H13506

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	H13506

LOCALITY

State(s):	Texas
General Locality:	Western Gulf of Mexico
Sub-locality:	6NM SE from Freeport

2021

CHIEF OF PARTY
Alex T. Bernier

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13506**

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:	**6NM SE from Freeport**
Scale:	**5000**
Dates of Survey:	**07/21/2021 to 10/06/2021**
Instructions Dated:	**05/13/2021**
Project Number:	**OPR-K380-KR-21**
Field Unit:	**Leidos**
Chief of Party:	**Alex T. 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 H13506

Project: OPR-K380-KR-21

Locality: Western Gulf of Mexico

Sublocality: 6NM SE from Freeport

Scale: 1:5000

July 2021 - October 2021

Leidos

Chief of Party: Alex T. Bernier

A. Area Surveyed

H13506 was located offshore of Freeport, Texas; and consisted of separate survey areas (Figure 1). The Main Area was located 6NM southeast of Freeport, with northern extents starting approximately 500 meters from the Freeport Harbor Inlet and continuing northeast to approximately off Follett's Island Beach. There were also multiple detached areas southwest from Freeport, associated with feature disproval SOW areas. These are referenced below as the Detached Area, and were located starting at the mouth of the Brazos River and continuing to the south-southwest.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
29° 1' 8.21" N 95° 29' 10.48" W	28° 47' 52.53" N 95° 5' 34.79" W

Table 1: Survey Limits

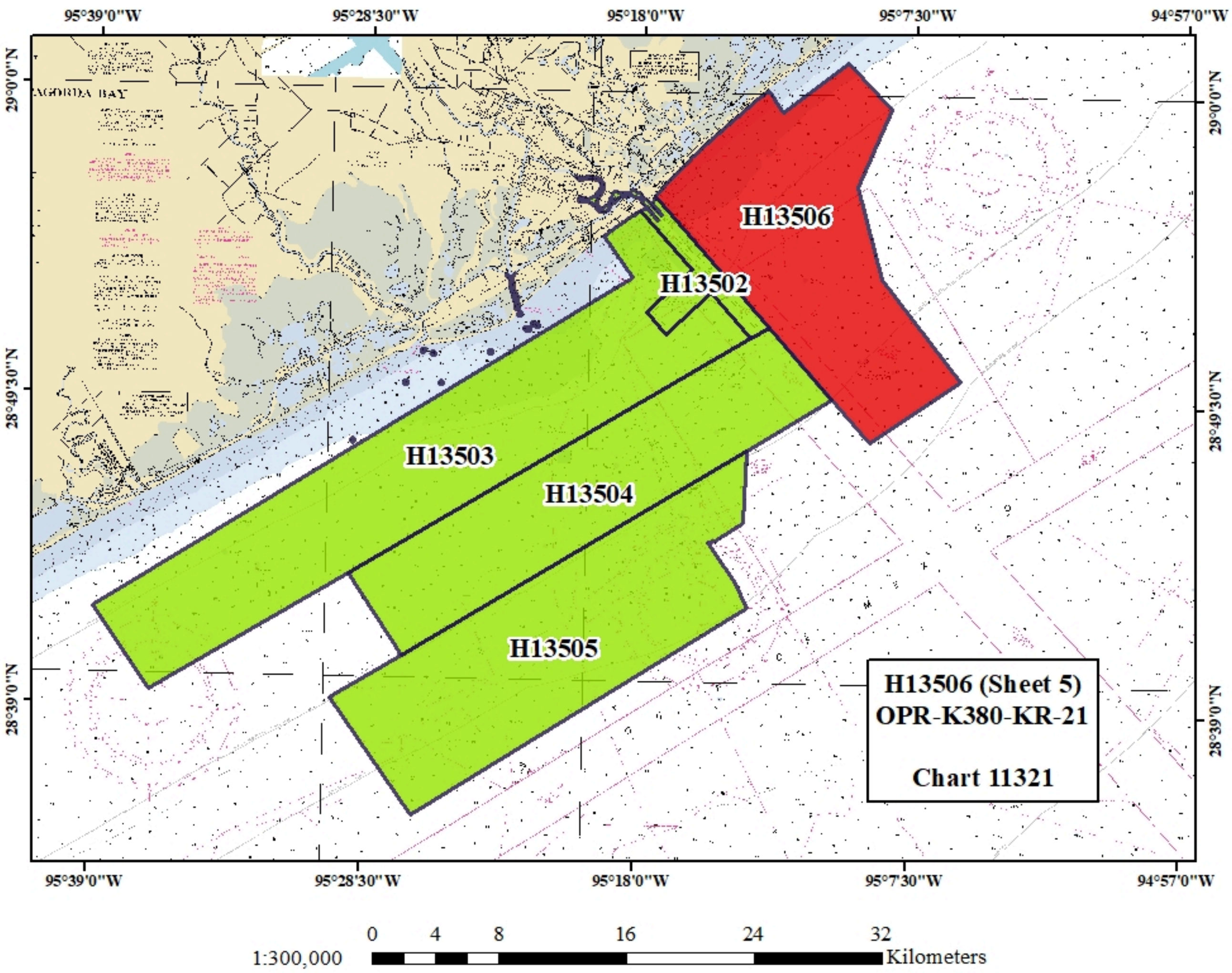

Figure 1: H13506 Survey Bounds

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 OPR-K380-KR-21 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 Intracoastal 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.

H13506 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 9). The assigned survey bounds were achieved across H13506 except where the inshore limit of the Navigable Area Limit Line (NALL) was reached in the Main Area around the vicinity of Surfside Beach, and within some of the

Detached Areas. Achieved coverage for the Main Area is depicted in Figure 3 through Figure 6. Achieved coverage for the Detached Area is depicted in Figure 7 through Figure 9.

