



U.S. Army Corps of Engineers  
Charleston District

## **APPENDIX D**

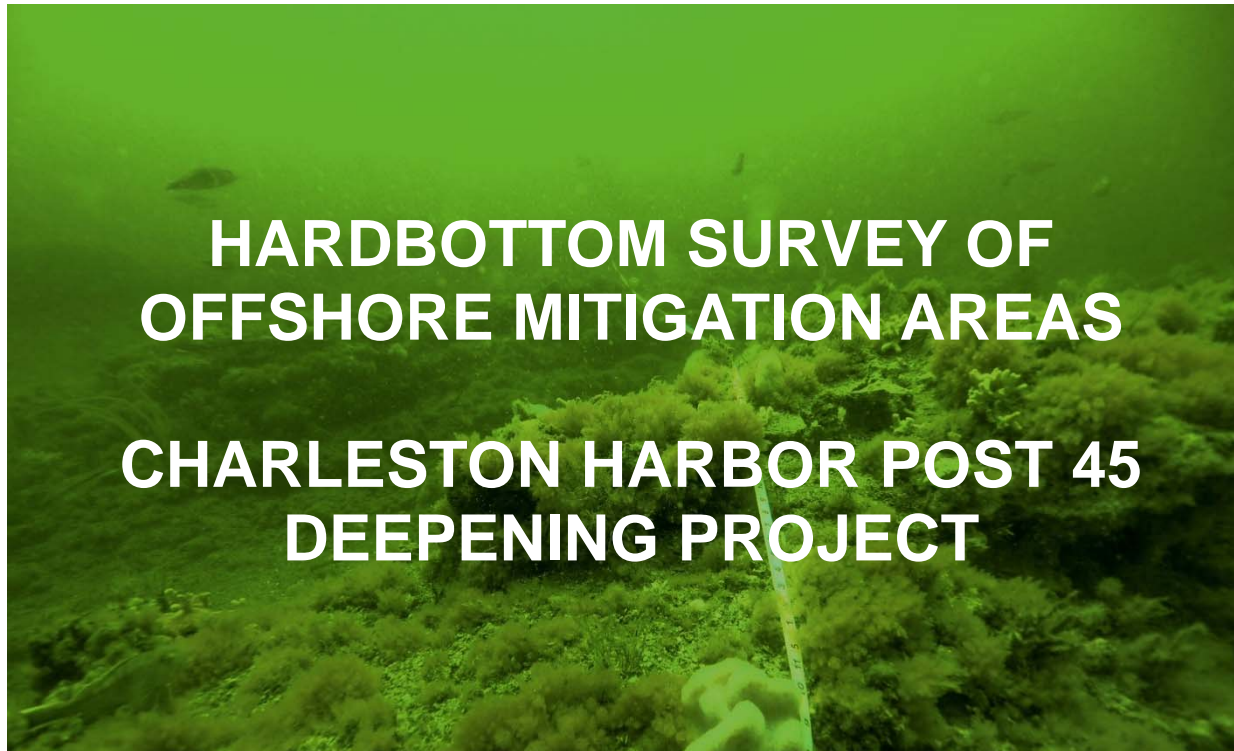
**CHARLESTON HARBOR POST 45  
BENEFICIAL USE OF DREDGED MATERIAL  
SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT**  
*CHARLESTON, SOUTH CAROLINA*

# **Hardbottom Habitat Identification in Support of Artificial Reef Sites**

30 September 2016



**U.S. Army Corps of Engineers  
Charleston District**



**HARDBOTTOM SURVEY OF  
OFFSHORE MITIGATION AREAS  
CHARLESTON HARBOR POST 45  
DEEPENING PROJECT**

**AUGUST 2016**

**Prepared by:  
Dial Cordy and Associates Inc.**

**Prepared for:  
South Carolina State Ports Authority  
and  
U.S. Army Corps of Engineers  
Charleston District**

**HARDBOTTOM SURVEY OF  
OFFSHORE MITIGATION AREAS**

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DEEPENING PROJECT**

**August 2016**

**FINAL REPORT**

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## **1.0 INTRODUCTION**

Dial Cordy and Associates Inc. (DC&A) was contracted by the South Carolina State Ports Authority (SCSPA) to conduct hardbottom and cultural resource surveys of two mitigation survey areas located north and south, respectively, of the Charleston Outer bar channel (Figure 1). The results of the survey will be used by the Charleston District, United States Corps of Engineers (USACE) to site locations for proposed artificial reefs, as mitigation for impacts associated with the Charleston Harbor Post 45 Deepening Project. This report summarizes the technical approach and results for the hardbottom survey portion of the survey. The results of the cultural resource surveys are provided in a separate report prepared by Panamerican Consultants Inc. (2016). In addition to the two surveys and separate survey results, a composite GIS graphic depicting both hardbottom locations and cultural resource anomalies was provided to the SCSPA and USACE. Survey data and video records will also be provided under separate cover.

## **2.0 TECHNICAL APPROACH**

### **2.1 Overview**

The hardbottom surveys performed within the north and south survey areas (Figure 1) included use of high frequency side-scan sonar to delineate consolidated and unconsolidated material, preparation of the draft hardbottom mosaics from interpreted side-scan records, completion of a towed-video survey along pre-approved transects to ground truth side-scan signatures, interpretation of video records and preparation of final hardbottom maps. A review of the method employed for each step above is provided below.

### **2.2 Side-scan Sonar Survey**

A side-scan sonar survey was performed of the north (1444.24 acres) and south (1801.11 acres) mitigation study area (Figure 1 and 2). Due to few allowable days during the winter and early spring to conduct survey operations 9-12 miles offshore from the entrance channel, the side-scan survey was conducted during three periods: 19 to 28 February; 25 to 30 April; and 23 to 26 May 2016. Figure 3 illustrates working conditions during one of the calmer survey days.

The vessel employed during the remote sensing survey was DC&A's 25-foot Parker 2520-XL *Haley Ann* (Figure 4) a modified "V"-hulled motor vessel powered by twin 125-horsepower Yamaha outboards. The vessel has a covered cabin and an ample, covered-deck area for the placement and operation of the necessary remote sensing equipment. The vessel conformed to all United States Coast Guard specifications, according to class, and had a full complement of safety equipment.

