W00331

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

DESCRIPTIVE REPORT

Type of Survey:	External Source Data
Registry Number:	W00331

LOCALITY

State(s):	North Carolina
General Locality:	Outer Banks, NC
Sub-locality:	Corolla, NC to Pea Island National Wildlife Refuge, NC

2014

NOAA National Geodetic Survey

Remote Sensing Division

LIBRARY & ARCHIVES

Date:

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00331

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):	**North Carolina**
General Locality:	**Outer Banks, NC**
Sub-Locality:	**Corolla, NC to Pea Island National Wildlife Refuge, NC**
Scale:	**10000**
Dates of Survey:	**11/25/2013 to 07/20/2014**
Project Number:	**OSD-RSD-15**
Data Source:	**NOAA Remote Sensing Division**
Chief of Party:	**Michael Aslaksen, Chief, Remote Sensing Division**
Soundings by:	**Topo-bathymetric LIDAR**
Imagery by:	**N/A**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**Meters at Mean Lower Low Water**

Remarks: W00331 has been designated a sub-region of W00300.

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

Descriptive Report Summary to Accompany **W00300**	
Project	OSD-RSD-15
Survey	W00300
State	Virginia, North Carolina, South Carolina
Locality	VA, NC, SC Coastline
Sub Locality	Cape Henry, VA to Winyah Bay, SC
Scale of Survey	variable
LASER Used	Riegl VQ-820G Lidar Sensor
Horizontal Datum	North American Datum of 1983
Vertical Datum	Mean Lower Low Water (MLLW)
Vertical Datum Correction	VDATUM
Projection	Latitude-Longitude (NAD83) - UTM Zone 18
Field Unit	Dewberry, Quantum Spatial, RC&A, Woolpert
Survey Dates	25 NOV 2013 to 20 JUL 2014
Chief of Party /Data Originator	NOAA Remote Sensing Division Chief, Mike Aslaskan
Lidar Online Archive	NOAA Data Access Viewer
Shoreline Online Archive	NOAA Shoreline Data Explorer

A. Area Surveyed

This topo-bathy lidar survey was acquired in accordance with the requirements defined in the National Geodetic Survey (NGS) Sandy Supplemental Statement of Work Volume 4. Please see the NGS Remote Sensing Division (RSD) DR/DAPR report for any deviations from this requirement.

The data set contains outer coast and inlet data from Winyah Bay, SC to Norfolk, VA. This is a subset of a larger Post Hurricane Sandy topo-bathy lidar data set that extends from South Carolina to New York. The entire data set spans 140 blocks and has been broken down into four sections for submission to the Office of Coast Survey (OCS). This data set contains block 01 through block 60, as outlined in Figure 1. See Appendix A. Bathymetric Coverage for grid coverage by block. The entire data set can be found on the NOAA Data Access Viewer.

Data was acquired within the following survey limits:

Table 1 Bounding Coordinates

Northeast Limit	Southwest Limit
36.97 N	33.18 N
76.30 W	79.18 W

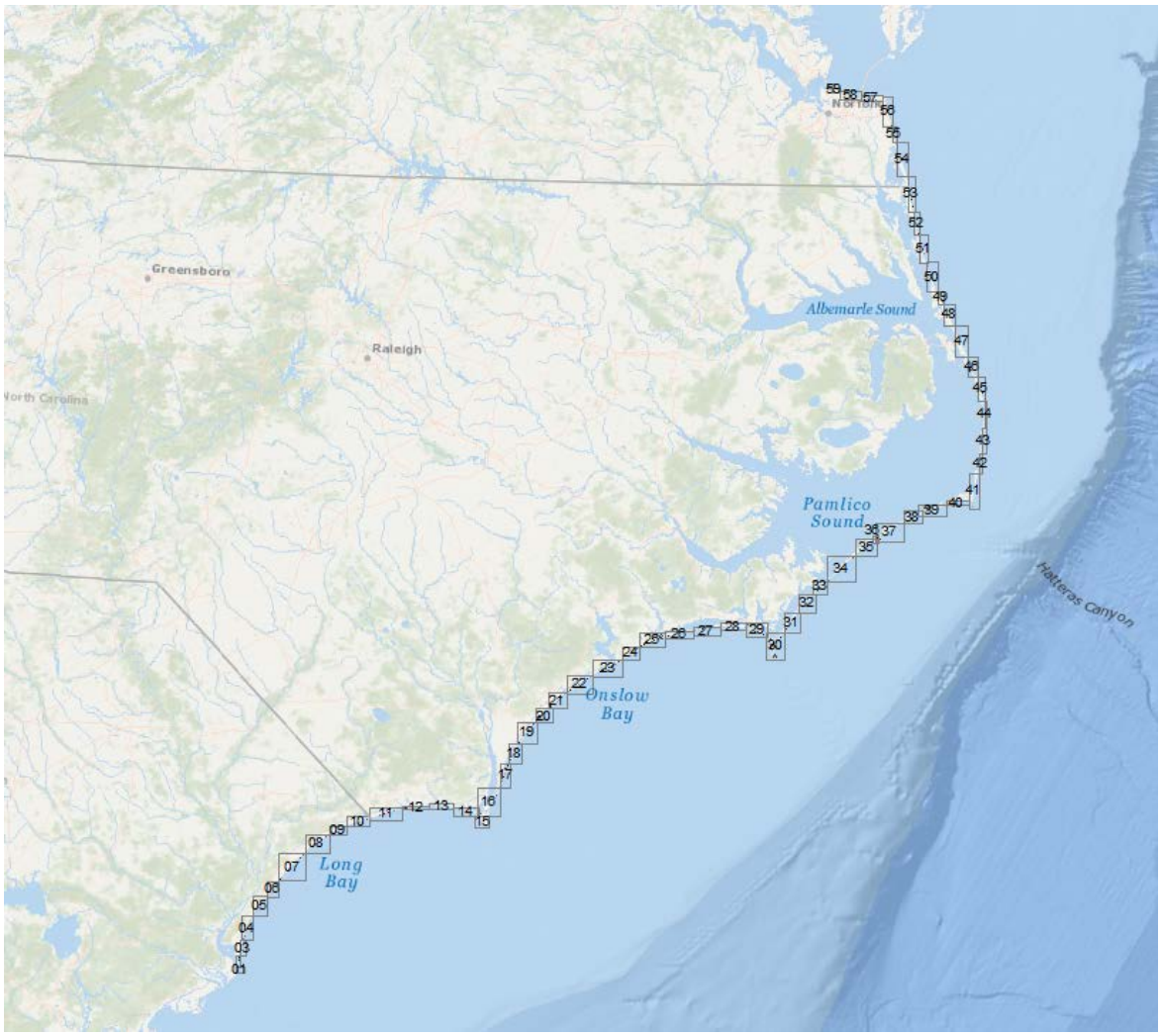


Figure 1 Image depicts region of coverage broken up by assigned block 01 through 60. The data contains topo-bathy lidar coverage of inlets and near shore outer coast gridded at 3m resolution. See Appendix A for bathymetric coverage by block.

B. Survey Purpose

The purpose of this survey was to update the national shoreline after Hurricane Sandy by the NOAA Remote Sensing Division (RSD). Data collection and processing was managed by private contractor, Dewberry. The survey limits and methods were determined by RSD.

C. Intended Use of Survey

In conjunction with RSD's Geographic Cell shoreline product (GC11173), data is adequate to supersede soundings and intertidal areas and add or modify features to the chart. The coverage meets Office of Coast Survey (OCS) Reconnaissance Coverage requirements for lidar data. The data should not be used to disprove submerged features due to excess water column noise described in Section D. Data Acquisition and Processing.

D. Data Acquisition and Processing

For a description of original data acquisition and processing systems, survey equipment, quality control procedures and data processing methods the following documents have been included with this data submission from the Remote Sensing Division and contractor:

DR_DAPR_VA1408_W00300_signed (RSD)
Supplemental_Sandy_Final_Report_of_Survey_20151030 (Dewberry)

Analysis for charting and additional product generation, as discussed in this document, was performed by the Sandy Integrated Ocean and Coastal Mapping Group at the UNH/NOAA Joint Hydrographic Center.

The lidar las files and aerial imagery were processed in ArcMAP 10.4.0, LP360 2015.1.76.7 for ArcMAP extension and Caris Base Editor 4.1. In LP360 the data were reviewed to confirm classification was correct, point source IDs were assigned to flight lines, data were in MLLW, fliers were removed, and to identify any additional features, not included in the RSD shoreline files. The aerial imagery was combined by block in ArcMAP and exported to GeoTIFF for ease of use within Caris. Caris Base Editor was used for final grid creation in csar and bag format and S-57 feature file attribution.

Seven classes of data, identified in the following table, were extracted by RSD from the full lidar data set, converted to MLLW, inverted to Z positive down, and clipped to MHW for chart submission.

Table 2 Lidar Classes Submitted from RSD

Lidar Class	Category
1	Unclassified
2	Ground
25	Water Column
26	Bathymetry
27	Water Surface
29	Submerged Features
30	S-57 Features

Class 2 ground and class 26 bathymetry represent the bare earth points. Chart features are not represented in these classes. Class 29 and 30 are reserved for features. No data points were found within class 29 or 30 for these blocks. All features, such as those represented in the shoreline file (piers, buoys, pilings, etc.), are located in class 1 unclassified, along with noise and other miscellaneous points not classified. Occasionally, features are also included in additional classes, such as 25 water column or 27 water surface (Figure 2).

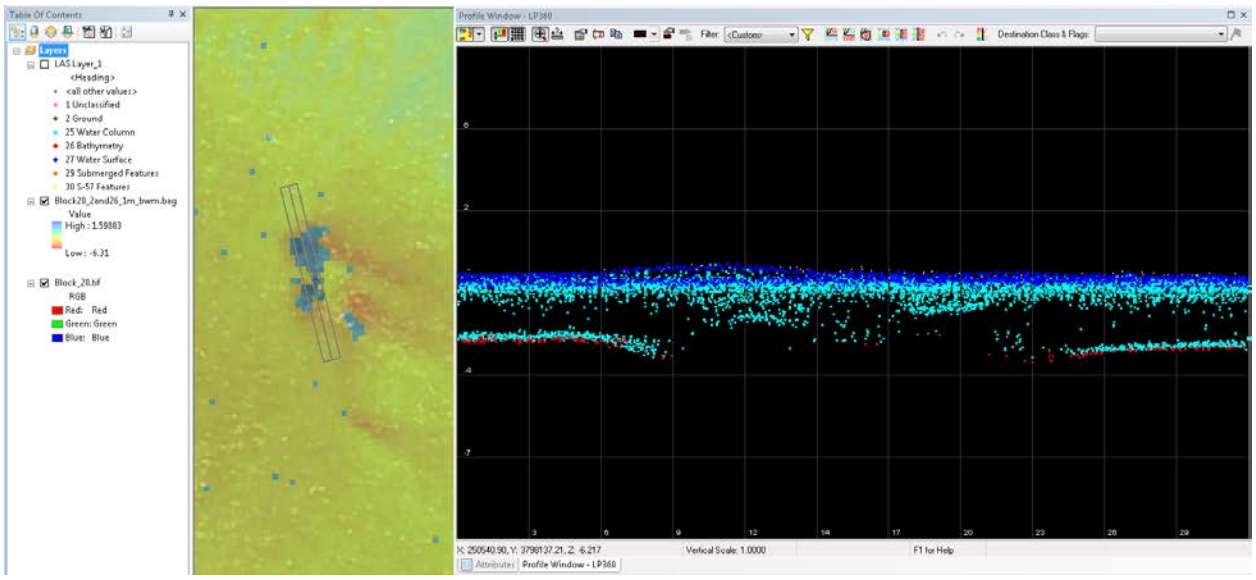


Figure 2 LP360 profile of submerged wreck represented in water column class, light blue points. Red points represent classified bathymetry and royal blue points represent classified water surface. Block 20.

The algorithm used to automatically classify the ground points for land and bathymetric elevations tracks and selects the bottom edge of the data set. This can result in data points not included in the ground or bathymetry class that may otherwise be considered ground or seafloor. As a consequence, the density of the gridded data can be reduced or shoal depths excluded. In the following image (Figure 3) the bottom edge of the intertidal area is classified bathy (red), while the top edge is classified water column (light blue). Of these classes, only the bathymetry class (red points) would be included in an elevation model.

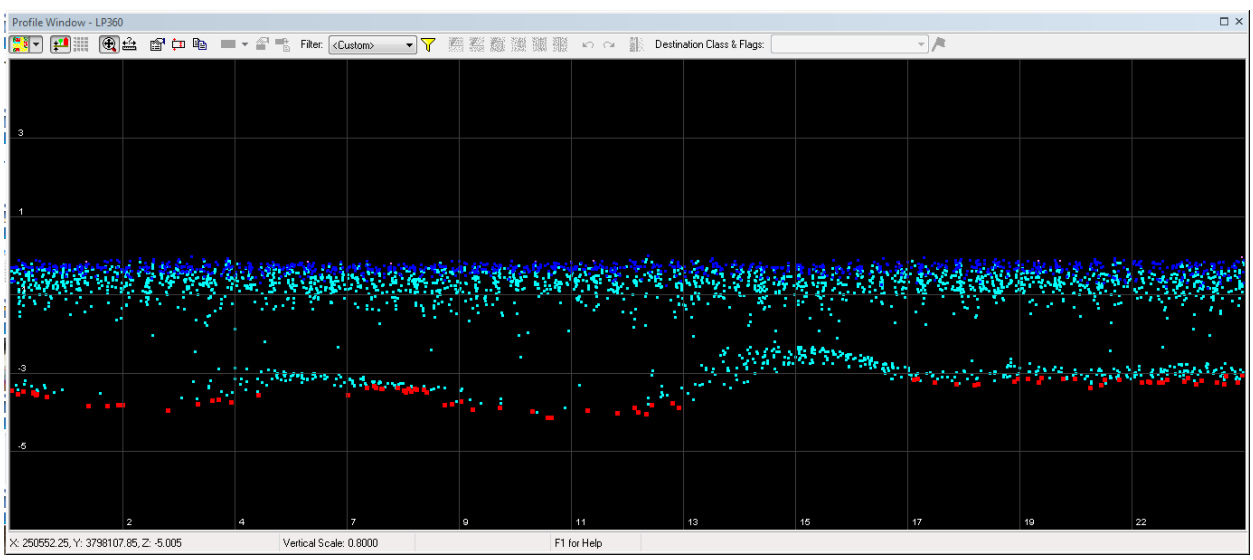


Figure 3 LP360 profile of shoal points on sand waves included in water column class (light blue), which ends up being excluded from the bare earth model. The surrounding classified bathymetry (red points) demonstrate how the bottom tracking algorithm only classifies the bottom edge of the ground/bathy points. Block 20.

The data were reviewed for submerged features outside of the RSD shoreline boundary extent. Blocks 1-60, represent the most southern extent of the full Sandy data set and have better clarity and less noise than northern blocks, however in shallow areas water column noise is enough to inhibit identification of features. The increased noise in the system was due to an increase in the sensitivity of the sensor to improve bathymetric measurements, as described on page 31 of the RSD DR DAPR.