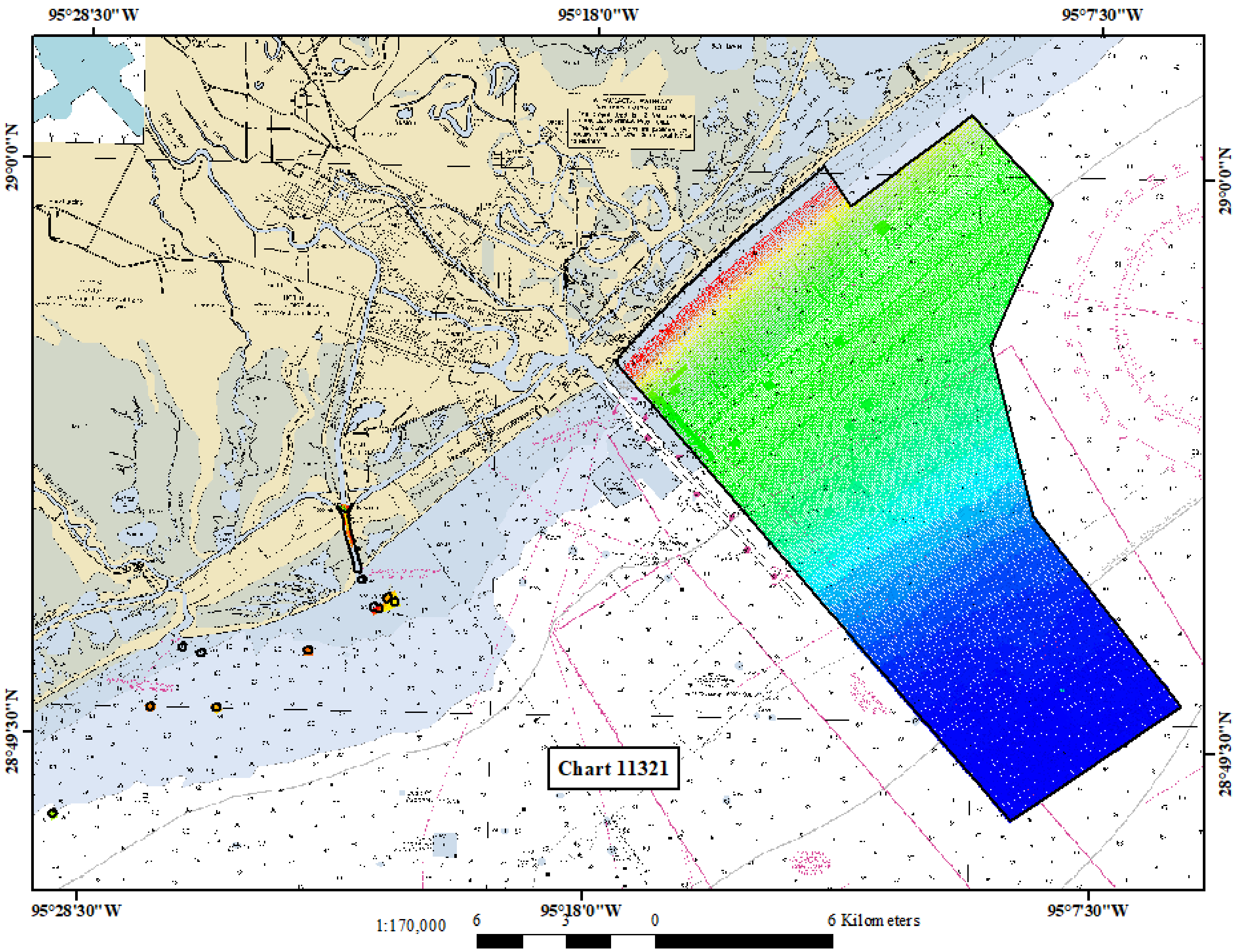

Figure 2: All Final Bathymetry Coverage for H13506

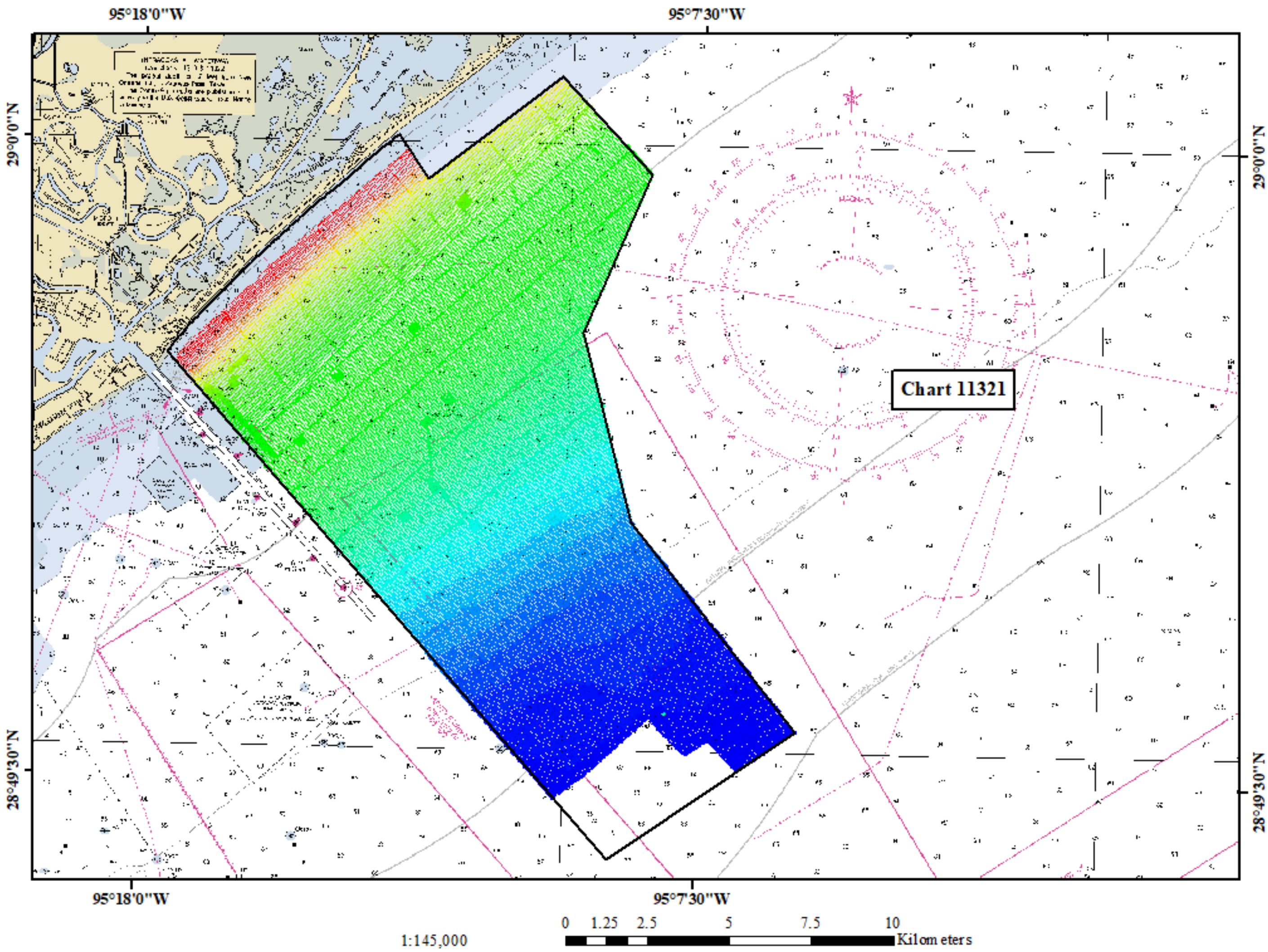

Figure 3: Main Area Final Bathymetry Coverage for H13506 (1-meter resolution)

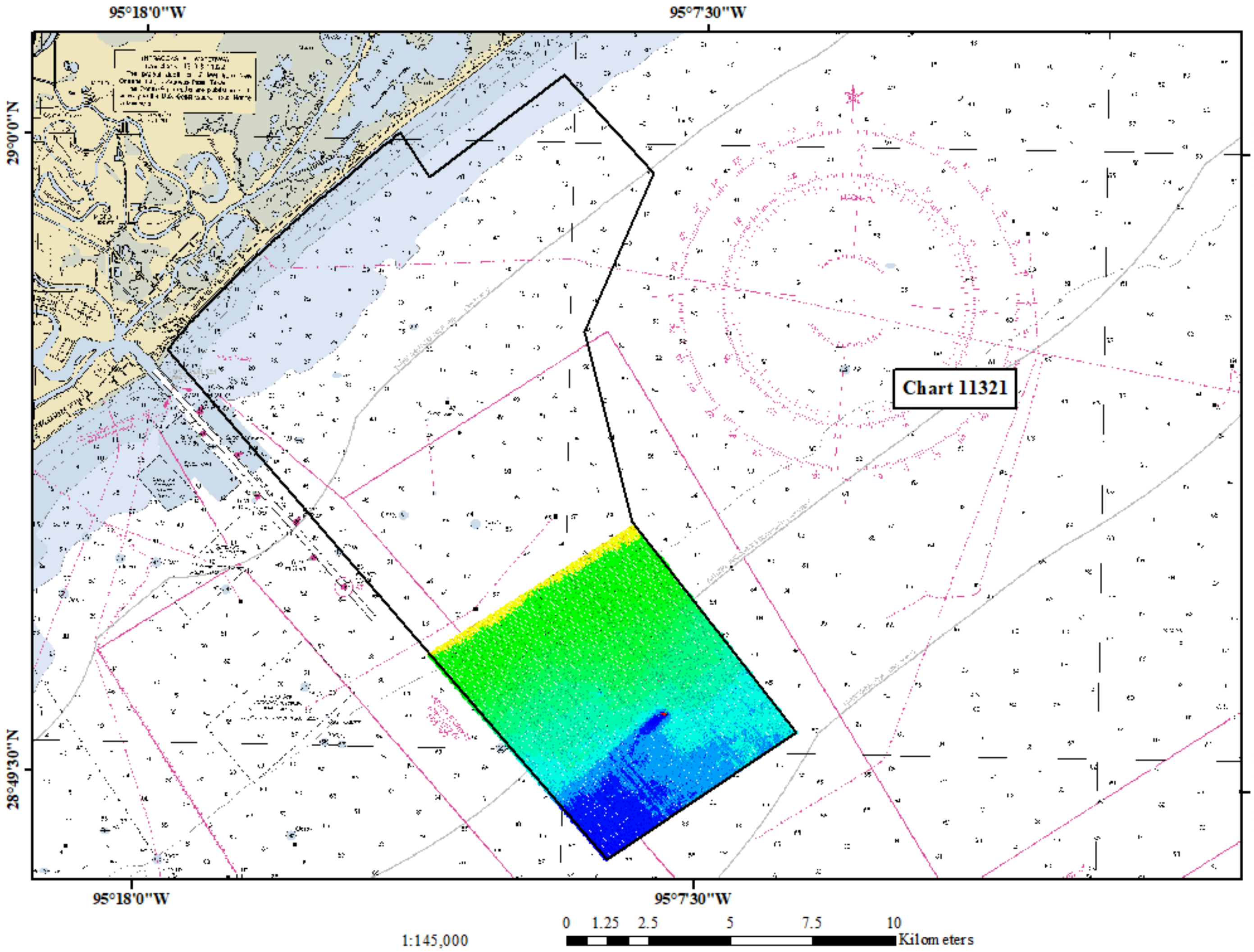

Figure 4: Main Area Final Bathymetry Coverage for H13506 (2-meter resolution)

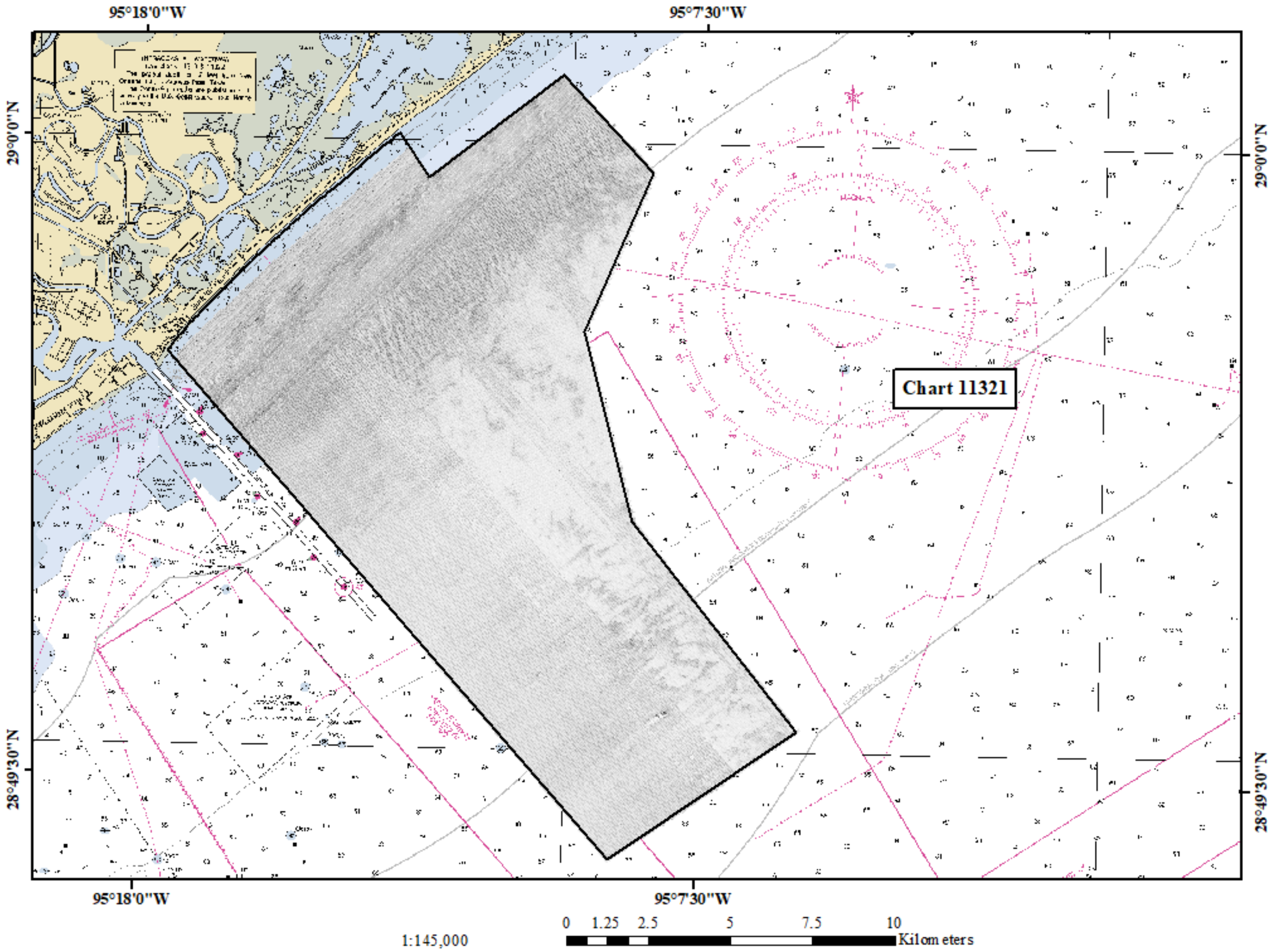

Figure 5: Main Area Final Side Scan Coverage for H13506 (First 100% coverage)

