Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

Atlantic Sand Assessment Project (ASAP)

Final Report of Findings

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1.0 Executive Summary

Aptim Federal Services, LLC (formerly known as APTIM Federal Services, LLC), together with affiliate firm Aptim Environmental & Infrastructure Inc. (formerly known as APTIM Environmental & Infrastructure Inc.) (collectively referred to as APTIM) was contracted by the Bureau of Ocean Energy Management (BOEM) in 2014, to conduct the Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continent Shelf of the United States project as part of BOEM's Hurricane Sandy Recovery Initiatives. The purpose of the project was to identify potential sand resources along the Atlantic Outer Continental Shelf from Maine to Florida, bounded on the west by the federal/state boundary (5.6 km/3 miles offshore) and on the east by a line 14.8 km/8 miles offshore and in waters depths up to 30 meters (m) (98 feet).

The project was broken down into four phases. Phase 1 consisted of historic data compilation, review and meetings with state representatives and stakeholders to identify existing data, data gaps, and project needs to aide in the development of a data acquisition plan. Phase 2 consisted of the collection of 4,262 line-km (2,301 nautical miles (nm)) of reconnaissance geophysical data (chirp sub-bottom, sidescan sonar, magnetometer, and swath bathymetry) and 260 geotechnical samples (160 vibracores and 100 surface grab sample) from Florida to Massachusetts in 2015. In 2016 APTIM conducted Phase 3, the first design-level survey, consisting of 1,338 planned km (722 nm) of geophysical data and 90 vibracores offshore New Jersey and New York. The final phase, Phase 4, was conducted in 2017 and entailed a second design-level investigation, consisting of 820 km (443 nm) of planned geophysical data and 90 vibracores offshore New Jersey and Delaware.

As part of the reconnaissance survey, APTIM collected 4,339 line km (2,342 nm) of chirp sub-bottom, interferometric sonar swath bathymetry, sidescan sonar and magnetometer data at widely-spaced lines across the Atlantic Outer Continental Shelf from Florida to Massachusetts. Geophysical survey operations took place between April 19, 2015 and July 26, 2015, followed by geotechnical field operations between July 29, 2015 and December 7, 2015. Geotechnical data consisted of 100 surface grab samples collected with a ponar grab sampler and 160 6.09 m (20 ft) vibracores collected with a 271B pneumatic vibracore. The selection of both surface grab samples and vibracore sample locations were determined in the field based on specific features indicative of sand deposits (i.e. sand hills and shoals and/or subsurface geology). Prior to the collection of any geotechnical samples, through the duration of the project, a qualified marine archaeologist reviewed all geophysical data at each proposed site to determine any cultural resources that needed to be avoided. Throughout geophysical and geotechnical operations, APTIM utilized protected species observers and other mitigation techniques to reduce or eliminate impacts to marine mammals and other protected resources.

The first design-level investigation resulted in the collection of 1,857 km (1,002 nm) of geophysical tracklines, at a 30 m (98 ft) line spacing, and 90 vibracore samples, placed at a 305 m (1,000 ft) centers, in New York and New Jersey to provide the necessary data coverage to fully design and permit future borrow areas in areas highly impacted by Hurricane Sandy. Prior to conducting the field investigation, APTIM reviewed the reconnaissance geophysical and geotechnical data (analyzed and processed for grain size, color, and carbonate content), and, along with input from BOEM and regional stakeholders, identified three (3) areas in New York (Moriches Inlet, Fire Island and Fire Island Inlet) and two (2) areas in New Jersey (F1 and MON-2/MON-4) for detailed investigations. Geophysical survey operations consisted of collecting 1,122 line km (605 nm) of geophysical data offshore New York, and 736 line km (397 nm) of geophysical data offshore New Jersey, between May 29, 2016 and June 29, 2016. Even though APTIM was not tasked with processing any of the geophysical data, a data review was conducted in order to estimate average thickness and potential volumes in each of the investigation areas. Following data review, APTIM allocated 59 vibracores to New York (which were collected in the Fire Island survey area) and 31 vibracores to New Jersey (which were collected in the F1 survey area). Geotechnical operations took place between August 9, 2016 and September 2, 2016.

The last phase of the project took place in 2017, when APTIM conducted a second design-level geophysical and geotechnical investigation along Mid-Atlantic States. As part of the survey planning for the 2017 investigations, APTIM once again reviewed the collected reconnaissance data, and, along with input from BOEM, allocated 820 line km (442 nm) of geophysical data and 90 vibracores to Delaware and New Jersey. New Jersey and BOEM representatives indicated interest in collecting design-level data in the G1 area offshore Brigantine, while Delaware representatives requested the collection of additional, more detailed reconnaissance data to augment their existing geophysical and geotechnical database. Between April 22, 2017 and May 12, 2017 APTIM collected 893 line km (482 nm) of geophysical data, with 391 line km (211 nm) being in New Jersey and 502 line km (271 nm) in Delaware. Following the geophysical survey, APTIM conducted a data review in order to identify areas for vibracore collection. From the collected geophysical data in New Jersey, APTIM personnel created a sand thickness surface (isopach) and isolated areas thicker than 2 meters. This process yielded four (4) areas for borrow area design data coverage. A total of 64 vibracores were allocated to New Jersey in order to achieve the necessary coverage at 305 m (1,000 ft) centers. The remaining 26 vibracores were allocated to Delaware and placed at a reconnaissance spacing in areas where the sub-surface geology indicated the presence of beach-compatible sands as well as areas of interest from the state representatives. Geotechnical survey operations were conducted between July 8, 2017 and August 3, 2017

Throughout the duration of the project APTIM submitted raw geophysical data and processed geotechnical and bathymetric data to BOEM and state representatives along with quarterly reports as status updates of the project. Upon completion of the project, APTIM has collected and submitted a total of 7,089 line km (3,828 nm) of geophysical data (chirp sub-bottom, sidescan sonar, magnetometer, and swath bathymetry data) together with vibracore logs, surface grab sample descriptions and photographs of 440 geotechnical samples and granularmetric reports, and grain size distribution curves for 2,156 analyzed subsamples collected along the entire Atlantic outer continental shelf.

With the resources provided by BOEM for this project, APTIM was able to collect a large geologic dataset advancing the reconnaissance-level understanding of potential sand resources on the Atlantic OCS, and to collect sufficient data to allow seven (7) sub-investigation areas to have the data needed to design and permit borrow areas for future use in shore protection projects.

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6.0 Acronyms

μPa - micropascal
AIS - Automatic Identification System
ASAP - Atlantic Outer Continental Shelf; Atlantic Sand Assessment Project
ASTM - American Society for Testing and Materials
AVS - American Vibracore Service's
BOEM - Bureau of Ocean Energy Management
BSSE - Bureau of Safety and Environmental Enforcement
cm - centimeter
CMEC - Construction Materials Engineering Council, Inc.
CORS - Continuously Operating Reference Stations
cy - cubic yards
dB - decibel
DGPS - Differential Global Positioning System
DIA - Design Investigation Area
DMA - dynamic management area
DOI - Department of Interior
EA - Environmental assessment
EPA - Environmental Protection Agency
FM - frequency modulated
Ft - feet
FWS - U.S. Fish and Wildlife Service
G&G - Geological & Geophysical
GAMS - GNSS Azimuth Measurement System.
GNSS - global navigation satellite system
HAPCs - Habitat Areas of Particular Concern
IMU - inertial measurement unit
kHz - kilohertz
km - kilometers
km/h - kilometers per hour
kW - kilowatt
LNTM - Local Notice to Mariners
M - meter
m^3 - cubic meters
MEC - munitions of explosive concern
NAVD88 - North American Vertical Datum 1988
NDZ - No Discharge Zones
NGS - National Geodetic Survey
Nm - nautical miles
NMFS - National Marine Fisheries Service
NOAA - National Oceanic and Atmospheric Administration
nT - nanotesla
NTL - Notice to Lessees and Operators
OCS - Outer Continental Shelf
ODMDS - ocean dredged material disposal site
POS - position orientation system
POSPac Mobile Mapping Suite - POSpac MMS
P-P - peak to peak
PPK - Post-Processed Kinematic
PSO - Protected Specie Observer
QA/QC - quality assurance quality control
RGT - 'Real Time Gypsy"
ROSSI - Reconnaissance Offshore Sand Search Inventory
SBAS - satellite-based augmentation system
SMA - Seasonal Management Areas
SV - sound velocity
TAR - Tidewater Atlantic Research, Inc.
US - United States
USACE - United States Army Corps of Engineers
USCG - United States Coast Guard
USGS - U.S. Geological Survey
UTM - Universal Transverse Mercator
VAC - volts alternating current

7.0 Introduction

The United States (US) Department of Interior (DOI) Bureau of Ocean Energy Management (BOEM) Marine Minerals Program is responsible for managing energy and mineral resources on the Outer Continental Shelf (OCS), specifically non-energy minerals (primarily sand and gravel) for use in coastal resiliency and storm damage reduction projects, including beach nourishment and coastal restoration. Sand is required for these restoration activities to assist in recovery from acute events like storms such as Hurricane Sandy, as well as chronic erosion from currents, wave activity, tides, and human intervention of natural sediment transport along beaches, coastal communities, and state and Federal lands. Coastal restoration provides shore protection and benefits important habitats and ecosystems, community rebuilding efforts (residential and commercial), and Federal and state economies through tourism and tax revenues. Proactively identifying sand resources is the first critical step necessary for BOEM to effectively manage the resource, allowing BOEM to locate and lease these resources to other agencies that require them for rebuilding projects promoting the long-term sustainability of communities and ecosystems. By identifying OCS sand resources, BOEM is in the unique position of providing resources to multiple federal, state, and local agencies to rebuild parkland, wildlife refuges and habitat, and other areas requiring additional material to stabilize and rebuild land.

Aptim Federal Services, LLC (formerly known as APTIM Federal Services, LLC), together with affiliate firm Aptim Environmental & Infrastructure Inc. (formerly known as APTIM Environmental & Infrastructure Inc.) (herein referred to collectively as APTIM) was contracted by BOEM on September 10, 2014, to conduct the Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continent Shelf of the US project as part of BOEM's Hurricane Sandy Recovery Initiatives. The goal of this project – also known as the Atlantic Sand Assessment Project (ASAP) – was to conduct a comprehensive geophysical and geological survey using state-of-the-art technology and methods to support the identification, characterization and delineation of federal OCS sand resources for use by coastal states in future coastal restoration efforts. These investigations were focused on the Atlantic OCS from Massachusetts to Florida, bounded on the west by the federal/state boundary (5.6 km/3 miles offshore) and on the east by a 14.8 km/8 mile line offshore and up to a maximum water depth of approximately 30 m (98 ft). The total planned data collection effort consisted of 6,420 km/3,466 nm, 5,600 km (3,023 nm) from the original contract with 820 km (423 nm) added via change order in 2016) of geophysical data (chirp sub-bottom, sidescan sonar, swath bathymetry and magnetometer data) and 440 geologic sample sites (consisting of 250 vibracores and 100 surface grab samples from the original order and 90 additional vibracores added via change order in 2016). A breakdown of the planned and as-collected geophysical and geotechnical datasets can be found in Table 1 below.

Table 1: Planned and As-Collected Geophysical and Geotechnical Data for the BOEM ASAP Project

Survey Phase		*Planned/Contracted*			*As-Collected/As-Run*		
		Geophysical (km)	Surface Grab Samples	Vibracores	Geophysical (km)	Surface Grab Samples	Vibracores
2015 Recon Level	Phase 2	4138	100	160	4339	100	160
2016 Design Level	Phase 3	1462	0	90	1857	0	90
2017 Design Level	Phase 4	840	0	90	893	0	90
	Total:	*6440*	*100*	*340*	*7089*	*100*	*340*

The ASAP project was divided into three phases: 1) historic data compilation, data review, stakeholder engagement and data acquisition plan development (2014/2105); 2) reconnaissance-level offshore geophysical and geological sampling investigations (2015); and 3) design-level geophysical and geological sampling investigations (2016). Upon completion of Phases 1, 2, and 3, BOEM awarded APTIM with Phase 4, where an additional 820 line km (422 nm) of geophysical data and 90 vibracores were to be collected along the Atlantic OCS in 2017. As part of this contract, APTIM was tasked with collecting all of the Phase 2, 3 and 4 data, providing raw/unprocessed geophysical data (chirp sub-bottom, sidescan sonar, and magnetometer), processed hydrographic data (swath bathymetry), and processed geologic data to BOEM for distribution to BOEM cooperative agencies for detailed processing and analysis.

During the first phase of the project, APTIM conducted a detailed literature and data search for current and historic geologic data, geophysical data and sand search projects within the investigation area as well as information regarding known potential sand sources. APTIM utilized both internal and external databases (including but not limited to U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), BOEM, United States Army Corps of Engineers (USACE), and various state agencies and academic institutions) to identify areas of potential beach compatible sources along the Atlantic OCS. In addition, APTIM utilized its own database of historic projects (consisting of publicly available and proprietary data) conducted in the different areas of interest to augment the dataset provided by state and federal institutions. All historic geological and geophysical datasets were compiled into a single ArcGIS database project and used to coordinate with individual states on their coastal restoration needs and identify areas that had been historically under-surveyed. The completed geodatabase was the foundation for all field operation planning.

Following the compilation of the available geophysical and geotechnical data into GIS, APTIM and BOEM hosted stakeholder meetings with representatives of all thirteen adjacent states (Maine, New Hampshire, Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia and Florida) including local, state, federal and nongovernmental participants. State representatives were encouraged to present APTIM with their areas of interest and priorities. APTIM was then tasked with assessing the chosen areas based on the original survey parameters stipulated by BOEM for this particular project by developing a detailed data acquisition plan.

APTIM conducted Phase 2 of the project in 2015, which entailed a reconnaissance-level investigation offshore eleven adjacent Atlantic OCS states. APTIM collected more than 4,200 km of geophysical data comprised of chirp sub-bottom, interferometric sonar swath bathymetry, sidescan sonar and magnetometer data. The geologic sampling resulted in the collection of 260 geotechnical samples (160 vibracores and 100 surface grab samples) using a 271B Alpine Pneumatic Vibracore system and a Ponar petite grab sampler. Vibracores and surface grab samples were described, photographed, and sampled for grain size and carbonate content testing. The raw/unprocessed chirp sub-bottom, sidescan sonar, and magnetometer reconnaissance data, together with the processed swath bathymetry and geologic sample analysis results were submitted to BOEM for future use in shore protection projects. In order to develop a detailed design-level investigation plan for 2016 APTIM reviewed the collected data sets to and, together with BOEM, identified potential sand borrow areas for the Phase 3 investigations.

Once the reconnaissance phase was completed in December 2015, APTIM began planning the design phase of the project. BOEM provided APTIM with a prioritized list of design-level investigation areas based on coordination with New York, New Jersey and Delaware stakeholders. Areas were ranked within each state based on need and relative timeframe for sand resource needs. Using the provided guidance, APTIM referenced the reconnaissance sediment analysis results and reconnaissance geophysical data in order to further delineate suitable areas to allocate the planned 1,400 km of geophysical data and 90 vibracores using the previously mentioned geophysical and geotechnical surveying systems. APTIM reviewed the results of the reconnaissance sediment analysis and categorized vibracores as generally favorable, satisfactory or unfavorable based on the general geologic character and percentage of sand, silt, shell and rock within the entire vibracore sample. Color coded sediment vibracores were then plotted onto the acquired reconnaissance chirp sub-bottom data for review. APTIM personnel analyzed the reconnaissance geophysical data to identify features with a geologic signature typical of beach compatible material and/or the presence of a shoaling feature to further delineate the proposed design-level investigation areas. General sediment thickness values were then imported into ArcGIS to assist with the modeling of a potential sand deposit and estimating a total volume that could be available in the different identified areas. From this data analysis and guidance from BOEM, APTIM compiled a 2016 design-level Data Acquisition Plan for three (3) areas offshore New York and two (2) offshore New Jersey, consisting of 30 m spaced geophysical design-level lines in all five (5) areas.

Design-level geophysical data acquisition began on May 29, 2016 and was completed on August 21, 2016 after collecting 1,843 line km of data aboard the *m/v Scarlett Isabella*. APTIM personnel reviewed the acquired design-level geophysical data and extended the previously digitized features in order to properly delineate the potential borrow areas. The preliminary models for potential borrow areas were then updated with the additional thickness data and volume estimates were calculated. Based off the design-level geophysical survey, more than 114,683,200 cubic meters (m^3) (150,000,000 cubic yards (cy)) of potentially beach compatible material within five (5) design-level investigation areas were identified. This volume, however is a preliminary volume of potential resources, resulting from an initial review of design-level geophysical and geotechnical data. These data have not been fully processed or interpreted, and therefore, the overall volume may actually decrease due to environmental, cultural, accessibility, and/or compatibility reasons after detailed processing and a borrow area design process is completed.

From the seismic data review, APTIM's ArcGIS and AutoCad team calculated an estimated total number of vibracores needed for full (305 m/1,000 ft spaced) vibracore coverage required for future borrow area design and permitting. As APTIM only had 90 vibracores available for the design-level survey, the five (5) remaining areas had to be further prioritized, allowing for full vibracore coverage in only two (2) of the five (5) design-level investigation areas. Prior to the collection of the sediment vibracores, geophysical data were submitted for archaeological clearance.

The design-level geologic sampling began on August 9, 2016 and was completed on September 2, 2016. The 2016 phase resulted in full data collection for two (2) complete Design Investigation Areas. Design Investigation Area F1, offshore New Jersey, contains approximately 7,339,700 m^3 (9,600,000 cy) of beach-compatible material while Design Investigation Area Fire Island, offshore New York, contains approximately 16,973,100 m^3 (22,200,000 cy) of beach-compatible material.

Phase 4 of the project consisted of 820 line km (442 nm) of planned design-level geophysical data collection and 90 vibracores. APTIM personnel reviewed the historic database and the reconnaissance dataset in Virginia, Maryland, Delaware, New Jersey and New York to identify additional areas that had a foreseeable need for sand in a coastal restoration project. After presenting the compiled data to BOEM and state representatives, and under BOEM direction, APTIM developed a survey plan for the collection of additional chirp sub-bottom, multibeam bathymetry, sidescan sonar and magnetometer data in Delaware and New Jersey. The geophysical survey operation took place between April 22, 2017 and May 12, 2017. APTIM reviewed the geophysical data in order to identify areas meeting the individual needs of each state for vibracore placement. This review resulted in full design-level vibracore coverage of additional potential borrow areas near borrow area G1 in New Jersey and additional detailed reconnaissance-level vibracores in Delaware. Geotechnical field operations took place from July 8, 2017 to August 3, 2017.

8.0 Scope of Work

The BOEM ASAP project was divided into three phases (historic data review, reconnaissance geophysical and geotechnical data collection, and design-level geophysical and geotechnical data collection), with a fourth phase added for additional design-level geophysical and geotechnical data collection.

Approximately 76% of the original data-collection effort was conducted at a widely-spaced reconnaissance-level effort. At the reconnaissance phase, 4,262 km (2,301 nm) of geophysical data were collected together with 260 geologic sample sites. The remaining 24% of the original Phase 2 and 3 contract were conducted at a design-level effort 1,338 km (722 nm) of geophysical data collection and 90 vibracore samples collected at much more closely spaced coverages to support future borrow-area design. Data allocations were done to maintain a minimum of 40% effort offshore New York and New Jersey as per contract requirements. The remaining state allocations were determined by considering length of coastline, analysis of historic need for sand resources and historic geophysical and geologic data density and quality.

8.1 Historic Data Review and Project Planning (Phase 1)

The first phase of this project consisted of compiling a comprehensive database on available historic geophysical and geotechnical data for states along the Atlantic OCS. This particular step was fundamental for the accurate planning and allocation of available project resources to satisfy the BOEM Hurricane Sandy Recovery Initiative goals and long-term planning goals for the Atlantic OCS states.

Historic datasets were reviewed and considered when drafting the geophysical and geologic reconnaissance plan as to not duplicate any previous relevant effort (Tables 2 and 3). In some cases, geophysical survey lines overlap due to the age or quality of data, and/or suite of systems used. Table 2 depicts the origin of APTIM's historic data from federal databases per state. Table 3 shows the critical data that exist per state (Buczkowski and Kelsey, 2007; Poppe et al., 2014 and Reid, et al., 2005).

Table 2: APTIM's Historic Data Source per State

State	*NOAA*	*USGS*	*State Agency*	*BOEM*	*USACE*	*WHOI*
Maine	X	X		X	X	
New Hampshire	X	X	X	X	X	
Massachusetts	X	X	X	X	X	
Rhode Island	X	X		X	X	
New York	X	X	X	X	X	X
New Jersey	X	X	X	X	X	
Delaware	X	X	X	X	X	
Maryland	X	X	X	X	X	
Virginia	X	X		X	X	
North Carolina	X	X	X	X	X	X
South Carolina	X	X	X	X	X	
Georgia	X	X	X	X	X	
Florida	X	X	X	X	X	X

Table 3: Critical Data per State

	Historic Core Data	*Historic Grab Data*	*Historic Geotechnical Survey Areas*	*Historic Geophysical Tracklines*	*Artificial Reefs*	*Wreck and Obstruction Information*	*Renewable Energy Leasing Areas*	*USACE/EPA Offshore Dredge Material Disposal Site*	*Submarine Cables*	*Habitat Areas of Particular Concern*	*Authorized and Previously Identified Potential Sand Resources*	*Munitions of Explosive Concern*	*Federal Wilderness Areas*	*Federal Land*	*Large Historic Beach Project*	*Critical Habitat*	*BOEM Suggested Geophysical Survey Areas*	*State Offshore Administrative Boundary*	*Aquatic Preserve*	*BOEM Lease Areas*
Maine	X	X		X		X	X	X	X			X		X				X		
New Hampshire	X	X	X	X		X						X		X				X		
Massachusetts	X	X	X		X	X	X	X	X			X	X	X	X	X		X		
Rhode Island	X	X			X	X	X	X	X		X	X		X				X		
New York	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X		
New Jersey	X	X		X	X	X	X	X	X	X	X		X	X	X			X		
Delaware	X	X		X		X	X	X		X	X			X	X			X		
Maryland	X	X	X	X	X	X	X	X			X			X	X			X		
Virginia	X	X		X	X	X	X	X	X	X	X	X		X	X			X		X
North Carolina	X	X		X	X	X	X	X	X	X	X	X	X	X	X			X		X
South Carolina	X	X		X	X	X	X	X		X	X	X	X	X	X			X		X
Georgia	X	X		X	X	X	X	X		X			X	X	X	X		X		
Florida	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X

State coordination meetings were attended by representatives from BOEM, United States Geological Survey (USGS), the USACE, state agencies and stakeholders, and nongovernmental organizations in eligible states along the east coast. A web-based conference was offered in conjunction with the coordination meetings for participants who were unable to attend the meetings in person. It should be noted that the New York coordination meeting was scheduled for January 28, 2015 in Stony Brook, NY; however the meeting was cancelled due to Winter Storm Juno and was held via web conference on January 30, 2015. The table below (Table 4) provides the date of each state coordination meeting.

Table 4: APTIM State Coordination Meetings

State(s)	*Date*
Maine	January 12, 2015
New Hampshire, Massachusetts & Rhode Island	January 13, 2015
New York	January 30, 2015
New Jersey	January 15, 2015
Delaware, Maryland & Virginia	January 8, 2015
North Carolina, South Carolina & Georgia	January 27, 2015
Florida	February 3, 2015

During the state coordination meetings, APTIM demonstrated an understanding of existing geophysical and geologic datasets offshore each state and presented the initial Data Acquisition Plan. The purpose of each meeting was to discuss, coordinate and implement, as best possible, each state's interest for data allocation along its coastline. In addition, the meetings served as an opportunity for APTIM to seek feedback from each stakeholder on existing datasets and upcoming field work in order to avoid duplication of effort. In coordination with BOEM, APTIM determined whether data collection should be reconnaissance in nature or if more detailed, site-specific data collection was needed at each potential location. Information on the general discussion with each state representative and their particular needs and interests are presented in the sections below.

8.1.1 Maine (ME)

APTIM held a state coordination meeting at the Maine Geological Survey in Augusta, Maine. Through state and federal coordination, APTIM discussed the best areas within the project scope to collect reconnaissance geophysical and geologic data. Historic data coverage, historic data quality, upcoming survey work and regional geomorphology was discussed to optimize the placement of reconnaissance geophysical lines, focusing on areas that fall within the project scope. In general, much of Maine was limited by the scope of the investigation, primarily due to water depths deeper than the 30 m (98 ft) threshold. Planned investigation areas were focused in the Kennebunk River paleo-delta within the Kennebunk River Basin and at the mouth of Penobscot

Bay. Focusing on these areas supported and/or complemented future investigations planned by NOAA and the Maine academic communities and would serve to supplement non-BOEM future activities (Kelley, et al., 2007).

During the reconnaissance geophysical survey, Maine representatives became aware that data collection was to begin in Maine during lobster season and a concern was raised by the fishing community as to the placement of the geophysical tracklines and the potential for impacts to fishermen's lobster gear. A conference call was held with Maine representatives, BOEM and APTIM on July 21, 2015 to discuss the geophysical line plan, the Local Notice to Mariners, and to consider mitigation for potential geophysical survey impacts to lobster gear. Although Maine representatives offered to notify local fishermen and to provide a law enforcement vessel to move gear away from planned lines ahead of survey operations, the removal or relocation of lobster gear and potential impacts to the gear from the planned geophysical survey could not be guaranteed. Maine representatives then inquired about the potential for reimbursement for damaged lobster gear from survey activities. BOEM responded that there was no reimbursement protocol for damaged lobster gear due to entanglement with towed geophysical gear. As a result, Maine voluntarily withdrew from the planned survey campaign consisting of 50 planned line km (27 nm) of geophysical data and six (6) geologic sample sites. The 50 planned geophysical line km were reallocated to the 2016 design-level survey effort, the two (2) proposed surface grab samples were allocated to Massachusetts' 2015 geotechnical survey effort, and the four (4) planned vibracores were reallocated for use in 2016 design-level investigations.

8.1.2 New Hampshire (NH)

A total of 50 km (27 nm) of reconnaissance seismic data and five (5) geologic sample sites were originally proposed to be collected in federal OCS waters offshore New Hampshire. Following the state coordination meeting, the allocation was removed due to the fact that none of New Hampshire's OCS fell within the survey area parameters required by BOEM for the project as most of the water depths in the study area region were deeper than the 30 m (98 ft) maximum depth requirement. A small area was identified that fell within the 30 m (98 ft) threshold of the project (with an area of approximately 0.67 square km, located at 42.916° N, 70.705° W). However, based on comments from stakeholder Larry Ward of the Center for Coastal & Ocean Mapping at the University of New Hampshire, this feature is likely a rock outcrop and does not pose significant potential as an eligible sand resource. As such, New Hampshire's allocation was reduced to 0% of the total effort as it lacked significant areas of interest/potential eligible for investigation under the project survey area restrictions.

8.1.3 Massachusetts (MA)

Massachusetts state coordination meeting was held at APTIM's office in Canton, Massachusetts. Historic data coverage, historic data quality, upcoming survey work and regional geomorphology was discussed to optimize the placement of reconnaissance geophysical lines and geologic data through local, state, and federal input. Areas near Plum Island, MA, although generally deeper than the project threshold of 30 m (98 ft), were designated as areas of significant interest to the state stakeholders for geologic sampling to ground-truth existing seismic data. Additionally, the data would provide a new grid of more detailed geophysical data collection slightly further offshore of historic datasets. Southwest of Nantucket was discussed and determined to be of the highest interest for exploration, with additional interest placed within Nantucket sound.

Massachusetts provided five (5) investigation sites with geophysical tracklines and geologic sample requests. The requested sites, from north to south, were 1) Merrimack/Plum Island; 2) South Shore; 3) Northern Nantucket Sound; 4) Western Nantucket Sound; and 5) Muskeget Channel.

Portions of sites one and two (1 and 2), Merrimack/Plum Island and South Shore, fell slightly outside of the 30 m (98 ft) bathymetric contour (between 30 and 35 m (98 and 114 ft)). However, these sites were included based on significant need and confidence of viable sediment resources, as well as communication from one (1) US-flagged dredger that they can dredge sand deposits as deep as 30 m (98 ft).

Massachusetts stakeholder proposed site numbers 3 (Northern Nantucket Sound) and 4 (Western Nantucket Sound) fall within Nantucket Sound. Unfortunately, the environmental assessment (EA) prepared by BOEM for this project explicitly excluded Nantucket Sound from the project area, and as such, APTIM was unable to collect data within Nantucket Sound. To make up for the loss of these study areas, APTIM selected additional areas south of Nantucket (on Old Man Shoal), south of Martha's Vineyard and Nomans Land Island National Wildlife Refuge, and south of Buzzards Bay for reconnaissance geophysical and geologic data collection. These areas all have geologic features of interest and are within regions where future shore-protection projects may be required.

Massachusetts had a significant amount of publicly available data for use in the planning processing, including Ackerman, et al., 2012; Ackerman, et al., 2006; Andrews, et al., 2010; Andrews, et al., 2014; Barnhardt, et al., 2006; Barnhardt, et al., 2009; Barnhardt, et al., 2010a; Barnhardt, et al., 2010b; Barnhardt, et al., 2010c; FitzGerald and Hein, 2009; Grow, et al., 1979; Hein, et al., 2006; Klitgord, 1985; O'Hara, 1975; Oldale and Bick, 1987; Oldale and Rendigs, 1994; Pendleton, et al., 2005; Ruppel, 1984; Sylwester, 1976; and Turecek, et al., 2012.

8.1.4 Rhode Island (RI)

APTIM held Rhode Island's state coordination meeting at APTIM's office in Canton, Massachusetts. APTIM discussed the best areas within the project scope to collect reconnaissance geophysical and geologic data, keeping in mind state and federal interest. Historic data coverage, historic data quality, upcoming survey work and regional geomorphology were discussed. Areas of interest were identified near the MA/RI border, in Block Island Sound, and areas south of Block Island for both geophysical and geologic data collection. Rhode Island stakeholders expressed a strong desire for more geologic sample sites as their historic geophysical data coverage are robust and fairly comprehensive. Geologic sample sites were spread throughout the investigation areas; however a focus was placed within Block Island Sound to groundtruth geophysical data in the area. Publicly available datasets that assisted with Rhode Island planning included McMullen, et al., 2009a and McMullen, et al., 2009b

8.1.5 Connecticut (CT)

Due to the BOEM ASAP project survey boundaries and restrictions and the lack of a Connecticut OCS in federal waters, data collection efforts were not allocated to the state. That said, Connecticut is not precluded from requesting a lease of OCS sand resources offshore Rhode Island, New York, or any other OCS area, and BOEM ASAP data collection efforts did occur on the OCS in federal waters adjacent to Connecticut state waters.

8.1.6 New York (NY)

Although Winter Storm Juno prevented APTIM from conducting a state coordination meeting in person, a conference call and web conference was held to discuss historic geophysical and geologic data, historic data quality, upcoming survey activity and areas of particular interest to both state and federal stakeholders. New York is significantly impacted by competing and existing seafloor uses and infrastructure, making mineral resource area identification difficult. Reconnaissance data collection was planned along most of the Long Island coast where feasible, outside of avoidance areas and cable buffers. Through discussions with state and federal representatives, specific emphasis was placed on expanding USGS Geophysical Survey Areas LI-1, LI-2, LI-3 and LI-4 where sand resources are thought to occur in viable thicknesses. Geophysical data in this area dates to 1996 and 1997 (Foster, Swift and Schwab, 1999). Widely spaced geophysical lines were placed between USGS area LI-3 and LI-4 to investigate potential sand flats.

APTIM acknowledged that the proposed geophysical survey lines and geologic sampling locations east of Montauk Point were adjacent to the Montauk Shoals significant coastal fish and wildlife habitat as designated by New York State in accordance with New York's federally-approved Coastal Management Program. While the lines are indeed adjacent to this area, they do not occur within the designated area. Based on geomorphology the planned reconnaissance-level data were designed to determine the regional potential for sand resources for eastern Long Island in accordance with the mitigation required by the EA.

In addition to the regional reconnaissance-level data collection planned for central and eastern Long Island, the stakeholders expressed an interest in attempting to locate potential resources offshore western Long Island, specifically for projects on the Rockaways which are in substantial need of long-term offshore sand sources. Due to the significant competing uses of the seafloor in this area, potential investigation areas were difficult to identify. That said, with the help and guidance of the New York stakeholders, reconnaissance-level geophysical and geologic data collection was planned in three (3) small areas that appear to have reduced potential for user conflict and potential for sand resources near the western end of Long Island.

New York had a significant amount of publicly available data for use in the planning processing, including Schwab, 1996a; Schwab, 1996b; Schwab, 1998; Schwab and Couch, 1997; and Schwab and Thieler, 1997.

8.1.7 New Jersey (NJ)

APTIM conducted a state coordination meeting at the Department of Environmental Protection in Trenton, New Jersey to discuss historic geophysical and geologic data, historic data quality, upcoming survey activity and areas of particular interest to both state and federal stakeholders. New Jersey has a substantial database of vibracores and good to excellent geophysical data coverage, consisting of approximately 260 vibracores and 3,218 km (1,738 nm) of seismic data collected on both the inner (state) and outer (federal) continental shelf to date. Primarily, the most recent datasets have been collected offshore Ocean County. New Jersey had identified authorized sand resources and borrow areas, some of which are permitted while others are close to design-level status. Areas to collect reconnaissance data were prioritized based on the federal and state coordination.

New Jersey provided proposed geophysical tracklines and geologic sample locations along most of the coast. APTIM used the geophysical tracklines as a baseline for the overall New Jersey reconnaissance data collection effort. Some areas were adjusted due to avoidance areas and cable buffers, while other tracklines were added to fulfill the state’s allocation. Minor data overlap occurred offshore Atlantic City and Ventnor; APTIM discussed this with New Jersey stakeholders and confirmed that re-collection of this dataset would be a benefit to the state. Re-collection of these data will allow comparison of new and old data, and allow APTIM to target two (2) existing deeper offshore borings, as requested by New Jersey stakeholders. In general, New Jersey representatives were interested in advancing historic datasets with APTIM’s new suite of acquisition systems. Most of the suggested geologic sample locations were placed where requested in initial geologic sample placement, while others were distributed to support the broad reconnaissance goals of the project.

USACE representatives expressed an interest to investigate an area offshore Monmouth County between historic datasets. Widely spaced reconnaissance lines were placed in this area to fill a data gap and potentially identify sand resources in features other than sand ridges.

New Jersey had a significant amount of publicly available data including Alpine Ocean Seismic Survey, 1997; Atlantic Wind Connection, 2011; Klitgord, 1976; Klitgord, 1985; McClennen, 1980; Robb, 1978; Smith, 1996; and Uptegrove, et al., 1995.

8.1.8 Delaware (DE)

Delaware has historic vibracores from 2002 and seismic data from 1994. APTIM met with representatives from the State of Delaware at the Maryland Geological Survey in Baltimore, Maryland to discuss historic data coverage, historic data quality, upcoming survey activities and regional geomorphology. The BOEM ASAP planned investigation was focused primarily within the eastern portions of the survey area, from 7 to 9 km to 14 km (4 to 5 nm to 8 nm) offshore, where there is a general lack of data. Delaware's historic data sets have generally good coverage between 5 km to 9 km (3 nm to 5 nm) offshore. Investigation efforts were allocated east of Hen and Chicken Shoal to potentially delineate the distal sand resources further offshore without impacting Hen and Chicken Shoal, which is considered an important environmental resource. In addition, Delaware expressed an interest to collect new data along Fenwick Shoal in southern Delaware. Fenwick Shoal has limited historic data, and appears to be a large sand shoal worthy of additional data collection to assist BOEM and Delaware with defining this large potential sand resource in the future.

Publicly available data assisting with historic data analysis in Delaware included McKenna and Ramsey, 2002 and Ramsey 1994

8.1.9 Maryland (MD)

APTIM met with representatives from the State of Maryland at the Maryland Geological Survey in Baltimore, Maryland to discuss historic data coverage, historic data quality, upcoming survey activities and regional geomorphology. Maryland is well covered with vibracores and historic seismic data from the 1990's and 2000's. In general, the northern coast of Maryland has a high density of historic data, where the southern and central coast does not. As such, the southern and central coasts were the primary focus for data collection.

Maryland provided APTIM with suggested geophysical tracklines and geologic sample locations. The geophysical tracklines and geologic sample locations were included in the Data Acquisition Plan as well as some additional tracklines in areas that were prioritized based on sand potential and state and federal input to fulfill the state's allocation. Some geophysical tracklines had some minor overlap with a recent historic USGS dataset. This USGS dataset was limited to sidescan sonar and swath bathymetry data and did not specifically target sand resources along the Delmarva Peninsula, instead approaching the area from a regional coverage perspective (Pendleton, Ackerman, Baldwin, Danforth, Foster, Thieler, & Brothers, 2015; Pendleton, E.A., Brothers, Thieler, Danforth, & Parker, 2015; Sweeney et al., 2015). In addition, the USGS has detailed coverage in state waters and nearshore federal waters, but much lower-resolution coverage in the offshore portion of the BOEM ASAP study area. As such, APTIM targeted gaps in the USGS data to collect new data, as well as focused datasets on targeted sand ridges within the USGS regional bathymetry and sidescan sonar dataset. APTIM and representatives from the State of Maryland believe it was valuable to collect reconnaissance data along these tracklines to verify and augment existing sidescan sonar and swath bathymetry data and to collect new chirp sub-bottom data.

Publicly available data assisting with historic data analysis in Maryland included Conkwright, et al., 2000; Conkwright and Williams, 1996; Wells, 1994; and Wells and Conkwright, 1996.

8.1.10 Virginia (VA)

APTIM met with representatives from the State of Virginia via conference call and web meeting at the Maryland Geological Survey in Baltimore, Maryland to discuss historic data coverage, historic data quality, upcoming survey activities and regional geomorphology. Two (2) areas of primary concern were identified, one being the regional area offshore Wallops Island and the other offshore Back Bay Wildlife Refuge. Widely spaced geophysical tracklines and geologic data collection efforts were focused in these areas to identify regional sand sources to satisfy state and federal interests. Much like Maryland, some geophysical tracklines have minor overlap with the an historic USGS dataset, with that dataset being limited to sidescan sonar and swath bathymetry data that did not specifically target sand resources along the Delmarva Peninsula. As such, APTIM and representatives from the State of Virginia believed it was valuable to collect additional reconnaissance data along those tracklines to verify historic sidescan sonar and swath bathymetry data. New chirp sub-bottom data was proposed to be collected to help identify regional sand resources in the Wallops Island area, and to develop new additional sand resources in the region offshore Virginia Beach in southern Virginia, where a large historic and future need for offshore sand resources exists. Publicly available data assisting with historic data analysis in Virginia included Berquist and Hobbs, 1988; Hobbs, 1996; and Hobbs, 1997.

8.1.11 North Carolina (NC)

APTIM held a state coordination meeting at the South Carolina Department of Natural Resources in Charleston, South Carolina. Through state and federal coordination, APTIM discussed the best areas within the project scope to collect reconnaissance geophysical and geologic data. Further, a second meeting was held via conference call to discuss and incorporate all stakeholder interests by prioritizing areas on the OCS most beneficial for reconnaissance data allocation. Historic data coverage, historic data quality, upcoming survey work and regional geomorphology were discussed to optimize the placement of reconnaissance geophysical lines. North Carolina is well covered to the north and offshore the Outer Banks, but is lacking vibracores and geophysical data south of Cape Lookout. North Carolina provided suggested geophysical tracklines focusing data collection south of Cape Lookout, consisting of widely spaced reconnaissance tracklines in 5 areas with a single reconnaissance track line generally connecting these areas. The goals of these tracklines and sample locations were to investigate the regional potential for sand resources in areas with limited historic data coverage, while targeting some specific areas offshore federal beach nourishment projects that may require additional sand resources in the future (including offshore Bogue Banks, Topsail Island, Wrightsville Beach, Carolina Beach, Kure Beach, Oak Island, Holden Beach and Ocean Isle Beach). APTIM incorporated these tracklines into the survey plan with minor edits to optimize the states data allocation by reducing line mileage that overlapped project boundaries and ocean dredged material disposal site (ODMDS) placement areas. In addition, APTIM added one (1) geophysical survey line and one (1) geologic sample location offshore northern North Carolina, specifically offshore Corolla. While this area is fully covered by recent historic geophysical data, it is lacking in geologic sample sites. The goal of this line is to provide geophysical data coverage for use in clearing a site for the collection of one (1) geologic sample to groundtruth the historic datasets.

Publicly available data assisting with historic data analysis in North Carolina included Childs, 1975; Thieler, 2001; Thieler, R., 2003; and Thieler, et al., 2013.

8.1.12 South Carolina (SC)

APTIM held a state coordination meeting at the South Carolina Department of Natural Resources in Charleston, South Carolina. Through state and federal coordination, APTIM discussed the best areas within the project scope to collect reconnaissance geophysical and geologic data. South Carolina has relatively good data coverage offshore of Edisto, Folly Island and along the northern coast offshore Myrtle Beach. South Carolina provided APTIM with suggested geophysical trackline and geologic sample suggestions in four (4) specific areas based on need and historic data density; Hilton Head, Folly/Kiawah, Cape Romain; and Long Bay. Reconnaissance data were generally focused to investigate potential sand flats, fill data gaps between historic datasets and expand previously identified borrow areas into federal waters. APTIM included most geophysical and geologic sample locations and made minor adjustments to broaden the areas of investigation keeping in mind federal interests for a broad reconnaissance dataset.

Portions of the geophysical tracklines offshore Folly Beach and Kiawah Island enter munitions of explosive concern (MEC) buffers. These geophysical tracklines were recommended by South Carolina stakeholders because of the pressing need for sand resources in the area. Dependent upon resource quality and quantity, stakeholders may propose to survey the area in more detail during future design and permitting activities to potentially clear the area of MEC. No geologic sample sites were collected within the MEC buffer.

Publicly available data assisting with historic data analysis in South Carolina included Gayes, and Donovan-Ealy, 1995; Gayes, et al., 1998; Schwab, 1999; Schwab and Gayes, 1995; Schwab and Morton, 2000; Van Dolah, et al., 1994; Van Dolah, et al., 1998; and Weight, et al., 1998

8.1.13 Georgia (GA)

APTIM held a state coordination meeting at the South Carolina Department of Natural Resources in Charleston, South Carolina. Through state and federal coordination, APTIM discussed the best areas within the project scope to collect reconnaissance geophysical and geologic data. An area of interest was identified between the northern-end of St. Simons Island to the southern-end of Jekyll Island, where little historic data existed. Broad reconnaissance geophysical tracklines were plotted within this area to investigate potential sand resources. Although some effort was placed offshore Jekyll Island – the largest existing shore protection project in the state – based on comments from the state representative at the state coordination meeting, extensive BOEM survey efforts near Jekyll Island were avoided as a historic sustainable sand source within state waters exists in the area to serve the project. APTIM also added additional geophysical tracklines along bathymetric highs at the northern and southern areas of the state to investigate potential shoal features to satisfy the reconnaissance goals of the BOEM ASAP survey. Publicly available data assisting with historic data analysis in Georgia included Childs, 1976.

8.1.14 Florida (FL)

Florida had a large number of historic seismic lines throughout the state and a significant number of vibracores offshore. APTIM met with representatives from the State of Florida at the Clearwater Beach Marriott in Clearwater, Florida to discuss historic data coverage, historic data quality, upcoming survey activities and regional geomorphology. A large portion of the Florida coast was already mapped by Reconnaissance Offshore Sand Search Inventory (ROSSI) polygons; showing locations of permitted borrow areas and others indicative of planned sediment searches. In order to not duplicate efforts, APTIM avoided data collection within these areas. Data collection was allocated based on need for resources and a general lack of data (Volusia County, southern Brevard and northern Indian River Counties). The USACE suggested investigation of an area offshore Hobe Sound to investigate a potential “sand wedge” of sediment that appears to have been transported off the inner continental shelf and deposited onto a lower shelf within the project boundaries of the BOEM ASAP project.

APTIM did not propose any new geophysical or geologic data collection efforts in the vicinity of Cape Canaveral Shoals. The reason for this is the fact that significant historic data currently exist throughout the entire region within the BOEM ASAP study area boundaries. In addition, there are existing federal sand resource borrow areas (including Canaveral Shoals Borrow Area II) within the region already. Based on these facts, it was decided at the Florida state coordination meeting by all in attendance that no new geophysical or geologic data collection efforts be allocated in the vicinity of Cape Canaveral Shoals as part of the BOEM ASAP project.

Publicly available data assisting with historic data analysis in Florida included Dillon, 1975; Dillon, 1976; Forde, 1997; Forde, 2005; Forde, et al., 2013; Hoenstine, et al., 2002; Popenoe, 1978; and Regional Offshore Sand Source Inventory (ROSSI): Florida Department of Environmental Protection http://rossi.urs-tally.com/Map.

9.0 2015 Reconnaissance-Level Survey (Phase 2)

Approximately 74% of the original planned data-collection effort was conducted at a widely-spaced reconnaissance-level effort across the entire BOEM ASAP study area (4,212 km (2,274 nm) of planned geophysical data collection and 260 geologic sample sites) as part of this reconnaissance effort from April 17, 2015 through December 13, 2015. The reconnaissance geophysical and geotechnical surveys were planned and executed in a manner in which each state along the Atlantic OCS would benefit from additional knowledge on the location and quality of potential sand resources along their coastline. The purpose of the survey was to provide individual states and agencies with a preliminary dataset which they could use for future beach restoration projects. A breakdown of each state's final data allocation can be found in Table 5 below.

Table 5: Planned Reconnaissance Data Allocation per State

State	*Geophysical*		*Geologic Sample Sites*	
	km	*%*	*Number*	*%*
Maine	0	0.00%	0	0.00%
New Hampshire	0	0.00%	0	0.00%
Massachusetts	210	4.99%	14	5.38%
Rhode Island	50	1.19%	10	3.85%
New York	736	17.47%	49	18.85%
New Jersey	950	22.55%	52	20.00%
Delaware	200	4.75%	8	3.08%
Maryland	100	2.37%	8	3.08%
Virginia	200	4.75%	10	3.85%
North Carolina	586	13.91%	37	14.23%
South Carolina	475	11.28%	30	11.54%
Georgia	200	4.75%	12	4.62%
Florida	505	11.99%	30	11.54%
Total	*4,212*	*100.00%*	*260*	*100.00%*

9.1 Systems, Equipment, Operations and Methods

As-run reconnaissance-level geophysical data collection resulted in 4,339 km (2,342 nm) of geophysical data (chirp sub-bottom, sidescan sonar, magnetometer and swath bathymetry) acquired along the Atlantic OCS from Massachusetts to Florida. Line directions throughout the Atlantic OCS varied based on the nature of the deposit being surveyed. Generally, lines were placed in order to maximize deposit coverage while also taking into account the most efficient survey plan and minimizing the amount of time lost during turns. The vessel maintained speeds from 3.5 to 4.5 knots during survey operations with the goal of 4 knot for optimal data collection. Variations in vessel speed were based upon wind and sea conditions.

The geophysical survey vessel and systems APTIM used are described in detail below.

9.1.1 Geophysical Survey Equipment

9.1.1.1 Vessels

The majority of the geophysical survey operations were conducted on the *m/v Atlantic Surveyor* operated by Divemasters Inc. The *m/v Atlantic Surveyor* (vessel diagram in Appendix A) is a 33.5 m (110 ft) steel-hulled vessel with a 2.7 m (9 ft) draft. (Figure 1). The vessel is equipped with twin Detroit V1671 engines, a fuel capacity of 16,850 gallons, and three (3) generators. The vessel can accommodate up to 12 members of the scientific crew (in addition to four (4) vessel crew) and has a potable water capacity of 6,000 gallons. The vessel has a clear deck area of 17 by 7.5 m (56 by 24.6 ft) that houses a portable office module for survey equipment setup and operation. The vessel also has a 20,000 pound, telescopic, stern-mounted A-frame and various deck winches to assist with geophysical survey equipment deployment and retrieval.

