H13504

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	H13504

LOCALITY

State(s):	Texas
General Locality:	Western Gulf of Mexico
Sub-locality:	10NM SSW from Freeport

2021

CHIEF OF PARTY
Bridget W. Bernier

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13504**

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

State(s):	**Texas**
General Locality:	**Western Gulf of Mexico**
Sub-Locality:	**10NM SSW from Freeport**
Scale:	**10000**
Dates of Survey:	**08/18/2021 to 10/05/2021**
Instructions Dated:	**05/13/2021**
Project Number:	**OPR-K380-KR-21**
Field Unit:	**Leidos**
Chief of Party:	**Bridget W. Bernier**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter Side Scan Sonar**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 15N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

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Descriptive Report to Accompany Survey H13504

Project: OPR-K380-KR-21

Locality: Western Gulf of Mexico

Sublocality: 10NM SSW from Freeport

Scale: 1:10000

August 2021 - October 2021

Leidos

Chief of Party: Bridget W. Bernier

A. Area Surveyed

H13504 was located 10NM SSW from Freeport, Texas; with southern extents approximately 10.2km offshore continuing north to approximately 10.7km offshore of Freeport, TX (Figure 1). The survey was conducted in accordance with coverage requirements listed in the Project Instructions.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
28° 52' 11.4" N 95° 29' 10.33" W	28° 40' 40.47" N 95° 10' 30.18" W

Table 1: Survey Limits

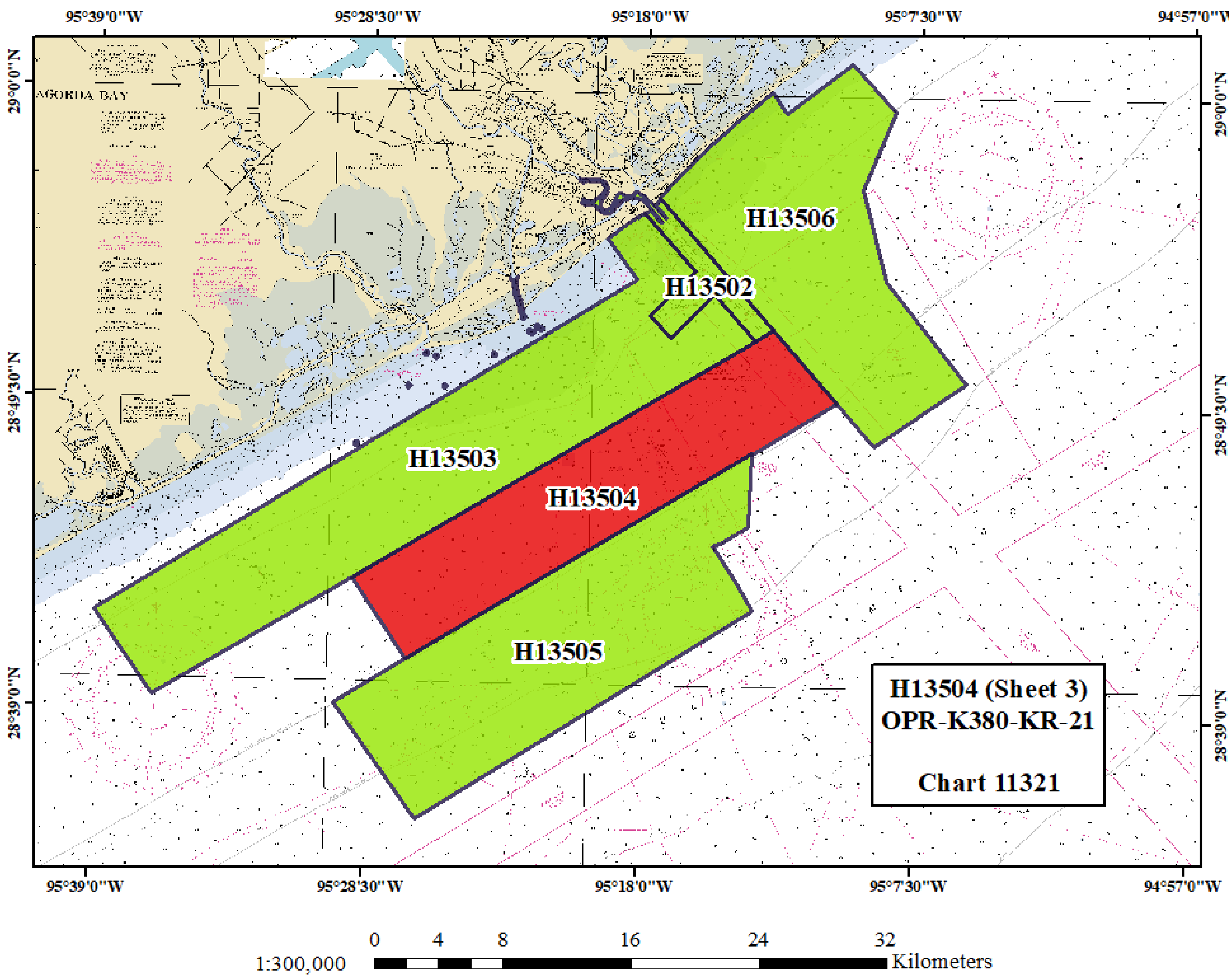

Figure 1: H13504 Survey Bounds

Survey limits were acquired in accordance with the requirements in the Project Instructions and the Hydrographic Survey Specifications and Deliverables (HSSD), April 2021.

A.2 Survey Purpose

This survey covers the general vicinity of the entrance channel to Port Freeport, Texas between the U.S. Coast Guard Station on the northwest of the entrance and Quintana Harbor to the southwest. The survey will wind 4.7 nautical miles south and west, around the Dow Chemical Plant Thumb to the Freeport Channel terminus. The surveyed area extends offshore 11 nautical miles to cover the approach channel, and 18 nautical miles southwest and 8 nautical miles northwest, outside safety fairway, where the AIS traffic deems intensity. Port Freeport, TX is undergoing channel expansion and deepening administered by the U.S Army

Corps of Engineers. Freeport will become the deepest port in Texas once the entrance and terminal channels reach the authorized 51-56 feet depth. With the physical position on the Intercoastal Waterway, direct rail and highway connections to major Texas hubs, and the deepened channels, Port Freeport is poised to exceed its current 28th ranking as the U.S. busiest port in tonnage transfer. Several powerful storms impacted the Port Freeport since the offshore vicinity was last surveyed in 2002 and the nearshore vicinity was last surveyed in the 1930s and 1960s. The Office of Coast Survey expects that modern hydrographic techniques will find significant changes to the seabed due to hurricane forces transforming the seafloor. Survey data from this project is intended to supersede all prior survey data in the common area.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

Leidos warrants only that the survey data acquired by Leidos and delivered to NOAA under Contract 1305M220DNCNJ0056 reflects the state of the sea floor in existence on the day and at the time the survey was conducted.

H13504 was surveyed in accordance with the following documents:
1. 1305M221FNCNJ0270 signed.pdf, received 08 June 2021
2. Hydrographic Survey Specifications and Deliverables (HSSD), April 2021
3. OPR-K380-KR-21_PRF_FINAL_05032021.000, received 08 June 2021
4. OPR-K380-KR-21_CSF_FINAL_05032021.000, received 08 June 2021
5. OPR-K380-KR-21 Project Brief, held 24 June 2021
6. OPR-K380-KR-21 and OPR-K380-KR-21 feature guidance follow-up.pdf, 30 July 2021
7. 1305M221FNCNJ0270 - Modification P21001.pdf received 11 August 2021

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 Sheets 2 through 5	Complete Coverage (Refer to HSSD Section 5.2.2.3)

Table 2: Survey Coverage

Leidos chose to achieve the coverage requirement using Complete Coverage, Option B (100% side scan sonar coverage with concurrent multibeam). Survey coverage achieved was in accordance with the requirements in the Project Instructions and the HSSD (Figure 2 through Figure 4).