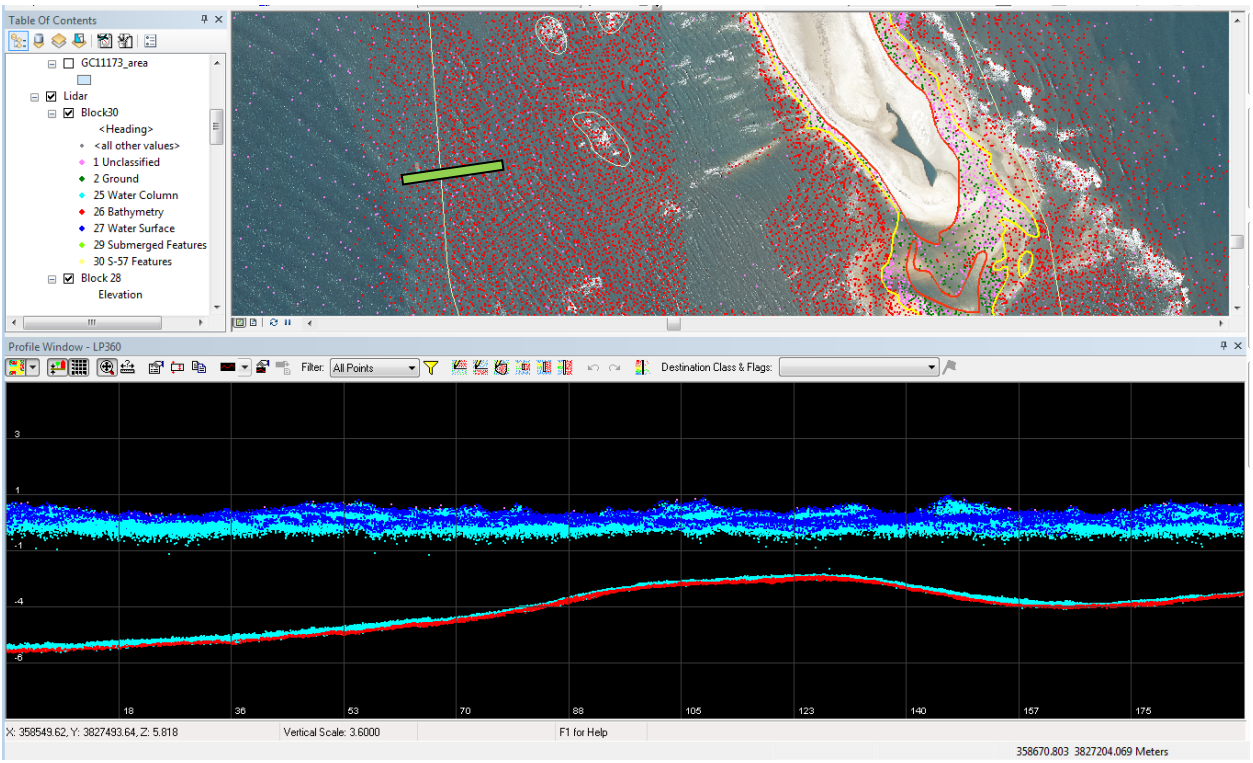


Figure 4 Block 28, off Cape Fear, favorable conditions achieved bathymetric coverage up to 6 m depth. Water column and surface noise only affected the top meter of water.

In LP360, the chart, LAS files, aerial imagery, and final shoreline GC11174 were used to search for and identify any additional features in the data, not included in the RSD shoreline. The features are digitized at survey scale and included in the final feature file W00300_FFF.000. The features include pilings, breakers, shoreline construction, beacons/buoys, obstructions and cartographic notes.

While reviewing the las files, minor edits and corrections were made to the las files before generating the final csar grid. Missing las files were obtained from RSD in blocks 2, 6, 7 and 39. Block 28 was received referenced to the Geoid and was converted to MLLW using VDatum. Some points were reclassified in block 14 and 16 and exported for gridding.

A 3 m grid surface was generated for the entire data set and used to make additional product layers. At this resolution, 92.4% of nodes have 5 soundings or more (Figure 5). An additional 1m surface was created for reference. The flight lines were collected at 20% sidelap, which limits the dataset to meeting OCS Reconnaissance Coverage requirements for lidar. The RSD and contractor reports mistakenly state 50% sidelap. This discrepancy was confirmed with RSD.

Table 3 Bathymetric Surfaces

Surface Name	Surface Type	Resolution	Depth Range (m)	Surface Parameter	Purpose
W00300_LI_3m_MLLW	BAG/CSAR	3m	-4.48 to 8.26	Shoalest Depth	Reconnaissance Coverage
W00300_LI_1m_MLLW	BAG/CSAR	1m	-14.7 to 27.1	Shoalest Depth	Reference

The following four additional files were created from the 3 m surface and submitted with the data set;

- survey scale sounding layer with 40 m radius spacing (HOB)
- contour file containing NOAA rounded 3, 6, 12 and 18 ft contours (HOB)
- coverage polygon (HOB)
- block 01 through 60 outlines, as seen in Figure 1 (SHP)

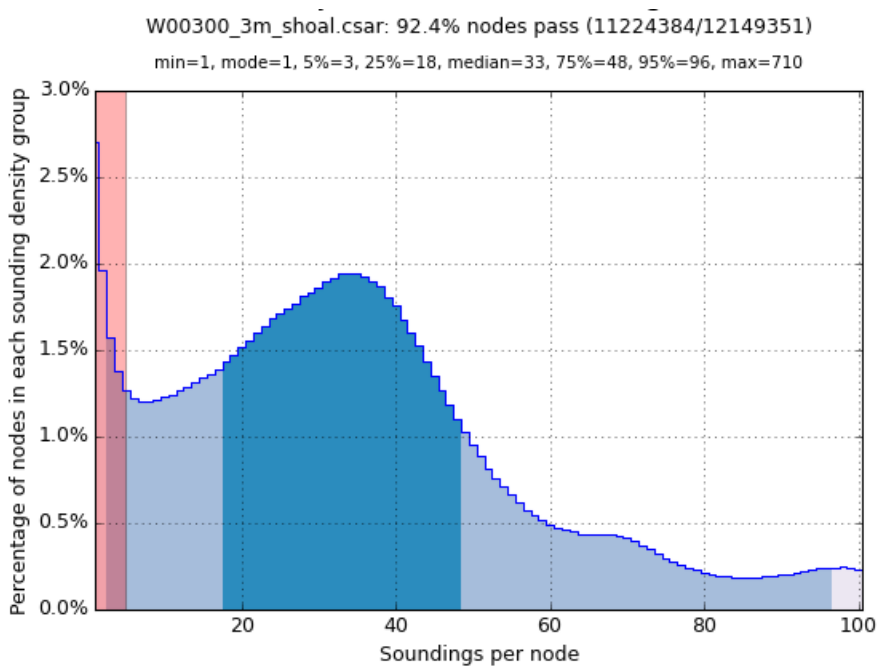


Figure 5 Representation of sounding density per node for the 3 m surface

E. Uncertainty

The standard deviation for the 3 m gridded surface ranges from 0 to 1.9 m with an average of 4 cm. These values are reflective of the bottom detection algorithm used to classify bottom points and not necessarily the standard deviation of the full ground points.

For information on positional accuracy of the data refer to pg 41, section 5.0 Uncertainty, of the RSD DR DAPR.

F. Results and Recommendations

The following are the largest scale RNCs and ENCs, which cover the survey area, 1:80,000 and higher, used to compare with W00300:

Chart	Scale	Edition	Edition Date	LNM Date	NM Date
12255	1:5,000	18	9/01/2014	7/2/2016	7/12/2016
11547	1:15,000	40	7/1/2015	7/2/2016	7/12/2016
11545	1:20,000	66	6/01/2015	7/2/2016	7/12/2016
12245	1:20,000	68	05/01/2013	7/2/2016	7/12/2016
12254	1:20,000	49	08/01/2011	7/2/2016	7/12/2016
12256	1:20,000	18	01/01/2014	7/2/2016	7/12/2016
11532	1:40,000	22	10/01/2012	7/2/2016	7/12/2016
11534	1:40,000	39	11/01/2015	7/2/2016	7/12/2016
11537	1:40,000	40	02/01/2015	7/2/2016	7/12/2016
11541	1:40,000	41	11/01/2015	7/9/2016	7/12/2016
11542	1:40,000	19	08/01/2014	7/16/2016	7/12/2016
11545	1:40,000	66	06/01/2015	7/2/2016	7/12/2016
11550	1:40,000	31	07/01/2015	7/2/2016	7/12/2016
12222	1:40,000	55	02/01/2015	7/2/2016	7/12/2016
11531	1:80,000	23	09/01/2012	7/2/2016	7/12/2016
11535	1:80,000	13	02/01/2012	7/2/2016	7/12/2016
11536	1:80,000	20	01/01/2015	7/2/2016	7/12/2016
11539	1:80,000	20	09/01/2014	7/2/2016	7/12/2016
11543	1:80,000	25	04/01/2015	7/2/2016	7/12/2016
11544	1:80,000	41	12/01/2013	7/2/2016	7/12/2016
11555	1:80,000	42	04/01/2015	7/2/2016	7/12/2016
12204	1:80,000	38	12/01/2012	7/2/2016	7/12/2016
12205	1:80,000	34	04/01/2014	7/2/2016	7/12/2016
12207	1:80,000	24	07/01/2014	7/2/2016	7/12/2016
12221	1:80,000	82	02/01/2014	7/2/2016	7/12/2016

ENC	Scale	Edition	Update Application	Issue Date
US4NC11M	1:80,000	13	7/20/2016	7/20/2016
US4NC13M	1:80,000	14	6/22/2016	6/22/2016
US4NC15M	1:80,000	19	7/1/2016	7/1/2016
US4NC16M	1:80,000	15	3/15/2016	5/4/2016
US4NC30M	1:80,000	21	7/15/2016	7/15/2016
US4NC31M	1:80,000	18	6/22/2016	6/22/2016
US4NC32M	1:80,000	10	10/28/2014	2/17/2016
US4NC53M	1:80,000	24	7/18/2016	7/18/2016
US5NC12M	1:40,000	38	6/8/2016	6/8/2016
US5NC14M	1:40,000	8	7/13/2016	7/13/2016
US5NC17M	1:15,000	37	6/17/2016	6/17/2016
US5NC18M	1:40,000	12	6/30/2016	6/30/2016
US5NC19M	1:40,000	9	6/20/2016	6/20/2016
US5NC51M	1:40,000	11	7/12/2016	7/12/2016
US5NC53M	1:40,000	10	6/15/2016	6/15/2016
US4SC20M	1:80,000	11	6/14/2016	6/14/2016
US4SC31M	1:80,000	12	6/15/2016	6/15/2016
US5SC32M	1:40,000	20	3/17/2016	3/17/2016
US5SC34M	1:40,000	22	6/7/2016	6/7/2016
US5VA11M	1:50,000	19	3/17/2016	3/28/2016
US5VA13M	1:40,000	32	3/17/2016	5/6/2016
US5VA15M	1:20,000	44	4/14/2016	4/20/2016
US5VA17M	1:20,000	27	4/12/2016	6/24/2016
US5VA18M	1:5,000	14	7/20/2016	7/20/2016
US5VA19M	1:20,000	27	3/17/2016	4/5/2016
US5VA20M	1:20,000	13	7/20/2016	7/20/2016

The dataset was reviewed for dangers to navigation, areas of significant bathymetric cover related to chart scale, and areas of significant shoreline change that may warrant return by a hydrographic platform. Survey scale soundings generated from the three meter surface were used to evaluate differences with the chart.

During evaluation several regions of significant change were detected around inlets and capes and submitted to the Atlantic Hydrographic Brach for consideration as Danger to Navigation (DtoN). The Branch analyzed the data and submitted 59 shoal soundings as DtoNs to MCD. The report created by the Branch, W00300_DtoN_#1, has been included in this data submission. As stated in the report, final sounding selection will be performed during HCell compilation. Figure 6 and 7 highlight two areas of significant change included in the DtoN submission.

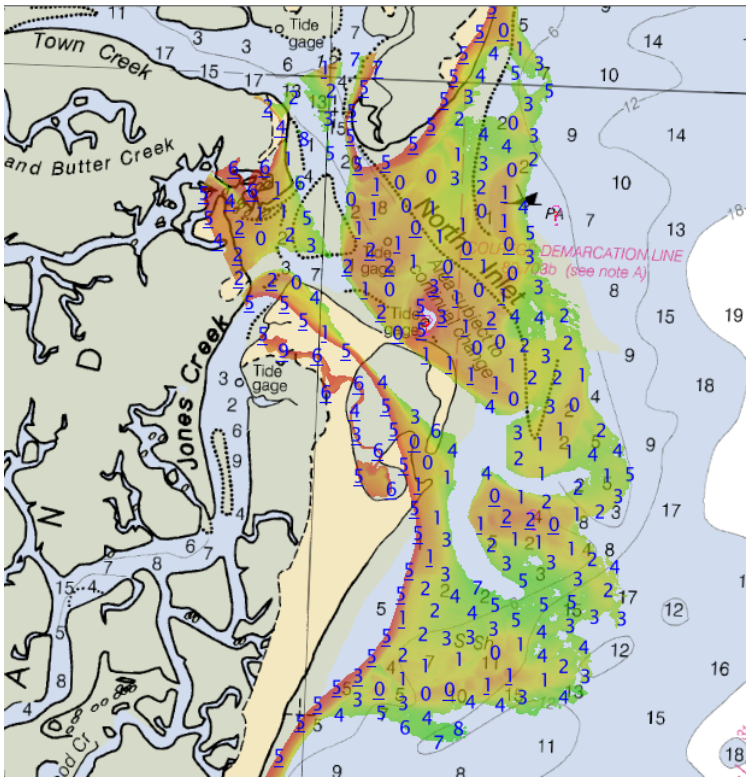


Figure 6 Lidar coverage over North Inlet, SC demonstrating extended shoaling offshore, not captured on chart 11532.

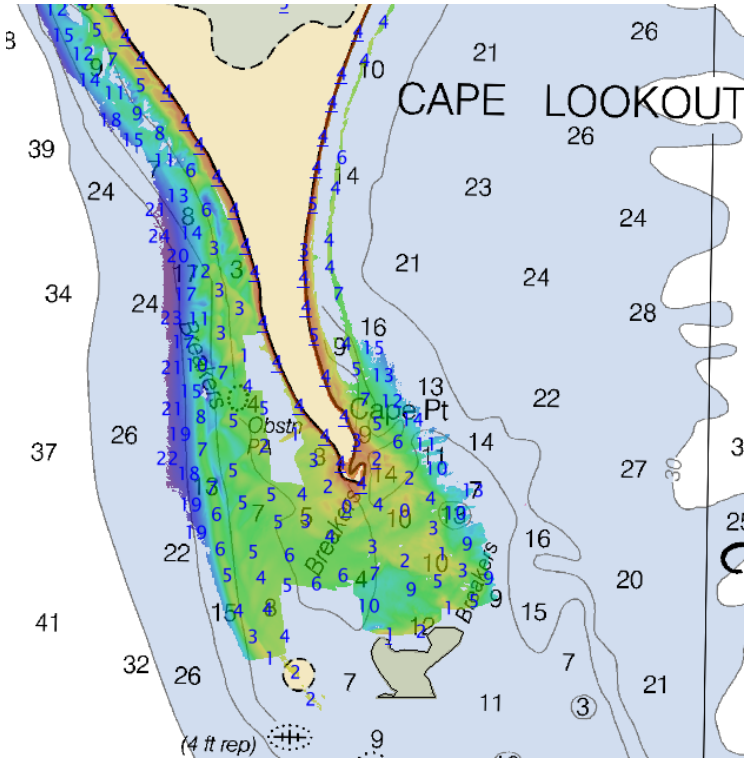


Figure 7 Topo-bathy lidar coverage over Cape Lookout, NC illuminating significant shoaling off the point. Background chart 11543.

Of the sixty blocks of data submitted, fifty-seven have significant bathymetric coverage (SBC) that could be used to update soundings on the chart. Thirteen blocks do not have significant bathymetric coverage. The following table highlights which blocks do (light grey) or do not (dark grey) have bathymetry and the corresponding RNCs and ENCs that cover the area. Blocks are considered insignificant bathymetric coverage if the laser did not penetrate the water surface, there is no data below MLLW, or the bathymetric coverage is so close to shore it would not warrant a sounding on the largest scale chart.