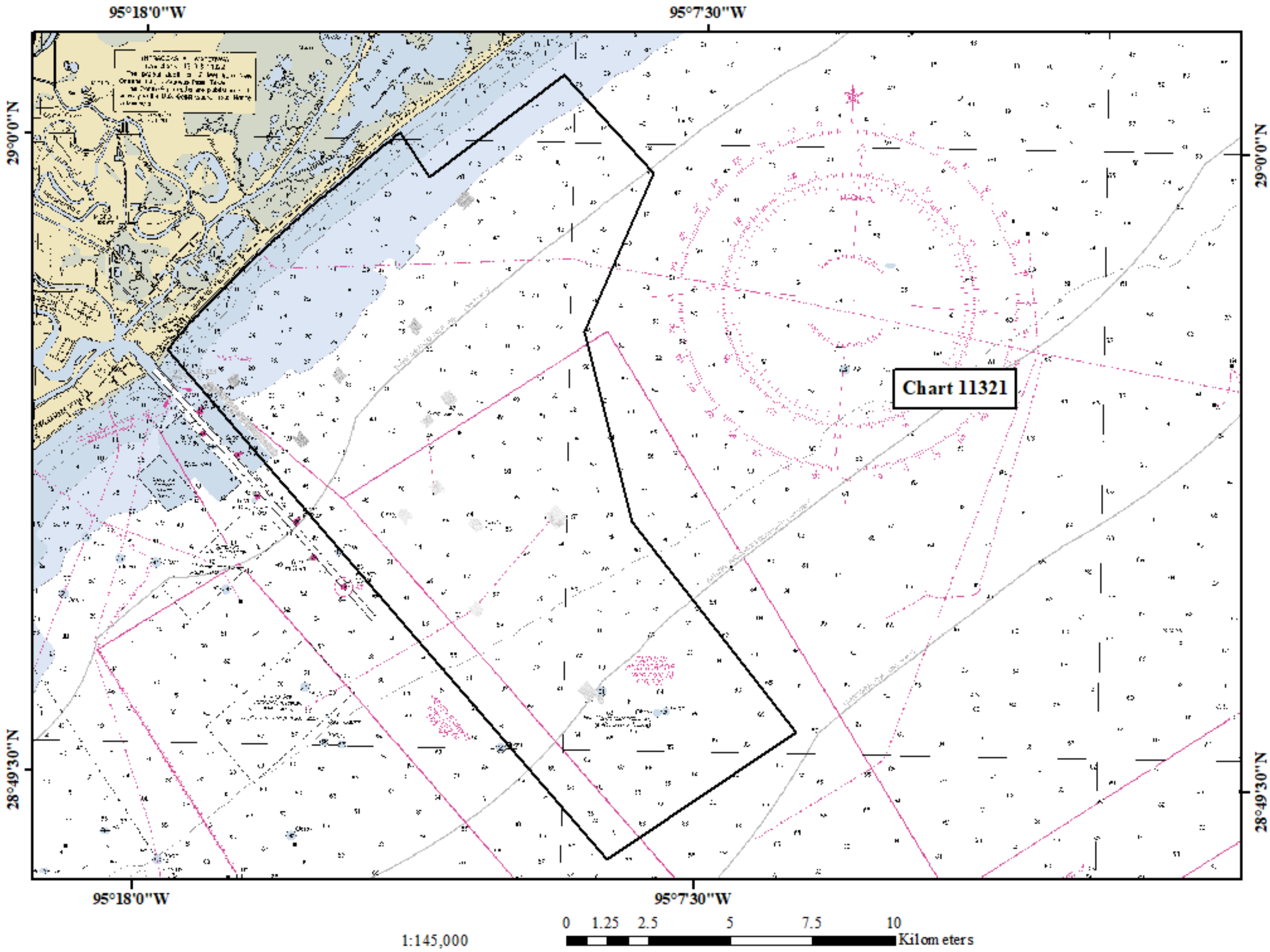

Figure 6: Main Area Final Side Scan Coverage for H13506 (Second 100% coverage)

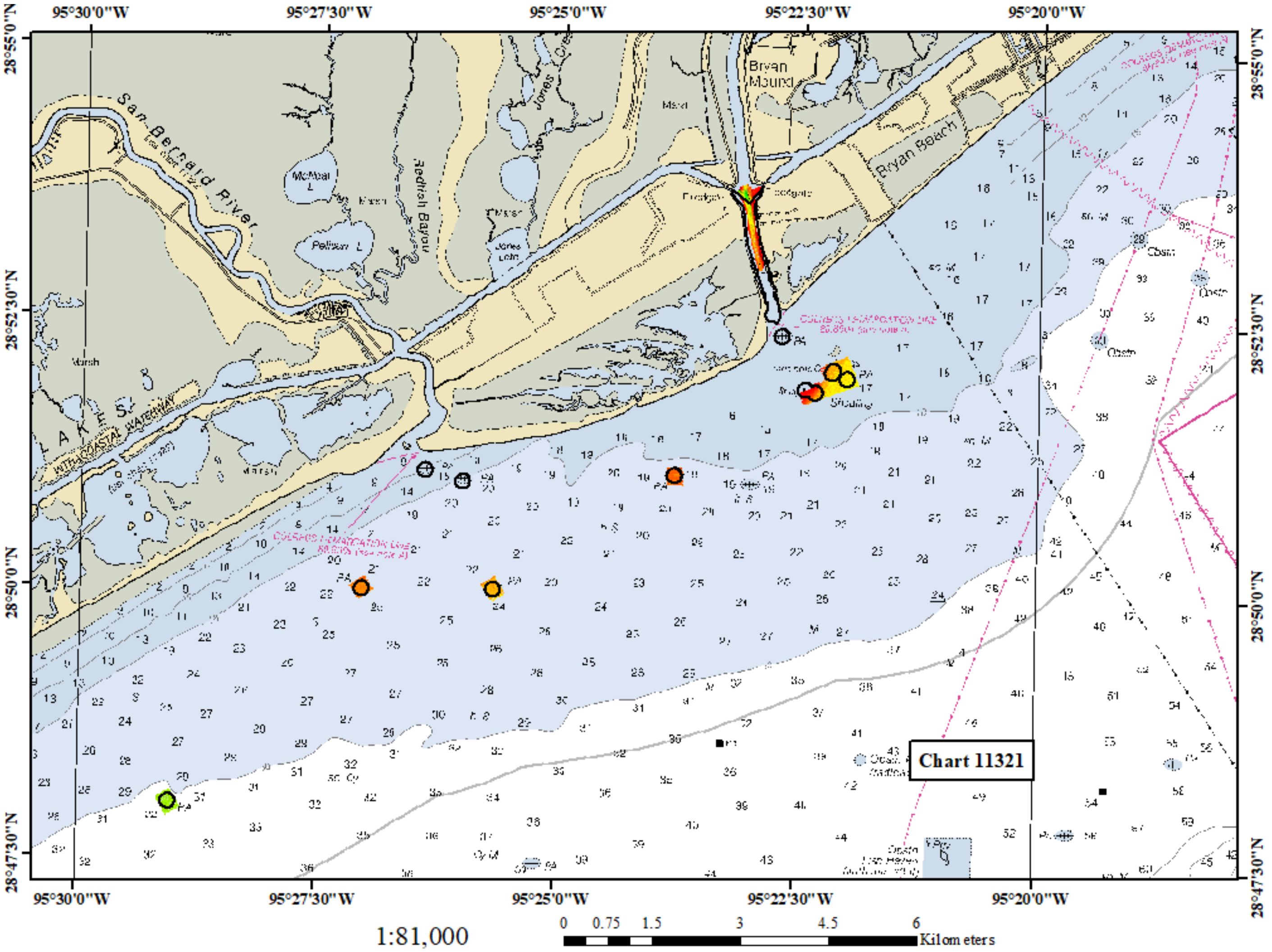

Figure 7: Detached Area Final Bathymetry Coverage for H13506 (1-meter resolution)

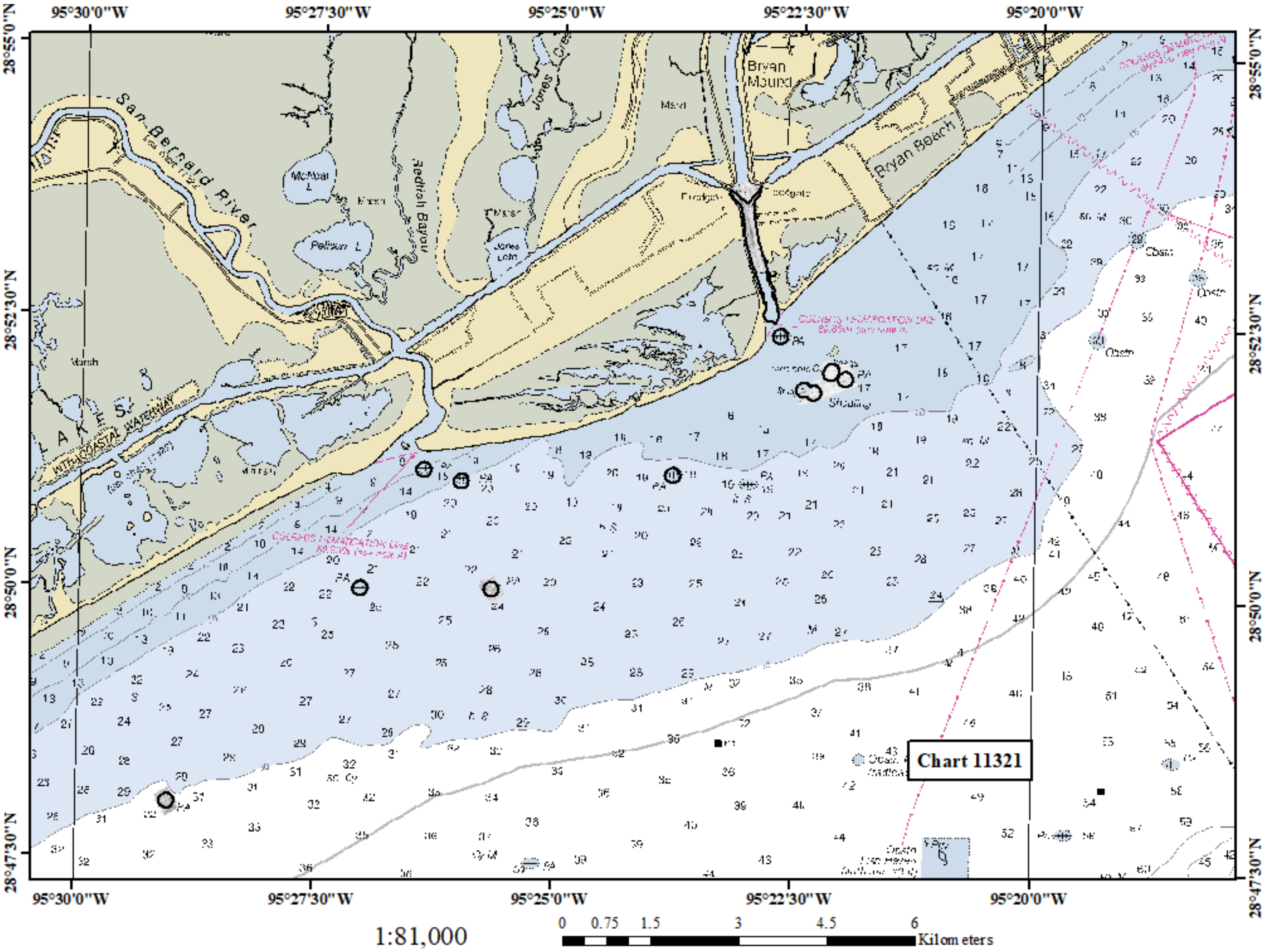

Figure 8: Detached Area Final Side Scan Coverage for H13506 (First 100% coverage)