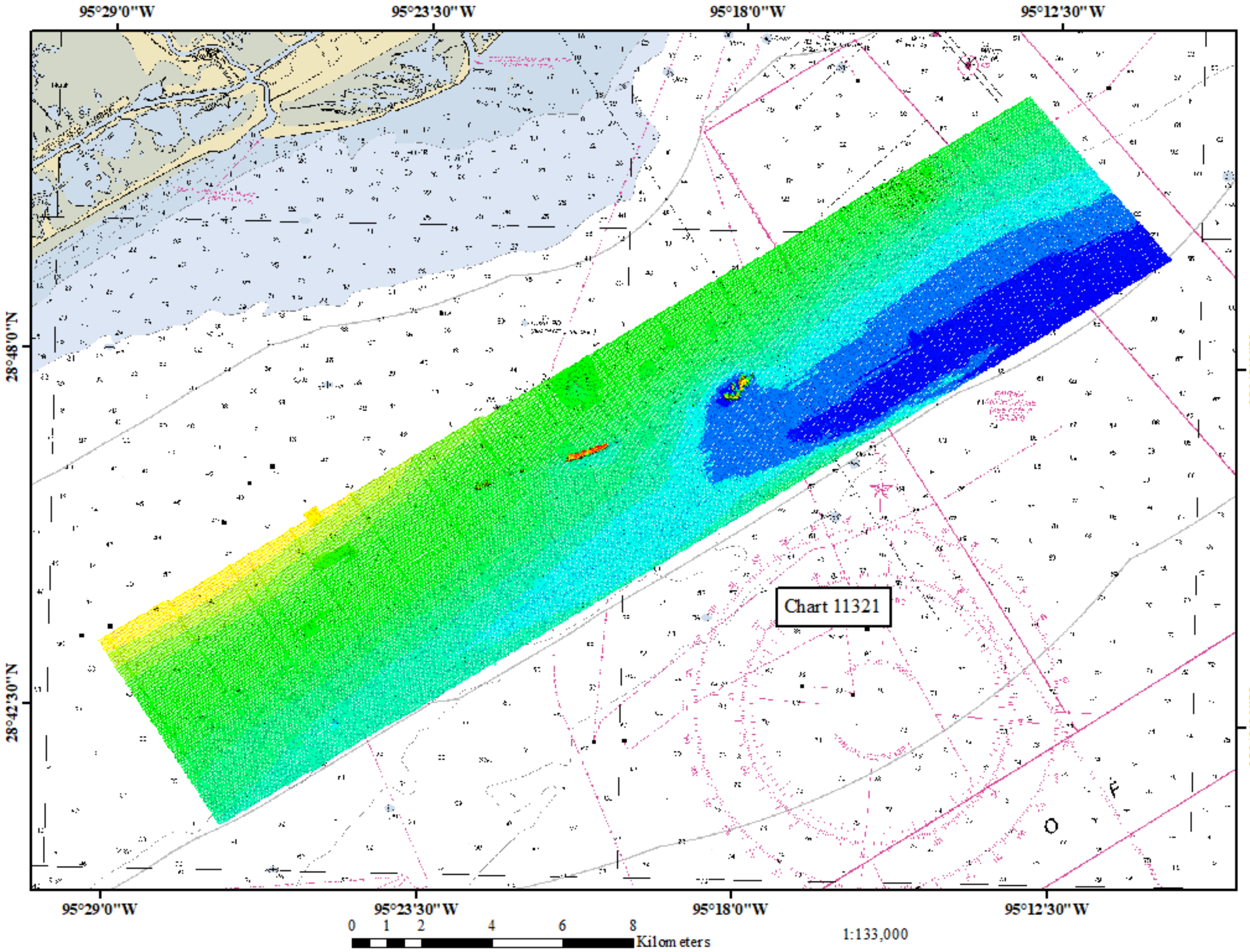

Figure 2: Final Bathymetry Coverage for H13504

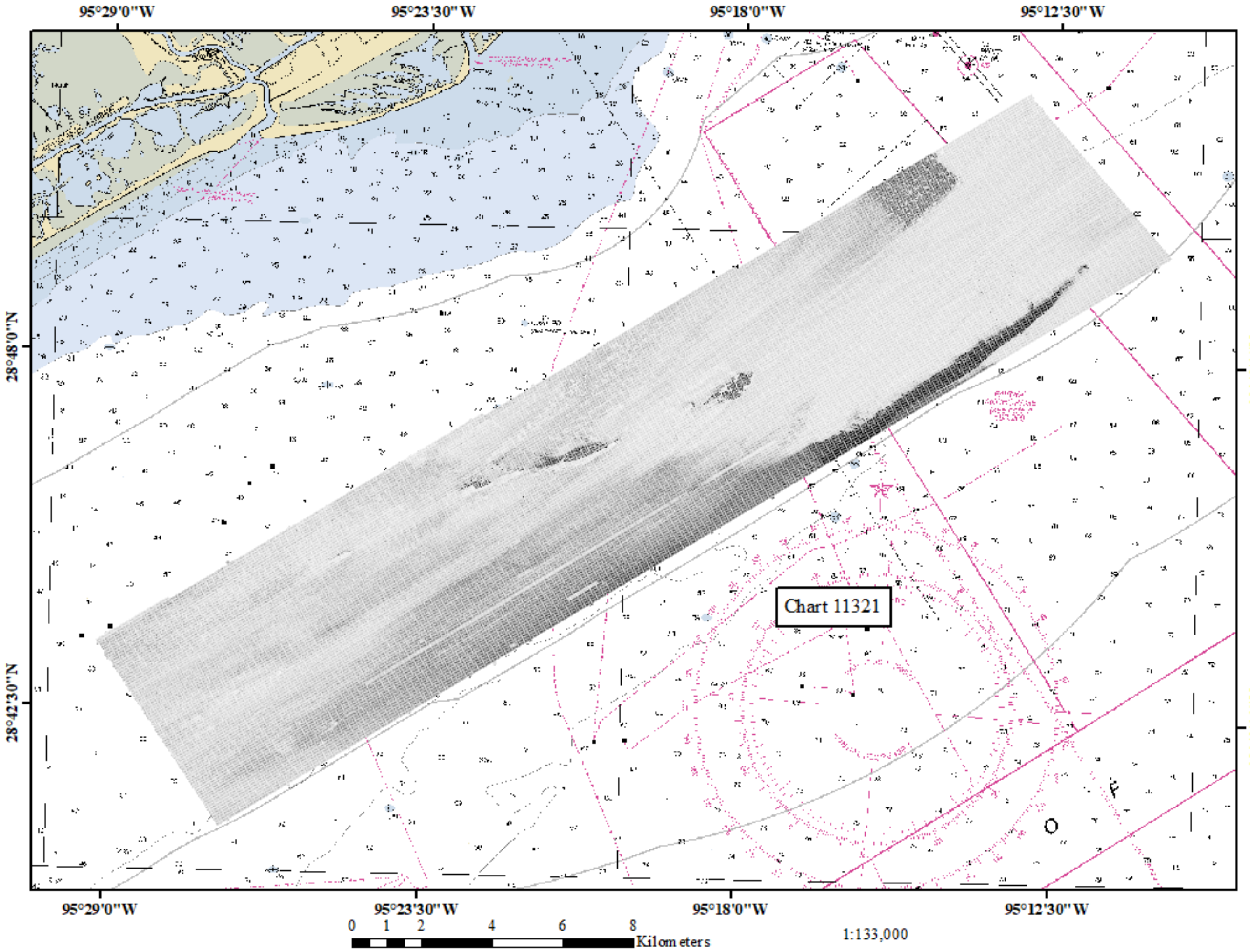

Figure 3: Final Side Scan Coverage for H13504 (First 100% Coverage)

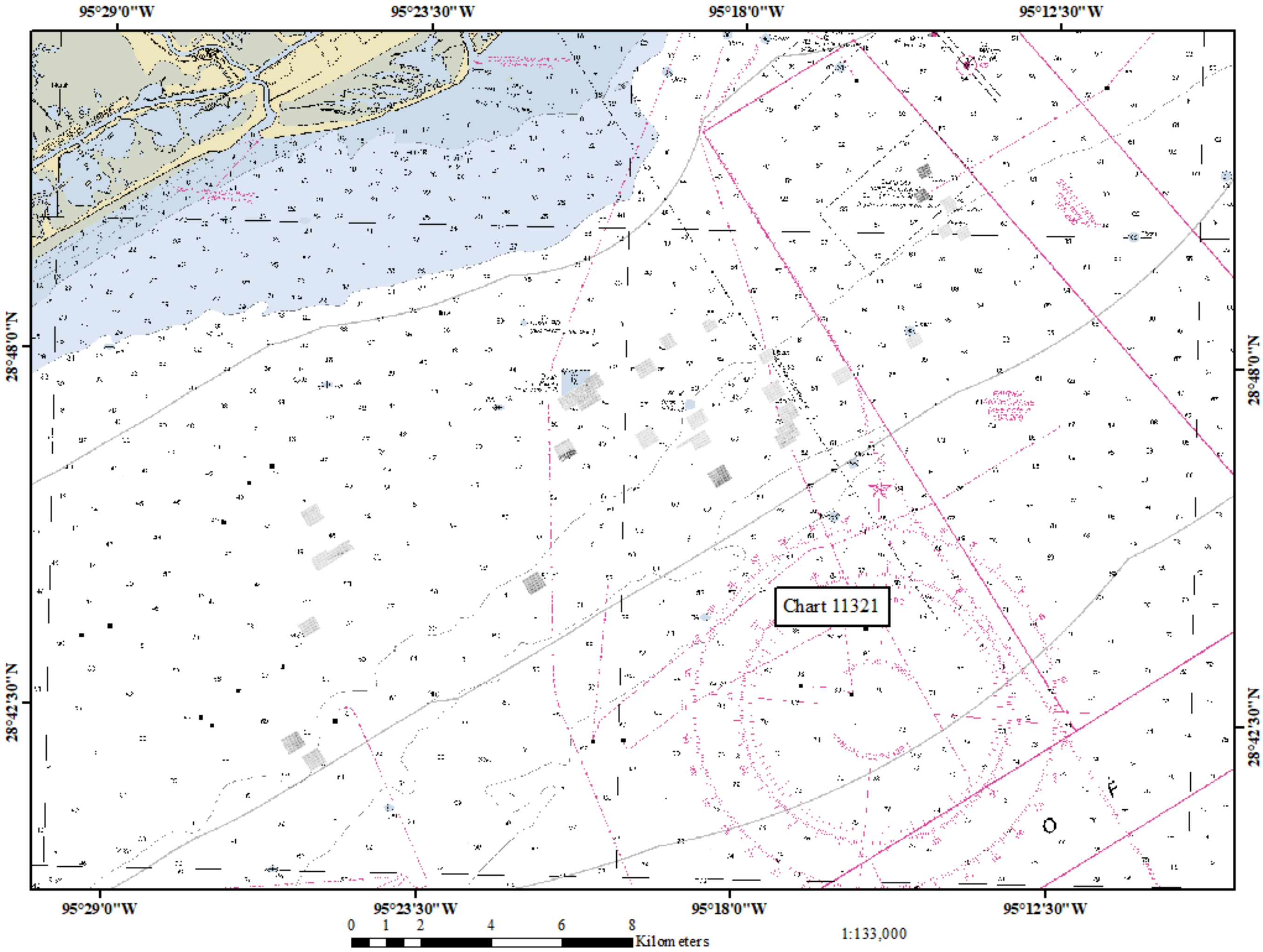

Figure 4: Final Side Scan Coverage for H13504 (Second 100% Coverage)