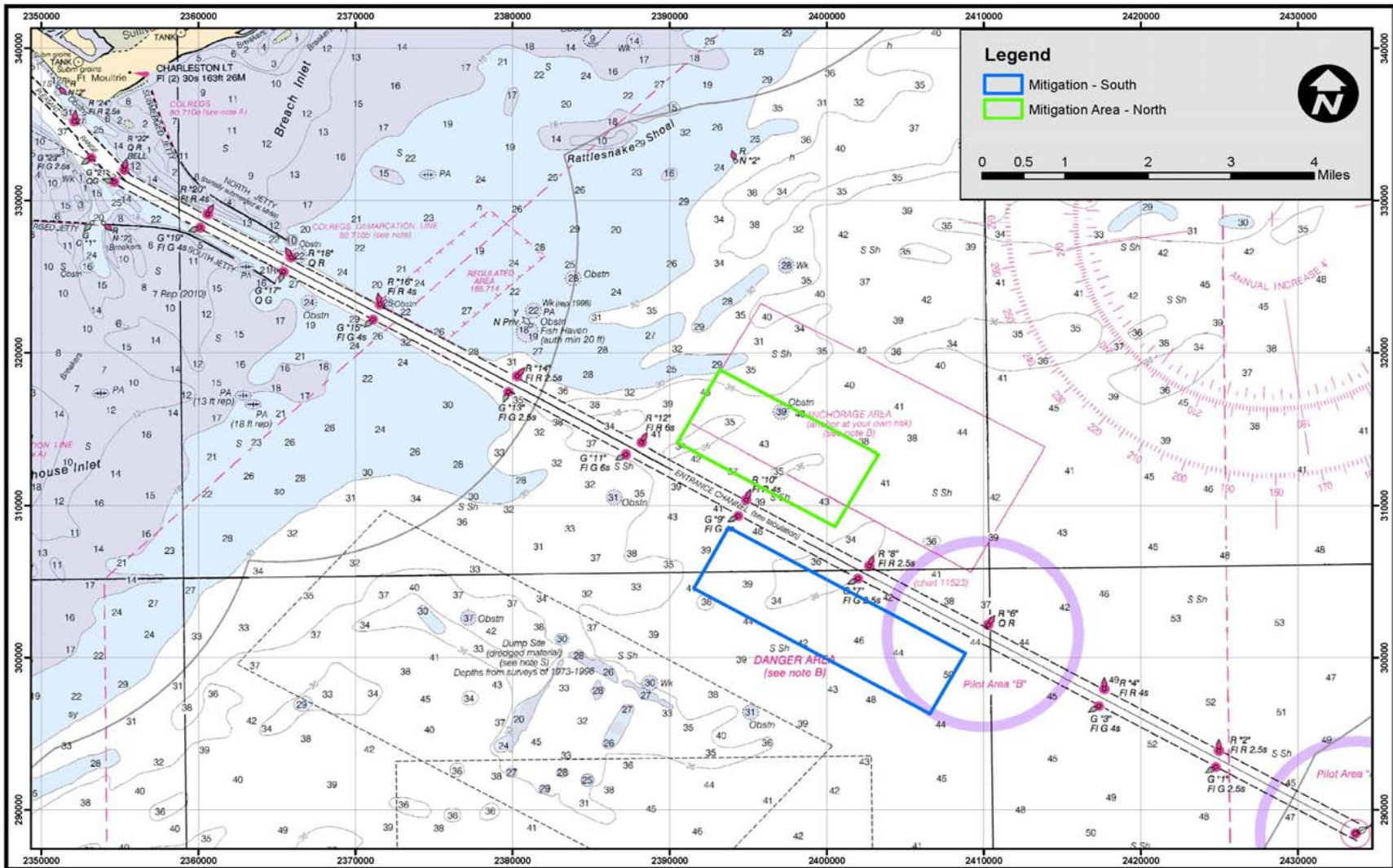
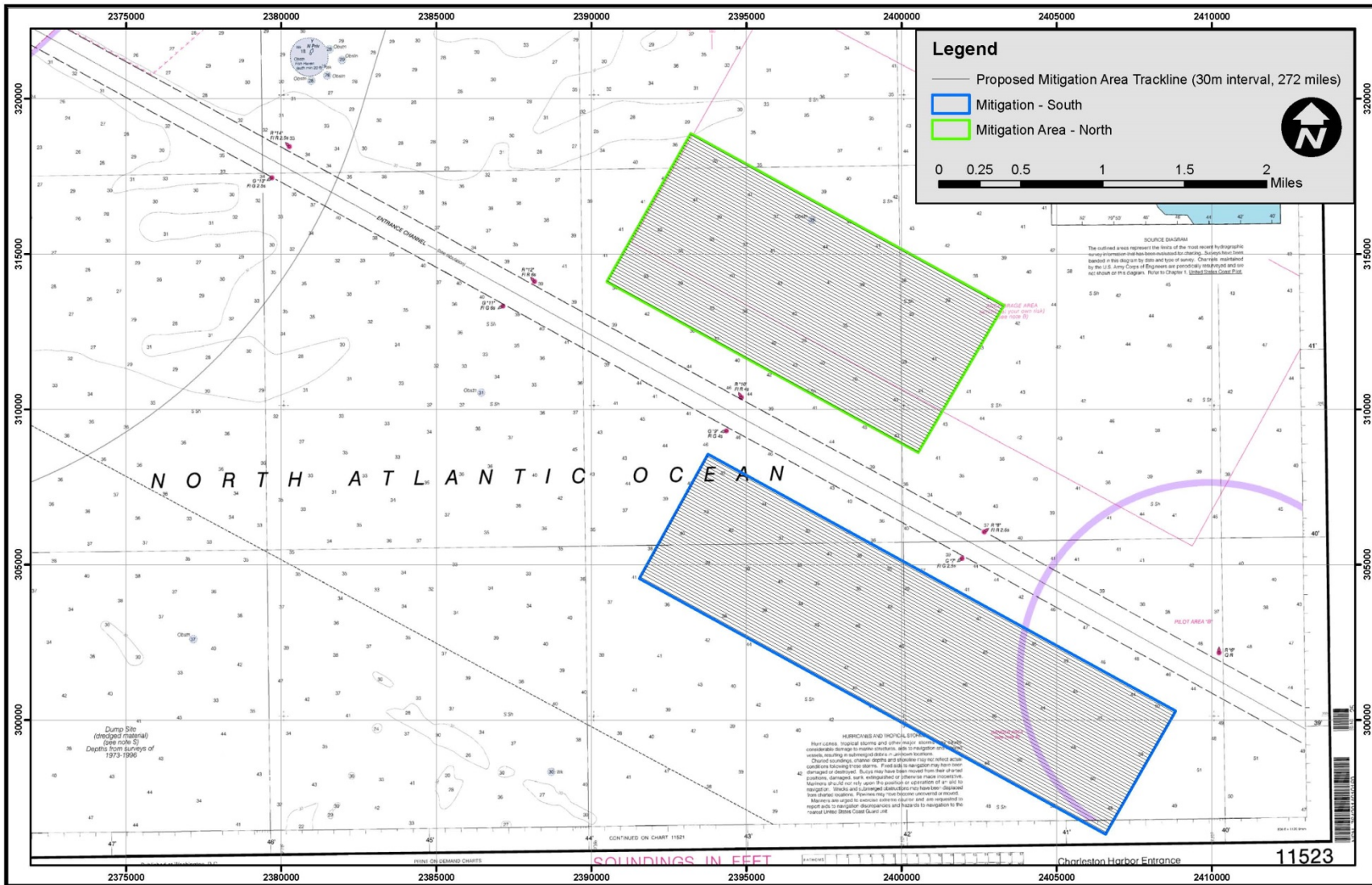


Figure 1. Location of North and South Mitigation Survey Areas





**Figure 2. Side-scan Survey Tracklines for North and South Survey Areas**





**Figure 3. Average Offshore Conditions During Survey**



**Figure 4. RV/Haley Ann Used for Survey**

The survey used a Marine Sonics Technology HDS sonar system with a dual-frequency [900-1800 kilohertz (kHz)] fish, interfaced with a differential global positioning system (DGPS) with accuracy levels that determine position to within one-meter (Figure 5). The side-scan sonar is an instrument that, through the transmission of dual fan-shaped pulses of sound and reception of reflected sound pulses, produces an acoustic image of the bottom. Under ideal circumstances, the side-scan sonar is capable of providing a near-photographic representation of the bottom on either side of the trackline of a survey vessel. HYPACK navigation software was used to locate the survey transects and maintain vessel tracking during data collection. Side-scan sonar data were collected along parallel transects, spaced at 30m intervals with a range of 45m, to achieve 120% percent overlapping coverage of adjacent survey lines (Figure 2). The sonar towfish was maintained at a height above the bottom that provided for the most accurate data collection (generally 10 to 30 feet).

### **2.3 Post-processing of Survey Records**

Post-processing of side-scan sonar records was accomplished using SonarWiz.MAP, a product that enables the user to view the side-scan data in digitizer waterfall format, pick targets and enter target parameters including length, width, height, material, and other characterizations into a database of contacts. In addition, SonarWiz.MAP “mosaics” the side-scan data by associating each pixel (equivalent to about 10 centimeters) of the side-scan image with its geographic location determined from the DGPS position (layback rectified) and distance from the DGPS position. SonarWiz.MAP is the industry standard for mosaicing capability, and the results are exported as geo-referenced Tiffs for importing to ARC GIS. SonarWiz.MAP can generate target reports in PDF, Word, or Excel format. Preparation of the hardbottom maps was completed using Arc GIS.

### **2.4 Towed-video Survey**

To confirm the presence and/or absence of hardbottom within the areas preliminarily identified as hardbottom habitat based on the side-scan survey records, video transects of the seafloor using a towed-video system were performed during June 27-29, 2016 (Figures 6 and 7). The selection of transect locations considered was based on verifying the location and edge of hardbottom features interpreted from side-scan record post-processing. Proposed transect locations were reviewed and approved by USACE staff prior to initiating the survey. Videography with real-time, on-screen, DGPS, position annotation was recorded at ten potential hardbottom sites (5 north and 5 south) to confirm the presence or absence of hardbottom features. Positioning for the towed-video survey was performed with an accuracy of within one-meter. The start and end point coordinates of the towed video transects are provided in Table1.

Video records were reviewed following the survey in the office and changes in benthic habitat noted along each transect. The analyst then used these results to refine the limits of hardbottom on the draft mosaics and to prepare final hardbottom maps.