Block	SBC	1:5,000	1:15,000 / 1:20,000	1:40,000 / 1:50,000	1:80,000	ENC
1	Y			11532	11531, 11535	US5SC32M
2	Y			11532	11531, 11535	US5SC32M
3	Y			11532	11531, 11535	US5SC32M
4	Y			11532	11531, 11535	US5SC32M
5	Y			11534	11531, 11535	US4SC20M, US5SC34M
6	Y			11534	11535	US4SC20M, US5SC34M
7	N			11534	11535	US4SC20M, US5SC34M
8	N			11534	11535	US4SC20M, US5SC34M
9	N			11534	11535	US4SC20M, US5SC34M
10	Y			11534	11535	US4SC20M, US5SC34M
11	Y			11534	11535, 11536	US4SC20M, US5SC34M, US4NC11M
12	Y			11534	11536	US5SC34M, US4NC11M
13	Y			11534	11536	US5SC34M, US4NC11M
14	Y			11534	11536	US5SC34M, US4NC11M, US4NC12M
15	Y			11534	11536, 11539	US4NC11M, US4NC12M
16	Y			11534	11536, 11539	US4NC11M, US4NC12M, US4NC13M
17	Y			11534	11539	US4NC12M, US4NC13M, US5SC34M
18	Y			11534, 11541	11539	US4NC13M, US5SC34M, US5NC51M
19	Y			11541	11539	US4NC13M, US5NC51M
20	Y			11541	11539	US4NC13M, US5NC51M
21	Y			11541	11539	US4NC13M, US5NC51M
22	Y			11541	11539	US4NC13M, US5NC51M, US5NC14M
23	Y			11541	11539, 11543	US4NC13M, US5NC14M
24	Y			11541	11539, 11543	US4NC15M, US5NC14M, US5NC51M
25	Y			11541	11543	US4NC15M, US5NC51M
26	Y			11541	11543	US4NC15M, US5NC51M
27	Y			11541	11543	US4NC15M, US5NC51M
28	Y		11547	11541, 11545	11543, 11544	US4NC15M, US5NC51M, US5NC18M, US5NC17M
29	Y		11547	11541, 11545	11543, 11544	US4NC15M, US5NC18M, US5NC17M
30	Y			11545	11543, 11544	US4NC15M, US5NC18M, US4NC16M
31	N			11545	11544	US5NC18M, US4NC16M
32	N			11545	11544	US5NC18M, US4NC16M
33	N			11550, 11545	11544	US5NC19M, US5NC18M, US4NC16M
34	N			11550	11544, 11548	US5NC19M, US4NC16M
35	N			11550	11544, 11555, 11548	US5NC19M, US4NC16M
36	Y			11550	11555, 11548	US4NC30M, US5NC19M

37	Y			11550	11555, 11548	US5NC19M, US4NC30M
38	Y				11555	US4NC30M
39	Y				11555	US4NC30M
40	N				11555	US4NC30M
41	Y				11555	US4NC30M
42	N				11555	US4NC30M
43	Y				11555	US4NC30M
44	N				12204, 11555	US4NC31M, US5NC19M
45	Y				12204, 12205	US4NC53M
46	Y				12204, 12205	US4NC31M
47	Y				12204, 12205	US4NC53M
48	N				12204, 12205	US4NC53M
49	N				12204, 12205	US4NC53M
50	Y				12204, 12205	US4NC53M
51	Y				12204, 12205	US4NC53M
52	Y				12204, 12205	US4NC53M, US4NC32M
53	Y				12205	US4NC32M
54	Y			12207	12205	US4NC32M, US5VA11M
55	Y			12207	12205	US4NC32M, US5VA11M
56	Y	12205		12207, 12222	12205, 12221	US4NC32M, US5VA11M, US5VA13M
57	Y		12256, 12254	12207, 12222	12205, 12221	US5VA19M, US5VA20M
58	Y	12255	12256, 12245, 12254	12222	12205, 12221	US5VA18M, US5VA20M
59	Y		12256, 12245, 12254	12222	12221	US5VA20M, US5VA15M
60	Y		12256, 12245	12222	12221	US5VA15M

At the time of submission of the data to the processing branch, shoreline GC11173 has been applied to several charts. Prior to the application of the shoreline to the chart, significant shoreline change was observed around several inlets and capes and further development of the surrounding bathymetry may be necessary at Cape Fear, Barden Inlet, North Inlet, Rich Inlet, Browns Inlet, and Beaufort Inlet.

The charted navigation aids, aids represented in the lidar and imagery, and 5th District local notice to mariners (2013 - 2016) were cross referenced for inconsistencies. Several discrepancies are highlighted with carto-notes in the final feature file. Due to the variable nature of the sandy inlets in this region, many charts do not represent the navigation aids, as the buoys are moved frequently. Even charted buoys have moved several times since this data set was collected, making buoy positions represented in the lidar and imagery outdated.

G. Vertical and Horizontal Control

The vertical datum for this project is Mean Lower Low Water. VDatum was used by RSD to convert the las files from the Geoid to MLLW. The horizontal datum for this project is North American Datum of 1983 (NAD83). For more details on the positioning methods used see the RSD DR DAPR submitted with this dataset.

H. Additional Results

Gaps in coverage exist due to flight line patterns and environmental conditions as seen in Figure 7.

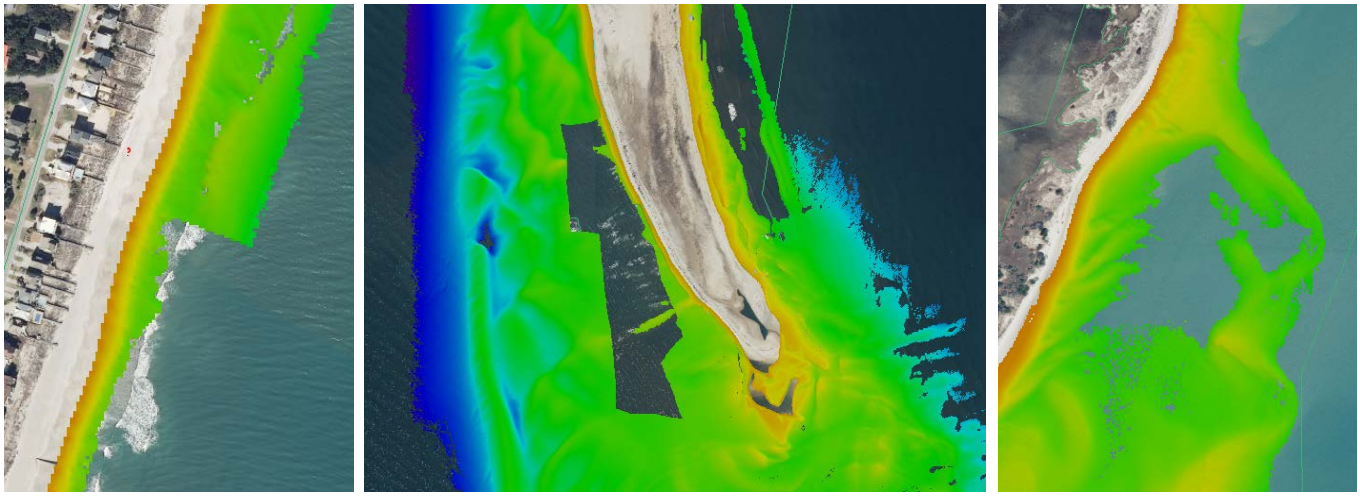


Figure 7 Examples of gaps in lidar coverage due to flight line patterns and extinction depth from W00301.

Several recent Office of Coast Survey Hydrographic surveys available at the National Center for Environmental Information (NCEI) appear to junction with W00300, however upon investigation, only one provides significant overlap. A surface comparison was performed with H12266, a 2010 survey by NRT2, in Beaufort Inlet, NC. W00300 was found on average 1.3 m shoaler, with differences ranging from -2.9 m to 7.6 m. These variable differences, from a four year period, reflect the transient nature of the seabed in this area, and possible need for frequent resurvey.

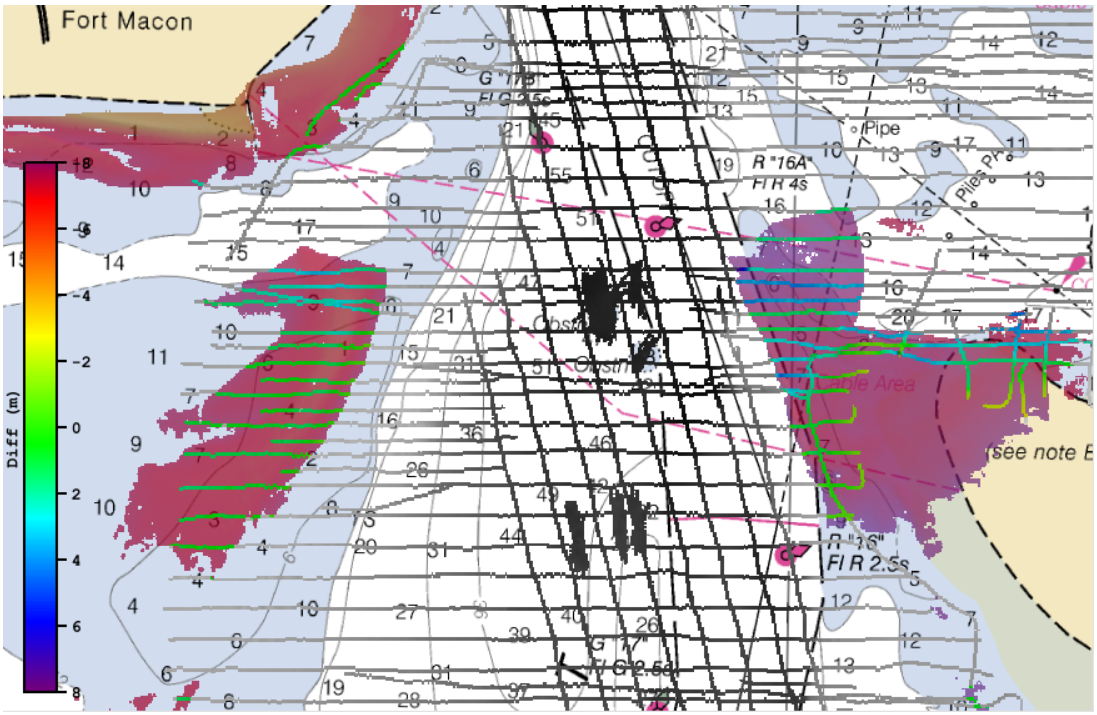


Figure 8 Area of overlap between survey H12266 (grey scale) and W00300 (red scale) in Beaufort Inlet. W00300 was found on average 1.3 m shoaler, as demonstrated in the rainbow colored difference grid. Background Chart 11547, 1:15,000.

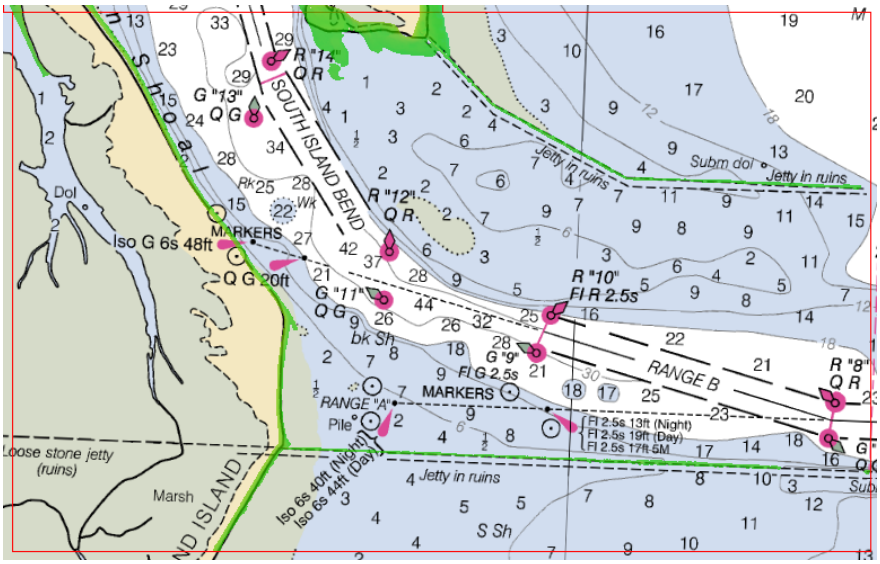
I. Approval

All records from RSD are included with the JHC IOCM products for final review and processing to the Processing Branch. The survey data meets or exceeds requirements for reconnaissance lidar data as set forth in the NOS Hydrographic Surveys and Specifications Deliverables Manual, Field Procedures Manual, Standing and Letter Instructions, and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Survey Summary Report.

Approver Name	Approver Title	Approval Date	Signature
Andrew A. Armstrong, III	Co-Director, Joint Hydrographic Center	8/24/2016	Andrew A. Armstrong III

Appendix A. Bathymetric Coverage

Images contain bathymetric coverage grid W00300_LI_3m_MLLW by block, over the largest scale chart.



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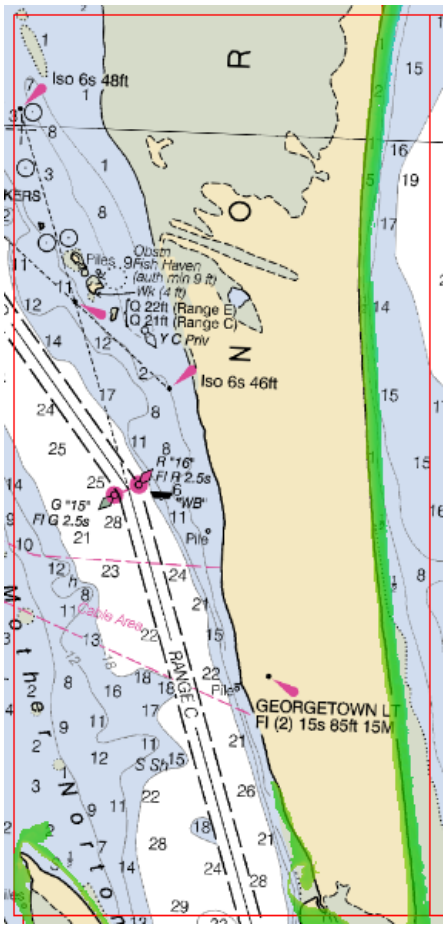

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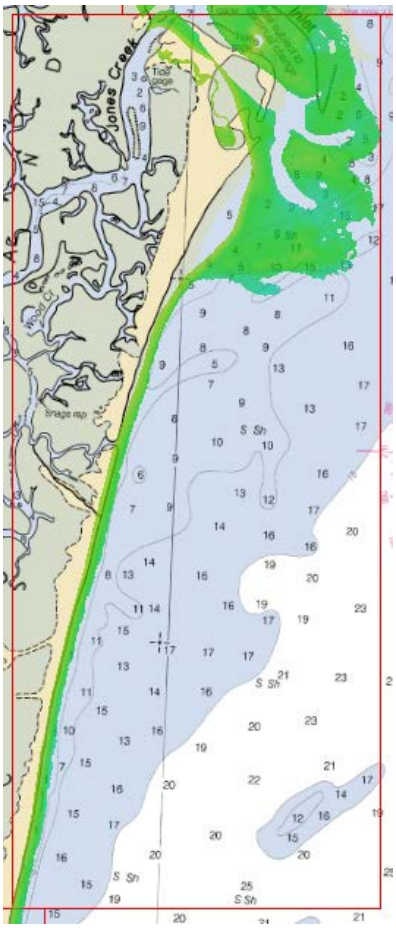

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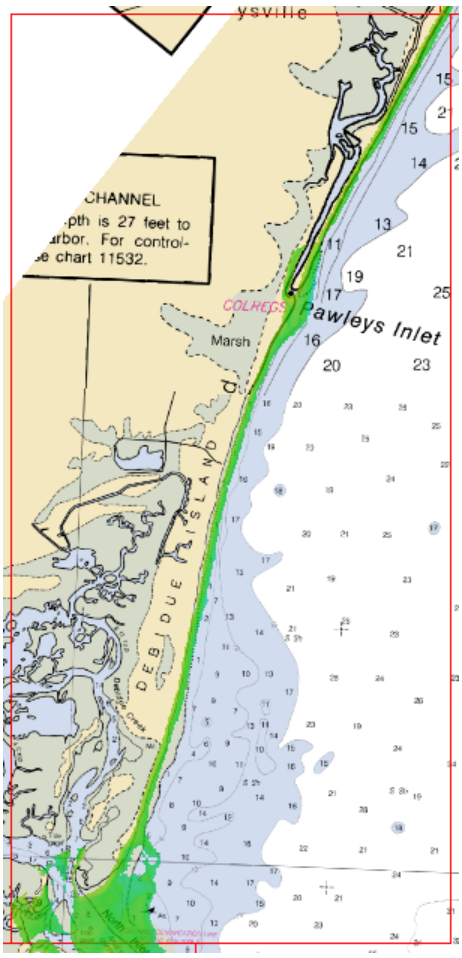