A.6 Survey Statistics

The following table lists the mainscheme and crossline acquisition mileage for this survey:

	HULL ID	*M/V Atlantic Surveyor*	*Total*
LNM	**SBES Mainscheme**	0	0
	MBES Mainscheme	0	0
	Lidar Mainscheme	0	0
	SSS Mainscheme	0	0
	SBES/SSS Mainscheme	0	0
	MBES/SSS Mainscheme	1401.75	1401.75
	SBES/MBES Crosslines	65.30	65.30
	Lidar Crosslines	0	0
Number of Bottom Samples			8
Number Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total SNM			56.33

Table 3: Hydrographic Survey Statistics

The following table lists the specific dates of data acquisition for this survey:

Survey Dates	Day of the Year
08/18/2021	230

Survey Dates	Day of the Year
08/23/2021	235
08/24/2021	236
08/25/2021	237
08/26/2021	238
08/27/2021	239
08/28/2021	240
08/29/2021	241
08/30/2021	242
08/31/2021	243
09/01/2021	244
09/02/2021	245
09/03/2021	246
09/04/2021	247
09/29/2021	272
09/30/2021	273
10/02/2021	275
10/05/2021	278

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Leidos used their ISS-2000 software on a Windows platform to acquire these survey data. Survey planning and data analysis were conducted using the Leidos SABER software on Linux platforms. Side scan sonar (SSS) data were collected on a Windows platform using Klein's SonarPro software. Subsequent processing and review of the SSS data, including the generation of coverage mosaics, were accomplished using SABER.

A detailed description of the systems and vessels used to acquire and process these data is included in the Data Acquisition and Processing Report (DAPR) for OPR-K380-KR-21, delivered previously with H13502. There were no variations from the equipment configuration described in the DAPR.

B.1.1 Vessels

The following vessels were used for data acquisition during this survey:

Hull ID	***M/V Atlantic Surveyor***
LOA	110 feet
Draft	9 feet

Table 5: Vessels Used

Figure 5: M/V Atlantic Surveyor

The M/V Atlantic Surveyor (Figure 5) was used to collect multibeam echo sounder (MBES) (RESON SeaBat T50), side scan sonar (SSS) (Klein 4000), and sound speed data during twenty-four hours per day survey operations.

A detailed description of the vessel used is included in the DAPR.

B.1.2 Equipment

The following major systems were used for data acquisition during this survey:

Manufacturer	Model	Type
Teledyne RESON	SeaBat T50-R	MBES
Klein Marine Systems	System 4000	SSS
Applanix	POS MV 320 v5	Positioning and Attitude System
AML Oceanographic	MVP30	Sound Speed System

Table 6: Major Systems Used

A detailed description of the equipment installed is included in the DAPR.

B.2 Quality Control

B.2.1 Crosslines

Multibeam echo sounder crosslines acquired for this survey totaled 4.66% of mainscheme acquisition. The resulting crossline to mainscheme percentage met the requirement to achieve approximately four percent of mainscheme mileage for a Complete Coverage multibeam survey (Section 5.2.4.2 of the HSSD). H13504 requirements were for Complete Coverage, Option B, based on the classifications defined in Section 5.2.2.3 of the HSSD.

The mainscheme lines were spaced 80 meters apart. Crosslines were generally spaced 2,000 meters apart based on line spacing and linear nautical miles of each survey area. In the field, hydrographers conducted daily comparisons of mainscheme to near nadir crossline data to ensure that no systematic errors were introduced and to identify potential problems with the survey systems. After the application of all correctors and completion of final processing in the office, separate CUBE PFM grids were built at 1-meter resolution. One grid contained the full valid swath (±65° from nadir, Class 2) of mainscheme multibeam and the other included only the near nadir swath (±5° from nadir, Class 1) crossline data. The difference grid was created by subtracting the 1-meter H13504 mainscheme CUBE depths from the 1-meter H13504 crossline CUBE depths.

The SABER Frequency Distribution Tool was used to analyze the difference grid created from the mainscheme and crossline PFM grids and the results of the analysis were compiled into the following section.

Section 5.2.4.2 of the HSSD states that the depth difference values are to be within the maximum allowable TVU, which for the range of depths observed in the crossline PFM comparison area (12.868 to 20.082 meters) was calculated to be between 0.527 to 0.564 meters. Comparisons of the final crossline data versus final mainscheme data showed that 99.99% of comparisons were within 0.300 meters or less within the calculated allowable TVU ranges (Figure 6). A single difference exceeded the maximum TVU, 0.608 meters, which was due steep slope. The distribution is spread about zero for all comparisons as presented in Figure 7.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	85667	20.64	39726	9.57	41765	10.06	4176	1.01
>0.01-0.02	68319	37.10	31900	17.26	36419	18.84		
>0.02-0.03	68873	53.69	31162	24.76	37711	27.92		
>0.03-0.04	57887	67.64	26041	31.04	31846	35.60		
>0.04-0.05	48006	79.21	21187	36.14	26819	42.06		
>0.05-0.06	31168	86.72	13897	39.49	17271	46.22		
>0.06-0.07	21405	91.87	10259	41.96	11146	48.90		
>0.07-0.08	12230	94.82	6316	43.49	5914	50.33		
>0.08-0.09	8561	96.88	4636	44.60	3925	51.27		
>0.09-0.1	4986	98.08	2957	45.31	2029	51.76		
>0.1-0.11	2821	98.76	1734	45.73	1087	52.03		
>0.11-0.12	1733	99.18	1165	46.01	568	52.16		
>0.12-0.13	1057	99.44	780	46.20	277	52.23		
>0.13-0.14	619	99.59	486	46.32	133	52.26		
>0.14-0.15	470	99.70	393	46.41	77	52.28		
>0.15-0.16	398	99.79	368	46.50	30	52.29		
>0.16-0.17	322	99.87	305	46.58	17	52.29		
>0.17-0.18	167	99.91	164	46.61	3	52.29		
>0.18-0.19	120	99.94	119	46.64	1	52.29		
>0.19-0.2	81	99.96	79	46.66	2	52.29		
>0.20-0.30	163	99.99	159	46.70	4	52.29		
>0.30-0.608	11	100.00	9	46.70	2	52.29		
Total	415054	100.00%	193832	46.70%	217046	52.29%	4176	1.01%
Reference Grid: H13504_MB_1m_MLLW_cross_CUBE_pfm_H13504_MB_1m_MLLW_main_CUBE_pfm.dif								

Figure 6: Tabular Results Crossing Analysis, Crosslines vs. Mainscheme Lines

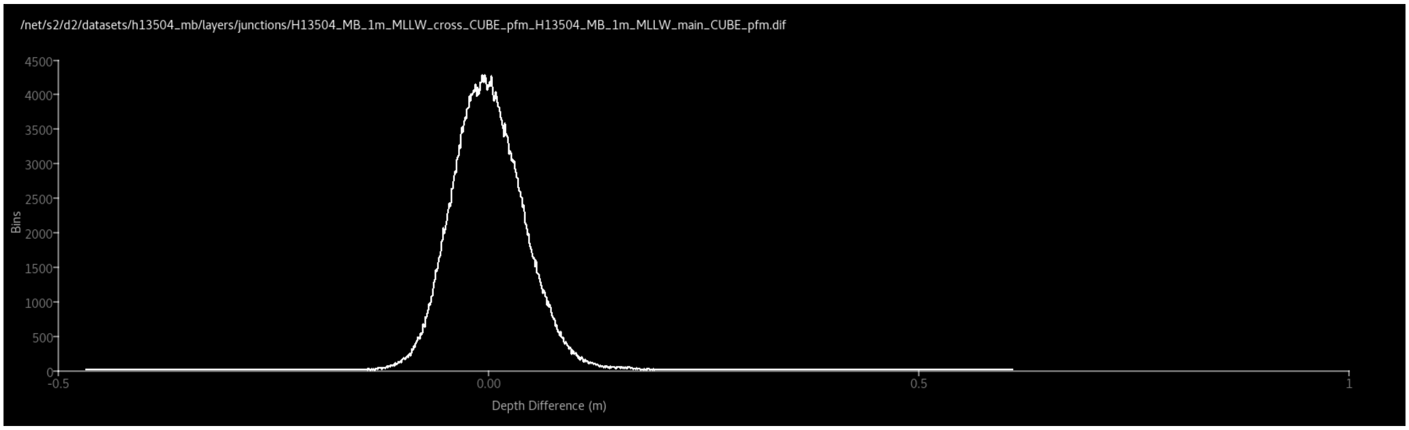

Figure 7: Plot of Crossing Analysis Crosslines vs. Mainscheme Lines

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.093 meters	0.20 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
M/V Atlantic Surveyor	1.0 meters/second	1.0 meters/second	1.0 meters/second	1.0 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

For specific details on the use and application of the SABER Total Propagated Uncertainty (TPU) model, refer to the DAPR. Once the TPU model was applied to the GSF bathymetry data, each beam was attributed with the horizontal uncertainty and the vertical uncertainty at the 95% confidence level. The vertical and horizontal uncertainty values, estimated by the TPU model for individual multibeam soundings, varied little across the dataset, tending to be most affected by beam angle. Individual soundings that had vertical and horizontal uncertainty values above IHO S-44 6th Edition, Order 1a were flagged as invalid during the uncertainty attribution.