For the geophysical and bathymetric investigations conducted for the BOEM ASAP project, the *m/v Atlantic Surveyor* was set up with an additional winch with a coaxial cable used for towing the sidescan sonar and magnetometer. The winch cable for both the chirp sub-bottom and sidescan sonar/magnetometer systems were run through a block secured to the A-Frame which was used for the daily deployment and retrieval of geophysical systems. Additionally an adjustable pole-mount was attached to the starboard side of the vessel for the bathymetric system. When the vessel returned to dock, the pole mount was raised and secured and once back offshore, lowered to its original position.

Figure 1: Divemasters Inc.'s *m/v Atlantic Surveyor*

During execution of the reconnaissance data collection effort, APTIM was notified that the vessel *m/v Atlantic Surveyor* would not be available for survey operations after July 15th, 2015 due to a required out-of-water biennial US Coast Guard inspection and recertification. Since it was unknown how long it would take for the *m/v Atlantic Surveyor* to be recertified, APTIM arranged for a vessel switch in Point Pleasant, New Jersey. APTIM demobilized the *m/v Atlantic Surveyor* July 13 through 15, 2015, and remobilized all geophysical survey equipment onto the *m/v Northstar Commander* July 16 and 17, 2015. Geophysical data acquisition began shortly after the vessel switch on July 19, 2015.

The *m/v Northstar Commander* (vessel diagram in Appendix A) is a 28 m (92 ft) long research vessel equipped with twin screw Volvo D125-E 450 hp motors (Figure 2). It has the capacity to accommodate 12 personnel, fuel capacity of 10,000 gallons and a water capacity of 2,900 gallons. In addition, the *m/v Northstar Commander* also has a 35 ton winch which was used for the deployment and retrieval of the chirp sub-bottom, a mounted 5 m (16.4 ft) A-frame which was used for the sidescan sonar/magnetometer deployment and towing and a pole mount that was used for the combined swath bathymetry and sonar. The deck was equipped with a deck office container where all geophysical systems were monitored by APTIM personnel.

Figure 2: Northstar Marine's *m/v Northstar Commander*

9.1.1.2 Navigation

A C-Nav 3050 differential global navigation satellite system (GNSS), owned and operated by APTIM, provided vessel navigation and horizontal positioning for all geophysical and geologic data acquisition (Figure 3). The C-Nav 3050 is an augmented GNSS system using proprietary dual frequency satellite corrections (C-NavC1/C-NavC2). The corrections are based on a global network of tracking stations. Each station has a minimum of two (2) active receivers with quality controlled feedback loops. Each satellite typically tracks seven (7) stations. The corrections are also fed directly to two (2) independent control centers that constantly monitor and maintain data quality for a precise GNSS solution. The manufacturer advertises that the system has a specified horizontal accuracy of 5 to 10 centimeters (cm) (2 to 3.9 inches) and vertical accuracy of 10 to 15 cm (3.9 to 5.9 inches) when receiving corrections in 'Real Time Gypsy" (RTG) mode. All data were collected using Hypack software and then integrated with individual data acquisition systems. Position data were logged as a *.raw* Hypack file.

Figure 3: Image showing a C-Nav 3050 GNSS receiver

9.1.1.3 Hypack

Hypack is a state-of-the-art navigation and hydrographic surveying system. Navigation, motion reference unit, magnetometer, and all depth sounder systems were interfaced with an onboard computer, and the data integrated in real time using Hypack Inc.'s Hypack 2015 software. Locations of the tow points on the vessel for each towed instrument in relation to the primary GNSS antenna and the length of cable between the tow point and each towed instrument was measured and entered into Hypack. The real time position of each towed instrument was calculated using the aforementioned values and a catenary factor specific to each systems towing attitude, and displayed in real time through Hypack and monitored by APTIM scientists. Online screen graphic displays included the pre-plotted survey lines, the updated vessel track across the survey area, adjustable left/right indicator, as well as other positioning information such as vessel speed and line bearing. The main navigation screen was replicated at the vessel's helm and used by the captain for navigation. The digital data were merged with positioning data (C-Nav), video displayed and recorded to each of the individual acquisition computers. Data were collected in Universal Transverse Mercator (UTM) meters. Each acquisition system parsed the corrected navigation string from Hypack to the incoming data; therefore all raw data were layback corrected.

9.1.1.4 Motion Reference Unit

An Applanix position orientation system (POS) MV 320 E GNSS system was used for reconnaissance-level data collection. The system was mounted to the survey vessel and used to collect attitude, heading, heave, position and velocity data of the survey vessel (Figure 4). The Applanix POS MV family is an inertially aided motion unit that provides highly accurate attitude corrections. The POS MV works by combining GNSS data with inertial measurement unit (IMU) angular rate and acceleration and GNSS Azimuth Measurement System (GAMS). GAMS calibration is required to calculate the misalignment of the inertial navigator to the heading produced from GAMS. Calibration is performed through careful physical measurement of system components and aggressive maneuvering of the survey vessel to reduce the dynamic heading alignment below one (1) degree (approximately) and subsequently calculate the misalignment with the GAMS heading. Motion data were logged (embedded within the *.raw* Hypack file) and integrated into all applicable systems. Raw attitude and GNSS data were also logged into Applanix file formats.

Figure 4: Applanix POS MV motion and attitude system

9.1.1.5 Combined Swath Bathymetry and Sonar

APTIM employed an EdgeTech 6205, fully integrated swath bathymetry and dual frequency sidescan sonar system, for the swath hydrographic and seafloor backscatter data collection (Figure 5). This system's configuration includes an over-the side vessel pole mount, sound velocity sensor at the sonar head, and is easily integrated with standard motion reference units, sound velocity profilers, and altimeters. Sound velocity profiles were taken at the beginning and end of each day and throughout the survey day via an underway sound velocity (SV) system as needed to adjust for changes in sound velocity in the water column. The 6205 uses ten (10) receive elements and one (1) discrete transmit element in a pair of transducer heads. The high number of channels enables enhanced rejection of multi-path effects as well as reverberation and acoustic noise. The swath of the bathymetry data can be either 350 m (1,148 ft) or 150 m (492 ft) and have a range resolution of 1 cm at 550 kilohertz (kHz). The maximum useable swath of the bathymetry is based on water depth and was monitored by APTIM scientists. In an effort to collect the maximum amount of data, the range was set to 150 m (492 ft) at 550 kHz. The quality of the bathymetric data decreases as the range increases and therefore data collection was limited to an approximate maximum of 8 to 10 times the water depth (less in areas where strong thermoclines were present). The bathymetric processor within the EdgeTech Discover software binned the data based on a user defined cell size related to range. The equal spacing binning method was utilized for this survey considering the relatively low relief of the targeted survey areas. The binned data were recorded into Hysweep as *.hsx* (Hysweep file) format.

Figure 5: Image of the EdgeTech 6205 fully integrated swath bathymetry and dual frequency sidescan sonar system

EdgeTech 6205 sidescan sonar swath coverage can be 250 m (820 ft) or 70 m (229 ft) with a range resolution of 1 cm (0.4 in) and 0.6 cm (0.2 in) in 550 and 1,600 kHz respectively. Sonar settings were monitored and adjusted in real-time to use optimal settings for environmental, oceanographic and geologic conditions in order to maximize data quality and coverage. Sidescan sonar data were recorded to *.jsf* files. It should be noted that the sonar data from the combined swath bathymetry and sonar system were collected as secondary data to APTIM's standalone towed sidescan sonar system (described later in this section).

The EdgeTech 6205 was fully integrated with the Applanix POS MV motion reference unit to correct swath bathymetry data for vessel motion. Navigation and horizontal positioning for the EdgeTech 6205 combined sonar system was provided by the C-Nav GNSS system, with the motion data provided by the Applanix POS MV system, both via Hypack. Bathymetry data were recorded in *.hsx* files and *.raw* (Hysweep/Hypack file) format.

Prior to the start of bathymetric data collection, a dual head patch test was required for the EdgeTech 6205 to precisely measure system misalignments in relation to the vessel's reference frame. Patch tests were conducted each time the pole mount was adjusted, retrieved for port calls, deployed, and as necessary for quality assurance and quality control (QA/QC) procedures. Offsets were calculated for latency, roll, pitch and yaw. In brief, a patch test is performed by collecting three (3) parallel survey lines perpendicular to a slope (or object) on the seafloor in a specific reciprocal pattern to account for Latency, Pitch, and Yaw biases. Three (3) additional survey lines are collected over flat bottom to account for roll bias. Survey lines are spaced three (3) to four (4) times the water depth to allow for sufficient overlap of swaths. The collected patch test data were loaded into Hysweep editor and processed using the Patch Test utility. Patch test trials were averaged and embedded within all processed sonar files. Patch test bias values varied between survey vessels as presented in table 6 below.

Table 6: Patch Test Bias Results for Phase 2

m/v Atlantic Surveyor				
	Roll	Latency	Pitch	Yaw
Head 1	1.40°	0.00	1.50°	1.00°
Head 2	1.45°	0.00	1.50°	1.00°
m/v Northstar Commander				
	Roll	Latency	Pitch	Yaw
Head 1	2.15°	0.00	2.00°	1.00°
Head 2	2.35°	0.00	2.00°	1.00°

9.1.1.6 Sub-bottom Profiler

An EdgeTech 3200 sub-bottom profiler with a 512i towfish was used to collect high-resolution seismic-reflection profile data. This system is a versatile wideband frequency modulated (FM) sub-bottom profiler that collects digital normal incidence reflection data over many frequency ranges within the 0.5 to 12 kHz range, also called a chirp pulse. This instrumentation generates cross-sectional images of the seabed capable of resolving bed separation resolutions of 0.06 to 0.10 m (depending on selected pulse/ping rate). The tapered waveform spectrum results in images that have virtually constant resolution with depth (Figure 6). The data were collected and recorded in the systems native, EdgeTech *.jsf* format. The seismic system was monitored and adjusted, if needed, in real-time to use the optimal settings for environmental, oceanographic and geologic conditions in order to ensure collection of the highest quality data. Navigation and horizontal positioning for the sub-bottom system were provided by the C-Nav GNSS system via Hypack utilizing the Hypack towfish layback correction.

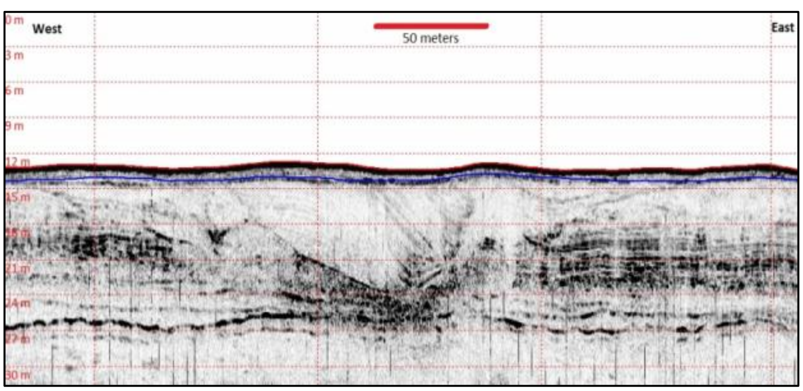


Figure 6: EdgeTech 3200 data example from the Atlantic OCS offshore Maryland in approximately 12.8 m (42 ft) of water depth

9.1.1.7 Magnetometer

A Geometrics G-882 Digital Cesium Marine Magnetometer was used to perform a cursory investigation of the magnetic anomalies within the study area (Figure 7). The magnetometer is run on 110 or 220 volts alternating current (VAC) power and capable of detecting and aiding the identification of any ferrous, ferric or other objects that may have a distinct magnetic signature. Factory set scale and sensitivity settings were used for data collection (0.004 nT/ πHz rms [nT = nanotesla or gamma]. APTIM typically used a 0.02 nT P-P [P-P = peak to peak] at 0.1 second sample rate (or 0.002 nT at 1 second sample rate). Sample frequency is factory-set at up to 10 samples per second. The magnetometer was towed in tandem with the primary sidescan sonar system (EdgeTech 4200-HFL) at an altitude of no greater than 6 m (19.7 ft) above the seafloor, per BOEM regulations, and far enough from the vessel to minimize vessel interference due to the system's high sensitivity. The tandem systems were attached to a marine grade hydraulic winch to adjust for changes in the seafloor and maintain an altitude of no greater than 6 m above the seafloor. Navigation and horizontal positioning for the magnetometer were provided by the C-Nav GNSS system via Hypack utilizing the Hypack towfish layback correction. Magnetometer data were recorded in *.raw* Hypack file format.

The purpose of the magnetometer survey was to establish the preliminary presence and location of any potential underwater wrecks, cultural resources, submerged hazards, or any other features that would affect vibracore activities. The data were reviewed by a qualified marine archaeologist to clear potential vibracore sites.

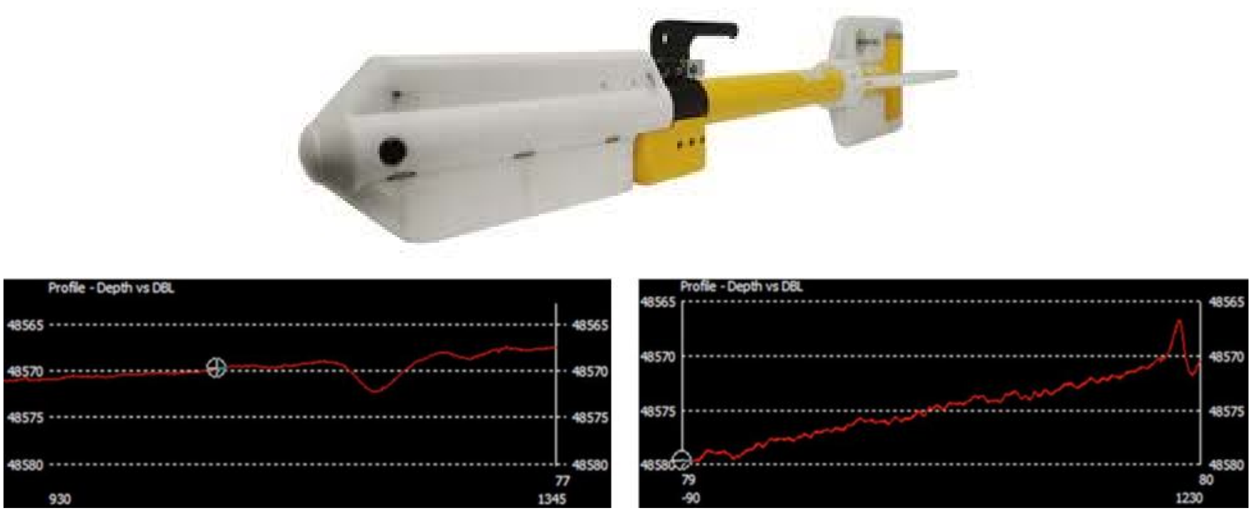


Figure 7: Geometrics G882 magnetometer (top) and magnetometer data examples (bottom) from the Maryland Outer Continental Shelf in approximately 20 m of water depth showing small magnitude multicomponent target (left) and small magnitude dipolar target (right)

9.1.1.8 Sidescan Sonar System

As the aforementioned EdgeTech 6205 was pole mounted, resulting in potential vessel motion and thermocline impacts to the backscatter data, APTIM collected additional sidescan sonar data from an independently towed system ensuring the collection of a quality dataset.

Figure 8: Image of the EdgeTech 4200 sidescan sonar towfish

APTIM employed an EdgeTech 4200-HFL sidescan sonar system which uses full spectrum chirp technology to deliver wide-band, high energy pulses coupled with high resolution and superb signal to noise ratio echo data (Figure 8). The portable sidescan sonar package includes a laptop computer running the Discover® acquisition software and a 300/600 kHz dual frequency towfish running in high definition mode. At 300 kHz the maximum range scale is 150 m (492 ft) and at 600 kHz the maximum range scale is 100 m (328 ft). The sensor was towed from a marine grade hydraulic winch in order to adjust for changes in the seafloor and maintain an altitude that is 10 to 20% of the range of the instrument, per BOEM guidelines. The frequencies of this system are sufficiently capable of identifying seafloor objects and features of at least 1 m (3.28 ft) in diameter. The sidescan sonar system was monitored and adjusted, if needed, in real-time to use the optimal settings for environmental, oceanographic and geologic conditions in order to maximize data quality and coverage to ensure collection of the highest quality data. Navigation and horizontal positioning for the sidescan sonar system were provided by the C-Nav GNSS system via Hypack utilizing the Hypack towfish layback correction. Sidescan sonar data were collected and recorded in the systems native, EdgeTech *.jsf* format.

9.1.2 Geotechnical Survey Equipment

Reconnaissance-level geotechnical data collection consisted of 260 geologic sample sites (160 vibracores and 100 surface grab samples) acquired along the Atlantic OCS from Massachusetts to Florida. The geotechnical survey vessel and systems APTIM used are described in detail below.

9.1.2.1 Survey Vessel

American Vibracore Service's (AVS) *m/v Thunderforce*, served as the vibracore and surface grab sample collection platform (Figure 9 and 10). Built in 1980, the *m/v Thunderforce* is a 33.5 m (110 ft) steel-hulled vessel with a draft of 2.1 m (6.8 ft) (vessel diagram in Appendix A). The vessel has a gross tonnage of 98 tons and is equipped with twin Detroit 780 horsepower diesel engines, a fuel capacity of 9,000 gallons and two (2), 30 kW Delco generators.

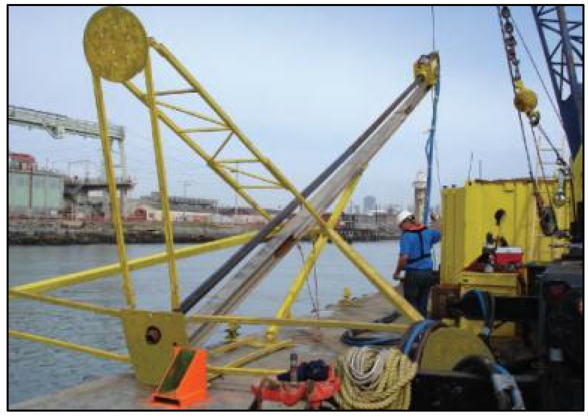


Figure 9 (left): AVS' *m/v Thunderforce* and Figure 10 (right): 271B Pneumatic Vibracore

9.1.2.2 Surface Grab Samples

APTIM utilized a Ponar petite grab sampler for collection of unconsolidated surface samples. The Ponar was lowered by hand over the side to the seafloor at predetermined and precleared sample locations while live boating. Live boating refers to the fact that no anchoring was conducted during the investigation to prevent damage to seafloor environmental or cultural resources, the vessel stayed onsite by adjusting engine power and steering only. Samples were collected within 15.24 m (50 ft) of precleared sample locations. Once near the seafloor, the Ponar was allowed to free fall, triggering the sampling device to penetrate and close below the seafloor, collecting a surface sediment sample. The Ponar was then retrieved to the deck of the vessel, and the sample was collected in secure sample bags. If enough sample was not retained to fill the entire sample bag, a secondary attempt (and so on) was conducted so that enough material was obtained to fill the sample bag. Once a full sample was obtained the bag was labeled and stored for transport back to APTIM's geotechnical laboratory for visual description, photographing and sediment analysis (described later in this document). In some cases, multiple attempts were conducted at one sample site.

9.1.2.3 Vibracore

APTIM and AVS utilized a 271B pneumatic vibracore, owned and operated by AVS, configured to collect undisturbed sediment vibracores up to 6.09 m (20 ft) in length (Figure 10). The self-contained, free-standing pneumatic vibracore unit contains an air-driven vibratory hammer assembly, an aluminum H-beam, which acts as the vertical beam upright on the seafloor, 6.09 m (20 ft) long steel tubes measuring 10.16 cm (4 in) in diameter, with a plastic vibracore liner and a drilling bit with a cutting edge. An air hose array provided compressed air from the compressor on deck to drive the vibracore. The vibracore unit was winch and A-Frame deployed and retrieved from the *m/v Thunderforce*.

The minimum recovery at each vibracore sample location was required to be 80% of the expected penetration though the unconsolidated strata through which it had penetrated. The total length recovery was measured and compared to the measured depth of penetration to calculate percent recovery. Penetration was determined with the use of a penetrometer and chart recorder. Depth of penetration beneath the surface of the bottom was known to within plus or minus 15.2 cm (0.5 ft) of actual penetration. The desired depth of penetration was 6.09 m (20 ft). However, that maximum penetration was not achieved at all sample locations. Penetration refusal occurred when less than 30.5 cm (1 ft) of advance was accomplished after 5 minutes of vibration. When refusal was met at less than 80% of the desired depth of penetration, AVS removed the sampled portion and a new vibracore pipe was prepared. A jet pump hose was attached to the top of the vibracore pipe just below the vibrator. The rig was lowered to the bottom and jetted down to a depth 0.6 m (2 ft) above where the first attempt met refusal. The jet was then turned off and the vibrator turned on, taking the additional part of the vibracore and 0.6 m (2 ft) of overlap. Retries were attempted until penetration reached refusal or until three (3) total tries had been attempted, whichever occurred first. In some cases, as an alternative to jetting the second attempt, APTIM and AVS elected to try and collect a full 6.09 m (20 ft) vibracore (without jetting).

9.2 Mitigation

BOEM prepared an EA to describe and evaluate the potential environmental impacts related to reasonably foreseeable Geological & Geophysical (G&G) survey activities associated with this effort. Similarly, BOEM consulted with relevant federal and state resource agencies to address other environmental requirements. As a result of the environmental review process, mitigation measures were identified that were incorporated into the Data Acquisition Plan to avoid or reduce adverse environmental impacts. The mitigation measures and reporting requirements can be found in the Final EA, which can be viewed at https://www.boem.gov/Disaster-and-Revoery-Initiatives-Atlantic-Coast/ under “Hurricane Sandy Rebuilding Initiatives.” APTIM complied with all Mitigation Measures applicable to the proposed activities, which include the implementation of:

- Time-area restrictions for geophysical surveys
- A geophysical survey protocol
- A vibracore sampling protocol
- Nighttime surveying and passive acoustic monitoring protocol
- A vessel strike avoidance protocol
- Historic and pre-contact site avoidance and reporting requirements
- Sensitive benthic habitat and communities avoidance requirements
- Marine pollution control plan
- Marine debris awareness program
- Navigational and commercial fisheries conflicts minimization requirements.

9.2.1 Time-Area Restrictions for Geophysical Surveys to Avoid North Atlantic Right Whales

Geophysical surveys were scheduled and conducted to the maximum extent practicable so that no active acoustic sources operating below 30 kHz (a conservative estimate of the upper hearing threshold for North Atlantic right whales) were used in the northeast critical habitat and northeast Seasonal Management Areas (SMAs, including Great South Channel, April 1 through July 31; Off Race Point, March 1 through April 30), mid-Atlantic SMAs (November 1 through April 30), and southeast critical habitat and southeast SMAs (November 15 through April 15). All operations in these areas during the specified times occurred during daylight hours.

If, during the course of a geophysical survey, a dynamic management area (DMA) was established, use of all sound sources operating below 30 kHz in that DMA were discontinued within 24 hours of its establishment. Any geophysical surveys in proximity of DMA boundaries remained at a distance such that received levels for all sound sources at these boundaries were no more than 160 dB re 1 µPa rms.

9.2.2 Geophysical Survey Protocol

Only electromechanical sources were used during geophysical surveys. Electromechanical sources are limited to boomer and chirp sub-bottom profilers, side-scan sonars, and single beam, interferometric, or multibeam depth sounders. The minimum number of geophysical sources possible was used to obtain the necessary geophysical data. APTIM used a chirp sub-bottom profiler, sidescan sonar and multibeam depth sounder to acquire geophysical data.

Besides noise introduced by the survey vessel, only the EdgeTech 3200 512i chirp sub-bottom profiler operated at frequencies below 180 kHz, which is the upper hearing threshold for cetaceans. Source levels for the sub-bottom profiler did not exceed 220 dB re 1 µPa and operated at the lowest power setting, narrowest beam width, and highest frequency possible to fulfill data needs and to effectively reduce exposure and received levels. Consistent with recent sound source verification studies on these active sources, threshold radii to 160 dB re 1 µPa were significantly less than 100 m (328 ft) because of the beam pattern characteristics and downward directivity. Moreover, the chirp towfish was towed as close to the seafloor as possible to further reduce the zone of ensonification.

Protocol requirements included:

1. An acoustic exclusion zone was monitored during the use of the sub-bottom profiler sound source operating below 180 kHz. The acoustic exclusion zone was a 100 m (328 ft) radius zone around the sound source. Accounting for differences in the source levels, operational

frequency, and deployment mode, this 100 m (328 ft) exclusion zone encompassed the 160 dB Level B harassment zone.

2. For geophysical surveys using sound sources operating at frequencies below 180 kHz, operations were monitored by a trained Protected Specie Observer (PSO). At least one (1) PSO was aboard the survey vessels at all times during daylight hours (dawn to dusk – i.e., from about 30 minutes before sunrise to 30 minutes after sunset) when survey operations were being conducted, including during conditions (e.g., fog, rain, darkness) that adversely affect the effectiveness of sea surface observations. If conditions deteriorated during daylight hours such that the observations were not possible, visual observations resumed as soon as conditions permitted. Ongoing activities continued, but were not to be initiated under such conditions (i.e., without appropriate pre-activity monitoring).

3. Visual monitoring of acoustic exclusion zones was conducted by searching the area around the vessel using hand-held reticle binoculars and the unaided eye to observe and document the presence and behavior of marine mammals and sea turtles. PSO's were crew members trained as observers. PSO's were solely dedicated to perform visual observer duties. PSO's operated under the following guidelines:
    a. Other than brief alerts to make personnel aware of maritime hazards, no additional duties were assigned to observers during their watch.
    b. A watch was no longer than six (6) continuous hours. Consequently, at least two (2) PSO's were onboard vessels to monitor the acoustic exclusion zone when daily survey activities exceeded six (6) hours.
    c. A break of at least two (2) hours occurred between 6-hour watches, no other duties were assigned during this period.

4. When operating during reduced visibility, observers monitored the waters around the acoustic exclusion zone using shipboard lighting. APTIM did not conduct nighttime operations of sound sources operating at frequencies below 180 kHz.

5. Start-up and shut-down requirements:
    a. The acoustic exclusion zone for sound sources operating below 180 kHz was monitored for all marine mammals and sea turtles for no less than 30 minutes prior to start-up and continued until operations ceased. Immediate shutdown of the sound source occurred if any non-delphinid cetacean was detected entering or within the acoustic exclusion zone. Immediate shutdown of the sound source occurred if any sea turtle was detected entering or within the acoustic exclusion zone provided the source was operating below 2 kHz. Subsequent restart of the equipment only

occurred following a confirmation that the exclusion zone was clear of all marine mammals and sea turtles for 30 minutes.

6. Shutdown of sound sources operating below 180 kHz was not required for delphinids approaching the vessel (or vessel's towed equipment) that indicated a "voluntary approach" on behalf of the animal. A "voluntary approach" was defined as a clear approach toward the vessel by the animal(s) with a vector that indicates that it is approaching the vessel and remains near the vessel or towed equipment. The intent of the animal(s) was subject to the determination of the PSO. If the PSO determined that the animal(s) was actively trying to avoid the vessel or the towed equipment, the acoustic sources were immediately shutdown. The PSO recorded the details of any non-shutdowns in the presence of a delphinid, including the distance of the animal(s) from the vessel at the first sighting, heading, position relative to the vessel, duration of sighting, and behavior.

7. Data on all marine mammal and sea turtle observations were recorded by the observer based on standard observer data collection protocols. This information included the following:
    a. Vessel name;
    b. Observers' names, affiliations, and resumes;
    c. Date;
    d. Time and latitude/longitude when daily visual survey began;
    e. Time and latitude/longitude when daily visual survey ended; and
    f. Average environmental conditions during visual surveys including:
        i. Wind speed and direction;
        ii. Sea state (glassy, slight, choppy, rough, or Beaufort scale);
        iii. Swell (low, medium, high, or swell height in meters); and,
        iv. Overall visibility (poor, moderate, good).
    g. Species (or identification to lowest possible taxonomic level);
    h. Certainty of identification (sure, most likely, best guess);
    i. Total number of animals;
    j. Number of calves and juveniles (if applicable/distinguishable);
    k. Description (as many distinguishing features as possible of each individual seen, including length, shape, color and pattern, scars or vessel when sighting occurred.
    l. Whether or not a shutdown was required, marks, shape and size of dorsal fin, shape of head, and blow characteristics);
    m. Direction of animal's travel relative to the vessel (drawing preferably);
    n. Behavior (as explicit and detailed as possible; note any observed changes in behavior);

o. Activity of requested/completed.

8. APTIM prepared a monthly report (attached Appendix C) for BOEM that summarized the survey activities and an estimate of the number of listed marine mammals, sea turtles, and any other protected species observed during these survey activities.

9.2.3 Vibracore Sampling Protocol

Only vibracorers were used to sample near-surface sediments during the geologic survey. The vibratory mechanism on the vibracore was the primary source of underwater sound during geologic sampling operations in addition to broadband noise from the vessel. The vibrating head was not operated until the vibracore platform made contact with the seabed and the vibracore barrel made contact with the seafloor. The vibrahead was not operated when the vibracore platform was being retrieved. Visual monitoring of an acoustic exclusion zone of 100 m (328 ft), consistent with the geophysical protocol, was implemented. The same startup and shutdown requirements, consistent with the geophysical protocol, were implemented when marine mammals and sea turtles were observed approaching or within the acoustic exclusion zone.

9.2.4 Nighttime Geophysical Surveys and Passive Acoustic Monitoring Protocol

APTIM only utilized sound sources operating below 180 kHz during daylight hours and under PSO observation. APTIM did not utilize any sound sources operating below 180 kHz during the nighttime.

9.2.5 Vessel Strike Avoidance Protocol

APTIM and subcontractors providing vessel services, regardless of host vessel size, complied with the following requirements:

1. Vessel operators, crews, and visual observers or PSO’s maintained a vigilant watch for marine mammals, sea turtles, and smalltooth sawfish, and slowed or stopped the vessel (regardless of vessel size) to avoid striking protected species. A visual observer aboard all survey vessels monitored an area around a transiting survey vessel, the vessel strike exclusion zone, to ensure it is free of marine mammals, sea turtles, and smalltooth sawfish. At least one (1) observer was aboard all vessels. In addition, vessel operators complied with National Marine Fisheries Service (NMFS) marine mammal and sea turtle viewing guidelines for the Northeast Region or the Southeast Region.

2. Marine mammals and sea turtles may surface in unpredictable locations or approach slowly moving vessels. When marine mammals or sea turtles were sighted in the vessel’s path or in close proximity to a moving vessel regardless of vessel size, vessel operators reduced

speed and shifted the engine to neutral. Engines were not re-engaged until the animals were clear of the exclusion area specified below.

3. In accordance with NMFS Compliance Guide for the Right Whale Ship Strike Reduction Rule (50 CFR 224.105 and 78 FR 73726–73736), when safety allows, vessels, regardless of size, transited within the 10-knot (18.5-km/h) speed restriction in DMA's, Northeast critical habitat and SMAs (Great South Channel, April 1 through July 31 Off Race Point, March 1 through April 30), mid-Atlantic SMA's (November 1 through April 30), and critical habitat and southeast SMA's (November 15 through April 15). When safety permitted, vessel speeds were also reduced to 10 knots (18.5 km/h) or less when mother/calf pairs, pods, or large assemblages of right whales were observed near a transiting vessel. A single animal at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures were exercised when an animal was observed. Mandatory reductions in speed also limited continuous noise levels related to propeller cavitation and hull-wave interaction.

4. When North Atlantic right whales were sighted at any time during the year, vessels, regardless of size, maintained a minimum separation distance of 500 m (1,640 ft). The following avoidance measures were taken if a vessel came within 500 m (1,640 ft) of a right whale:
    a. While underway, the vessel operator steered a course away from the right whale at 18.5 km/h (10 knots) or less until the minimum separation distance had been established.
    b. If a right whale was spotted in the path of a vessel or within 100 m (328 ft) of a vessel underway, the operator reduce speed and shifted engines to neutral. The operator only re-engaged engines after the right whale had moved out of the path of the vessel and was more than 100 m (328 ft) away. If the right whale was still within 500 m (1,640 ft) of the vessel, the vessel selected a course away from the whale's course at a speed of 18.5 km/h (10 knots) or less. This procedure was also followed if a right whale was spotted while a vessel is stationary. Whenever possible the vessel remained parallel to the whale's course while transiting, avoiding abrupt changes in direction until it had left the area.

5. Vessels regardless of size maintained a minimum separation distance of 100 m (328 ft) year-round if whales other than right whales, seals, or manatees were sighted. The survey complied with other relevant manatee construction conditions when operating within the species' range. All vessels followed routes of deep water whenever possible. Year-round, vessels, regardless of size, maintained a distance of 50 m (164 ft) or greater from delphinid

cetaceans. If encountered during transit, the vessel attempted to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

6. All vessels, regardless of size, maintained a distance of 50 m (164 ft) or greater if sea turtles or smalltooth sawfish were sighted, whenever possible. The survey complied with other relevant smalltooth sawfish construction conditions when operating within the species range. Nighttime geophysical activities were not conducted.

7. Sightings of any injured or dead protected species were reported to BOEM and NMFS or U.S. Fish and Wildlife Service (FWS) within 24 hours, regardless of whether the injury or death was caused by their vessel.

9.2.6 Historic and Pre-contact Sites Avoidance and Reporting Requirements

The project limited vibracore sampling to near-surface sand deposits with a maximum seafloor disturbance footprint of less than 2 m^2 (21.5 ft^2) for each sample. The sampling duration for a 6.09 m (20 ft), 7.6 to 10.1 cm (3 to 4 in) diameter vibracore is typically less than 15 minutes in place. Samples were being collected to characterize sand resources and were not expressly for archaeological interest or identification. The sediment targeted was generally limited to near-surface sands rather than other geologic deposits, such as finer-grained material typical to near-surface or exposed Holocene and Pleistocene back-barrier deposits (where potentially intact cultural layers may be preserved). Those other geologic units were not the target for sampling and or potential subsequent use. Any penetration below the surface sand layer was incidental and limited in nature. Any geologic or other information of archaeological interest was documented, and any potential cultural layers were noted and photographed. This information will be made available for use in the design of any future borrow area(s) to ensure future activities that may be proposed include necessary avoidance or protection measures. The following mitigation measures were implemented:

1. APTIM's selected vessels utilized live boating methodology during vibracore sampling operations to avoid unnecessary anchoring and seafloor disturbance. No spudding or clump weight anchoring was allowed. Although APTIM minimized anchoring to the extent possible, there were some instances where anchoring was not avoidable due to emergencies or field conditions. In these instances, a minimum-sized anchor/anchor array were used and advance or real-time clearance, through remote sensing, diver observation, or other means within the footprint of anchoring, was implemented.

2. Before seafloor sampling was conducted, a geologic sampling plan was submitted to BOEM within a week of receiving cultural resource clearance.

3. APTIM provided to BOEM a determination by a Qualified Marine Archaeologist from TAR as to whether any potential archaeological resources were present in the area. APTIM's "Qualified Marine Archaeologist" meets the Secretary of the Interior's Professional Qualifications Standards for Archaeology (Federal Register 1983); has demonstrable, professional experience in interpretation of marine geophysical data; and familiarity with the Study Area.

4. All geologic sampling avoided potential archaeological resources by a minimum of 50 m (164 ft). All associated anchoring, if any, avoided potential archaeological resources by 100 m (328 ft). The avoidance distance was calculated from the maximum discernible extent of the archaeological resource. During vibracoring, vibracore penetration rates were monitored to help ensure minimum sampling in geology units not indicative of surface sands.

5. While the TAR marine archeologist did make some recommendations (out of an abundance of caution) to move some potential vibracore sites based on discrete magnetic, sidescan sonar, and/or chirp sub-bottom profiler targets or anomalies, APTIM did not encounter any suspected historic and pre-contact archaeological resources during offshore operations. APTIM did not discover any previously undiscovered suspected archaeological resource.

9.2.7 Sensitive Benthic Habitat and Communities Avoidance Requirements

APTIM generally avoided anchoring, geologic sampling, and any other seafloor-disturbing activities in the vicinity of sensitive benthic habitat and associated communities, including hard bottom, rippled scour depressions, cobbled seafloor, reef tract, and Habitat Areas of Particular Concern (HAPCs) not only because of their conservation value, but also because these areas are not likely to be host to sand rich deposits. Any seafloor-disturbing activities in these areas avoided these habitats and general seafloor impacts by either 1) using live boating methodology to support geologic sampling and/or, 2) require site- specific geophysical data in advance of sampling to map and otherwise avoid benthic resources. All sensitive benthic habitats were avoided by at least 50 m (164 ft) during vibracoring or other seafloor-sampling activities, whereas anchoring avoided sensitive benthic habitat by 100 m (328 ft).

1. As previously described, no spudding or clump weight anchoring was allowed. Although APTIM plans to minimize anchoring, there were some instances where anchoring was not avoidable due to emergencies or field situations/conditions. In these instances, a minimum-sized anchor/anchor array was used and advance or real-time clearance, through remote

sensing, diver observation, or other means within the footprint of anchoring, was conducted.

2. APTIM provided advance (sequential) site-specific information from sub-bottom, side-scan sonar, or multibeam/swath backscatter of equivalent resolution to determine the presence of potential sensitive benthic resources prior to undertaking any seafloor-disturbing activities. APTIM used this information to ensure that physical impacts on sensitive benthic resources were avoided or minimized.

3. Before seafloor sampling was conducted, a geologic sampling plan was submitted to BOEM, and BOEM confirmed that the plan was consistent with the required mitigation measures.

9.2.8 Marine Pollution Control Plan

APTIM undertook adequate measures to control marine pollution during the different stages of the survey, as required by BOEM, the United States Coast Guard (USCG) and the Environmental Protection Agency (EPA). All equipment, materials and belongings onboard were secured to the structures of the vessels by means of appropriate straps and ropes, in order to prevent objects from accidentally being lost overboard and becoming marine debris. The equipment was labeled with reflective APTIM logos in case they were lost at sea. Debris may injure marine fauna after they consume or become entangled, and it may damage the structure of vessels and take away from the visual appeal of coastal environments. Designated containers with lids for the disposal of litter and scraps produced during the survey were utilized and made accessible throughout the vessels for appropriate disposal of trash onboard. Cigarette butt containers were also available onboard for the crew. Containers with oils, lubricants and cleaning agents were securely stored inside bins and cabinets affixed to the vessels.

APTIM's contracted vessels undertook all necessary precautions to prevent discharges of waste or hazardous materials that may impair water quality. Sufficient spill response equipment and supplies were available onboard to contain and recover the maximum scenario spill keyed to the proposed operations, though there were no such occurrences. All vessel operations were compliant with USCG regulations and the EPA's Vessel General Permit, as applicable. There were no noncompliant discharges during BOEM ASAP operations. As an additional measure to reduce the likelihood of accidental spills, vessel fueling only occurred in port at a docking facility; no at-sea cross-vessel fueling was permitted.

Appropriate precautions were taken in order to minimize the effects of underwater noise produced by the seismic survey equipment, which could harm marine mammals, through the use of BOEM-certified PSOs. Vessel sewage was only discharged outside of No Discharge Zones (NDZs) as prescribed by EPA policy, in order to protect marine habitats and waters regularly used by humans.

9.2.9 Marine Debris Awareness Program

All APTIM employees and sub-contractors participating in offshore operations were educated on marine trash and debris awareness elimination as per Bureau of Safety and Environmental Enforcement (BSSE) Notice to Lessees and Operators (NTL) Number 2012-G0. APTIM ensured that its employees and sub-contractors were made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris were not intentionally or accidentally discharged into the marine environment where it could affect protected species.

9.2.10 Navigation and Commercial Fisheries Operations Conflict Minimization Requirements

APTIM submitted notification of all BOEM ASAP activities via the USCG Local Notice to Mariners (LNTM) program. The call sign of the survey vessel and preferred communication channel were identified.

Consistent with applicable USCG regulations, all designated vessels were equipped with an Automatic Identification System (AIS) that broadcast vessel's identity, type, position, course, speed, and navigational status during surveying activities. Any vessel greater than 20 m (65 ft), regardless of operational status, employed an AIS system.

No hydrophone streamer or other source towline exceeded 100 m (328 ft) beyond the survey vessel to minimize the effective footprint of operations and minimize disturbance to fisheries vessels, fisheries gear, and/or other shipping or boating traffic.

During surveys, APTIM notified all fisheries vessels observed within 2 km (6,500 ft) of a geophysical survey to avoid potential entanglement in fishing gear. Vessels flew the appropriate USCG-approved day shapes (masthead signals used to communicate with other vessels) and displayed the appropriate lighting, during daylight and any nighttime operations, to designate the vessel had limited maneuverability.

To minimize interaction with fishing gear that may be present, APTIM traversed or visually scanned the general survey area, or used other effective methods, prior to commencing survey operations to determine the presence of deployed fishing gear. Observed fishing gear was avoided by a minimum of 30 m (98 ft). Fishing gear was not relocated or otherwise disturbed.

9.3 Geophysical Survey Operations and Site Selection

9.3.1 Survey Operations

APTIM conducted a preliminary vessel mobilization in Point Pleasant, New Jersey from April 6, 2015 to April 8, 2015. This initial mobilization consisted of loading all the survey equipment, connecting cables and tow-systems to their respective survey computers, installing all positioning systems and antennas, attaching the EdgeTech 6205 to the pole mount, measuring raw offsets and configuring the navigation software. Once all systems were properly connected and integrated, APTIM survey crew conducted a bench test of each individual geophysical survey system to ensure that everything was properly configured. Following the completion of the preliminary mobilization, the *m/v Atlantic Surveyor* began its transit from New Jersey to West Palm Beach, Florida.

Upon arriving in West Palm Beach, the vessel was met by APTIM's geophysical and hydrographic survey team on April 16, 2015 at the Rybovich Marina. On April 16, 2015, the APTIM crew conducted additional measurements of the systems' offsets using a laser range finder for more accurate vessel and towed systems positioning. On April 17, 2015, the vessel left the dock to conduct a wet test of the survey systems and returned to the marina at the end of the day. On April 18, 2015, the vessel departed to conduct calibrations for the bathymetric system (EdgeTech 6205 and Applanix POS MV). On April 19, 2015 the crew finalized all necessary calibrations and calculations and began collecting geophysical data in Martin County in the early afternoon. The vessel continued to progress north towards Massachusetts, where the survey was completed on July 26, 2015. Additional dates and information on the geotechnical field operations are described below by state (for report consistency, when describing multiple states, descriptions always proceed from north to south).

Toward the end of reconnaissance geophysical operations, the IMU, an integral part of the POS MV system which provides vessel motion corrections to bathymetric data, failed during data collection offshore Montauk, New York. Hydrographic data collection was put on hold while geophysical data collection continued (survey lines in New York, NY_102 through NY_107, Rhode Island, RI_001 through RI_018 and Massachusetts, MA_001 through MA_008) until the failed part was exchanged on July 21, 2015. The survey lines were then rerun for hydrographic data following completion of geophysical data collection on July 26, 2015.

Throughout the duration of the project, survey operations took place during daylight hours only (dawn to dusk). Geophysical operations began with a PSO clearance of 30 minutes once the observer was able to see the exclusion zone of 100 m around the chirp sub-bottom source. Once the exclusion zone was clear, geophysical systems (i.e. chirp sub-bottom) began a power ramp-up, starting from the lowest power output and reaching full power in at least 20 minutes.

Generally, survey operations were conducted in seas less than 1 m (3 ft), however the direction of swells, the period and wind speeds were also key components on determining operational conditions. During operations, both a digital field log and a field book were used. The field book was populated with pertinent times (start of day, end of day, start of PSO clearance, time of full power etc.), and any additional pertinent events (PSO shut down, transit times, when patch tests occurred, weather down days, crew change days etc.). Additionally, general information on the lines run (start and end time, event numbers, line azimuth etc.) were also logged.

The digital field book was populated with information on planned versus as run km, individual power and range settings for each of the geophysical systems for each line, any towing adjustments done to the sidescan sonar and magnetometer (i.e. cable in or out) and a QA/QC check that the data files were digitally recorded and that planned lines were completed. At the end of the survey day, the raw data for each system was reviewed and checked for data quality and control. Magnetometer data was imported into single beam and checked for completion, while sidescan sonar and seismic data were played-back for QA/QC purposes.

Field digital logs and field books for the reconnaissance geophysical survey operations are included in Appendix D and E.

9.3.1.1 Massachusetts (MA)

Geophysical operations began in Massachusetts on July 20, 2015, and were completed on July 26, 2015. A total of 216 km (116 nm) of geophysical were collected in Massachusetts, see Maps 1 through 4 (all maps are included under Section 13: Maps) for as-run tracklines. Due to shoaling features or outcrops and shallow water depths, lines MA_016, MA_020 and MA_022 were cut short for navigational safety reasons. Geologic sample locations were cleared and approved by Tidewater Atlantic Research’s (TAR) marine archeologist on September 16, 2015.

9.3.1.2 Rhode Island (RI)

Geophysical operations began in Rhode Island on July 19, 2015 and were completed on July 20, 2015. A total of 54 km (29 nm) of geophysical data were collected in Rhode Island, see Maps 5 through 7 for as-run tracklines. Geologic sample locations were cleared and approved by TAR’s marine archeologist on September 18, 2015, and a revised approval of sample RI_SS01 on October 6, 2015.

9.3.1.3 New York (NY)

Geophysical operations began in New York on July 2, 2015 and were completed on July 19, 2015. A total of 768 km (415 nm) of geophysical data were collected in New York, see Maps 8 through 12 for as-run tracklines. Geologic sample locations were cleared and approved by TAR’s marine archeologist on September 8, 2015, and a revised approval of samples NY_VC10, NY_VC10, NY_SS17, NY_VC24, NY_VC35 and NY_SS46 on October 6, 2015. 5. While the TAR marine archeologist did make these revised site recommendations (out of an abundance of caution) based on discrete magnetic, sidescan sonar, and/or chirp sub-bottom profiler targets or anomalies, APTIM did not encounter any suspected historic and pre-contact archaeological resources during offshore operations. APTIM did not discover any previously undiscovered suspected archaeological resource.

9.3.1.4 New Jersey (NJ)

Geophysical operations began in New Jersey on June 16, 2015 and were completed on July 2, 2015. A total of 969 km (523 nm) of geophysical data were collected in New Jersey, see Maps 13 through 18 for as-run tracklines. New Jersey lines NJ_015, NJ_016, NJ_028, NJ_033, NJ_034 and NJ_057, were cut short due shallow to water depths. Geologic sample locations were cleared and approved by TAR's marine archeologist on August 28, 2015.

9.3.1.5 Delaware (DE)

Geophysical operations began in Delaware on June 13, 2015 and were completed on June 16, 2015. A total of 203 km (110 nm) of geophysical data were collected in Delaware, see Map 19 for as-run tracklines. Delaware line DE_006 was cut short due to shallow water depths. Geologic sample locations were cleared and approved by TAR's marine archeologist on July 16, 2015.

9.3.1.6 Maryland (MD)

Geophysical operations began in Maryland on June 12, 2015 and were completed on June 13, 2015. A total of 100 km (54 nm) of geophysical data were collected in Maryland, see Map 20 for as-run tracklines. Maryland line MD_003 was cut short due to shallow water depths. Geologic sample locations were cleared and approved by TAR's marine archeologist on July 16, 2015.

9.3.1.7 Virginia (VA)

Geophysical operations began in Virginia on June 2, 2015 and were completed on June 11, 2015. A total of 201 km (108 nm) of geophysical data were collected in Virginia, see Maps 21 and 22 for as-run tracklines. Due to shoaling features in northern Virginia, lines VA_018, VA_019, VA_020 and VA_021 were adjusted, but kept as close to their original location as possible, and/or cut short to avoid potentially hazardous water depths. Geologic sample locations were cleared and approved by TAR's marine archeologist on July 16, 2015.

9.3.1.8 North Carolina (NC)

Geophysical operations began in North Carolina on May 21, 2015 and were completed on June 02, 2015. A total of 587 km (317 nm) of geophysical data were collected in North Carolina, see

Maps 23 through 25 for as-run tracklines. North Carolina lines NC_009 and NC_010 were unable to be completed in full over a small portion of Frying Pan Shoals due to shallow water depths. Geologic sample locations were cleared and approved by TAR's marine archeologist on July 16, 2015.

