Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

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U.S. Department of the Interior
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List of Abbreviations and Acronyms

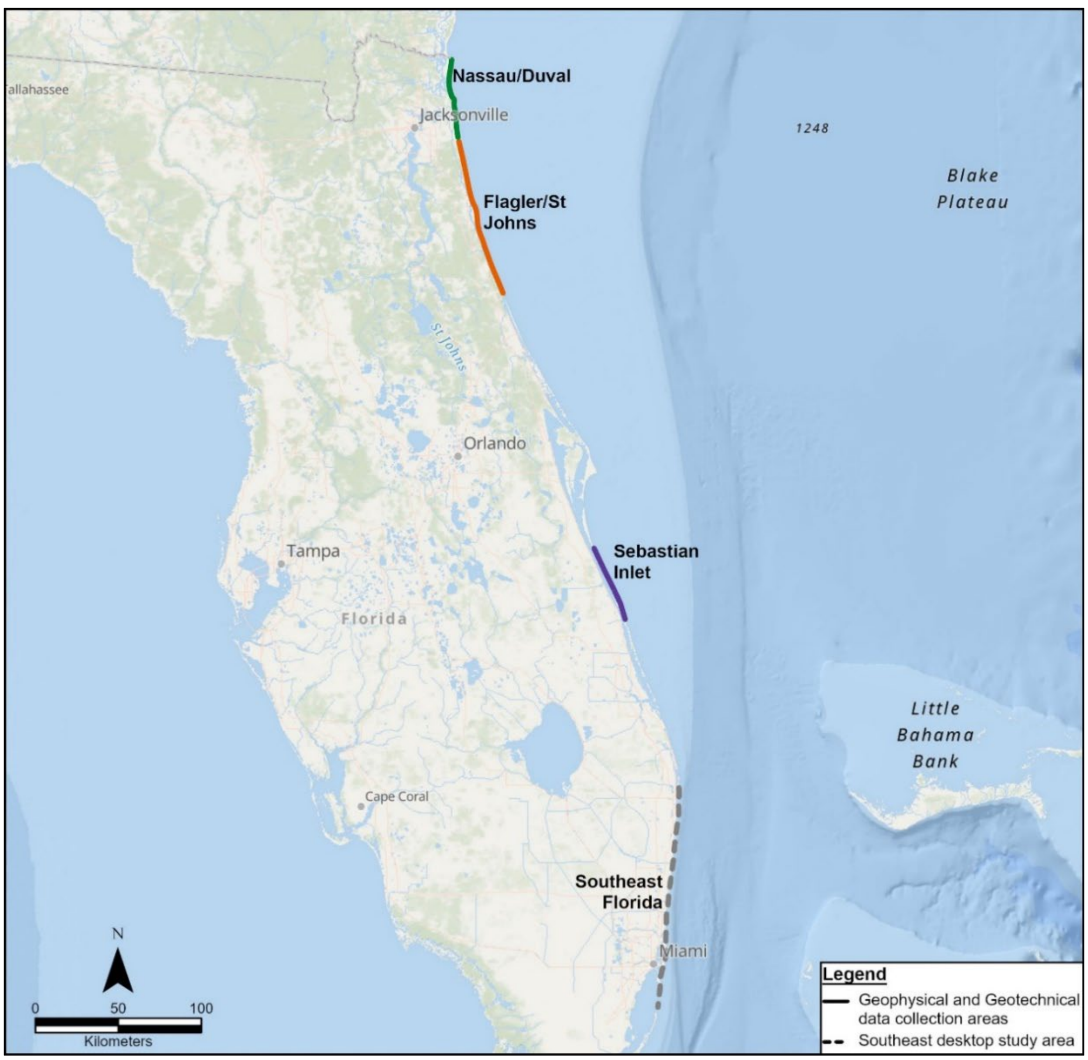
%	percent
AGC	Automatic Gain Control
APTIM	Aptim Federal Services, LLC
ASAP	Atlantic Sand Assessment Project
ASTM	American Society for Testing and Materials
BA	U.S. Army Corps of Engineers Borrow Area(s)
BOEM	Bureau of Ocean Energy Management
cm	centimeter(s)
CRM	Coastal Relief Model
DOI	Department of the Interior
EGN	Empirical Gain Normalization
ENC	Electronic Navigational Chart
FDEP	Florida Department of Environmental Protection
FGS	Florida Geologic Survey
ft	feet
ft/ms	feet per millisecond
ft/s	feet per second
GAMS	GNSS Azimuth Measurement System
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
Hz	hertz
ID/IQ	Indefinite Delivery/Indefinite Quantity
IMU	Inertial Measurement Unit
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
m	meter(s)
MBES	Multibeam Echosounder
mcm	million cubic meters
mcy	million cubic yards
mi	mile(s)
mm	millimeter(s)
MMIS	Marine Minerals Information System
MMP	Marine Minerals Program
m/ms	meter per millisecond
m/s	meter per second
nm	nautical mile(s)
NAD	North American Datum
NAVD	North American Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
nT	nanotesla
OCS	Outer Continental Shelf
Olsen	Foth Olsen
POS MV	Position Orientation System for Marine Vessels
POSPac MMS	POSPac Mobile Mapping Suite
SAND	Sand Availability and Needs Determination
SVP	Sound Velocity Profile
TPU	Total propagated uncertainty
TWI	The Water Institute

UGC	User-Defined Gain Control
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
USCS	Unified Soils Classification System
USGS	United States Geological Survey
VAC	volts alternating current

1 Executive Summary

In 2021, the Bureau of Ocean Energy Management (BOEM), Marine Minerals Program (MMP), within the Department of the Interior (DOI) contracted Aptim Federal Services, LLC (APTIM) under an Indefinite Delivery/Indefinite Quantity (ID/IQ) to support the identification, characterization, and delineation of Outer Continental Shelf (OCS) sand to further MMP's development of a National Offshore Sand Inventory, as well as other marine minerals in support of development of a future National Offshore Critical Mineral Inventory. Under this ID/IQ, APTIM has been tasked with assisting BOEM in the identification and characterization of sediment resource areas, determining the locations of potential OCS hard/critical minerals, and collecting baseline data to better understand and characterize potential physical, chemical, biological, and cultural impacts from marine mineral extraction. The third Task Order (140M0122F0020) issued under the ID/IQ Contract No. 140M0121D0006 was to conduct geophysical and geological data acquisition and analysis on the Atlantic OCS offshore northeast and central Florida and conduct a desktop analysis offshore of southeast Florida within 200 miles (321.9 kilometers) offshore Miami. Field collection regions included offshore Sebastian Inlet (serving Brevard, and northern Indian River Counties), offshore Duval and Nassau Counties, and offshore Flagler and St. Johns Counties (also potentially serving Volusia County) (Figure 1).

Figure 1: Map of Florida showing the priorities for data collection



To properly address BOEM's needs as well as those of state and local agencies, APTIM approached this task order by first conducting a detailed desktop study and initial data synthesis in the area (Task 1). During Task 1, APTIM worked closely with BOEM, U.S. Army Corps of Engineers (USACE), and pertinent state and local stakeholder groups (Florida Department of Environmental Protection (FDEP), county and community representatives, etc., to ensure accurate historic data coverage offshore Nassau, Duval, Flagler, St. Johns, Volusia, Brevard, and Indian River Counties. The APTIM Team coordinated with individual stakeholders to identify data gaps, current sand resource needs, and identify any planned and/or ongoing projects that may overlap data coverage. Task 2 had no activities included as part of the scope. Once the results of the desktop study were reviewed and study areas and plans established, APTIM proceeded to Tasks 3 through 7, which included geophysical and geological data collection, processing, and reporting to BOEM as well as coordination to ensure project goals were achieved and that respective counties had the necessary data to begin their coastal restoration efforts. For Task Order No. 3, a series of strategic questions were proposed for each of the three regions. These are presented below along with summaries of key findings.

Across the three field study areas, the APTIM Team discovered numerous new potential sand resource deposits and verified and constrained existing USACE resource areas. Offshore the Nassau and Duval region, one new resource was identified between USACE Borrow Area (BA) A3a and A4, while the remaining seven identified resources further confirmed, constrained, or expanded existing USACE resources. The largest resource delineated as part of this study was calculated as having a potential gross volume of 82 million cubic yards (63 million cubic meters) of sand. Offshore the St. Johns and Flagler Counties, 11 resources were identified with 10 of those further constraining existing USACE resources. Of the identified potential gross volumes, the largest resource identified was 434 million cubic yards (331 million cubic meters), which combined several existing USACE resources into one single deposit. Additionally, a new resource was identified as part of this study offshore the northern portion of St. Johns County, which indicated a potential gross volume of 113 million cubic yards (86 million cubic meters) of sand further offshore from the current USACE resources. Offshore Flagler County, several resources were further constrained and refined with the collected geophysical and geotechnical data that allowed for the identification of up to 113 million cubic yards (86 million cubic meters) of sediment. Offshore Sebastian Inlet, additional geophysical and geotechnical data within the footprint of the 2015 Atlantic Sand Assessment Project data allowed for further delineation of the resource identified and extended it towards Bethel Shoals. This identified resource did appear to have a higher shell content than other areas, which would require additional data collection to further constrain and identify how widespread the shell deposit was; however, there are roughly 682 million cubic yards (521 million cubic meters) of resources within that region.