**Figure 5. Marine Sonics Sonar Fish Used for Survey**



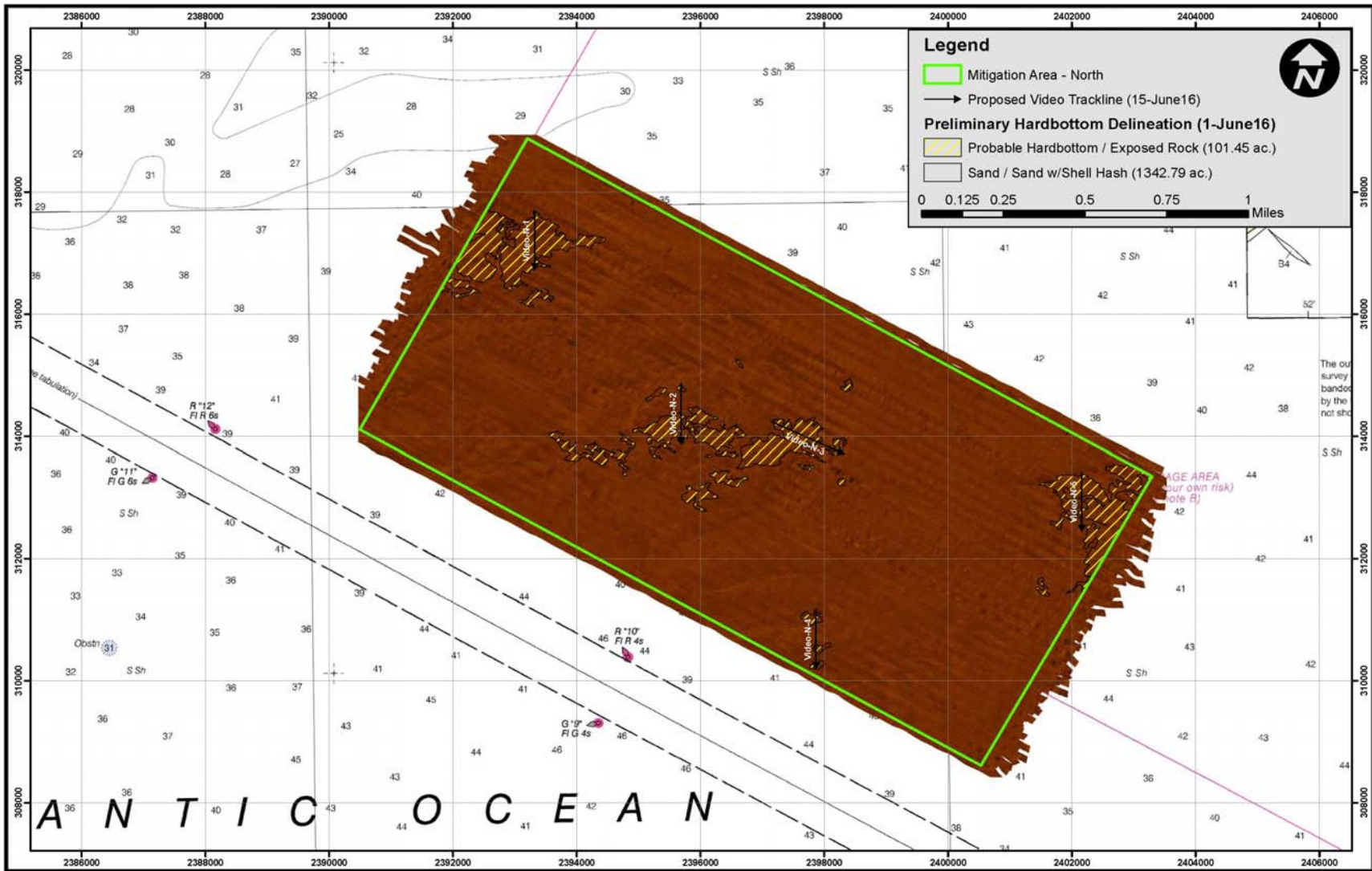


Figure 6. Draft Hardbottom Map and Proposed Towed-video Transects for North Mitigation Area

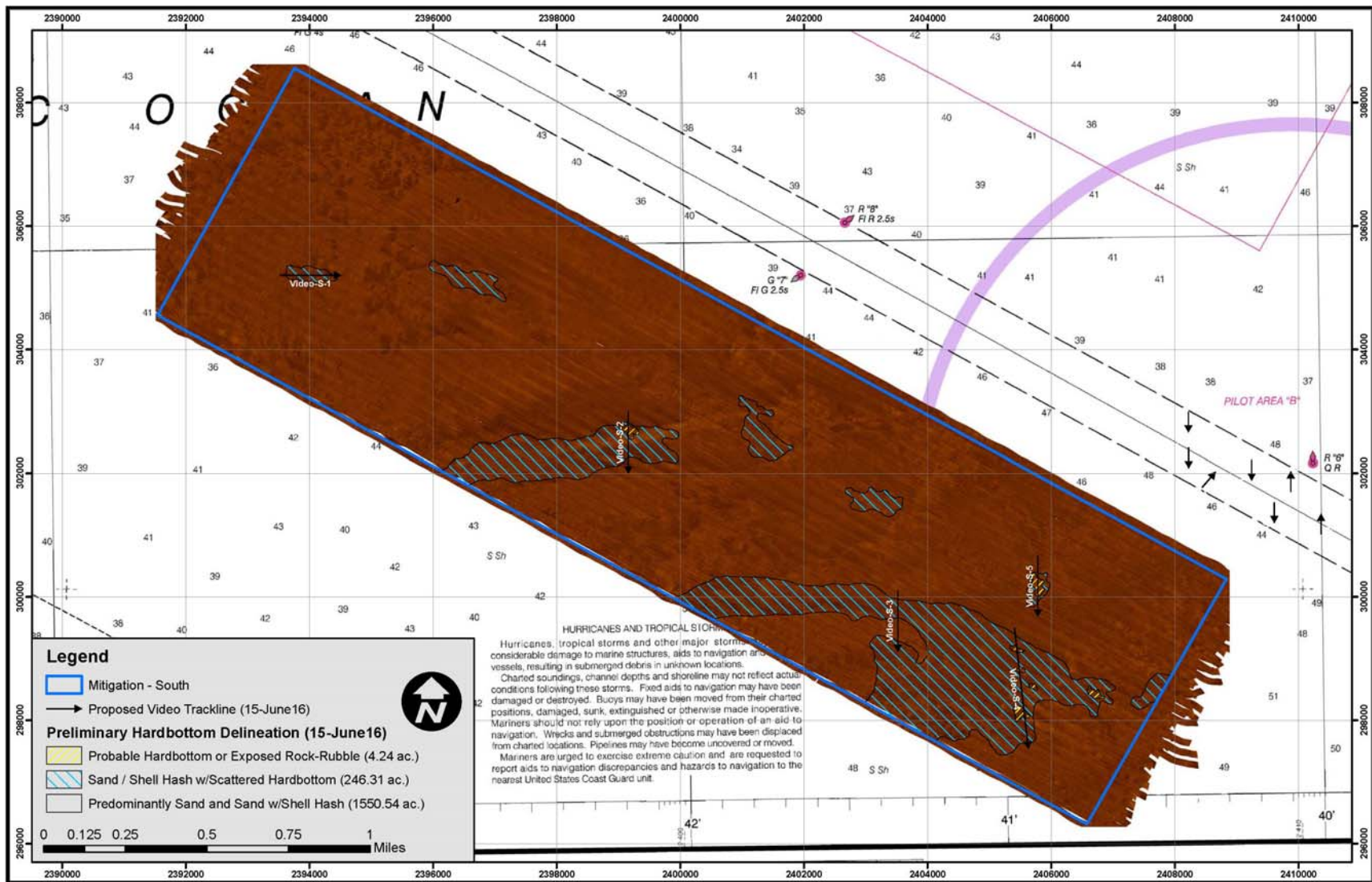


Figure 7. Draft Hardbottom Map and Proposed Towed-video Transects for South Mitigation Area

**Table 1. Coordinates for towed-video transects.**

<b>Transect</b>	<b>Date</b>	<b>Time</b>	<b>Coordinates</b>	
N1 Start	6/29/2016	10:11:06	3242N0165	07943W2795
N1 Stop	6/29/2016	10:17:59	3241N8220	07943W2843
N2 Start	6/29/2016	10:29:29	3241N5323	07942W8251
N2 Stop	6/29/2016	10:36:23	3241N3444	07942W8412
N3 Start	6/29/2016	10:47:48	3241N4141	07942W5318
N3 Stop	6/29/2016	10:54:49	3241N3036	07942W3376
N4 Start	6/29/2016	11:09:06	3240N9124	07942W4116
N4 Stop	6/29/2016	11:16:51	3240N7344	07942W4158
N5 Start	6/29/2016	11:39:20	3241N1105	07941W5747
N5 Stop	6/29/2016	11:47:34	3241N2667	07941W5631
S1 Start	6/29/2016	12:29:25	3239N9258	07943W2821
S1 Stop	6/29/2016	12:36:17	3239N9240	07943W0948
S2 Start	6/29/2016	12:54:59	3239N5482	07942W1870
S2 Stop	6/29/2016	13:04:11	3239N3765	07942W1864
S3 Start	6/29/2016	13:13:06	3239N0788	07941W3316
S3 Stop	6/29/2016	13:20:59	3238N9224	07941W3400
S4 Start	6/29/2016	13:33:26	3238N9714	07940W9731
S4 Stop	6/29/2016	13:49:43	3238N6514	07940W9327
S5 Start	6/29/2016	14:00:39	3238N9753	07940W8957
S5 Stop	6/29/2016	14:05:38	3239N0960	07940W8934



## 2.5 Report Preparation and Other Deliverables

Draft and final deliverables prepared for this task included the draft and final report, side-scan records, daily field log, video survey records, and all Arc GIS files.