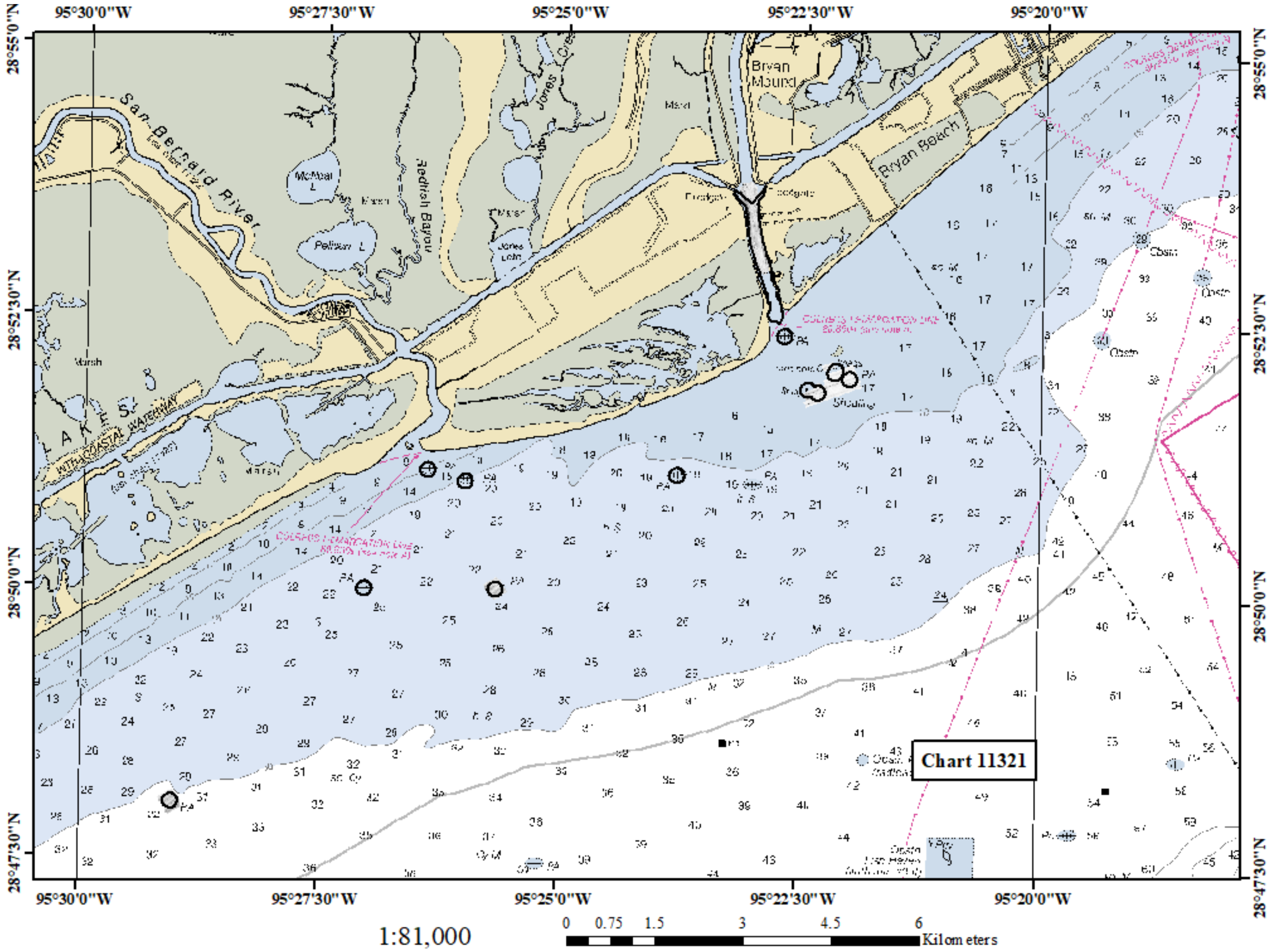

Figure 9: Detached Area Final Side Scan Coverage for H13506 (Second 100% coverage)

A.6 Survey Statistics

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

	HULL ID	*M/V Atlantic Surveyor*	*R/V Oyster Bay II*	*Total*
LNM	**SBES Mainscheme**	0	0	0
	MBES Mainscheme	0	0	0
	Lidar Mainscheme	0	0	0
	SSS Mainscheme	0	0	0
	SBES/SSS Mainscheme	0	0	0
	MBES/SSS Mainscheme	1171.74	369.88	1541.62
	SBES/MBES Crosslines	58.22	16.73	74.95
	Lidar Crosslines	0	0	0
Number of Bottom Samples				9
Number Maritime Boundary Points Investigated				0
Number of DPs				0
Number of Items Investigated by Dive Ops				0
Total SNM				60.47

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
07/12/2021	193

Survey Dates	Day of the Year
07/13/2021	194
07/14/2021	195
07/15/2021	196
07/16/2021	197
07/17/2021	198
07/19/2021	200
07/20/2021	201
07/21/2021	202
07/22/2021	203
07/30/2021	211
08/01/2021	213
08/04/2021	216
08/05/2021	217
08/08/2021	220
08/09/2021	221
08/10/2021	222
08/11/2021	223
08/12/2021	224
08/18/2021	230
08/19/2021	231
08/22/2021	234
08/23/2021	235
09/21/2021	264
09/22/2021	265
09/23/2021	266
09/24/2021	267
09/25/2021	268
09/26/2021	269
09/30/2021	273
10/01/2021	274
10/04/2021	277
10/05/2021	278

Survey Dates	Day of the Year
10/06/2021	279

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*	*R/V Oyster Bay II*
LOA	110 feet	30 feet
Draft	9 feet	3 feet

Table 5: Vessels Used

Figure 10: M/V Atlantic Surveyor

Figure 11: R/V Oyster Bay II

The M/V Atlantic Surveyor (Figure 10) 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. The R/V Oyster Bay II (Figure 11) was used to collect MBES (RESON SeaBat T50), SSS (Klein 4900), and sound speed data during twelve hours per day survey operations.

A detailed description of the vessels 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
Klein Marine Systems	System 4900	SSS
Applanix	POS MV 320 v5	Positioning and Attitude System
AML Oceanographic	MVP30	Sound Speed System
AML Oceanographic	BaseX2	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 4.86% 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). H13506 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, and crosslines were generally spaced 1,900 to 2,000 meters apart. 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 for all data. 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 H13506 mainscheme CUBE depths from the 1-meter H13506 crossline CUBE depths. Additional comparisons were conducted of each vessels mainscheme to crossline depth data. These results are summarized in Figure 12.

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 Total Vertical Uncertainty [TVU]. Of the three mainscheme to crossline analysis conducted the 100% of the R/V Oyster Bay comparisons were within TVU. The M/V Atlantic Surveyor analysis had one difference which exceeded the maximum allowable TVU due to the presence of sediment buildup from an anchor drag scar made on the seafloor in between the days of mainscheme and coincident crossline data acquisition. Results for all crossing analysis are summarized in Figure 12.

As multiple vessels were used to survey H13506 repeatability analysis was performed between the data collected by both vessels where coincident. Results are summarized in Figure 13. There were four comparisons which exceeded the maximum allowable TVU which were all related to Feature 06.

Results for analysis conducted are presented in Figure 14 to Figure 21.

Crossing Analysis	Minimum and Maximum CUBE Depth (meters) of Crossline Grid	IHO Order 1A Maximum Allowable Uncertainty (meters) for the Range of Depths	Percentage of Depth Differences Within IHO Order 1A Maximum Allowable Uncertainty
M/V Atlantic Surveyor and R/V Oyster Bay II Multibeam 1-meter Crossline (Class 1) to M/V Atlantic Surveyor and R/V Oyster Bay II Multibeam 1-meter Mainscheme	3.095 – 20.708	0.502 – 0.568	99.99%
M/V Atlantic Surveyor Multibeam 1-meter Crossline (Class 1) to M/V Atlantic Surveyor Multibeam 1-meter Mainscheme	11.182 – 20.708	0.521 – 0.568	99.99%
R/V Oyster Bay II Multibeam 1-meter Crossline (Class 1) to R/V Oyster Bay II Multibeam 1-meter Mainscheme	3.095 – 12.066	0.502 – 0.524	100.00%

Figure 12: Summary of Crossing Analysis

Repeatability Analysis	Minimum and Maximum CUBE Depth (meters) of Comparison	IHO Order 1A Maximum Allowable Uncertainty (meters) for the Range of Depths	Percentage of Depth Differences Within IHO Order 1A Maximum Allowable Uncertainty
M/V Atlantic Surveyor 1-meter Multibeam Data to R/V Oyster Bay II 1-meter Multibeam Data	6.852 – 17.237	0.508 – 0.548	99.99%

Figure 13: Summary of Vessel Comparison Repeatability Analysis

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	69408	20.28	32048	9.36	34025	9.94	3335	0.97
>0.01-0.02	54286	36.13	25309	16.75	28977	18.40		
>0.02-0.03	53523	51.77	24004	23.77	29519	27.03		
>0.03-0.04	44406	64.74	19172	29.37	25234	34.40		
>0.04-0.05	38611	76.02	16075	34.06	22536	40.98		
>0.05-0.06	26651	83.80	10601	37.16	16050	45.67		
>0.06-0.07	18796	89.29	6882	39.17	11914	49.15		
>0.07-0.08	11772	92.73	4174	40.39	7598	51.37		
>0.08-0.09	8831	95.31	2821	41.21	6010	53.12		
>0.09-0.1	6054	97.08	1809	41.74	4245	54.36		
>0.1-0.11	3683	98.16	985	42.03	2698	55.15		
>0.11-0.12	2254	98.82	519	42.18	1735	55.66		
>0.12-0.13	1529	99.26	322	42.28	1207	56.01		
>0.13-0.14	978	99.55	162	42.32	816	56.25		
>0.14-0.15	608	99.73	75	42.34	533	56.41		
>0.15-0.2	821	99.96	111	42.38	710	56.61		
>0.2-0.25	88	99.99	12	42.38	76	56.64		
>0.25-0.3	12	99.99	6	42.38	6	56.64		
>0.3-0.35	3	99.99	3	42.38	0	56.64		
>0.35-0.4	8	99.99	8	42.39	0	56.64		
>0.4-0.45	1	99.99	1	42.39	0	56.64		
>0.45-0.5	3	99.99	3	42.39	0	56.64		
>0.5-0.55	4	99.99	4	42.39	0	56.64		
>0.55-0.573	1	100.00	1	42.39	0	56.64		
Total	342331	100.00	145107	42.39	193889	56.64	3335	0.97
Reference Grid: H13506_AS_OBII_MB_1m_MLLW_Cross_5degree_2022-01-21_pfm_H13506_AS_OBII_MB_1m_MLLW_Main_2022-01-20_pfm.dif								

