7) RMS_z is the RMS of the differences between a reference station zoned to a zoning station.

8) S_z is the random error for zoning and equals MNR / (MNR_{max} / RMS_z)

9) Zoning Station is the station name assigned by JOA to locations throughout the project area where water levels were collected for zoning purposes only.

10) ***S*** is the total random error for a zone and includes the random error for the zone (S_z) along with the random error for measurements at the reference station (S_r). S equals the square root of the sum of S_z and S_r squared.

11) The 95% Confidence Interval for each zone is estimated as the systematic datum error for the reference station (*b*) plus 1.96 times the total random error for the zone (*S*).

From: Paul Turner - NOAA Federal [mailto:paul.turner@noaa.gov]
Sent: Friday, September 23, 2016 10:20 PM
To: George Reynolds <ggr@oceansurveys.com>
Subject: Re: BMG Zoning Gauge Recovery

Hi George

Please continue with your plan to recover the gauge, there is no issue.

Paul
--
Paul Turner
Physical Scientist
NOAA's National Ocean Service
Office of Coast Survey

301-713-2700 ext 106

On Fri, Sep 23, 2016 at 9:10 AM, George Reynolds <ggr@oceansurveys.com> wrote:

Hi Paul,

Today is the end of the 30 day period for our bottom mounted zoning gauge deployment. We are planning to recover the gauge this week unless Co-Ops has any issues with this plan.

Thanks

George

From: Paul Turner - NOAA Federal [mailto:paul.turner@noaa.gov]
Sent: Thursday, June 2, 2016 4:21 PM
To: George Reynolds <ggr@oceansurveys.com>
Cc: Emily Clark - NOAA Federal <emily.clark@noaa.gov>
Subject: Re: OSI, Hydrographic Survey; Request for Task Order Quote Coast Pilot Question

Hi George-

There are no specific items to investigate with regards to the Coast Pilot. You are asked to read and compare the Coast Pilot paragraph descriptions for relevant geographic location and validate the relevant section(s) looking for any significant navigational features that might be helpful for inclusion to the Coast Pilot.

Pertinent information that we'd be interested in receiving includes: Aids to navigation, Landmarks, Ferries, Geographic names, Dangers, Channels, Anchorages; Shoreline changes - Note condition, additions, and deletions of wharves, piers, and other waterfront structures. High-Def Sea level photography to supplement the Coast Pilot narrative. i.e. of major lighthouse, harbor, or views that would assist the mariner in location or orientation.

Thanks,

Paul

From: Paul Turner - NOAA Federal [mailto:paul.turner@noaa.gov]
Sent: Thursday, May 26, 2016 8:07 AM
To: George Reynolds <ggr@oceansurveys.com>
Cc: Emily Clark - NOAA Federal <emily.clark@noaa.gov>
Subject: Re: OSI, Hydrographic Survey; Request for Task Order Quote Coast Pilot Question

Hi George-

The coast pilot requirement is the same as last year and you will valid the existing coast pilot unless you are provided with explicit instructions from OCS Coast Pilot. I've submitted that request and will forward that to you once I've received it.

Paul

--
Paul Turner
Physical Scientist
NOAA's National Ocean Service
Office of Coast Survey
301-713-2700 ext 106
Paul.Turner@noaa.gov

On Thu, May 26, 2016 at 8:03 AM, George Reynolds <ggr@oceansurveys.com> wrote:

Good Morning,

We have the following question regarding the Coast Pilot requirement.

Per the Project Instructions “Perform a Coast Survey Review”, Per the HSSD, 8.1.3. “A Coast Pilot Field Report will be Provided by HSD Operations” The question is, will we be doing a Coast Pilot verification or, like last year, is the assignment valid only if we are provided explicit instructions on what to verify?