As discussed in the DAPR, SABER generates two vertical uncertainty surfaces; the Hypothesis Standard Deviation (Hyp. StdDev) and the Hypothesis Average Total Propagated Uncertainty (Hyp. AvgTPU). A third vertical uncertainty surface is generated from the larger value of these two uncertainties at each node and is referred to as the Hypothesis Final Uncertainty (Hyp. Final Uncertainty).

Per HSSD Section 5.2.2.2, H13504 depth data fell within a single grid resolution at 1-meter.

The final H13504 1-meter PFM CUBE surface contained final vertical uncertainties that ranged from 0.210 meters to 1.029 meters. The IHO Order 1a maximum allowable vertical uncertainty was calculated to range between 0.520 to 0.569 meters, based on the minimum CUBE depth (10.959 meters) and maximum CUBE depth (20.939 meters). Results from the SABER Check PFM Uncertainty function identified that there were 324 nodes in the final H13504 1-meter PFM CUBE surface with final vertical uncertainties that exceeded IHO Order 1a allowable vertical uncertainty. These nodes were all associated with features, particularly within the bounds of the charted fish haven area, and in areas of steep slopes along the coral outcroppings. The SABER Frequency Distribution Tool was also used to review the Hyp. Final Uncertainty surface within the final H13504 1-meter PFM grid. Results showed that 99.99% of all nodes had final uncertainties less than or equal to maximum allowable vertical uncertainty of 0.360 meters, which was below the allowable calculated TVU range.

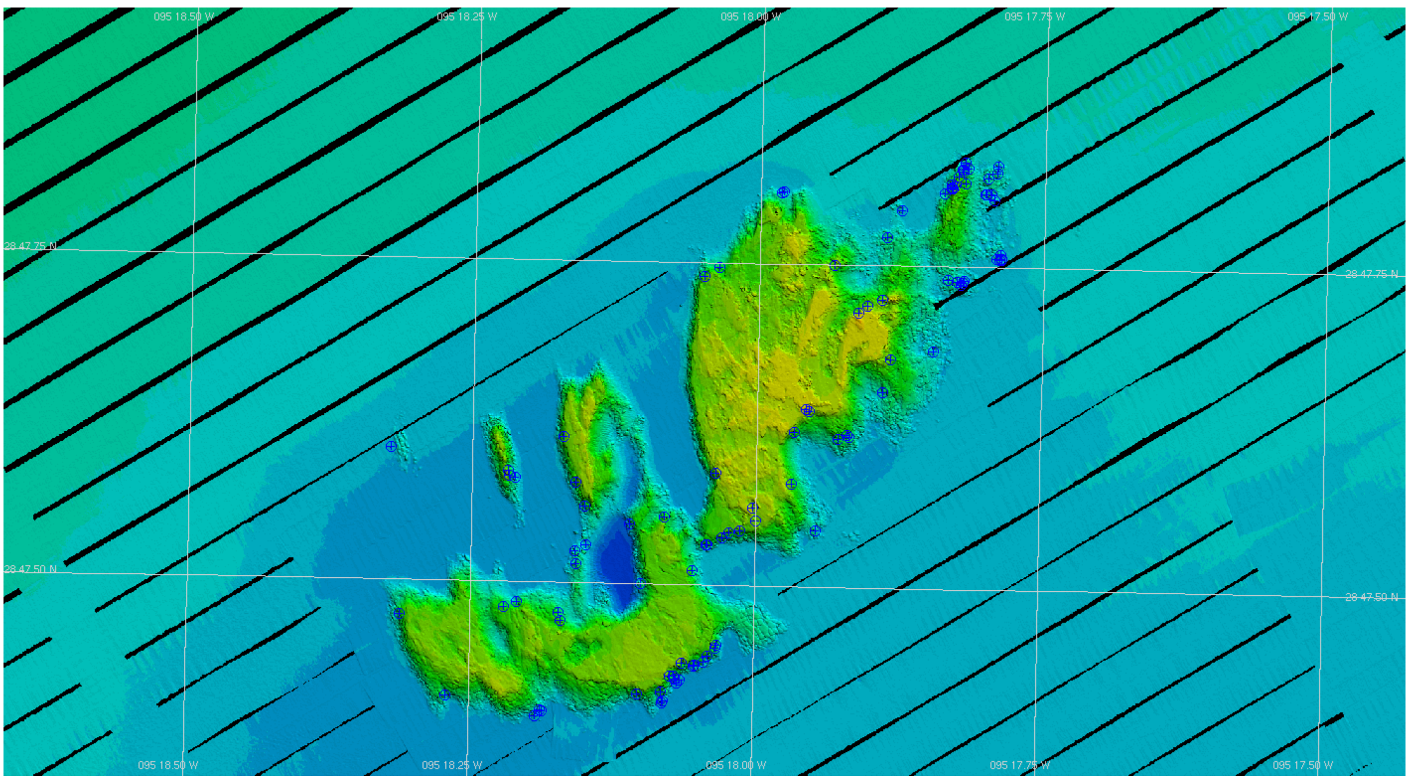

Figure 8: Example Nodes in H13504 1-meter CUBE surface with Uncertainty Exceeding (Blue Symbols) IHO Along Slopes

B.2.3 Junctions

Per the Project Instructions, junction analysis was performed between H13504 and the surveys listed in the table below. Figure 9 shows the general locality of H13504 as it relates to the sheets against which junctions were performed. Analysis of H13504 to H13505 and H13506 will be provided within those respective Descriptive Reports as final analysis and processing efforts for H13505 and H13506 remain on-going. Analysis between H13504 to H13502 and H13503 are discussed below.

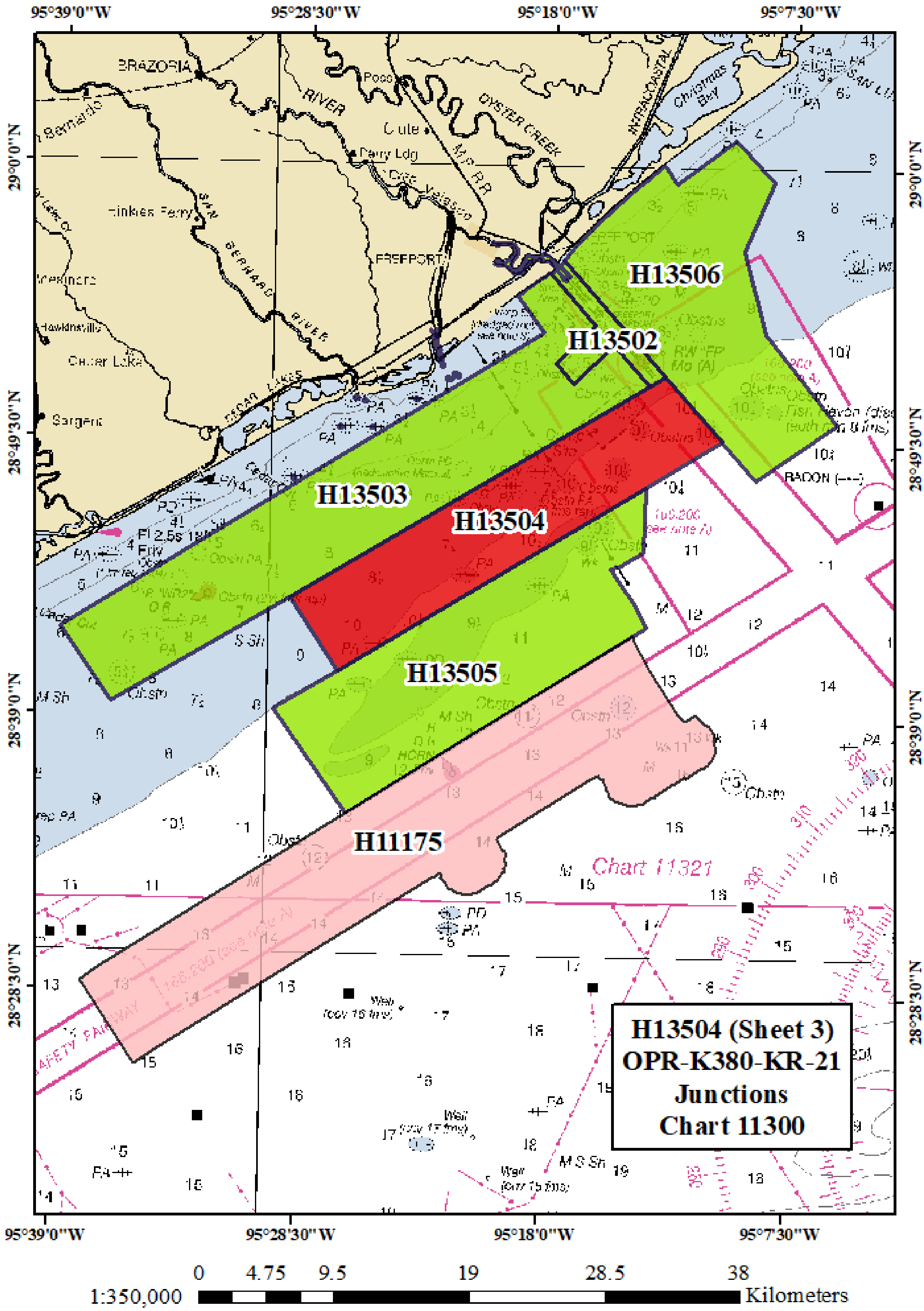

Figure 9: General Locality of H13504 with Junctioning Surveys

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13502	1:5000	2021	Leidos, Inc.	N
H13503	1:5000	2021	Leidos, Inc.	N

Table 9: Junctioning Surveys

H13502

Junctioning survey H13502 was conducted in 2021 and junctions to the north of H13504. For this analysis the H13502 50-centimeter CUBE depth surface was compared to the H13504 1-meter CUBE depth surface. Junction analysis was conducted on the common area of these two sheets, with an overlapping area of approximately 150-1500 meters. Observed depths within the common area were 17.392 to 147.784 meters which resulted in a calculated allowable TVU range of 0.549 to 0.551 meters.