9.3.1.9 South Carolina (SC)

Geophysical operations began in South Carolina on May 05, 2015 and were completed on May 21, 2015. A total of 511 km (276 nm) of geophysical data were collected in South Carolina, see Maps 26 through 29 for as-run tracklines. Water depths shallower than expected were encountered throughout areas of the survey, including survey lines SC_001, SC_002, SC_003, SC_004, SC_008 and SC_009 and SC_038. Survey lines were adjusted, but kept as close to their original location as possible within water depths feasible to conduct geophysical survey operations. While conducting geophysical survey activities offshore South Carolina, APTIM was significantly impacted by weather delays from Subtropical Storm Ana from May 6 through May 10, 2015. Geologic sample locations were cleared and approved by TAR's marine archeologist on July 13, 2015.

9.3.1.10 Georgia (GA)

Geophysical operations began in Georgia on May 01, 2015 and were completed on May 04, 2015. A total of 203 km (110 nm) of geophysical data were collected in Georgia, see Maps 30 through 32 for as-run tracklines. Shallow water depths were encountered throughout areas of the survey, including survey lines GA_011, GA_014, GA_015, GA_016, GA_019, GA_020, and GA_022. Survey lines were adjusted, but kept as close to their original location as possible within water depths feasible to conduct geophysical survey operations. Geologic sample locations were cleared and approved by TAR's marine archeologist on July 13, 2015.

9.3.1.11 Florida (FL)

Geophysical operations began in Florida on April 19, 2015, and were completed on May 01, 2015. A total of 527 km (284 nm) of geophysical data were collected in Florida, see Maps 33 through 37 for as-run tracklines. Geologic sample locations were cleared and approved by TAR's marine archeologist on July 13, 2015.

9.3.2 Data Review and Geotechnical Site Selection

As part of the original project scope, APTIM was not tasked with conducting any formal geophysical data processing other than a certain level of post-processing for QA/QC purposes. As described in our proposal, APTIM reviewed a minimum of 10% of all geophysical data collected for QA/QC purposes. Throughout the survey, every few lines from each of the states were imported into the proper processing software for the dataset (SonarWiz for sidescan sonar and chirp sub-bottom, and Hypack for magnetometer) for review, confirming data quality, navigation strings, and completeness. In addition, APTIM kept detailed data acquisition master spreadsheets for each survey phase (Appendix D) detailing acquisition parameters for each individuation line, for each individual acquisition system, and detailing the planned lines. As part of these spreadsheets, a QA/QC checklist was included to ensure that each individual digital acquisition file for each acquisition system was indeed recorded and confirmed. In addition, the master spreadsheets included the planned line names, planned line mileage, and as-run mileage as a check to ensure that all planned lines were fully collected prior to transiting away from the survey area.

During the geophysical data collection, the crew leader of each shift was tasked with selecting appropriate sites for potential geologic sample sites (both surface grab samples and vibracores). When a sand hill, shoal or subsurface deposit indicative of a potential sand resource was identified during data collection, target fixes were collected within the Hypack navigation software. In addition, all chirp sub-bottom data were printed during collection to provide a large scale overview of each chirp sub-bottom line, and large-format posters of the Data Acquisition Plan maps (depicting historic data locations and planned survey lines) were hung on the wall of the offshore survey office. Upon completing a specific survey area, APTIM scientists were tasked with reviewing both the printed chirp sub-bottom logs, the Data Acquisition Plan maps, available historic data in the area, as well as the targets recorded in the navigation software to determine locations indicative of potential beach-compatible sand resources that should be sampled during the follow-on reconnaissance geotechnical survey. Areas that appeared generally thicker, such as sand hills and/or shoal complexes, were generally sampled with vibracores. Regions with relatively thinner deposits, sometimes in-between areas of higher relief, were sampled with a surface grab sample. Whenever possible, geotechnical samples were placed on or close to geophysical survey line intersections in order to provide a more comprehensive correlation of the strata with the collected chirp sub-bottom data. A final x/y location for each sample was logged on a master spreadsheet (together with a brief description) to be reviewed by the TAR marine archaeologist for any cultural resource artifacts or anomalies (Appendix E).

9.3.2.1 Cultural Resource Review - Site Clearance

Prior to the collection of any vibracores, a qualified marine archaeologist from TAR reviewed all geophysical data at each proposed geologic sample collection site to identify and avoid cultural resources or other magnetic/electromagnetic anomalies, such as MEC. TAR archeologists were not present during geophysical data collection. However, TAR was provided all geophysical data along with the proposed vibracore sites. TAR reviewed the geophysical data and cleared or rejected potential geologic sample locations prior to sampling. When TAR rejected a location, the nearest permissible clear location for vibracore or surface grab sample activity was identified and replaced as the sample location. A final report with the CRS assessment of each vibracore site can be found in Appendix B

9.3.2.2 Bathymetry data processing

The EdgeTech 6205 bathymetry data were processed under the original contract between APTIM and BOEM for the ASAP project and submitted as *.xyz* files to each of the states.

The recorded raw swath bathymetry data were corrected in real time for motion artifacts (heave, pitch and roll) and heading from the data acquired by the Applanix POS M/V system. Sound velocity profiles collected while underway throughout the survey were applied in real time and embedded within the raw bathymetry file. Post-processing of the swath bathymetry data were performed using Hysweep 2015 MBMAX64 Editor, which involved applying a tidal correction that was derived from a combination of C-NAV satellite-based augmentation system (SBAS) GNSS ellipsoidal heights and NOAA observed tides. Each line was inspected for any data outliers and swaths were reduced to eliminate poor quality outer beams. Final ASCII *.xyz* files were exported for each state as one-meter grids. All data were presented in the North American Vertical Datum of 1988 (NAVD88) meters and horizontal projection Universal Transverse Mercator (UTM) meters.

9.4 Geotechnical Survey Operations

The reconnaissance-level geotechnical collection effort consisted of collecting 160 vibracores and 100 surface grab samples offshore of Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia and Florida. The reconnaissance-level geologic sampling cruise began mobilization in Fort Pierce, Florida, on July 27, 2015, and completed mobilization on July 29, 2015. Sampling commenced on July 29, 2015 and progressed north. Table 7 shows the geotechnical dates for each state.

Table 7: 2015 Reconnaissance Geotechnical Survey Operation Dates per State and Allocated Geotechnical Samples

State	*Begin Date*	*End Date*	*Vibracores*	*Surface Grab Samples*
Massachusetts	December 7, 2015.	December 13, 2015.	7	7
Rhode Island	November 22, 2015.	December 9, 2015.	6	4
New York	October 27, 2015.	December 6, 2015.	31	18
New Jersey	October 11, 2015.	October 27, 2015.	32	20
Delaware	September 18, 2015.	September 19, 2015.	5	3
Maryland	September 17, 2015	September 18, 2015	5	3
Virginia	September 8, 2015.	September 17, 2015.	6	4
North Carolina	August 25, 2015.	September 16, 2015.	23	14
South Carolina	August 21, 2015.	August 25, 2015.	19	11
Georgia	August 16, 2015.	August 21, 2015.	7	5
Florida	July 29, 2015.	August 16, 2015.	19	11

Marine mammal mitigation measures for the geotechnical operations were the same as the geophysical survey and were similarly implemented. Prior to any sample being collected, the PSO conducted a 30 minute clearance of the 100 m (328 ft) exclusion zone. The area around the vessel was constantly monitored by the PSO and operations were terminated once clearance could no longer be maintained. Field books for the reconnaissance geotechnical survey operations are included in Appendix E.

After reconnaissance-level geotechnical operations, it was noted that a number of vibracores in certain areas had excessive recovery, where the recovery value exceeded the known penetration value. After detailed discussions with BOEM, APTIM reviewed all of the data and vibracore collection procedures and developed a white paper (included with this report in Appendix G) to discuss the potential causes of this excessive recovery. In summary, several potential issues were evaluated in the white paper. Issues related to the penetrometer were typically catastrophic, showing instantaneous failure, not changes in measurement parameters. Based on the robustness of the system and the mitigation designed into the software, APTIM does not believe that the penetrometer was the source of vibracore recovery lengths exceeding penetration depths. Similarly, APTIM does not believe that a sufficient volume of geologic material would be able to infiltrate the cutting bit, core catcher, core liner, and vibracore pipe assembly to cause recovery lengths exceeding penetration depths. The tolerances of the cutting bit, core catcher, core liner, and vibracore pipe assembly are simply too tight, and the void space simply too large to allow sufficient material to travel the length of the core liner and into the top of the core liner. While some coring operations have the potential to collect repeat/redundant samples by inadvertent up and down motion of the vibracore head, such motion would be recorded and video displayed by the AVS penetrometer system, and in the very few instances that this was observed, notes were included describing the situation. APTIM does not believe that redundant/repeat sampling was an issue causing recovery lengths exceeding penetration depths.

Finally, after detailed review of the data, APTIM was able to identify a potential trend between percent recovery and the time individual vibracore attempts spent on penetration plateaus hammering on resistant geologic layers. Generally speaking, the longer a vibracore spent hammering on a resistant surface, the more likely it was to retain more material than it penetrated. While APTIM is unable to test for the specific cause, previous investigations and investigators indicate that two forces may cause excessive recovery: sand swelling due to loosening of compact sand grains from the vibratory energy (C. Dill, personal communication, April 11, 2017; C. Hein, personal communication, April 13, 2017; K. Kaltenbach, personal communication, April 11, 2017; B. Lackey, personal communication, April 11, 2017), or oversampling of the surrounding stratigraphic material as the vibracore rig bounces (short bounces, but at a high frequency) for an extended period of time on a resistant layer. Either way, as the material is either expanding or entering the core liner laterally from the same stratigraphic unit, vibracore logs can be corrected for this issue by linearly recompressing the stratigraphic units above the resistant layers to conform to the penetrometer log depths and available chirp sub-bottom data (Széréméta et al., 2004; Ousley et al., 2014).

9.4.1 Geotechnical data sampling/processing

Upon collection of the vibracores and removal of the vibracore tube, APTIM geologists measured, marked, and cut each vibracore into 1.52 m (5 ft) sections to prepare the vibracores for transportation. Each vibracore section was then labeled onboard the vessel. After geotechnical survey operations were completed, all vibracore sections were transported to APTIM's accredited geotechnical laboratory in Boca Raton, Florida. APTIM geologists split each vibracore lengthwise and logged them in detail by describing sedimentary properties by layer in terms of layer thickness, wet Munsell color, texture (grain size), composition and presence of clay, silt, gravel, or any other identifying features. The vibracores were logged in accordance with the American Society for Testing and Materials (ASTM) Standard Materials Designation D2488-09a for the description and identification of soils using the visual-manual procedure. Wet Munsell colors were determined from the methodology described in the Munsell Soil Color Book, as recommended by the Florida Department of Environmental Protection's Offshore Sand Search Guidelines.

Sediment subsamples were extracted from the vibracore sample halves at irregular intervals based on distinct stratigraphic layers and sediment quality (strata with apparent high fines content were typically avoided) in the sediment sequence. The subsample collection depths were noted on the logs, and the subsamples were stored in labeled plastic bags. The archived (un-sampled) halves of the vibracore sections were then wrapped and placed into D-Tube plastic storage containers for transfer to Columbia University's Lamont Doherty Earth Observatory (LDEO) core archive facility in New York, while the sampled halves were stored at APTIM to be available for additional review and sampling as needed. The vibracore log descriptions were entered into the gINT software program.

The split vibracores were photographed in 0.6 m (2.0 ft) intervals using an Olympus Stylus TG-3 16 megapixel digital camera that was mounted on a frame directly above the vibracores. The photographs were taken using the normal image compression mode (shooting at "Normal" quality) using full spectrum overhead lighting and an 18% gray background, which provides a known reference color and is the standard reference value against which all camera light meters are calibrated. Photographs included the project name, vibracore name, depth interval, and scale. Photograph procedures were determined from the methodology described in the Florida Department of Environmental Protection's Offshore Sand Search Guidelines. The photographs were downloaded from the camera as *.jpg's*, formatted for consistency, and then exported into the finalized *.pdf* format.

Upon collection of the surface grab samples, APTIM geologists stored the samples in labeled plastic bags and buckets onboard the vessel. The sample buckets were transported with the vibracores to APTIM's accredited geotechnical laboratory in Boca Raton, Florida. Sedimentary properties of the surface grab samples were also described according to the above procedures. Each surface grab sample was split into two (2) representative subsamples, one (1) subsample was used to conduct the laboratory analysis and the other subsample was provided to the LDEO core archive facility with the vibracore archived sections. The surface grab samples were also photographed according to the above procedures, with the exception of a scale and depth interval as each sample was photographed in its entirety. The grab sample log descriptions were entered into the gINT software program.

For the 2015 reconnaissance investigation, a total of 1,009 geologic subsamples were processed and analyzed. For the 160 vibracores, 909 subsamples were collected and processed. All of the 100 surface grab sample subsamples were processed (Table 8). Geologic sample information and results (vibracore and surface grab sample logs, granularmetric reports, grain size distribution curves exported from gINT into formatted templates in *.pdf* format, vibracore and grab sample photographs in *.pdf* and *.jpg* formats, gINT project files, and *.xls* files exported from gINT) were submitted to BOEM.

Table 8: Reconnaissance Geotechnical Sample and Subsamples per State

State	*Vibracores*	*Vibracore Subsamples*	*Surface Grab Samples*	*Total Analyzed Subsamples*
Massachusetts	7	44	7	51
Rhode Island	6	36	4	40
New York	31	197	18	215
New Jersey	32	207	20	227
Delaware	5	31	3	34
Maryland	5	36	3	39
Virginia	6	30	4	34
North Carolina	23	87	14	101
South Carolina	19	75	11	86
Georgia	7	43	5	48
Florida	19	123	11	134
Total	*160*	*909*	*100*	*1009*

The sediment subsamples extracted from the vibracores and the surface grab samples were prepared for processing in APTIM's geotechnical laboratory. This laboratory is accredited by the Construction Materials Engineering Council, Inc. (CMEC) for sieve, carbonate, and field vane shear analyses (ASTM Standard Materials Designations D6913, D1140, D421, D4648, and CPE-HAT-09). Geologic subsamples were analyzed to determine grain size, sorting, percent fines, percent carbonate, Unified Soil Classification System (USCS) classification, and color. The testing methods are summarized below.

9.4.1.1 Mechanical Sieve Analysis

The sediment subsamples were analyzed to determine color and grain size distribution. During sieve analysis, the dry and washed Munsell colors were noted. Dry and washed Munsell colors were determined from the methodology described in the Munsell Soil Color Book, as recommended by the Florida Department of Environmental Protection's Offshore Sand Search Guidelines. Grain size was determined through sieve analysis in accordance with ASTM Standard Materials Designation D6913 for particle size analysis of soils. This method covers the quantitative determination of the distribution of sand particles. Sediment finer than the No. 230 sieve (4.0 phi) was analyzed following ASTM Standard Materials Designation D1140. Mechanical sieving was accomplished using calibrated sieves with a gradation of half phi intervals. Additional sieves representing key ASTM sediment classification boundaries were included to meet appropriate beach compatible mineral characterization. Weights retained on each sieve were recorded cumulatively. The sieve stack used for mechanical analysis is provided in Table 9. Grain size results were entered into the gINT software program, which computes the mean and median grain size, sorting, and fines (silt/clay) percentages for each sample using the moment method. Grain size results are displayed on the granularmetric reports, grain size distribution curves, and logs.

Table 9: Granularmetric Analysis Mesh Sizes

Sieve Number	*Size (phi)*	*Size (mm)*
3/4	-4.25	19.00
5/8	-4	16.00
7/16	-3.5	11.20
5/16	-3	8.00
3 ½	-2.5	5.60
4	-2.25	4.75
5	-2	4.00
7	-1.5	2.80
10	-1	2.00
14	-0.5	1.40
18	0	1.00
25	0.5	0.71
35	1	0.50
45	1.5	0.36
60	2	0.25
80	2.5	0.18

120	3	0.13
170	3.5	0.09
200	3.75	0.08
230	4	0.06

9.4.1.2 Carbonate Analysis

Carbonate content was determined by percent weight using the acid leaching methodology described by Twenhofel and Tyler, 1941, and the testing procedures outlined within CPE-HAT-09. Results were entered into the gINT software program and displayed on the granularmetric reports and grain size distribution curves.

9.4.1.3 Field Vane Shear Analysis

Clays are distinguished from other fine grained soils by differences in size and mineralogy. While the vibracores were logged, clay was identified visually based on the cohesiveness of the sediment. Field vane shear tests were conducted on the clay layers, if applicable, during vibracore logging in accordance with ASTM Standard Materials Designation D4648 for field vane shear tests in cohesive soils. These tests were conducted to characterize the consistency of the clay material. Results of these tests were entered into the gINT software program and displayed on the vibracore logs.

10.0 2016 Design-Level Survey (Phase 3)

The 2016 design-level data collection effort consisted of approximately 26% of the total original project data (1,462 km (789 nm) of geophysical tracklines and 90 vibracore samples). Per contract requirements, data allocations were done to maintain a minimum of 40% of the survey effort offshore New York and New Jersey. The goal of the second field phase was to provide New Jersey and New York with the necessary data coverage to fully design and permit as many borrow areas as possible in areas highly impacted by Hurricane Sandy and likely requiring beach restoration efforts in the near future.

In order to accurately target the areas of interest, APTIM reviewed the results of the 2015 reconnaissance datasets and worked closely with BOEM's cooperating state agencies and stakeholders to develop a survey plan that maximized the potential for locating quality beach-compatible sediments in project quantities for future shore protection and restoration projects. Since the project was funded by the appropriation of Hurricane Sandy recovery funds, and due to the contract requirement that 40% of the overall project effort be dedicated to New York and New Jersey, BOEM and APTIM agreed to focus the second phase of geophysical and geotechnical data collection to the areas most affected by the storm in October, 2012. As such, the remaining 1,462 km (789 nm) of geophysical tracklines and 90 vibracore samples were concentrated only in New York and New Jersey.

10.1 Design Site Selection

Upon completion of the 2015 Phase 2 Reconnaissance geophysical and geotechnical survey operations, APTIM coordinated with BOEM on identifying areas of interest for the design-level investigation offshore New York and New Jersey and areas which will require coastal restoration efforts in the near future. From these discussions five (5) areas were selected, three (3) in New York and two (2) in New Jersey (details on individual areas are described below). For general planning purposes, APTIM reviewed the results from the collected geotechnical samples (surface grabs and vibracores) and determined what individual vibracores and therefore areas appeared to be promising in terms of thickness of beach-compatible sands. Individual seismic lines were then reviewed to determine a potential overall deposit thickness and available volume. Final areas were then selected targeting bathymetric highs and sub-surface stratigraphy correlating to sand deposits.

10.1.1 New York (NY)

BOEM and New York stakeholders, including the New York District of the USACE, (via BOEM) provided APTIM with a list of prioritized shore protection/restoration project areas likely needing OCS sand within the next three (3) years, including the Rockaway Peninsula, Fire Island (Moriches Inlet and areas east) and Westhampton. Based on a review of the reconnaissance data, APTIM designated three (3) design-level investigation areas; BOEM ASAP Moriches Inlet Design Area, BOEM ASAP Fire Island Design Area, and BOEM ASAP Fire Island Inlet Design Area.

10.1.1.1 BOEM ASAP Moriches Inlet Design Area

This is an area on the OCS offshore Moriches Inlet, identified and delineated based on a bathymetric high, sub-bottom acoustic properties consistent with potential sand resources, and the sediment analysis results of vibracore NY-BOEM-2015-VC35. Chirp sub-bottom and NY-BOEM-2015-VC35 data indicated potential sand deposits ranging up to 3 m (10 ft) thick with a mean grain size ranging from 0.26 mm to 0.44 mm. The BOEM ASAP Moriches Inlet Design Area is bound to the west and south by a submarine cable buffer and extends to the northwest approaching the federal/state boundary. During data collection, APTIM monitored the geophysical data in real-time to visually delineate the targeted sand resource. In an effort to maximize data collection of targeted resources, APTIM ended data collection in the northwest portion of the proposed area at the western extent of the resource, or at the extent of the proposed lines (which are bound by the federal boundary and a submarine cable), whichever occurred first. The planned geophysical line mileage for this design area was 285 km (154 nm).

10.1.1.2 BOEM ASAP Fire Island Design Area

This is an area on the OCS offshore central-west Fire Island, identified and delineated based on the presence of a bathymetric high, sub-bottom acoustic properties consistent with potential sand resources, and the sediment analysis results of vibracore NY-BOEM-2015-VC23, NY-BOEM-2015-VC23A, NY-BOEM-2015-VC28 and NY-BOEM-2015-VC28A. Chirp sub-bottom and vibracore data indicated potential sand deposits ranging up to 5.5 m (18 ft) thick with a mean grain size ranging from 0.14 mm to 2.08 mm. The range in grain size was due to what appeared to be an isolated non-homogenous lithologic unit at approximately 3.3 m (11 ft) below the seafloor with silt, shell and rock fragments. Above the isolated unit at approximately 3.3 m (11 ft), the mean grain size ranges from 0.22 mm to 0.44 mm. The northern edge of the proposed design-level survey area is bound by the federal/state boundary. The planned geophysical line mileage for this design area was 409 km (220 nm).

10.1.1.3 BOEM ASAP Fire Island Inlet Design Area

BOEM and the New York District of the USACE identified a significant need for offshore sand resources for future projects along the Rockaway Peninsula in western Long Island. During the planning phase prior to the reconnaissance-level investigation, APTIM identified a significant amount of existing seafloor infrastructure within the regions offshore the Rockaway Peninsula. As a result, only three (3) small areas nearest the Rockaway Peninsula were clear to conduct geophysical and geologic investigations. APTIM added these areas to our reconnaissance-level investigation in hopes of identifying potential sand resources adjacent to the Rockaway Peninsula. Unfortunately, these data (NY-BOEM-2015-VC09 and NY-BOEM-2015-VC10) indicate that these areas are predominantly clay, and therefore were excluded from consideration in the design-level investigation. As a result, and in coordination with BOEM, APTIM identified the closest area of potentially-compatible sand resources to the Rockaway Peninsula approximately 37 km (20 nm) east of the Rockaway Peninsula.

This OCS resource was identified and delineated based on a bathymetric high, sub-bottom acoustic properties consistent with potential sand resources, and the sediment analysis results of vibracore NY-BOEM-2015-VC20 and surface sample NY-BOEM-2015-SS21. Chirp sub-bottom and geologic sample data indicated potential sand deposits over 4.5 m (15 ft) thick with a mean grain size ranging from 0.17 mm to 0.64 mm. The deposit did appear to have some isolated areas of fine-grained sand with silt content slightly above 5%, which made this a less attractive deposit. That said, being the closest resource to the Rockaway Peninsula, and based on the high need for future sand resources in that area, APTIM proposed collecting design-level geophysical data within this area. The planned geophysical line mileage for this design area was 312 km (168 nm).

A total of 1,006 km (543 nm) of planned geophysical data line mileage was allocated in New York.

10.1.2 New Jersey (NJ)

BOEM and New Jersey stakeholders (via BOEM) provided APTIM with a list of prioritized shore protection/restoration project areas likely needing OCS sand within the next three (3) or five (5) years. Specifically, New Jersey provided four exact shapes, including MON-4 and MON-2 offshore Monmouth County, F1 offshore Ocean County and M8 offshore Cape May County. APTIM compared the suggested investigation areas with results of the BOEM ASAP reconnaissance-level sedimentary analyses and selected two (2) areas for design-level geophysical data collection. These include the F1 area proposed by the USACE for the Hurricane Sandy Manasquan to Barnegat project (sand needed within three (3) years) and an area offshore Monmouth County that contained a more-detailed reconnaissance-level investigation (combining MON-2 and MON-4) that complements the BOEM ASAP 2015 reconnaissance-level investigation. APTIM designated these two (2) design-level investigation areas as BOEM ASAP F1 Design Area and BOEM ASAP MON-2/MON-4 Design Area.

10.1.2.1 BOEM ASAP F1 Design Area

This is an area on the OCS offshore Lavallette, New Jersey. This area was originally suggested by USACE for use in future (<3 years) shore protection projects. The F1 proposed shape provided by BOEM and New Jersey appeared to be based on limited data and overlapped a region selected by APTIM for data collection as part of the BOEM ASAP 2015 reconnaissance-level investigation. As a result, APTIM was able to refine and delineate F1 based on a series of bathymetric highs, sub-bottom acoustic properties consistent with potential sand resources, and the sediment analysis results of vibracores NJ-BOEM-2015-VC36 and NJ-BOEM-2015-VC36A and surface sample NJ-BOEM-2015-SS35. Vibracore NJ-BOEM-2015-VC34, also within the original F1 shape, did not contain significant amounts of compatible material, allowing APTIM to focus design-level investigations to a smaller area in the central-north section of the original F1 shape. Chirp sub-bottom and geologic sample sites NJ-BOEM-2015-VC36, NJ-BOEM-2015-VC36A and NJ-BOEM-2015-SS35 data indicated potential sand deposits over 6 m (19.7 ft) thick with a mean grain size ranging from 0.35 mm to 0.99 mm. The planned geophysical line mileage for this design area was 327 km (176 nm)

10.1.2.2 BOEM ASAP MON-2/MON-4 Design Area

Information on MON-4 and MON-2 was provided to APTIM by BOEM, including supporting documentation titled "Significant Sand Resource Areas in State and Federal Waters Offshore Monmouth County, New Jersey." This poster publication contained reconnaissance-level isopach data with potential sand resource thicknesses of up to 8 m (27 ft). In addition to the material provided by BOEM and New Jersey, this OCS resource was identified and delineated based on the BOEM ASAP 2015 reconnaissance data, which showed a bathymetric high, sub-bottom acoustic properties consistent with potential sand resources, and the sediment analysis results of BOEM reconnaissance vibracores NJ-BOEM-2015-VC46 and NJ-BOEM-2015-VC46A and surface sample NJ-BOEM-2015-SS45. These data indicated potential sand deposits over 15 feet thick with a mean grain size ranging from 0.27 mm to 0.68 mm. APTIM decided to combine these adjacent areas to create one design-level investigation area bound to the south by a submarine cable buffer and to the southwest by an offshore dredge materials disposal site. The planned geophysical line mileage for this design area was 353 km (190 nm).

While MON-2 and MON-4 comprised a promising target for sand resources, adding these areas to the design-level investigation put APTIM over the 5,600 km (3,023 nm) total planned mileage as originally proposed. As a result, APTIM collected this survey area last (beginning with MON-4 at the north and progressing south into MON-2) and made every attempt to collect all of the planned line mileage within the budgeted time allocated to the design-level geophysical investigations. Actual MON-2/MON-4 as-run mileage was dependent upon the final as-run mileage of the other design-level areas; if other design-level areas were expanded or reduced based on the extent of each targeted resource within each design-level area, MON-2/MON-4's mileage budget was adjusted accordingly. The overall field operations went well (including production levels and weather impacts), allowing APTIM to successfully collect these extra data.

A total of 680 km (367 nm) of design-level geophysical data were planned for New Jersey.

10.2 Systems, Equipment, Operations and Methods

APTIM encountered favorable weather conditions during the 2016 design-level geophysical survey, resulting in the collection of 1,857 km (1,002 nm) of geophysical data (chirp sub-bottom, sidescan sonar, magnetometer, and swath bathymetry), well over the planned amount. The geophysical survey vessel and systems APTIM used are described in detail below.

10.2.1 Geophysical Survey Equipment

For the 2016 design-level geophysical survey, APTIM utilized Hypack as the navigation software, the EdgeTech 6205 interferometric sonar, the EdgeTech 3200 sub-bottom profiler with a 512i towfish, a Geometrics G-882 Digital Cesium Marine Magnetometer and a EdgeTech 4200-HFL sidescan sonar system. Specific technical information on these systems can be found in the 2015 Reconnaissance-Level Survey (Phase 2), Geophysical Survey Equipment section of this report (Section 9.1.1). Only instruments utilized during Phase 2 of the project that differed from those used during the reconnaissance survey in 2015 are described below.

10.2.1.1 Vessel

For the 2016 design-level survey, APTIM utilized Boston Harbor Cruise's *m/v Scarlett Isabella*, based in Boston, Massachusetts, for all geophysical survey operations. The *m/v Scarlett Isabella* (vessel diagram in Appendix A) is a 40 m (131 ft) steel hull vessel with a 10 m (33 ft) beam and a maximum 4 m (13.1 ft) draft (Figure 11). The *m/v Scarlett Isabella* was built in 2010 and can accommodate up to 14 scientific personnel. The vessel had a large amount of available deck space to accommodate geophysical office containers and had a knuckle crane, customizable "A" and "J" type frames, pole mounts, and a winch necessary for the deployment of the geophysical systems. The *m/v Scarlett Isabella* had the secure storage and clean work area necessary for the safe and adequate deployment and repair of the geophysical systems.

Figure 11: Boston Harbor Cruises *m/v Scarlett Isabella*

10.2.1.2 Navigation

The navigation and positioning system deployed for the survey was a Trimble Differential Global Positioning System (DGPS) interfaced to Hypack, Inc.'s Hypack 2017 (Figure 12). A Pro Beacon receiver provided DGPS correction from the nearest USCG navigational beacon and the DGPS received the civilian signal from the Global Positioning System (GPS) NAVSTAR satellites. The locator automatically acquired and simultaneously tracked the NAVSTAR satellites, while receiving precisely measured code phase and Doppler phase shifts, which enabled the receiver to compute the position and velocity of the vessel. The receiver then determines the time, latitude, longitude, height, and velocity once per second. GPS accuracy with differential correction provides for a position accuracy of 30 to 122 cm (1 to 4 ft).

Figure 12: Trimble DGPS navigation system

10.2.1.3 Motion Reference Unit

Figure 13: POS MV OceanMaster

APTIM began the survey using an Applanix POS MV SurfMaster. The system was mounted to the survey vessel and used to collect attitude, heading, heave, position and velocity data of the survey vessel. The Applanix POS MV family is an inertially aided motion unit that provides highly accurate attitude corrections. The POS MV works by combining GNSS data with IMU angular rate and acceleration and GAMS, for a position accuracy of 0.5 - 2 m^2 (5.3 ft-21.5 ft^2), roll and pitch accuracy of 0.04º and a heading accuracy of 0.06° (4 m/13.1 ft baseline). The motion reference unit was replaced on June 10, 2016 with an Applanix POS MV OceanMaster (Figure 13) which functions in the same way as the SurfMaster but better suited for larger vessels. The position accuracy on the POS MV OceanMaster is 0.5 - 2 m^2 (5.3 ft-21.5 ft^2), roll and pitch accuracy of 0.02º and a heading accuracy of 0.01° (4 m/13.1 ft baseline).

GAMS calibration was required to calculate the misalignment of the inertial navigator to the heading produced from GAMS. Calibration was performed through careful physical measurement of system components and aggressive maneuvering of the survey vessel to reduce the dynamic heading alignment below one (1) degree (approximately) and subsequently calculate the misalignment with the GAMS heading. Motion data were logged (embedded within the raw Hypack file) and integrated into all applicable systems.

POS M/V data groups were logged at 25 Hz for post-processing using Applanix's POSPac Mobile Mapping Suite (POSpac MMS). POSpac MMS utilizes GNSS observation data from National Geodetic Survey Continually Operating Reference Stations (NGS CORS) to post-process GNSS baselines. Post-processing increases overall positional accuracy and allows for ellipsoidal tidal corrections and a more robust attitude and horizontal position solution. Post-processed POS M/V data were applied to the swath bathymetry data as described later in this document.

10.3 Geophysical Survey Operations and Site Selection

The 2016 design survey operations began with mobilization of the *m/v Scarlett Isabella* in Boston, Massachusetts, on May 25, 2016. Mobilization efforts began with loading all survey equipment, determining the equipment layout, connecting towfish and tow cables, measuring vessel offsets and finally conducting a bench test of all survey equipment. On May 27, 2016, after conducting a project safety meeting with APTIM and vessel crews, the vessel left the dock and headed towards the project survey area boundaries in order to perform system calibrations and a wet test. After conducting the GAMS calibration, patch test and geophysical system deployment and testing, the vessel returned to the dock in Boston where final adjustments were made to the systems.

On May 29, 2016 the *m/v Scarlett Isabella* began transiting to the Moriches Inlet survey area in New York. Geophysical operations were completed in Moriches Inlet on June 2, 2016, at which time the vessel transited to the Fire Island survey area. After a crew change from June 8 through the 10, 2016, survey operations in Fire Island were completed on June 14, 2016. Operations in Fire Island Inlet in New York took place between June, 14, 2016 and June 18, 2016. From June 19, 2016 and June 24, 2016 field operations were taking place in the F1 survey site, with a crew change occurring on June 23, 2016. On June 24, 2016, after completing the remaining lines in F1, the *m/v Scarlett Isabella* transited to the MON2/MON4 survey site, where geophysical data collection was completed on June 29, 2016. A summary of the survey days per area can be found in Table 10 below.

Table 10: 2016 Design-level Geophysical Survey Operation Dates per Survey Area

State	*Survey Area*	*Survey Operation Dates*
New York	Moriches Inlet	May 29, 2016- June 02, 2016
New York	Fire Island	June 03, 2016- June 14, 2016
New York	Fire Island Inlet	June 14, 2016- June 18, 2016
New Jersey	F1	June 19, 2016- June 24, 2016
New Jersey	MON2_MON4	June 24, 2016- June 29, 2016

Standard QA/QC of data collected during the first shift of design-level data acquisition yielded minor concerns with vessel motion artifacts in the bathymetry data due to the large vessel size. Although the vessel motion artifact in the bathymetry data were within acceptable limits and could be corrected during post processing, APTIM chose to replace the POS MV SurfMaster with the POS MV OceanMaster, which is capable of correcting for larger vessel movements. Patch test bias values were updated due to movement of the IMU in relation to the vessel reference frame. Averaged bias results are presented in Table 11 below.

Table 11: Patch Test Bias Values for Phase 3

m/v Scarlett Isabella					
		Roll	Latency	Pitch	Yaw
POS M/V	Head 1	2.50	0.00	4.00	-1.00
Oceanmaster	Head 2	2.40	0.00	4.00	-1.00
POS M/V	Head 1	1.50	0.00	1.00	-1.00
Surfmaster	Head 2	1.60	0.00	1.00	-1.00

Daily survey operations were conducted in the same manner as the 2015 Reconnaissance survey described in section 2015 Reconnaissance-Level Survey (Phase 2), Geophysical Survey Operations section of this report (Section 9.3).

Upon completion of survey operations, the *m/v Scarlett Isabella* returned to its home dock in Boston, Massachusetts where demobilization took place until June 30, 2016 at which time all field personnel returned to their respective home offices. Field digital logs and field books for the 2016 design-phase geophysical survey operations are included in Appendix D and E.

10.3.1 Data Review and Geotechnical Site Selection

APTIM was not tasked with conducting a full analysis and interpretation of the geophysical data, however APTIM conducted a general review with minimal processing and interpretation in order to estimate average thicknesses and volumes of the potential resources. This was done to ensure the design-level geologic sampling (vibracore) collection effort targeted the highest potential areas of the resource within each design-level investigation area. APTIM reviewed the results of the design-level geophysical dataset and determined the following from each design-level investigation areas

BOEM ASAP Moriches Inlet Design Investigation Area (DIA) offshore New York was divided into two (2) higher-potential subareas; Moriches Inlet East and Moriches Inlet West (outlined as purple polygons on Map 38). Moriches Inlet East had an approximate average thickness of 1.9 m (6.2 ft), resulting in a potential volume of 2,641,700 m^3 (3,455,200 cy) (Table 12). Moriches Inlet West had an approximate average thickness of 2.1 m (6.9 ft), resulting in a potential volume of 2,099,200 m^3 (2,745,700 cy). In order to cover these areas with 305 m (1,000 ft) spaced design-level vibracores, 38 vibracores would have been required (black circles on Map 38).

BOEM ASAP Fire Island DIA offshore New York was divided into two (2) higher-potential subareas; Fire Island East and Fire Island West (outlined as purple polygons on Map 39). Fire Island East has an approximate average thickness of 2.1 m (6.9 ft), resulting in a potential volume of 12,405,700 m^3 (16,226,000 cy) (Table 12). Fire Island West has an approximate average thickness of 2.5 m (8.2 ft), resulting in a potential volume of 3,129,850 m^3 (4,093,700 cy). In order to cover these areas with 305 m (1,000 ft) spaced design-level vibracores, 98 vibracores would have been required (black and red circles on Map 39).

BOEM ASAP Fire Island Inlet DIA offshore New York was divided into two (2) higher-potential subareas; Fire Island Inlet East and Fire Island Inlet West (outlined as purple polygons on Map 40). Fire Island Inlet East had an approximate average thickness of 6.3 m (20.6 ft), resulting in a potential volume of 45,975,400 m^3 (60,133,600 cy) (Table 12). Fire Island Inlet West had an approximate average thickness of 4.8 m (15.7 ft), resulting in a potential volume of 1,416,500 m^3 (1,852,700 cy). In order to cover these areas with 305 m (1,000 ft) spaced design- level vibracores, 103 vibracores would have been required (black circles on Map 40).

BOEM ASAP F1 DIA offshore New Jersey was divided into two (2) higher-potential subareas; F1 North and F1 South (outlined as purple polygons on Map 41). F1 North had an approximate average thickness of 2.7 m (8.8 ft), resulting in a potential volume of 8,156,400 m^3 (10,668,200 cy) (Table 12). F1 South had an approximate average thickness of 3.2 m (10.5 ft), resulting in a potential volume of 8,126,600 m^3 (10,629,200 cy). In order to cover these entire areas with 305 m (1,000 ft) spaced design-level vibracores, 78 vibracores would have been required (black and red circles on Map 41).

BOEM ASAP MON-2/MON-4 DIA offshore New Jersey was divided into three (3) higher-potential subareas; MON-4, MON-2 North and MON-2 South (outlined as purple polygons on Map 42). MON-4 had an approximate average thickness of 4.4 m (14.5 ft), resulting in a potential volume of 12,494,800 m^3 (16,342,600 cy) (Table 12). MON-2 North had an approximate average thickness of 3.6 m (11.8 ft), resulting in a potential volume of 15,358,000 m^3 (20,087,600 cy). MON-2 South had an approximate average thickness of 3.6 m (11.8 ft), resulting in a potential volume of 7,304,600 m^3 (9,554,100 cy). In order to cover these areas with 305 m (1,000 ft) spaced design- level vibracores, 125 vibracores would have been required (black circles on Map 41).

In order to cover all of the DIA subareas containing potential beach-compatible sand deposits at 1,000-foot spaced design-level vibracores (spacing suitable for borrow-area design), APTIM would have needed to collect 442 total vibracores (Table 12). The total vibracore allocation is shown in Maps 38 through 42 as both black circles with crosshairs and red circles with crosshairs. As APTIM only had 90 vibracores available to collect as part of this phase, APTIM proposed and collected the sites depicted by the red circles with crosshairs.

Table 12: Preliminary Estimates of Thickness, Potential Volume, and Required Vibracore Allocation Needs to Cover DIA's

State	*Design Investigation Area (DIA)*	*Area (m^2)*	*Average Thickness (m)*	*Volume (m^3)*	*Volume (cy)*	*# of Vibracores (1,000 ft Spacing)*
New York	Moriches Inlet East	1,397,717	1.9	2,641,685	3,455,195	23
New York	Moriches Inlet West	1,009,266	2.1	2,099,274	2,745,747	15
New York	Fire Island East	5,907,476	2.1	12,405,700	16,226,047	80
New York	Fire Island West	1,267,160	2.5	3,129,886	4,093,737	18
New York	Fire Island Inlet East	7,286,123	6.3	45,975,437	60,133,619	98
New York	Fire Island Inlet West	298,204	4.8	1,416,470	1,852,673	5
New Jersey	F1 North	2,987,701	2.7	8,156,424	10,668,203	42
New Jersey	F1 South	2,563,606	3.2	8,126,630	10,629,234	36
New Jersey	MON-4	2,859,231	4.4	12,494,842	16,342,641	39
New Jersey	MON-2 North	4,242,569	3.6	15,358,099	20,087,641	59
New Jersey	MON-2 South	2,057,649	3.6	7,304,656	9,554,131	27
			Total	*119,109,101*	*155,788,868*	*442*

The BOEM ASAP Moriches Inlet DIA and its two subareas were smaller, thinner, and less homogenous than the other areas (Map 43). The subareas with beach-compatible sand thicknesses were also laterally restricted with potential dredgeability issues. As such, it was decided that this area, while having the potential for beach-compatible sands in project quantities, was not as favorable for allocating the limited design-level vibracores available as compared to other DIAs investigated as part of the ASAP 2106 design-level geophysical survey. Therefore, no design-level vibracores were proposed as part of this effort. Design-level geophysical data remain in place to aid in future vibracore collection and borrow area design efforts.

The BOEM ASAP Fire Island DIA, and its two subareas, consisted of three main sand shoal deposits. The two comprising Fire Island East consisted of one larger, wide shoal reaching 4 m (13.1 ft) in thickness, and a smaller, attached second shoal only 2.5 m (8.2 ft) thick. A third shoal in Fire Island West was the thickest, reaching over 4 m (13.1 in) in thickness. Based on the potential thickness, dredgeability, and location of these deposits, APTIM proposed the collection of 59 design-level vibracores within Fire Island DIA; 46 in the larger hill within the Fire Island East subarea and 13 within the Fire Island West subarea (depicted as purple circles in Map 44). Coupled with the reconnaissance vibracores already collected, the proposed vibracores would supply full, design-level coverage for two potential borrow areas that have the possibility for beach-compatible sand in project quantities of up to 147,128,200 m^3 (19,243,6400 cy) (Fire Island East) and 2,291,100 m^3 (2,996,600 cy) (Fire Island West).

The BOEM ASAP Fire Island Inlet DIA consisted of one, large, surficial sand deposit. This area is the thickest deposit investigated as part of the design-level geophysical survey mainly due to the fact that it is a surficial, non-shoal sand deposit with no obvious bottom (neither shown acoustically, using the geophysical data, or in the collected geologic data). Fire Island Inlet has significant paleofluvial channels cutting though and underneath the deposit, especially in the southwestern section. The subarea marked as the potential beach-compatible sand deposit (depicted as the purple polygon in Map 45) has large sections of the thickest area excluded from the deposit. This exclusion is solely due to complex, paleofluvial channels that appear to contain significant fine materials that are likely not beach compatible. While having beach-compatible sand units within them, the reconnaissance vibracores do confirm the presence of some finer material (as fine as 0.17 millimeter), material that may potentially be too fine for use on area beaches. While having the potential for beach-compatible sands in large project quantities, due to its complexity and the presence of significant paleofluvial systems, as well as the potential for a slightly lower mean grain size, this area was considered a lower priority candidate for the limited design-level vibracores available as compared to the other DIAs. Therefore, no design-level vibracores were proposed as part of this effort. Design-level geophysical data remain in place to aid in future vibracore collection and borrow area design efforts.

The BOEM ASAP F1 DIA, and its two subareas, consisted of three main sand shoal deposits. The F1 North subarea has two attached sand shoals. The northern shoal (attached in its central southern section to the southern shoal) is the thickest, approaching 6 m (19.7 ft), but is adjacent to a submarine cable buffer. The southern portion is also thick, reaching approximately 4 m (13.1 ft) in thickness, but has a lower/thinner crest. The dredgeability of the northern area may be questionable due to its location near a cable buffer (though well outside of the actual cable) and its overall geometry. The sand shoal in F1 South is much wider and has a maximum thickness of approximately 6 m (19.7 ft). This hill is relatively more dredgeable due to its geometry and distance away from obvious obstructions. Based on the potential thickness, dredgeability, and location of these deposits, APTIM proposed collection of 31 design-level vibracores within F1 DIA. The 31 design-level vibracores were collected within the F1 south subarea (depicted as purple circles in Map 46). Coupled with the reconnaissance vibracore already collected, the proposed vibracores supplied full, design-level coverage for one potential borrow area that has the possibility for beach-compatible sand in project quantities of up to 7,361,600 m^3 (9,628,600 cy). Due to the lateral constraints, geometry and potential dredgeability issues, design-level vibracores were not proposed in subarea F1 North at this time. Design-level geophysical data remains in place in subarea F1 North to aid in future vibracore collection and borrow area design efforts.

The BOEM ASAP MON-2/MON-4 DIA consisted of three main subareas, each one a single shoal trending northeast-southwest (Map 47). The northernmost shoal, MON-4 has a thickness of up to 9 m (29.5 ft). The central shoal, MON-2 North, consisted of a northwest, southwest trending shoal, reaching thicknesses of up to 7 m (23 ft). The southernmost shoal, MON-2 South has a thickness of up to 6 m (19.7 ft). The entire area is bound to the west by an ODMDS as well as extensive artificial reefs and debris. In addition, significant historic vibracores already exist within these deposits. All three subareas have potentially beach-compatible sand in project quantities and represent quality features to target for borrow area design. Based on the fact that significant historic geologic data already exist, APTIM thought it better to assign the limited design-level vibracores available to other DIAs to best leverage the available data. BOEM and/or interested parties may have enough data to do a preliminary borrow area design, at least for a portion of the area, and if not, would only need to collect a subset of the overall 305 m (1,000 ft) design- level vibracores to complete the data needed for design. Therefore, design-level vibracores were not planned in MON-2/MON-4 DIA as part of this effort. Design-level geophysical data, together with historic vibracore data remain in place throughout MON-2/MON-4 to aid in future vibracore collection and borrow area design efforts.

While the 2016 ASAP design-level geophysical data covered a large enough area to potentially design up to 119,109,200 m^3 (155,788,900 cy) of beach-compatible material, the limitation of 90 design-level vibracores as part of the geotechnical phase (to be placed at 305 m (1,000 ft) spacing to satisfy the general industry standard for borrow area design) reduced the final design-level coverage significantly. The 2016 ASAP design-level vibracore allocation is summarized in Table 13 below.

Table 13: Estimates Of Thickness, Potential Volume, and the Proposed Design-Level Vibracore Allocation for Phase 3

State	Design Investigation Area (DIA)	Area (m^2)	Average Thickness (m)	Volume (m^3)	Volume (cy)	# of Vibracores (1,000 ft Spacing)
New	F1 South	2,244,380	3.28	7,361,565	9,628,566	31
New	Fire Island East	3,588,492	4.10	14,712,816	19,243,642	46
New	Fire Island West	909,147	2.52	2,291,051	2,996,583	13
			Total	*24,365,432*	*31,868,791*	*90*

It is important to point out that these volumes are preliminary volume estimates of potential resources, resulting from an initial review of design-level geophysical and geotechnical data. These data have not been fully processed or interpreted, and therefore, the overall volume may actually decrease due to environmental, cultural, accessibility, and/or compatibility reasons after detailed processing and a borrow area design process is completed.

10.3.1.1 Cultural Resource Review - Site Clearance

Prior to collecting any vibracores, sites were cleared by a marine archaeologist at TAR as described in the 2015 Reconnaissance-Level Survey (Phase 2) Cultural Resource Review - Site Clearance section (Section 9.3.2.1). TAR submitted clearance and approval letters for the New Jersey sites on the July 29, 2016 and for the New York sites on July 30, 2016, both of which are included in Appendix B.

10.3.1.2 Bathymetry data processing

The design-level interferometric swath bathymetry data collected with the EdgeTech 6205 were processed as described in the 2015 Reconnaissance-Level Survey (Phase 2) Bathymetry Data Processing section (Section 9.3.2.2) with the addition of post-processing of the attitude and position data using Applanix's POSPac Mobile Mapping Suite (POSpac MMS). Post-processed attitude and position data were exported from POSpac MMS as a smoothed best estimate trajectory (SBET) file and applied within Hypack's MBMAX64. Post-processed ellipsoidal heights were utilized for tidal corrections using MBMAX64's real time kinematic tide correction function using Geoid12b. Swath coverage was sufficient to minimize beam angle to forty-five (45) degrees port and starboard channel in order to utilize high quality beams. Beam angles were not limited in shallow water segments of the survey areas to maximize data coverage.

A vertical offset was discovered when comparing portions of 2015 reconnaissance bathymetry data that overlaps with the 2016 design level survey. The reconnaissance level data relied on a combination of regional observed tidal data and satellite based augmented system (SBAS) GNSS corrections for water levels. This tidal method was an efficient and cost effective method to derive water levels for the vast survey areas. The reconnaissance level survey was determined to be within the accuracy needed to establish the general bathymetric conditions of isolated survey lines. The 2016 design survey utilized post-processed GNSS data that produces higher confidence ellipsoidal heights and tidal corrections when applied within MBMax64. The difference between the two methods for deriving tidal heights and vertical elevations is the source of the vertical offsets between the 2015 and 2016 data.