Figure 14: Tabular Results Crossing Analysis, Crosslines vs. Mainscheme Lines

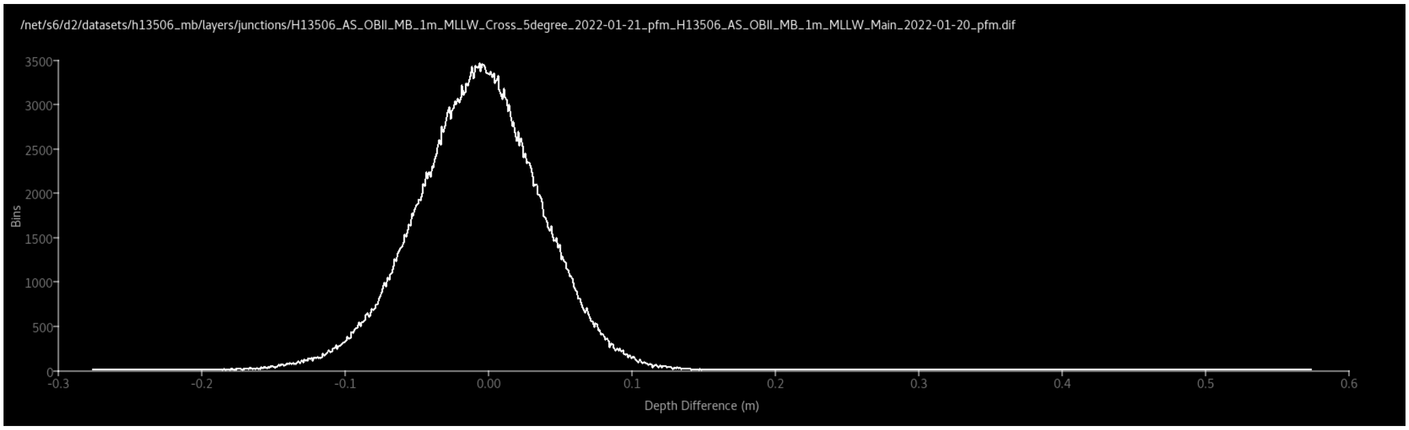

Figure 15: Plot of Crossing Analysis Crosslines vs. Mainscheme Lines

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	61176	20.41	28080	9.37	30143	10.06	2953	0.99
>0.01-0.02	47505	36.26	21933	16.69	25572	18.59		
>0.02-0.03	46921	51.92	20693	23.59	26228	27.34		
>0.03-0.04	38667	64.82	16357	29.05	22310	34.79		
>0.04-0.05	33126	75.88	13540	33.57	19586	41.32		
>0.05-0.06	22877	83.51	9110	36.61	13767	45.92		
>0.06-0.07	16376	88.98	6128	38.65	10248	49.34		
>0.07-0.08	10414	92.45	3785	39.92	6629	51.55		
>0.08-0.09	7966	95.11	2565	40.77	5401	53.35		
>0.09-0.1	5567	96.97	1708	41.34	3859	54.64		
>0.1-0.11	3374	98.09	925	41.65	2449	55.46		
>0.11-0.12	2067	98.78	477	41.81	1590	55.99		
>0.12-0.13	1384	99.24	287	41.91	1097	56.35		
>0.13-0.14	862	99.53	159	41.96	703	56.59		
>0.14-0.15	498	99.70	76	41.98	422	56.73		
>0.15-0.2	788	99.96	111	42.02	677	56.95		
>0.2-0.25	87	99.99	12	42.03	75	56.98		
>0.25-0.3	11	99.99	6	42.03	5	56.98		
>0.3-0.4	8	99.99	8	42.03	0	56.98		
>0.4-0.5	3	99.99	3	42.03	0	56.98		
>0.5-0.573	897	100.00	140	42.03	757	56.98		
Total	299686	100.00%	125972	42.03%	170761	56.98%	2953	0.99%
Reference Grid: H13506_AS_MB_1m_MLLW_Cross_5degree_2022-01-24_pfm_ H13506_AS_MB_1m_MLLW_Main_2022-01-21_pfm.dif								

Figure 16: Tabular Results Crossing Analysis, M/V Atlantic Surveyor Crosslines vs. Mainscheme Lines

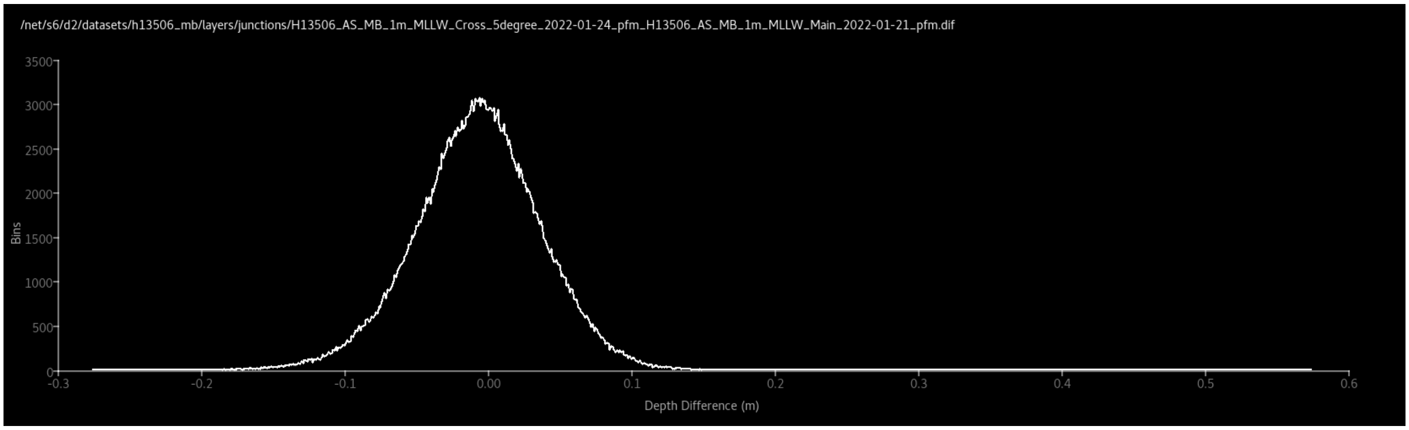

Figure 17: Plot of Crossing Analysis M/V Atlantic Surveyor Crosslines vs. Mainscheme Lines

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	8298	20.36	4003	9.82	3913	9.60	382	0.94
>0.01-0.02	6752	36.93	3403	18.17	3349	17.82		
>0.02-0.03	6404	52.64	3283	26.23	3121	25.48		
>0.03-0.04	5390	65.87	2849	33.22	2541	31.71		
>0.04-0.05	5005	78.15	2534	39.44	2471	37.78		
>0.05-0.06	3404	86.50	1448	42.99	1956	42.58		
>0.06-0.07	2175	91.84	692	44.69	1483	46.22		
>0.07-0.08	1240	94.88	353	45.55	887	48.39		
>0.08-0.09	801	96.85	235	46.13	566	49.78		
>0.09-0.1	451	97.96	77	46.32	374	50.70		
>0.1-0.11	265	98.61	27	46.39	238	51.28		
>0.11-0.12	166	99.01	27	46.45	139	51.62		
>0.12-0.13	144	99.37	34	46.54	110	51.89		
>0.13-0.14	117	99.65	4	46.55	113	52.17		
>0.14-0.15	111	99.93	0	46.55	111	52.44		
>0.15-0.16	26	99.99	0	46.55	26	52.51		
>0.16-0.17	3	99.99	0	46.55	3	52.51		
>0.17-0.175	1	100.00	0	46.55	1	52.52		
Total	40753	100.00%	18969	46.55%	21402	52.52%	382	0.94%
Reference Grid: H13506_OBII_MB_1m_MLLW_Cross_5degree_2022-01-21_pfm_ H13506_OBII_MB_1m_MLLW_Main_2022-01-20_pfm.dif								

Figure 18: Tabular Results Crossing Analysis, R/V Oyster Bay II Crosslines vs. Mainscheme Lines

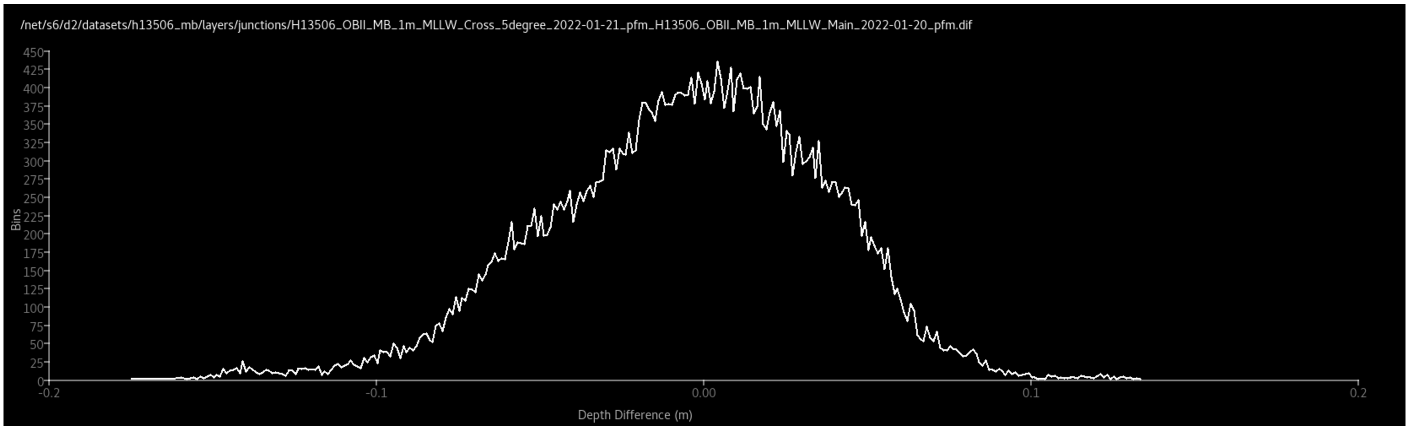

Figure 19: Plot of Crossing Analysis R/V Oyster Bay II Crosslines vs. Mainscheme Lines