## 3.0 RESULTS

The side-scan survey was conducted during three periods (ie. 19 to 28 February; 25 to 30 April, and 23 to 26 May 2016) of the two mitigation areas shown in Figure 1 and 2. A draft mosaic of side-scan images was developed and interpreted hardbottom features identified (Figures 6 and 7). Based on the draft map, a towed-video survey was performed to further refine the hardbottom locations with the study areas (Figures 8 and 9), with final hardbottom maps prepared (Figures 10 and 11). A summary of the benthic habitat changes observed along each video transect was prepared (see Appendix A). Side-scan and video records along with Arc GIS files were provided under separate cover to the USACE.

The north and south mitigation study areas cover a total of 1444.24 acres and 1801.09 acres, respectively. The three principal habitat types present includes: Probable Hardbottom/Exposed Rock, Sand and Sand with Shell-Hash, and Sand/Shell Hash with Scattered Hardbottom. Hardbottom refers to a classification of reef communities that occur in temperate, subtropical, and tropical regions that lack the diversity, density, and reef development of other types of coral communities [South Atlantic Fisheries Management Council (SAFMC) 1998]. For the purposes of this investigation, hardbottom habitat is defined as exposed areas of rock or consolidated sediments, distinguished from surrounding unconsolidated sediments, which may or may not be characterized by scattered live or dead biota, generally located in the ocean rather than in the estuarine system.

### North Mitigation Area Benthic Resources

The northern mitigation site is comprised of 1342.07 acres of Sand or Sand with Shell Hash. Within the northern mitigation site the area associated with Hardbottom/Exposed Rock is estimated at 102.17 acres out of 1444.24 total acres (Figure 10). Figure 12 illustrates a close-up view of the side-scan signature for the hardbottom resources in the northwest corner of the study area. Vertical relief was generally less than one to two feet.

Low relief hardbottom areas are subjected to periods of a sand veneer covering the hardbottom and exposure of rock (Figure 13). Depending on multiple factors with emphasis on duration of hardbottom exposure, octocorals (*Leptogorgia virgulata*, *Lophogorgia hebes*, and *Titanideum frauenfeildii*), sponges (*Cliona spp.*, *Ircinia campana*, *Haliclona oculata*), macroalgae, bryozoans and ascidians (Burgess et al. 2011; Van Dolah et al. 1997), can grow large enough to withstand impacts from sand migration (Figure 14). Often the fringes of hardbottom and exposed rock rubble provide a transition between predominantly exposed and periodically exposed habitat. Burgess et al. (2011) state that nearshore hardbottom habitat is typically patchy and surrounded by large expanses of sand and that reef organisms are often exposed to sediment movement

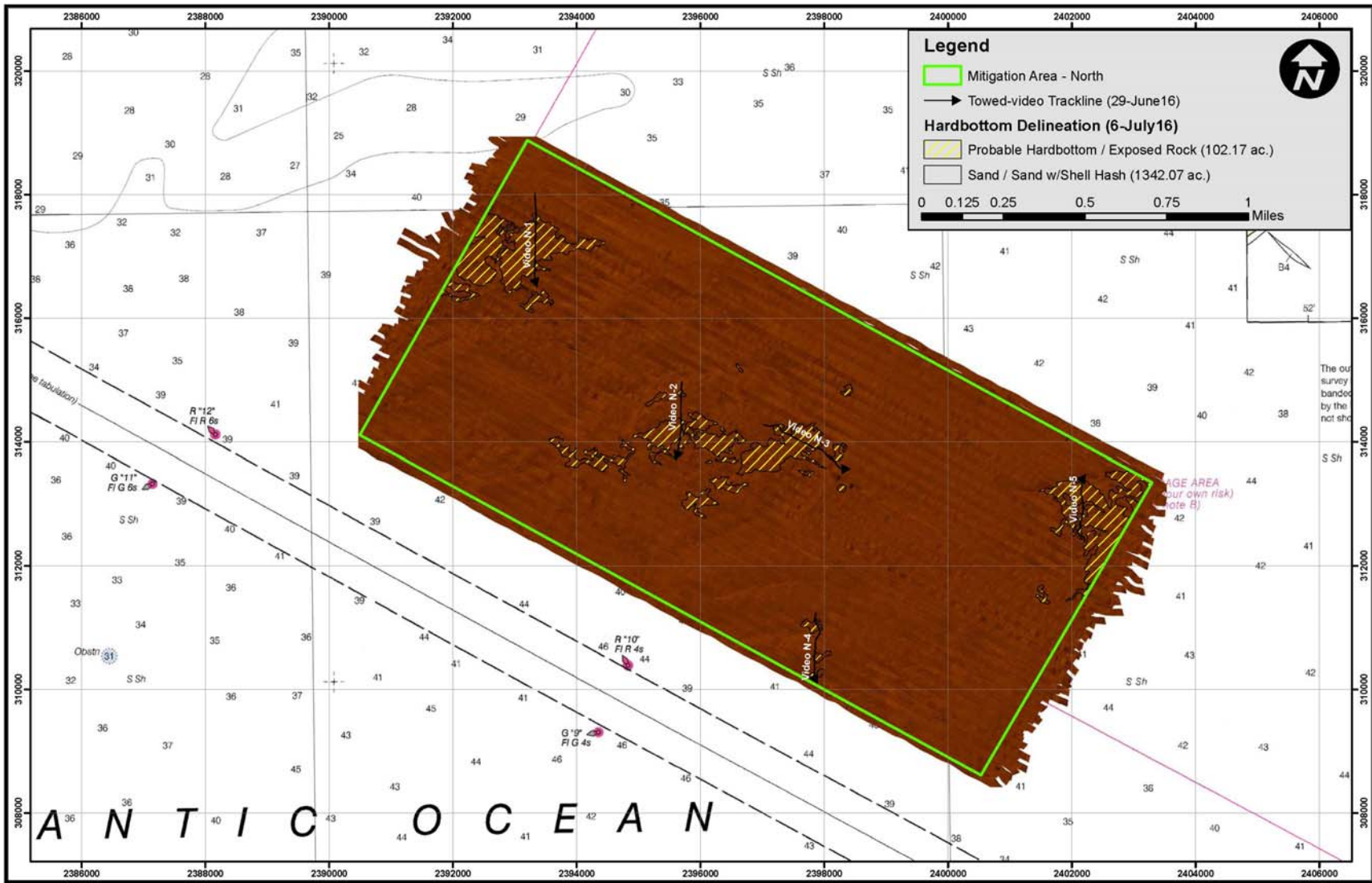


Figure 8. Actual Towed Video Transect Lines and Hardbottom Coverage for North Mitigation Area