The difference grid was generated by subtracting the H13502 data from the H13504 data. Positive values indicate that H13504 depth data were deeper than H13502 depth data. Throughout the common area, H13504 CUBE depths were deeper than H13502 13.12% of the time and were shoaler than H13502 86.39% of the time (Figure 10). The distribution is spread about zero for all comparisons as presented in Figure 11.

100.00% of the comparisons were 0.287 meters or less, within the calculated allowable TVU range.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	20252	10.36	8233	4.21	11064	5.66	955	0.49
>0.01-0.02	16980	19.04	5385	6.96	11595	11.59		
>0.02-0.03	18341	28.42	4188	9.10	14153	18.82		
>0.03-0.04	17907	37.57	2701	10.49	15206	26.60		
>0.04-0.05	19742	47.67	2011	11.51	17731	35.67		
>0.05-0.06	17807	56.77	1241	12.15	16566	44.14		
>0.06-0.07	17591	65.77	838	12.58	16753	52.70		
>0.07-0.08	14817	73.34	434	12.80	14383	60.06		
>0.08-0.09	14350	80.68	325	12.97	14025	67.23		
>0.09-0.1	11848	86.74	145	13.04	11703	73.21		
>0.1-0.11	8893	91.29	99	13.09	8794	77.71		
>0.11-0.12	5914	94.31	31	13.11	5883	80.72		
>0.12-0.13	3910	96.31	14	13.11	3896	82.71		
>0.13-0.14	2658	97.67	6	13.12	2652	84.07		
>0.14-0.15	1738	98.56	2	13.12	1736	84.95		
>0.15-0.16	1238	99.19	3	13.12	1235	85.59		
>0.16-0.17	691	99.55	0	13.12	691	85.94		
>0.17-0.18	455	99.78	0	13.12	455	86.17		
>0.18-0.19	188	99.87	0	13.12	188	86.27		
>0.19-0.2	92	99.92	0	13.12	92	86.31		
>0.2-0.21	57	99.95	0	13.12	57	86.34		
>0.21-0.22	31	99.97	0	13.12	31	86.36		
>0.22-0.23	23	99.98	0	13.12	23	86.37		
>0.23-0.24	12	99.98	0	13.12	12	86.38		
>0.24-0.25	13	99.99	0	13.12	13	86.38		
>0.25-0.26	6	99.99	0	13.12	6	86.39		
>0.26-0.27	9	99.99	0	13.12	9	86.39		
>0.27-0.287	2	100.00	0	13.12	2	86.39		
Total	195565	100.00%	25656	13.12%	168954	86.39%	955	0.49%
Reference Grid: H13504_MB_1m_MLLW_Final_pfm_H13502_MB_50cm_MLLW_Final_bag.dif								

Figure 10: Tabular Results Junction Analysis H13504 vs. H13502

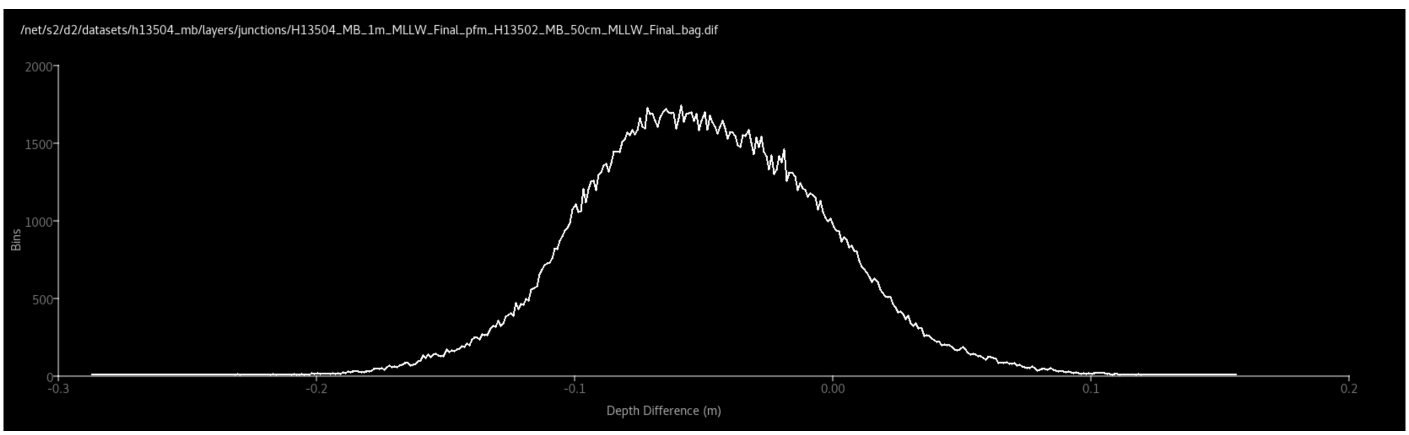

Figure 11: Plot of Junction Analysis H13504 vs. H13502

<u>H13503</u>

Junctioning survey H13503 was conducted in 2021 and junctions to the north of H13504. For this analysis the H13503 1-meter CUBE depth surface was compared to the H13504 1-meter CUBE depth surface.

Junction analysis was conducted on the common area of these two sheets, with an overlapping area approximately 180-29,490 meters. Observed depths within the common area were 13.861 to 17.744 meters which resulted in a calculated allowable TVU range of 0.531 to 0.551 meters.

The difference grid was generated by subtracting the H13503 data from the H13504 data. Positive values indicate that H13504 depth data were deeper than H13503 depth data. Throughout the common area, H13504 CUBE depths were deeper than H13503 47.25% of the time and were shoaler than H13503 51.58% of the time (Figure 10). The distribution is well spread about zero for all comparisons as presented in Figure 11.

100.00% of the comparisons were 0.298 meters or less, within the calculated allowable TVU range.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	389490	23.89	185119	11.36	185270	11.37	19101	1.17
>0.01-0.02	308441	42.82	153600	20.78	154841	20.87		
>0.02-0.03	297592	61.07	146508	29.77	151084	30.13		
>0.03-0.04	241356	75.88	112429	36.67	128927	38.04		
>0.04-0.05	186961	87.35	80344	41.59	106617	44.58		
>0.05-0.06	100232	93.50	42484	44.20	57748	48.13		
>0.06-0.07	54443	96.84	24353	45.69	30090	49.97		
>0.07-0.08	25672	98.41	12111	46.44	13561	50.81		
>0.08-0.09	14710	99.32	7092	46.87	7618	51.27		
>0.09-0.1	6409	99.71	3351	47.08	3058	51.46		
>0.1-0.11	2696	99.88	1561	47.17	1135	51.53		
>0.11-0.12	1136	99.95	664	47.21	472	51.56		
>0.12-0.13	466	99.97	288	47.23	178	51.57		
>0.13-0.14	210	99.99	144	47.24	66	51.57		
>0.14-0.15	99	99.99	66	47.25	33	51.58		
>0.15-0.16	52	99.99	39	47.25	13	51.58		
>0.16-0.17	26	99.99	20	47.25	6	51.58		
>0.17-0.18	20	99.99	14	47.25	6	51.58		
>0.18-0.19	11	99.99	9	47.25	2	51.58		
>0.19-0.2	4	99.99	4	47.25	0	51.58		
>0.2-0.298	5	100.00	3	47.25	2	51.58		
Total	1630031	100.00%	770203	47.25%	840727	51.58%	19101	1.17%
Reference Grid: H13504_MB_1m_MLLW_Final_pfm_H13503_MB_1m_MLLW_Final_pfm.dif								

Figure 12: Tabular Results Junction Analysis H13504 vs. H13503

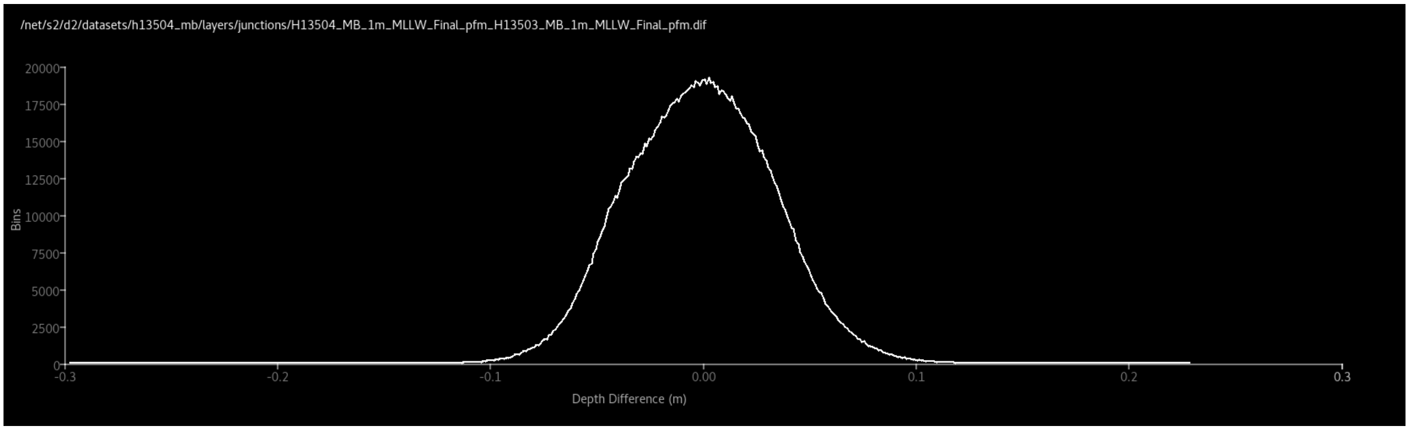

Figure 13: Plot of Junction Analysis H13504 vs. H13503

B.2.4 Sonar QC Checks

Sonar system quality control checks were conducted as detailed in the DAPR.