10.4 Geotechnical Survey Operations

The design-level geotechnical collection effort consisted of collecting 90 vibracores within five (5) design-level areas offshore New York and New Jersey. The design-level geologic sampling cruise mobilized in Ft. Pierce, Florida prior to transiting north towards the survey areas. APTIM scientists and vessel crew members boarded the vessel in Point Pleasant, New Jersey and sampling commenced on August 9, 2016. The design-level geologic sample collection was completed on September 2, 2016. Geotechnical vibracores in New Jersey were collected between August 9, 2016 and August 16, 2016 and vibracores in New York were collected between August 16, 2016 and September 2, 2016 (Table 14). Geotechnical survey operations were delayed due to weather on August 12, 2016, and delayed due to repairs from August 29th through the 30th. APTIM conducted two crew changes, one on August 17, 2017 and the second on August 26, 2017. Field books for the 2016 design-phase geotechnical survey operations are included in Appendix E.

Table 14: 2016 Design-level Geotechnical Survey Operations per Survey Area

State	*Survey operation dates*
New York	August 16, 2017- September 2,2017
New Jersey	August 9, 2017- August 16, 2017

10.4.1 Geotechnical data sampling/processing

A total of 555 vibracore subsamples were collected from the 90 vibracores and analyzed at APTIM's accredited geotechnical laboratory in Boca Raton, Florida (Table 15). Geologic subsample information and results (vibracore logs, granularmetric reports, grain size distribution curves exported from gINT into formatted templates in *.pdf* format, vibracore photographs in *.pdf* and *.jpg* formats, gINT project files, and *.xls* files exported from gINT) were submitted to BOEM on December 6, 2016.

Geotechnical data sampling and processing for Phase 3 were conducted as described in the 2015 Reconnaissance-Level Survey (Phase 2) Geotechnical Data Sampling/Processing section (Section 9.4.1), with the exception that surface grab samples were not collected during Phase 3.

Table 15: 2016 Design-Level Vibracore Allocation and Analyzed Subsamples per Survey Area

State	*Vibracores*	*Analyzed Subsamples*
New York	59	380
New Jersey	31	175
Total	*90*	*555*

10.4.2 Mitigation

For the 2016 Design-Level survey (Phase 3), APTIM followed the same protocols, rules and regulations as described in the 2015 Reconnaissance-Level Survey (Phase 2) Mitigation section (Section 9.2).

11.0 2017 Design-Level Survey (Phase 4)

Upon completion of the original project scope in 2016, BOEM was able to secure additional Hurricane Sandy contingency funding that had remained unallocated after other Hurricane Sandy projects were completed. This new fourth phase consisted of collecting an additional 820 km (443 nm) of design-level geophysical data and 90 vibracores along the Atlantic OCS. Once awarded the change order contract, BOEM and APTIM began discussing locations to collect additional data. The final decision on which states would receive the additional data took into account the available phase funds and how to efficiently maximize data coverage along the coast. As part of the discussion, APTIM prepared draft sediment thickness (isopach) surfaces for the 2015 reconnaissance-level investigation areas between Montauk, New York and the Virginia/North Carolina state line that, based off the reconnaissance-level survey, appeared to be areas of potential beach-compatible sands. APTIM also prepared draft cost estimates for doing additional work spread between Montauk, New York and the Virginia/North Carolina state line (larger, more expensive mobilization/survey area) or additional work limited to offshore New Jersey and Delaware (smaller, less expensive mobilization/survey area). Upon reviewing the maps and cost estimates, BOEM decided (and communicated to APTIM) that the geophysical and geotechnical data allocation for the fourth phase would be assigned to Delaware and New Jersey, as both areas had Hurricane Sandy impacts and pending projects in need of sand resources.

As part of the survey planning, APTIM conducted state meetings with representatives in New Jersey and Delaware. During those meetings, both states provided APTIM with areas of interest along the coastline. New Jersey was interested in an area designated as G1, while Delaware had some scattered areas of interest, however was more focused on augmenting their geophysical and geotechnical reconnaissance-level database. The individual site selection process and phase goals are explained in detail in the Design Site Selection below.

11.1 Design Site Selection

BOEM and APTIM, together with the state cooperative agencies and other stakeholders, held multiple discussions to finalize a specific survey plan. Those decisions and the resulting 2017 data acquisition plan are described below.

11.1.1 New Jersey

In coordination with New Jersey stakeholders, including USACE, BOEM indicated an interest in potential OCS resources in the area identified as G1 offshore Brigantine, New Jersey. The area was delineated by USACE Philadelphia District and a shapefile of the site was provided by BOEM and New Jersey stakeholders. The shape straddles the Federal/State boundary, extending approximately 324 m (1,062 ft) west of the boundary into state waters. In addition, the G1 area overlaps with a portion of APTIM's BOEM ASAP 2015 reconnaissance geophysical tracklines. APTIM's BOEM ASAP 2015 reconnaissance data indicated that a bathymetric high, potentially consisting of beach-compatible material, lies within the area northeast of G1 (Map 48). Although no reconnaissance geologic sample sites were located within G1, sample analysis of New Jersey vibracores NJ-BOEM-2015-VC18, NJ-BOEM-2015-VC20 and NJ-BOEM-2015-VC23, indicated favorable material within the vibracore samples. Geologic sample sites classified as favorable contain greater than 50% sand (throughout the vibracore), low silt and/or clay content and little to no shell and/or rock and gravel.

APTIM proposed to survey the entire area east of the Federal/State boundary and extend a 305 m (1,000 ft) buffer along the southern and eastern boundaries of G1. In addition, APTIM proposed to extend the survey lines approximately 2.3 km (1.2 nm) north and east to maximize the overall borrow area deposit potential and volume based on the preliminary 2015 BOEM ASAP reconnaissance isopach and granularmetric results of NJ-BOEM-2015-VC23. The remaining portion of G1, which lies west of the Federal/State boundary in state waters, was not surveyed due to contract requirements and the environmental assessment created for the ASAP project, which permits survey activities within Federal waters only.

A total of 341 km (184 nm) of geophysical data were planned for collection within and adjacent to the New Jersey G1 area. APTIM personnel planned to start the survey by collecting every fourth line in order to provide a general idea of the sub-surface geology of the area. Once the sand hills (or other beach-compatible materials) were identified, the planned line file was to be modified (i.e. some lines extended or cut short) to allow for better coverage of the best areas of interest. The main survey lines trended in a northeast, southwesterly direction and were spaced 30 m (98 ft) apart with tie lines spaced roughly 500 m apart (1,640.4 ft), perpendicular to the main survey lines.

Map 48 depicts APTIM's proposed geophysical survey lines for the 2017 design-level data acquisition offshore New Jersey.

11.1.2 Delaware

APTIM held a conference call with BOEM and Delaware stakeholders on April 7, 2017 to discuss survey area selection, data allocation and survey layout criteria. Based on historic data coverage and APTIM's 2015 data, Delaware stakeholders requested that the 2017 data allocation be used to collect data at a reconnaissance-level spacing. Specifically, data collection was focused 5.5 km to 10.1 km (3 nm to 5.5 nm) offshore from Rehoboth Beach to the Delaware/Maryland border, where limited historic data exist. In addition, Delaware stakeholders provided three (3) areas where potential resources may exist; two (2) areas were located east and southeast of Rehoboth Beach and one (1) area located southeast of Bethany Beach. APTIM proposed to collect additional data in the areas of the potential resources at a higher-level reconnaissance spacing to locate and delineate the potential resources in higher detail.

The potential resource located east of Rehoboth Beach is in a distal sand flat approximately 9.3 km (5 nm) offshore of APTIM's 2015 reconnaissance-level geophysical tracklines and vibracore DE-BOEM-2015-VC03. The granularmetric results from DE-BOEM-2015-VC03 indicated a mean grain size of approximately 0.15 mm, which APTIM recognized to be finer than the native beach sand of approximately 0.35 mm (or larger) and classified as unfavorable; therefore, the area was avoided as part of APTIM's initial planning for the 2017 survey effort. Delaware stakeholders with the Delaware Geological Survey indicated their preference to investigate areas indicative of finer grain sizes to reduce overall shell content, which has been perceived as armoring the shoreface after previous restoration efforts. Aligned with Delaware stakeholder's request, APTIM allocated a portion of the 2017 data budget to the distal sand flat to further delineate the potential resource.

The granularmetric results of APTIM's vibracores DE-BOEM-2015-VC05 and DE-BOEM-2015-VC01 (on Fenwick Shoal), located east and southeast of Bethany Beach, indicated favorable material. The 2017 acquisition plan served to expand upon the 2015 reconnaissance data. Tracklines were added between the 2015 reconnaissance data to further investigate the potential resources in the areas of the favorable vibracore samples (Map 49).

A total of 479 km (259 nm) were planned for geophysical data collection offshore Delaware (Map 49). The majority of the main survey lines trend in a north, south direction with tie lines running perpendicular to the main survey lines trending in an east-west direction. The planned survey lines in the area of APTIM's reconnaissance vibracore DE-BOEM-2015-VC01, on Fenwick Shoal, trend in a northeast-southwest direction with perpendicular tie lines trending northwest-southeast, in an effort to better characterize the Fenwick Shoal sand deposit. The survey lines were laid out at a more detailed reconnaissance level for the entire Delaware geophysical data collection effort ranging from 225 m (738 ft) to 900 m (2,953 ft) apart based on locations of potential resources and specific requests from BOEM and Delaware stakeholders.

11.2 Systems, Equipment, Operations and Methods

2017 design-level geophysical survey operations resulted in the collection of 893 km (482 nm) of geophysical data (chirp sub-bottom, sidescan sonar, magnetometer and swath bathymetry) acquired along the New Jersey and Delaware OCS. The geophysical survey vessel and systems APTIM used are described in detail below.

11.2.1 Geophysical Survey Equipment

For the 2017 Design-Level geophysical survey (Phase 4), APTIM utilized Hypack 2017 as the navigation software, the EdgeTech 3200 sub-bottom profiler with a 512i towfish, a Geometrics G-882 Digital Cesium Marine Magnetometer and a EdgeTech 4200-HFL sidescan sonar system. Information on these systems can be found in the 2015 Reconnaissance-Level Survey, Geophysical Survey Equipment section (Section 9.1.1). Instruments utilized during the 2017 design-level survey that differ from those used during the reconnaissance-level survey in 2015 are described below.

11.2.1.1 Navigation and Motion Reference Unit

An Applanix position orientation system (POS) MV OceanMaster GNSS system was used for the 2017 design-level data collection for positioning and vessel motion. The system was mounted to the survey vessel and used to collect attitude, heading, heave, position and velocity data of the survey vessel (Figure 14). The Applanix POS MV family is an inertially aided motion unit that provides highly accurate attitude corrections. The POS MV works by combining GNSS data with IMU angular rate and acceleration and GAMS, for a position accuracy of 0.5 to 2 m^2 (5.3 ft to 21.5 ft^2), roll and pitch accuracy of 0.02°, and a heading accuracy of 0.01° (4 m/13.1 ft) baseline).

Figure 14: Applanix POS MV motion and attitude system

GAMS calibration is required to calculate the misalignment of the inertial navigator to the heading produced from GAMS. Calibration is performed through careful physical measurement of system components and aggressive maneuvering of the survey vessel to reduce the dynamic heading alignment below one (1) degree (approximately) and subsequently calculate the misalignment with the GAMS heading. Motion data were logged (as a .raw Hypack file) and integrated into all applicable systems.

POS M/V data groups were logged at 25 Hz for post-processing using Applanix's POSPac Mobile Mapping Suite (POSpac MMS). POSpac MMS utilizes GNSS observation data from National Geodetic Survey Continually Operating Reference Stations (NGS CORS) to increase overall positional accuracy allowing for ellipsoidal tidal corrections and a more robust attitude solution. Post-processed POS M/V data were applied to the swath bathymetry data as described later in this document.

11.2.1.2 Multibeam Bathymetry

For the 2017 Phase 4 survey, APTIM used a Reson Seabat 7125 SV2 multibeam echosounder system to collect swath bathymetry data (Figure 15) as opposed to the previously used interferometric sonar system. The goal of using the multibeam echosounder system was to collect and provide a bathymetry data product with improved accuracy, resolution and coverage. While the multibeam bathymetry system used for Phase 4 (described below) achieved these goals, it does not collect interferometric backscatter data, and as such, no interferometric backscatter data were collected for Phase 4. Sidescan sonar backscatter data, however, was collected as was done for the previous phase field investigations

Figure 15: Image of the Reson Seabat 7125 SV2 multibeam echosounder system

The Reson Seabat 7125 SV2 multibeam echosounder system's standard configuration includes an over-the side vessel pole mount, sound velocity sensor at the sonar head, and is easily integrated with standard motion reference units, sound velocity profilers, and altimeters. Sound velocity profiles were be taken at the beginning and end of each day and throughout the survey day via an underway sound velocity (SV) system as needed to adjust for changes in sound velocity in the water column. The 7125 SV2 is a selectable dual frequency multibeam echosounder, and can operate at 200 kHz with 1.0 degree across track and 2.0 degree along track focus or 400 kHz with 0.5 degree across track and 1.0 degree along track focus. The 400 kHz frequency was selected for this survey. The multibeam head was installed to line up as closely as possible with the across-beam axis of the vessel's center of mass and in conjunction with the POS/MV IMU. Horizontal and vertical offsets from the multibeam heads to the navigation antennas and IMU were measured and applied in Hypack Hysweep hardware. Multibeam soundings and real time sound velocity measurements at the sonar head were recorded directly to Hysweep acquisition software. The maximum useable swath of the bathymetry was based on water depth and was monitored by APTIM scientists in an effort to collect the maximum amount of data.

The Reson 7125 was fully integrated with an Applanix POS MV OceanMaster motion reference unit to correct swath bathymetry data for vessel motion. Navigation and horizontal positioning for the Reson 7125 was provided by the GNSS system, with the motion data provided by the Applanix POS MV OceanMaster system via Hypack. Bathymetry data were recorded in *.hsx* files and *.raw* (Hysweep/Hypack file) format.

Prior to the start of bathymetric data collection, a single head patch test was conducted for the Reson Seabat 7125 SV2 system to precisely measure system misalignments in relation to the vessel's reference frame. Offsets were calculated for latency, roll, pitch and yaw. In brief, the patch test was performed by collecting two (2) parallel survey lines perpendicular to a slope (or object) on the seafloor in a specific reciprocal pattern to account for latency, pitch, and yaw biases. One (1) additional survey line was collected over flat bottom in reciprocal direction to account for roll bias. Survey lines were spaced two (2) to three (3) times the water depth to allow for sufficient overlap of swaths. The collected patch test data were loaded into Hysweep editor and processed using the Patch Test utility. System latency was negligible due to the incorporation of a one pulse per second (1 PPS) timing device. Patch tests were required at the onset of the survey and whenever the side-mount pole, IMU, or antennas were moved.

Patch test trials were re-processed upon completion of the survey using post-processed SBET files from POSPac MMS. The application of SBET files and ellipsoidal tides improved consistency throughout all patch test trials. Final patch test bias results are embedded in all processed bathymetry files and are presented below in Table 16.

Table 16: Patch Test Bias Results for Phase 4

m/v Atlantic Surveyor				
	Roll	Latency	Pitch	Yaw
Head 1	0.30	0.00	-2.50	-0.50

11.2.2 Geotechnical Survey Equipment

11.2.2.1 Samantha Miller

For 2017, APTIM teamed with Alpine Ocean Seismic Survey, Inc. (Alpine) to collect the vibracores. For the first part of the geotechnical survey operations conducted in New Jersey, Alpine utilized the *m/v Samantha Miller*, owned and operated by Miller's Launch in Staten Island, New Jersey (Figure 16). The *m/v Samantha Miller* is a 20 m (65.6 ft) long utility/crane/offshore supply vessel with a 2 m (6.5 ft) draft. It has a maximum cursing speed of 9 kt, and has a fuel capacity of 12,000 gallons. It is equipped with a 4-ton hydraulic crane, 50' telescopic boom which was used to deploy and retrieve the vibracore rig.

Figure 16: *m/v Samantha Miller*

11.2.2.2 r/v Shearwater

Alpine's *r/v Shearwater*, based in Norwood, New Jersey, served as the vibracore collection platform on the second part of the field operation (Figure 17 and 18). Built in 1981, refit and repowered in 2011, the *r/v Shearwater* is a 33.5 m (110 ft) steel-hulled vessel with a draft of 2.7 m (8.85 ft). The vessel has a gross tonnage of 198 tons and is equipped with twin John Deere 526 horsepower engines, a fuel capacity of 13,800 gallons and two (2), 135 kW John Deere generators. The vessel is certified to carry 20 persons and has a potable water capacity of 5,000 gallons. The *r/v Shearwater* is USCG approved and compliant with 29 CFR sub chapter T Oceans. The vessel has a clear deck area of 109 m^2 (1,173 ft^2) and is equipped with a stern mounted 2 Ton A-frame and winch.

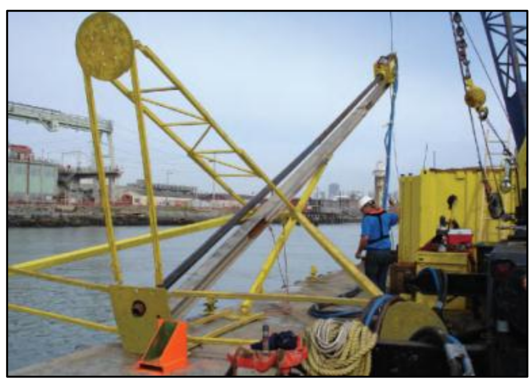


Figure 17 (left): Alpine's *r/v Shearwater* and Figure 18 (right): 271 Alpine Pneumatic Vibracore

11.3 Geophysical Survey Operations and Site Selection

11.3.1 Survey Operations

The 2017 design-level investigation campaign began on April 18, 2017, with the geophysical and survey crew arriving in Point Pleasant, New Jersey and the systems loaded onto the *m/v Atlantic Surveyor*. Mobilization efforts consisted of setting up the equipment layout and tow points, setting up systems, connecting cables, setting up top-side boxes and measuring offsets. Final system set-up and bench testing was conducted on April 19, 2017. On April 20 and 21, 2017, the survey vessel left the dock to perform a wet test and system calibrations, including GAMS calibration, patch test and beam angle test for the Reson 7125. Upon completion of the calibrations and review of the results acquired, the survey team transited to the New Jersey survey area at the end of the day on April 21, 2017.

Survey operations started in the G1 area on April 22, 2017, with every fourth line being collected. From April 25 through April 27, 2017, operations were placed on hold due to bad weather, which gave the APTIM team time to review the already collected geophysical data and make adjustments to the planned line file so the sand hills/shoals and other areas with the most potential sand volume were properly mapped. Between April 27, and April 28, 2017 a partial crew change took place with some of APTIM's personnel being replaced. Survey operations continued in the G1 area on April 28, 2017 and were completed on May 1, 2017, at which time the vessel returned to Point Pleasant, New Jersey due to weather and for a second partial crew change. On May 02, 2017, the *m/v Atlantic Surveyor* left New Jersey and began its transit to the Delaware survey and calibration area.

Collection of the Delaware survey lines began on May 03, 2017 and continued until May 5, 2017, at which time operations were placed on hold due to weather. On May 7, 2017 Delaware survey operations were resumed and were completed on May 12, 2017, at which time the vessel began to transit back to Point Pleasant, NJ for demobilization. While transiting up to New Jersey, the vessel had to take shelter in Atlantic City on May 13 and 14, 2017, before arriving at the dock in Point Pleasant on May 20, 2017. While the vessel was at Atlantic City, APTIM's survey team began demobilization by offloading some of the systems for transport back to the St. Petersburg, Florida office. Once the *m/v Atlantic Surveyor* arrived at Point Pleasant, the last items were removed from the vessel and demobilization efforts were completed on May 18, 2017.

Daily survey operations for Phase 4 were conducted in the same manner as described in the 2015 Reconnaissance-Level Survey, Geophysical Survey Operations and Site Selection section (Section 9.3). Field digital logs and field books for the 2017 design-phase geophysical survey operations are included in Appendices D and E.

The 2017 design-level geophysical survey resulted in the collection of 893 km (482 nm) to geophysical data, with 391 km (211 nm) being collected offshore New Jersey and 502 km (271 nm) offshore Delaware.

11.3.2 Data Review and Geotechnical Site Selection

APTIM personnel were not tasked with conducing any processing of the geophysical data acquired during the survey. However, in order to strategically place the available vibracores, some data review was necessary. Since each survey area was designed and planned in order to fulfill different objectives, APTIM used a different approach to reviewing the data for each state.

11.3.2.1 New Jersey

The survey in the G1 area was planned to allow for future borrow area design, which requires vibracores to be placed at a 305 m (1,000 ft) centers in the areas of interest. For the purpose of properly placing the available 90 vibracores, much like the process conducted for the 2016 design-level data processing, the chirp sub-bottom data was imported into SonarWiz and the boundary between the likely beach-compatible and non-beach-compatible material was digitized and a isopach surface was generated. From that surface, areas with a sediment thickness greater than 2 m (6.5 ft) were isolated (see purple polygons in Map 50) as the 2017 geotechnical investigation areas.

Vibracores were then plotted to comply with the industry standard of care which suggest that an area of interest be sampled by vibracores placed at 305 m (1,000 ft) centers. The four 2017 investigation areas in the G1 survey area were sampled by 64 vibracores.

11.3.2.2 Delaware

The survey in the area offshore Delaware was intended to append the existing database of geophysical data along the coastline and provide a better understanding of the general sub-surface geology and stratigraphic record. As such, the geophysical chirp sub-bottom data was imported into SonarWiz, bottom tracked, gained and inspected for any sub-surface geologic features indicative of sand deposits.

The vibracores in Delaware were placed following the general guidelines used during the reconnaissance phase of the project in 2015. Since the geophysical data were not collected in a manner that would allow for a thickness surface to be generated, vibracores were placed based on areas that the state was interested in, where the sub-surface geology indicated the potential presence of a sand deposit and locations were there was a lack of historic geotechnical data coverage (Map 51). The remaining 26 vibracores were allocated throughout the Delaware coastline, with 11 on the northern sand flat, four (4) in the central area and 11 in Fenwick Shoal.

11.3.2.3 Cultural Resource Review - Site Clearance

Prior to collecting any vibracores, sites were cleared by a marine archaeologist at TAR as described in the 2015 Reconnaissance-Level Survey (Phase 2) Cultural Resource Review - Site Clearance section (Section 9.3.2.1). TAR submitted clearance and approval letters for the New Jersey sites on the June 26, 2017 and for the Delaware sites on July 6, 2017 which are included in Appendix B.

11.3.2.4 Bathymetry data processing

The 2017 Phase 4 design-level multibeam bathymetry data collected with the Reason 7125 were processed as described in the 2016 Design-Level Survey (Phase 3), Bathymetry Data Processing section (Section 10.3.1.2).

11.4 Geotechnical Survey Operations

The design-level geotechnical collection effort consisted of collecting 90 vibracores offshore of Delaware and New Jersey. The design-level geologic sampling cruise began mobilization on July 6, 2017 and completed mobilization on July 7, 2017 onboard the *m/v Samantha Miller* in Staten Island, NJ. Once mobilization was complete, the survey vessel transited to Atlantic City, arriving onsite on July 8, 2017. While still at the dock, APTIM, Alpine and vessel crew conducted a safety meeting and practiced deployments of the vibracore rig. Once the practice deployments were finalized, the vessel transited to the G1 survey site where it collected one vibracore before returning to the Atlantic City dock. Operations continued until July 11, 2017 at which time a safety stand-down was conducted to review rig deployment and retrieval procedures and general deck safety protocols. Survey operations in the G1 survey area onboard the *m/v Samantha Miller* resumed on July 12, 2017 and were completed on July 22, 2017, at which time the vessel began transiting to Lewes, Delaware.

Geotechnical survey operations in Delaware began on July 23, 2017, and were down for weather on July 24, 2017. A vibracore was collected on July 25, 2017, however operations were terminated due to mechanical issues. No vibracores were collected on July 26, 2017 due to bad weather. On July 27, 2017, after completing a single vibracore site, operations were shut down for weather and the vessel transited to Ocean City, Maryland. Upon arriving in Ocean City, the decision was made to switch from the *m/v Samantha Miller* to the *m/v Shearwater*, therefore, APTIM personnel removed all equipment from the vessel and returned home while Alpine's team re-mobilized their equipment onboard the *m/v Shearwater*.

On July 31, 2017 the survey team returned to Elizabeth, New Jersey to meet and re-mobilize the *m/v Shearwater*. Once mobilization was complete, the vessel transited to Delaware, where it began geotechnical survey operations on August 1, 2017. Vibracore operations were completed on August 3, 2017, at which time the vessel returned to Elizabeth, NJ, arriving on August 4, 2017 completing the geotechnical survey operations. The vessel was demobilized and the remaining Delaware vibracores were offloaded for transport. A summary of the operations completion dates per area can be found in Table 17. Field books for the 2017 geotechnical survey operations are included in Appendix E.

Table 17: 2017 Design-Level Geotechnical Survey Operation Dates per Survey Area

State	*Survey operation dates*
New Jersey	July 8, 2017- July 22, 2017
Delaware	July 23, 2017- August 3, 2017

11.4.1 Geotechnical data sampling/processing

A total of 592 vibracore subsamples were collected from the 90 vibracores and analyzed at APTIM's accredited geotechnical laboratory in Boca Raton, Florida (Table 18). Geologic subsample information and results (vibracore logs, granularmetric reports, grain size distribution curves exported from gINT into formatted templates in *.pdf* format, vibracore photographs in *.pdf* and *.jpg* formats, gINT project files, and *.xls* files exported from gINT) were submitted to BOEM on October 20, 2017.

Table 18: 2017 Design-Level Vibracore Allocation and Analyzed Subsamples per Survey Area

State	*Vibracores*	*Analyzed Subsamples*
New Jersey	64	436
Delaware	26	156
Total	*90*	*592*

Geotechnical data sampling and processing for Phase 4 were conducted as described in the 2015 Reconnaissance-Level Survey (Phase 2) Geotechnical Data Sampling/Processing section (Section 9.4.1), with two exceptions. The exceptions were that surface grab samples were not collected at this time, and the photographs were taken utilizing the fine image compression setting.

After the Phase 2 and Phase 3 data were shared by BOEM to their cooperative agency partners, there were some concerns mentioned related to the quality of the vibracore photographs. As a result, APTIM reviewed our procedures and settings and changed the camera image compression from "Normal" to "Fine", allowing for the camera to shoot at high quality. As such, the vibracore photographs for Phase 4 of are higher quality and resolution than the Phase 2 and 3 photographs.

11.5 Mitigations

For the 2017 Design-Level survey (Phase 4), APTIM followed the same protocols, rules and regulations as described in the 2015 Reconnaissance-Level Survey (Phase 2) Mitigation section (Section 9.2).

12.0 Submittals

Throughout the life of the project, APTIM has provided BOEM with timely submittals of project data, reports and quarterly updates on project schedule. Prior to commencement, APTIM held state and government stakeholder meetings to identify areas of potential beach compatible sources of sand in proximity to coastal areas where those resources are likely to be needed and gained information on stakeholder areas of interest. APTIM submitted Data Acquisition Plans prior to each collection effort to BOEM and stakeholders for review and comment, APTIM finalized each acquisition plan accordingly to meet the needs of both state and federal agencies in order to provide a comprehensive dataset without duplicating historical data collection efforts. Following collection, geophysical and geologic data were submitted to BOEM via portable hard drive. Tables 19 and 20 below outline APTIM's geophysical, geologic data submittals and project document submittals. All submitted quarterly reports are also included in Appendix F.

13.0 Summary

APTIM was contracted by BOEM on September 10, 2014, to conduct an Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continent Shelf of the United States. The study area was located from 5.6 kilometers (km) (3 nautical miles) offshore to 14.8 km (8 nm) offshore U.S. coastlines on the Atlantic OCS within water depths of 30 m (98 ft). OCS sand sources are limited to 30 m (98 ft) of water depth due to practical and economical limitations of the current dredging industry, including restrictions of the current dredging fleet that is available to U.S. beach nourishment projects. APTIM conducted a reconnaissance geophysical data and geologic sample collection effort offshore Florida to Massachusetts in 2015 and a design-level geophysical survey and geologic sample collection effort offshore New York and New Jersey in 2016. In addition, BOEM added a second design-level investigation for 2017. Overall, the project resulted in the collection a total of 7,089 km (3,828 nm) of geophysical (chirp sub-bottom, sidescan sonar, magnetometer, and swath bathymetry) data and 440 geologic sample sites (340 vibracores and 100 surface grab samples) (Table 21).

APTIM was not tasked with conducting a full analysis and interpretation of the geophysical data (beyond QA/QC analyses). However, APTIM conducted a general review with minimal processing and interpretation in order to ensure geologic sample placement for reconnaissance and design-level geologic investigations by estimating average thicknesses and volumes of potential sand resources. Based on minimal geophysical data processing and the results of the geologic sample

Table 19: Geophysical and Geotechnical Data Submittal Dates

State	*2015 Recon Geophysical Data Submittal*	*2015 Recon Processed Swath Bathymetry Data*	*2015 Recon Processed Geotechnical data*	*2016 DL Geophysical Data Submittal*	*2016 DL Processed Swath Bathymetry Data*	*2016 DL Processed Geotechnical data*	*2017 DL Geophysical/Processed Swath Bathymetry Data Submittal*	*2017 DL Processed Geotechnical data*	*All (2015, 2016, & 2017) Raw Hydrographic Data*
Massachusetts	September 9, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	N/A	N/A	October 20, 2017
Rhode Island	September 9, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	N/A	N/A	October 20, 2017
New York	September 9, 2015	April 14, 2016	September 12, 2016	August 5, 2016	December 6, 2016	December 6, 2016	N/A	N/A	October 20, 2017
New Jersey	August 12, 2015	April 14, 2016	September 12, 2016	August 5, 2016	December 6, 2016	December 6, 2016	September 21, 2017	October 20, 2017	October 20, 2017
Delaware	August 12, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	September 21, 2017	October 20, 2017	October 20, 2017
Maryland	August 12, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	N/A	N/A	October 20, 2017
Virginia	August 12, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	N/A	N/A	October 20, 2017
North Carolina	June 16, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	N/A	N/A	October 20, 2017
South Carolina	June 16, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	N/A	N/A	October 20, 2017
Georgia	June 16, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	N/A	N/A	October 20, 2017
Florida	June 16, 2015	April 14, 2016	September 12, 2016	N/A	N/A	N/A	N/A	N/A	October 20, 2017

Table 20: Project Management Submittal Dates

Project Deliverables	
Document	*Submittal*
Project Management Plan	January, 13, 2015
Data Management Plan	January 15, 2015
Reconnaissance Data Acquisition Plan	March 24, 2015
2014 - 4th Quarter Progress Report	May 15, 2015
2015 - 1st Quarter Progress Report	May 15, 2015
Project Health and Safety Plan	April 9, 2015
2015 - 2nd Quarter Status Report	July 15, 2015
2015 - 3rd Quarter Status Report	October 8, 2015
2015 - 4th Quarter Status Report	December 29, 2015
Design-Level Data Acquisition Plan	May 24, 2016
2016 - 1st Quarter Status Report	April 6, 2016
2016 - 2nd Quarter Status Report	July 8, 2016
2016 - 3rd Quarter Status Report	October 19, 2016
2016 - 4th Quarter Status Report	January 10, 2017
2017 - 1st Quarter Status Report	May 24, 2017
2017 Design-Level Data Acquisition Plan	
2017 - 2nd Quarter Status Report	July 31, 2017
2017 - 3rd Quarter Status Report	October 18, 2017
Draft Final Report of Findings	October 20, 2017
Final Report of Findings	

Table 21: Project As Collected and Project Percent Allocation per State

	2015 Reconnaissance		*2016 Design*		*2017 Design*		*Total*			
	As Collected	*As Collected*	*As Collected*	*As Collected*	*As Collected*	*As Collected*	*As Collected*		*As Collected*	
	km	*number*	*km*	*number*	*km*	*number*	*km*	*%*	*number*	*%*
Maine	0	0	0	0	0	0	0	0.00%	0	0.00%
New Hampshire	0	0	0	0	0	0	0	0.00%	0	0.00%
Massachusetts	216	14	0	0	0	0	216	3.05%	14	3.18%
Rhode Island	54	10	0	0	0	0	54	0.76%	10	2.27%
New York	768	49	1122	59	0	0	1890	26.65%	108	24.55%
New Jersey	969	52	736	31	391	64	2096	29.57%	147	33.41%
Delaware	203	8	0	0	502	26	705	9.94%	34	7.73%
Maryland	100	8	0	0	0	0	100	1.41%	8	1.82%
Virginia	201	10	0	0	0	0	201	2.84%	10	2.27%
North Carolina	587	37	0	0	0	0	587	8.28%	37	8.41%
South Carolina	511	30	0	0	0	0	511	7.21%	30	6.82%
Georgia	203	12	0	0	0	0	203	2.86%	12	2.73%
Florida	527	30	0	0	0	0	527	7.43%	30	6.82%
Total	*4339*	*260*	*1857*	*90*	*893*	*90*	*7089*	*100.00%*	*440*	*100.00%*

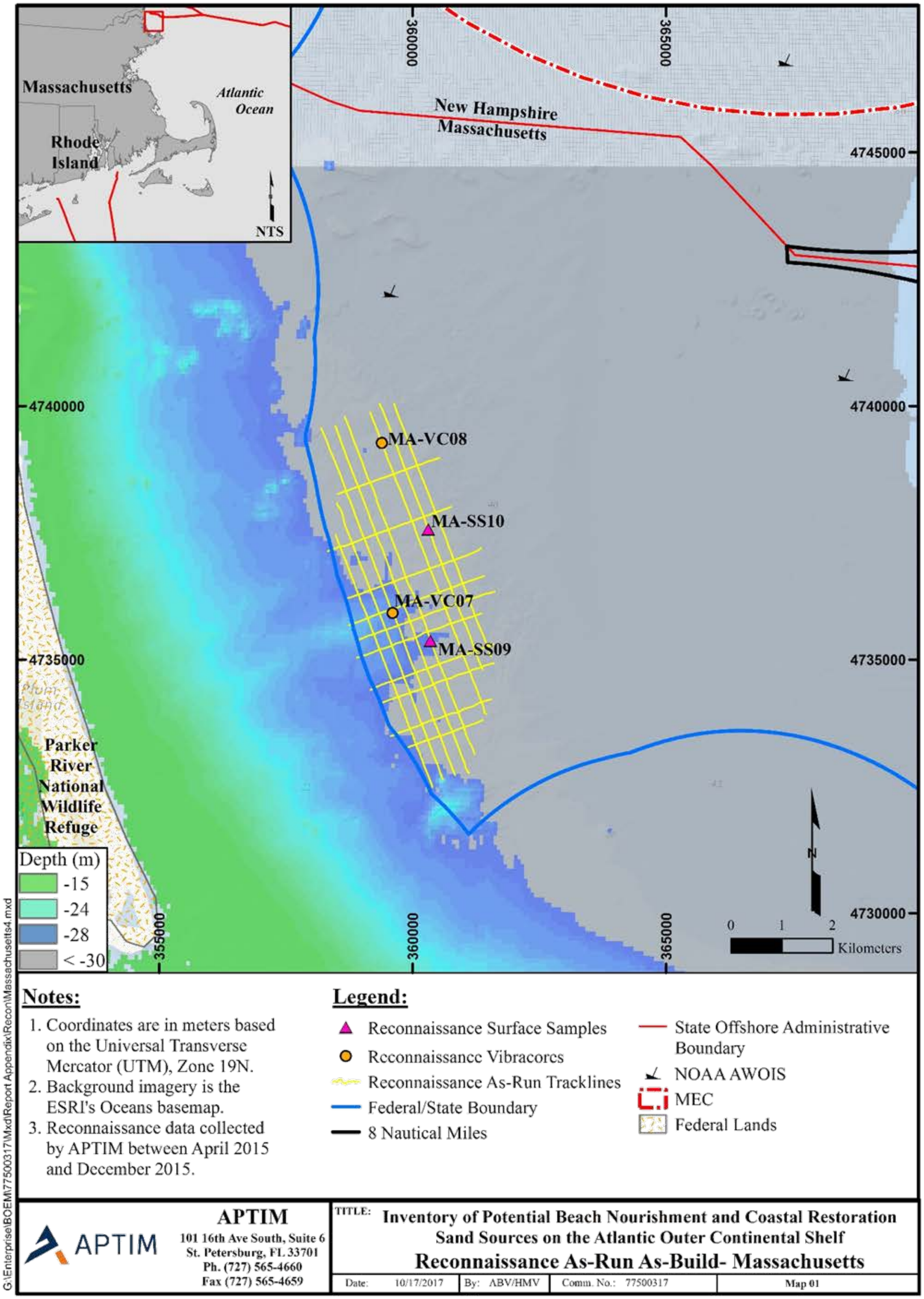
results, APTIM identified multiple areas offshore every state within the investigation areas containing deposits of potentially beach compatible sand resources. Further, the 2016 design-level geophysical data indicated potential beach compatible sand resources up to preliminary (un-designed) volumes of 67,668,500 m^3 (88,507,000 cy) throughout the investigation areas offshore New York and approximately 51,440,700 m^3 (67,281,850 cy) offshore New Jersey. For 2017, the design-level data resulted in full geotechnical and geophysical coverage of four potential borrow areas offshore Brigantine, New Jersey, and a more-detailed reconnaissance-level understanding of the potential sand resources on the Delaware OCS. As previously mentioned, the estimated preliminary volumes are based off an initial review of the collected data. Final borrow area delineations and final volume calculations are to be determined by BOEM cooperative agencies in each state, and may be less then what is shown here due to environmental, cultural, accessibility, and/or compatibility reasons after detailed processing and a borrow area design process is completed. During the BOEM ASAP project, these data were made available to BOEM to share with individual states cooperative agencies, enabling them to conduct a detailed processing and interpretation of the data, including taking into account environmental constraints and dredge feasibility to develop a final borrow area for coastal restoration efforts.

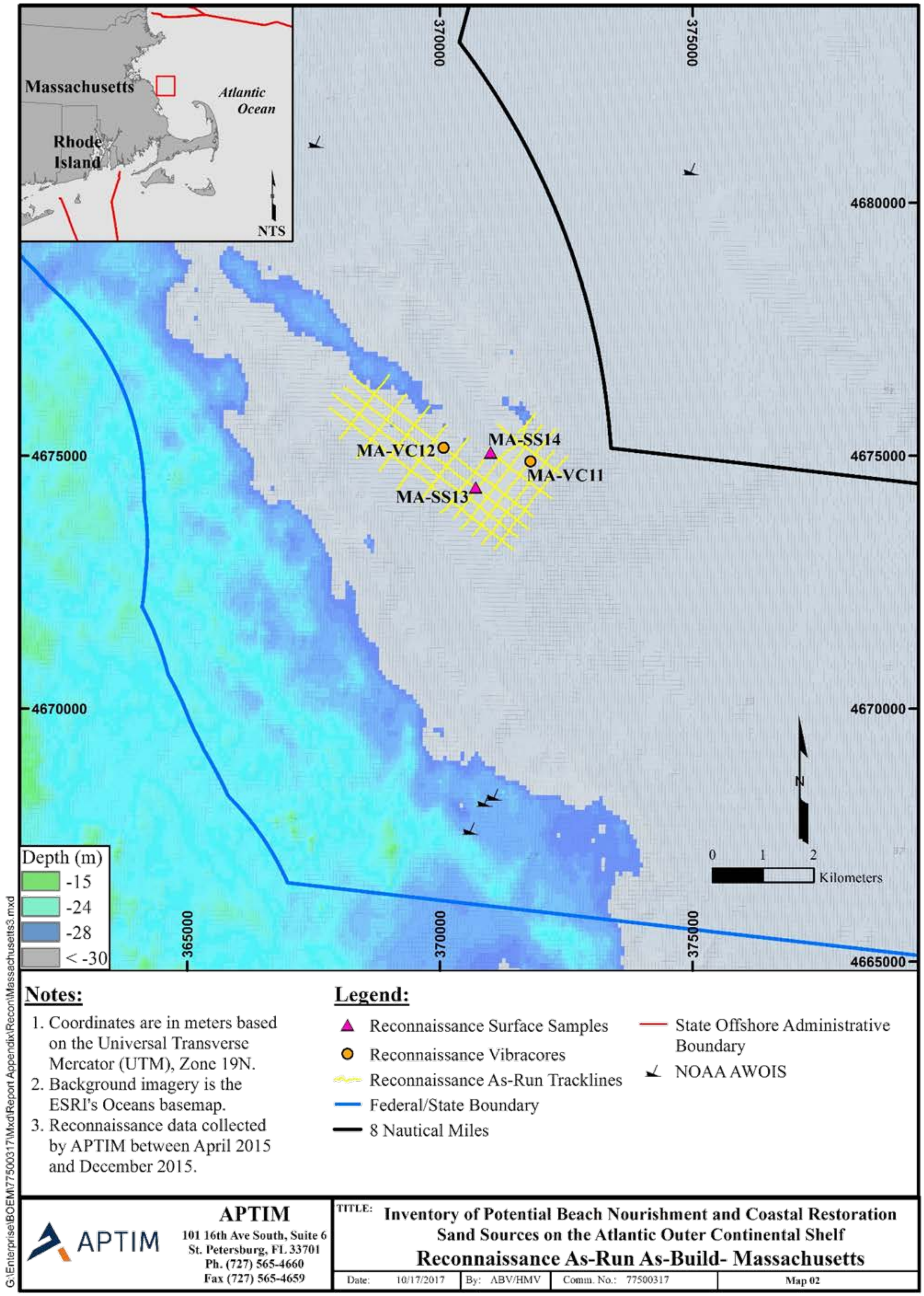
At the completion of this project, APTIM had collected 7,089 km (3,828 nm) of geophysical data, 340 vibracores, and 100 surface grab samples along the Atlantic OCS from Massachusetts to Florida. With the resources provided by BOEM for this project, APTIM was able to collect a large geologic dataset advancing the reconnaissance-level understanding of potential sand resources on the Atlantic OCS, and to collect sufficient data to allow seven (7) sub-investigation areas to have the data needed to design and permit borrow areas for future use in shore protection projects.

14.0 Maps

This section, beginning on the following page, contains the 51 maps described in the above sections. These maps are provided as ArcGIS digital Map Products in Appendix H (digital submittal only). These digital map packages were exported using ArcGIS 10.5. To open double click on the desired map. An ESRI license is required to view. All data has been packaged with the map and should automatically reconnect. Basemaps are ESRI Ocean Basemap and will require an internet connection in order to display. Map packages have the standard basic metadata contained within the package information, this must be viewed in an ESRI product.