Thanks

George

From: Paul Turner - NOAA Federal [mailto:paul.turner@noaa.gov]
Sent: Tuesday, August 2, 2016 10:34 AM
To: George Reynolds <ggr@oceansurveys.com>
Cc: Kathryn Pridgen - NOAA Federal <kathryn.pridgen@noaa.gov>; Emily Clark - NOAA Federal <emily.clark@noaa.gov>
Subject: Final Project Instructions

Good morning George-

The revised PI's for OSI's OPR-K354-KR-16 Approaches to Atchafalaya Bay are attached.

The revision reflects the removal of the requirement to level the subordinate gauge under the Vertical Control section. OSI is using a Pressure Mounted Bottom Gauge as a subordinate tide gauge which does not have a required leveling component.

Paul

--

Paul Turner
Physical Scientist
NOAA's National Ocean Service
Office of Coast Survey

301-713-2700 ext 106
Paul.Turner@noaa.gov

From: Paul Turner - NOAA Federal [mailto:paul.turner@noaa.gov]
Sent: Thursday, October 6, 2016 9:38 AM
To: George Reynolds <ggr@oceansurveys.com>
Cc: Kathryn Pridgen - NOAA Federal <kathryn.pridgen@noaa.gov>
Subject: Re: OPR-K354-KR-16 SOS Sensor Calibration

Hi George

I think you may have interpreted the HSSD section 5.2.2.3 as a calibration required at the end of survey operations. You only need to recalibrate a sensor if it will no longer be used on the project. Based on the information that you provided me, you have met the calibration timeline of at least once per year and do not need to take any action.

Paul

On Wed, Oct 5, 2016 at 11:04 PM, George Reynolds <ggr@oceansurveys.com> wrote:

Hi Paul,

We have a question regarding the need to complete a post survey calibration of our sound speed equipment. The oldest calibration date for the SOS instruments used on this project is July 19, 2016 which is only ~2.5 months prior to the completion of the survey. With a relatively fresh manufactures calibration on all of our sensors, are we required to provide post survey calibration certificates for the SOS units employed on this survey?

Please let me know if you have any questions or need additional information.

Thanks

George

On Tuesday, October 11, 2016 3:05 PM, Brian Mohr - NOAA Federal <brian.mohr@noaa.gov> wrote:

Got them, thank you..

Brian Mohr
Physical Scientist - Data Manager
Hydrographic Surveys Division
brian.mohr@noaa.gov
301 713 2707 x116

On Thu, Oct 6, 2016 at 8:54 AM, <blj@oceansurveys.com> wrote:

Good Morning,

Attached are the survey outlines for Surveys H12905, H12906, H12907, and H12908 under project number OPR-K354-KR-16.

Please let me know if there is any additional information required.

Regards,

Bonnie

********** ********** ***
Bonnie Johnston
OCEAN SURVEYS, INC.
129 Mill Rock Road East, Old Saybrook, CT 06475
T 860-388-4631 x158 **M** 781-975-6687 **F** 860-388- 5879
blj@oceansurveys.com | www. oceansurveys.com
Follow us: LinkedIn | Twitter | Faceb ook

A note to the reader about this e-mail correspondence: Sections that have either been superseded or are not pertinent to wellheads have been marked with a black line strike through.

From: Paul Turner - NOAA Federal [mailto:paul.turner@noaa.gov]
Sent: Tuesday, May 10, 2016 1:18 PM
To: George Reynolds <ggr@oceansurveys.com>
Cc: Kathryn Pridgen - NOAA Federal <kathryn.pridgen@noaa.gov>
Subject: OPR-K354-KR-16 Draft Files

Hi George-

~~You should be hearing from NOAA's A.G.O. in the next week or so regarding the task order for OPR-K354-KR-16.~~

~~I've attached the draft CSF & PRF along with a project layout for reference and planning purpose's. Please note the following:~~