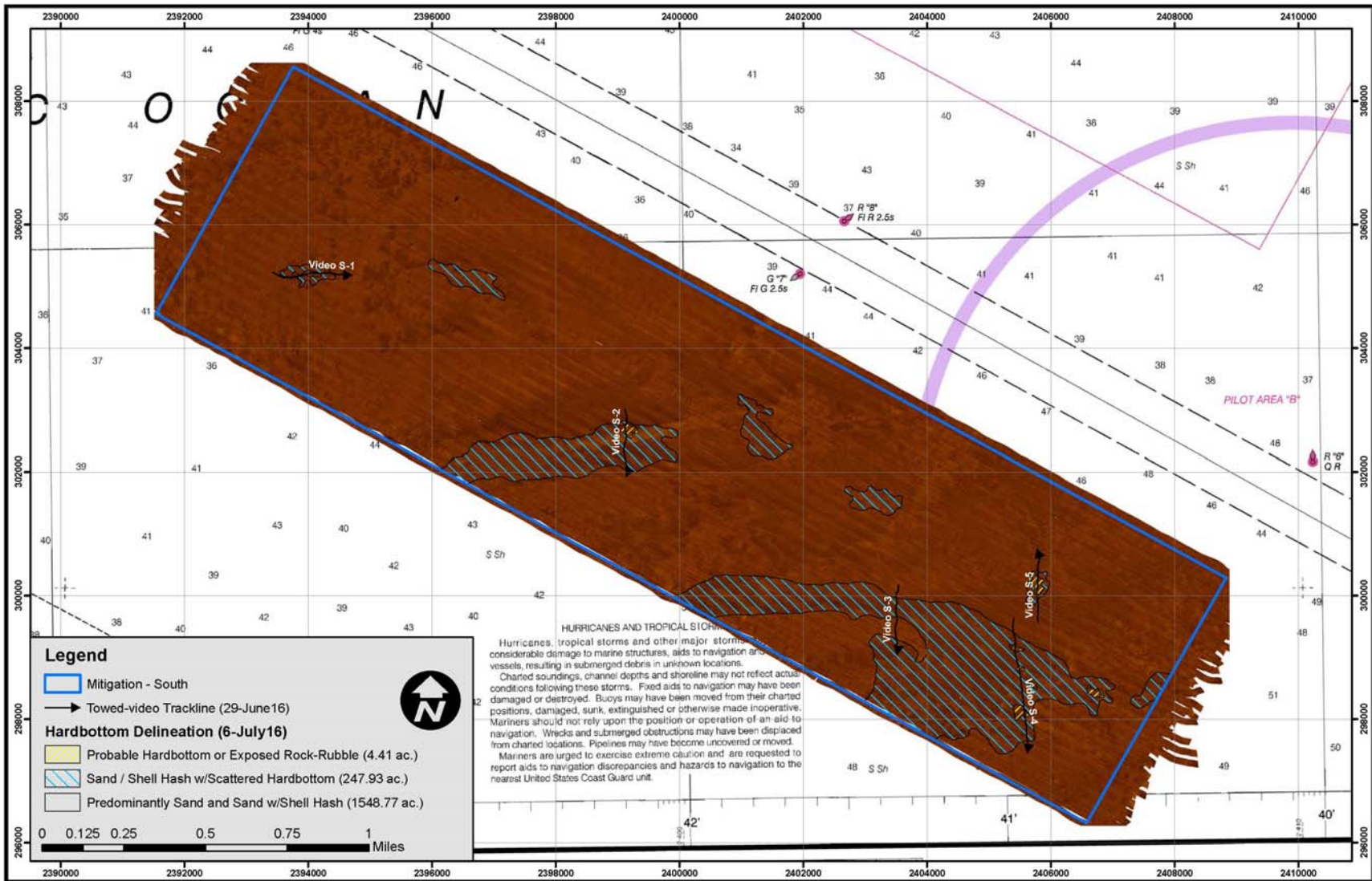


Figure 9. Actual Towed Video Transect Lines and Hardbottom Coverage for South Mitigation Area