14.1 2015 Reconnaissance-Level Survey Maps (Phase 2)


Massachusetts
Rhode Island
Atlantic Ocean
NTS
New Hampshire
Massachusetts
360000
365000
355000
4745000
4740000
4735000
4730000
MA-VC08
MA-SS10
MA-VC07
MA-SS09
Parker River National Wildlife Refuge
Plum Island
Depth (m)
-15
-24
-28
< -30
0 1 2 Kilometers
N
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Massachusetts4.mxd
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 19N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.
Legend:
Reconnaissance Surface Samples
Reconnaissance Vibracores
Reconnaissance As-Run Tracklines
Federal/State Boundary
8 Nautical Miles
State Offshore Administrative Boundary
NOAA AWOIS
MEC
Federal Lands
APTIM
APTIM
101 16th Ave South, Suite 6
St. Petersburg, FL 33701
Ph. (727) 565-4660
Fax (727) 565-4659
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
Reconnaissance As-Run As-Build- Massachusetts
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 01


Massachusetts
Rhode Island
Atlantic Ocean
NTS
370000
375000
365000
4680000
4675000
4670000
4665000
MA-VC12
MA-SS14
MA-VC11
MA-SS13
N
0 1 2 Kilometers
Depth (m)
-15
-24
-28
< -30
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 19N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.
Legend:
Reconnaissance Surface Samples
Reconnaissance Vibracores
Reconnaissance As-Run Tracklines
Federal/State Boundary
8 Nautical Miles
State Offshore Administrative Boundary
NOAA AWOIS
APTIM
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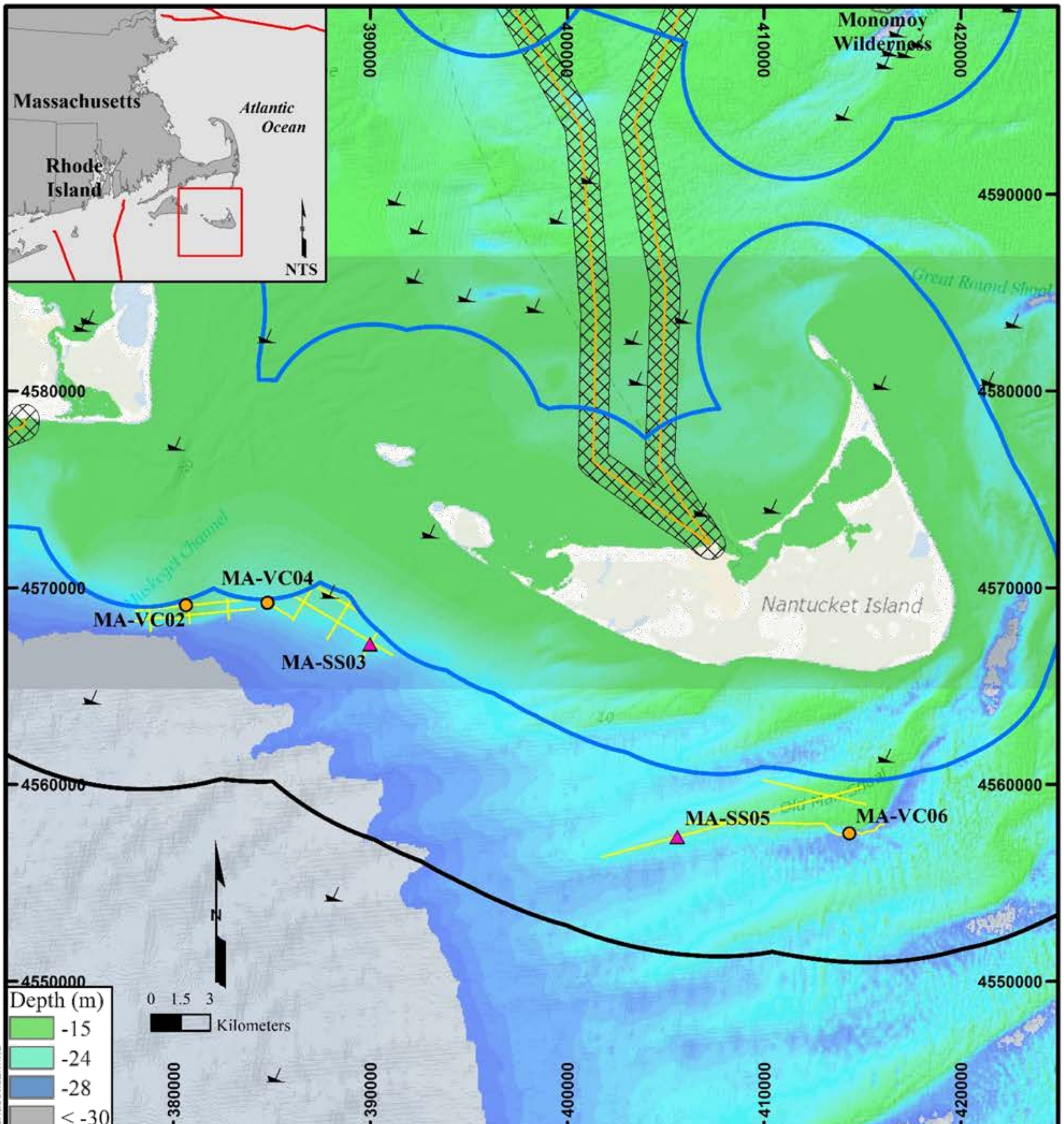
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
Reconnaissance As-Run As-Build- Massachusetts
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 02
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Massachusetts3.mxd



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 19N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Cables
- 1km Cable Buffer
- Federal Wilderness Areas
- Federal Lands

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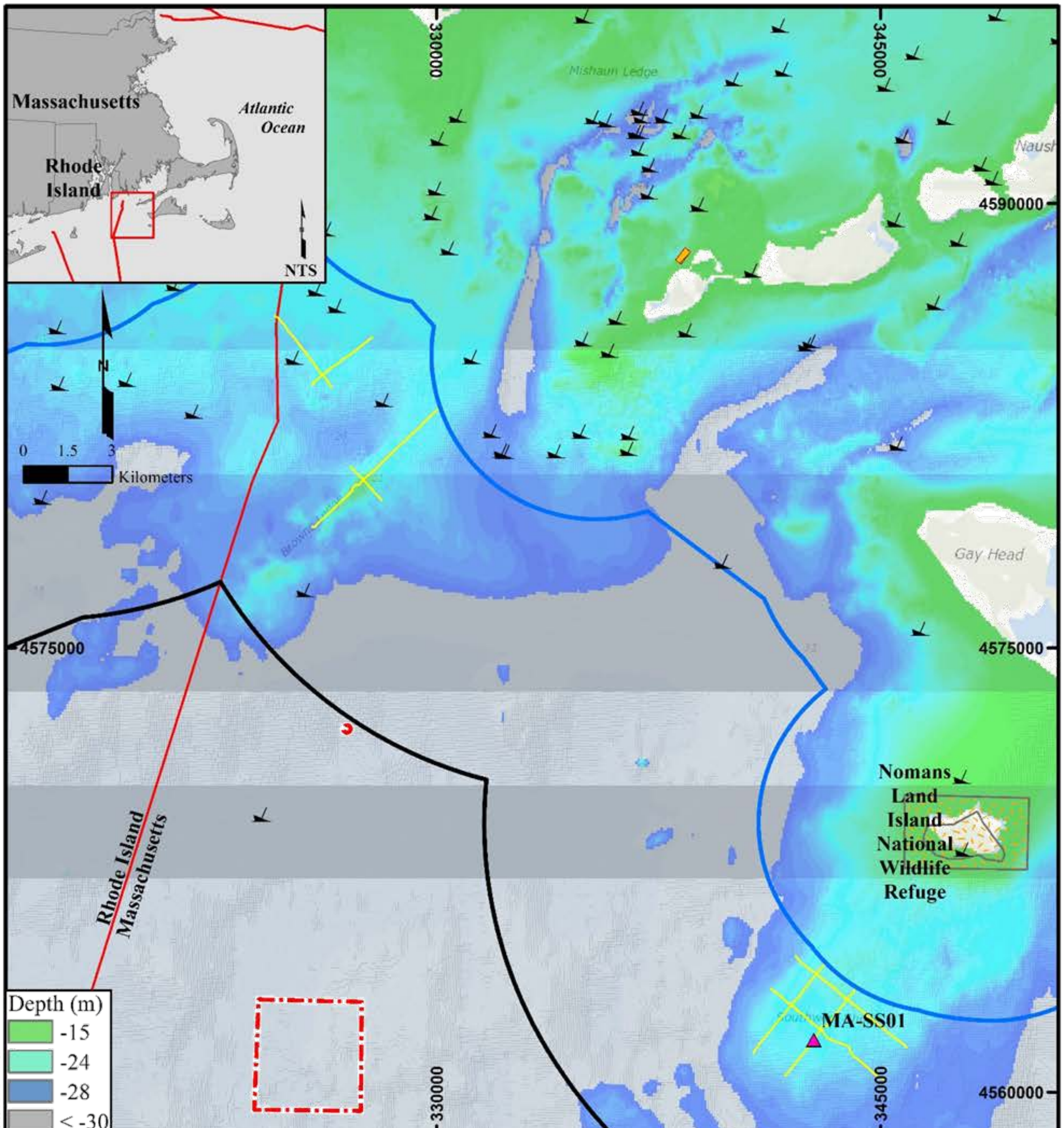
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Massachusetts

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 03



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Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 19N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- MEC
- USACE/EPA ODMDS
- Federal Lands

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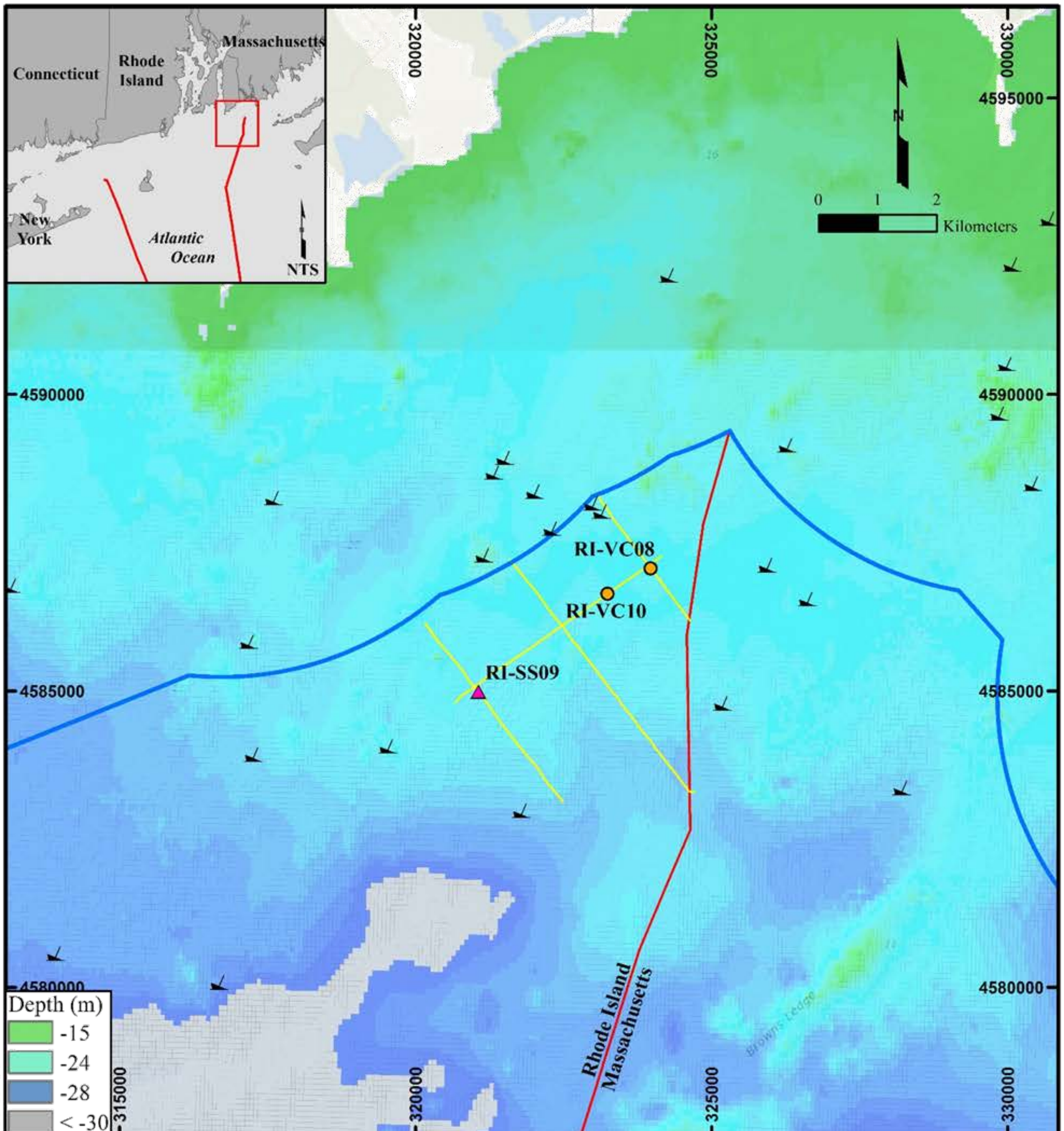
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Massachusetts

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 04



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\RhodeIsland3.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 19N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS

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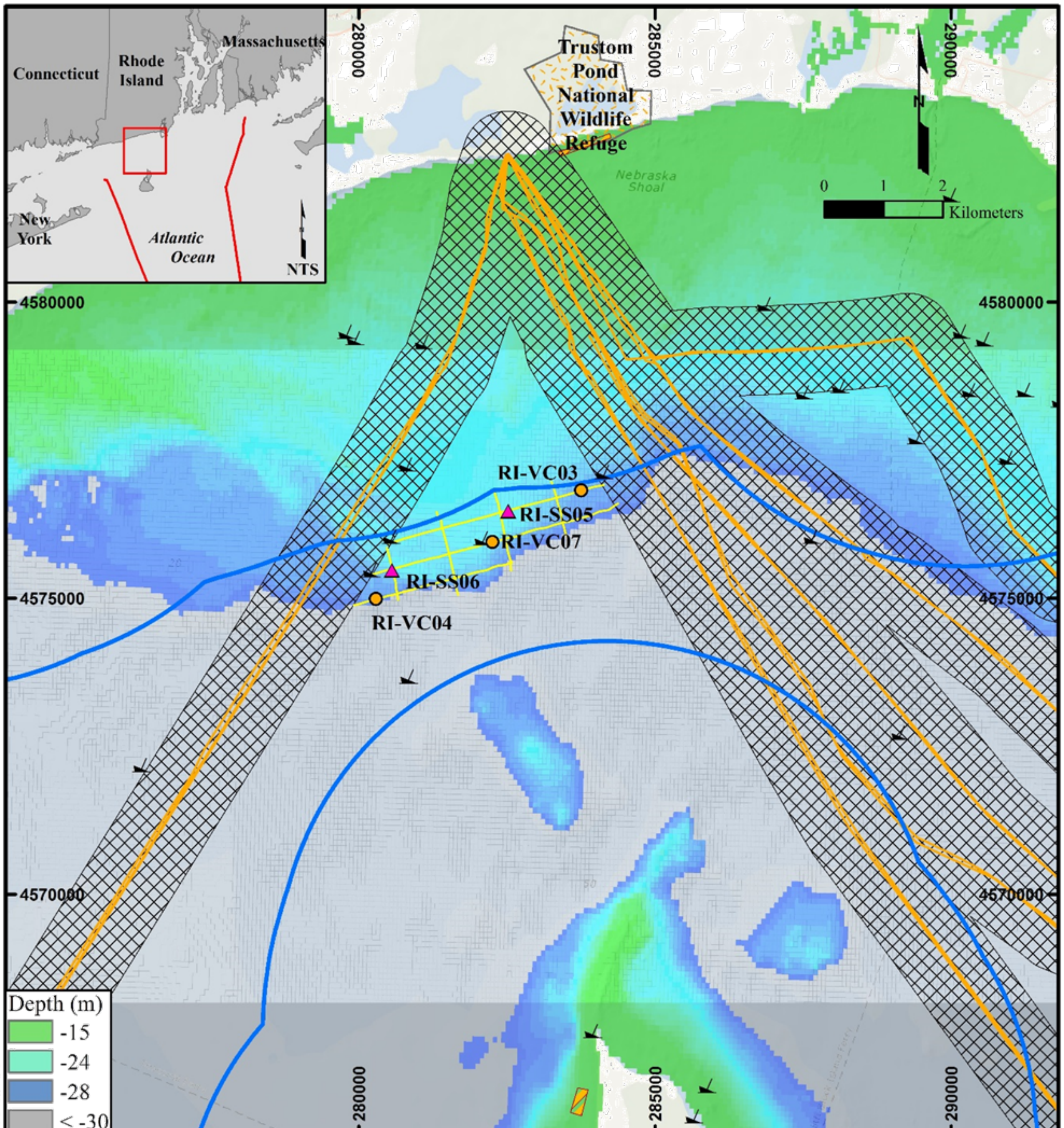
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Rhode Island

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 05



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Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 19N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- State Offshore Administrative Boundary
- NOAA AWOIS
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS
- Federal Lands

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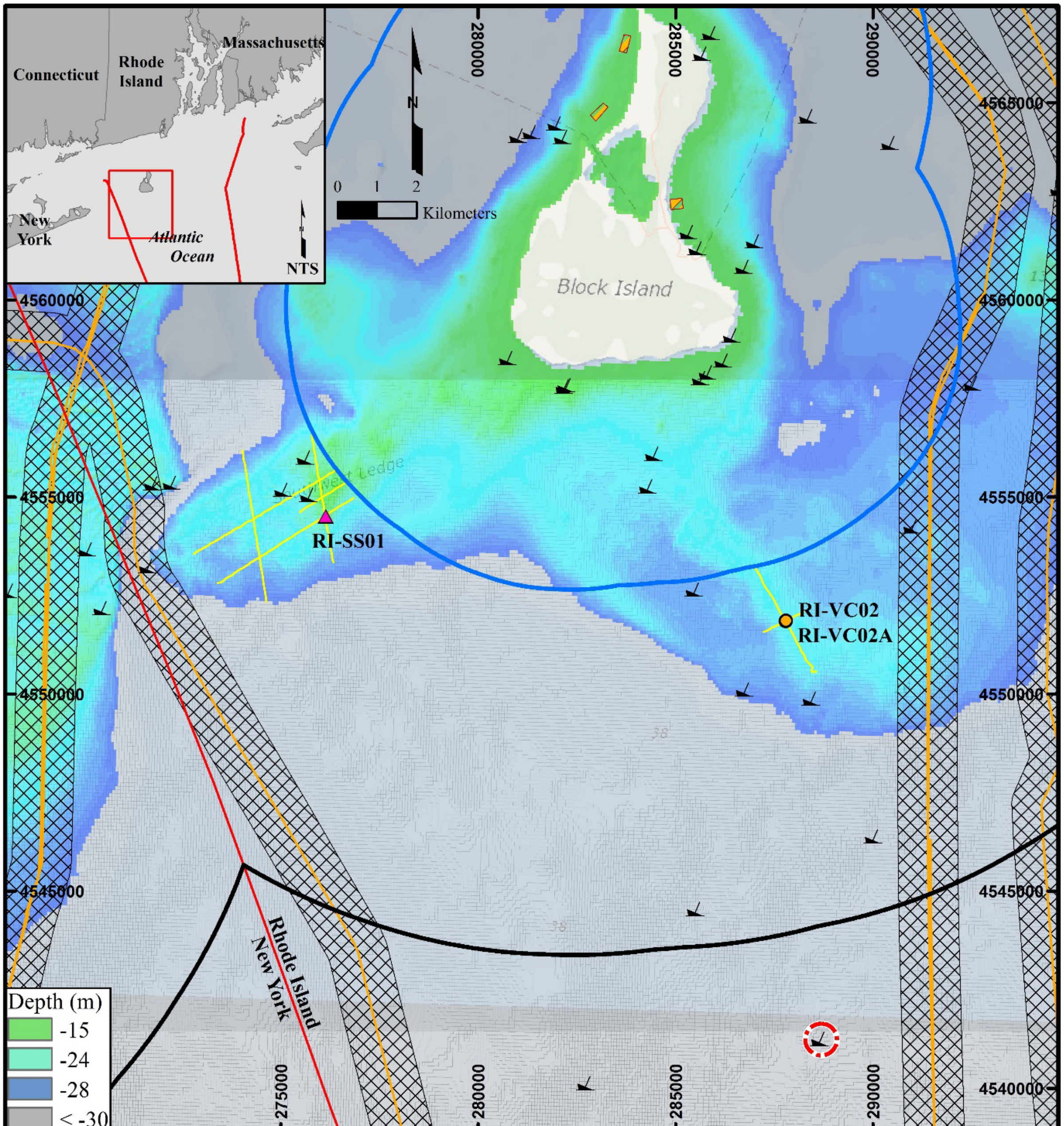
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**
Reconnaissance As-Run As-Build- Rhode Island

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 06



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\RhodeIsland1.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 19N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- MEC
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS

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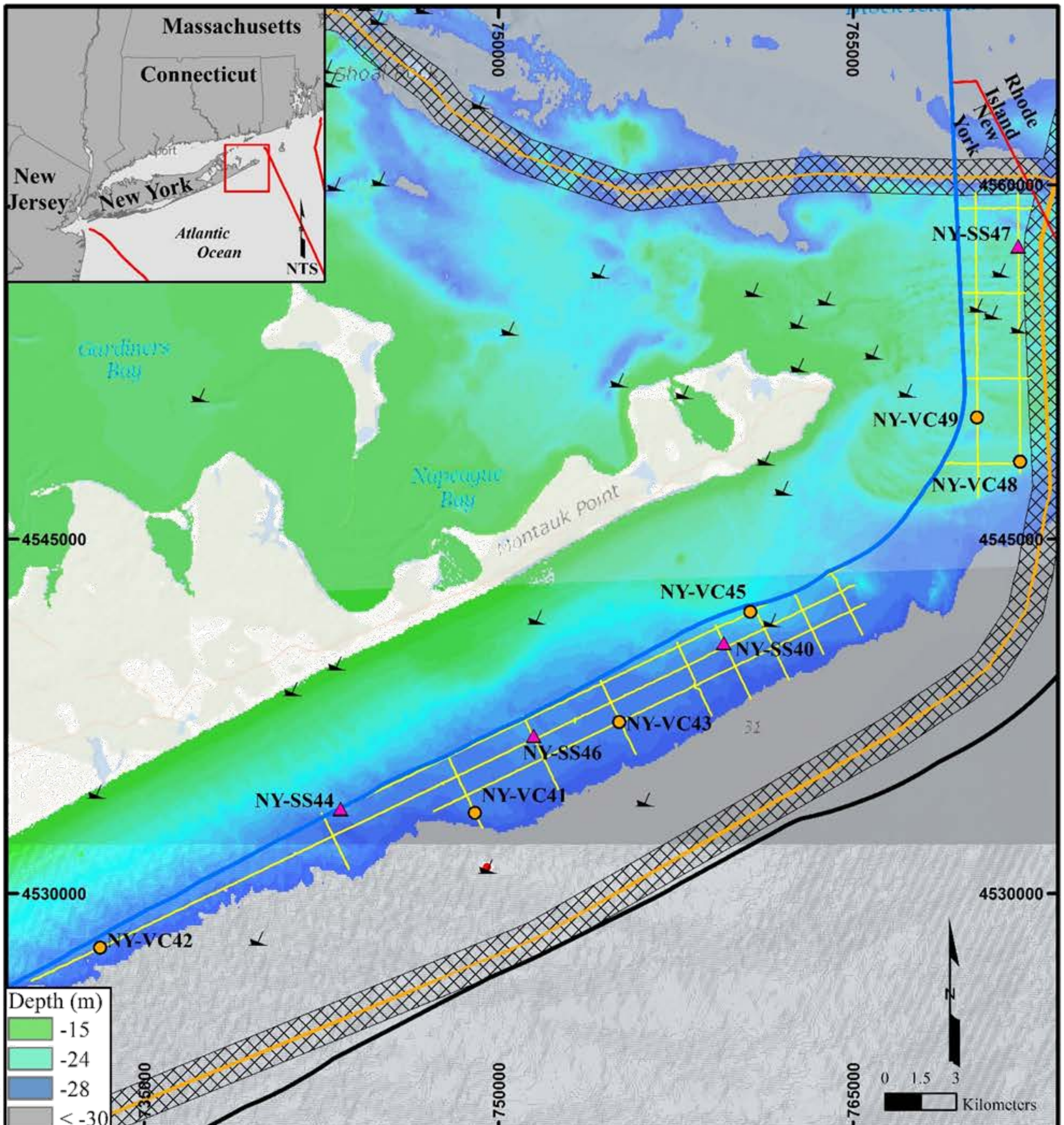
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

Reconnaissance As-Run As-Build- Rhode Island

Date: 10/17/2017 | By: ABV/HMV | Comm. No.: 77500317 | Map 07



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Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- MEC
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS

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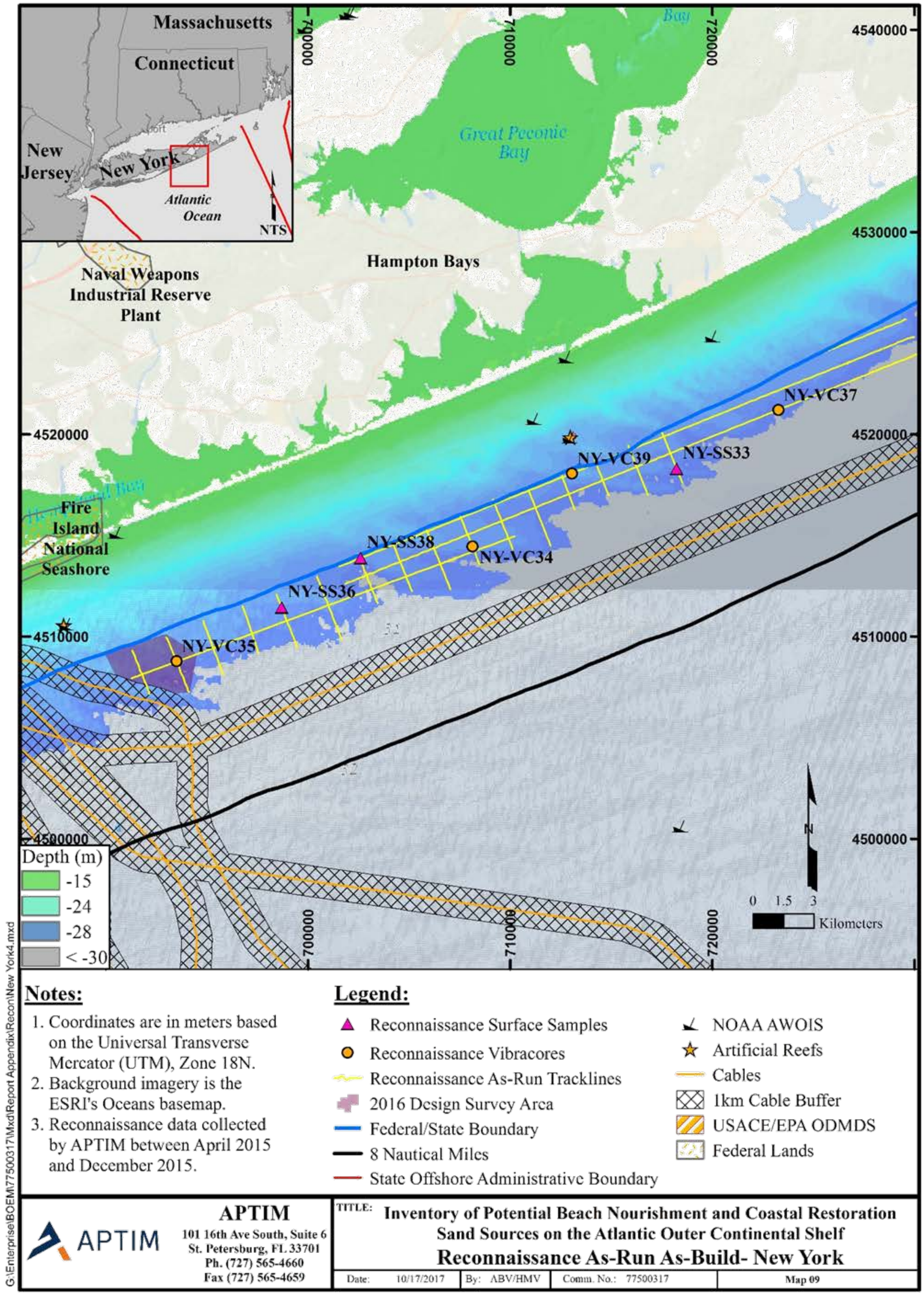
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

Reconnaissance As-Run As-Build- New York

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 08


Massachusetts
Connecticut
New Jersey
New York
Atlantic Ocean
NTS
Great Peconic Bay
Hampton Bays
Naval Weapons Industrial Reserve Plant
Fire Island National Seashore
NY-VC37
NY-VC39
NY-SS33
NY-SS38
NY-VC34
NY-SS36
NY-VC35
4540000
4530000
4520000
4510000
4500000
700000
710000
720000
0 1.5 3 Kilometers
Depth (m)
-15
-24
-28
< -30
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.
Legend:
Reconnaissance Surface Samples
Reconnaissance Vibracores
Reconnaissance As-Run Tracklines
2016 Design Survey Area
Federal/State Boundary
8 Nautical Miles
State Offshore Administrative Boundary
NOAA AWOIS
Artificial Reefs
Cables
1km Cable Buffer
USACE/EPA ODMDS
Federal Lands
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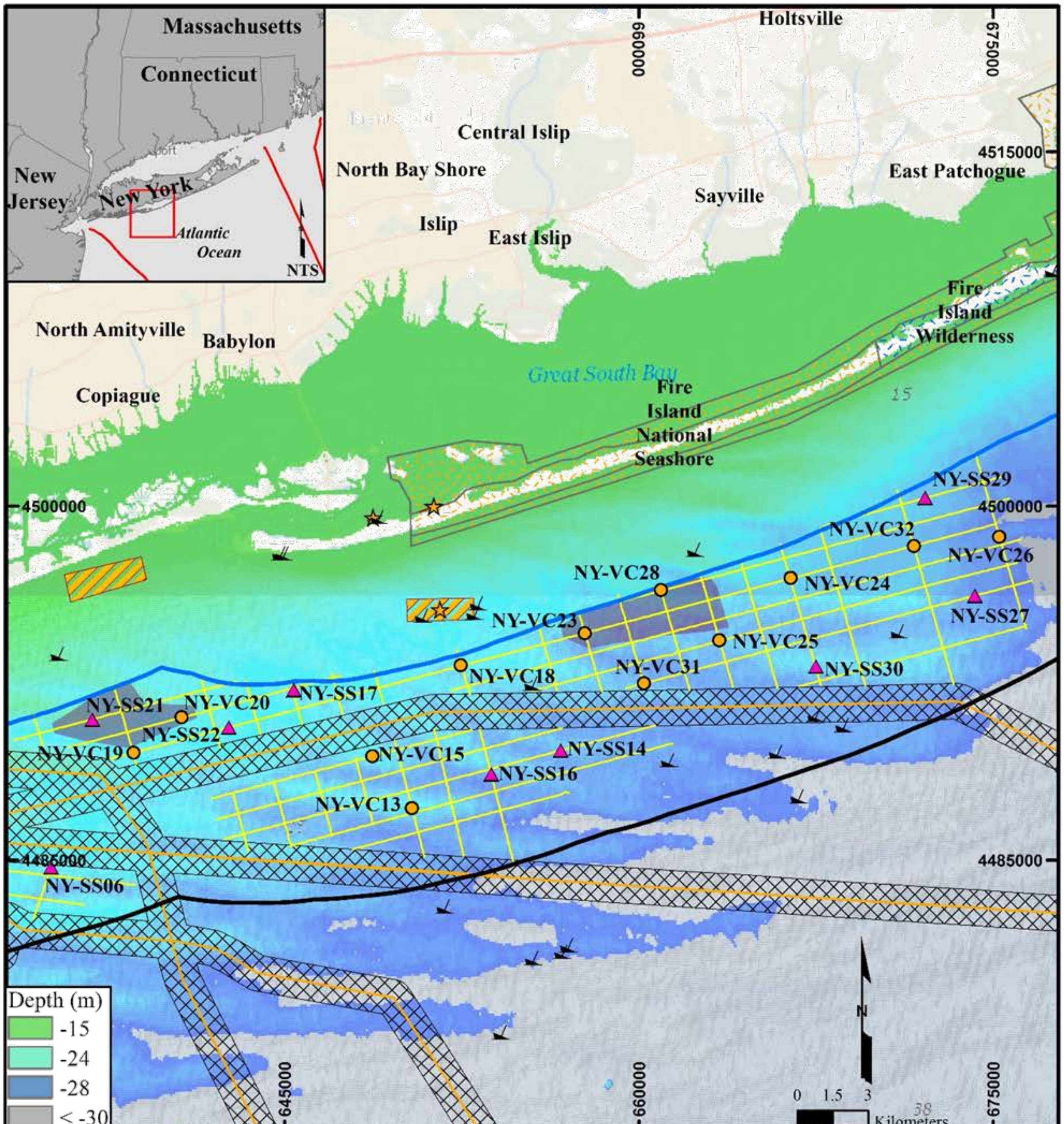
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
Reconnaissance As-Run As-Build- New York
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 09
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\New York4.mxd



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\New York3.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- 2016 Design Survey Area
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS
- Federal Lands
- Federal Wilderness Areas

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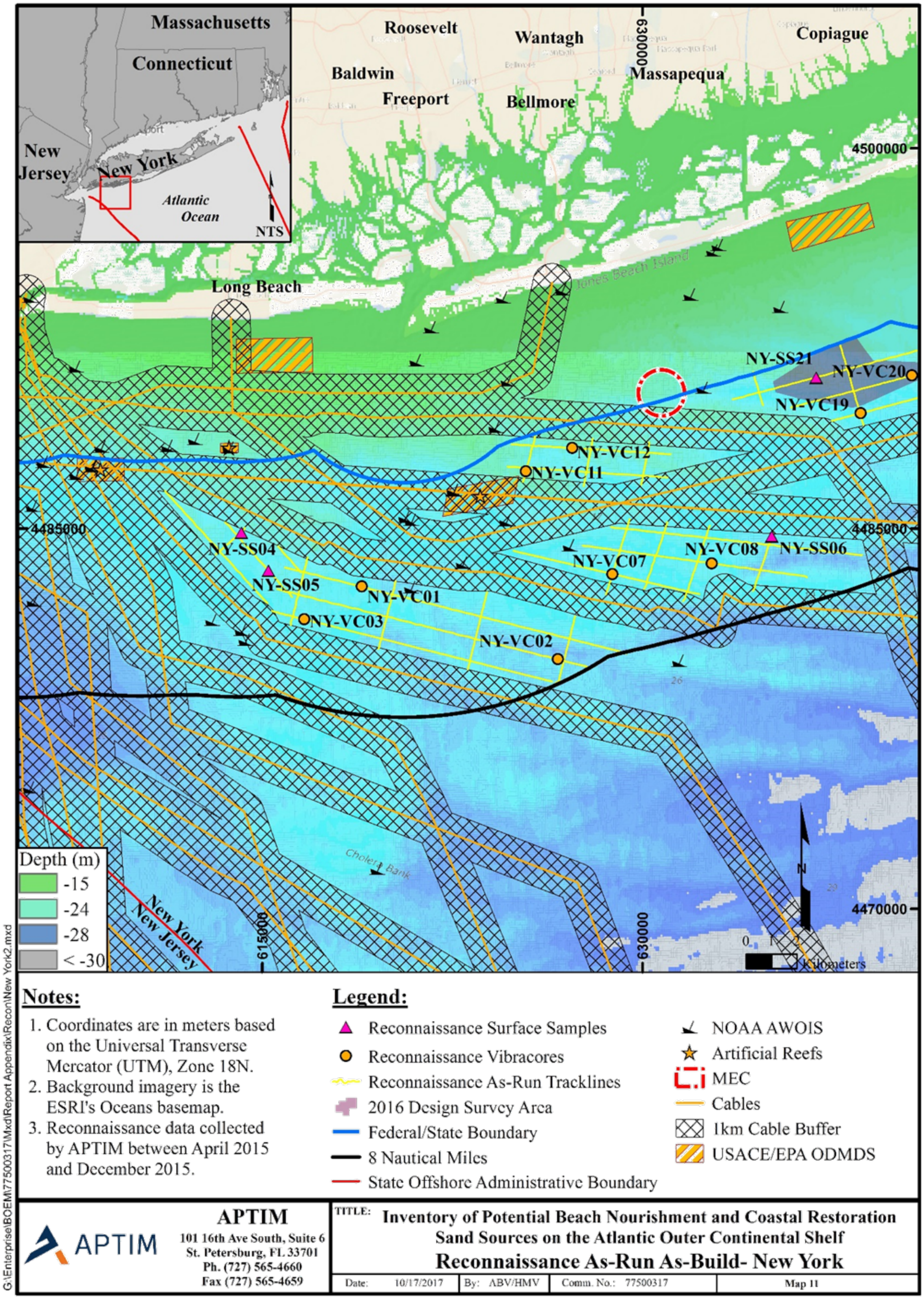
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- New York

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 10



Massachusetts
Connecticut
New Jersey
New York
Atlantic Ocean
NTS
Roosevelt
Wantagh
Copiague
Baldwin
Massapequa
Freeport
Bellmore
Long Beach
Jones Beach Island
630000
4500000
4485000
4470000
615000
NY-SS21
NY-VC20
NY-VC19
NY-VC12
NY-VC11
NY-SS04
NY-SS05
NY-VC01
NY-VC03
NY-VC02
NY-VC07
NY-VC08
NY-SS06
Cholera Bank
Depth (m)
-15
-24
-28
< -30
New York
New Jersey
0 1 2 Kilometers
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\New York2.mxd
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.
Legend:
Reconnaissance Surface Samples
Reconnaissance Vibracores
Reconnaissance As-Run Tracklines
2016 Design Survey Area
Federal/State Boundary
8 Nautical Miles
State Offshore Administrative Boundary
NOAA AWOIS
Artificial Reefs
MEC
Cables
1km Cable Buffer
USACE/EPA ODMDS
APTIM
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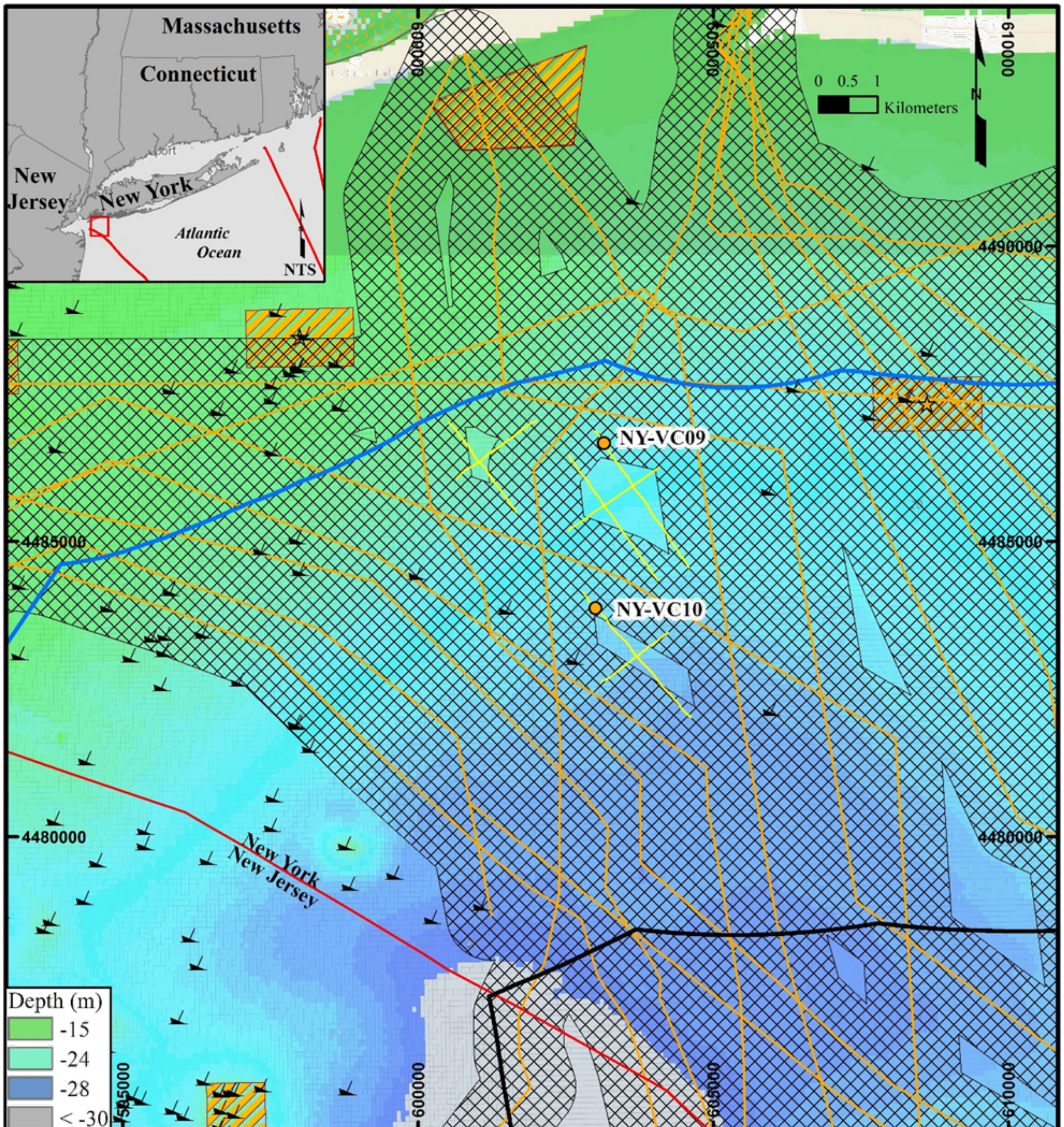
Ph. (727) 565-4660
Fax (727) 565-4659
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
Reconnaissance As-Run As-Build- New York
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 11



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Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS
- Federal Lands

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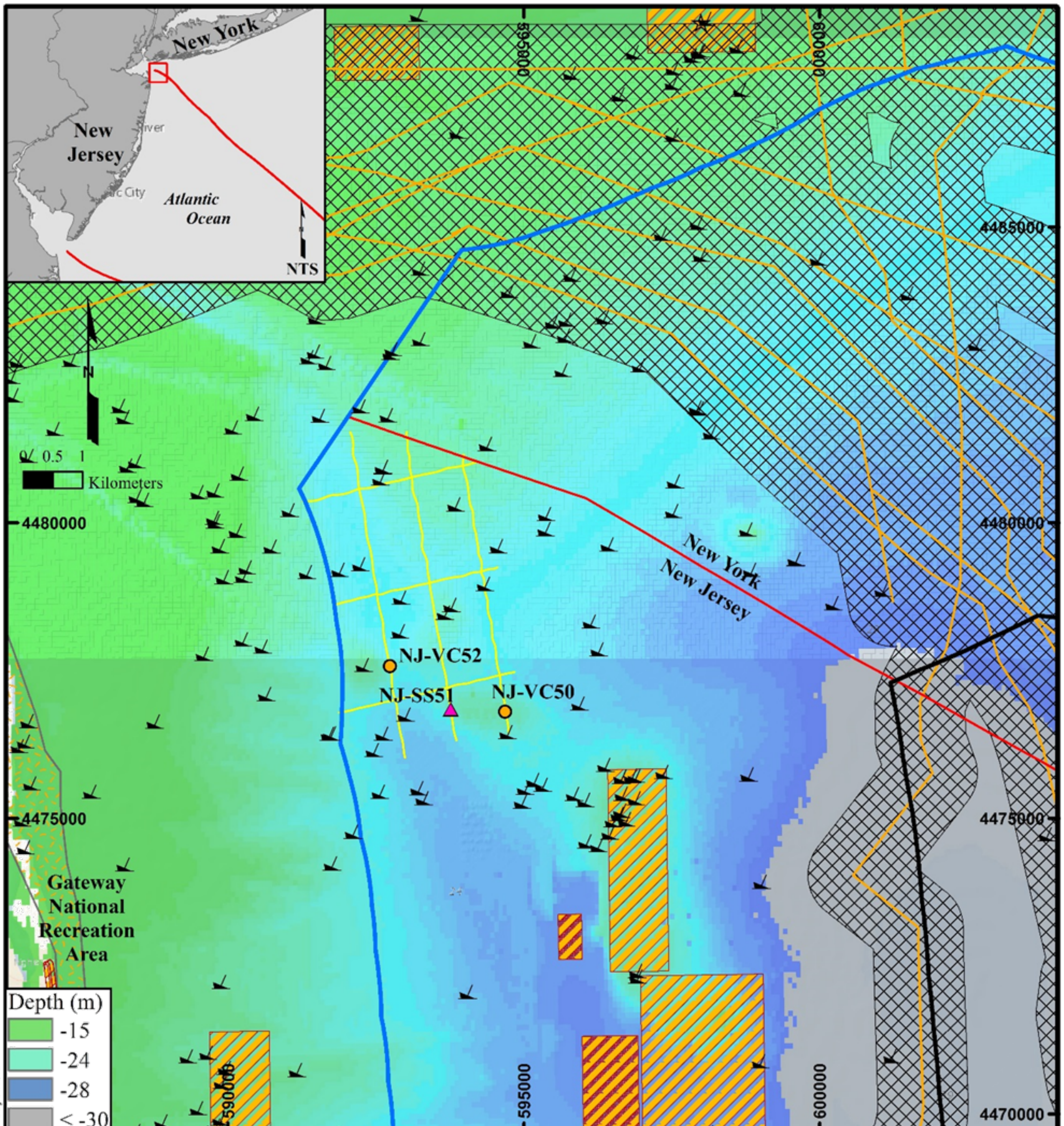
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- New York

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 12



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS
- Federal Lands

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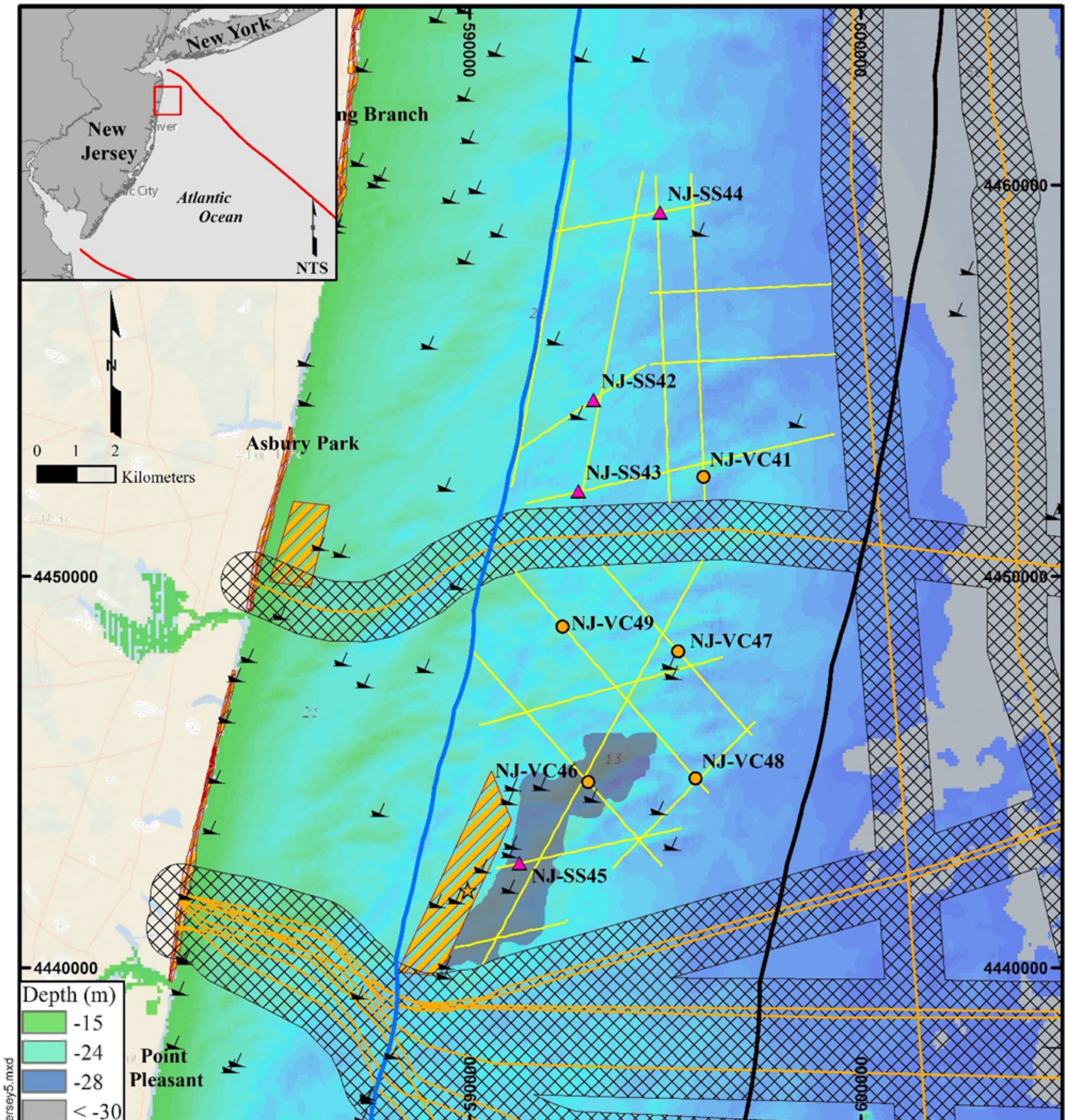
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- New Jersey

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 13



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\New Jersey5.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- 2016 Design Survey Area
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS
- Federal Lands

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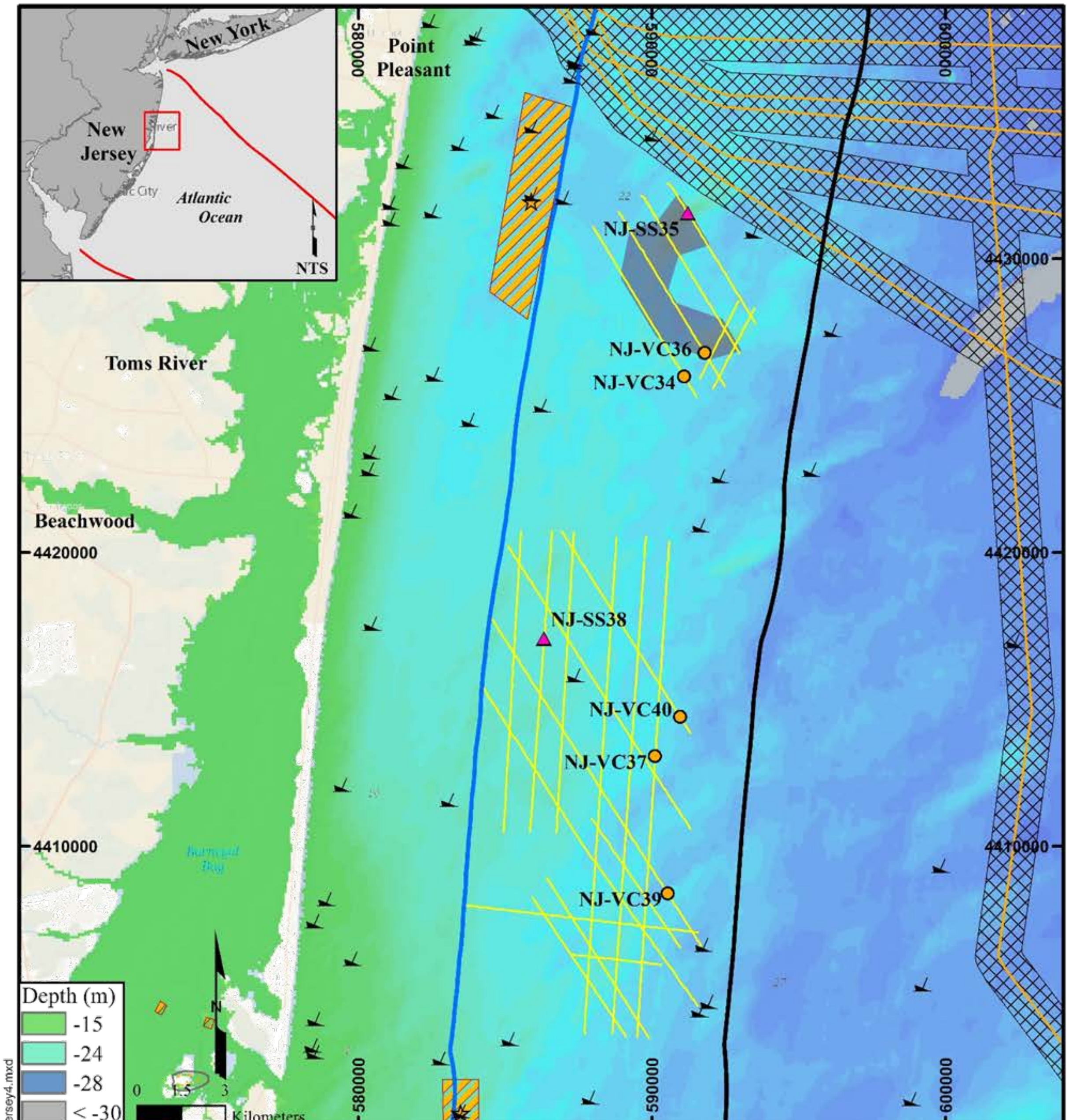
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