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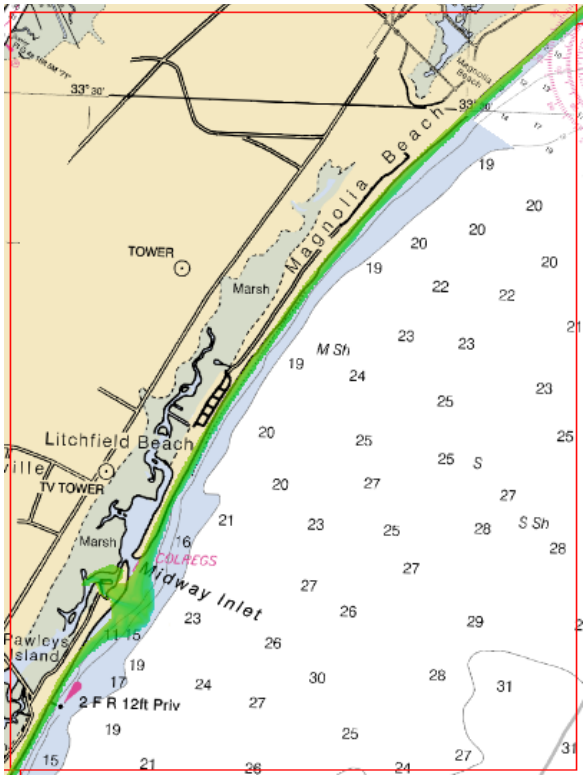

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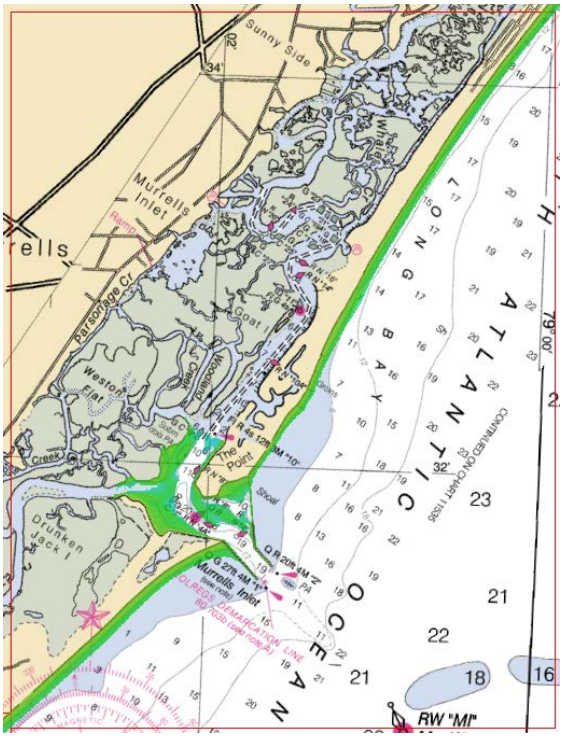

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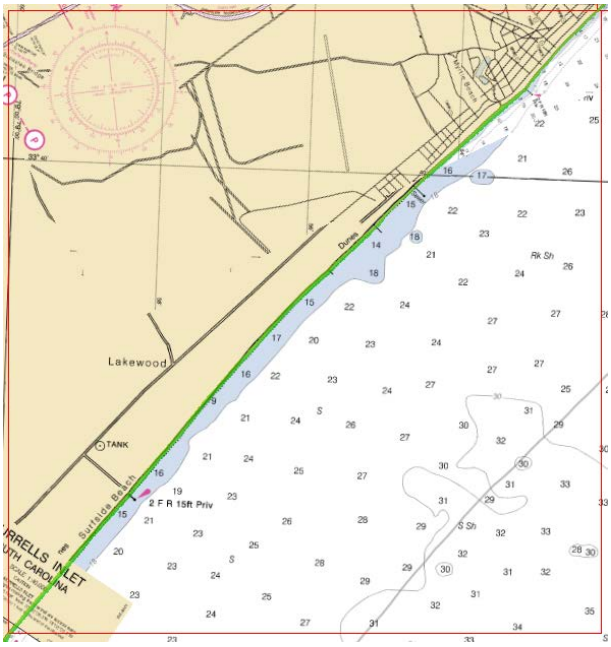

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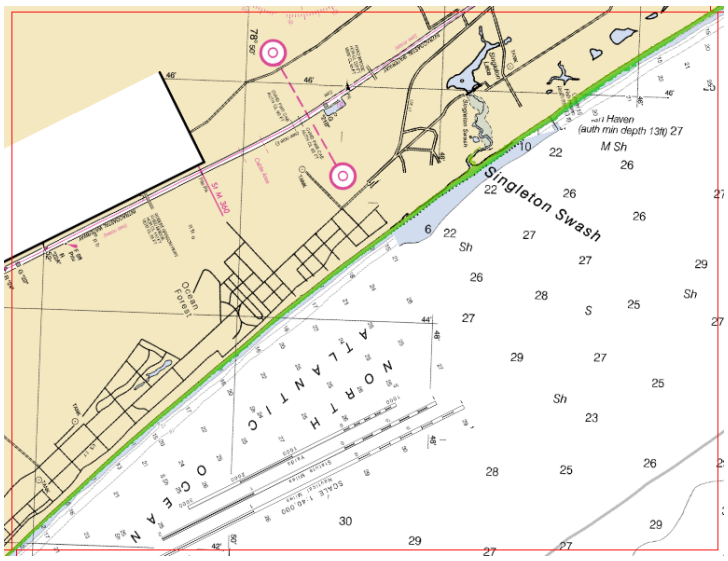

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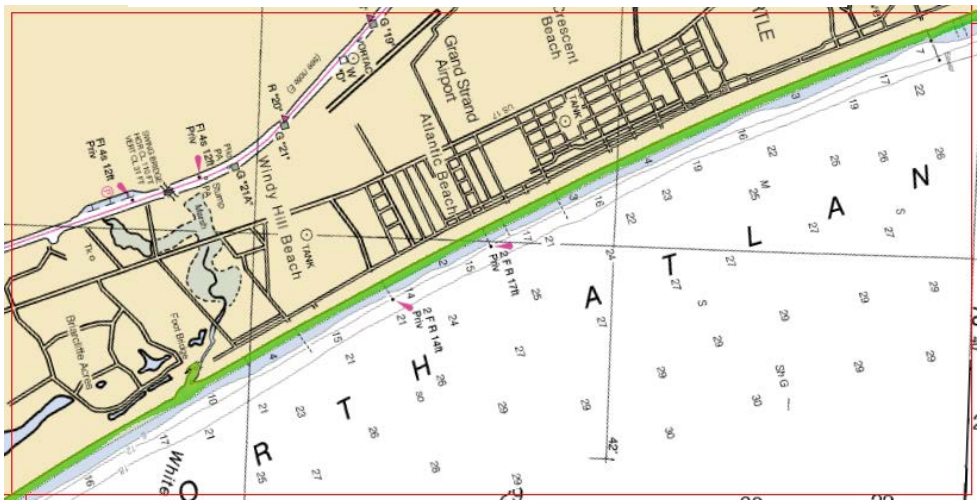

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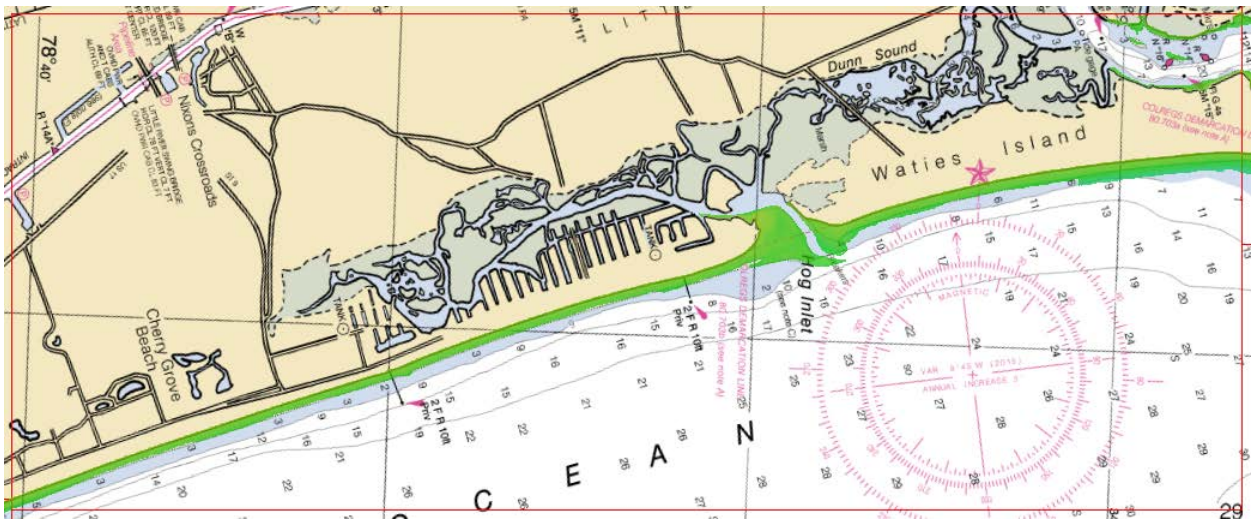

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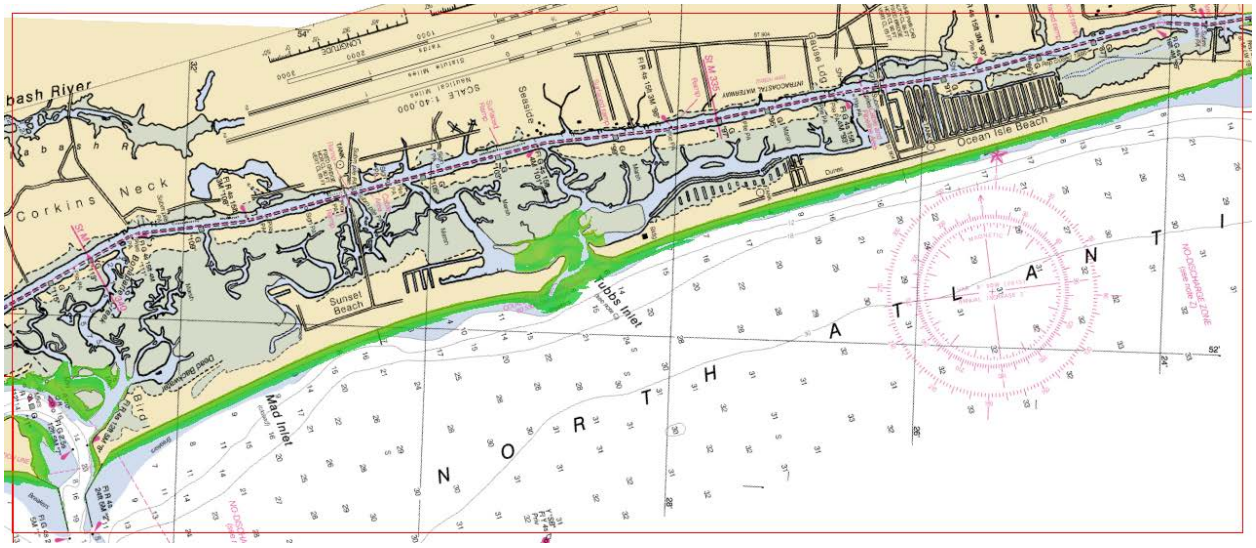

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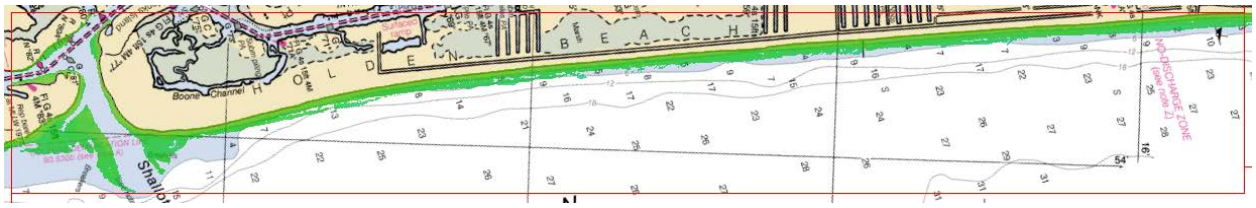

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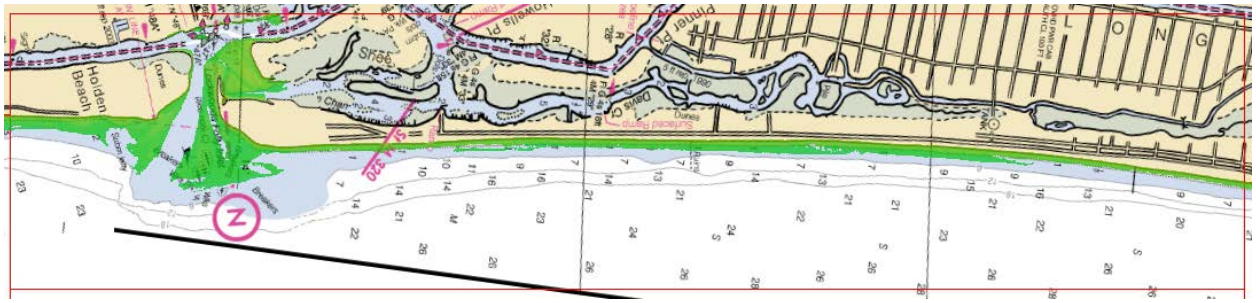

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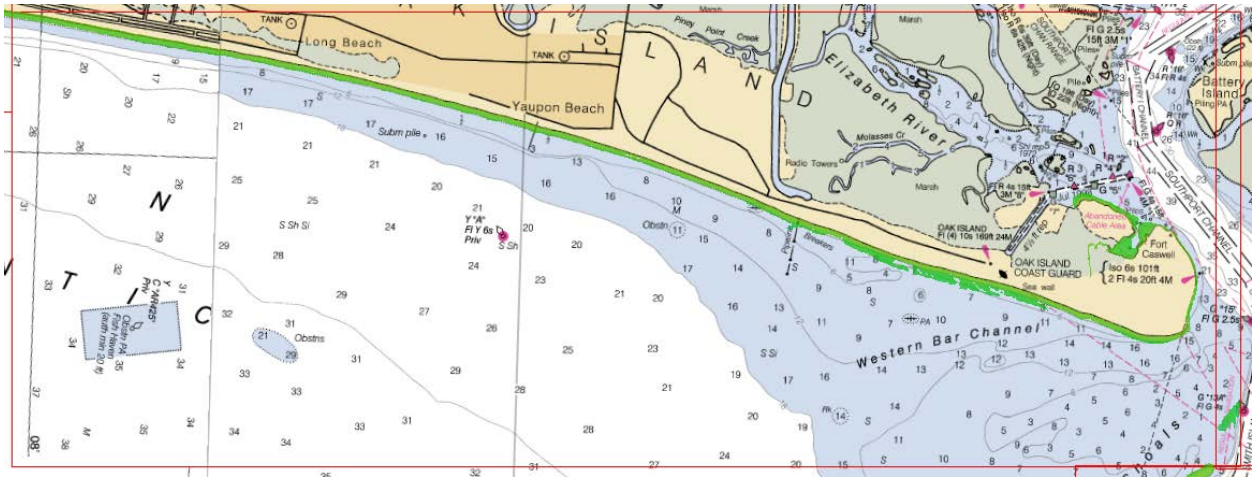