Nassau and Duval Region:

1. What is the composition, quality, and extent of the potential resource(s)?

The identified resources in the Nassau and Duval region consist mostly of sand shoals with varying sand quality, ranging from as fine as 2.29 phi (0.20 millimeter) to as coarse as 2.01 phi (0.25 millimeter). Most identified deposits coincide in some way with existing identified USACE Borrow Areas. Additionally, an identified resource indicates the potential for additional beach compatible sands outside of the established USACE boundary. Exploratory data collected between A3a and A4 provided a new potential resource that is closer to shore than A3a.

2. Based on the resulting data collection, should any areas be recommended for further investigation by design-level survey or eliminated from further consideration?

Although the region is highly variable in its sand composition, Identified Resources 4 (that best correlates with USACE BA A3a), 5, 6 (BA A4), and 8 (BA A4) would likely benefit from additional mapping and sampling to further constrain their sand boundaries. Resource 4 (BA A3a), although further from shore, appeared to have a large volume potential that could be utilized in upcoming years. Identified Resource 5 would benefit from additional data to further determine its potential volume and how it relates to Identified Resource 6 (BA A4) and 4 (BA A3a). Identified Resource 8 (BA A4) would be an easy replacement for current Borrow Area F1 that is being used for several renourishment projects and likely to be depleted soon. Geotechnical data collected in the NA7-R070 resource identified from the Atlantic Sand Assessment Project geophysical data likely eliminates that area as a potential resource due to the high fine content in BOEMVC-2024-FL-09. Additionally, geotechnical data collected in NA7-R040 (BOEMVC-2024-FL-05 and BOEMVC-2024-FL-07) indicate that the deposit is likely not beach compatible due to sands with a high content of silt/clay.

3. What is the origin and evolution of the resource deposits identified?

All newly identified and delineated sediment resources are surficial sedimentary deposits that closely align with the presence of bathymetric highs or shoals. These shoals primarily appear to be the result of shelf oceanographic processes, with variable sand content and acoustic facies of the surficial unit sitting atop a sharp erosional boundary, likely the transgressive ravinement. The shallow stratigraphy below these deposits is highly variable between layered strata, shallow acoustic basement, and ubiquitous paleochannels or erosional valleys representing a long history of cut and fill processes. The majority of the surficial units and potential resource deposits have a similar geophysical acoustic facies of transparent to chaotic character that often represents sand-rich units, which is confirmed by available geologic ground truth. The variability in sand (from fine to coarse) and the presence of interbedding is also typical of shelf sedimentary processes. Some of the potential resource deposits may have more than one internal unit, with some of the shoals appearing relatively uniform above the interpreted ravinement while others have an internal layered facies, likely indicating their origin as a mostly reworked relict unit.

Flagler and St. Johns Counties:

1. Do these areas show the potential for sediment resources in excess of 5 feet (1.5 meters)?

This study identified numerous potential resources exceeding 5 feet (1.5 meters) thickness offshore of both Flagler and St. Johns counties. These resources consist primarily of surficial sand shoals with variable grain size as fine as 2.37 phi (0.19 millimeters) and as coarse as 1.67 phi (0.31 millimeters). Along the northern region of the study area offshore St. Johns County, most identified features are thicker than 5 feet (1.5 meters), with the most promising regions being further offshore according to the interpolated data using the Coastal Relief Model. The furthest offshore region mapped as part of this survey, indicates the presence of sand that is roughly 16 feet (4 meters) thick. Similar to St. Johns County, the thicker sand resources off Flagler County are located further offshore. These identified resources are located within larger surficial sediment units that may represent additional resource occurrence but do not have sufficient geological sampling to define as a potential borrow deposit. The shore-oblique deposits identified indicate that there is a high variability in the sediment composition of these resources; however, based on the data collected, the offshore-most portion of the identified resources indicates a thickness up to 10-12 feet (3.0-3.6 meters) in some portions of the deposit.

2. What are the trends and variability of the sediment among these similar shore-oblique shoal features?

This study investigated three shore-oblique shoals in the center of the study area to investigate their potential as resource deposits and underlying geologic processes. The investigated shoal complexes are related to a larger surficial sedimentary unit that contains the existing defined shoal boundaries and bathymetric highs, but is more laterally extensive than previously mapped.

These shoals thin rapidly to the north and south and are separated from each other by areas of minimal modern shelf sedimentation and complex outcropping relict strata. The shore-oblique shoals have a variable internal stratigraphic architecture ranging from homogenous sand deposits of shelf origin to bathymetric highs containing severely eroded and reworked relict landforms related to earlier depositional systems.

The center of the shore-oblique shoals consistently appears to be of modern shelf origin and overlies a clearly defined transgressive ravinement surface. These most-promising resource deposits are thickest to the east of the study area, extending seaward out of the area of investigation while thinning rapidly towards the coastline. The shoals and associated surficial sedimentary unit that contain these sand resources are bounded at their base by a clear erosional surface separating the surficial sands from shallow basement strata and highly variable paleochannel and tidal inlet deposits. The shoals and surficial units dramatically thin moving shore-parallel off the crest, with the inter-shoal bathymetric lows containing outcropping relict strata or thin (1-4 feet [0.3-1.2 meter]) veneers of surficial sediment. The consistent observation of shallow seaward dipping basement stratigraphy to the west of the central and southern shoal complexes may indicate an underlying structural control on the preservation of clastic deposits available to be reworked and source the modern marine shoal fields.

3. What is the seaward extent of some of these more promising deposits?

As mapped and delineated with the data collected during this study, the thickest sand resources are located further offshore. From the correlation of the geophysical, geotechnical, and Coastal Relief Model, it is likely that the sand resources correlate with the 52.5-65.6 foot (16-20 meter) bathymetric contour of the model. However, as previously mentioned, these resources are variable in their composition and beach compatibility; therefore, additional data should be collected in order to further verify the composition and extent of the resources that could reach 14-17 miles (22.5- 27.3 kilometers) offshore.

Identified resources located in the Flagler and St. Johns region are hosted within broad surficial sedimentary units, shoals, and wave fields ubiquitous across this portion of the shelf. These surficial deposits vary greatly in thickness, from thin (sub-meter) veneers to shoals over 19.6 feet (6 meters) thick. These deposits also exhibit two general internal architectures: 1) uniform facies overlying a sharp erosional unconformity, and 2) variable internal structure within the topographic high of the shoal complex, including preserved channel forms and layering. Also present throughout the study area are numerous shallow stratigraphic paleochannels, inlets, and other features exhibiting highly variable sedimentary facies. This indicates potentially two-end members of the resource deposit origin: 1) resulting from marine oceanographic processes and 2) partially eroded and reworked relict landforms of earlier depositional environments. The surficial units to the north containing resource deposits 10 (BA SJ9-R069/SJ7-R088) and 11 appear to represent both types of shoal formation, with potential relict stratigraphy located landward and younger, shelf-transport deposits located seaward. The southern resource deposits (12-19) appear uniformly to be of shelf origin, with no observed internal structure. These shelf deposits were likely sourced from ravinement and reworking of sand-rich deposits contained within the underlying paleochannel complexes.

Sebastian Inlet:

1. What is the composition, quality, and extent of any potential resources identified?

The identified resources in the Sebastian Inlet region consist mostly of sand shoals with varying sand quality, ranging from as fine as 1.85 phi (0.28 millimeters) to as coarse as 1.12 phi (0.46 millimeters) with some having a higher shell content. Exploratory lines and vibracores collected offshore of Range Monument R90 indicated there are two potential small resources in the area. Resources identified offshore Indian River County indicate that there is a large sand shoal; however, with a higher shell content than other areas. Additional data would be required to establish the final composite information of the area and if it would be beach compatible. If, with further investigation, this deposit is indicative of being viable, it could be a significant resource for the county.

2. Based on the resulting data collection, should any areas be recommended for further investigation by design-level survey or eliminated from further consideration?

Given the size of the area, Identified Resource 22 (BA IR7-R214) would likely benefit from additional geophysical and geotechnical data collection to further constrain the shell content in the area and how it would impact the composite shell content of the area. Identified Resources 20 (BA A2) and 21 are likely smaller; however, could be further delineated as a potential resource closer to the northern portion of Brevard County.

3. What is the geologic origin and evolution of the resource deposits identified?

The potential resource deposits identified in this region generally are located within two surficial sedimentary units that have a variable shelf morphology (ranging from ridges to flat highs to apparent wave fields) but are nearly uniformly bounded below by a flat erosional unconformity interpreted as the transgressive ravinement surface. The consistent position of these deposits above this ravinement surface supports their interpretation as likely being marine in origin due to oceanographic processes following Holocene transgression. Unlike the other study areas, there is little evidence for shallow stratigraphic channels, inlets, or other units that may have provided a source of sediment to the shelf during transgression. The northeast-southwest orientation of the surficial sedimentary unit hosting Identified Resource 20 (BA A2) and 21 may indicate some relation to the adjacent Canaveral shoals. It is possible that they are related to the Holocene retreat of the Cape Canaveral massif, which is a process well studied elsewhere but not investigated in detail in the Florida Atlantic (e.g., Swift, 1975; Swift et al., 1978). Regardless of their initial origin and material sourcing, the potential resource deposits are likely to be controlled entirely by recent and future oceanographic and shelf current conditions.