Reconnaissance As-Run As-Build- New Jersey

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 14



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\New Jersey4.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- 2016 Design Survey Area
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS
- Federal Lands

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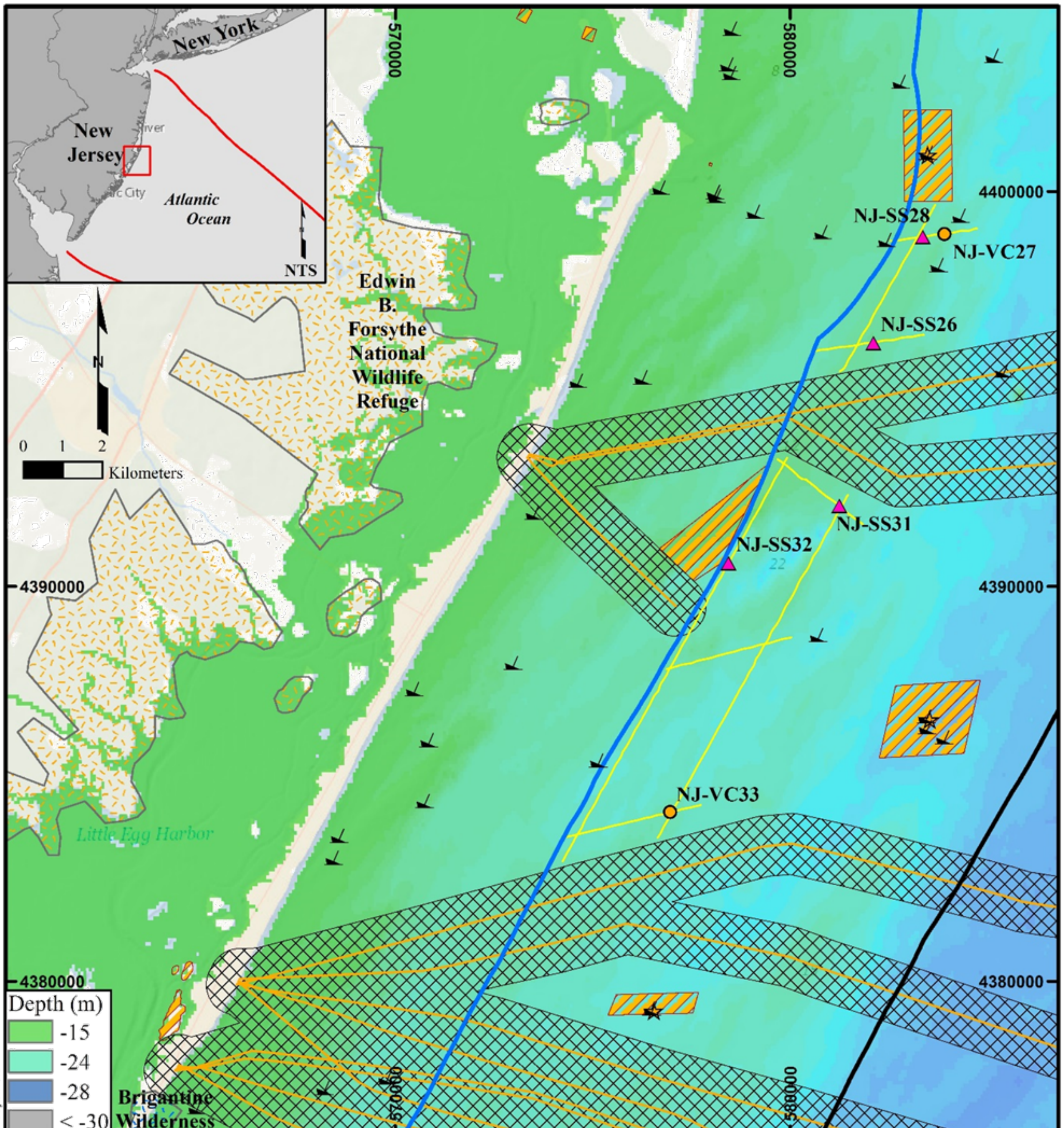
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- New Jersey

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 15



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\New Jersey3.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Cables
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- USACE/EPA ODMDS
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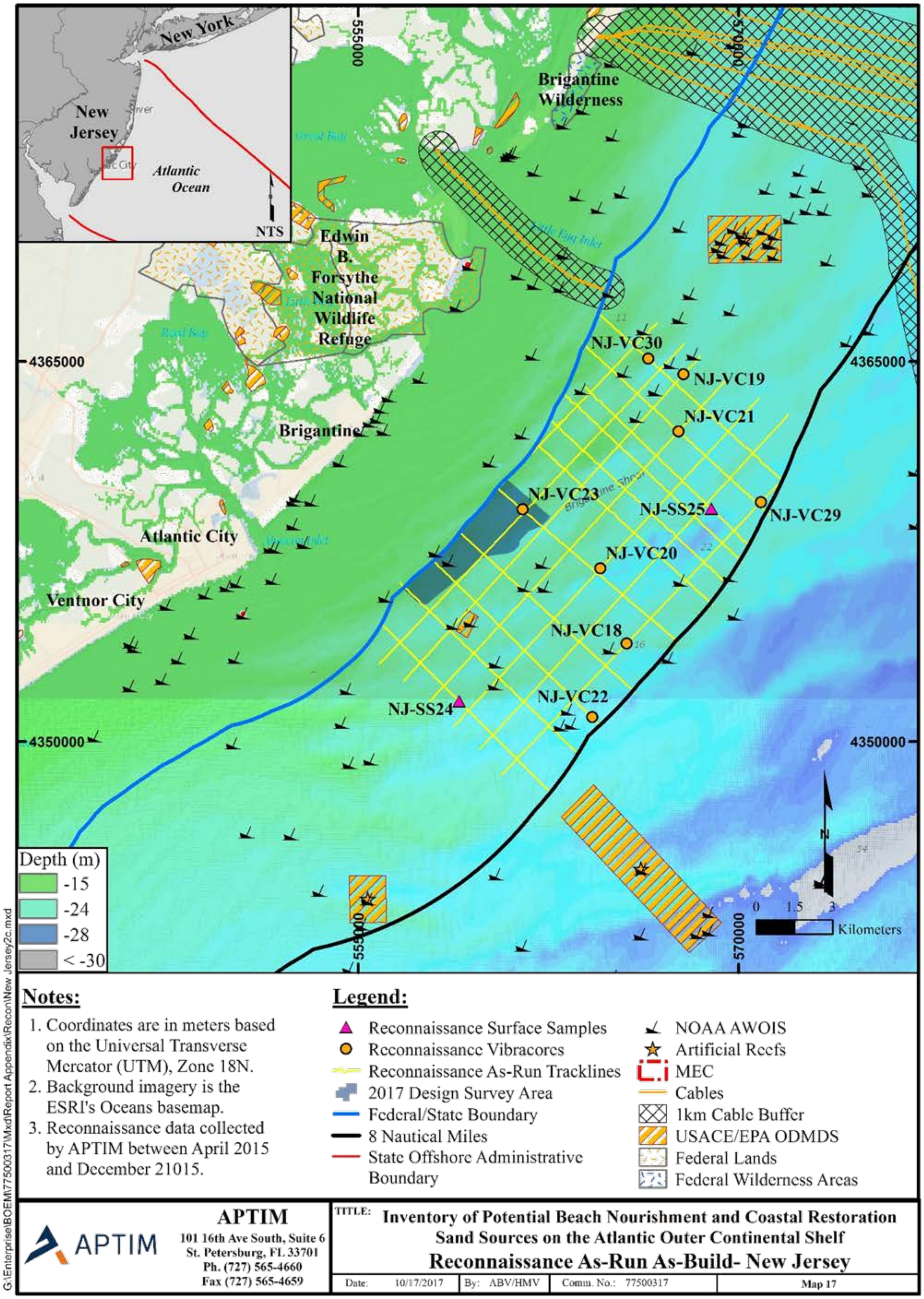
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

Reconnaissance As-Run As-Build- New Jersey

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 16



New York
New Jersey
Atlantic Ocean
NTS
Brigantine Wilderness
Edwin B. Forsythe National Wildlife Refuge
Brigantine
Atlantic City
Ventnor City
555000
570000
4365000
4350000
NJ-VC30
NJ-VC19
NJ-VC21
NJ-VC23
NJ-SS25
NJ-VC29
NJ-VC20
NJ-VC18
NJ-SS24
NJ-VC22
Depth (m)
-15
-24
-28
< -30
0 1.5 3 Kilometers
N
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\New Jersey2c.mxd
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 21015.
Legend:
Reconnaissance Surface Samples
Reconnaissance Vibracores
Reconnaissance As-Run Tracklines
2017 Design Survey Area
Federal/State Boundary
8 Nautical Miles
State Offshore Administrative Boundary
NOAA AWOIS
Artificial Reefs
MEC
Cables
1km Cable Buffer
USACE/EPA ODMDS
Federal Lands
Federal Wilderness Areas
APTIM
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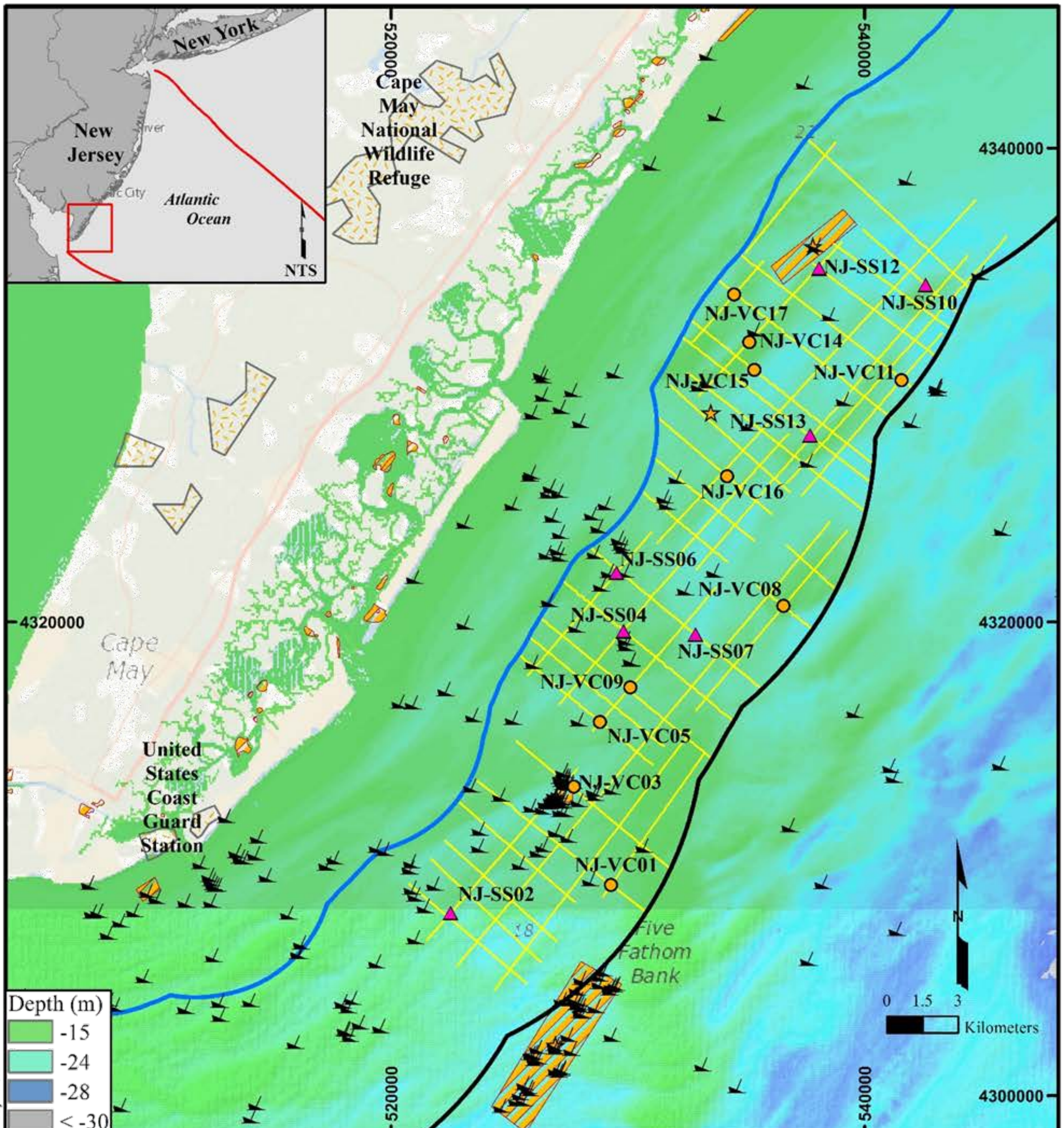
Fax (727) 565-4659
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
Reconnaissance As-Run As-Build- New Jersey
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 17



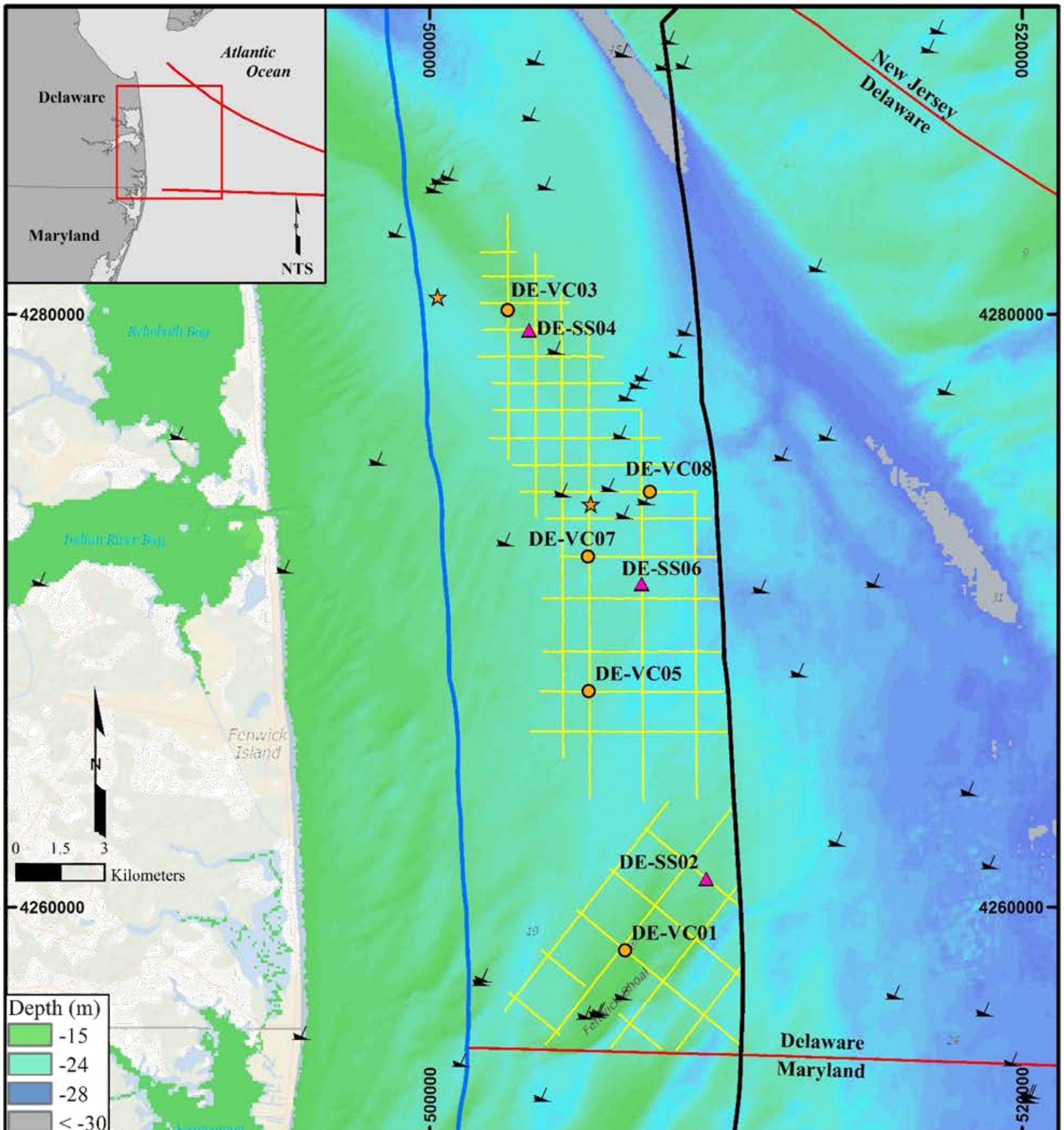
Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- USACE/EPA ODMDS
- Federal Lands

APTIM 101 16th Ave South, Suite 6 St. Petersburg, FL 33701 Ph. (727) 565-4660 Fax (727) 565-4659	TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf** **Reconnaissance As-Run As-Build- New Jersey**		
Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 18



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Delaware.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs

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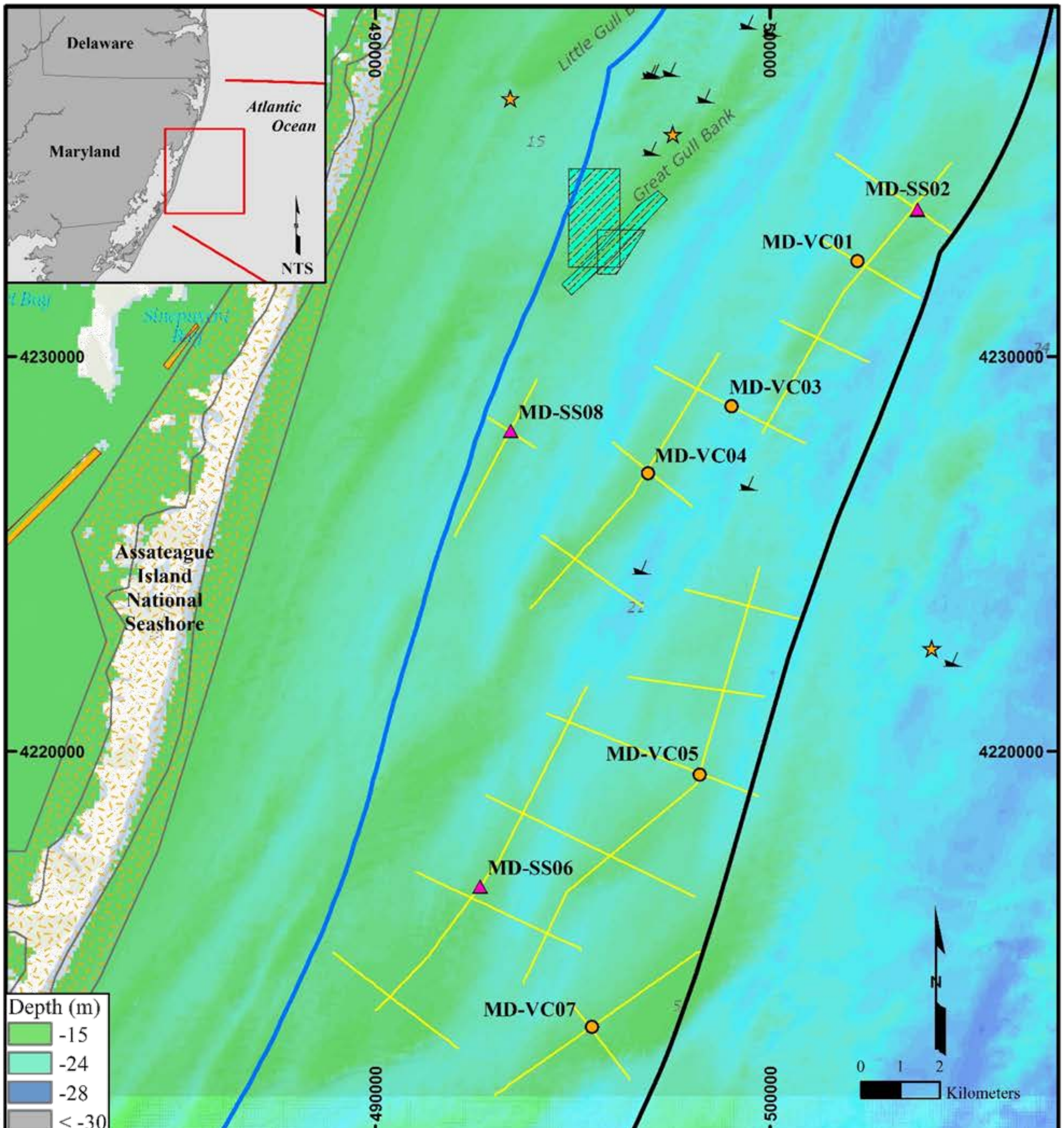
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Delaware

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 19



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Maryland.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Authorized Borrow Areas and Potential Borrow Areas
- USACE/EPA ODMDS
- Federal Lands

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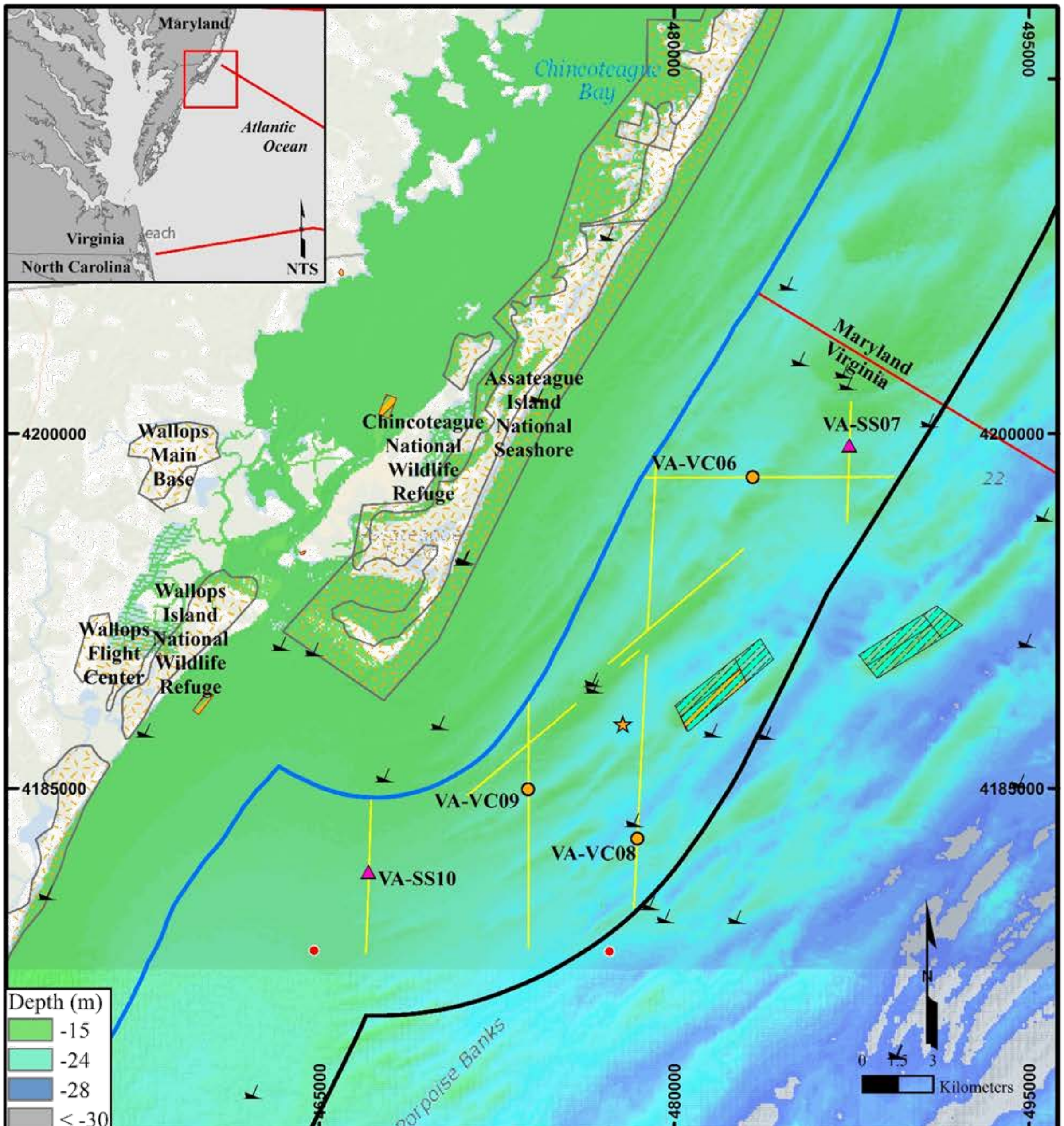
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

Reconnaissance As-Run As-Build- Maryland

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 20



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Virginia2.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- MEC
- Authorized Borrow Areas and Potential Borrow Areas
- USACE/EPA ODMDS
- Federal Lands

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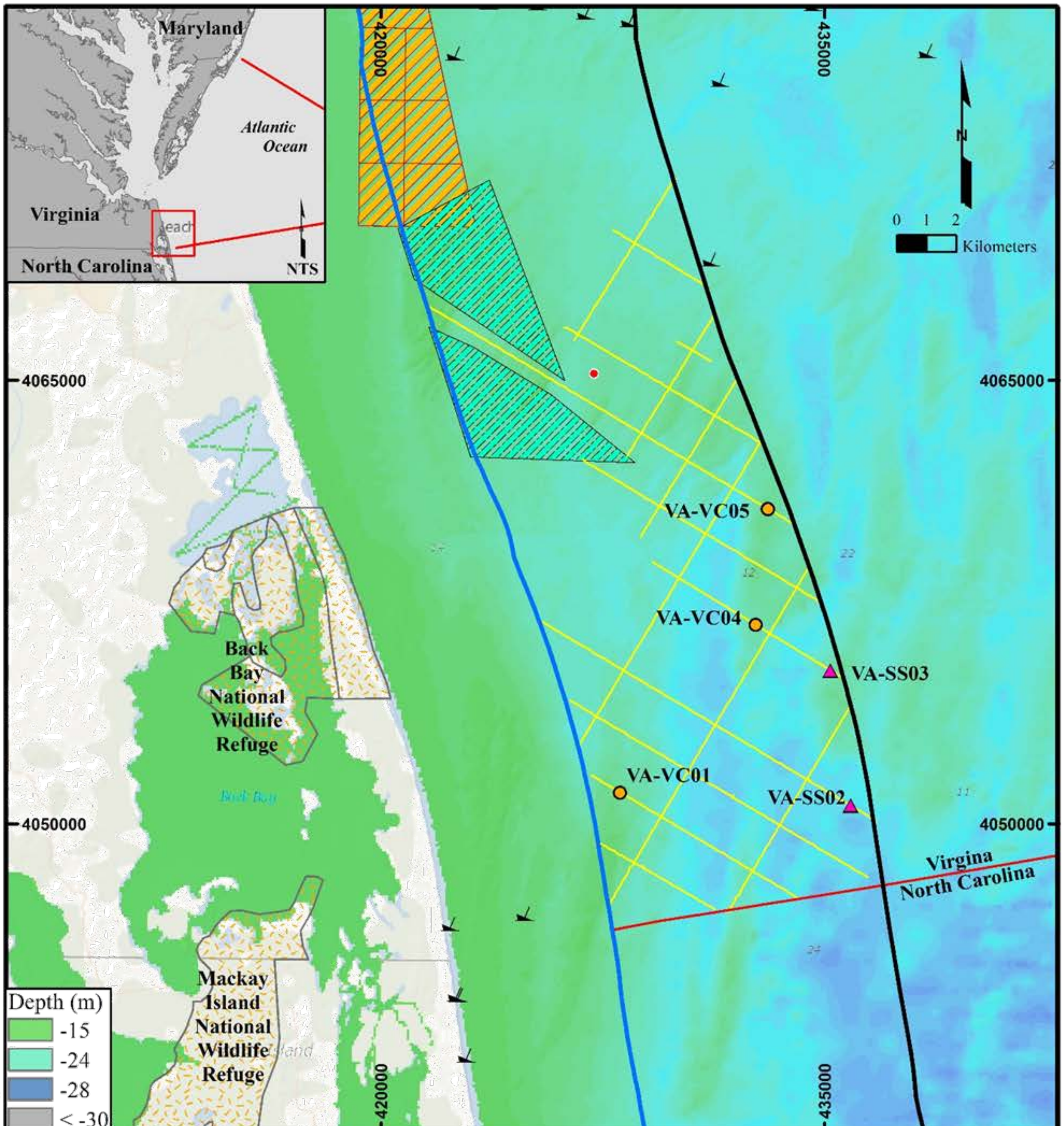
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**
Reconnaissance As-Run As-Build- Virginia

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 21



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- MEC
- Authorized Borrow Areas and Potential Borrow Areas
- USACE/EPA ODMDS
- Federal Lands

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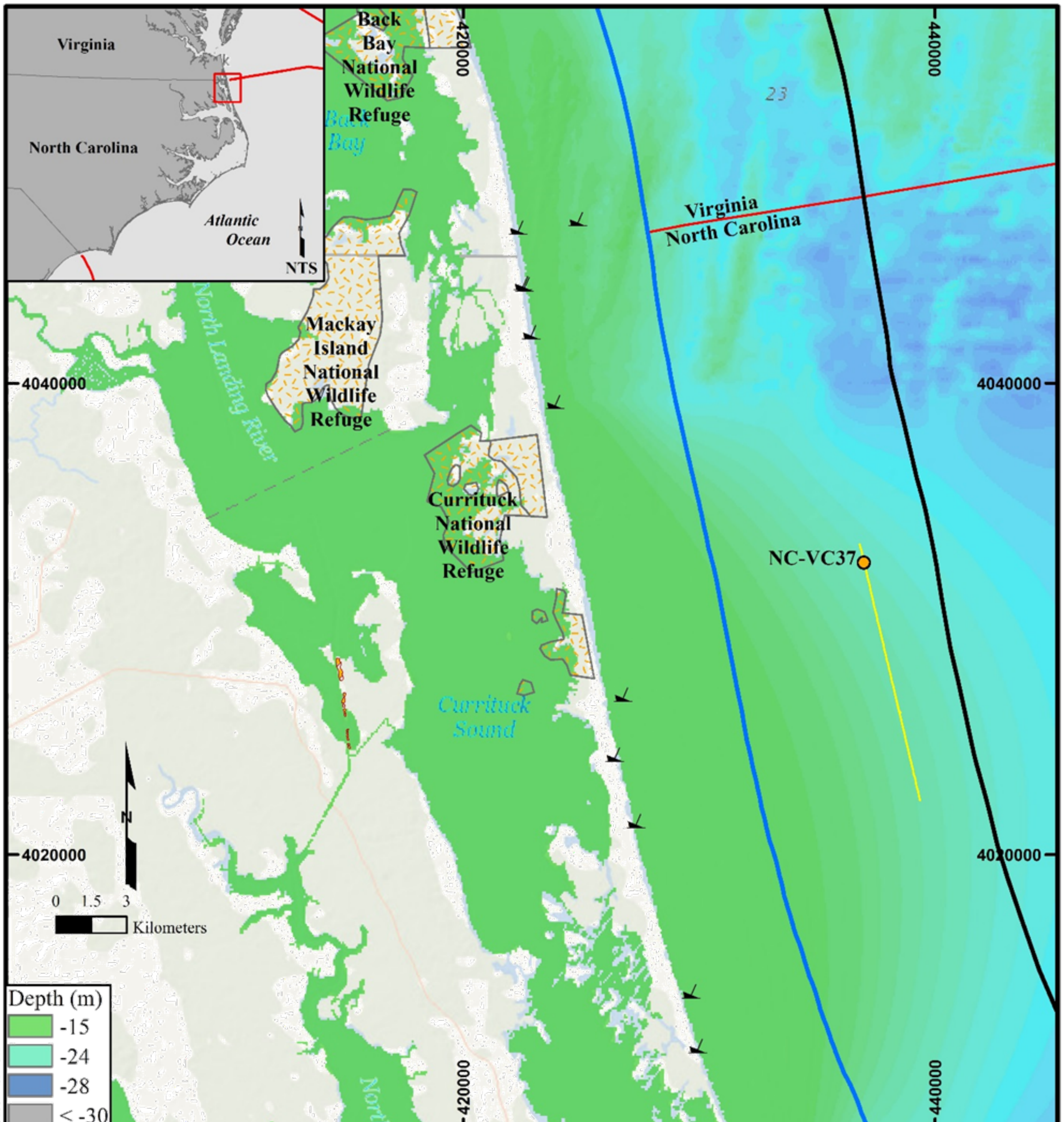
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Virginia

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 22

G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Virginia1.mxd



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\North Carolina3.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- USACE/EPA ODMDS
- Federal Lands

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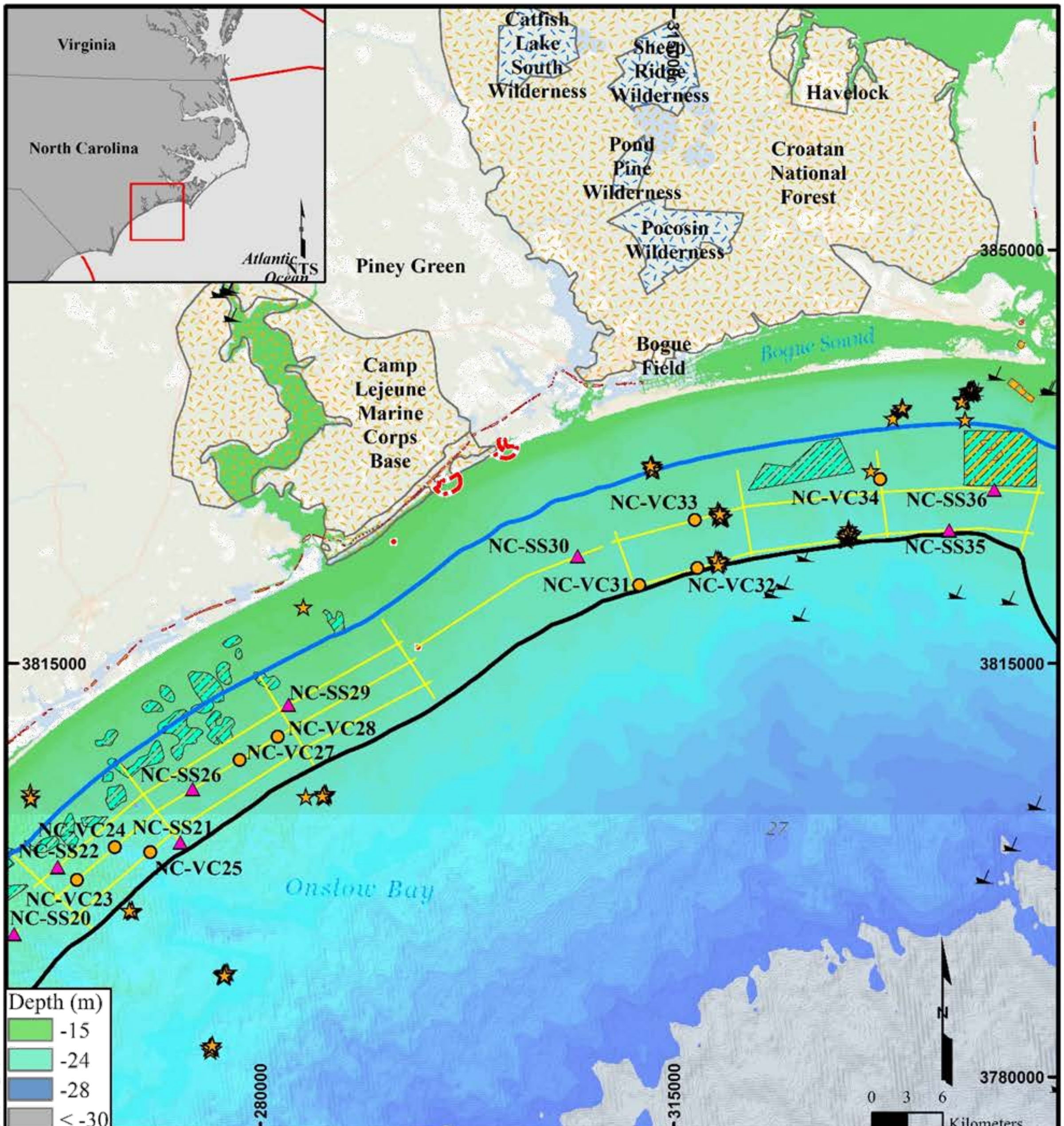
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- North Carolina

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 23



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\North Carolina2.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-Run Tracklines
- Federal/State Boundary
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- MEC
- Authorized Borrow Areas and Potential Borrow Areas
- USACE/EPA ODMDS
- Federal Lands
- Federal Wilderness Areas

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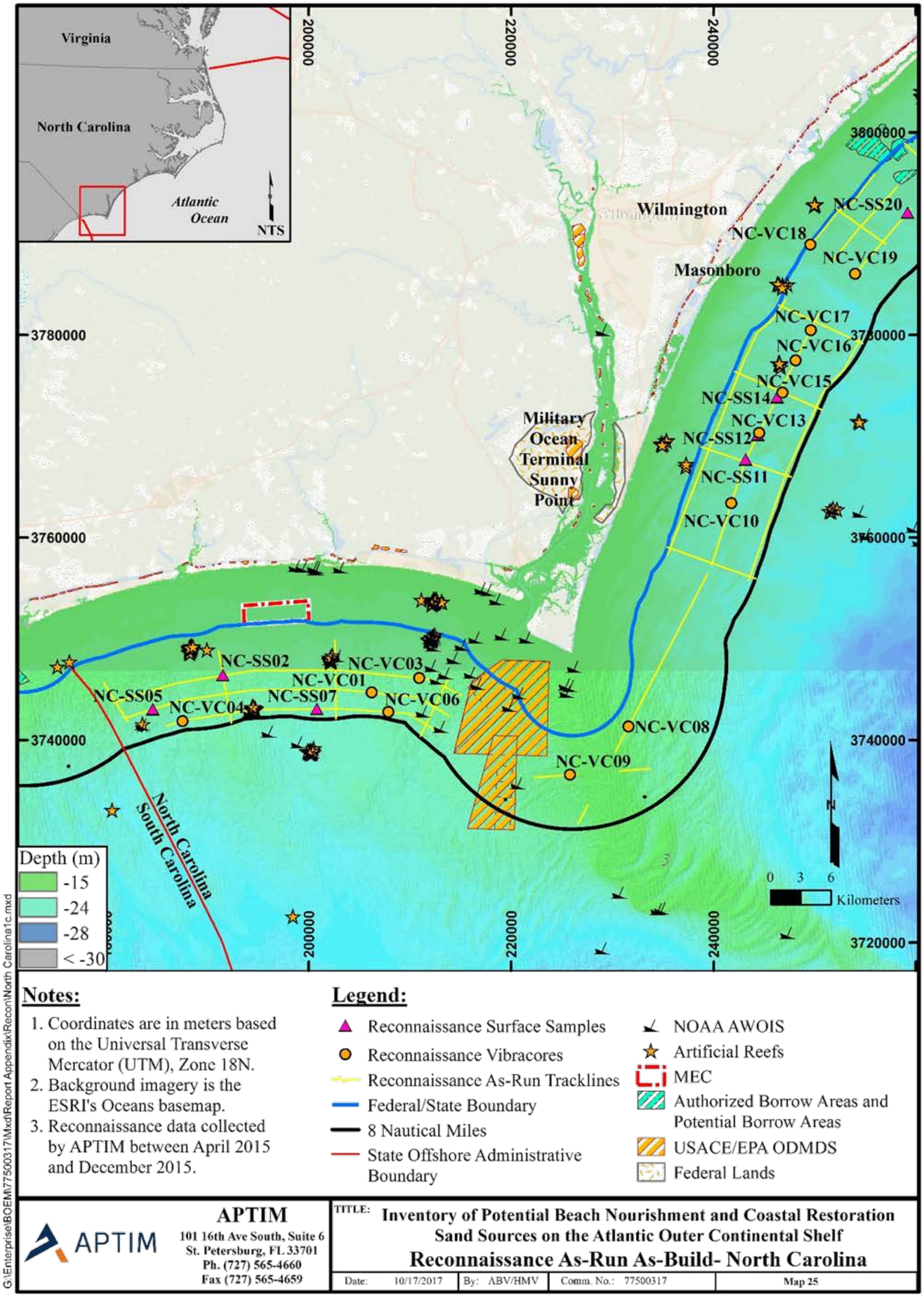
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- North Carolina

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 24


Virginia
North Carolina
Atlantic Ocean
NTS
200000
220000
240000
3800000
3780000
3760000
3740000
3720000
Wilmington
Masonboro
Military Ocean Terminal Sunny Point
NC-SS20
NC-VC18
NC-VC19
NC-VC17
NC-VC16
NC-VC15
NC-SS14
NC-VC13
NC-SS12
NC-SS11
NC-VC10
NC-SS02
NC-VC03
NC-VC01
NC-SS05
NC-VC04
NC-SS07
NC-VC06
NC-VC08
NC-VC09
North Carolina
South Carolina
Depth (m)
-15
-24
-28
< -30
0 3 6
Kilometers
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\North Carolina1c.mxd
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.
Legend:
Reconnaissance Surface Samples
Reconnaissance Vibracores
Reconnaissance As-Run Tracklines
Federal/State Boundary
8 Nautical Miles
State Offshore Administrative Boundary
NOAA AWOIS
Artificial Reefs
MEC
Authorized Borrow Areas and Potential Borrow Areas
USACE/EPA ODMDS
Federal Lands
APTIM
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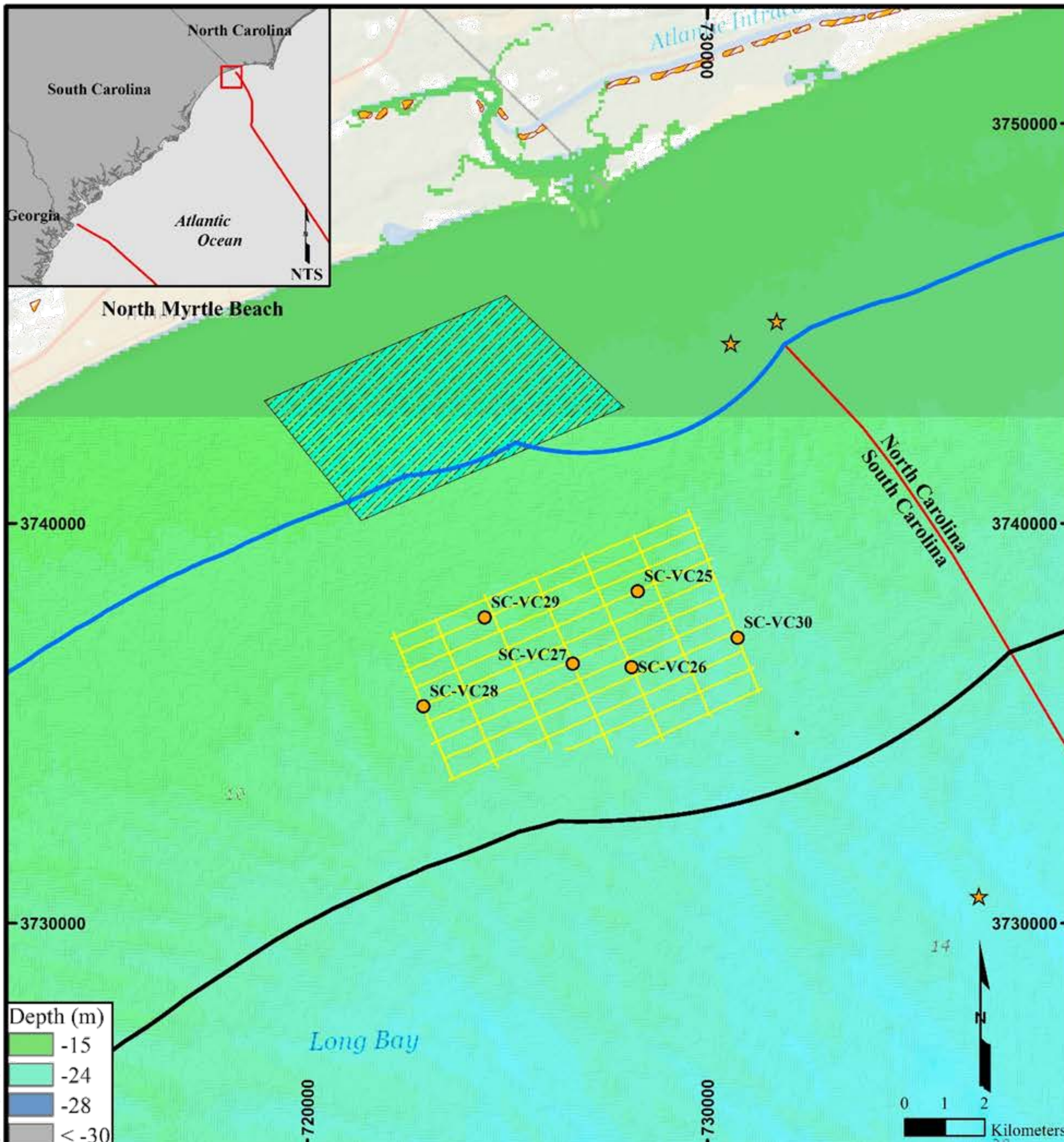
Fax (727) 565-4659
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
Reconnaissance As-Run As-Build- North Carolina
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 25



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\South Carolina4.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- 8 Nautical Miles
- Federal/State Boundary
- State Offshore Administrative Boundary
- Artificial Reefs
- Authorized Borrow Areas and Potential Borrow Areas
- USACE/EPA ODMDS

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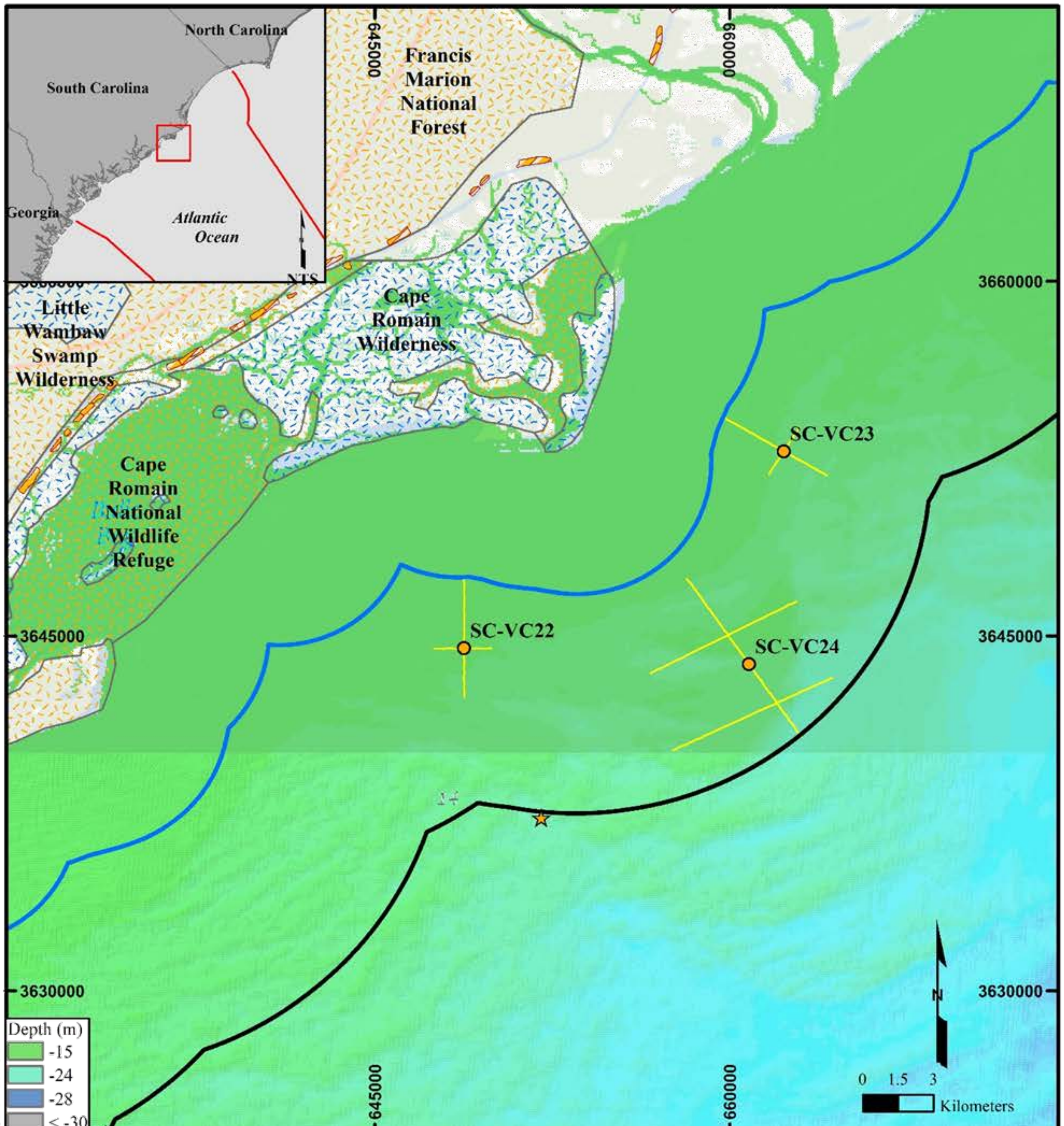
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- South Carolina