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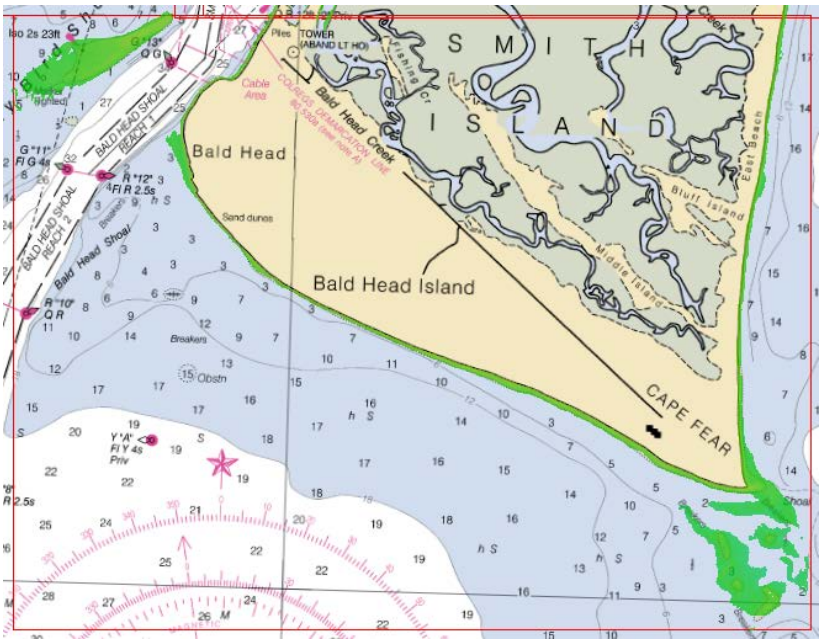

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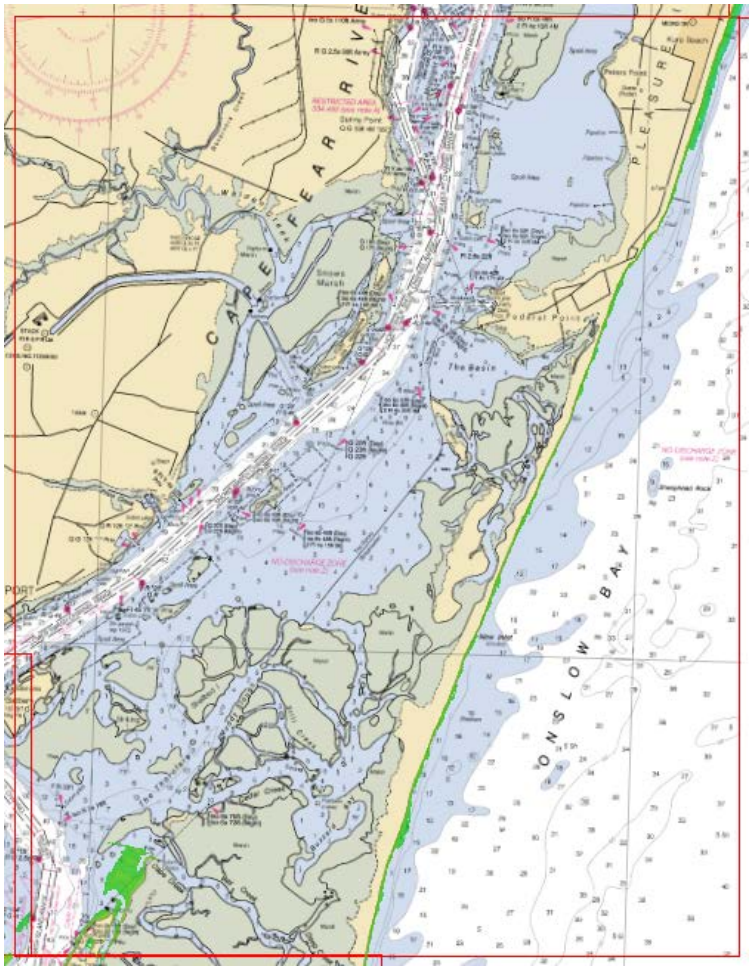

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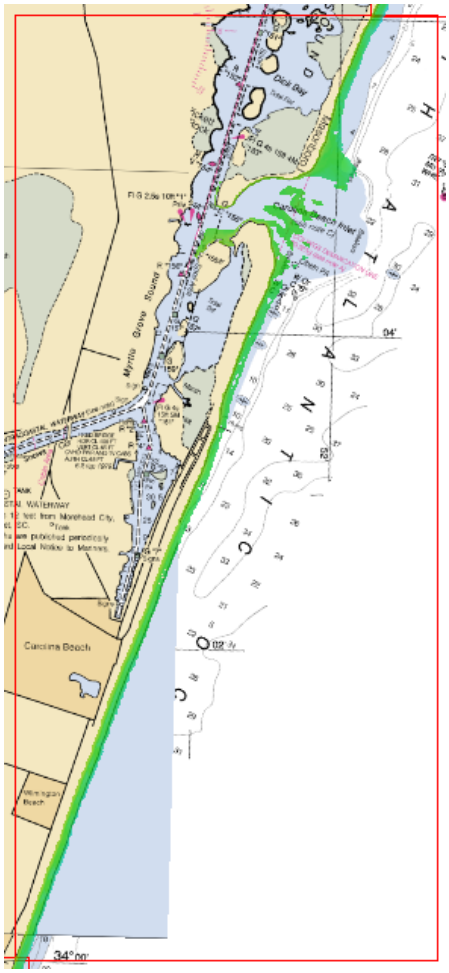

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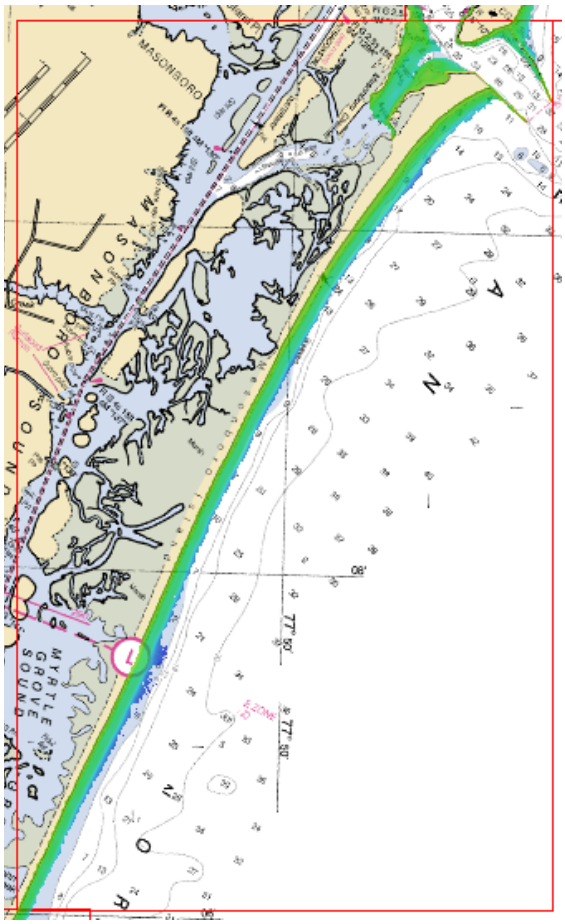

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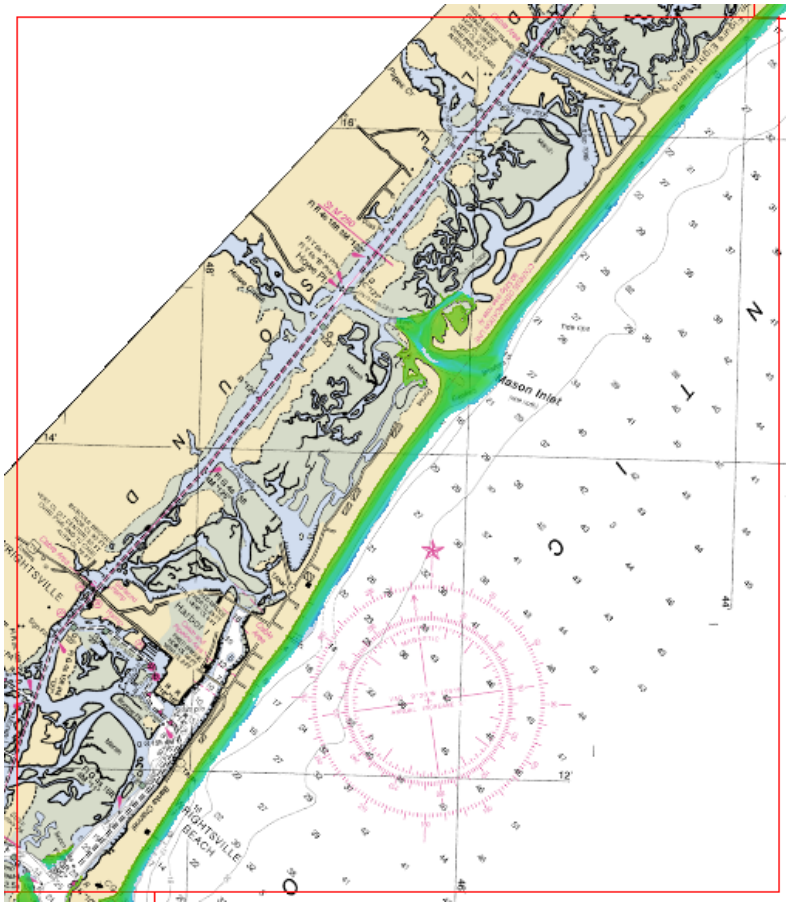

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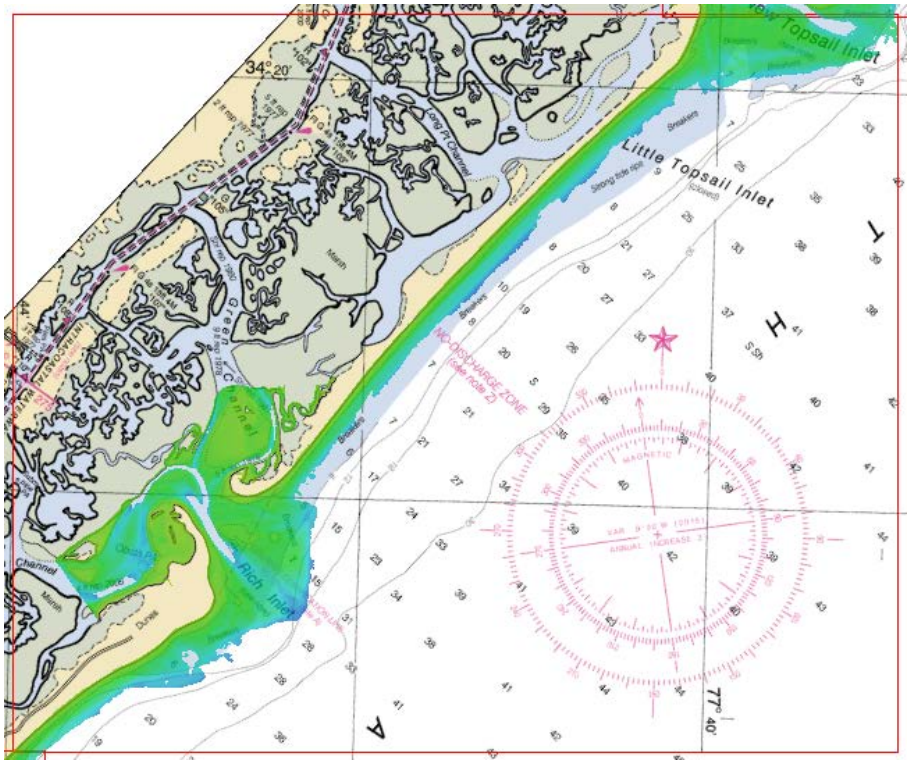

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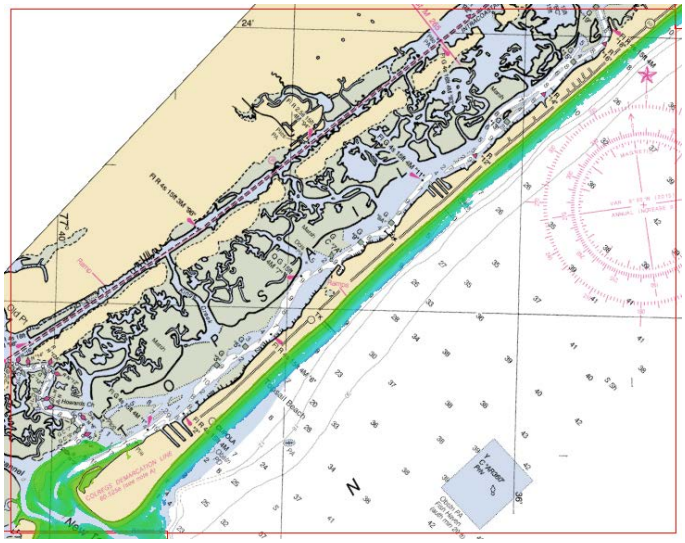

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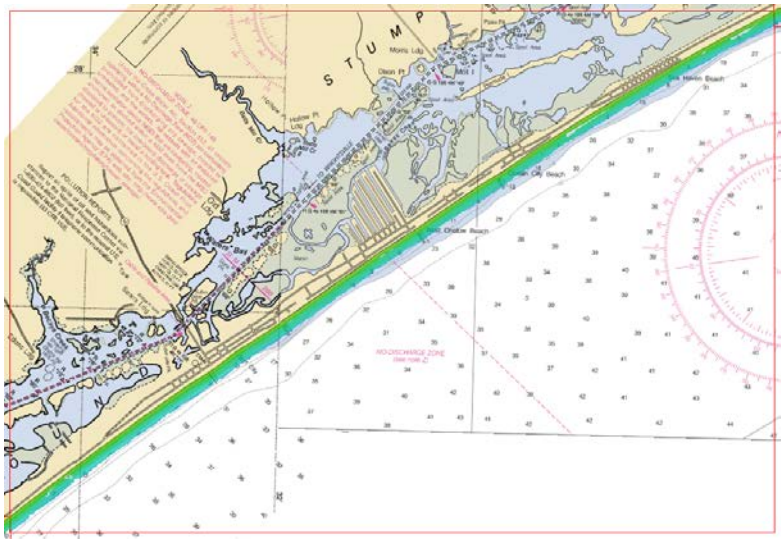

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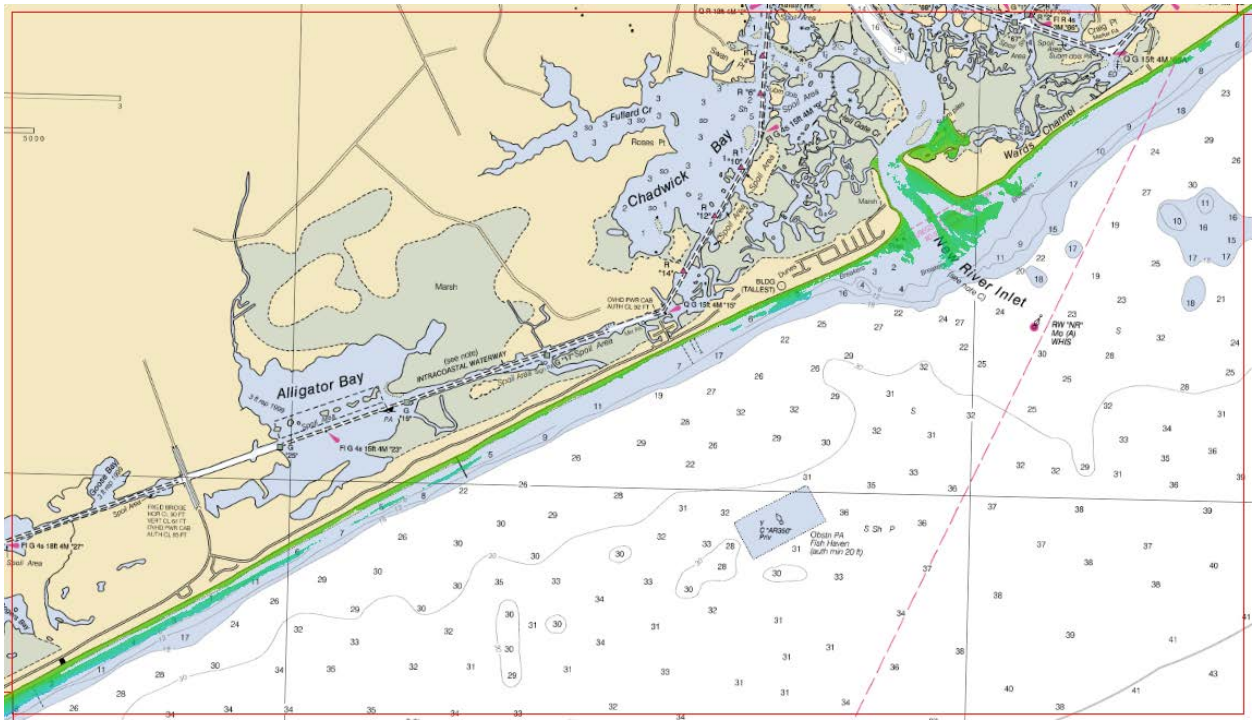