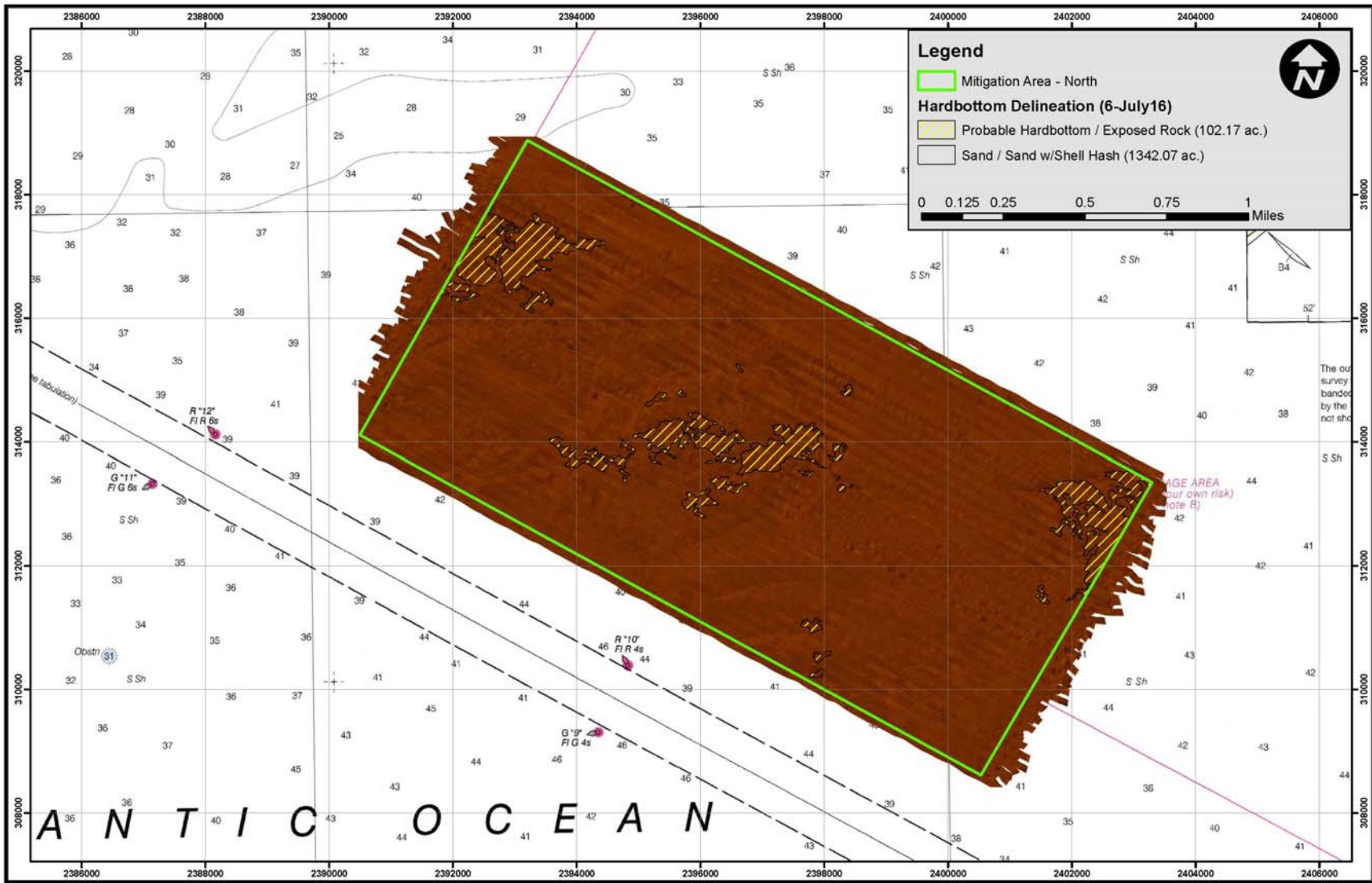


Figure 10. Final Hardbottom Delineation for North Mitigation Area

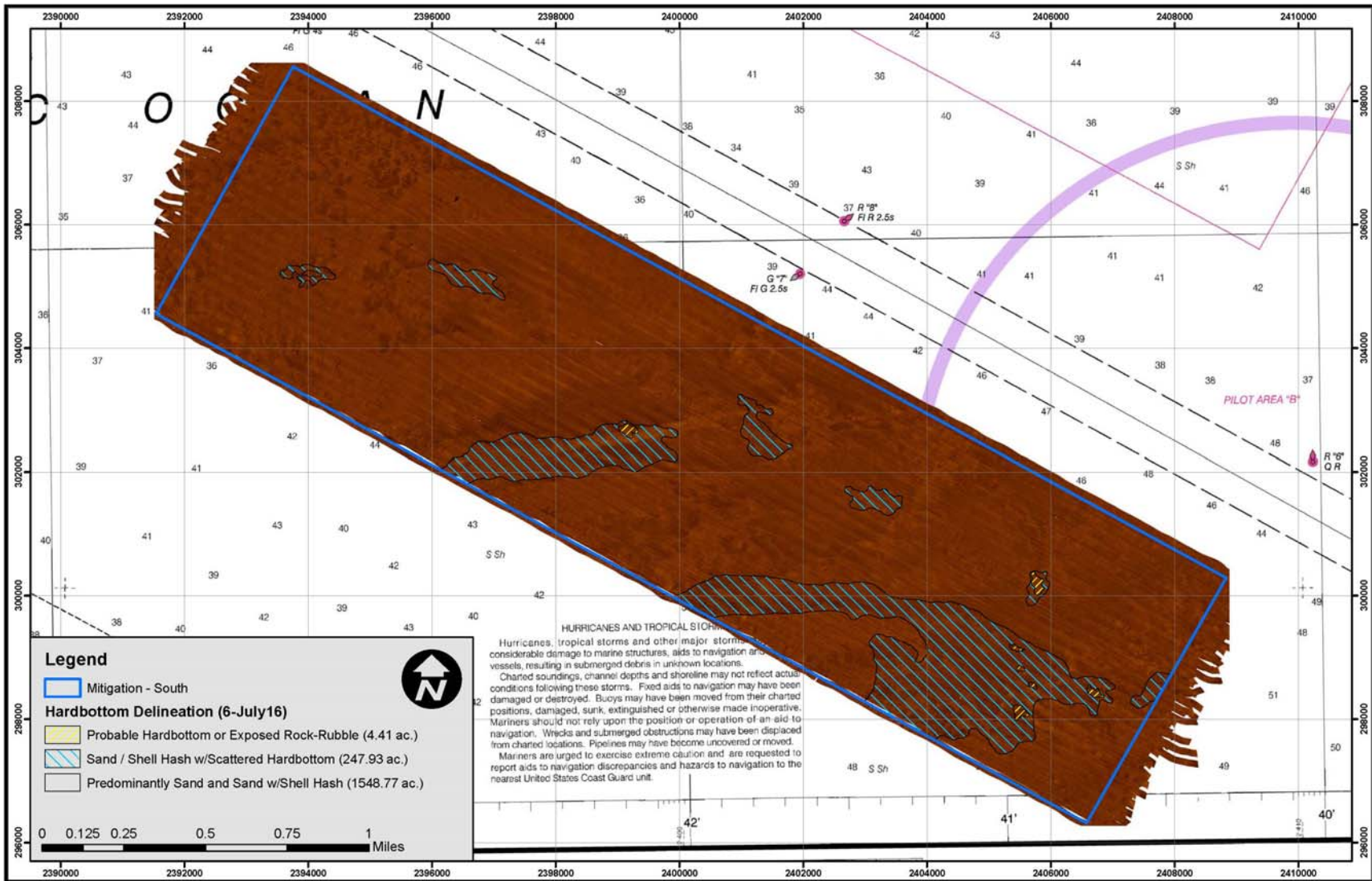
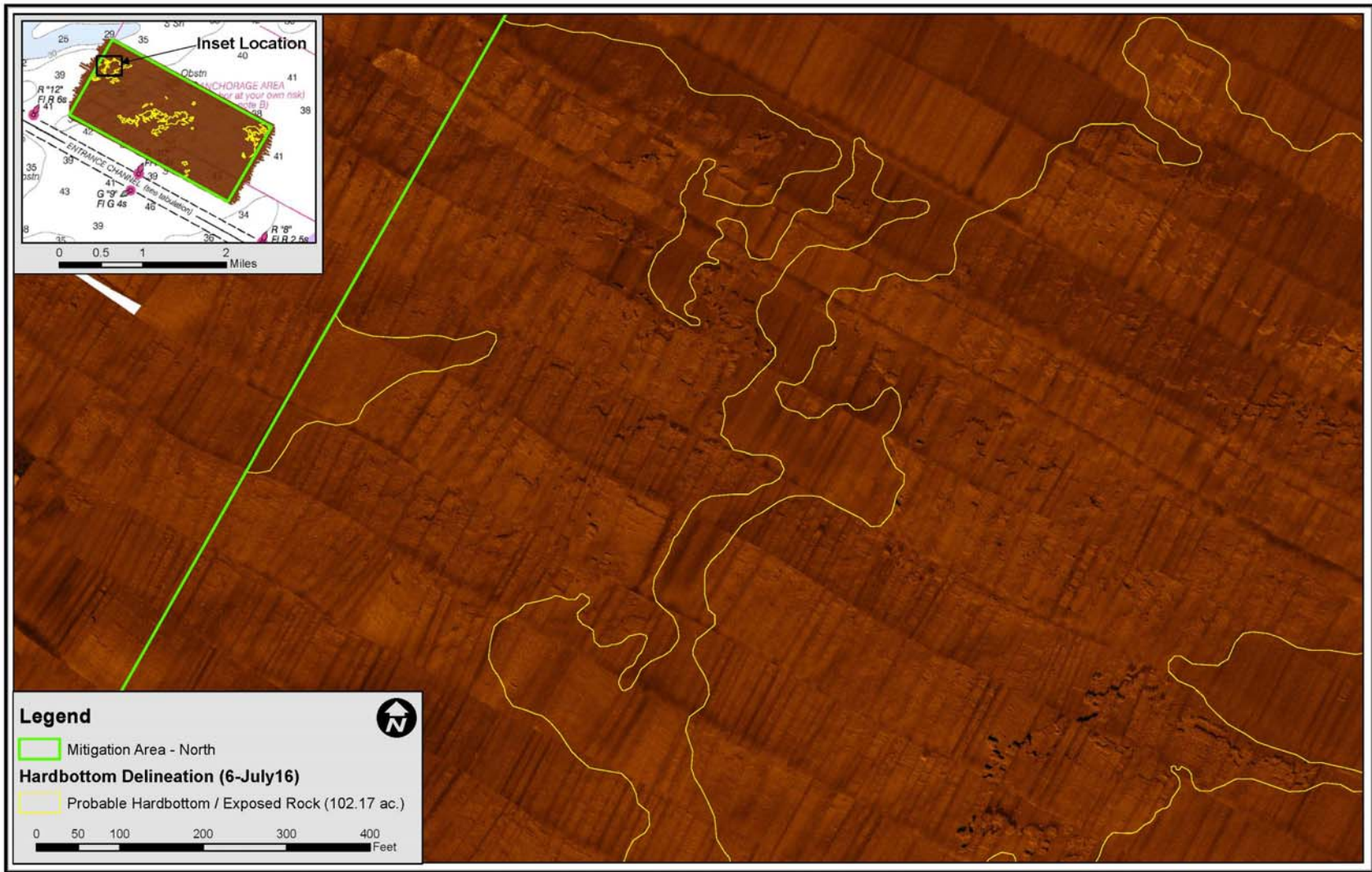


Figure 11. Final Hardbottom Delineation for South Mitigation Area





**Figure 12. Close-up View of Hardbottom Mosaic in Northwest Corner of North Mitigation Area**



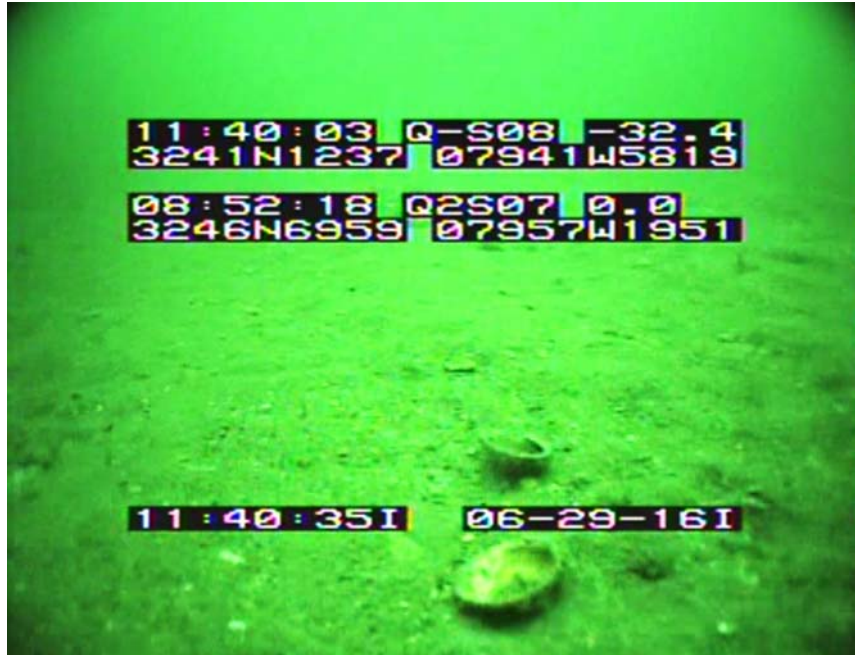


Figure 13. Image from Video Record of Typical Sand/Shell Hash Habitat within the North Mitigation Area