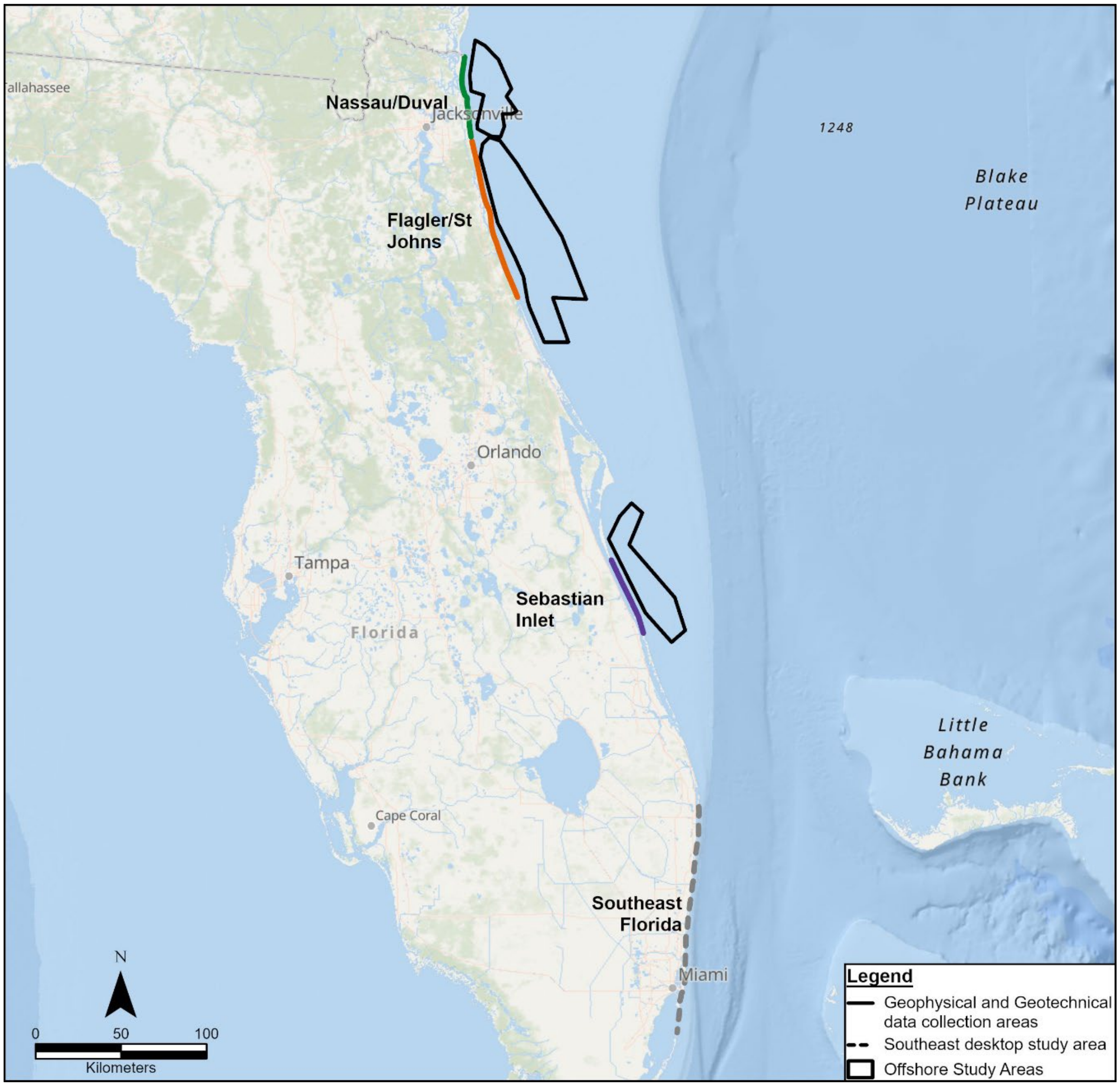
2 Introduction and Approach

In 2021, the Bureau of Ocean Energy Management (BOEM), Marine Minerals Program (MMP), within the Department of the Interior (DOI) contracted Aptim Federal Services, LLC (APTIM) under an Indefinite Delivery/Indefinite Quantity (ID/IQ) to support the identification, characterization, and delineation of Outer Continental Shelf (OCS) sand to further MMP's development of a National Offshore Sand Inventory, as well as other marine minerals in support of development of a future National Offshore Critical Mineral Inventory. Under this ID/IQ, APTIM is tasked with assisting BOEM in the identification and characterization of sediment resource areas, determining the locations of potential OCS hard/critical minerals, and collecting baseline data to better understand and characterize potential physical, chemical, biological, and cultural impacts from marine mineral extraction. This will provide BOEM with information on where marine minerals are located, the volume and/or quality that may be available for use, and determine measures to minimize impacts from resource exploration or extraction. Resource evaluation and robust baseline datasets support BOEM in the leasing and development of OCS minerals, assessing potential environmental impacts and necessary mitigation, minimization measures, and continuing to successfully partner with stakeholders and communities who may benefit from OCS mineral resources. Accurate inventory of potential sand resources along the OCS is critical for enabling economically efficient and successful implementation of many shore protection, habitat restoration, and beach nourishment programs, and for relevant management agencies and communities to engage in realistic long-term planning.

The U.S. Army Corps of Engineers (USACE) South Atlantic Coastal Study and associated South Atlantic Division, Sand Availability and Needs Determination (SAND) Study evaluated current and future beach resiliency projects along the Florida Atlantic coast to assess specific project sediment needs, what sediment resources are currently identified that could support project construction and maintenance, and help define priority areas where sediment needs are outpacing known supply, and would benefit from new strategic investigations. A key BOEM priority is to continue supporting the South Atlantic Coastal Study and SAND programs through resource evaluation programs including new geological and geophysical data collection, detailed desktop studies, and scientific investigations aiding in the delineation and characterization of OCS minerals that may be suited for coastal resiliency projects. Accurate knowledge of the likely occurrence, distribution, and origin of offshore sediment resources also directly supports the BOEM responsibility for providing equitable and sustainable stewardship of OCS minerals.

This report is the result of the third task order (Task Order No. 140M0122F0020) issued under the ID/IQ Contract No. 140M0121D0006: Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida (Figure 2). The Florida study area was divided into four regions based on prior assessments of sediment resource needs and BOEM strategic priorities. These regions are: (1) Offshore Sebastian Inlet (including Brevard and northern Indian River Counties), (2) offshore Duval and Nassau Counties, (3) offshore Flagler and St. Johns Counties (also potentially serving Volusia County), and (4) Southeast Florida (within 200 miles, [321.9 kilometers] of Miami). Offshore data collection was conducted within Regions 1-3, while Region 4 was limited to a desktop investigation. These high-priority regions were selected either because projected demand for OCS sediment resources outpaces known resources as identified by the USACE South Atlantic Division SAND program, or recent active project sediment requirements are far outpacing earlier projected demand for OCS resources, or identified as having offshore data gaps by the National Oceanic and Atmospheric Administration (NOAA) community mapping coordination program (SeaSketch).

Figure 2: Task Order No. 3 investigation regions along Northeast and Central Florida



BOEM Task Order No. 3 was designed to meet these strategic goals through a combination of desktop study, reconnaissance-level geological and geophysical data collection (both exploration and appraisal surveys depending on specific region), development of a conceptual geologic framework to aid in interpretation of sediment resource origin and occurrence, and offshore resource delineation and characterization. Reconnaissance-level investigation provides a first-order evaluation of the potential sediment resources. Several area-specific strategic questions reference design-level surveys: the results of this study and these focused questions are to identify areas that are most promising and would benefit from future design-level investigations by relevant stakeholders and agencies. An initial data collection strategy and set of questions were specified for each of the four (4) regions.

2.1 Region 1, Offshore Nassau/Duval

This region includes Jacksonville Harbor, Nassau County, and northern Duval County. The USACE SAND study found several areas of forecasted need exceeding known sediment availability, and numerous resource areas on the OCS in this region were rated as "unverified plus"- lacking sufficient data to evaluate their suitability for further development. This task order was intended to conduct appraisal-level geophysical surveys and vibracore geological sampling to evaluate these high-uncertainty potential resources, allow for correlation and linkages between Task Order No. 3 data collection and the previous BOEM Atlantic Sand Assessment Project (ASAP) study, and address the following questions:

1. What is the composition, quality, and extent of potential resource(s)?
2. Based on this new data and analysis should these area(s) be further investigated at a design-level or should they be removed from further near-term consideration as a beach-quality resource?
3. What is the origin and evolution of the deposit(s)?