B.2.5 Equipment Effectiveness

There were no conditions or deficiencies that affected equipment operational effectiveness.

B.2.6 Factors Affecting Soundings

Biological Interference

Within the acquired H13504 MBES and SSS data instances of dense biological interference were observed during discrete areas on various days of survey which required numerous holiday fill lines. Throughout survey acquisition sport fishing and commercial shrimping via trawls were common within the H13504 survey bounds. These observances did not have any significant impact on the final CUBE surface.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: On the M/V Atlantic Surveyor, the MVP30 was the primary system used to collect sound speed profile (SSP) data, refer to the DAPR for additional details. SSP data were obtained at intervals frequent enough to meet depth accuracy requirements. Section 5.2.3.3 of the HSSD requires that if the sound speed measured at the sonar head differs by more than two meters/second from the commensurate profile data, then another cast shall be acquired.

All sound speed profiles applied for online bathymetry data collection were acquired within 500 meters of the bounds of the survey area as specified in Section 5.2.3.3 of the HSSD.

Confidence checks of the sound speed profile casts were routinely conducted by comparing at least two consecutive casts taken with different SSP sensors.

All individual SSP files are delivered with the H13504 data and are broken out into sub-folders, which correspond to the purpose of each cast. Also, all individual SSP files for H13504 have been concatenated into two separate files based on the purpose of the cast, provided in CARIS format files (.svp), and delivered under (H13504/Processed/SVP/CARIS_SSP) on the delivery drive. In accordance with HSSD Section 8.3.6, SSP files were also converted to NCEI format, as detailed in the DAPR, and provided as a separate delivery to NCEI. Refer to the DAPR for additional details.

B.2.8 Coverage Equipment and Methods

All equipment and survey methods are detailed in the DAPR.

B.2.9 Multibeam Coverage Analysis

As stated in Section A.4, H13504 was assigned as Complete Coverage; Leidos chose to achieve the coverage requirement following Option B (100% side scan sonar coverage with concurrent multibeam bathymetry). To achieve this coverage, the SSS was set to 50-meter range scale, and main scheme survey lines were spaced at 80-meters to ensure 100% SSS coverage. Disproval areas were covered with either 100% multibeam coverage or 200% side scan coverage.

The SABER Gapchecker program was used to flag MBES data gaps within the CUBE surface. Additionally, the entire surface was visually scanned for holidays at various points during the data processing effort. Additional survey lines were run to fill any holidays that were detected. Bathymetric data and side scan sonar imagery were reviewed and bathymetric splits were acquired if deemed necessary per Hydrographer’s discretion, as noted in Section 5.2.2.1 of the HSSD.

A final review of the CUBE Depth surface of the H13504 1-meter PFM showed that there were no holidays as defined for complete coverage surveys in Section 5.2.2.3 of the HSSD. Any remaining three by three unpopulated nodes in the final MBES surfaces were along the outer swath data, outside of the SSS nadir coverage gap, and was fully covered with 100% SSS coverage.

The final H13504 CUBE PFM grid was examined for the number of soundings contributing to the chosen CUBE hypotheses for each node by running SABER’s Frequency Distribution Tool on the Hypothesis Number of Soundings (Hyp. # Soundings) surface. The Hyp. # Soundings surface reports the number of soundings that were used to compute the chosen hypothesis. Analysis was conducted on the Hyp. # Soundings surface from the PFM grid to ensure that the requirements for complete coverage surveys, as specified in HSSD Section 5.2.2.3 were met. Within the final 1-meter PFM grid, 99.20% of all nodes contained five or more 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. Multibeam files associated with calibration were listed within the OPR-K380-KR-21 DAPR; the DAPR and calibration data were previously delivered with H13502.

B.4 Backscatter

Side Scan Sonar (SSS) Coverage Analysis: For all details regarding SSS data processing, see the DAPR. Leidos chose to adhere to the coverage requirements in the Project Instructions using Complete Coverage, Option B (100% side scan sonar coverage with concurrent multibeam).

Leidos generated two separate coverage mosaics at 1-meter cell size resolution as specified in Section 8.2.1 of the HSSD (See section B.2.9 for additional information). The first 100% and second 100% coverage mosaics were independently reviewed using tools in SABER to verify data quality and swath coverage. The SABER Gapchecker routine was used to flag data gaps within each of the 100% SSS coverage mosaics. Additionally, the entirety of each SSS surface was visually scanned for holidays at various points during the data processing effort. Additional survey lines were run to fill any holidays that were detected. Both coverage mosaics are determined to be complete and sufficient to meet the requirements contained within the Project Instructions and HSSD. Each 100 percent coverage mosaic is delivered as a single georeferenced raster file (datum of NAD83) in floating point GeoTIFF format, as specified in Sections 8.2.1 and 8.3.3 in the HSSD.

Multibeam Echo Sounder Seafloor Backscatter: Leidos collected MBES backscatter data with all GSF data acquired, in accordance with HSSD Section 6.2. The MBES settings used were checked to ensure acceptable quality standards were met and to mitigate acoustic saturation of the backscatter data. The MBES backscatter data acquired were written to the GSF in real-time by ISS-2000 and are delivered in the final GSF files for this sheet. Evaluation of backscatter data and processing were not required for OPR-K380-KR-21 and therefore no additional processing was performed by Leidos and no additional products were produced.

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
Leidos	SABER	5.4.1.5.5

Table 10: Primary bathymetric data processing software

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

Manufacturer	Name	Version
Leidos	SABER	5.4.1.5.5

Table 11: Primary imagery data processing software

The following Feature Object Catalog was used: NOAA Profile Version 2021.

The primary data processing software used for both bathymetry and imagery was SABER.

B.5.2 Surfaces

The following surfaces and/or BAGs were submitted to the Processing Branch:

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H13504_MB_1m_MLLW_Final	BAG	1 meters	10.959 meters - 20.939 meters	N/A	Complete Coverage, Option B (100% side scan sonar coverage with concurrent multibeam)
H13504_SSSAB_1m_400kHz_1of1	SSS Mosaic (.tif)	1 meters	0 meters - 0 meters	N/A	First 100% SSS
H13504_SSSAB_1m_400kHz_2of2	SSS Mosaic (.tif)	1 meters	0 meters - 0 meters	N/A	Second 100% SSS (Disproval coverage)

Table 12: Submitted Surfaces

Complete Coverage Section 5.2.2.3 of the HSSD requires 1-meter node resolution for depths ranging from 0 meters to 20 meters. Leidos generated the CUBE PFM grid for H13504 at 1-meter resolution. SABER populates the CUBE depth with either the node's chosen hypothesis or the depth of a feature or designated sounding set by the hydrographer, which overrides the chosen hypothesis. The range of CUBE depths of the H13504 1-meter PFM grid were from 10.959 meters (35.955 feet; 0.223 meters Total Vertical Uncertainty [TVU]) to 20.939 meters (68.697 feet; 0.210 meters TVU). In the northeast corner of the H13504 survey limits there is an area of approximately 392 meters by 2,736 meters which has resulting CUBE depths deeper than 20 meters. HSSD requirements for node resolution were met at 1-meter node resolution within these depths and therefore these depths deeper than the HSSD 1-meter resolution are retained within the delivered Final 1-meter surface.

The final gridded bathymetry data are delivered as a Bathymetric Attributed Grid (BAG). The BAG file was exported from the CUBE PFM grid as detailed in the DAPR.

C. Vertical and Horizontal Control

In accordance with HSSD Section 2.2, the horizontal datum for this project is NAD83. HSSD Section 2.2 states that the “only exception for the NAD83 datum requirement is that the S-57 Final Feature File (Section 7.3) will be in the WGS84 datum to comply with international S-57 specifications”. As discussed in the DAPR Section C.7, for every feature flag in a MBES GSF file, SABER converts the position from the NAD83 datum to the WGS84 datum to generate the S-57 file and comply with HSSD and IHO requirements. Feature positions meet the precision stated in HSSD Section 7.4 for each respective datum. Depending on geographic reference there may be approximately a 1-meter difference comparing positions between NAD83 and WGS84 datums. Therefore, if the feature overrides from the BAG surface (NAD83) are compared to the Final Feature File S-57 positions (WGS84) it is anticipated that there could be positional differences exceeding those listed in Section 7.4 of the HSSD. Additional information discussing the vertical and horizontal control for this survey can be found in the DAPR.

C.1 Vertical Control

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

ERS Datum Transformation

The following ellipsoid-to-chart vertical datum transformation was used:

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	OPR-K380-KR-21_NAD83_VDatum_MLLW.cov

Table 13: ERS method and SEP file

Refer to the DAPR for details regarding the application of VDatum to the MBES data files. No final tide note was provided nor was it required from NOAA Center for Operational Oceanographic Products and Services (CO-OPS).