- ~~Change in sheet limits and total SNM's have been reduced to a total of 130 SNM's and **sheet H12906** has a special coverage requirement of 200 meter set line spacing (SSS with either SB or MB) for all waters less then 6 meters water depth.~~
- ~~The other three sheets are assigned as complete coverage with the option for 100% SSS with concurrent MB.~~
- With respect to **BSSE wellheads**, these features should only be recommended for charting within the FFF if the hydrographer feels the object merits individual cartographic representation; otherwise, the gridded bathymetry can be considered sufficient (where the feature is flagged with "descrp = delete" and "remrks=obstruction addressed as represented in the surface") - see HSSD Section 7.
- ~~All **Offshore Platforms** (OFSPLF) were assigned within the CSF. Either visually confirm existing charted platforms or develop non-existing, charted platforms for removal from the chart. Refer to HSSD Section 7.3.~~

~~Please let me know if you have any questions or comments at this time and you will receive all the project files and instructions once everything has been reviewed and approved through A.G.O.~~

Thanks,

Paul
--
Paul Turner
Physical Scientist
NOAA's National Ocean Service
Office of Coast Survey

301-713-2700 ext 106
Paul.Turner@noaa.gov

From: Paul Turner - NOAA Federal <paul.turner@noaa.gov>
Date: 4/22/16 11:21 AM (GMT-05:00)
To: George Reynolds <ggr@oceansurveys.com>
Cc: Kathryn Pridgen - NOAA Federal <kathryn.pridgen@noaa.gov>
Subject: OPR-K354-KR-16_Sheets

Hi George-

~~I've revised and adjusted the sheet limits for OPR-K354-KR-16 and have attached a shp file with the draft limits. Please use this area for planning purpose's.~~

~~Please refer to the screen grab that I've also included regarding the sheet priorities. At this point, I have not assigned H numbers but will be working on getting you a complete (draft) csf/prf which will include all assigned sheets, junctions, bottom samples, etc....I am hoping to get this to you the week of May 2nd - 6th pending HSD approval.~~

The following are a few items to consider regarding planning purpose's for this project.

~~**Coverage Requirements:**~~

~~**For sheets 1, 2, 4 & 5** - Complete Coverage accomplished using either: A) Complete coverage MBES depth and backscatter data, or B) 100% SSS coverage with concurrent set line spacing MBES depth and backscatter data.~~

~~**For Sheet 3**, 200 M set line spacing using SSS coverage with concurrent SBES depth data.~~

Additional Tasks:

Wellhead Investigation Requirement

For assigned BSSE wellheads (OBSTRN CATOBS=2):

1. If obstruction is found and considered a danger to navigation, develop the feature (7.3.3), designate the feature (7.4), submit it as a DtoN (1.5), and include it in the FFF (7.3).
2. If obstruction is found and merits individual cartographic representation, develop the feature (7.3.3), designate it (7.4), and submit in FFF (7.3).
   Note: if the obstruction is deeper than 20m then it is highly unlikely to merit individual cartographic representation.
3. If obstruction is found and does not merit cartographic representation, do not investigate it as a feature. Include it in the FFF with “descrp = delete” and “remrks=obstruction addressed as represented in the surface”
4. If the obstruction is not found, in cases where 100% SSS with concurrent multibeam is being used as the primary coverage technique, a 50m disproval search radius using a technique described in Section 7.3.4 is necessary.

This project currently has ~255 well heads within the sheet limits.

~~**Vertical Control:**~~

~~Discrete tides using the Lawma, LA NWLON Gauge.~~

~~And~~

~~OCS would also like a VDatum proposal which I will provide you with more information nearly next week. I am still writing up that portion and we can have a call about that to discuss the details in involved.~~

I will follow-up with you later next week regarding the project instructions and files.

Paul

--

Paul Turner
Physical Scientist
NOAA's National Ocean Service
Office of Coast Survey

301-713-2700 ext 106
Paul.Turner@noaa.gov

APPROVAL PAGE

H12907

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 NCEI for archive

- H12907_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- H12907_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.

Briana Welton Hillstrom

Digitally signed by HILLSTROM.BRIANA.WELTON.1267667531
Date: 2018.06.15 14:56:32 -04'00'

Approved:_____

Commander Briana W. Hillstrom, NOAA
Chief, Atlantic Hydrographic Branch