2.2 Region 2, Offshore Flagler/St. Johns

This region covers the area offshore Flagler and St. Johns Counties. The OCS contains numerous prominent bathymetric features including large named shoals, shore-oblique ridge complexes, and shelf bedforms associated with unconsolidated sediments likely representing the complex interactions between active shelf processes and past sedimentary deposits (BOEM ASAP; Phelps et al., 2007). Many of these shoals or other surficial sedimentary units have been previously appraised and designated as proven borrow areas, while many other similar features are delineated as "unverified" or "unverified plus" sediment resources pending additional investigation. This study conducted a mixture of appraisal and exploration surveys designed to further characterize the sediment resource potential of these units and answered these questions:

1. Do these areas show the potential for sediment resources in excess of 5 feet (1.5 meters)?
2. What are the trends and variability of the sediment among these similar shore-oblique shoal features?
3. What are the seaward extents of some of these more promising deposits?

2.3 Region 3, Offshore Sebastian Inlet

This region encompasses southern Brevard County to northern Indian River County. Prior analysis found several coastal projects, such as the south reach of the Brevard County Shore Protection project, whose sediment needs are currently supplied by long-distance transport and could benefit from identification of viable resources in the nearby OCS (USACE SAND). Several potential borrow areas had been previously identified in this area (BOEM ASAP). The study intended to further investigate and constrain these potential sediment resources by conducting an appraisal-level geophysical survey and vibracore geological sampling to address the following questions:

1. What is the composition, quality, and extent of potential resource(s)?
2. Based on the new data and analysis should these area(s) be further investigated at a design-level or should they be removed from further near-term consideration as a beach-quality resource?
3. What is the origin and evolution of the deposit(s)?

2.4 Region 4, Offshore Southeast Florida (Desktop Analysis)

The area offshore of Miami, from West Palm Beach to Biscayne Bay, has a significantly different OCS morphology and geologic framework than Regions 1 through 3. The significant narrowing of the shallow OCS, presence of the southeast Florida reef track, and complex cross-shelf sediment transport down the continental slope to the Miami Terrace translated to major technical and scientific challenges in identifying and developing OCS sediment resources in an area with large sediment resource needs (southeast Florida SAND). The study conducted a desktop analysis intended to evaluate potential sediment resource occurrence in water depths up to 656.2 feet (200 meters) (far beyond the typically applied 98.4 feet [30 meters] range used in current OCS borrow area design), evaluated what knowledge and/or data gaps limit such analysis, and identified any existing datasets that could be re-processed, interpreted, or otherwise used to address this long-term strategic question. The study addressed the following questions in the desktop analysis, and delivered an assessment of the highest-potential data to BOEM for further consideration:

1. What data exist?
2. What is the accessibility of these data?
3. What additional processing is necessary to utilize these data?

Results from the Southeast Florida Desktop Analysis are submitted in Appendix A.

2.5 Project Approach

In order to address BOEM's strategic goals, support partners at the local, state, and federal level, and deliver specified resource evaluation and research question outcomes, APTIM implemented Task Order No. 3 following a structured approach in line with BOEM IDIQ-designated tasks. The following is a high-level overview of the workflow with details provided in subsequent sections:

1. Existing Data Synthesis and Review: APTIM conducted an initial data inventory and detailed desktop study for the specified study areas. Known publicly available datasets, reports, and studies pertinent to sand resources were collected and assessed to identify key data/ knowledge gaps and relevance to BOEM Task Order No. 3 objectives. A preliminary geologic framework was developed for the study area to begin to place known sediment resources into geologic context and assess their likely origin. This desktop synthesis and analysis was used to provide initial hypotheses to regional questions.
2. Stakeholder Coordination: APTIM engaged with regional stakeholders through close collaboration with BOEM, other federal agencies including the U.S. Geological Survey (USGS) and USACE, the FDEP, and key local-to-state stakeholders (i.e., county officials, local planners, community representatives, academia, etc.) to review initial desktop study results, survey current sediment resource needs, and identify any ongoing or planned projects that may overlap with the proposed BOEM work. The results of the desktop analysis and stakeholder engagement then drove study area refinement and field data collection plans to maximize the value of new data investment, achieve overall project goals, and support stakeholder coastal restoration and resiliency efforts.
3. Development of Field Data Acquisition Plans: APTIM and The Water Institute (TWI), in coordination with BOEM, reviewed stakeholder input for each region and integrated these with the initial desktop analysis to determine an appropriate allocation of geophysical and geologic data for each region to maximize the utility of new data collection in addressing sediment resource needs and successfully answer the proposed regional questions.
4. Acquisition, Processing, and Interpretation of OCS Geological and Geophysical Data: Task Order No. 3 followed a phased approach to the collection of geophysical, hydrographic, and geological datasets (see Section 1 for detailed methodology). Successful resource evaluation requires identifying potential sediment resources, estimating their spatial extent and volume, and ground truthing of their geotechnical characteristics to allow for potential users to assess the compatibility of the sediments with a given project. This study first collected a full suite of geophysical and hydrographic data (multibeam bathymetry, magnetometer, sidescan sonar, and sub-bottom profiler data) to characterize potential sediment resources but also allowed for evaluation of potential environmental, cultural resources, habitat, or infrastructure avoidances; the results of which were necessary for the next phase of geological data collection and the ultimate goal of borrow area development. Initial interpretations of geophysical data were conducted to assess resource potential, refine initial hypotheses, and design a geological data collection strategy to ground-truth potential resources identified and advance regional questions such as the geologic origin and evolution of sediment resource deposits.

5. Resource Evaluation, Region-Specific Outcomes, and Recommendations: APTIM provided updated potential resource deposit volume and character estimates, identified areas for further investigation, and recommended next steps for resource evaluation.

3 Desktop Study and Initial Geologic Framework

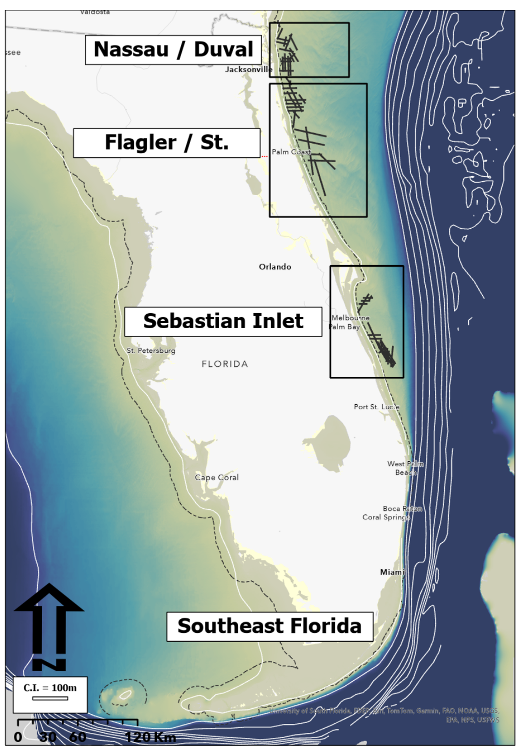
This section summarizes the general stratigraphic framework of the Florida Atlantic Outer Continental Shelf and results of the desktop study organized by each focus region.

3.1 Florida Atlantic OCS Stratigraphic Framework and Geologic Evolution

Understanding ongoing sediment transport processes, shelf bathymetric variability, and underlying stratigraphic frameworks are important components in the assessment of the origin, evolution, and variability of OCS sediment resources. The Florida Atlantic OCS is characterized by significant variability in bathymetry, shelf width, and underlying geologic framework that has implications for the presence and extent of sediment resources (USACE, 2020). The Florida Atlantic Margin bathymetry changes drastically from north to south (Figure 3). In the north, the OCS is characterized by a broad, gently sloping continental shelf 62.1 miles (~100 kilometers) that transitions to the Florida-Hatteras Slope at the 397 feet, (600 meters) isobath. Differing from the typical shelf-slope-rise pattern, the slope then grades into the large, flat Blake Plateau at 3280.8 feet (1,000 meters), while in southeast Florida, the slope steeply drops into the Straits of Florida separating Florida from the Bahamas Platform (Uchipi, 1968; Milliman, 1967). The shelf narrows from its maximum width of 86.4 miles (130 kilometers) east of Jacksonville to less than 6.2 miles (10 kilometers) offshore of Miami-Dade to the south (Figure 3; Lidz, 1997; Finkl, 2008).