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	148093	15.13	63581	6.50	77507	7.92	7005	0.72
>0.01-0.02	123482	27.75	47941	11.40	75541	15.64		
>0.02-0.03	131867	41.23	43856	15.88	88011	24.63		
>0.03-0.04	123342	53.83	34329	19.39	89013	33.73		
>0.04-0.05	117529	65.84	27617	22.21	89912	42.92		
>0.05-0.06	86444	74.67	17299	23.97	69145	49.98		
>0.06-0.07	66809	81.50	12161	25.22	54648	55.57		
>0.07-0.08	45287	86.13	8636	26.10	36651	59.31		
>0.08-0.09	36652	89.87	7126	26.83	29526	62.33		
>0.09-0.1	26841	92.61	5002	27.34	21839	64.56		
>0.1-0.11	20234	94.68	3665	27.71	16569	66.25		
>0.11-0.12	15627	96.28	3010	28.02	12617	67.54		
>0.12-0.13	12144	97.52	2725	28.30	9419	68.50		
>0.13-0.14	9045	98.44	2082	28.51	6963	69.22		
>0.14-0.15	6317	99.09	1525	28.67	4792	69.71		
>0.15-0.2	8614	99.97	2230	28.90	6384	70.36		
>0.2-0.25	255	99.99	109	28.91	146	70.37		
>0.25-0.3	26	99.99	13	28.91	13	70.37		
>0.3-0.4	0	99.99	0	28.91	0	70.37		
>0.4-0.5	2	99.99	0	28.91	2	70.37		
>0.5-0.6	1	99.99	1	28.91	0	70.37		
>0.6-0.671	2	100.00	2	28.91	0	70.37		
Total	978627	100.00%	282922	28.91%	688700	70.37%	7005	0.72%
Reference Grid: H13506_MB_1m_MLLW_AS_pfm_H13506_MB_1m_MLLW_OBII_pfm.dif								

Figure 20: Tabular Results Vessel Comparison Analysis, M/V Atlantic Surveyor vs. R/V Oyster Bay II

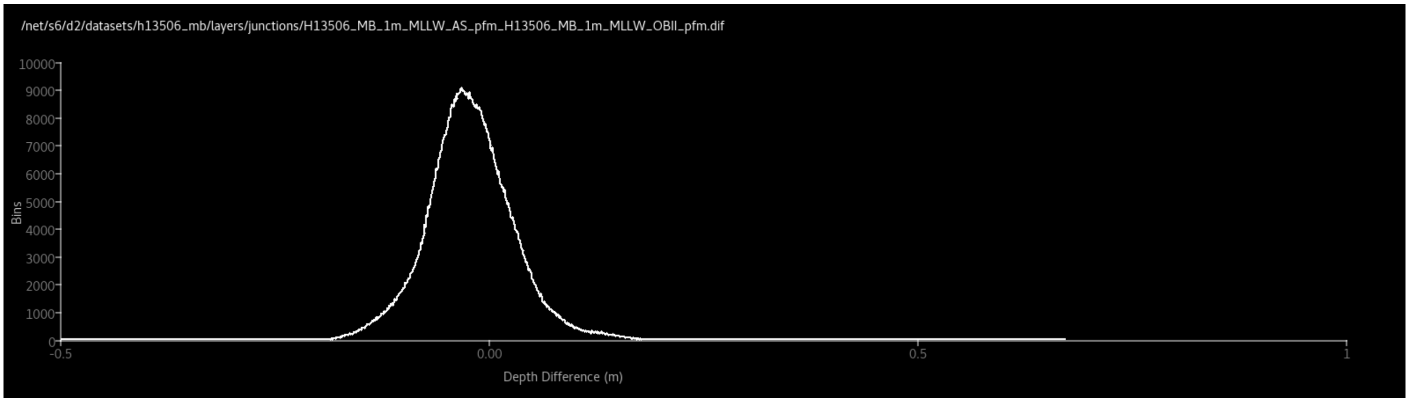

Figure 21: Plot of Vessel Comparison Analysis M/V Atlantic Surveyor vs. R/V Oyster Bay II

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
R/V Oyster Bay II	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 5.2.2.3, H13506 depth data fell within two resolution surfaces (1-meter and 2-meter).

The final H13506 1-meter Main Area PFM CUBE surface contained final vertical uncertainties that ranged from 0.210 meters to 1.066 meters. The IHO Order 1a maximum allowable vertical uncertainty was calculated to range between 0.502 to 0.571 meters, based on the minimum CUBE depth (3.084 meters) and maximum CUBE depth (21.204 meters). Results from the SABER Check PFM Uncertainty function identified that there were 2,354 nodes in the final H13506 1-meter Main Area PFM CUBE surface with final vertical uncertainties that exceeded IHO Order 1a allowable vertical uncertainty. Many of the nodes were associated with features on the sea floor such as anchor scars and in areas of steep slopes such as the reef outcroppings, however, the majority of these uncertainties were associated with the outer ranges of swath data resulting from the SABER calculated uncertainty due to variability between sound speed profiles (SSP) within MBES data. These uncertainties were limited to a few R/V Oyster Bay II data files where SSP casts were variable as a result of the water mixing near the Port Freeport inlet. In these instances, sound speed profiles had high variability leading to SABER calculating a higher uncertainty value for some outer beam data. A thorough review of the final gridded surface in post-processing showed no artifacts in the data and that all nodes which had an elevated CUBE uncertainty in the CUBE depth data agreed well with coincident data. The SABER Frequency Distribution Tool was also used to review the Hyp. Final Uncertainty surface within the final H13506 1-meter Main Area PFM grid. Results showed that 99.99% of all nodes had final uncertainties less than or equal to maximum allowable vertical uncertainty of 0.571 meters.

The final H13506 2-meter PFM CUBE surface contained final vertical uncertainties that ranged from 0.210 meters to 0.657 meters. The IHO Order 1a maximum allowable vertical uncertainty was calculated to range between 0.539 to 0.570 meters, based on the minimum CUBE depth (15.425 meters) and maximum CUBE depth (21.105 meters). Results from the SABER Check PFM Uncertainty function identified that there was one node in the final H13506 2-meter PFM CUBE surface with final vertical uncertainties that exceeded the IHO Order 1a allowable vertical uncertainty. This node was associated with an anchor scar. The SABER Frequency Distribution Tool was also used to review the Hyp. Final Uncertainty surface within the final H13506 2-meter PFM grid. Results showed that 99.99% of all nodes had final uncertainties less than or equal to maximum allowable vertical uncertainty of 0.570 meters.

The final H13506 1-meter Detached Area PFM CUBE surface contained final vertical uncertainties that ranged from 0.210 meters to 0.500 meters. The IHO Order 1a maximum allowable vertical uncertainty was calculated to range between 0.501 to 0.520 meters, based on the minimum CUBE depth (2.117 meters) and maximum CUBE depth (10.953 meters). Results from the SABER Check PFM Uncertainty function identified that there were no nodes in the final H13506 1-meter Detached Area PFM CUBE surface with final vertical uncertainties that exceeded IHO Order 1a allowable vertical uncertainty. The SABER Frequency Distribution Tool was also used to review the Hyp. Final Uncertainty surface within the final H13506 1-meter PFM grid. Results showed that 100% of all nodes had final uncertainties less than or equal to maximum allowable vertical uncertainty of 0.520 meters.

B.2.3 Junctions

Per the Project Instructions, junction analysis was performed between H13506 and the surveys listed in the table below and illustrated in Figure 22. Results from the comparison to H13502 and H13504 are discussed below.

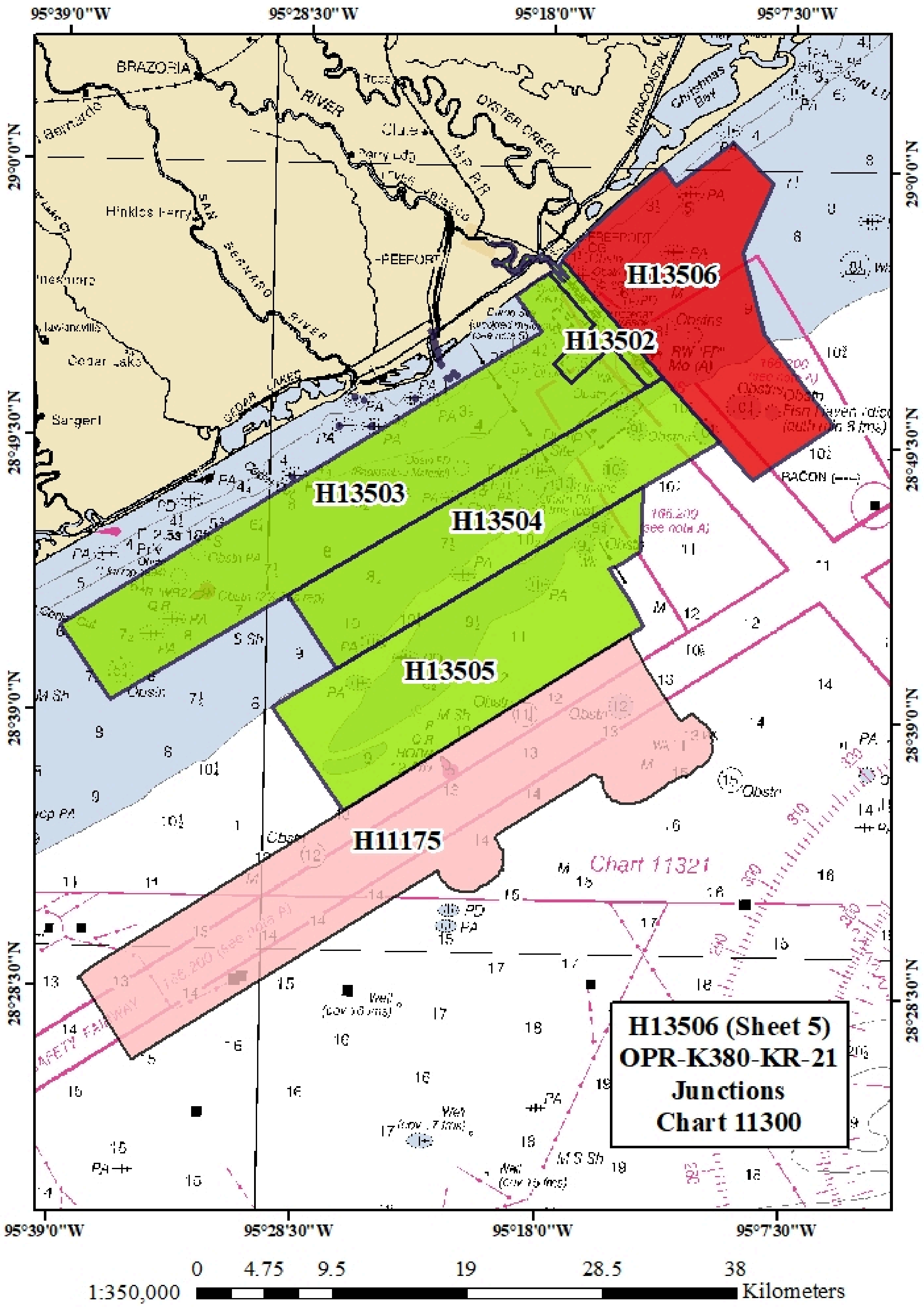

Figure 22: General Locality of H13506 with Junctioning Surveys

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13502	1:5000	2021	Leidos, Inc.	W
H13504	1:10000	2021	Leidos, Inc.	W

Table 9: Junctioning Surveys

H13502

Junctioning survey H13502 was conducted in 2021 and junctions to the west of H13506. For this analysis the H13502 Final 50-centimeter CUBE surface was compared to the H13506 1-meter CUBE depth surface. Junction analysis was conducted on the common area of these two sheets, with an overlapping area approximately 10,500 by 110 meters along the entirety of the western edge of H13506. Observed depths within the common area were 3.174 to 17.697 meters which resulted in a calculated allowable TVU range of 0.502 to 0.550 meters.