C.2 Horizontal Control

The horizontal datum for this project is North American Datum of 1983 (NAD 83).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 15.

PPP

The vessel kinematic data (POS/MV files) were post-processed in Applanix POSPac software using the Applanix PP-RTX solution to generate the Smoothed Best Estimate of Trajectory (SBET) solutions which were applied through SABER to the multibeam data. Refer to the DAPR for additional information and for details regarding all antenna and transducer offsets. Any soundings with total horizontal uncertainties exceeding the maximum allowable IHO S-44 6th Edition Order 1a specifications were flagged as invalid and therefore were not used in the CUBE depth calculations.

D. Results and Recommendations

D.1 Chart Comparison

Chart comparisons were conducted using a combination of SABER and CARIS' HIPS and SIPS. H13504 data meet data accuracy standards and bottom coverage requirements. Leidos recommends updating the common areas of all charts using data from this survey. Review showed that the H13504 depth data were generally in good agreement (primarily within ±0.5 meters) with charted depths compared to the ENCs listed in Section D.1.1.

Charting recommendations for new features and updates to charted features, are documented in the H13504 S-57 FFF. Additional charted objects are discussed in later sections.

United States Coast Guard (USCG) District 8 LNM publications were reviewed for changes subsequent to the date of the Project Instructions and before the end of survey. The LNM reviewed were from week 23/21 (09 June 2021) until week 04/22 (26 January 2022).

D.1.1 Electronic Navigational Charts

The following are the largest scale ENCs, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date
US5FPOBB	1:10000	1	06/15/2020	01/05/2022
US5FPOBC	1:10000	3	09/27/2021	01/05/2022
US4TX41M	1:80000	21	09/27/2021	01/05/2022

Table 14: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

Figure 14 details the Leidos submitted DTON and Anti-DTON reports for H13504. Reports were submitted per HSSD in S-57 format to the Atlantic Hydrographic Branch (AHB). DTON 02 was not forwarded by AHB for immediate charting. Refer to the Project Correspondence for email correspondence related to submitted files.

DTON Report Name	Date Submitted to AHB	AHB Submitted to NDB and MCD	NDB Registration	Feature Number(s)
H13504_DTON_01.000	2021-09-29	2021-09-29	DD-35128	04
H13504_DTON_02.000	2022-01-21	N/A	N/A	02

Figure 14: DTON Reports

D.1.3 Charted Features

There were numerous assigned charted features in the final CSF (OPR-K380-KR-21_CSF_FINAL_05032021.000) within the SOW of H13504. Per HSSD Section 8.1.4, these charted features are not addressed in this section; refer to the H13504 S-57 FFF (H13504_FFF.000) for all the details and recommendations regarding these features. Within the FFF there are several charted obstructions which Leidos covered and identified within the H13504 data, however the objects are not recommended for charting as obstructions. Rather, they are recommended to be charted as a soundings and contours, as Leidos identified the obstructions to be coral outcroppings. These coral outcroppings were found to cover large areas within H13504, intermittently spanning across the middle of the sheet's SOW area. In all cases where observed, these coral outcroppings were found to be appropriately captured by CUBE (Figure 15).

In addition to the assigned features within the CSF there were several unassigned objects. The DMPGRD (dumping ground) area charted on ENCs US5POBB, US5POBC, and US4TX41M was a particularly dynamic area and exhibited several piles of sediment (Figure 16). Within this area were multiple objects with heights of approximately 1-meter. While the objects met the criteria to be a feature as defined in the HSSD with a 1-meter height; a feature over-ride was not set on all of these observed features within the DMPGRD as the controlling depths within the surrounding area were from the sediment mounds. The sediment mounds were characterized as natural and Leidos utilized HSSD Section 7.3.2 for determining if a feature over-ride was necessary. CUBE depths honored the sediment mounds within 0.5-meter TVU, therefore no feature over-rides were set on sediment mounds either. The DMPGRD is not retained within the FFF per the investigation requirements from the CSF.

SSS contacts associated with the coral outcropping and within the DMPGRD were retained within the H13504 Side Scan Sonar Contact S-57 file (H13504_SSS_Contacts.000).