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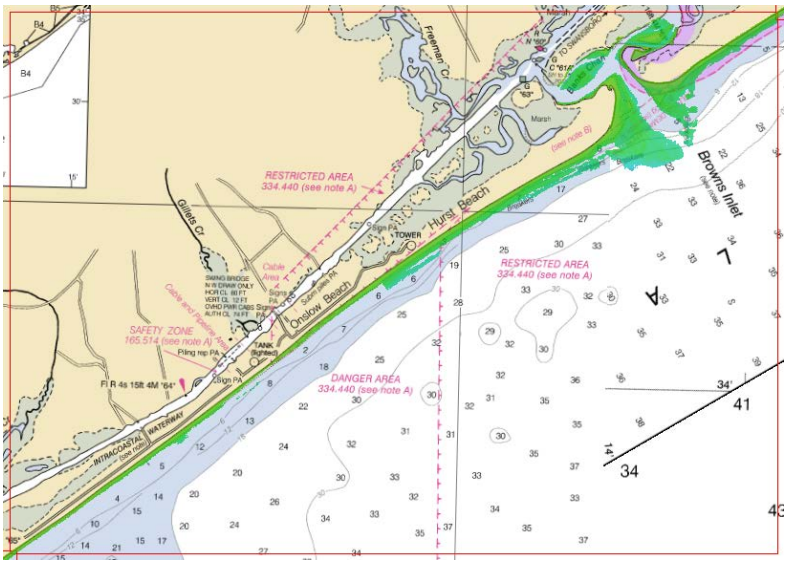

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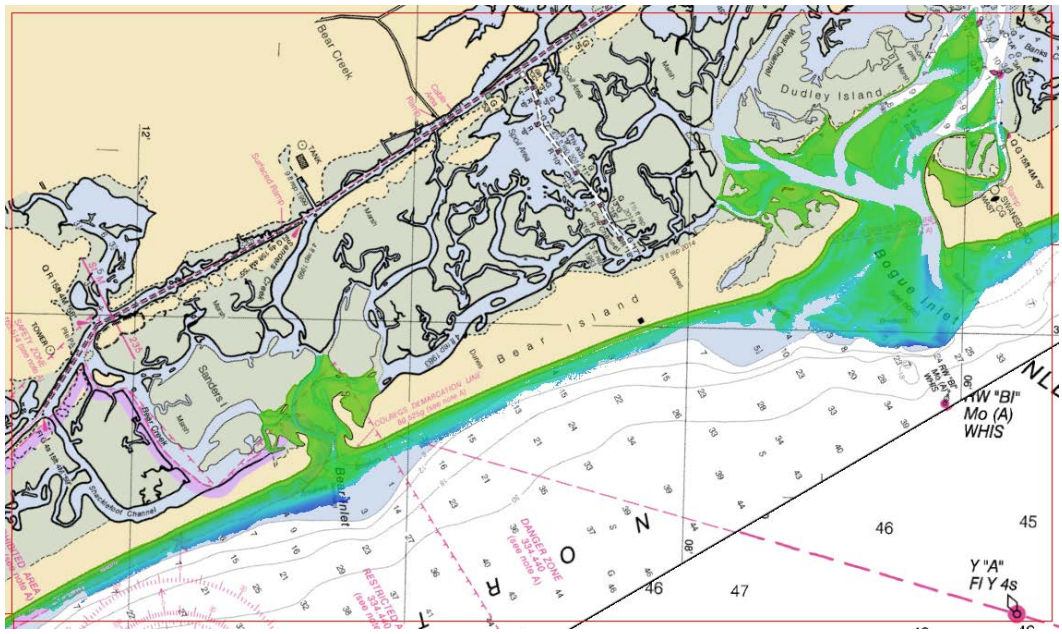

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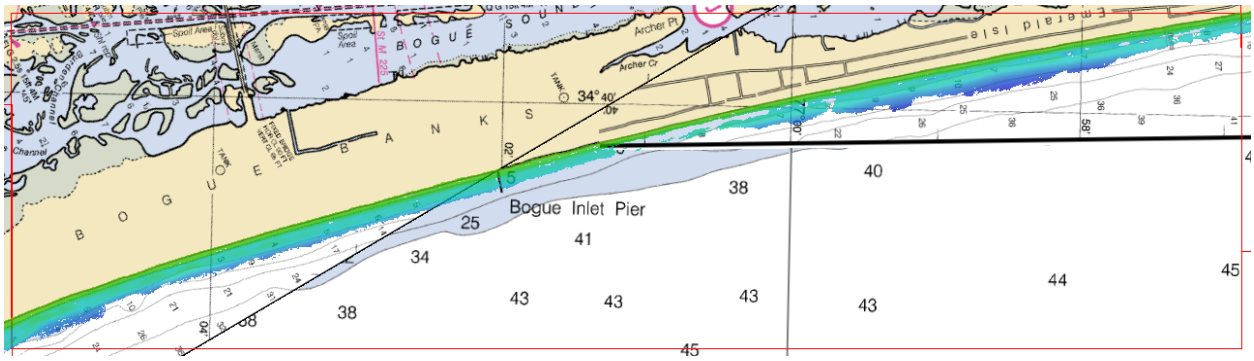

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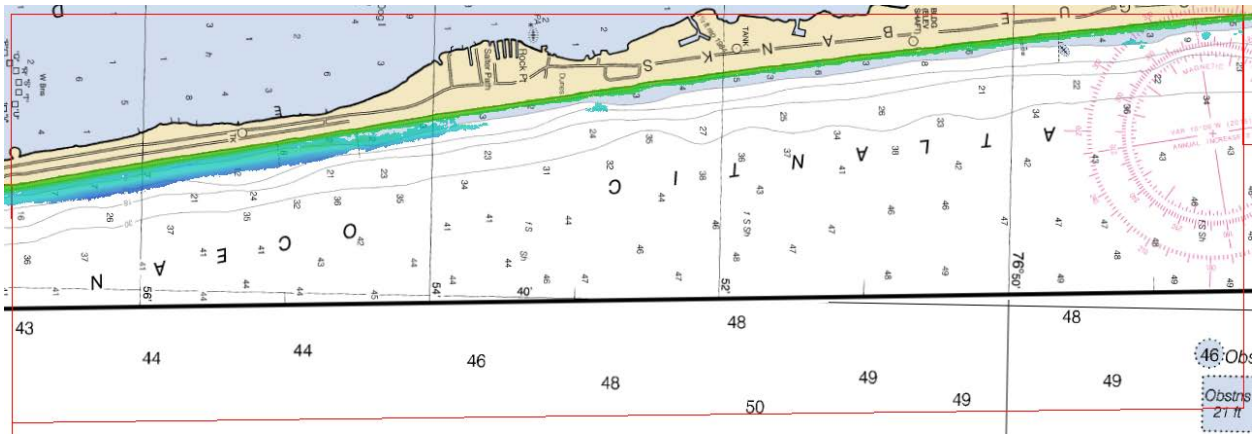

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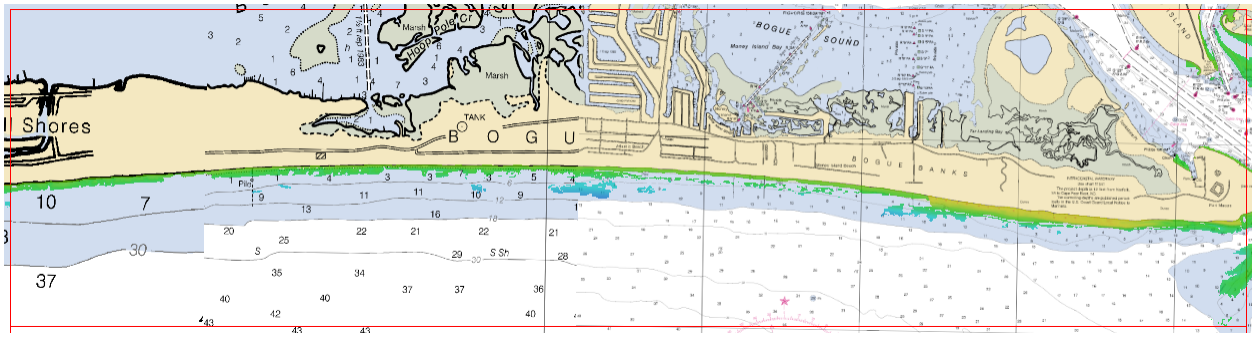

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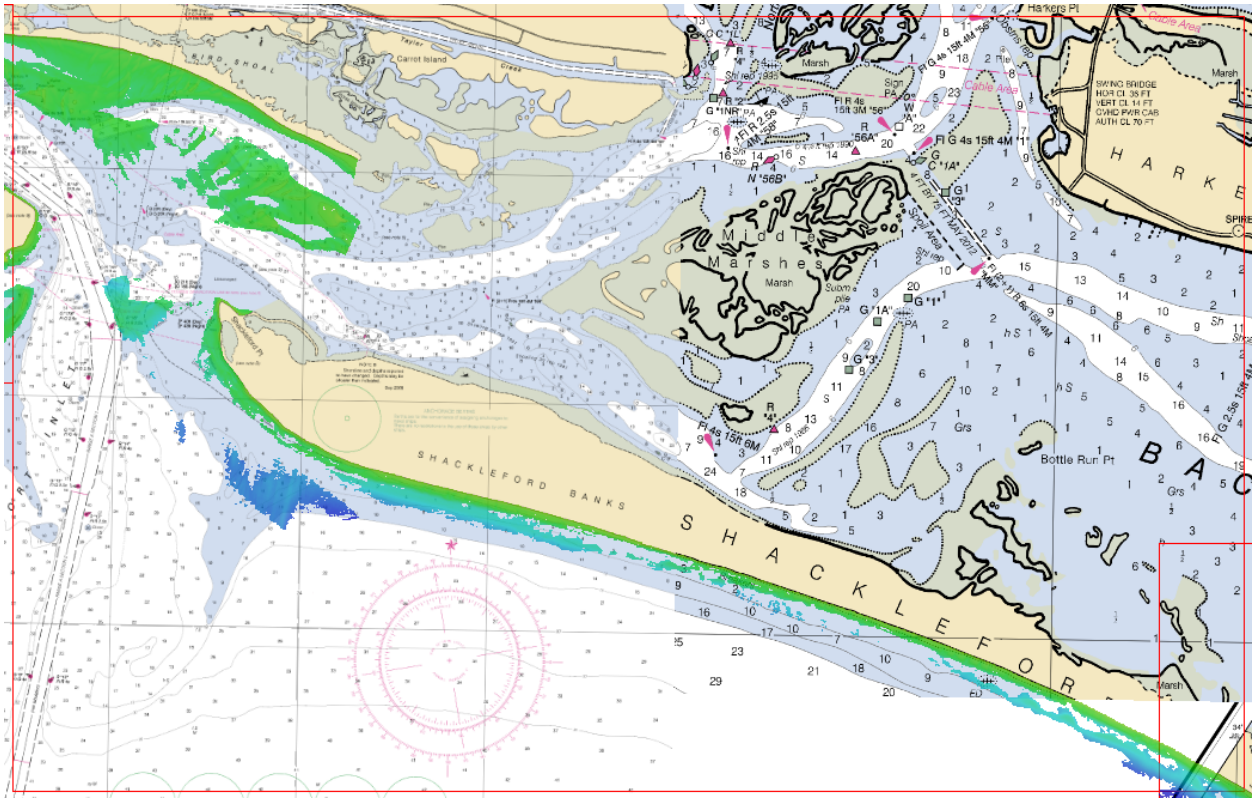

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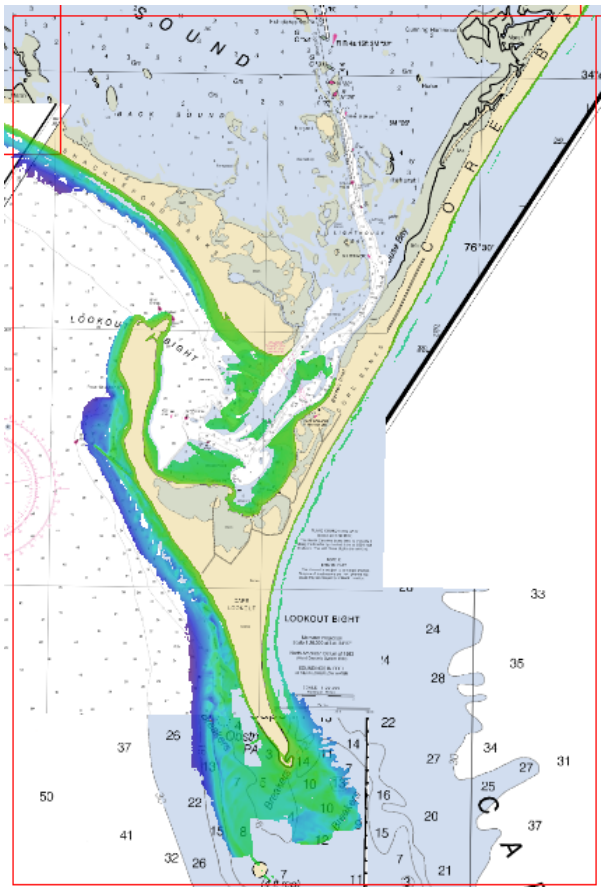

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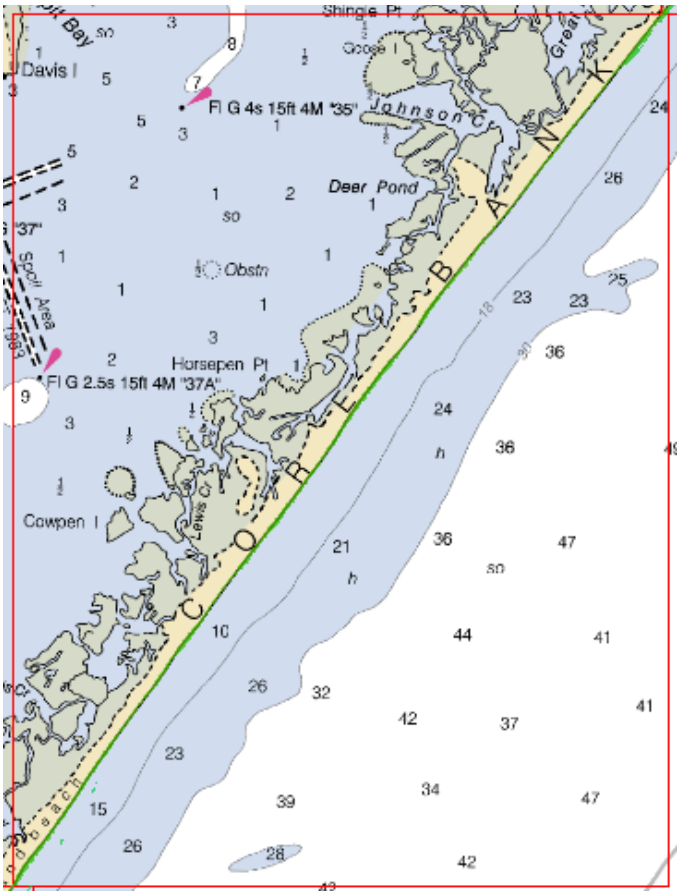