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 26



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\South Carolina3.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- Artificial Reefs
- USACE/EPA ODMDS
- Federal Wilderness Areas
- Federal Lands

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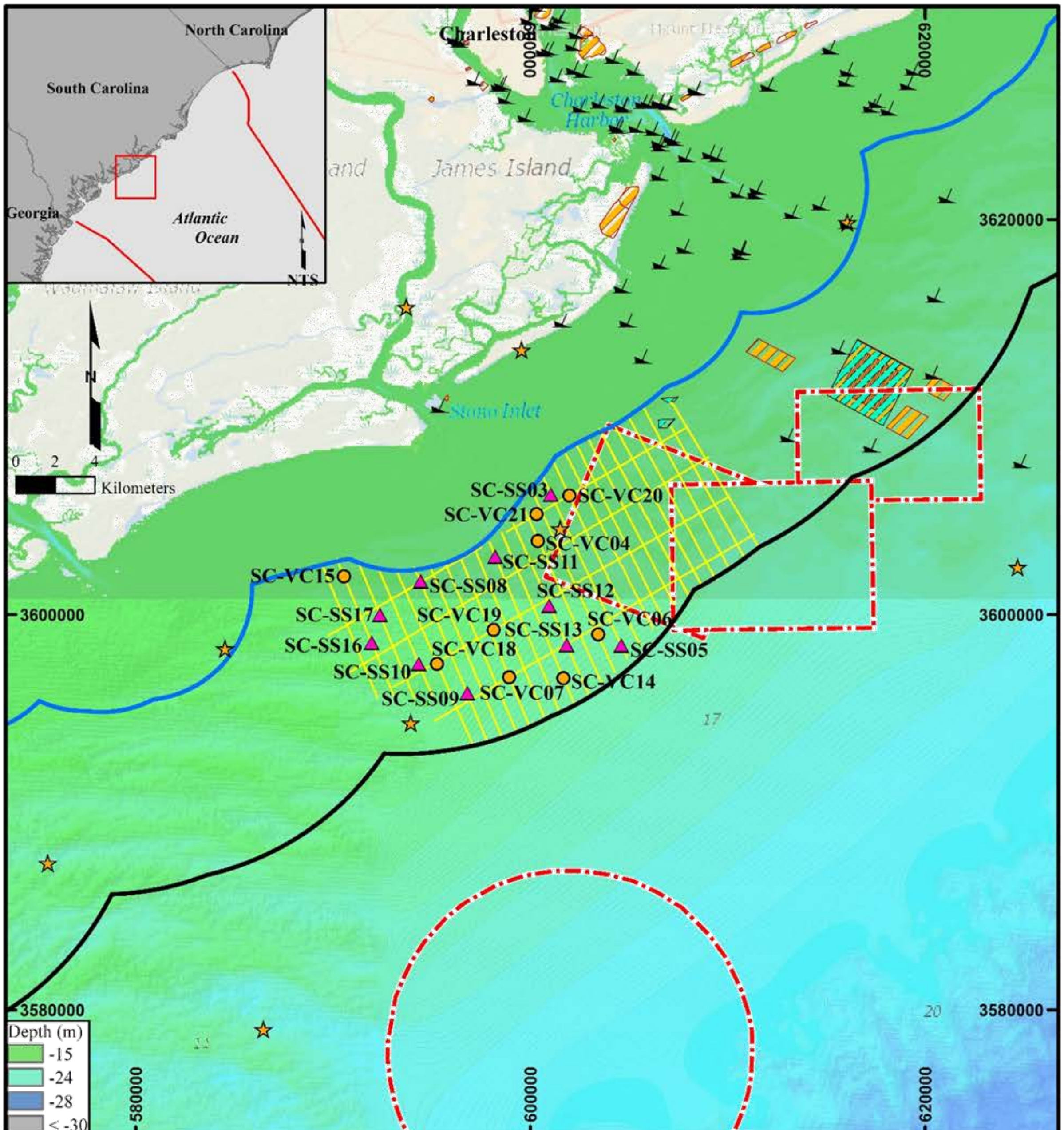
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- South Carolina

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 27



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\South Carolina2.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- MEC
- Authorized Borrow Areas and Potential Borrow Areas
- USACE/EPA ODMDS

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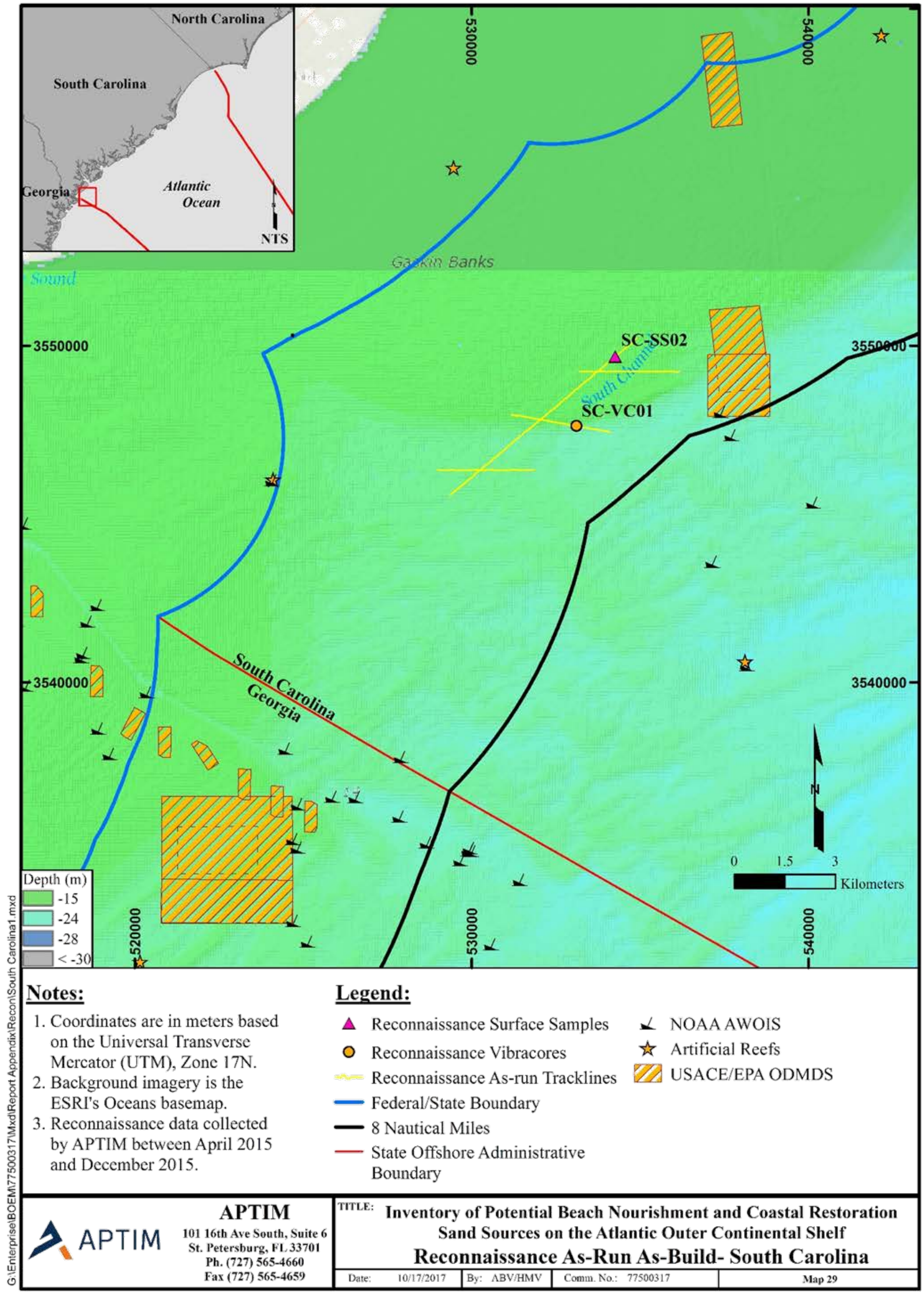
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- South Carolina

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 28


North Carolina
South Carolina
Georgia
Atlantic Ocean
NTS
530000
540000
520000
3550000
3540000
Gaskin Banks
Sound
SC-SS02
SC-VC01
South Channel
South Carolina
Georgia
0 1.5 3 Kilometers
N
Depth (m)
-15
-24
-28
< -30
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\South Carolina1.mxd
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.
Legend:
Reconnaissance Surface Samples
Reconnaissance Vibracores
Reconnaissance As-run Tracklines
Federal/State Boundary
8 Nautical Miles
State Offshore Administrative Boundary
NOAA AWOIS
Artificial Reefs
USACE/EPA ODMDS
APTIM
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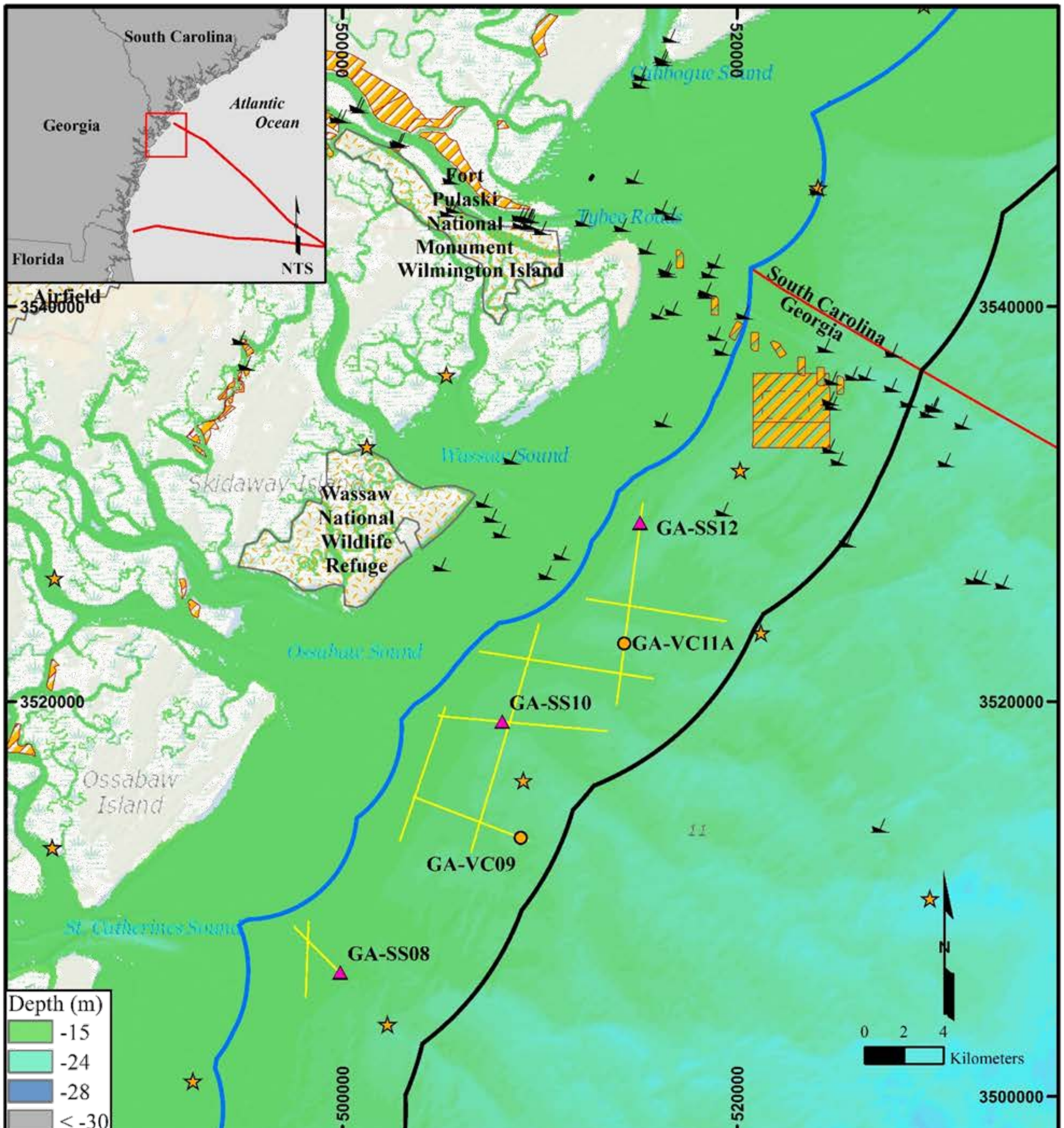
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
Reconnaissance As-Run As-Build- South Carolina
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 29



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- USACE/EPA ODMDS
- Federal Lands

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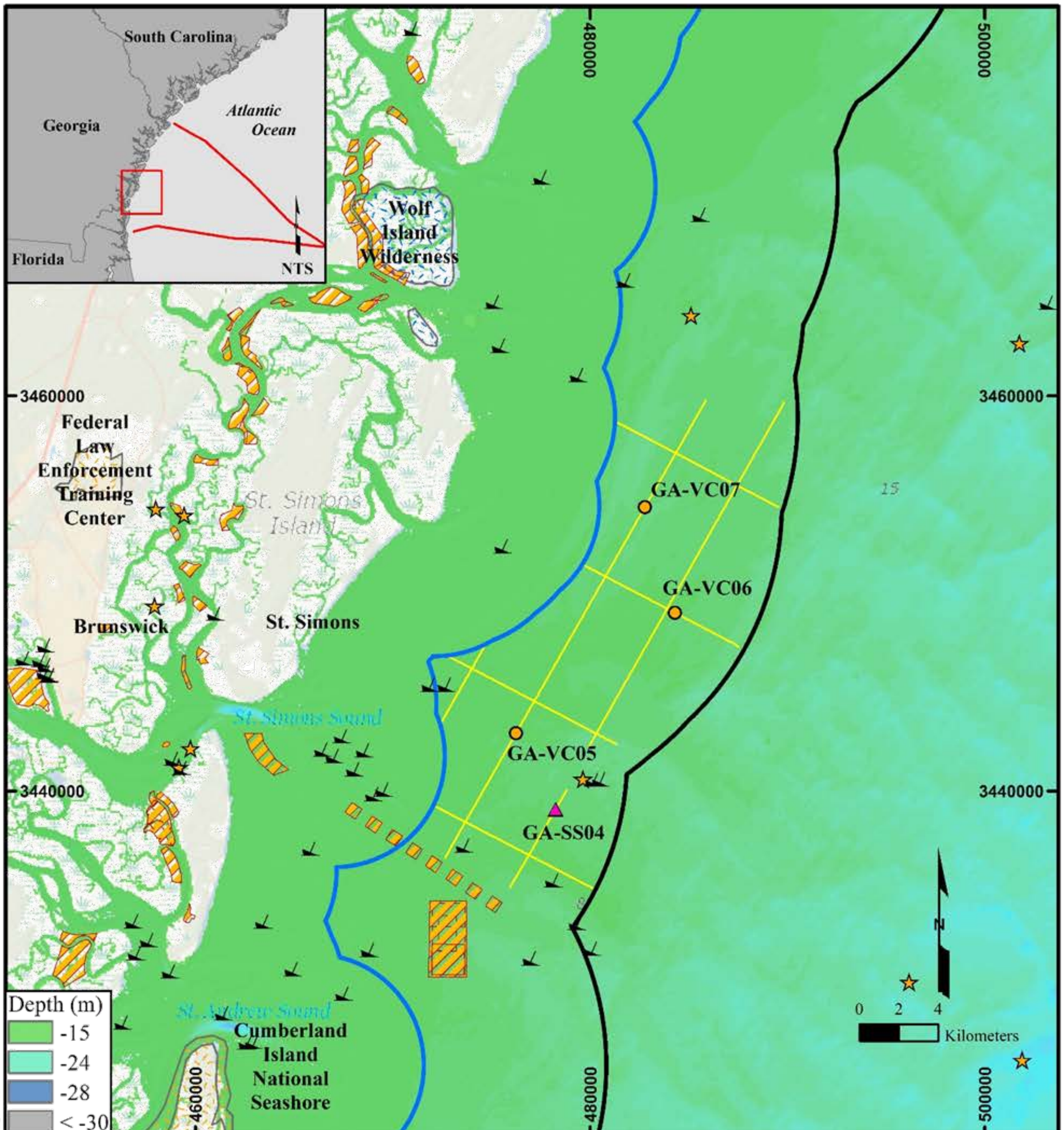
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Georgia

Date:	10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 30



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Georgia2.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- USACE/EPA ODMDS
- Federal Wilderness Areas
- Federal Lands

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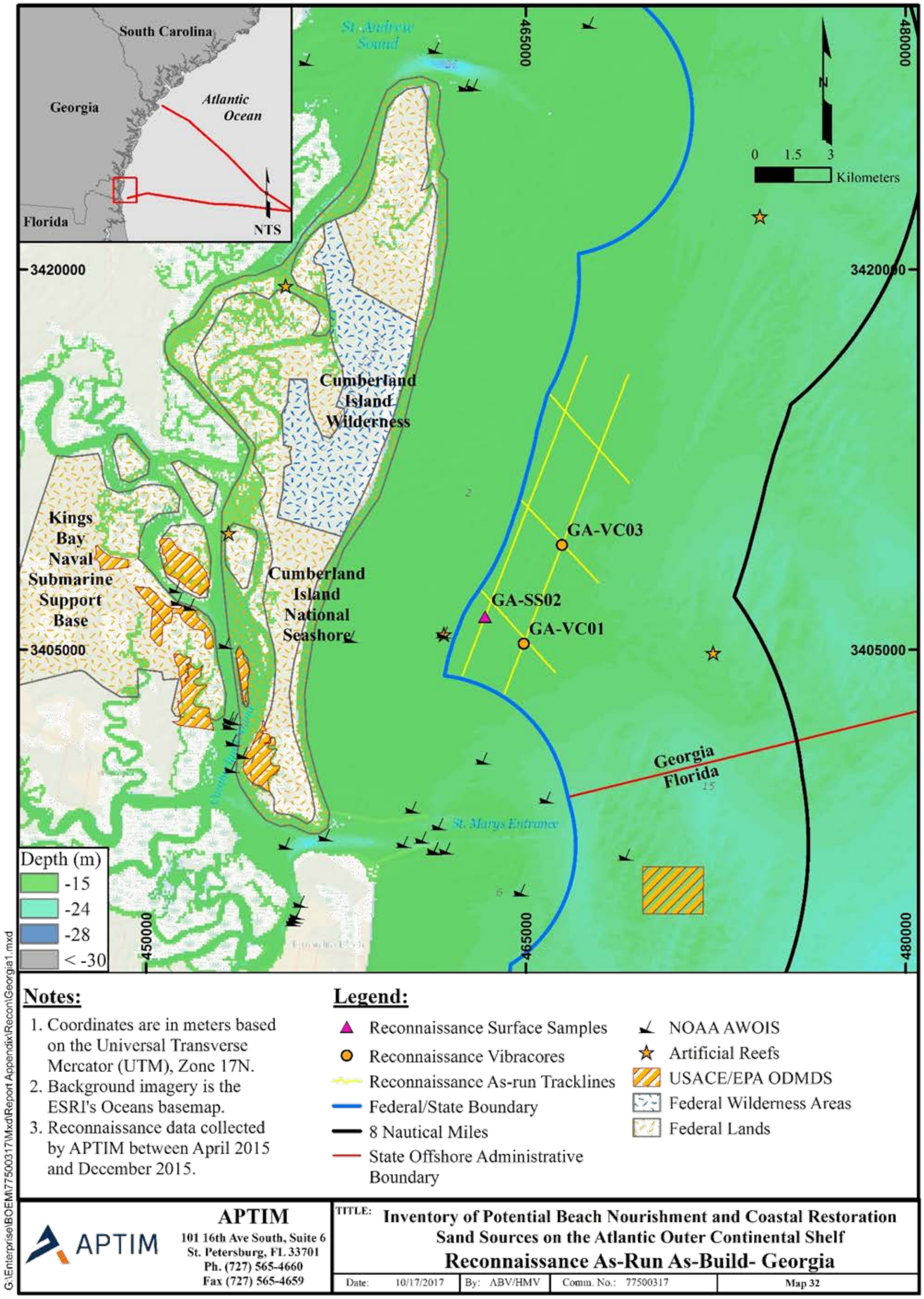
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Georgia

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 31


South Carolina
Georgia
Atlantic Ocean
Florida
NTS
St. Andrew Sound
465000
480000
3420000
3405000
450000
0 1.5 3 Kilometers
Cumberland Island Wilderness
Kings Bay Naval Submarine Support Base
Cumberland Island National Seashore
GA-VC03
GA-SS02
GA-VC01
Georgia
Florida
St. Marys Entrance
Depth (m)
-15
-24
-28
< -30
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.
Legend:
Reconnaissance Surface Samples
Reconnaissance Vibracores
Reconnaissance As-run Tracklines
Federal/State Boundary
8 Nautical Miles
State Offshore Administrative Boundary
NOAA AWOIS
Artificial Reefs
USACE/EPA ODMDS
Federal Wilderness Areas
Federal Lands
APTIM
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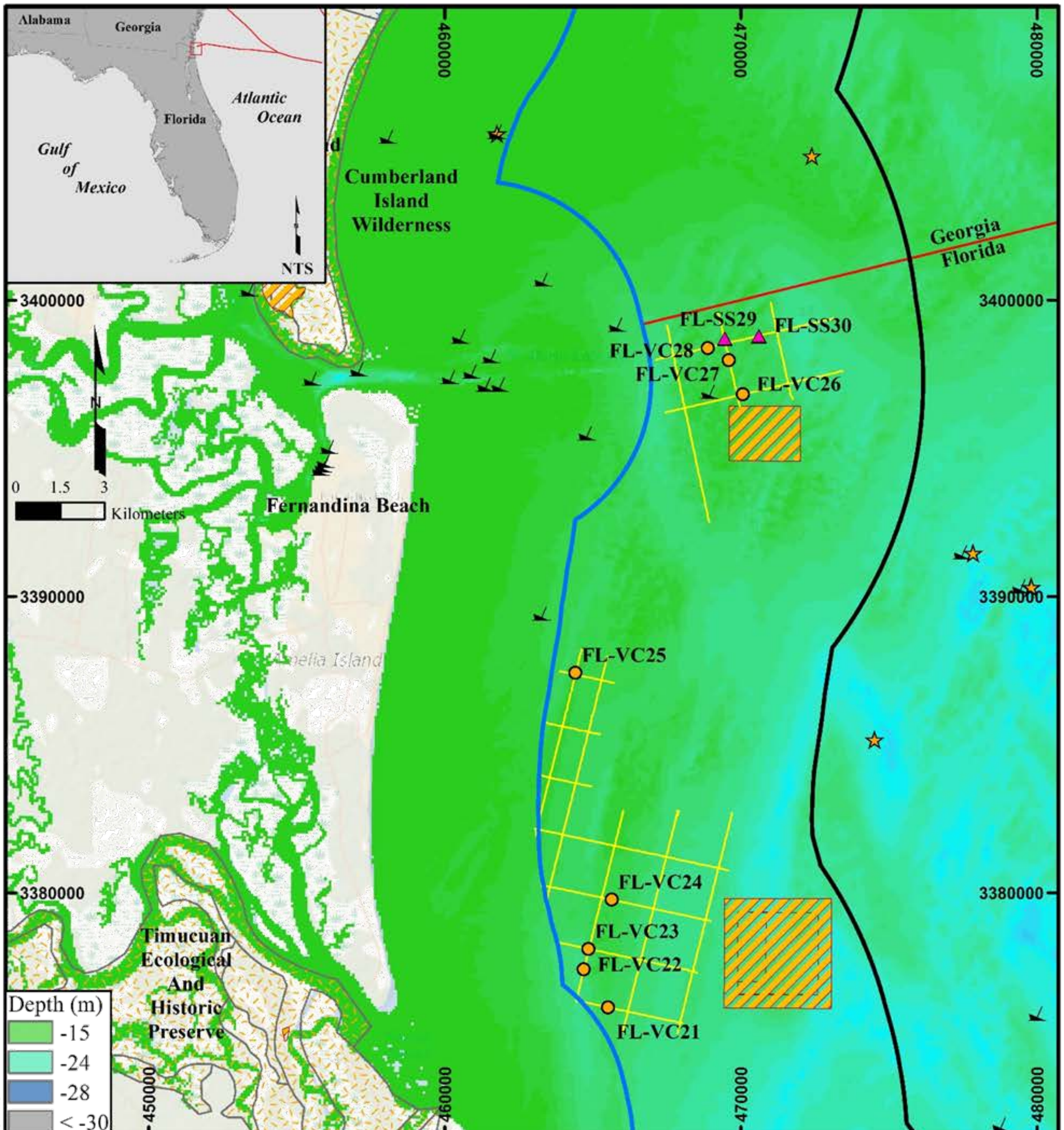
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
Reconnaissance As-Run As-Build- Georgia
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 32
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Georgia1.mxd



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- USACE/EPA ODMDS
- Federal Wilderness Areas
- Federal Lands

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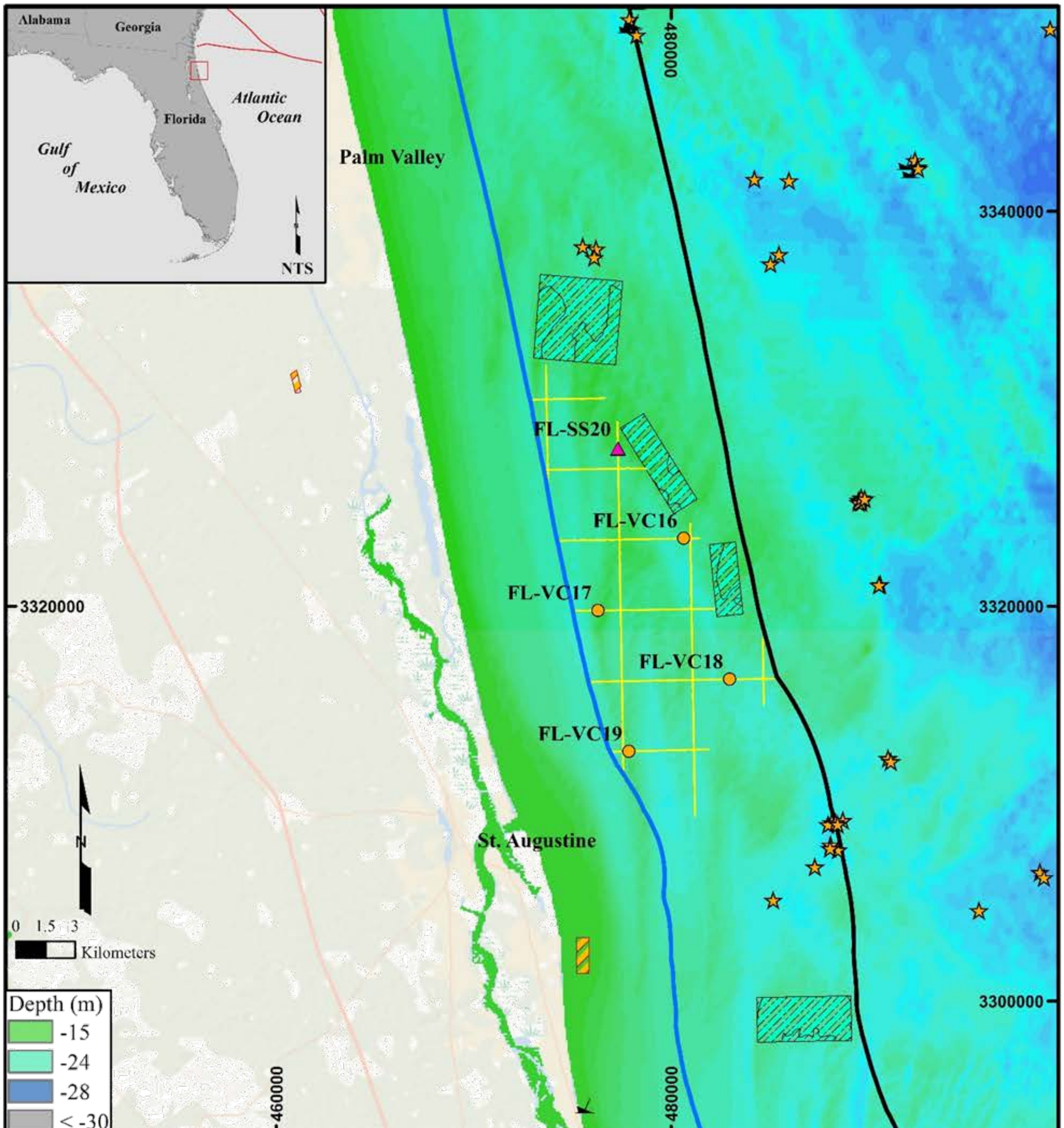
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Florida

Date:	10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 33



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Florida4.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Authorized Borrow Areas and Potential Borrow Areas
- USACE/EPA ODMDS

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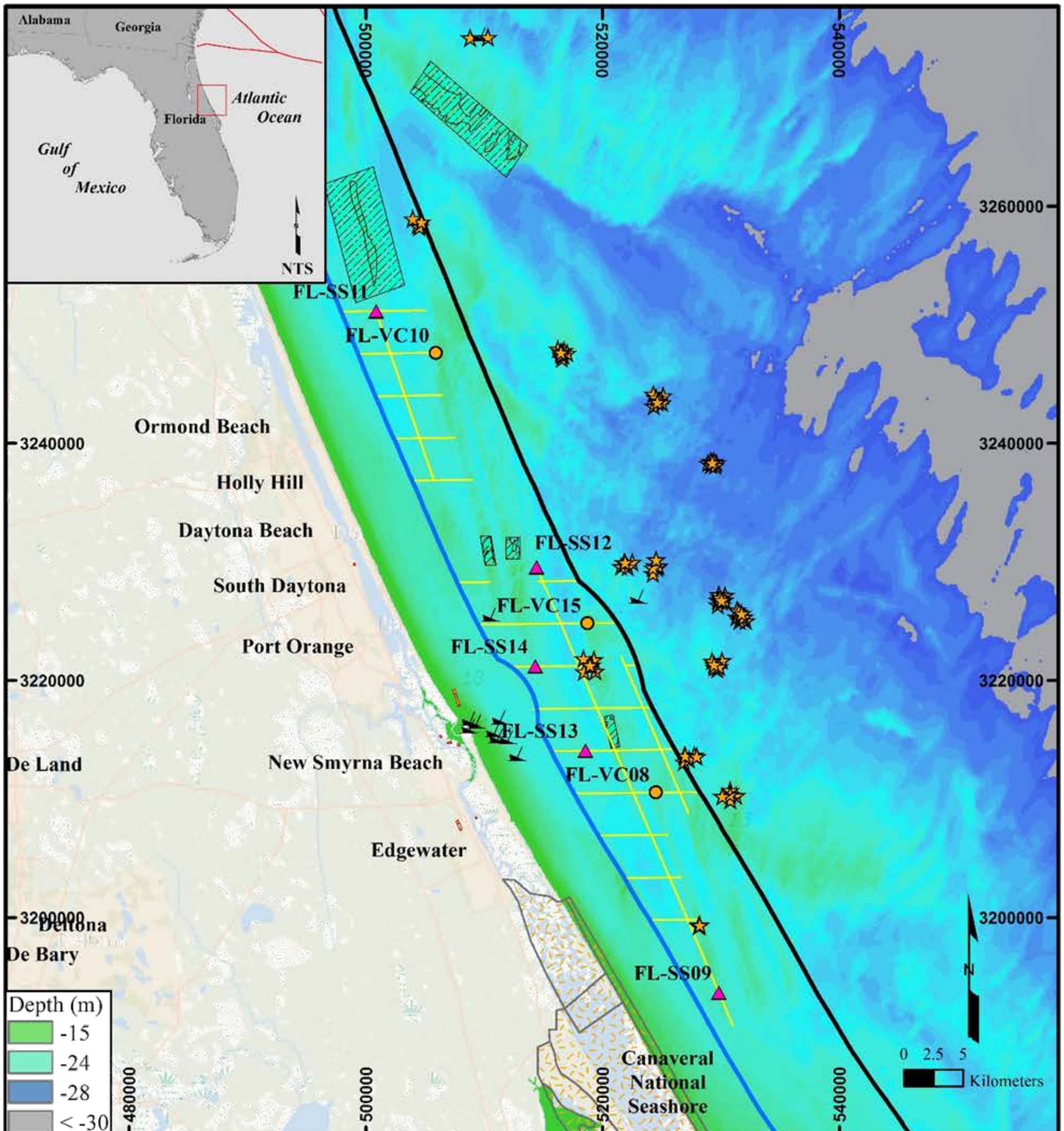
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Florida

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 34



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Authorized Borrow Areas and Potential Borrow Areas
- USACE/EPA ODMDS
- Federal Lands

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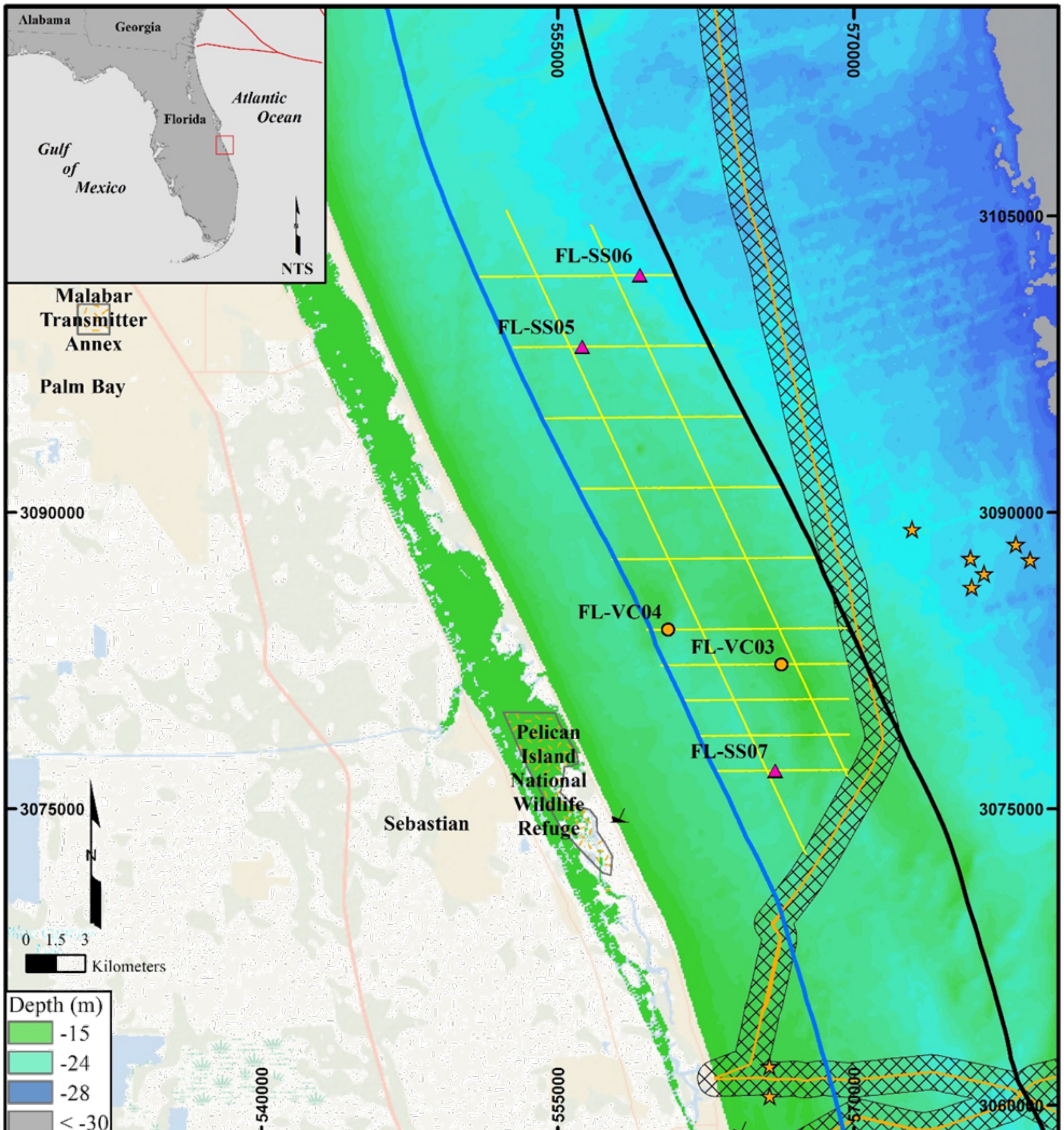
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Florida

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 35



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Florida2.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS
- Federal Lands

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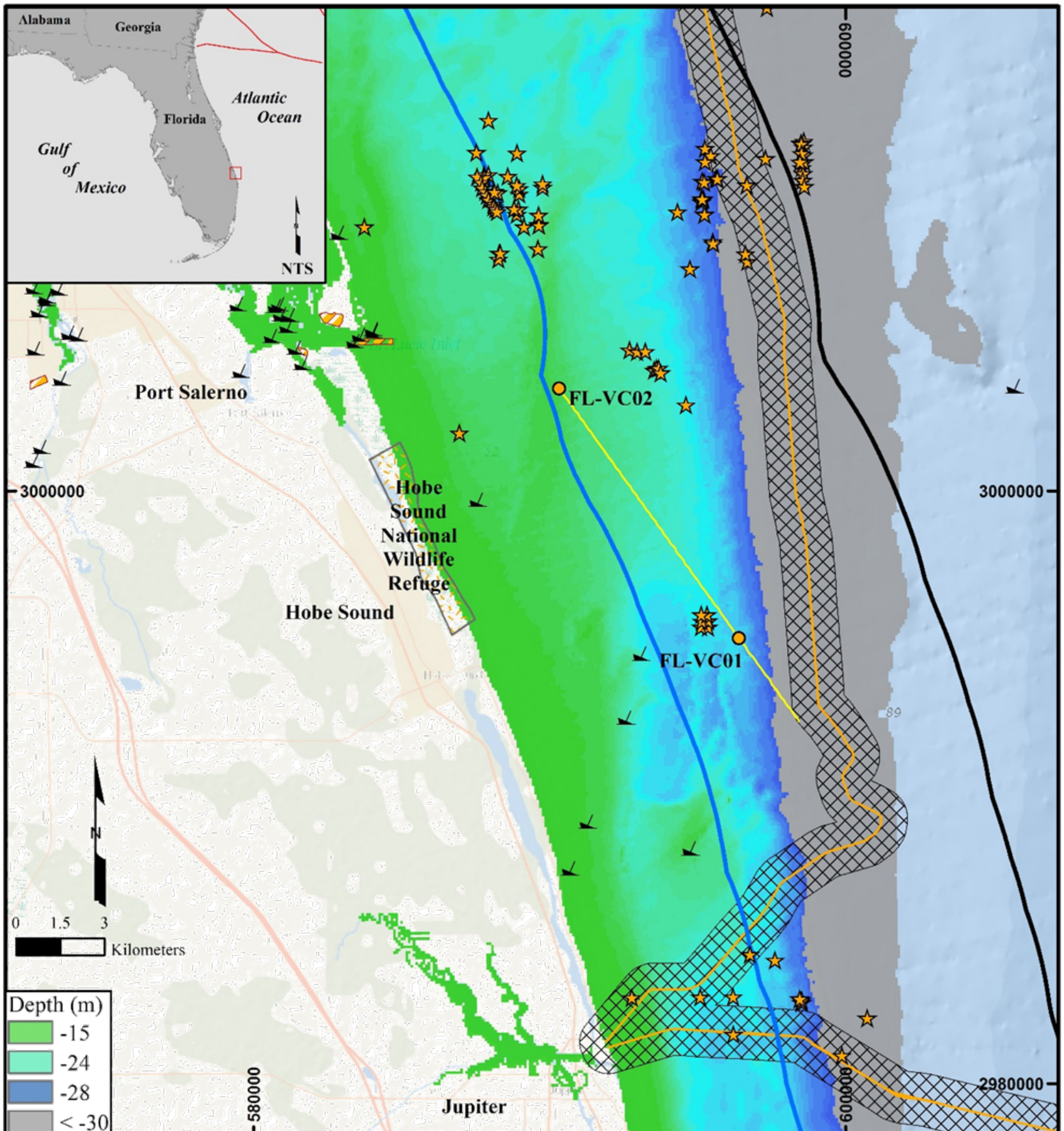
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Florida

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 36



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Recon\Florida1.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 17N.
2. Background imagery is the ESRI's Oceans basemap.
3. Reconnaissance data collected by APTIM between April 2015 and December 2015.

Legend:

- Reconnaissance Surface Samples
- Reconnaissance Vibracores
- Reconnaissance As-run Tracklines
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary
- NOAA AWOIS
- Artificial Reefs
- Cables
- 1km Cable Buffer
- USACE/EPA ODMDS
- Federal Lands

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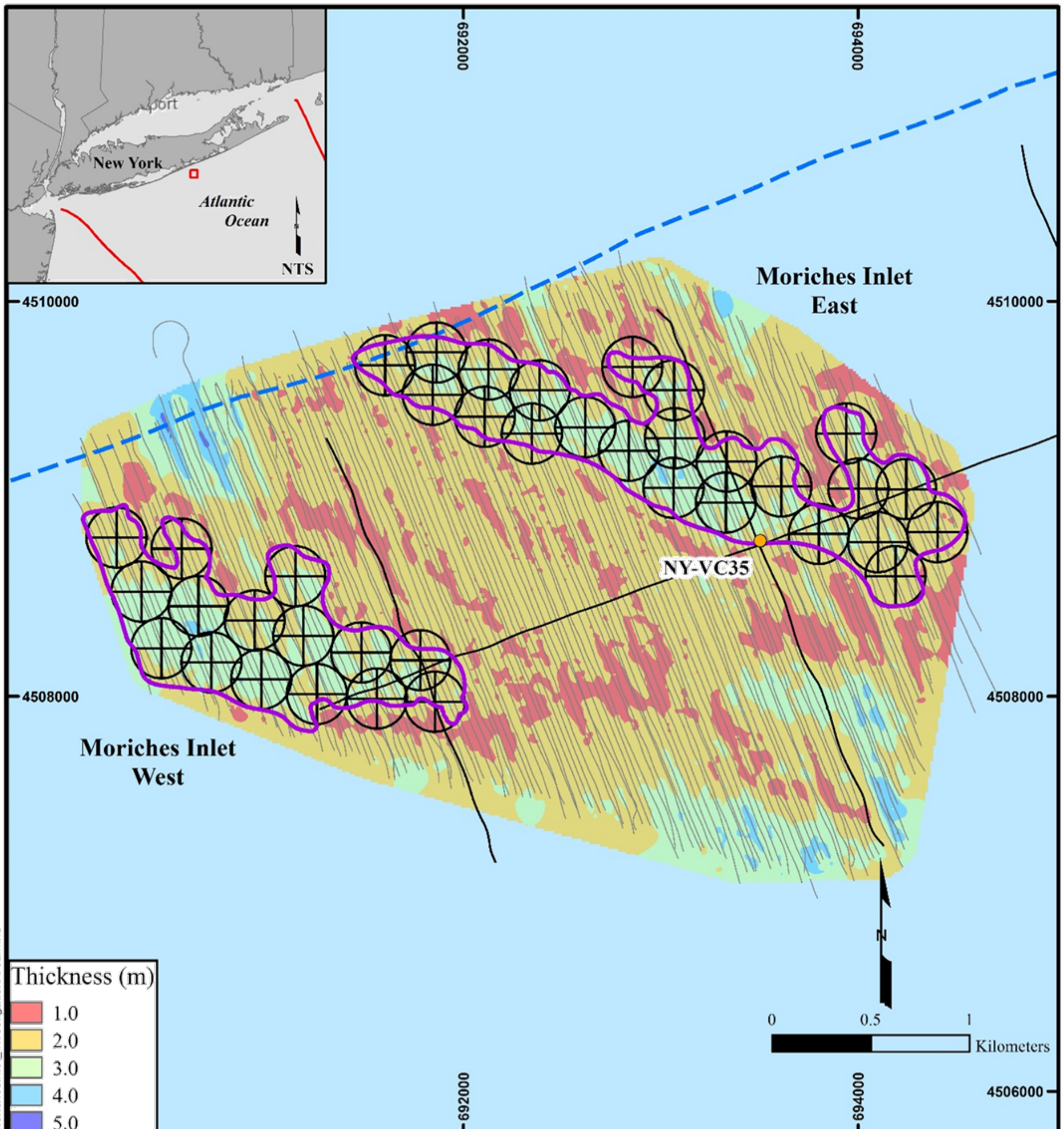
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

Reconnaissance As-Run As-Build- Florida

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 37

14.2 2016 Design-Level Survey Maps (Phase 3)



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.
3. Circles around each vibracore location represent the 1000 ft. area of influence for each individual vibracore.

Legend:

- Design Investigation Areas
- Design-Level VC for full DIA coverage, future collection
- Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- Federal/State Boundary
- State Offshore Administrative Boundary

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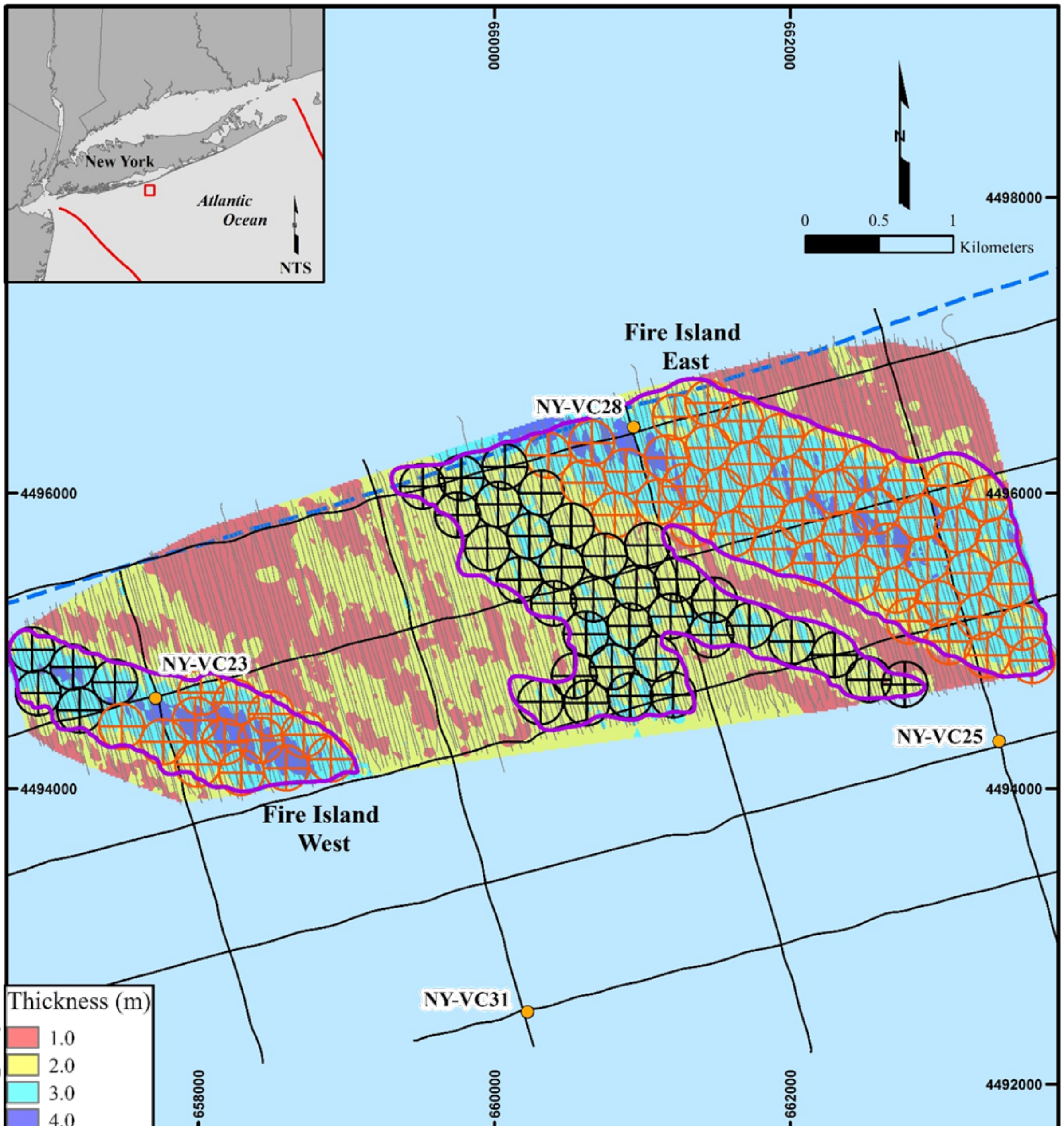
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

2016 Design Planned Vibracores- NY, Moriches Inlet

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 38



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Design 2016\FireIsland_InvestigationArea.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.
3. Circles around each vibracore location represent the 1000 ft. area of influence for each individual vibracore.