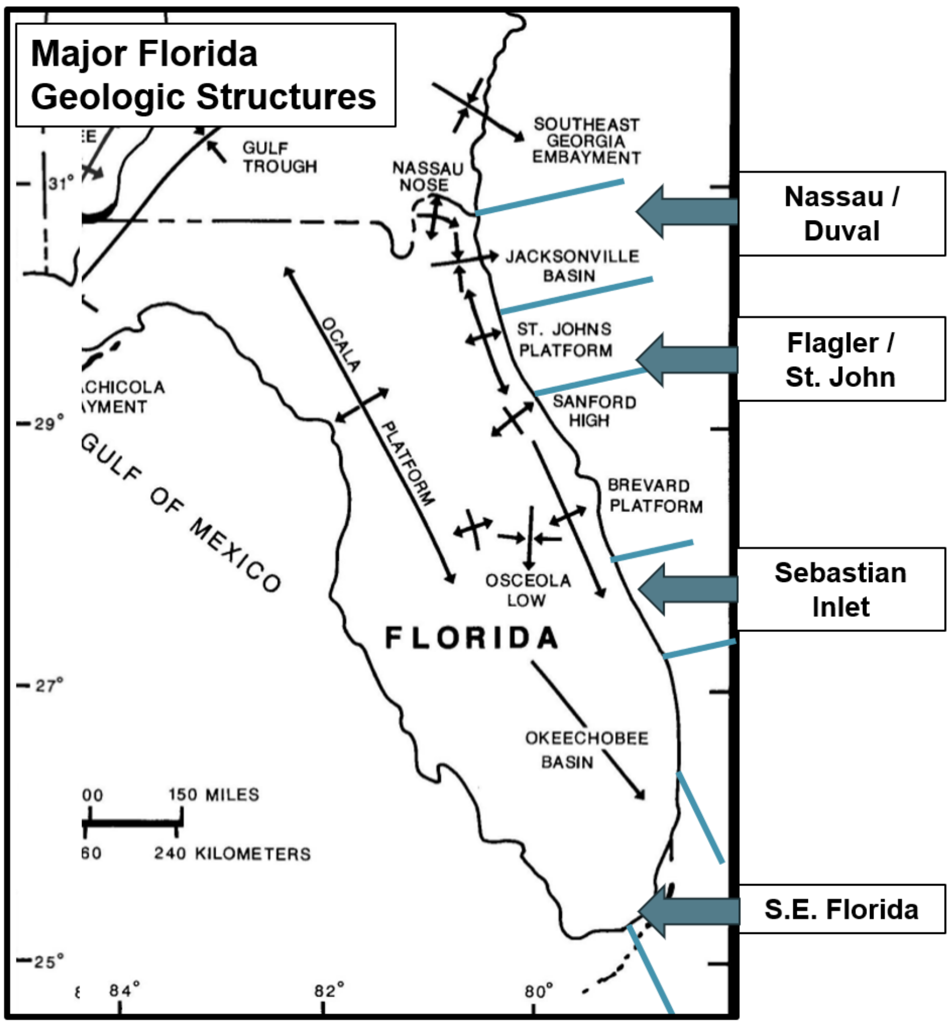
Figure 3: The Florida OCS and BOEM Task Order No. 3 regional focus areas 328.08 feet (100 meters)

Note the significant narrowing of the continental shelf from north to south. Bathymetric contour intervals are in white. New geophysical data collected under this task order are shown in black.



These changes in shelf physiography correspond to the underlying structure and stratigraphy of the southern Atlantic Margin (Figure 4; Scott, 1991). The Peninsular Arch, a northwest-southeast trending deep structural feature that is responsible for the orientation of the Florida Peninsula (Applin, 1951), has persisted since the Jurassic Period and is a major control on the relative stratigraphic sequences through the Tertiary (Winston, 1976). However, the majority of these structures do not appear to have a modern topographic expression but remain important for the near surface lithostragraphic framework and distribution of shallow bedrock (Scott, 1991). An exception is southeast Georgia Embayment and Jacksonville sub-basin (Figure 4), which sits at the Georgia-Florida border and has persisted as a major depositional basin dominated by siliciclastic deposition since the Tertiary (Scott, 1988).

Figure 4: Geologic structures of Florida and designated OCS study area boundaries (modified from Scott, 1991)

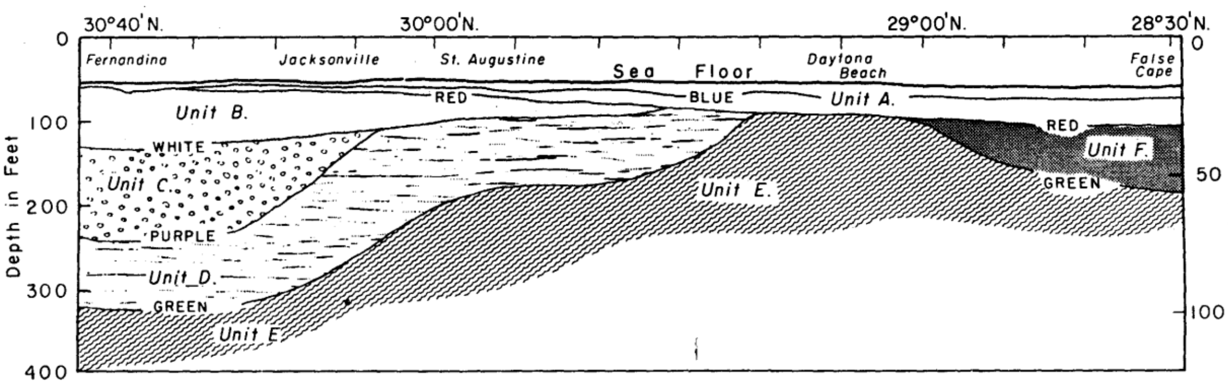


The general geology of the southeastern Coastal Plain has been well studied from Georgia to south Florida. There exists a significant transition in both underlying stratigraphy and recent sedimentology from the terrigenous southeast Georgia Embayment and Florida Platform along the Peninsular Arch towards the calcareous province of south Florida (Edsall, 1978; Paull and Dillion, 1979; Paull and Dillon, 1980). The shelf is comprised of seaward dipping Tertiary strata overlain by Quaternary deposits of variable origin and preservation. The most recent and relevant stratigraphic units along the eastern coast of north-central and central Florida include the upper Eocene Ocala group limestones (Puri,1957), overlain by the Miocene

Hawthorn formation of highly variable lithology of siliciclastic and calcareous strata. Notably, the Hawthorn is absent in some areas of central Florida such as Volusia, St. Johns, and Flagler Counties where more recent sediments unconformably overlay the Eocene (Wyrick, 1960). These Eocene and Miocene units are variably overlain by undifferentiated Pliocene siliciclastic and limestone deposits before reaching the Anastasia formation, a regionally significant limestone and coquina hash unit that outcrops along the nearshore in several areas (Akers, 1972). Finally, the modern shelf is mantled with undifferentiated Holocene deposits of variable composition (Meisburger and Duane, 1971).

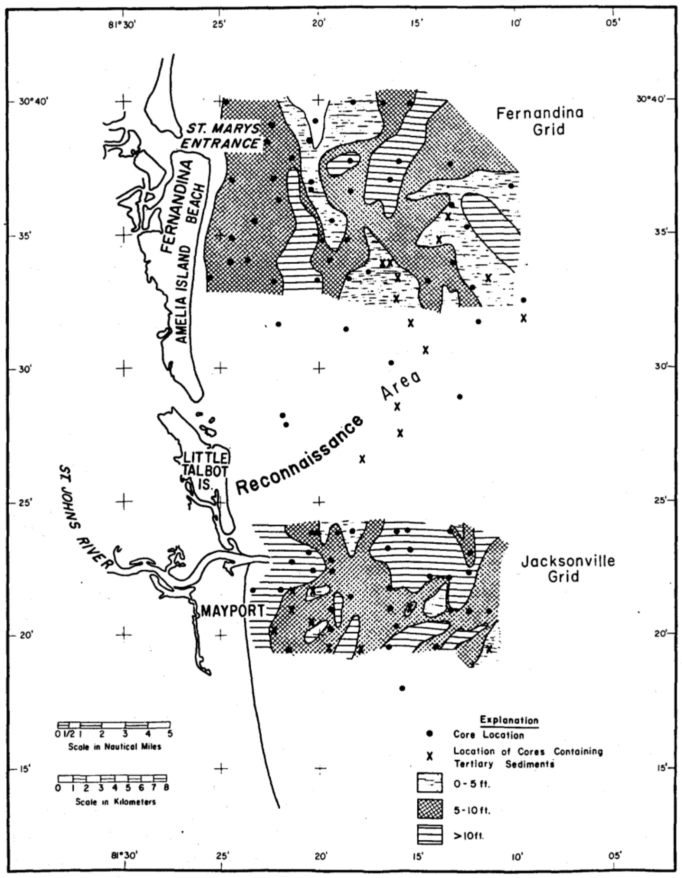
The northernmost OCS, containing this study's focus areas of Nassau, Duval, Flagler, and St. Johns, has an upper stratigraphic sequence of Tertiary to Holocene and Modern sedimentary units (Schlee, 1977). Pre-Miocene units are composed primarily of carbonate limestones and mudstones, transitioning in the post-Miocene to silicious sand and siltstones. These units appear to correspond with those sequences present in the modern Coastal Plain (Scott, 1991). The earlier Tertiary carbonates thicken towards the south and seaward (Chen, 1965). Earlier seismic stratigraphic and borehole sampling indicates an overall progradation of the shelf and continental slope seaward since the Miocene, with associated eastward structural dips (Emery and Uchipi, 1972). Overlying these Tertiary units are siliciclastics formations representing the record of Quaternary glacial eustatic cycles (Hawkes et al., 2016). In several locations along the northern shelf, some areas where underlying Tertiary and Miocene units appear to outcrop at the seafloor or are covered only by thin veneers of modern sediment (Edsall, 1978), while in others, Quaternary to Modern sedimentary accumulations can reach tens of meters (Figure 5; Meisburger and Field, 1976). These shallow sedimentary units reflect a complex history of sea-level transgression and regression and associated deposition, erosion, and reworking of numerous fluvial, coastal, and marine environments.