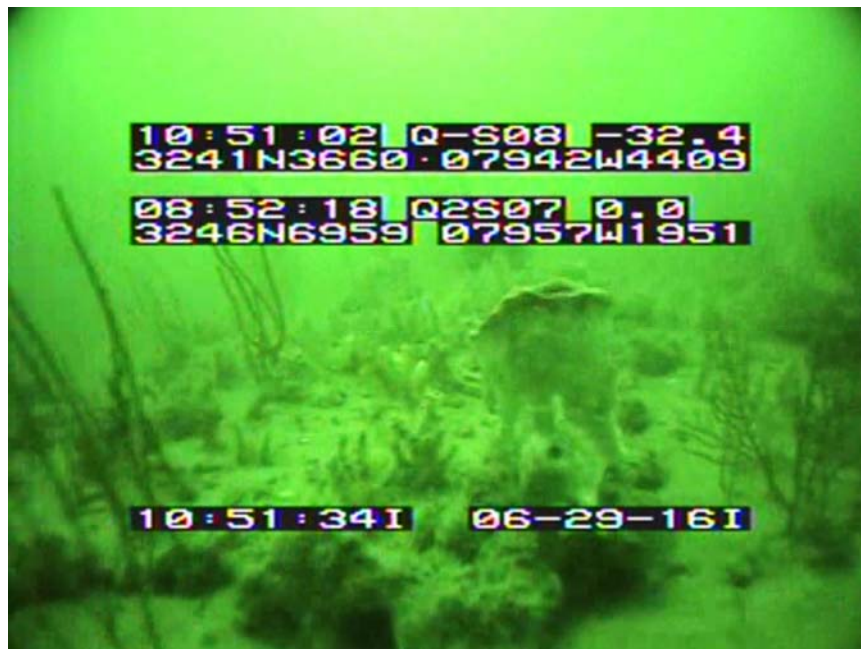


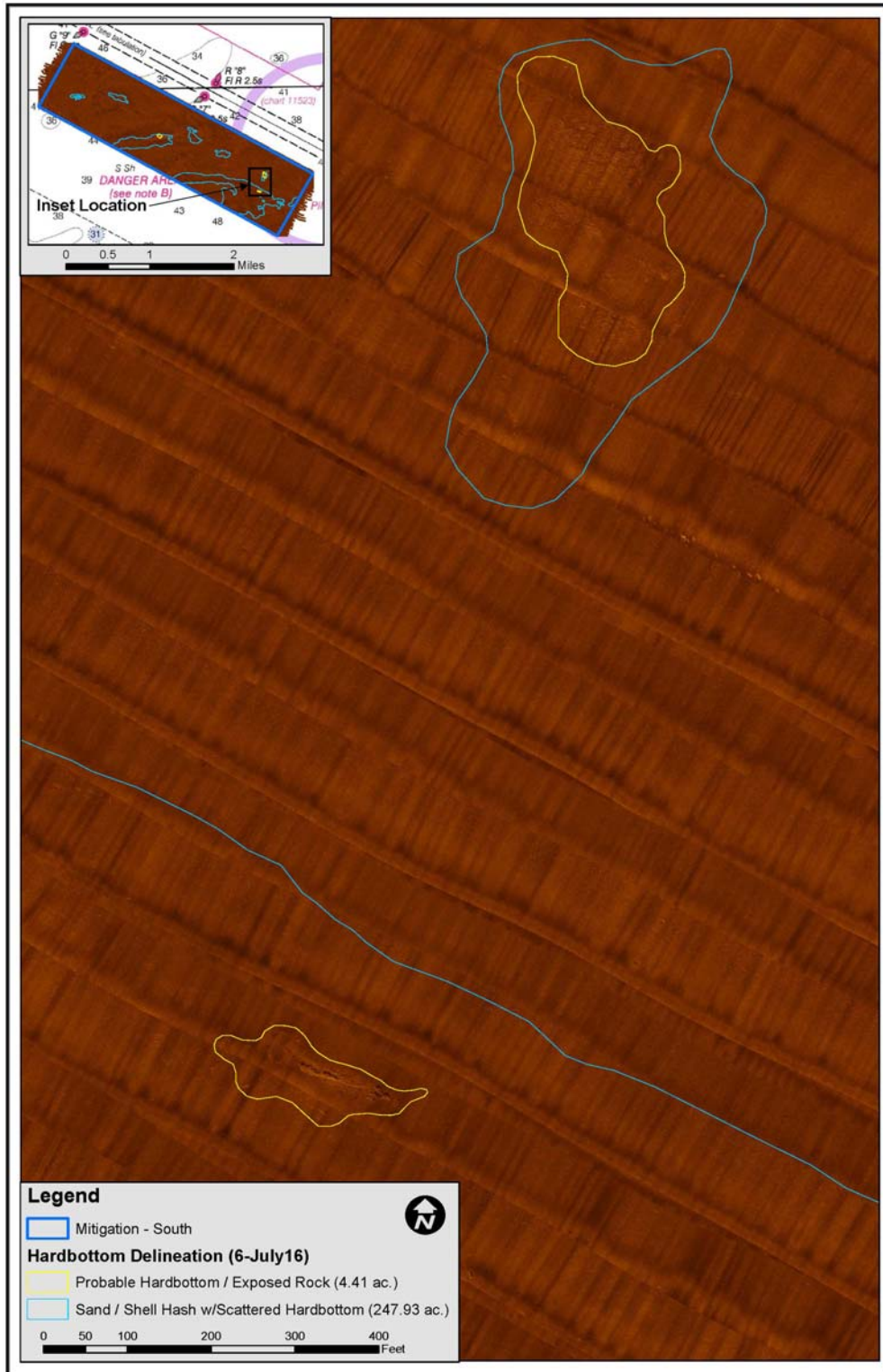
Figure 14. Image from Video Record of Typical Hardbottom Habitat within the North Mitigation Area

resulting from winds, tides and storms. Video records taken along the five transects provide evidence of the habitats included in this area

### **South Mitigation Area Benthic Resources**

The southern mitigation site is dominated by 1548.77 acres of Sand and Sand with Shell Hash, 247.93 acres of Sand/Shell Hash with Scattered Hardbottom, and 4.41 acres of Probable Hardbottom and Exposed Rock within the 1801.09-acre southern mitigation area (Figure 11). A close-up view of the hardbottom side-scan image in the southern north area is shown in Figure 15. Vertical relief was on average less than one foot.

Due to the dynamic nature of the low relief hardbottom habitats associated with the Charleston coast, a thin veneer of sand/sand with shell-hash causes some hardbottoms to have an ephemeral nature with scattered-periodically exposed rock. Due to temporal changes of hardbottom exposure in this area, established hardbottom communities consisting of octocorals (*L. virgulata*, *L. hebes*, and *T. frauenfeldii*), sponges (*Cliona spp*, *I. campana*, *H. oculata*), macroalgae, bryozoans and ascidians (Burgess et al. 2011; Van Dolah et al. 1997) protruding through a thin veneer of sand are prevalent (Figure 16). This habitat type encompassed 247.93 acres of the southern mitigation area. Hardbottom areas with a slightly higher relief are less effected by sand movement; which provide an important habitat and foraging grounds for a diverse array of invertebrate and fish species (Figure 17). Video records taken along the five transects provide evidence of the habitats included in this area



**Figure 15. Close-up View of Hardbottom Mosaic in Southeast Corner of South Mitigation Area**



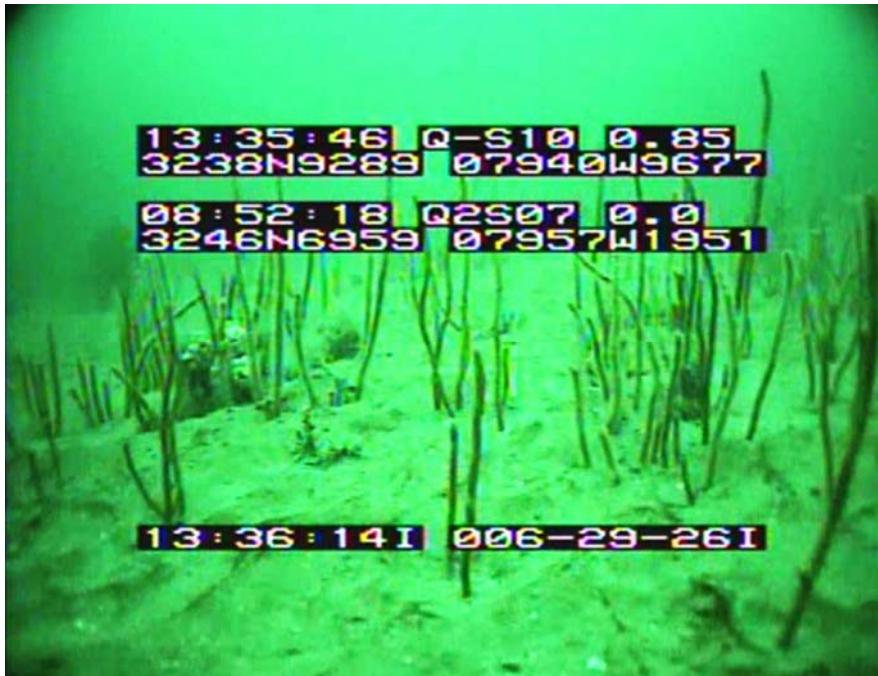


Figure 16. Image from Video Record of Sand/Shell and Scattered Hardbottom Habitat within the South Mitigation Area



Figure 17. Image from Video Record of Typical Hardbottom Habitat within the South Mitigation Area

#### 4.0 REFERENCES

- Burgess, D. E., G.H.M. Riekerk, and D.C. Bergquist. 2011. The 2007-2009 Grand Stand nourishment project: Impact of sand migration on invertebrate communities associated with nearshore and hardbottom habitats. Submitted to US Army Corps of Engineers, Charleston District, Prepared by SC Department of Natural Resources, Marine Resource Division.
- Panamerican Consultants, Inc. 2016. Cultural Resources Survey for the Post 45 Charleston Harbor Project Impact Area and Artificial Reef Site Clearance. Charleston County, South Carolina. July 2016. Prepared for Dial Cordy and Associates Inc. 122 pp.
- South Atlantic Fisheries Management Council. 1998. Final habitat plan for the South Atlantic region: Essential Fish Habitat requirements for fishery management plans of the South Atlantic Fishery Management Council. 457pp. plus appendices.
- Van Dolah, R.F., P.H. Wendt, D.A. Goldman, A.B. Wrona, R.A. Pardieck, and M.V. Levisen. 1997. An assessment of benthic infaunal assemblages and sediments in the vicinity of the Charleston ocean dredged material disposal site. Final report prepared by the South Carolina Department of Natural Resources Marine Resources Research Institute for the U.S. Army Corps of Engineers, Charleston District. 59 pp.