Legend:

- Design Investigation Areas
- Design-Level VC for collection
- Design-Level VC for full DIA coverage, future collection
- Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- Federal/State Boundary
- State Offshore Administrative Boundary

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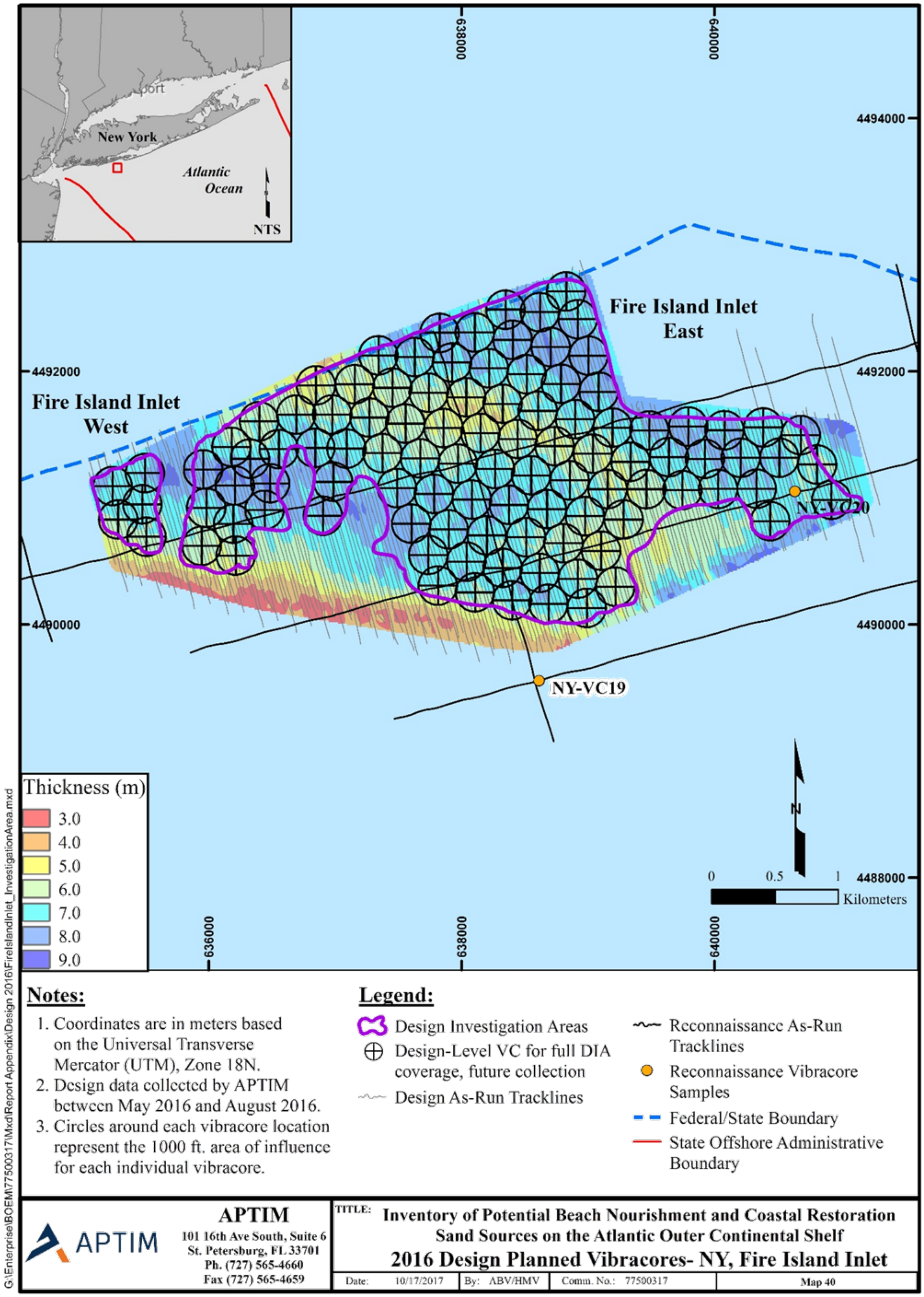
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

2016 Design Planned Vibracores- NY, Fire Island

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 39


New York
Atlantic Ocean
NTS
638000
640000
636000
4494000
4492000
4490000
4488000
Fire Island Inlet East
Fire Island Inlet West
NY-VC20
NY-VC19
N
0 0.5 1 Kilometers
Thickness (m)
3.0
4.0
5.0
6.0
7.0
8.0
9.0
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.
3. Circles around each vibracore location represent the 1000 ft. area of influence for each individual vibracore.
Legend:
Design Investigation Areas
Design-Level VC for full DIA coverage, future collection
Design As-Run Tracklines
Reconnaissance As-Run Tracklines
Reconnaissance Vibracore Samples
Federal/State Boundary
State Offshore Administrative Boundary
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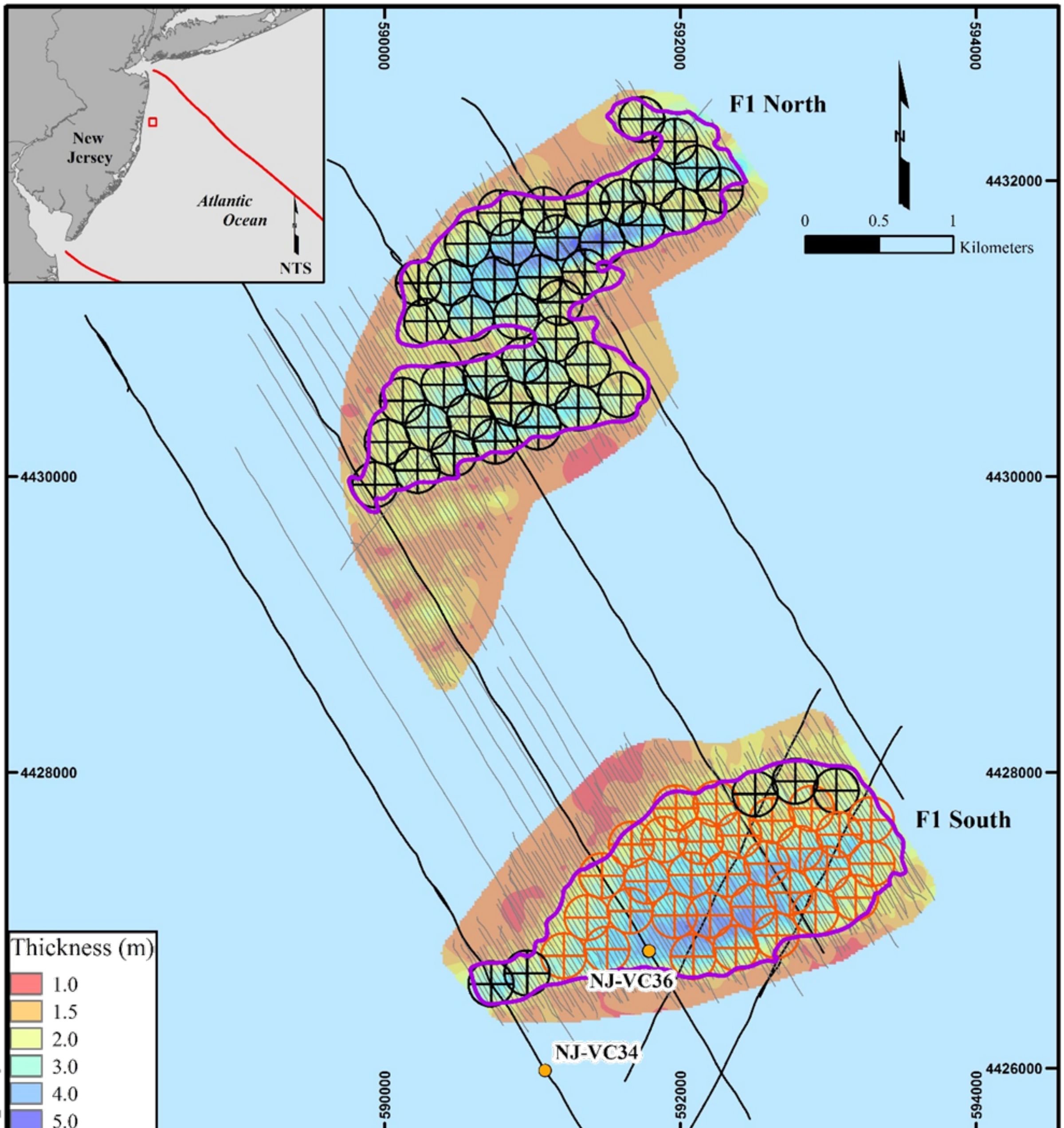
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
2016 Design Planned Vibracores- NY, Fire Island Inlet
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 40
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Design 2016\FireIslandInlet_InvestigationArea.mxd



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.
3. Circles around each vibracore location represent the 1000 ft. area of influence for each individual vibracore.

Legend:

- Design Investigation Areas
- Design-Level VC for collection
- Design-Level VC for full DIA coverage, future collection
- Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- State Offshore Administrative Boundary

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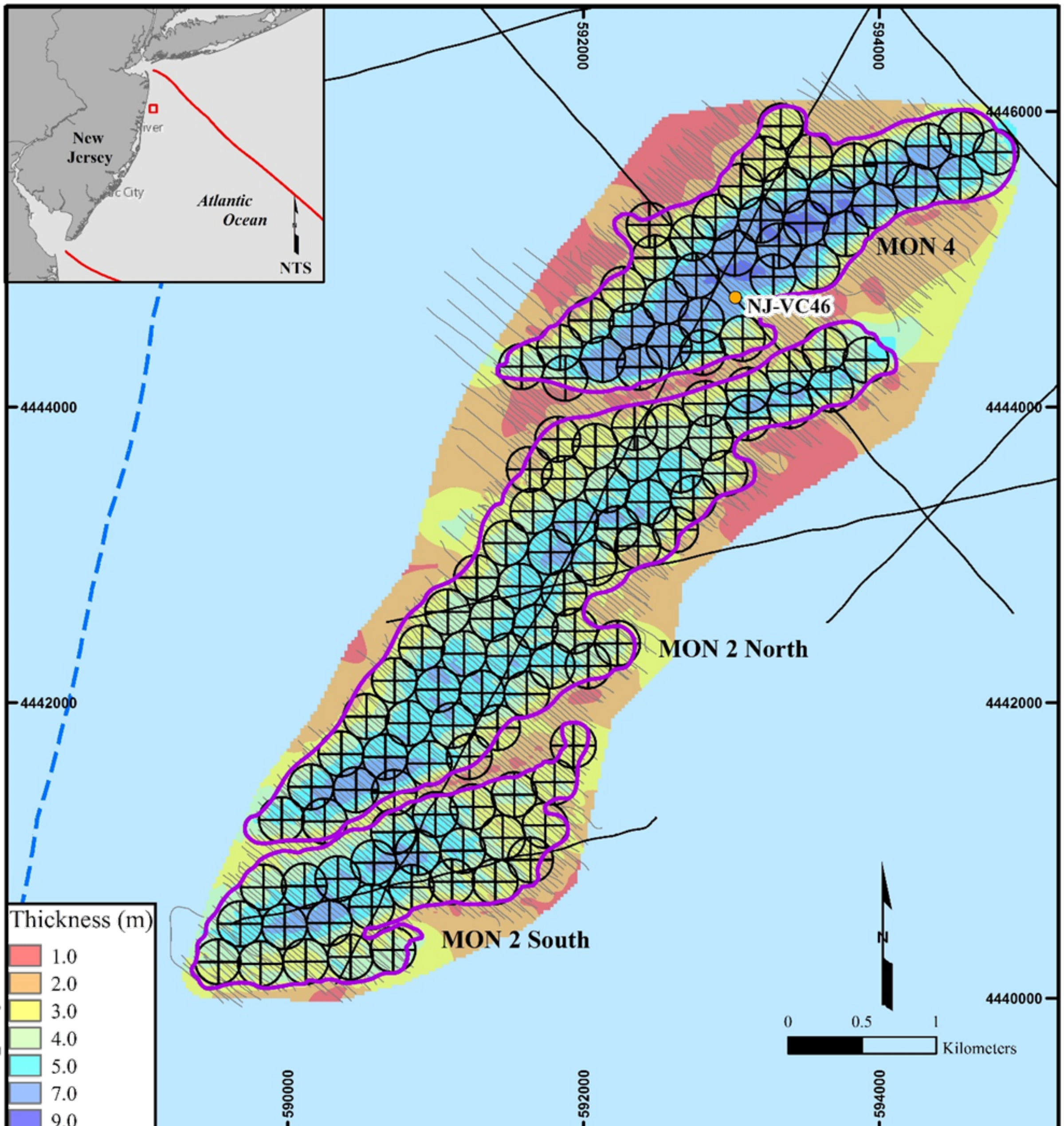
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

2016 Design Planned Vibracores- NJ, F1

Date:	10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 41



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Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.
3. Circles around each vibracore location represent the 1000 ft. area of influence for each individual vibracore.

Legend:

- Design Investigation Areas
- Design-Level VC for full DIA coverage, future collection
- Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- Federal/State Boundary
- State Offshore Administrative Boundary

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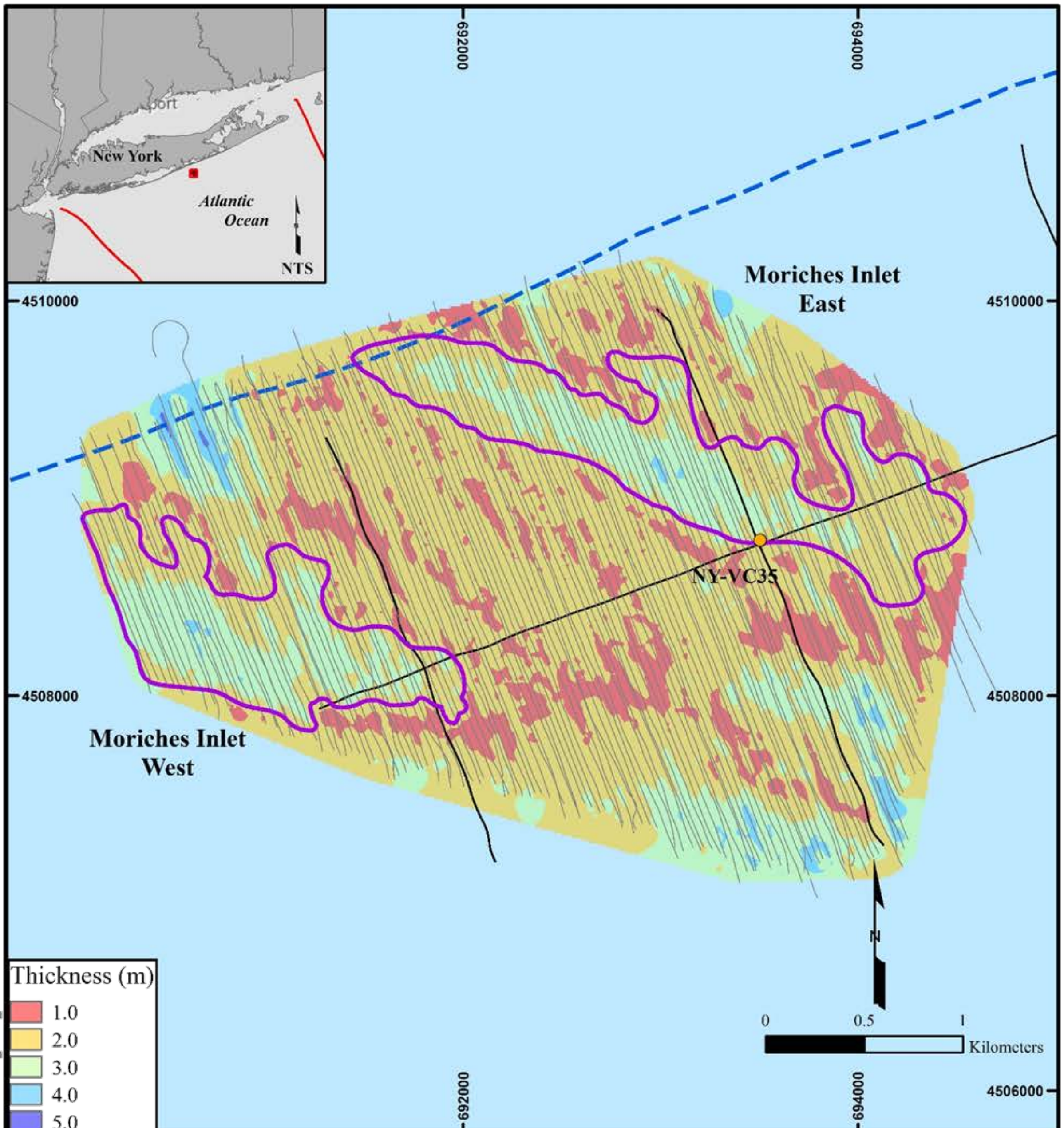
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

2016 Design Planned Vibracores- NJ, MON2-MON4

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 42



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. 2. Design data collected by APTIM between May 2016 and August 2016.

Legend:

- Design Investigation Areas
- Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- Federal/State Boundary
- State Offshore Administrative Boundary

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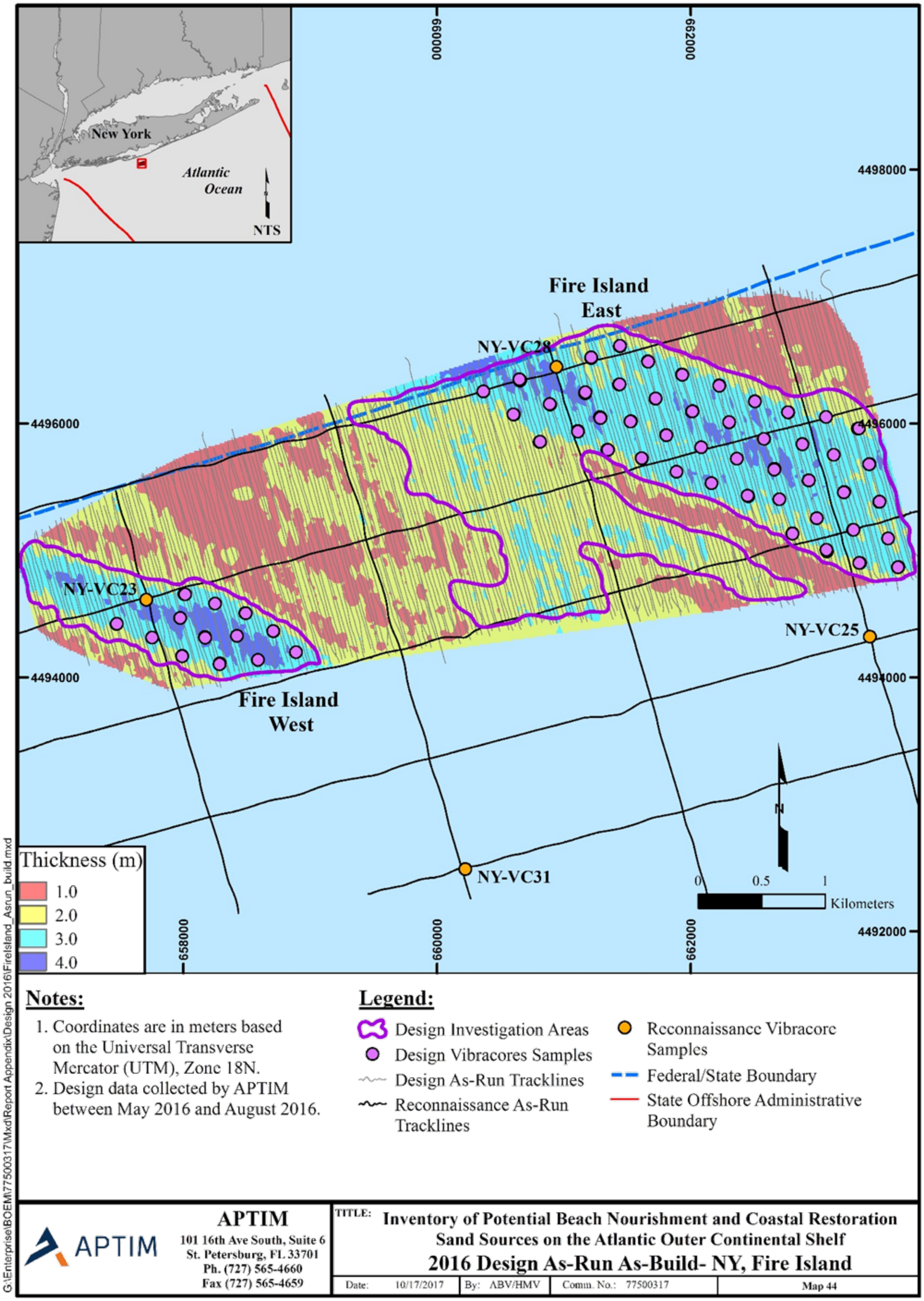
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

2016 Design As-Run As-Build- NY, Moriches Inlet

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 43

G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Design 2016\MorichesInlet_Asrun_build.mxd


New York
Atlantic Ocean
NTS
Fire Island East
Fire Island West
NY-VC28
NY-VC23
NY-VC25
NY-VC31
660000
662000
658000
4498000
4496000
4494000
4492000
Thickness (m)
1.0
2.0
3.0
4.0
0 0.5 1 Kilometers
N
G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Design 2016\FireIsland_Asrun_build.mxd
Notes:
1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.
Legend:
Design Investigation Areas
Design Vibracores Samples
Design As-Run Tracklines
Reconnaissance As-Run Tracklines
Reconnaissance Vibracore Samples
Federal/State Boundary
State Offshore Administrative Boundary
APTIM
APTIM
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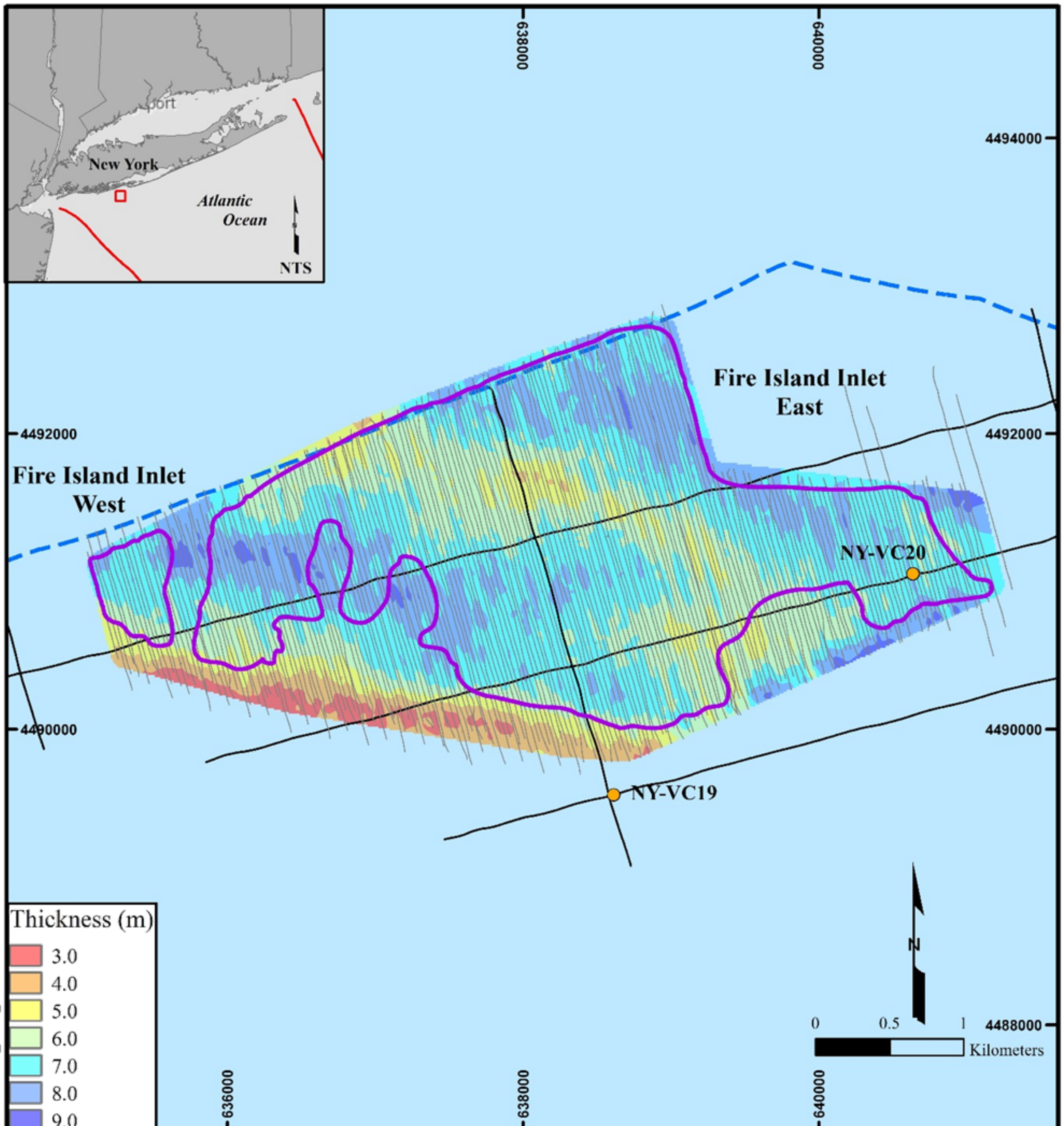
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf
2016 Design As-Run As-Build- NY, Fire Island
Date: 10/17/2017
By: ABV/HMV
Comm. No.: 77500317
Map 44



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.

Legend:

- Design Investigation Areas
- Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- Federal/State Boundary
- State Offshore Administrative Boundary

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TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

2016 Design As-Run As-Build- NY, Fire Island Inlet

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 45

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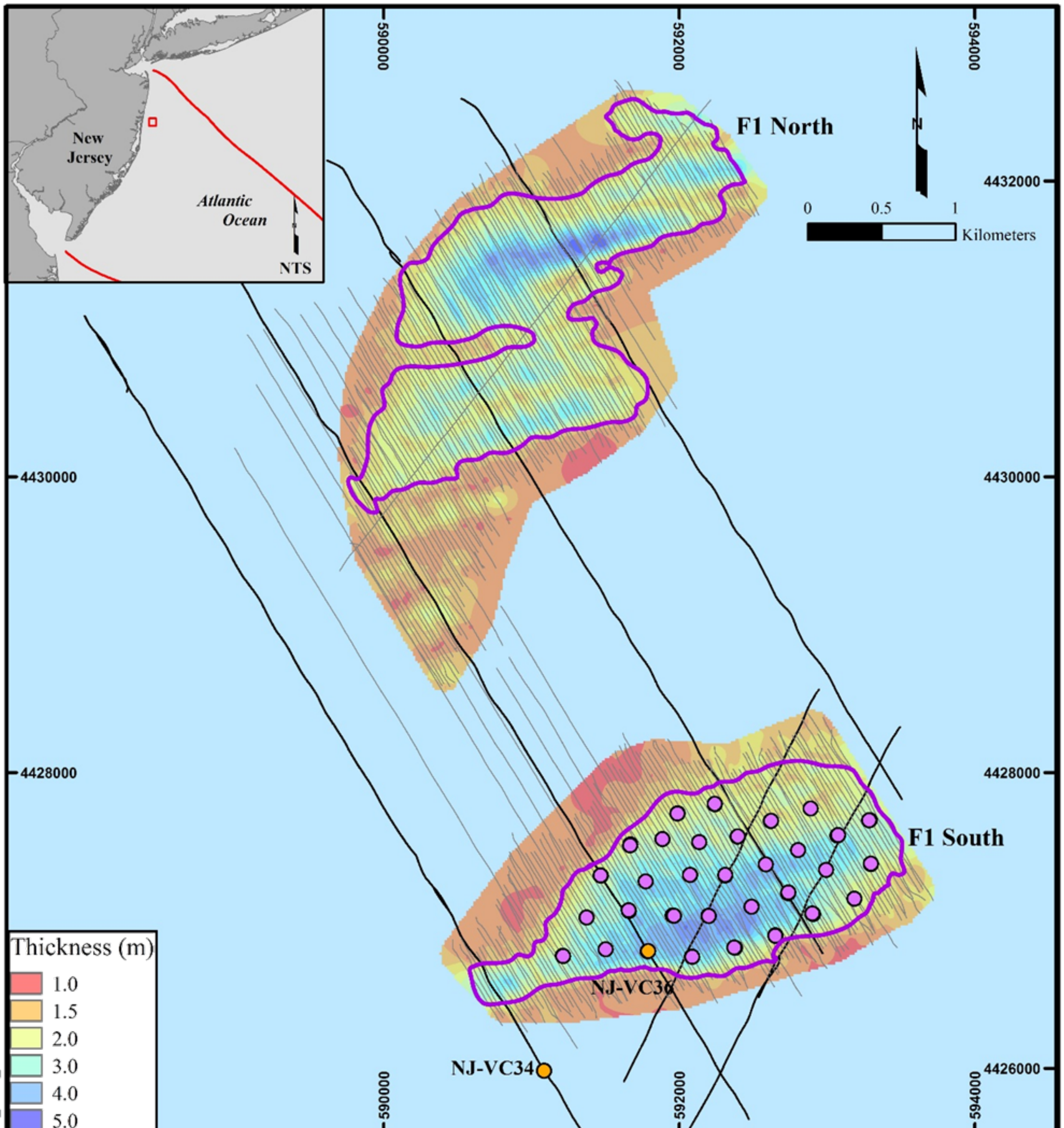

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.

Legend:

- Design Investigation Areas
- Design Vibracores
- Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- State Offshore Administrative Boundary

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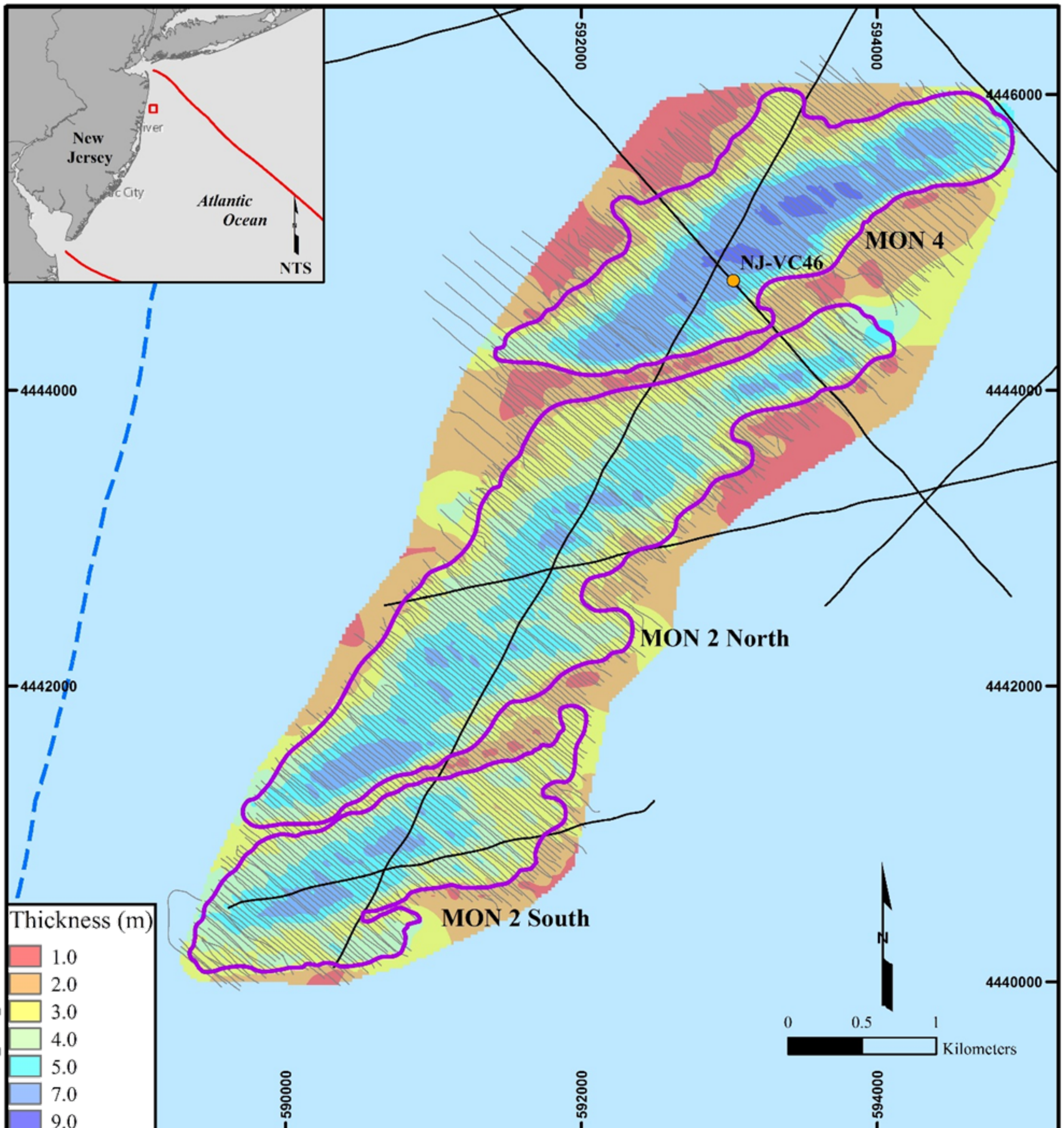
TITLE: Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf

2016 Design As-Run As-Build- NJ, F1

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 46



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\Design 2016\MON2-MON4_Asrun_build.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between May 2016 and August 2016.

Legend:

- Design Investigation Areas
- Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- Federal/State Boundary
- State Offshore Administrative Boundary

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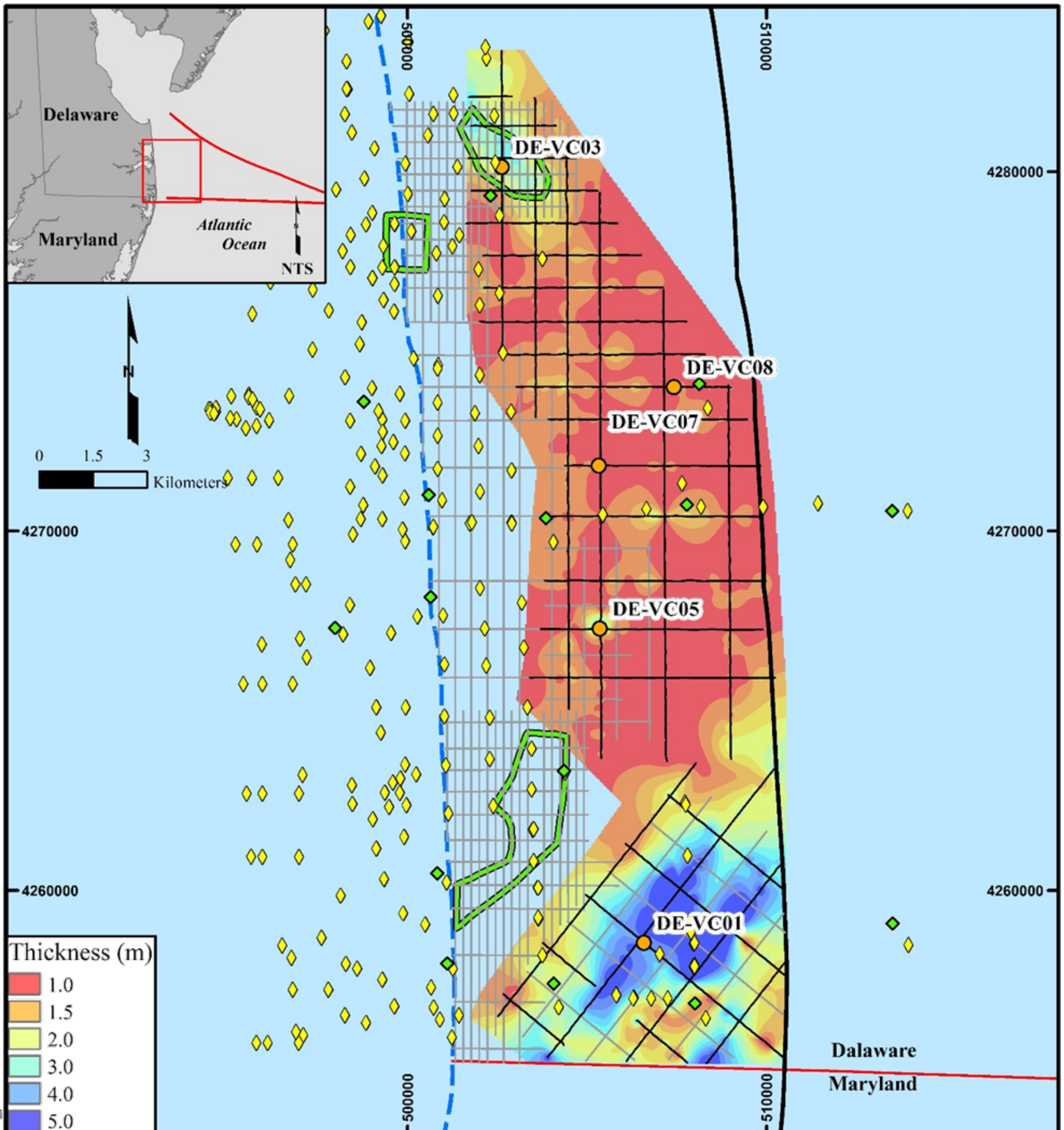
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

2016 Design As-Run As-Build- NJ, MON2-MON4

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 47

14.3 2017 Design-Level Survey Maps (Phase 4)



Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Recon and Desing data collected by APTIM in 2015 and 2016.
3. Historic vibracores are from the DE USGS Report Investigations No. 63.
4. DE Geologic Society vibracores are from the 1994 Sand Resources Interim Report.

Legend:

- DE Potential Resources
- 2017 Design Planned Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- USGS Historic Vibracores
- Delaware Geologic Society vibracore locations
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary

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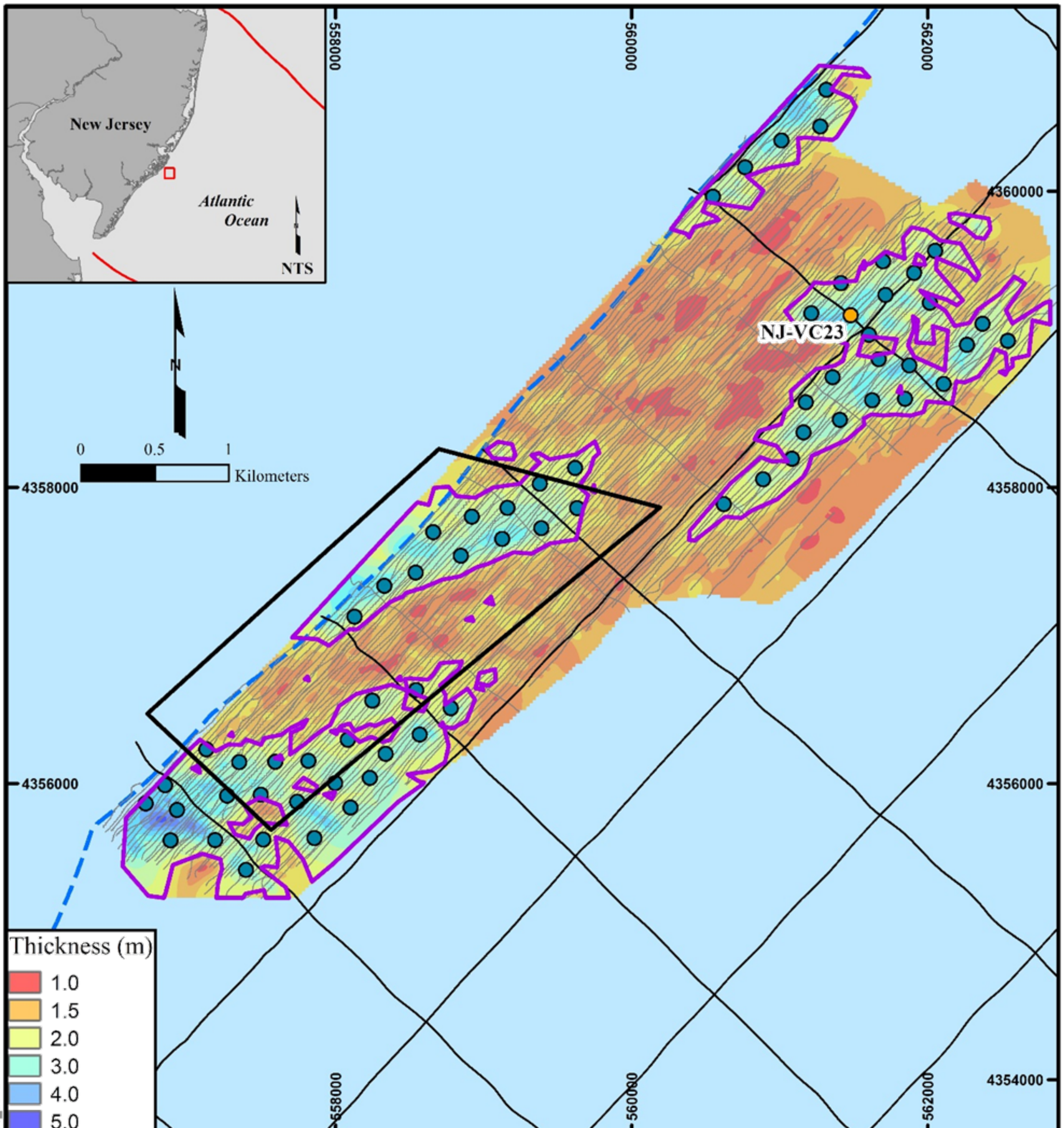
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**
2017 Design Survey Plan- Delaware

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 49



G:\Enterprise\BOEM\77500317\Mxd\Report Appendix\2017 survey\G1_as run.mxd

Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between April and August 2017.

Legend:

- G1 Survey Area
- 2017 Design Investigation Areas
- 2017 Design Vibracores Samples
- 2017 Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- Federal/State Boundary
- State Offshore Administrative Boundary

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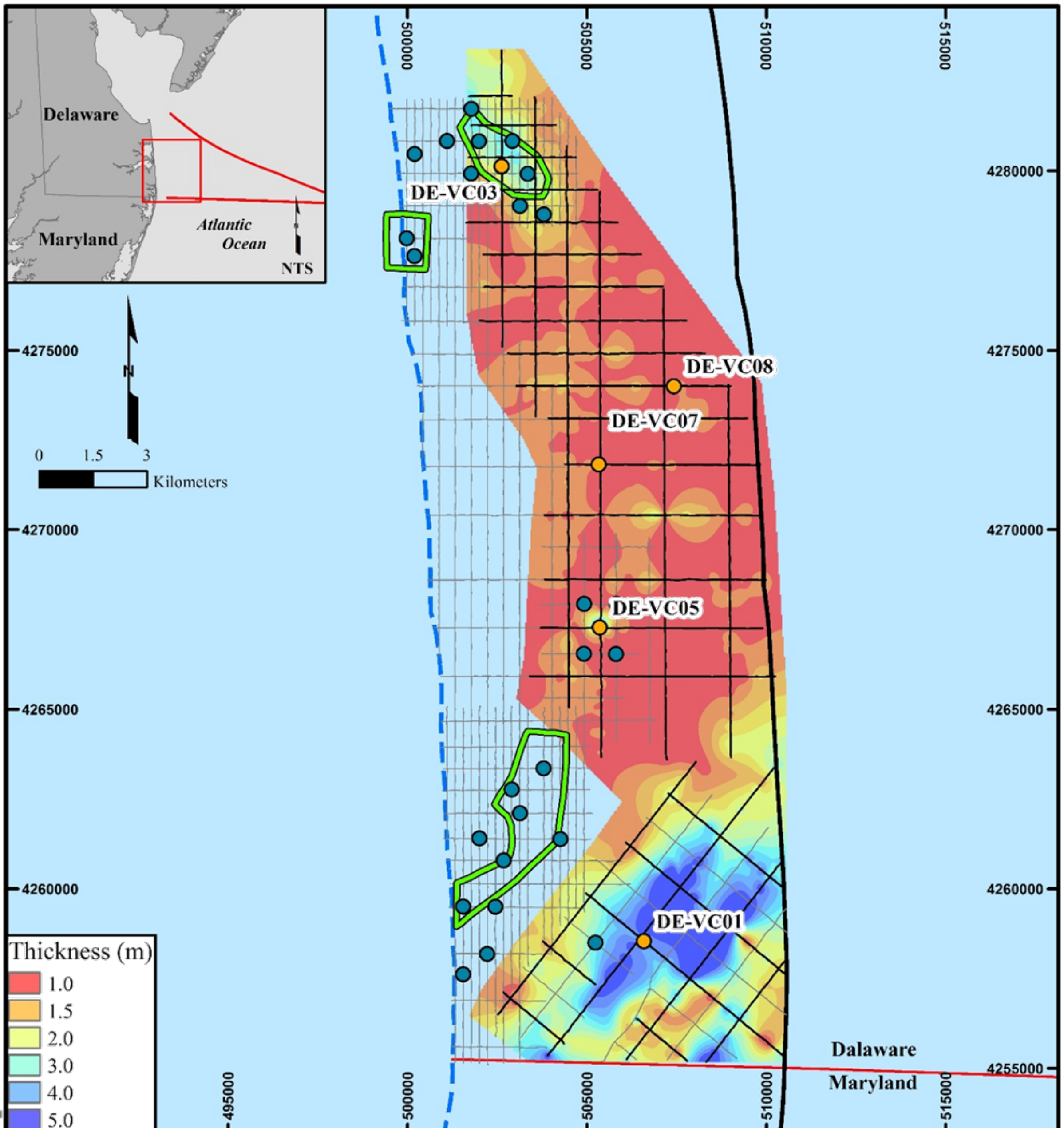
TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

2017 Design As-Run, As-Build- NJ, G1

Date:	10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 50



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Notes:

1. Coordinates are in meters based on the Universal Transverse Mercator (UTM), Zone 18N.
2. Design data collected by APTIM between April and August 2017.

Legend:

- DE Potential Resources
- 2017 Design Vibracores Samples
- 2017 Design As-Run Tracklines
- Reconnaissance As-Run Tracklines
- Reconnaissance Vibracore Samples
- Federal/State Boundary
- 8 Nautical Miles
- State Offshore Administrative Boundary

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TITLE: **Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continental Shelf**

2017 Design As-Run As-Build- Delaware

Date: 10/17/2017	By: ABV/HMV	Comm. No.: 77500317	Map 51

15.0 References

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16.0 Appendices

Appendix A

Survey Vessel Diagrams

Appendix B

Cultural Resource Review Reports

Appendix C

Final Protected Species Observer Summary Reports

Appendix D

Master Geophysical Digital Field Logs

Appendix E

Written Field Log Books

Appendix F

Quarterly Project Progress Reports

Appendix G

White Paper on Vibracores with Recovery Exceeding Penetration

Appendix H
(digital submittal only)

ArcGIS Digital Map Products for BOEM ASAP Final Report Maps