Figure 5: Conceptual shore-parallel cross section of the Northern Florida shelf
Units A-D represent likely Quaternary siliciclastics, while Unit E is potentially earlier Tertiary carbonates. From Meisburger and Field, 1976.



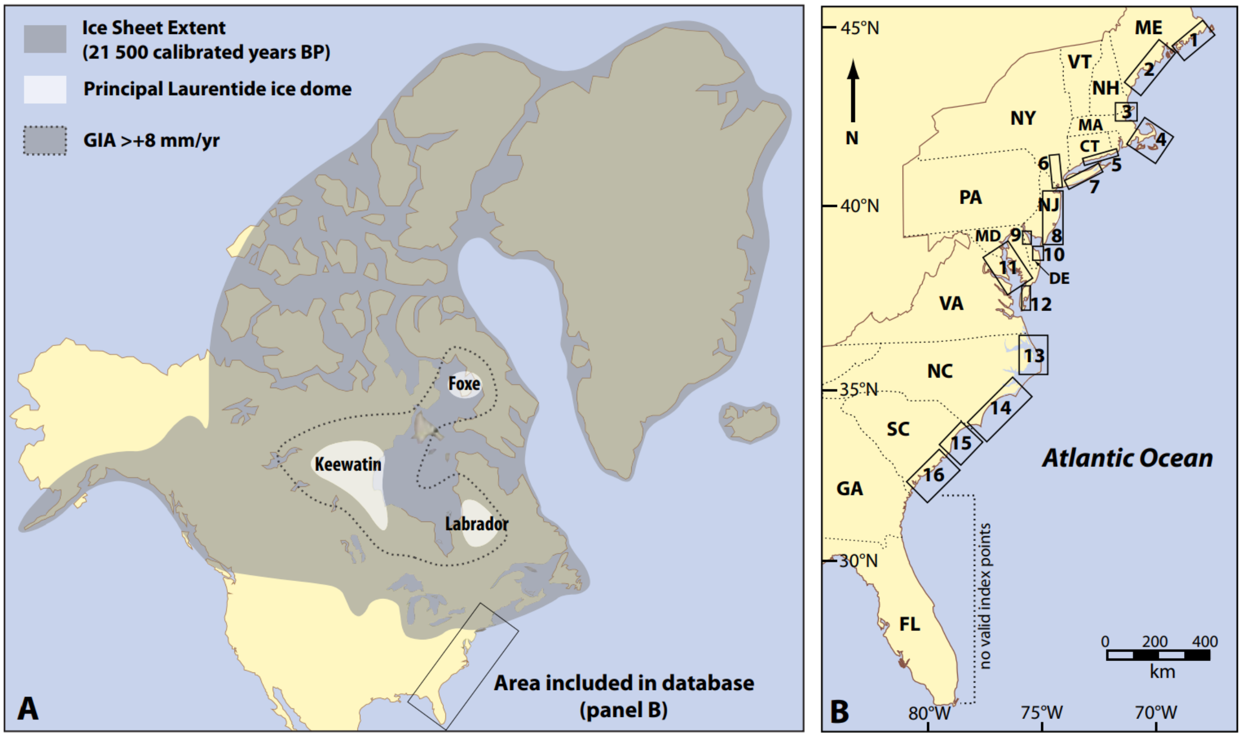
The thickness of these unconsolidated sediments varies significantly, with previous investigations ascribing primarily local controls such as pre-existing relief to these changes in volume and sediment characteristics (Duane, 1968; Nocita et al., 1991; Bodge and Rosen, 1988). The northernmost Florida Shelf has been interpreted to contain variable patterns of recent deposition unconformable with adjacent Tertiary outcropping units (Figure 6; Meisburger and Field, 1976). In some regions close to Cape Canaveral, relief along the pre-Holocene surface (inferred as Eocene limestones) was found to be a dominant control on Holocene sand thickness, with the presence of significant relief presumably generated by karstification during shelf exposure during Quaternary glacioeustatic cycles (Bacchus and Zarillo, 1991). Ubiquitous across much of the Florida Shelf are sand shoals of variable size, orientation, and composition (Swift et al., 1973; McBridge and Moslow, 1991). These deposits have historically been a primary focus of potential offshore sand prospecting (URS, 2007), but the exact control on their occurrence and evolution is not as well known. Additionally, sand ridges and shoals often comprise critical fisheries habit on the Atlantic shelf and often require additional considerations (Normandeau Associates, Inc., 2014). Formation of similar bodies has been ascribed to reworking of abandoned tidal deltas left behind during shoreline transgression (Mcbride and Moslow, 1991), ravinement and reworking of barrier islands (Bacchus and Zarillo, 1991), storm-driven erosion of exposed shelf strata (Bacchus and Zarillo, 1991), and long-shore transport from far-field sources (Swift et al., 1972). Investigation of these shoals in various regions across the shelf have revealed significant variability in their orientation relative to prevailing wind-and-wave driven currents as well as mobility on modern timescales (Duane et al., 1972; Garde, 1991). It is likely that the presence and distribution of both modern sand ridges and shoals, as well as larger sand fields likely has a strong relation to the underlying stratigraphy in terms of creation of relief necessary for preservation of transgressive coastal lithosomes (Laplace, 1993), providing material for reworking during transgression and modern storm conditions (Mayhew and Parkinson, 2007), and/or controlling modern migration and reworking (Garde, 1991).

Figure 6: Thicknesses of surficial sediments offshore on the Northern Florida shelf
Note the patterns of sediment accumulation potentially related to pre-existing relief, and broad areas of Tertiary sediments at the modern seafloor. From Meisburger and Field, 1976.



The timing and spatial pattern of the most recent sea-level transgression in the Holocene (~21,000 years) is very poorly known for the Florida Atlantic compared to other locations along the continental margin (Engelhart and Horton, 2012; Figure 7). These data gaps are in part driven by the lack of previously identified deposits capable of preserving appropriate dating material within preserved spatial context (Hawkes et al., 2016). More recent studies have attempted to help constrain mid-Holocene coastal evolution using beach ridges such as those found at Cape Canaveral (Rodrigues et al., 2022), while others have used preserved peat sequences along tidal creeks, particularly within the northern Nassau-Duval region, but large ambiguities remain (Hawkes et al., 2016). Interestingly, earlier offshore work in the same region reported the presence of preserved peat deposits in modern water depths of 10 to 20 meters (Meisburger and Field, 1976). The modern sampling of equivalent offshore units would provide a unique opportunity for contributing the Holocene sea-level record of Florida and particularly the processes responsible for formation and preservation of coastal systems undergoing marine transgression.

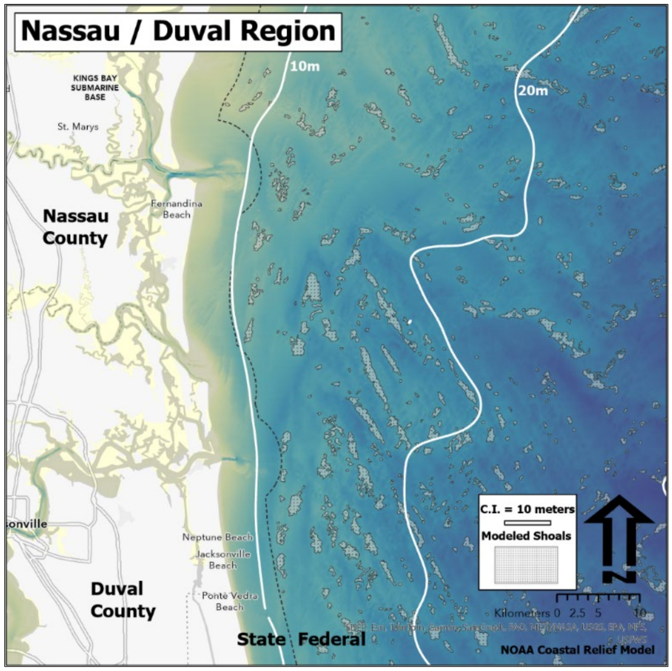
Figure 7: Holocene sea-level rise compilation after Engelhart and Horton, 2012
Note the lack of valid sea-level rise data points along the Florida Atlantic Margin. Shaded extent is the region subject to glacial-isostatic adjustment.



3.1.1 Nassau and Duval Counties

This region occurs at the transition from the southern edge of the southeast Georgia Embayment to the Peninsular Arch region of Florida (Figure 8). The modern coastline hosts several major tidal inlets that are actively building ebb-tide deltas into the inner shelf adjacent to the study area. Prior work identified significant variability in relative inputs by terrigenous sediment from the Piedmont compared to in-situ calcareous sediment generation (Meisburger and Duane, 1971; Meisburger and Field, 1973; Valentine, 1979). It remains unclear the relative contribution of longshore transport of fine-grained terrigenous material compared to more local sourcing of reworked inlet and potential fluvial deposits from older Quaternary stratigraphy (Meisburger and Field, 1975). Prior work identified significant variability in geophysical acoustic facies and associated lithology for features of similar bathymetric expression, indicating multiple potential origins of the surficial sedimentary deposits and/or a complex history of partial erosion and reworking during Quaternary sea-level fluctuations (e.g., Meisburger and Field, 1976; Ayers and Pilkey, 1981; Long et al., 2021). This region is relatively unique compared to the rest of the study areas in the large degree of potential preserved paleochannel deposits of either fluvial or tidal origin, similar to that noted offshore of Cumberland Island in Georgia, several miles north of the study area (Long et al., 2021). Additionally, prior geologic investigations noted the presence of preserved Holocene peat and paleosols in the field area unconformably overlying Eocene strata (Meisburger and Field, 1975). Such markers may help constrain the overall history of coastal evolution throughout the Holocene transgression.