**APPENDIX A**  
**TOWED VIDEO SURVEY**  
**POST-PROCESSING RECORDS**



**Table A-1. Benthic habitat observations along the ten towed-video survey transects.**

<b>Transect</b>	<b>Date</b>	<b>Time</b>	<b>Coordinates</b>		<b>Benthic classification</b>	<b>Notes</b>
N1	6/29/2016	10:11:06	3242N0165	07943W2795	Sand	Sand
	6/29/2016	10:12:18	3241N9814	07943W2782	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	10:13:00	3241N9616	07943W2785	Sand	Sand
	6/29/2016	10:13:21	3241N9520	07943W2793	Hardbottom	Hardbottom small ledge (<1 ft)w/Sand veneer (octocorals present)
	6/29/2016	10:14:57	3241N9075	07943W2816	Sand	Sand
	6/29/2016	10:15:12	3241N9002	07943W2814	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	10:17:59	3241N8220	07943W2843	Sand	Sand
	6/29/2016	10:17:59	3241N8220	07943W2843	Sand	Sand
N2	6/29/2016	10:29:29	3241N5323	07942W8251	Sand	Sand w/Shell Hash
	6/29/2016	10:30:52	3241N4942	07942W8280	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	10:31:14	3241N4842	07942W8287	Sand	Sand
	6/29/2016	10:33:16	3241N4283	07942W8295	Hardbottom	Hardbottom (octocorals present)
	6/29/2016	10:35:10	3241N3732	07942W8355	Sand	Sand w/Shell Hash
	6/29/2016	10:36:23	3241N3444	07942W8412	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
N3	6/29/2016	10:47:48	3241N4141	07942W5318	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	10:52:30	3241N3487	07942W3912	Sand	Sand
	6/29/2016	10:54:24	3241N3135	07942W3443	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	10:54:49	3241N3036	07942W3376	Sand	Sand
N4	6/29/2016	11:09:06	3240N9124	07942W4116	Sand	Sand
	6/29/2016	11:10:31	3240N8816	07942W4099	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	11:11:43	3240N8572	07942W4013	Sand	Sand
	6/29/2016	11:15:01	3240N7783	07942W4183	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	11:15:47	3240N7588	07942W4191	Sand	Sand
	6/29/2016	11:16:25	3240N7438	07942W4189	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	11:16:51	3240N7344	07942W4158		
N5	6/29/2016	11:39:20	3241N1105	07941W5747	Hardbottom	Hardbottom outcropping w/Sand veneer (octocorals present)
	6/29/2016	11:47:34	3241N2667	07941W5631	Sand	Sand

**Table A-1. (continued)**

<b>Transect</b>	<b>Date</b>	<b>Time</b>	<b>Coordinates</b>		<b>Benthic classification</b>	<b>Notes</b>
S1	6/29/2016	12:29:25	3239N9258	07943W2821	Sand/Shell Hash	Sand/Shell Hash
	6/29/2016	12:32:17	3239N9169	07943W2259	Sand	Sand
	6/29/2016	12:35:25	3239N9270	07943W1233	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	12:35:38	3239N9269	07943W1165	Sand	Sand
	6/29/2016	12:36:17	3239N9240	07943W0948	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
S2	6/29/2016	12:54:59	3239N5482	07942W1870	Sand	Sand
	6/29/2016	12:56:49	3239N5179	07942W1834	Sand	Sand
	6/29/2016	12:57:32	3239N5151	07942W1842	Sand	Sand
	6/29/2016	12:58:20	3239N4939	07942W1870	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	12:59:33	3239N4676	07942W1870	Sand/Shell Hash	Sand/Shell Hash
	6/29/2016	13:00:05	3239N4571	07942W1906	Sand	Sand
	6/29/2016	13:02:15	3239N4164	07942W1875	Sand/Shell Hash	Sand/Shell Hash
	6/29/2016	13:02:37	3239N4093	07942W1862	Sand	Sand
	6/29/2016	13:03:17	3239N3975	07942W1822	Hardbottom	Hardbottom w/Sand veneer (octocorals present)
	6/29/2016	13:03:28	3239N3936	07942W1810	Sand/Shell Hash	Sand/Shell Hash
6/29/2016	13:04:11	3239N3765	07942W1864	Shell Hash	Shell Hash	
S3	6/29/2016	13:13:06	3239N0788	07941W3316	Sand	Sand
	6/29/2016	13:14:04	3239N0596	07941W3353	Sand/Shell Hash	Sand/Shell Hash
	6/29/2016	13:14:35	3239N0494	07941W3411	Sand	Towfish pulled off bottom
	6/29/2016	13:14:58	3239N0397	07941W3400	Sand	Sand-Towfish back on bottom
	6/29/2016	13:17:15	3238N9946	07941W3399	Sand/Shell Hash	Sand/Shell Hash
	6/29/2016	13:18:38	3238N9663	07941W3441	Shell Hash	Shell Hash
	6/29/2016	13:20:08	3238N9400	07941W3431	Sand/Shell Hash	Sand/Shell Hash
	6/29/2016	13:20:59	3238N9224	07941W3400	Sand	Sand
S4	6/29/2016	13:33:26	3238N9714	07940W9731	Sand	Sand
	6/29/2016	13:33:53	3238N9649	07940W9745	Sand	Unknown dark substance on top of sand, looks like a cyanobacteria bloom
	6/29/2016	13:34:31	3238N9525	07940W9741	Hardbottom	Hardbottom w/Sand veneer and cyanobacteria(octocorals present mainly Titanideum frauenfeldii)
	6/29/2016	13:35:32	3238N9335	07940W9691	Sand	Sand
	6/29/2016	13:35:46	3238N9289	07940W9677	Hardbottom	Hardbottom w/Sand veneer (octocorals present mainly Titanideum frauenfeldii)

**Table A-1. (concluded).**

<b>Transect</b>	<b>Date</b>	<b>Time</b>	<b>Coordinates</b>		<b>Benthic classification</b>	<b>Notes</b>
	6/29/2016	13:36:13	3238N9198	07940W9668	Sand	Sand
	6/29/2016	13:36:39	3238N9114	07940W9671	Hardbottom	Hardbottom (small ledge <1ft, Octocorals present leptogorgia virgulata and Titanideum frauenfeldii)
	6/29/2016	13:37:01	3238N9041	07940W9682	Sand	Sand
	6/29/2016	13:37:16	3238N8992	07940W9691	Hardbottom	Hardbottom w/Sand veneer and Octocorals T. frauenfeldii
	6/29/2016	13:37:32	3238N8941	07940W9693	Sand	Sand
	6/29/2016	13:39:54	3238N8478	07940W9562	Hardbottom	Hardbottom w/ sand veneer, octocorals present T. frauenfeldii
	6/29/2016	13:40:01	3238N8457	07940W9556	Sand	Sand with Cyanobacteria
	6/29/2016	13:44:01	3238N7669	07940W9445	Sand/Shell Hash	Sand/Shell Hash
	6/29/2016	13:44:32	3238N7563	07940W9442	Hardbottom	Hardbottom w/sand veneer (octocorals present)
	6/29/2016	13:44:52	3238N7491	07940W9436	Sand	Sand
	6/29/2016	13:45:29	3238N7361	07940W9425	Hardbottom	Hardbottom w/sand veneer (Octocorals and sponges present)
	6/29/2016	13:47:03	3238N7043	07940W9375	Sand	Sand
	6/29/2016	13:49:43	3238N6514	07940W9327	Sand/Shell Hash	Sand w/Shell Hash
S5	6/29/2016	14:00:39	3238N9753	07940W8957	Sand	Sand
	6/29/2016	14:03:36	3239N0479	07940W8971	Hardbottom	Hardbottom/Rock rubble (octocorals present)
	6/29/2016	14:04:16	3239N0641	07940W8952	Sand	Sand
	6/29/2016	14:04:30	3239N0697	07940W8945	Hardbottom	Hardbottom/Rock rubble (octocorals present)
	6/29/2016	14:05:38	3239N0960	07940W8934	Sand	Sand