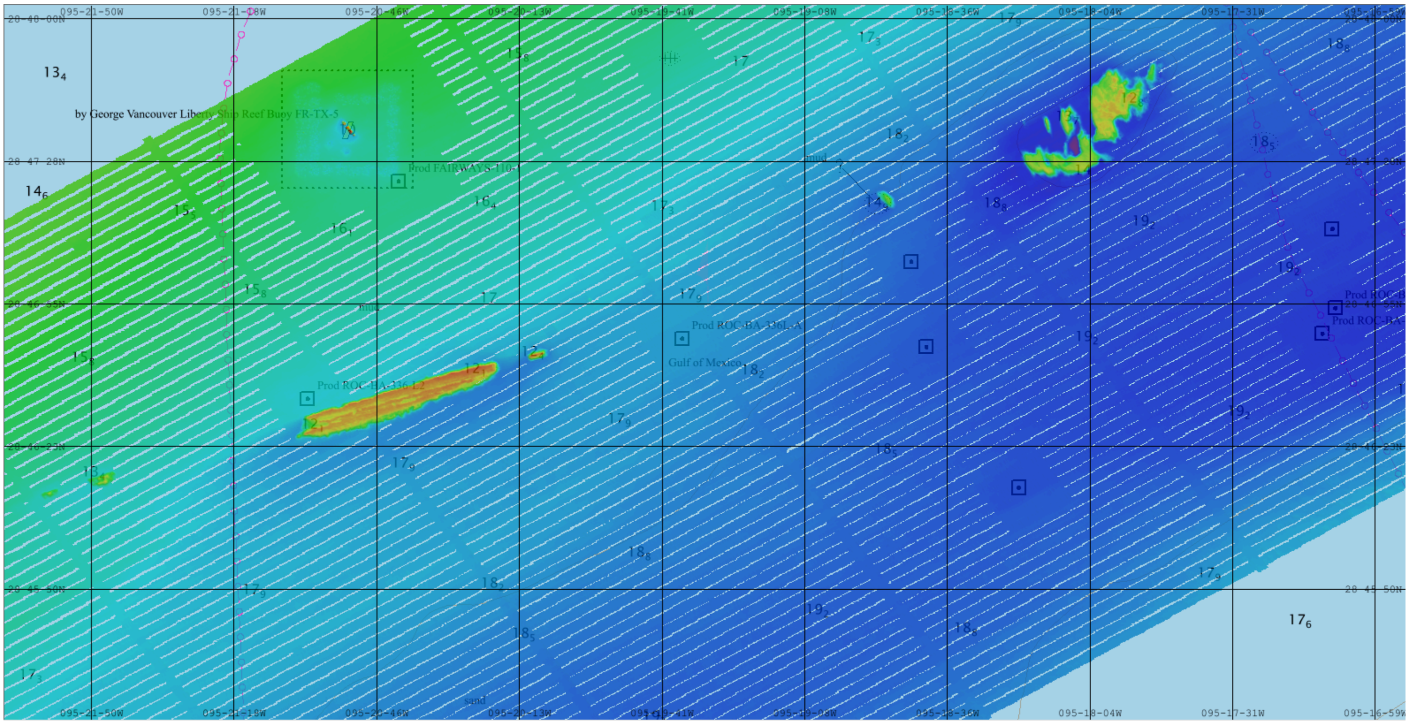

Figure 15: Coral Outcroppings within H13504 MBES Coverage

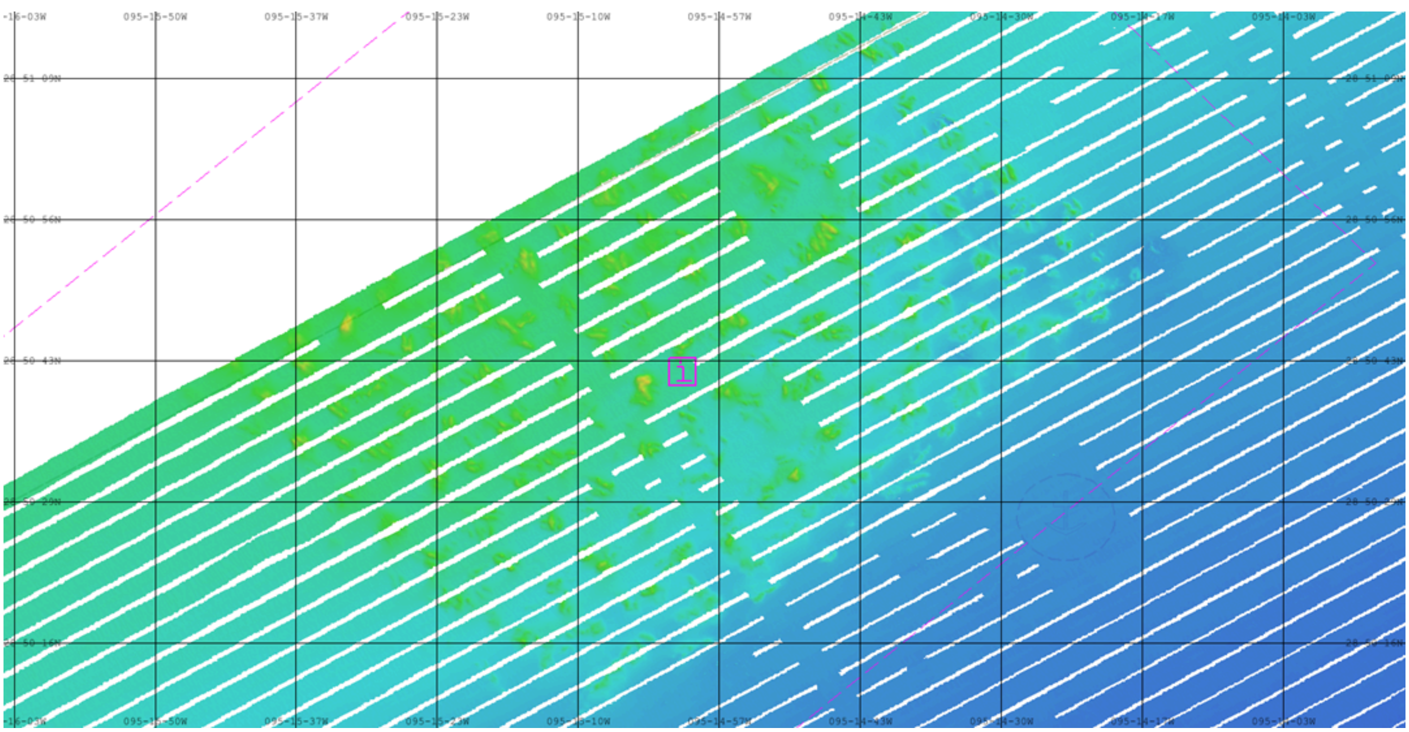

Figure 16: ENC US4TX41M DMPGRD with H13504 MBES Coverage

D.1.4 Uncharted Features

See the H13504 S-57 FFF for all the details and recommendations regarding new uncharted features investigated.

D.1.5 Channels

There were no assigned channels within the H13504 SOW from the final CSF. However, the survey area was coincident to Safety Fairway (FAIRWY) to the Freeport Harbor Channel (ENC US4TX41M and US5POBC), H13502 CUBE depths were in agreement with the charted depths.

D.2 Additional Results

D.2.1 Aids to Navigation

There was one assigned Aid to Navigation (ATON) within the SOW of H13504 within the final CSF. During survey, this BOYSPP (George Vancouver Liberty Ship Reef Buoy FR-TX-5) was not found to be present. Per HSSD Section 1.6.2.2 as the ATON was listed in the USCG Light List, Leidos submitted an ATON Discrepancy Report to the USCG and forwarded to NOAA. LNM 47/21 (24 November 2021) subsequently noted the ATON as MISSING. This assigned BOYSPP is documented within the H13504 FFF. No other ATONs were present within the bounds of the H13504 survey limits.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

In accordance with both the Project Instructions and Section 7.2.3 of the HSSD, bottom characteristics were obtained for H13504. Bottom characteristics were acquired at the eight locations assigned in the final PRF (OPR-K380-KR-21_PRF_FINAL_05032021.000). Leidos did not modify the bottom sample locations from the locations proposed by NOAA in the PRF. Bottom characteristics are included in the S-57 FFF. In addition, images of the sediment obtained for each bottom sample are referenced in the S-57 FFF and are included on the delivery drive under the folder H13504/Processed/Multimedia.

D.2.4 Overhead Features

There were no overhead features within this survey area.

D.2.5 Submarine Features

Within the final CSF there were several assigned submarine features (cables and pipelines) for investigation. Within the H13504 data Leidos classified three additional features as exposed pipelines based on their characteristics and size in MBES and SSS data. These pipelines fell outside of charted pipeline or cable areas (Features 04, 07, and 09). Feature 04 was exposed approximately 2-meters above the surrounding depth area which Leidos submitted as DTON 01, following HSSD Section 1.7.2. The remaining two exposed pipelines were approximately 0.3m higher than the surrounding depth area, determined to be non-dangerous and were submitted to NOAA following HSSD Section 1.7.3.

In accordance with Project Instructions, dated 06 July 2021, exposed or unburied pipelines were to be submitted to Texas General Land Office of Texas (GLO) as a .KMZ file if the data fell within the bounds of the State of Texas Coastal Zone Management Area (CZMA), in place of HSSD Section 1.7.1. The three identified exposed pipelines fell within the TX CZMA and Leidos submitted the .KMZ file to TX GLO; refer to Project Correspondence.

Charted assigned submarine features were not observed in H13504 to be exposed or unburied, refer to the H13504 S-57 FFF.

The CSF investigation requirements for the submerged cables (CBLSUB) listed “Visually confirm feature object existence. If discrepancy, discuss in DR (see HSSD Section 8.1.4). Do not include feature in FFF.” No sections of charted cables were observed within the H13504 MBES or SSS data therefore the CBLSUB are not discussed within the H13504 S-57 FFF.

SSS contacts associated with the submarine features were retained within the H13504 Side Scan Sonar Contact S-57 file (H13504_SSS_Contacts.000).

D.2.6 Platforms

Platforms were assigned from the CSF and are addressed in the H13504 FFF.

D.2.7 Ferry Routes and Terminals

No ferry routes or terminals exist within this survey area.

D.2.8 Abnormal Seafloor or Environmental Conditions

No abnormal seafloor or environmental conditions, as defined in Section 8.1.4 of the HSSD, exist within this survey area other than those discussed in Section B.2.6.

D.2.9 Construction and Dredging

No construction or dredging exists for this survey area.

D.2.10 New Survey Recommendations

No new survey recommendations are made for the area surrounding this survey area.

D.2.11 ENC Scale Recommendations

No new ENC recommendations are made for the area surrounding this survey 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.

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 Hydrographic Survey Specifications and Deliverables, Project Instructions, and Statement of Work. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required. Previously, or concurrently, submitted deliverables for OPR-K380-KR-21 are provided in the table below.

Report Name	Report Date Sent
OPR-K380-KR-21 Final Project Summary Report.pdf	2021-11-05
OPR-K380-KR-21_ Marine_Species_Awareness_Training_Record.pdf	2021-11-22
OPR-K380-KR-21_Coast Pilot Review Report.pdf	2021-11-30
OPR-K380-KR-21_DAPR.pdf	2022-01-21
H13502_DR.pdf	2022-01-21
OPR-K380-KR-21_20220201.zip (NCEI Sound Speed Data)	2022-02-01
OPR-K380-KR-21 Marine Mammal Sighting Forms.pdf	2022-02-03
H13503_DR.pdf	2022-02-07

Approver Name	Approver Title	Approval Date	Signature
Bridget W. Bernier	Data Processing Manager	02/07/2022	Bridget W Bernier Digitally signed by Bridget W Bernier Date: 2022.02.07 11:49:51 -05'00'

F. Table of Acronyms

Acronym	Definition
AHB	Atlantic Hydrographic Branch
AST	Assistant Survey Technician
ATON	Aid to Navigation
AWOIS	Automated Wreck and Obstruction Information System
BAG	Bathymetric Attributed Grid
BASE	Bathymetry Associated with Statistical Error
CO	Commanding Officer
CO-OPS	Center for Operational Products and Services
CORS	Continuously Operating Reference Station
CTD	Conductivity Temperature Depth
CEF	Chart Evaluation File
CSF	Composite Source File
CST	Chief Survey Technician
CUBE	Combined Uncertainty and Bathymetry Estimator
DAPR	Data Acquisition and Processing Report
DGPS	Differential Global Positioning System
DP	Detached Position
DR	Descriptive Report
DTON	Danger to Navigation
ENC	Electronic Navigational Chart
ERS	Ellipsoidal Referenced Survey
ERTDM	Ellipsoidally Referenced Tidal Datum Model
ERZT	Ellipsoidally Referenced Zoned Tides
FFF	Final Feature File
FOO	Field Operations Officer
FPM	Field Procedures Manual
GAMS	GPS Azimuth Measurement Subsystem
GC	Geographic Cell
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSD	Hydrographic Surveys Division

Acronym	Definition
HSSD	Hydrographic Survey Specifications and Deliverables
HSTB	Hydrographic Systems Technology Branch
HSX	Hypack Hysweep File Format
HTD	Hydrographic Surveys Technical Directive
HVCR	Horizontal and Vertical Control Report
HVF	HIPS Vessel File
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
ITRF	International Terrestrial Reference Frame
LNM	Linear Nautical Miles
MBAB	Multibeam Echosounder Acoustic Backscatter
MCD	Marine Chart Division
MHW	Mean High Water
MLLW	Mean Lower Low Water
NAD 83	North American Datum of 1983
NALL	Navigable Area Limit Line
NTM	Notice to Mariners
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRT	Navigation Response Team
NSD	Navigation Services Division
OCS	Office of Coast Survey
OMAO	Office of Marine and Aviation Operations (NOAA)
OPS	Operations Branch
MBES	Multibeam Echosounder
NWLON	National Water Level Observation Network
PDBS	Phase Differencing Bathymetric Sonar
PHB	Pacific Hydrographic Branch
POS/MV	Position and Orientation System for Marine Vessels
PPK	Post Processed Kinematic
PPP	Precise Point Positioning
PPS	Pulse per second

Acronym	Definition
PRF	Project Reference File
PS	Physical Scientist
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
RTX	Real Time Extended
SBES	Singlebeam Echosounder
SBET	Smooth Best Estimate and Trajectory
SNM	Square Nautical Miles
SSS	Side Scan Sonar
SSSAB	Side Scan Sonar Acoustic Backscatter
ST	Survey Technician
SVP	Sound Velocity Profiler
TCARI	Tidal Constituent And Residual Interpolation
TPU	Total Propagated Uncertainty
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UTM	Universal Transverse Mercator
XO	Executive Officer
ZDF	Zone Definition File