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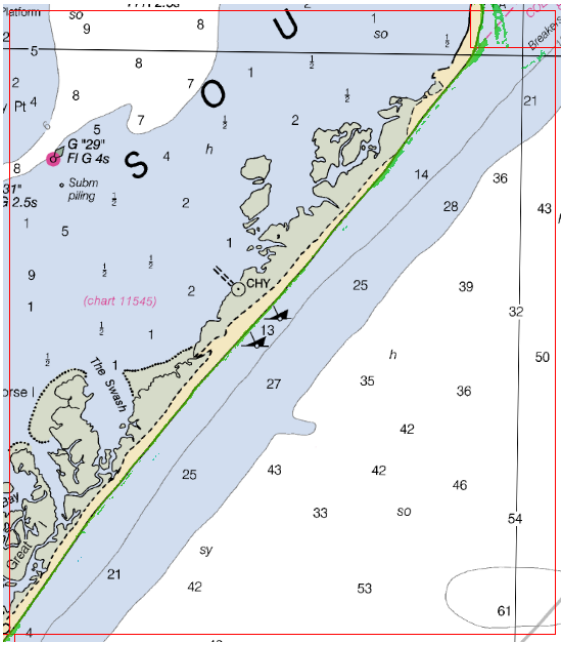

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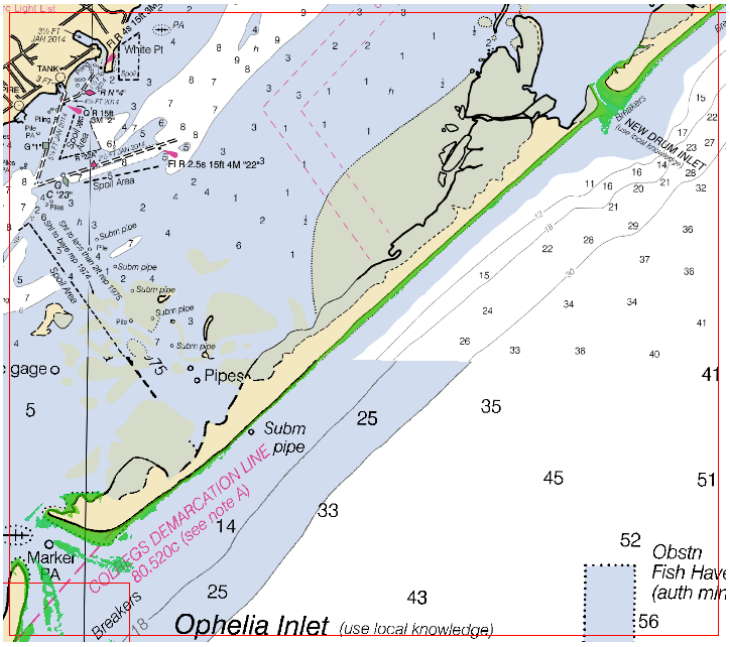

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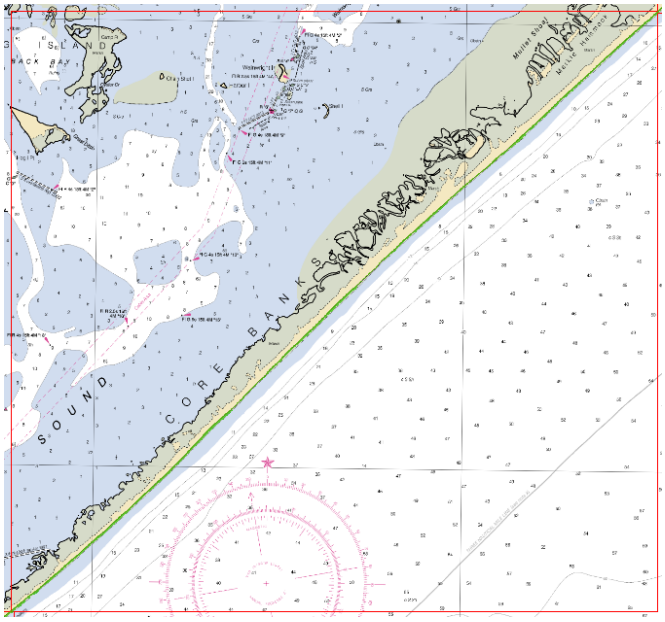

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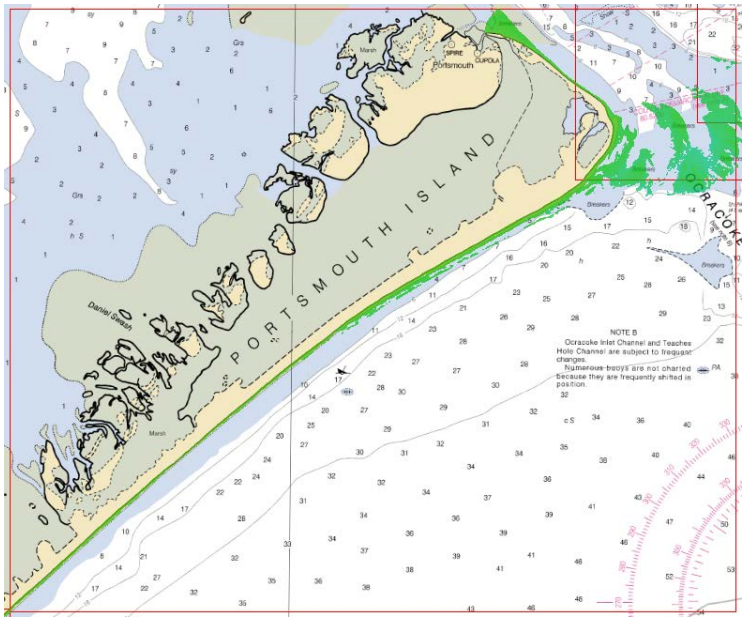

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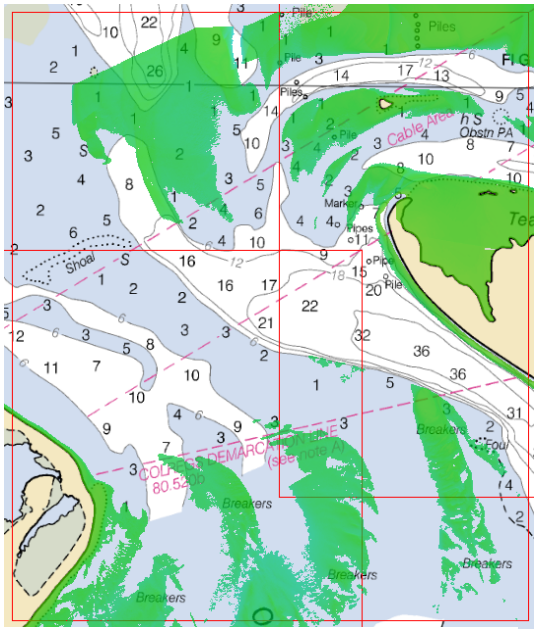

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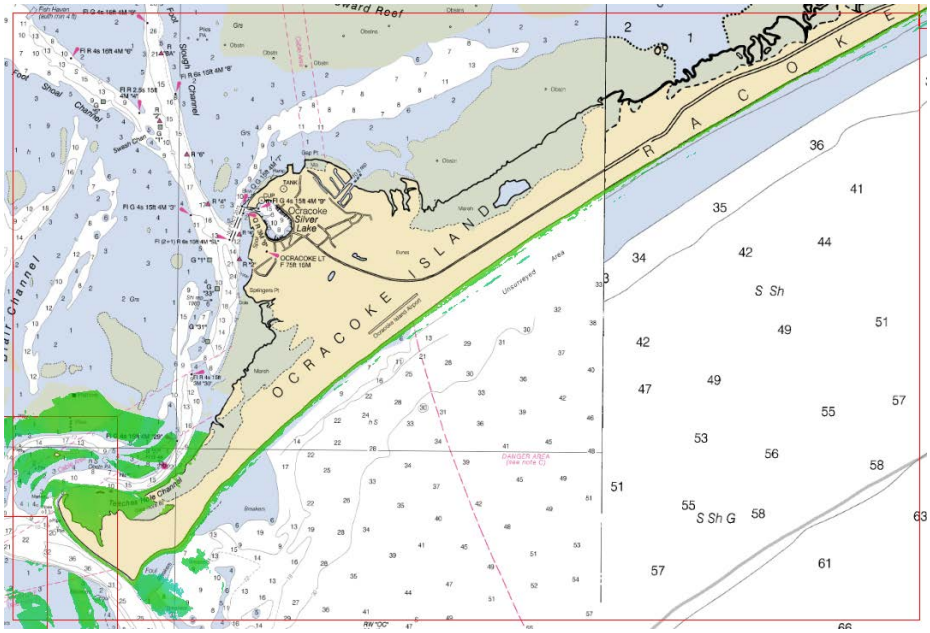

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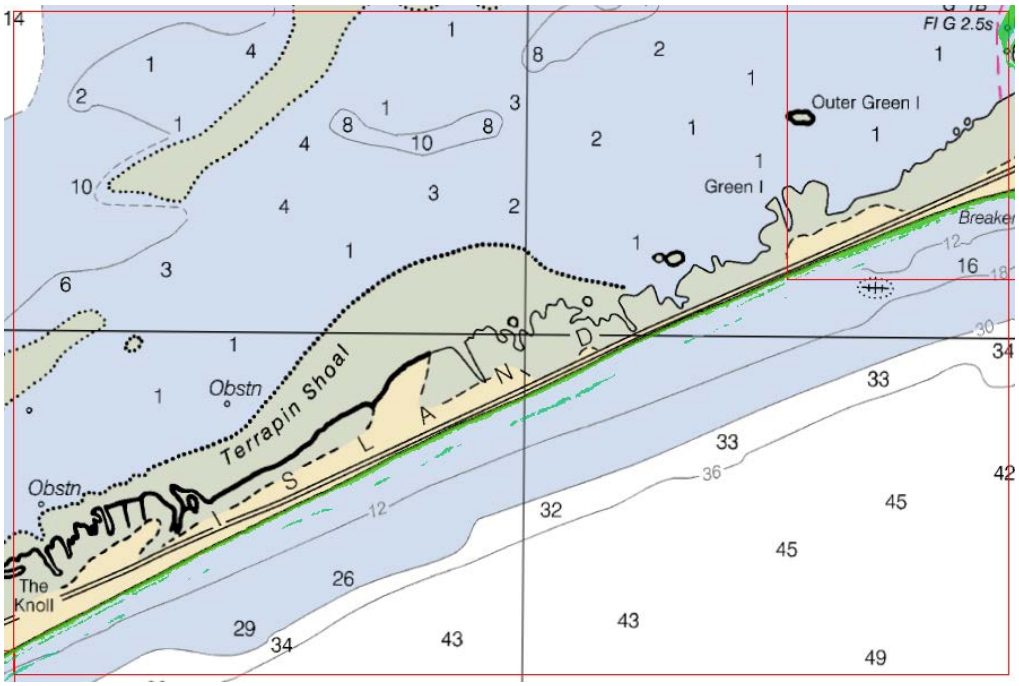

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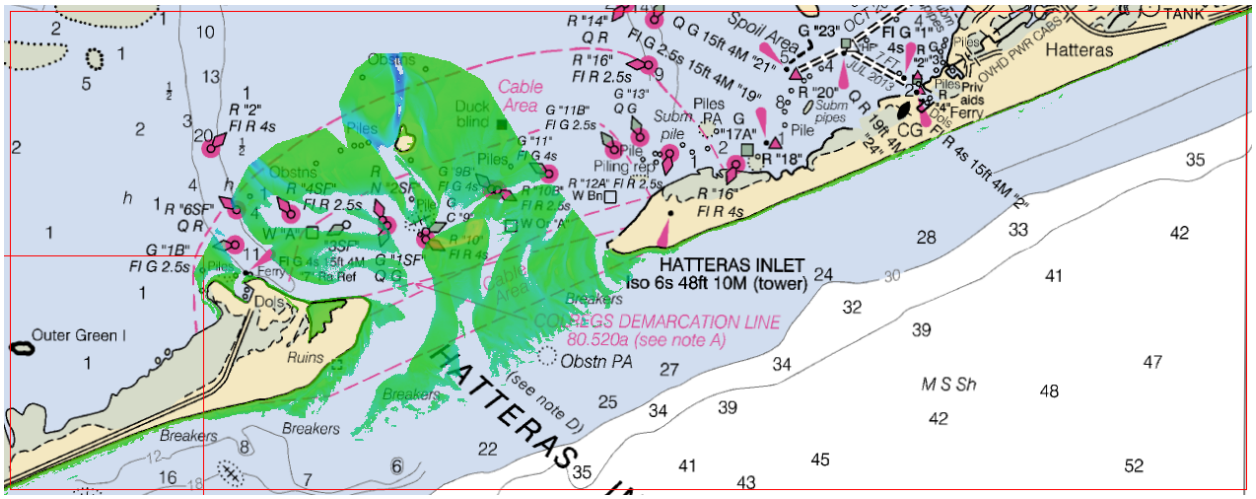

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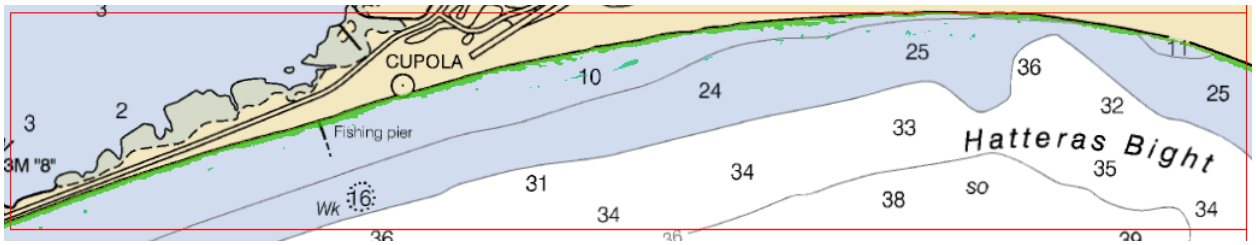

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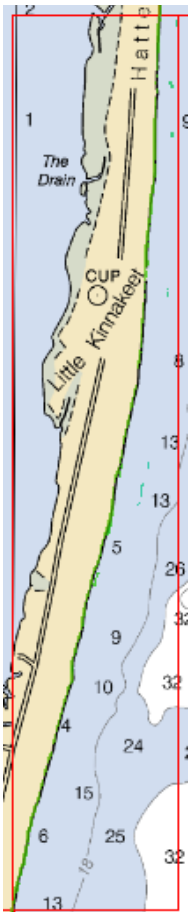

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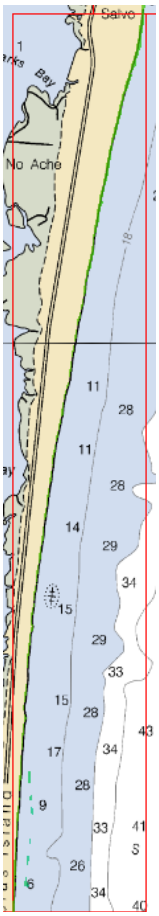

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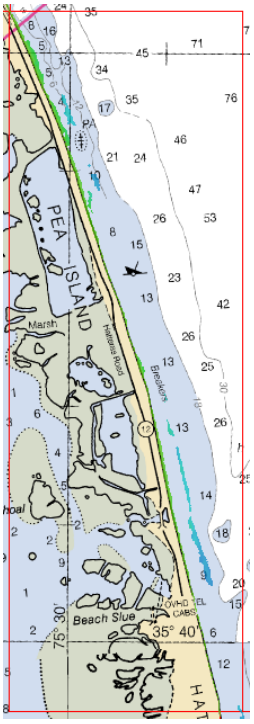

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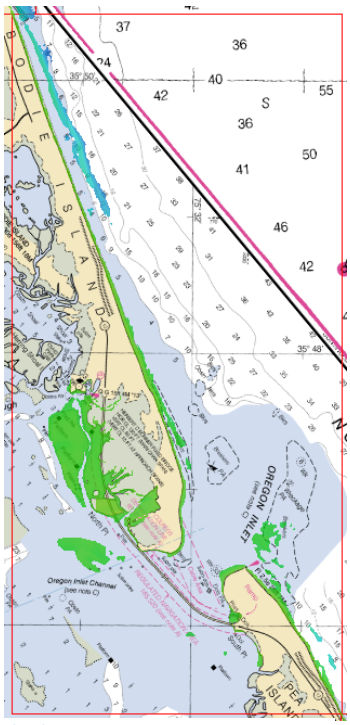