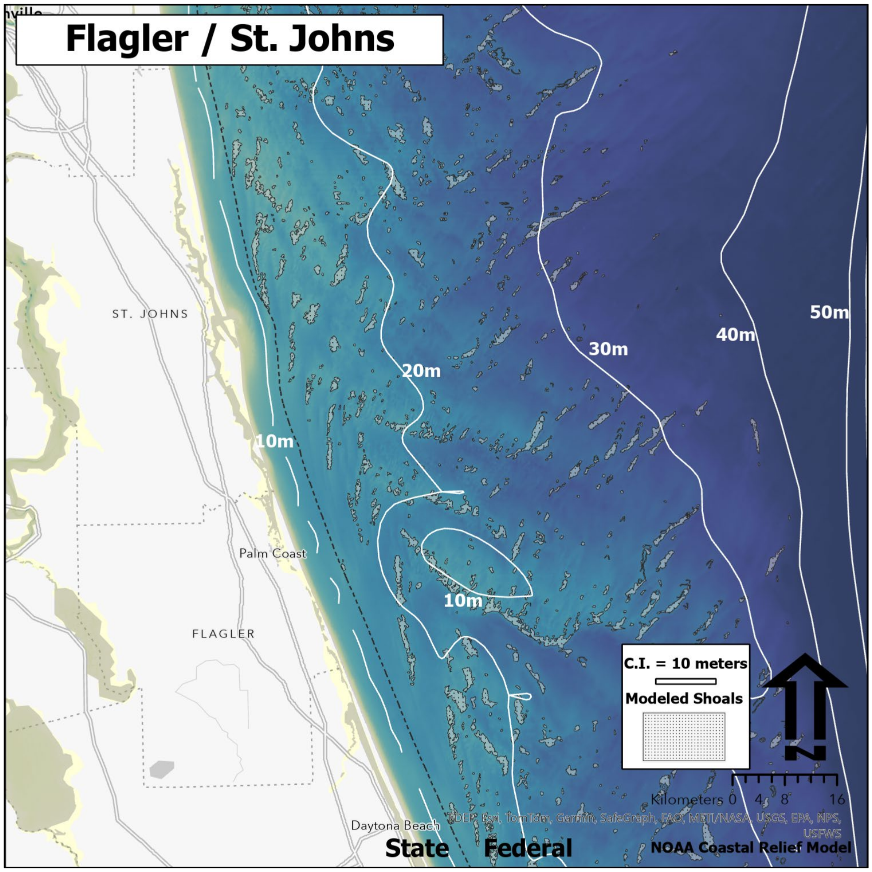
Figure 8: Nassau/Duval Region
Gray stippled polygons represent NOAA National Centers for Environmental Information Modeled Shoal features. The Nassau/Duval OCS is relatively shallow and wide compared to the rest of the Florida Atlantic OCS, with average water depths of 32.8-49.2 feet (10-15 meters) in the majority of the study area.



3.1.2 Flagler and St. Johns Counties

The Flagler and St. Johns region (Figure 9) is located south of Nassau and Duval, and maintains a relatively wide shelf, although with water depths increasing to 65.6 to 98.4 feet (20 to 30 meters) on average compared to the northernmost Florida study area. Previous work has noted the variability of the shoal orientations and the apparent superposition of northeast-southwest trending features on top of larger northwest-southeast shoals, which may indicate different mechanisms and timing of generation (Swift et al., 1975; Hayes and Nairn, 2004; Lobo et al., 2010; Thieler et al., 2014). Prior investigations found highly variable sediments ranging from calcareous sands to poorly sorted silts and gravels, all at apparently a similar stratigraphic position. The relative thickness and composition have been speculated to be related to storm wave erosion of underlying stratigraphy combined with some degree of littoral drift (Meisburger and Duane, 1971; Hoenstine and Freedenberg, 1995). In some locations, the stratigraphic architecture of the bathymetric high indicates the high is composed of amalgamated relict strata, while in others the shoal has a transparent to chaotic acoustic facies overlying a reflector that likely corresponds to the transgressive ravinement. Analogous to the facies observed in the Nassau region, certain paleochannels exhibit steeply dipping reflectors along their flanks with minimal overburden, while others are filled by low-amplitude, laminated strata.

Figure 9: Flagler and St. Johns Region
Gray stippled polygons represent NOAA National Centers for Environmental Information Modeled Shoal features. The Flagler/St. Johns OCS has an average water depth of 65.6 to 98.4 feet (20 to 30 meters) in the majority of the study area.

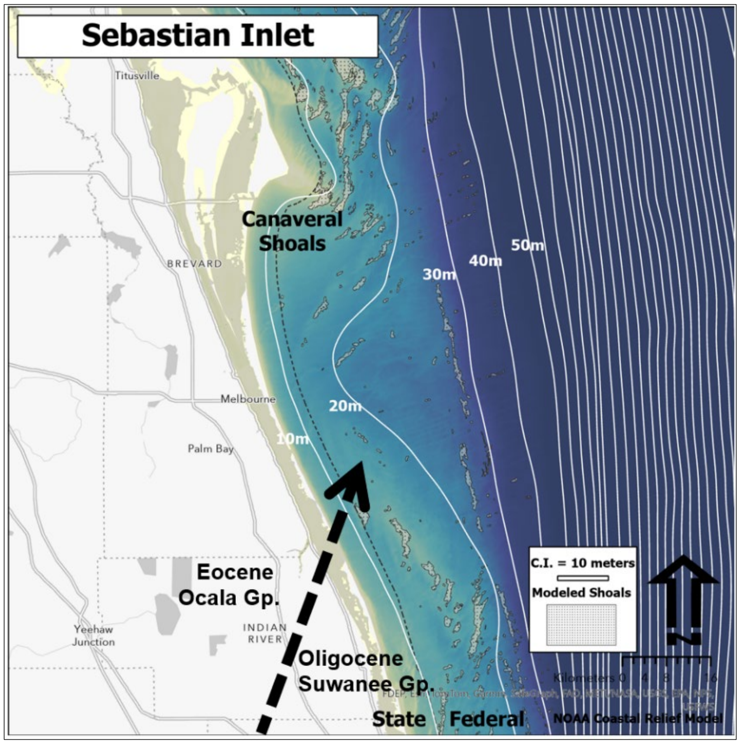


3.1.3 Sebastian Inlet

The Sebastian Inlet region ranges from Cape Canaveral to the north, to the Sebastian Inlet (Figure 10). The shelf narrows to 12.4 miles (~20 kilometers) compared to the much broader northeastern Florida OCS, but similarly contains numerous shoals or bathymetric highs between 32.8 to 98.4 feet (10 to 30 meters) water depth. Cape Canaveral and the associated Canaveral Shoals to the north create a seaward coastline bulge, while to the south a set of shelf shoals creates a similar seaward bathymetric high but with no associated cape (Meisburger and Duane, 1971). This region is situated within the transition from the northern Brevard Platform structural high to the Okeechobee Basin to the south, with implications for the relative dominance of siliciclastic versus carbonate sedimentary processes (Puri, 1957; LaPlace, 1993). Shallow stratigraphic sequences (upper ~200 feet [61 meters]) range from modern shelf sediments to irregularly preserved Pleistocene-Miocene clastic units, such as the Hawthorn, which in turn unconformably overly Eocene Ocala or Oligocene Suwannee limestones (Figure 10; Puri, 1957). This transition has been constrained near the modern coast and appears to have implications for long-term accommodation generation (Scott, 1988). The most recent sedimentary deposits appear to primarily be related to Quaternary sea-level cycles and their associated transgression and regression of linked coastal-marine depositional systems, with earlier work finding Holocene-age beach sediments unconformably adjacent to Miocene formations (Meisburger and Duane, 1971). Prior investigations found shelf morphology in the region generally described by a set of inshore shoals separated from outboard offshore shoals by a series of shelf flats, before transitioning to the outer shelf at 98.4 feet (~30 meters) water depth (Meisburger and Duane, 1971). The shoals have been a particular focus of earlier work for their potential as sediment resources as well as for their apparent connection to differing oceanographic conditions. The majority of the shoals previously studied within this region had been characterized as linear, with the notable exception of several named shoals whose curvilinear shape may indicate a different geologic origin.

Figure 10: Sebastian Inlet Region

Cape Canaveral and the associated Canaveral Shoals are the most prominent seafloor features to the north, while another significant series of shoals referred to as Bethel Shoals dominates the south. The onshore boundary of the Eocene Ocala group limestones to the north and the Oligocene Suwanee group limestones to the south is shown in black.