The difference grid was generated by subtracting the H13506 data from the H13502 data. Positive values indicate that H13502 depth data were deeper than H13506 depth data. Throughout the common area, H13502 CUBE depths were deeper 64.64% of the time and were shoaler 34.61% of the time (Figure 23). The distribution is spread about zero for all comparisons as presented in Figure 24.

100.00% of the comparisons were 0.390 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	513928	15.35	259467	7.75	229507	6.85	24954	0.75
>0.01-0.02	436206	28.37	255209	15.37	180997	12.26		
>0.02-0.03	469266	42.39	298452	24.28	170814	17.36		
>0.03-0.04	432350	55.30	293865	33.06	138485	21.50		
>0.04-0.05	416692	67.74	297017	41.93	119675	25.07		
>0.05-0.06	315234	77.16	232930	48.88	82304	27.53		
>0.06-0.07	248284	84.57	184554	54.40	63730	29.43		
>0.07-0.08	171682	89.70	125856	58.15	45826	30.80		
>0.08-0.09	136585	93.78	96993	61.05	39592	31.98		
>0.09-0.1	87958	96.40	59573	62.83	28385	32.83		
>0.1-0.11	52297	97.97	32475	63.80	19822	33.42		
>0.11-0.12	29188	98.84	15939	64.28	13249	33.82		
>0.12-0.13	16318	99.32	7026	64.48	9292	34.09		
>0.13-0.14	8930	99.59	2976	64.57	5954	34.27		
>0.14-0.15	5186	99.75	1354	64.61	3832	34.39		
>0.15-0.2	8147	99.99	889	64.64	7258	34.60		
>0.2-0.25	346	99.99	2	64.64	344	34.61		
>0.25-0.3	25	99.99	0	64.64	25	34.61		
>0.3-0.39	1	100.00	0	64.64	1	34.61		
Total	3348623	100.00%	2164577	64.64%	1159092	34.61%	24954	0.75%
Reference Grid: H13502_MB_50cm_MLLW_Final_bag_H13506_MB_1m_MLLW_1of2_All_For_Junctions_Only_2022-01-21_pfm.dif								

Figure 23: Tabular Results Junction Analysis H13506 vs. H13502

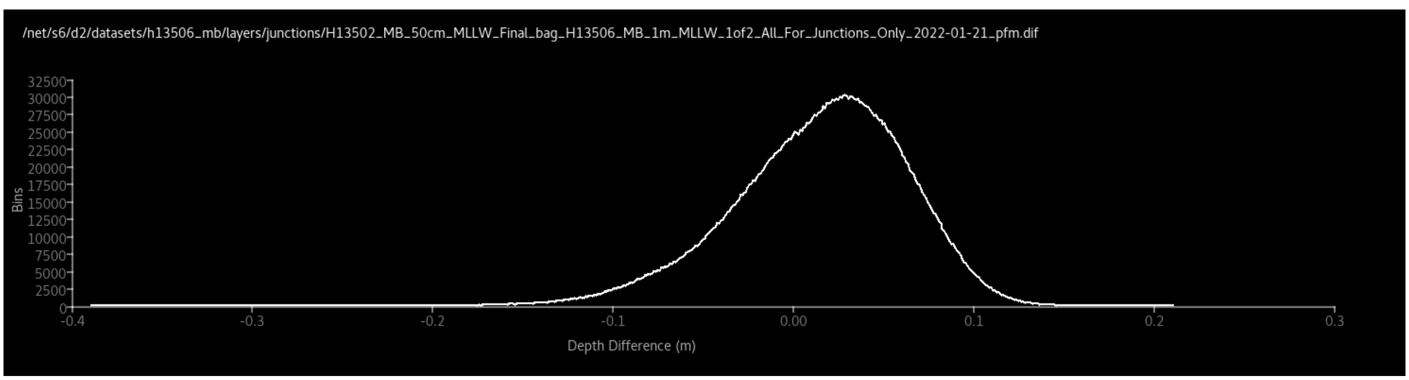

Figure 24: Plot of Junction Analysis H13506 vs. H13502

<u>H13504</u>

Junctioning survey H13504 was conducted in 2021 and junctions to the west of H13506. For this analysis the H13504 Final 1-meter CUBE surface was compared to the H13506 1-meter CUBE depth surface. Junction analysis was conducted on the common area of these two sheets, with an overlapping area approximately 6,200 by 200 meters along the entirety of the western edge of H13506. Observed depths within the common area were 17.338 to 20.079 meters which resulted in a calculated allowable TVU range of 0.548 to 0.564 meters.

The difference grid was generated by subtracting the H13506 data from the H13504 data. Positive values indicate that H13504 depth data were deeper than H13506 depth data. Throughout the common area, H13504 CUBE depths were deeper 38.82% of the time and were shoaler 60.53% of the time (Figure 25). The distribution is well spread about zero for all comparisons as presented in Figure 26.

100.00% of the comparisons were 0.367 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	122149	13.50	57199	6.32	59071	6.53	5879	0.65
>0.01-0.02	102445	24.82	50249	11.87	52196	12.30		
>0.02-0.03	108144	36.77	51680	17.59	56464	18.54		
>0.03-0.04	100977	47.93	46621	22.74	54356	24.54		
>0.04-0.05	101114	59.10	42902	27.48	58212	30.98		
>0.05-0.06	81937	68.16	30796	30.88	51141	36.63		
>0.06-0.07	71133	76.02	23737	33.50	47396	41.87		
>0.07-0.08	53323	81.91	15697	35.24	37626	46.02		
>0.08-0.09	46835	87.09	12388	36.61	34447	49.83		
>0.09-0.1	35424	91.00	8113	37.51	27311	52.85		
>0.1-0.11	26000	93.88	5112	38.07	20888	55.16		
>0.11-0.12	18671	95.94	2977	38.40	15694	56.89		
>0.12-0.13	13326	97.41	1808	38.60	11518	58.16		
>0.13-0.14	8960	98.40	1025	38.71	7935	59.04		
>0.14-0.15	5508	99.01	507	38.77	5001	59.59		
>0.15-0.16	3615	99.41	270	38.80	3345	59.96		
>0.16-0.17	2195	99.65	110	38.81	2085	60.19		
>0.17-0.18	1400	99.81	67	38.82	1333	60.34		
>0.18-0.19	716	99.89	25	38.82	691	60.42		
>0.19-0.2	429	99.93	12	38.82	417	60.46		
>0.2-0.25	547	99.99	19	38.82	528	60.52		
>0.25-0.3	43	99.99	0	38.82	43	60.53		
>0.3-0.367	2	100.00	0	38.82	2	60.53		
Total	904894	100.00%	351314	38.82%	547701	60.53%	5879	0.65%
Reference Grid: H13504_MB_1m_MLLW_2022-01-23_bag_H13506_MB_1m_MLLW_1of2_All_For_Junctions_Only_2022-01-21_pfm.dif								

Figure 25: Tabular Results Junction Analysis H13506 vs. H13504

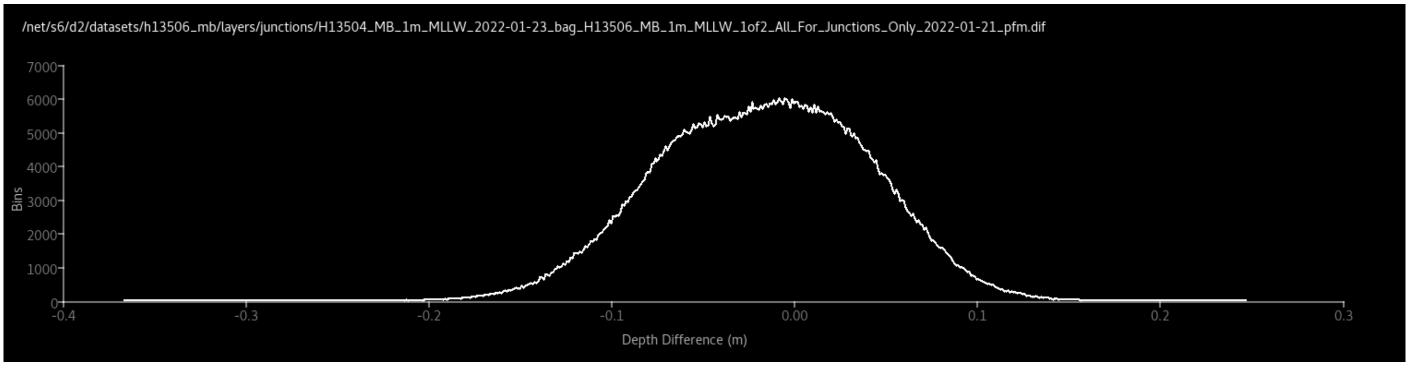

Figure 26: Plot of Junction Analysis H13506 vs. H13504

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

Dense biological interference were observed during discrete areas and during various days of survey which required numerous holiday reruns. Due to these environmental factors, there were at times significant data masking of the SSS data. Based on this observed occurrence, in several areas where the data acquisition was planned for 200% SSS (over assigned disproval areas) Leidos modified the survey acquisition strategy to also acquire 100% MBES in order provide a more robust data product while also limiting the amount of required holiday line acquisition. The end result was that there were no significant impacts to the final sounding data.

Additionally, throughout survey acquisition fishing and trawling were observed, and occasionally evidence of these activities can be seen in H13506 data, with no negative impacts. There were also observed fishing pots and temporary fishing floats within the Detached Area at the mouth of the Brazos River, see Section D.1.4 for more information regarding these objects being removed from or left in the H13506 data.

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, and on the R/V Oyster Bay II, the AML BaseX2 was the primary system used to collect SSP data, refer to the DAPR for additional details. SSP data were obtained at intervals frequent enough to meet depth accuracy requirements.

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 H13506 data and are broken out into sub-folders, which correspond to the purpose of each cast. Also, all individual SSP files for H13506 have been concatenated into two separate files based on the purpose of the cast, provided in CARIS format files (.svp), and delivered under (H13506/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

Leidos chose to achieve the complete coverage requirement using 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 three CUBE Depth surfaces for H13506 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, beyond the side scan nadir coverage gap, and fully covered with 100% SSS coverage.

All final H13506 CUBE PFM grids were 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 all PFM grids 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 Main Area PFM grid 99.33% of all nodes contained five or more soundings. Within the final 1-meter Detached Area PFM grid 99.88% of all nodes contained five or more soundings. Within the final 2-meter PFM grid 99.64% of all nodes contained five or more soundings.

As noted in Section A.4, the assigned survey bounds were achieved across H13506 except where the inshore limit of the Navigable Area Limit Line (NALL) was reached in the Main Area around the vicinity of Surfside Beach, and within some of the Detached Areas.