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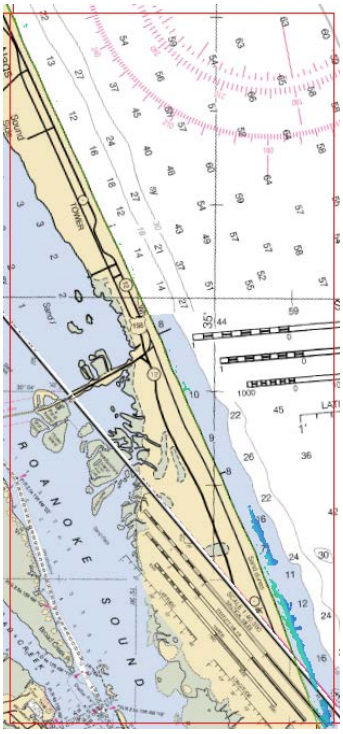

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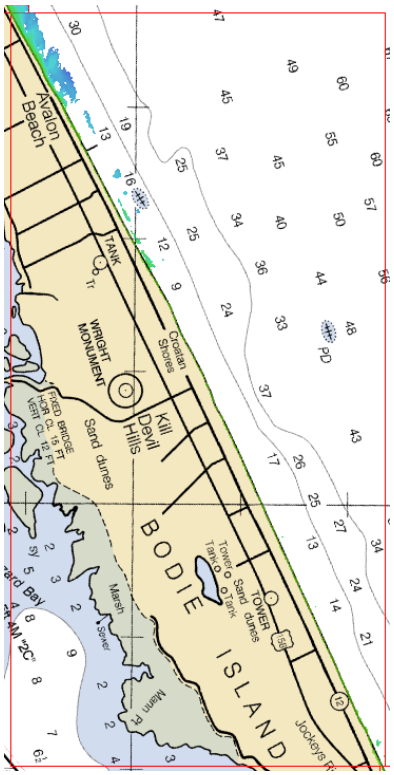

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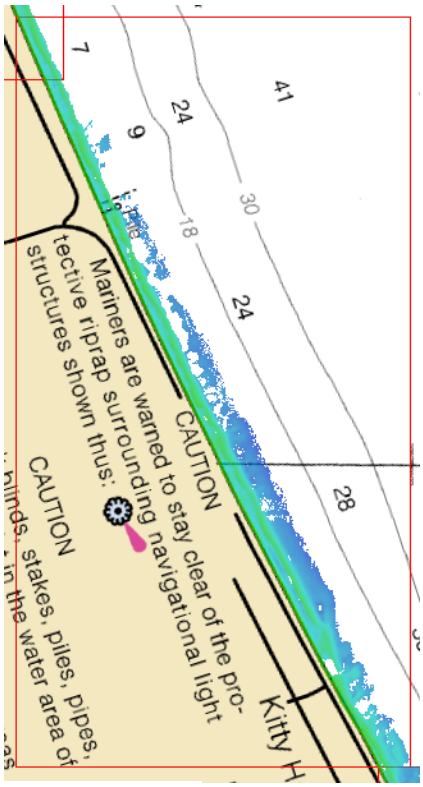

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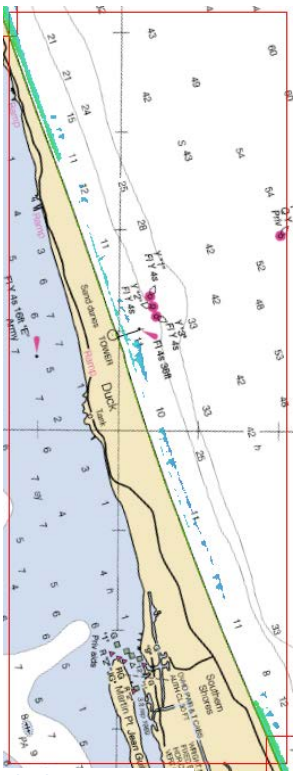

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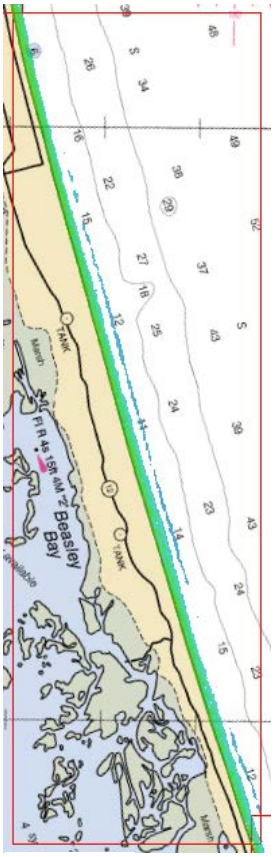

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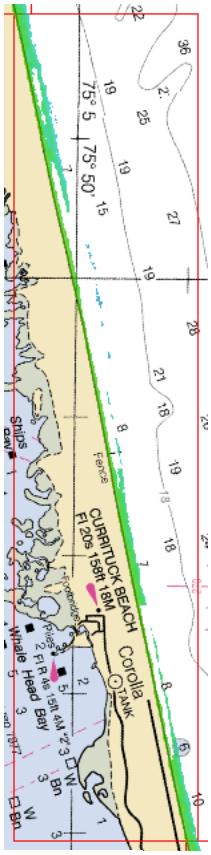

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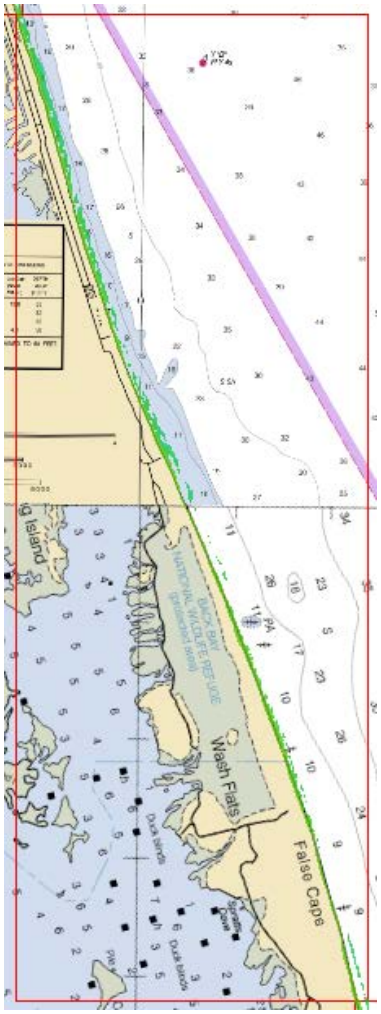

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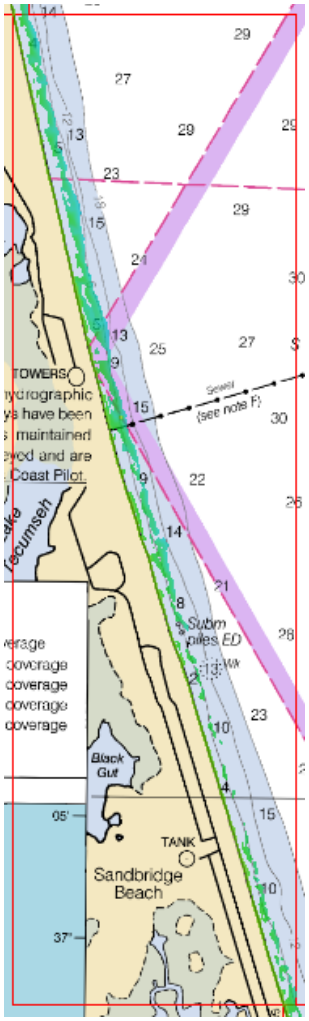

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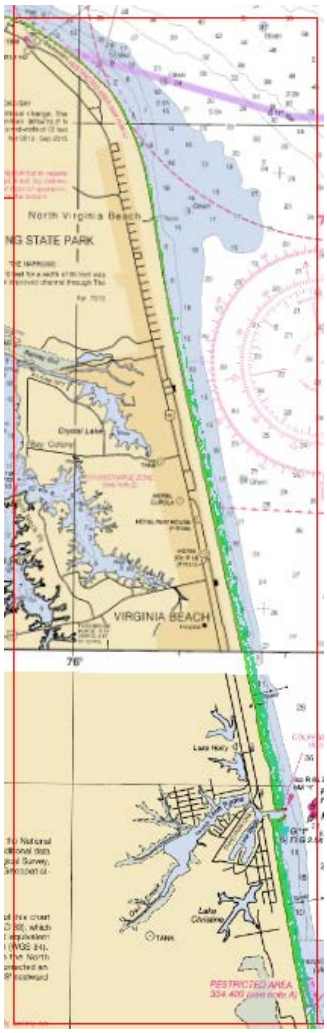

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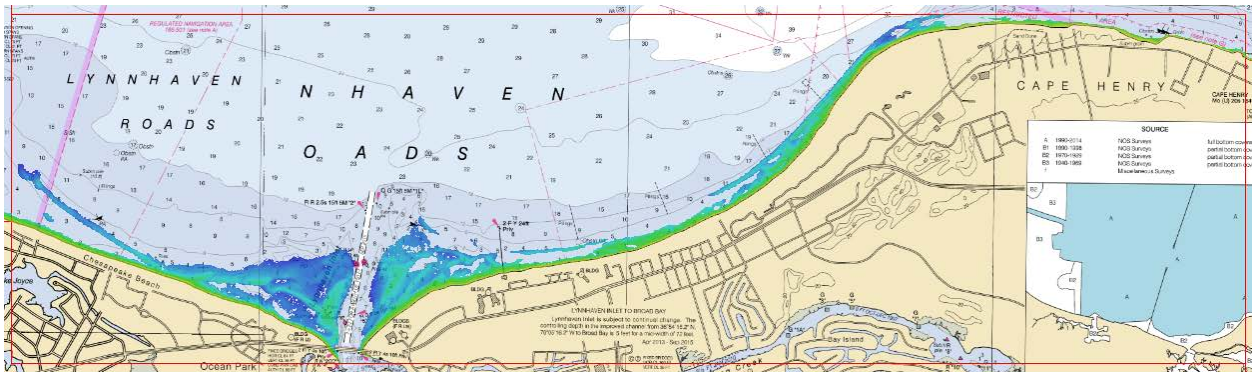

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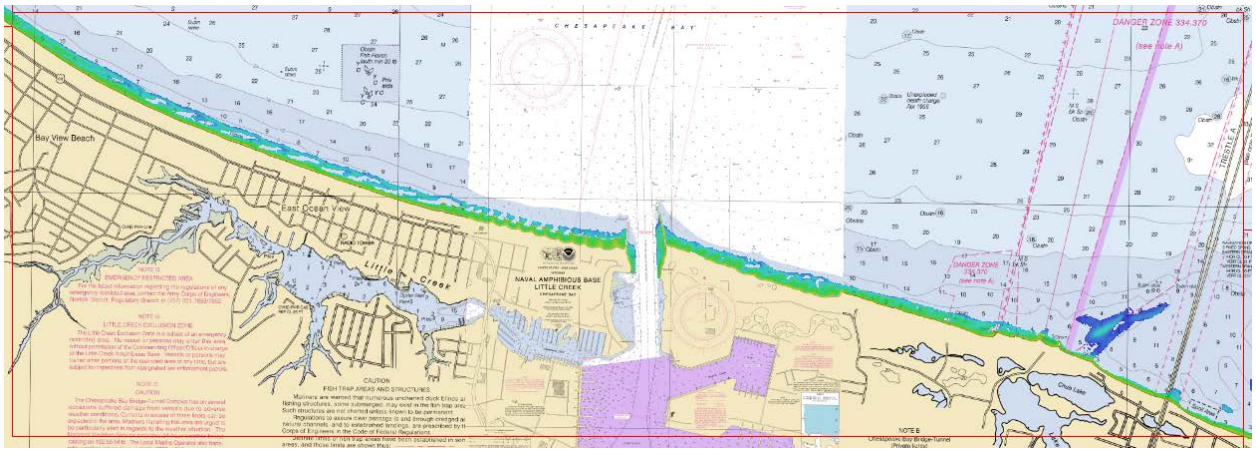

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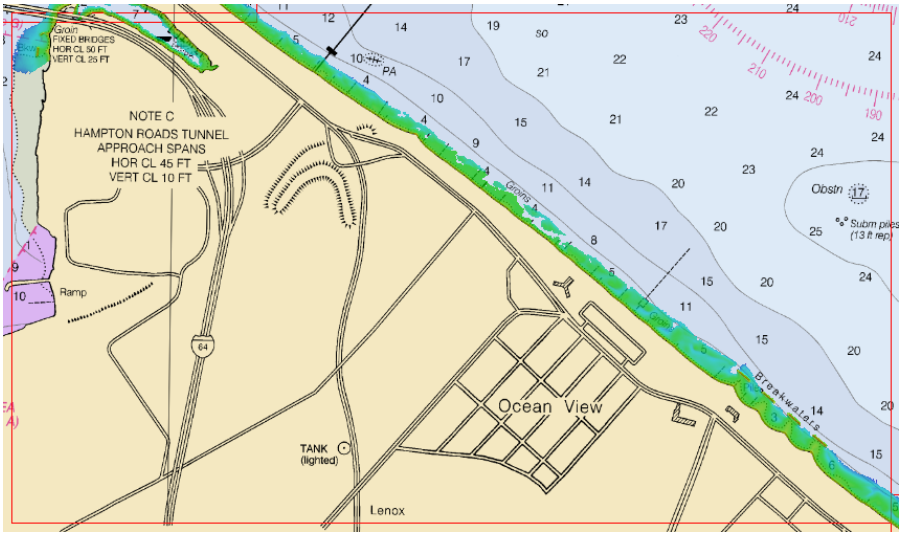

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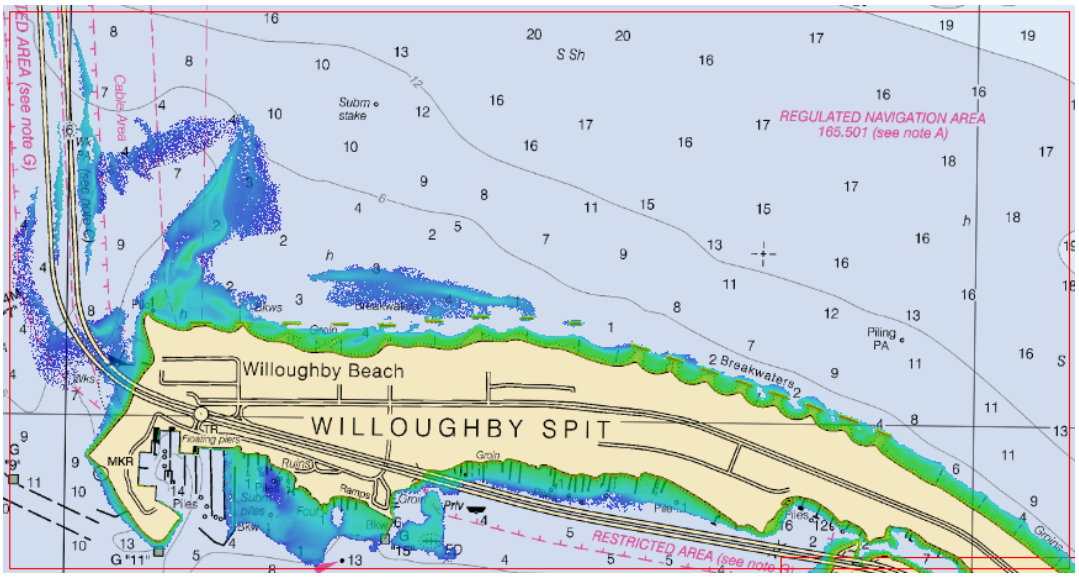

Block 52

APPENDIX I

TIDES AND WATER LEVELS

Survey W00331 does not include supplemental tide or water level information.

APPENDIX II

SUPPLEMENTAL SURVEY RECORDS AND CORRESPONDENCE

Survey W00331 does not include supplemental survey records or correspondence.

APPROVAL PAGE

W00331

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

The following products will be sent to NCEI for archive

- W00331_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records

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

Briana Welton Hillstrom

Digitally signed by HILLSTROM.BRIANA.WELTON.1267667531
Date: 2018.06.05 08:50:55 -04'00'

Approved:_____

Lieutenant Commander Briana Hillstrom, NOAA
Chief, Atlantic Hydrographic Branch