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. All 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
H13506_MB_1m_MLLW_1of2	BAG	1 meters	3.084 meters - 21.204 meters	N/A	Complete coverage, Option B (100% side scan sonar coverage with concurrent multibeam)
H13506_MB_1m_MLLW_2of2	BAG	1 meters	2.117 meters - 10.953 meters	N/A	Complete coverage, Option B (100% side scan sonar coverage with concurrent multibeam)
H13506_MB_2m_MLLW_Final	BAG	2 meters	15.425 meters - 21.105 meters	N/A	Complete coverage, Option B (100% side scan sonar coverage with concurrent multibeam)
H13506_SSSAB_1m_400kHz_900kHz_1of1	SSS Mosaic (.tif)	1 meters	0 meters - 0 meters	N/A	First 100% SSS
H13506_SSSAB_1m_400kHz_900kHz_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 grid resolution for depths ranging from 0 meters to 20 meters and 2-meter grid resolution for depths ranging from 18 meters to 40 meters. Leidos generated the CUBE PFM grids for H13506 at 1-meter and 2-meter resolutions. Per previous approval, Leidos generated the two node resolution surfaces using all data by area; and therefore not restricting the resulting surfaces to be of the single depth bands. This was done to ensure that any feature over-rides were retained between overlapping areas of coverage; as occurred within H13506 data.

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 H13506 1-meter 1of2 PFM grid were from 3.084 meters (10.118 feet; 0.210 meters TVU) to 21.204 meters (69.567 feet; 0.216 meters TVU). The range of CUBE depths of the H13506 1-meter 2of2 PFM grid were from 2.117 meters (6.946 feet; 0.260 meters TVU) to 10.953 meters (35.935 feet; 0.270 meters TVU). The range of CUBE depths of the H13506 2-meter PFM grid were from 15.425 meters (50.607 feet; 0.220 meters TVU) to 21.105 meters (69.242 feet; 0.210 meters TVU).

The final gridded bathymetry data are delivered in Bathymetric Attributed Grid (BAG) format. The BAG files were 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. H13506 data met 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 H13506 CUBE data were varied in agreement with charted depths compared to the ENCs listed in Section D.1.1. While CUBE depths generally agreed with the charted depths greater than thirteen meters (±0.2m), depths less than thirteen meters varied from charted depths by approximately 0.5 to 2.0 meters with CUBE depths generally found to be deeper than charted.

Charting recommendations for new features and updates to charted features, are documented in the H13506 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 05/22 (02 February 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
US5FPOBC	1:10000	3	09/27/2021	01/05/2022
US5FPOCB	1:10000	8	09/30/2021	01/18/2022
US5FPOCC	1:10000	4	09/13/2021	09/13/2021
US5FPODB	1:10000	3	08/27/2021	11/24/2021
US5TX51M	1:40000	42	12/13/2021	12/14/2021
US4TX41M	1:80000	21	09/27/2021	01/05/2022

Table 14: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

Refer to Figure 27 and Section D.1.4 for significant shoals or hazardous features within the area covered by this survey. Figure 27 details the Leidos submitted DTON and Anti-DTON reports for H13506. Reports were submitted per HSSD in S-57 format to the Atlantic Hydrographic Branch (AHB). Per the CSF there was one assigned feature within H13506 with investigation requirements that indicated that if not present to conduct a disproval and submit an Anti-DTON expeditiously, Leidos submitted this through the H13506_Anti-DTON_01-2 file. Refer to the Project Correspondence for email correspondence related to submitted files.

Within the Detached Area at the mouth of the Brazos River was an assigned CSF obstruction; foul area. During survey operations on H13506, acquisition within this foul area was conducted to the extent possible based on the observed NALL limits and overall safety concerns. A portion of the survey bounds for the foul area was covered by MBES and SSS data which, along with visual observations of the area during survey, confirmed the area to be appropriately categorized as an obstruction, foul area. Large amounts of floating debris and uprooted trees were observed throughout this area, and flowing down from the Brazos River, which affected survey operations; further restricting and confining survey based on vessel, equipment, and personnel safety as floating debris strikes to the survey vessel occurred. Temporary fishing gear were also observed in this area as described in Section D.1.4. Additionally, there were visual observations of abandoned or wrecked boats, above the water surface along the shoreline and riverbank, which were not safe to approach or acquire any data. Upon arrival to this survey area the survey team utilized an unmanned aerial drone to aid with developing information regarding where the survey vessel could safely conduct operations. Still images from the aerial drone’s data collection are included on the delivery drive under the folder H13506/Processed/Multimedia and referenced in the H13506 FFF for this foul area. As this obstruction, foul area, is recommended as being retained in the H13506 FFF, there are no individual features or contacts set on individual objects within this areas MBES or SSS data.

Within a separate nearshore detached area assigned south of the Brazos River, the field observed a moving exposed tree. Leidos was in this area on two separate days, 2021-07-21 (JD 202) and 2021-07-30 (JD 211). On JD 202 100% MBES was collected over the area and there were no submerged or exposed objects identified. On JD 211 the field team returned to the area to finalize the NALL and noted that there was a bobbing exposed tree now present. Data and photos were collected for the object on JD 211, and this was the last day in this area where the exposed tree was observed as coverage requirements had been met. Based on data review and Leidos' experience with moving debris in the Brazos River as described above, Leidos concluded this exposed tree was transient. As the tree was considered to be transient the MBES data were invalidated and there are no corresponding SSS contacts. Refer to Project Correspondence for additional details as Leidos had sought clarification from NOAA regarding this object.

DTON Report Name	Date Submitted to AHB	AHB Submitted to NDB and MCD	NDB Registration	Feature Number(s)
H13506_Anti-DTON_01-2.000	2021-07-30	2021-08-02	DD-34747	N/A
H13506_DTON_01.000	2021-08-02	2021-08-04	DD-34765	07

Figure 27: 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 H13506. Per HSSD Section 8.1.4, these charted features are not addressed in this section, refer to the H13506 S-57 FFF (H13506_FFF.000) for all the details and recommendations regarding these features.

Within the final CSF there was an assigned meta-object quality of data (M_QUAL) which had the investigation requirements to conduct a disproval and submit an Anti-DTON expeditiously (Section D.1.2). As this was an assigned feature and meta-object; Leidos received HSSD clarification regarding the inclusion of the meta-object within the H13506 FFF, see Project Correspondence and H13506 FFF.

The offshore area within the H13506 bounds is categorized as an anchorage area. Throughout survey operations on H13506 it was observed that this anchorage area is heavily used by commercial vessels accessing the Freeport, TX port and area. Throughout the offshore anchorage area the H13506 MBES and SSS data are characterized by having numerous anchor scars and drag scars observed in the seafloor sediment. These anchor and drag scars are found spanning across large areas of the MBES and SSS data, and in some occurrences the sediment buildup around the scars was found to have heights in the range of 1 to 1.5 meters above the surrounding natural seafloor. As this sediment buildup was determined to be natural bottom and was also found to flatten and smooth out over time, reducing any height, there are no MBES features or SSS contacts set on these items within the data.

Also, within this anchorage area of H13506, there were three assigned charted features (obstruction, fish haven, and underwater rock – coral) which were observed within the H13506 MBES and SSS data. Based on review and analysis of the H13506 data, Leidos has determined that these three features have similar characteristics and signatures; all appearing to be the same type of object; coral outcroppings. Within the H13506 FFF, per HSSD the charted obstruction and underwater rock are recommended for deletion; however as the investigation requirements for the Fish Haven list to retain the feature; that charted feature is recommended to be retained. These three H13506 features are recommended to be charted as obstructions as they fall within the bounds of the active anchorage area, refer to the H13506 FFF (Features 02, 03, and 04).

D.1.4 Uncharted Features

See the H13506 S-57 FFF for all the details and recommendations regarding new uncharted features investigated. During the course of H13506 survey operations, fishing gear and temporary floats were observed within the Detached Area at the mouth of the Brazos River. Due to their temporary nature, there are no features associated with these markers within the H13506 S-57 FFF. When a temporary fishing surface float was identified and correlated to objects in the MBES data, as these were not true seafloor the MBES data were invalidated and no longer contributed to a CUBE surface. In many cases, where it was not possible to confirm the fishing gear were not derelict or tied to a surface float, the object was retained in the MBES data. See Section B.2.6 for more information.

D.1.5 Channels

There were no assigned channels within the H13506 SOW from the final CSF. However, the survey area was coincident to Safety Fairway (FAIRWY) to the Freeport Harbor Channel (ENC US4TX41M and US5POBC).
H13506 CUBE depths were in agreement with the charted depths.

Additionally, while acquiring data for the assigned obstruction foul area described in Section D.1.2, MBES and SSS data were acquired north of the assigned detached SOW area for this object. These additional data north of the foul area were coincident with a portion of the Intracostal Waterway for the Brazos River Crossing. H13506 CUBE depths were in agreement with the charted depths in this location. See Section D.2.9 for more information.

D.2 Additional Results

D.2.1 Aids to Navigation

There were no assigned Aids to Navigation (ATON) within the SOW of H13506 from the final CSF.

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 H13506. Bottom characteristics were acquired at the nine locations assigned in the final PRF (OPR-K380-KR-21_PRF.000). Leidos did not modify the bottom sample locations from the location 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 H13506/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 assigned submarine features (pipelines) for investigation. Along these assigned submarine features, there were no observations of characteristics consistent with a pipeline in the SSS or MBES data. As such, the presence of pipelines associated with these assigned features within H13506 SOW bounds can neither be confirmed nor disproven. No other uncharted or unburied pipelines were found within the H13506 survey data.

D.2.6 Platforms

Platforms were assigned from the CSF and are addressed in the H13506 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 other 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 and D.1.2.

D.2.9 Construction and Dredging

No construction or dredging exists within the assigned H13506 area.

While acquiring data for the assigned obstruction foul area described in Section D.1.2, MBES and SSS data were acquired north of the assigned detached SOW area for this object. These additional data north of the foul area were coincident with a portion of the Intracostal Waterway for the Brazos River Crossing. This area was an unassigned dredged area relative to the Intracostal Waterway for the Brazos River Crossing. H13506 CUBE depths were in agreement with the charted depths in this location, see Section D.1.5. The MBES and SSS data coincident to these dredged areas confirmed the existence of prior dredging activities, and some evidence of small sediment mounds from dredging were present. As the observed CUBE depths were within the range of the charted dredge area, there were no individual features or contacts set within the MBES or SSS data for these sediment mounds.

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 Surveys 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
H13504_DR.pdf	2022-02-07
H13505_DR.pdf	2022-02-10

Approver Name	Approver Title	Approval Date	Signature
Alex T. Bernier	Lead Hydrographer	02/11/2022	Alex T Bernier Digitally signed by: Alex T Bernier DN: CN = Alex T Bernier C = US O = Leidos OU = A01410D00000171F4D884FE0000D620 Date: 2022.02.11 12:12:12 -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