4 Historic Data Review/Survey Plan Development

For Task Order No. 3, APTIM was tasked with conducting geophysical and geological data collection in three regions along the eastern Florida coast that are distinguished by geographic and geologic/oceanographic characteristics: the region offshore Duval and Nassau Counties, the region offshore St. Johns and Flagler Counties, and the region offshore southern Brevard and northern Indian River Counties near Sebastian Inlet. Prior to finalizing the survey plan, APTIM, in coordination with BOEM, held stakeholder engagement meetings with FDEP, USACE, and individual counties and their planning and consulting engineers. APTIM and TWI concurrently conducted a review of publicly available geological and geophysical data, results from prior investigations, and scientific/technical reports. Scientific/technical reports covered the three study areas to develop an initial desktop survey and synthesis of potential sand resources. From the compiled data, the team developed an initial geologic framework to aid in the understanding and prediction of potential sediment resources within the regions.

To design a line plan that met the needs of both BOEM and local stakeholders, APTIM and TWI held virtual stakeholder meetings with FDEP, USACE, local county representatives and their consultants to discuss the findings of the desktop study and request information and guidance on their sand needs and future projects. During the meetings, APTIM asked stakeholders if they knew of additional data that the team appeared to be missing, if there were areas they viewed as data gaps, and if they were aware of any planned upcoming surveys to avoid duplication of efforts. Additionally, stakeholders were asked if there were any potential beach nourishment projects that would go to construction in the next five (5) years, and how these projects would impact near-term and long-term needs for new resources for emergencies or future work. Since the original scope of work was written before the east coast of Florida was impacted by Hurricanes Ian and Nicole in 2022, APTIM and team also asked stakeholders if these storms generated any new specific needs not previously considered by the team. From this input, APTIM was able to refine the line plan to address these needs.

On March 8, 2023, a stakeholder engagement meeting was conducted with FDEP and included attendees from BOEM, TWI, and APTIM. The purpose of this meeting was to inform stakeholders and solicit feedback on upcoming data acquisition activities. Once the floor of the meeting was opened for questions, FDEP expressed that there are significant long term sand needs in Volusia and Flagler Counties exacerbated by recent storm impacts. Additionally, FDEP requested if, from the data collected, current USACE Borrow Areas could be re-classified to better assist counties with their restoration needs. The current classifications along the north end of Florida had several overlapping unverified resources; therefore, additional data could be used to discriminate the different boundaries and further differentiate between the multiple deposits. In the St. Johns and Flagler region, FDEP stakeholders discussed how Flagler County had been using mostly truck-haul for their nourishment needs, and, along with Volusia County, is expected to have several nourishment projects over the next few years. Along Brevard and Indian River Counties, FDEP representatives said that there was a need for additional design work to identify more borrow areas for the future. The Brevard area relies on the Canaveral Shoals Borrow Area, which addresses the need for the northern area of Brevard County; however, there were no identified resources that could be utilized for future work along the central and south portions of Brevard County. Similarly, Indian River County needed additional mapping and sampling efforts to identify resources to meet future needs.

On March 20, 2023, BOEM and APTIM held a stakeholder meeting with the USACE to better understand upcoming needs and how this project could assist in their current projects. Throughout the three investigation regions, the USACE had several identified resources which are used for various projects along the coast. There were several emergency response projects occurring due to the impacts from Hurricanes Ian and Nicole, which are likely depleting the already established resources faster than anticipated. As discussed in the meeting with FDEP, Volusia County was presented as having the most immediate need for sand resources within the next 1 to 2 years. In the Duval region, the current volume need will likely be greater than the current identified resources in Borrow Area F1 (also known as S), which is currently the county's main sand source. Beach nourishment in Nassau County following Hurricane Nicole will be done utilizing resources from Kings Bay. Geotechnical data along the coast indicates that Nassau County has significant resources and there was not an immediate need to identify additional resources. Although some counties have multiple resources already identified, Duval and St. Johns likely had the highest immediate need for additional resources due to the high level of erosion observed along the coast.

On April 11, 2023, APTIM and BOEM hosted a stakeholder meeting with members of Flagler and St. Johns County, as well as their project engineer representatives of Foth Olsen (Olsen), to discuss their current coastal management needs and how this task order can assist the counties. Along northern St. Johns County, there was an interest in potentially filling in the area between N1, N2, and N3 and determining if those resources could extend beyond their current footprints, since those deposits are not likely to fulfill the long-term sand needs of the counties. Along Flagler County, there was a growing need to identify resources that are closer to the northern portion of the county since the only two available resources (S1 and 3A) were over 10.7 nautical miles (20 kilometers) away and as currently designed, do not have the necessary volume to support the local need. Several of the nearshore resources previously sampled had not proved to have the proper grain size composite; however, there were other potential deposits based on the bathymetric data as well as the Marine Minerals Information System (MMIS) Modeled Shoals feature that both the county representatives and Olsen were interested in for reconnaissance level investigations for future identification and borrow area design. As part of this meeting, it was discussed that future coastal management plans would likely have to utilize resources further offshore to meet the growing sand need for the Florida east coast.

On the morning of April 19, 2023, BOEM and APTIM hosted a stakeholder meeting with members of Brevard and Indian River Counties, as well as their project engineers from Olsen and APTIM, to discuss their current coastal needs and interests and how this task order could improve their local beaches. In Brevard County, there were several identified areas that the stakeholders were interested in investigating. Around Cape Canaveral, there was significant interest in expanding current Canaveral Shoals II to the east and south as well as collecting data along False Cape, just north of Cape Canaveral, as several sand deposits are expected to be utilized as additional resources in that area. Stakeholder representatives for Brevard County suggested that their future project needs and predicted increase in restoration efforts due to storm damage would be helped by prioritizing finding a future potential borrow area along the bathymetric ridge between R-80 and R-90 monuments. Based on some of the historic data collected in the regions, as well as the trend and size of the ridge, stakeholders were highly interested in collecting geophysical and geologic data to verify some previous findings and researching this deposit as a potential resource. Having a potential resource in the general area of R-90 would add a secondary source besides Canaveral Shoals II and allow the southern region of Brevard County to utilize offshore resources instead of truck-haul. The second priority area identified by the county were the shoals just south of Brevard County between R-150 and R-213, which previously had been identified as part of the ASAP study and showed some potential to meet future sand needs. At the time, Brevard County had several planned hurricane work response projects that were expected to last two years, in addition to a nourishment project along the Mid Reach region that would begin over the next 1 to 2 years. In Indian River County, there were several restoration activities expected once Federal Emergency Management Agency funding became available in Sectors 3, 4, and 5 to repair damages from prior hurricanes. However, these projects would rely on truck-haul instead of offshore sources due to the lack of these resources. Based on their needs, any offshore deposits identified would be highly valuable for the county.

On the afternoon of April 19, 2023, APTIM and BOEM held a stakeholder meeting with Nassau and Duval County project engineer representatives from Olsen to discuss their current coastal management needs and how this task order can assist their needs. It was noted by Olsen that the center of the island in state waters was relatively stable; therefore, there were no current sand needs. Additionally, there had been significant mapping efforts in federal waters along Nassau County. In Duval County, future restoration efforts would be taking place in state waters utilizing the material accumulated north of the St. Johns River in Fort George Inlet. For exploratory purposes, Olsen discussed how the region southwest of the current F1 borrow area and the area northeast of the USACE borrow area cluster of B1, DU8-R044, DU8-R047, and DU8-R048 in A1 was interesting based on the overall ridge trend. Based on data at the time, it was believed that those areas would be of interest for future resources. Additionally, Olsen pointed out that the area west of F1 and the Ocean Dredged Material Disposal Site is likely hardbottom and that there was little information on the consequences ("bleed out") of having the Ocean Dredged Material Disposal Site in that proximity to F1 and how that is impacting the F1 deposit and its surrounding areas. Based on the current needs for both counties and current available resources, stakeholders from Olsen discussed how the purpose in this region would likely be exploratory to identify resources for future use.

For the evaluation of the proposed survey plan APTIM, TWI, and BOEM reviewed the available historic data, as well as county needs, to determine an appropriate allocation of geophysical and geologic data for each county. The final allocation of the proposed 449.73 nautical miles (833.1 line-kilometers) of hydrographic (multibeam bathymetry) and geophysical (chirp sub-bottom, sidescan sonar, and magnetometer) data are presented in Table 1. Vibracores were allocated based on the overall need of adjacent beaches, historic data coverage, and to ground-truth potential resources identified in the geophysical survey results. Vibracore sites were chosen with the goal of maximizing the information collected about the target deposit characteristics and underlying strata and/or to augment the understanding of the geologic framework and evolution of each region (Sections 5.1.2.7, 5.1.2.7.2 and 5.1.2.7.3). Final as-run and as-built maps are in Appendix B Map 1a-1c.

Table 1: Geophysical and geotechnical data allocation per study area

Region	%	Allocated line (km)	Allocated line (nm)	As-run line (km)	As-run line (nm)	Number of vibracores
Sebastian Inlet	25%	212.0	114.4	247.6	133.7	15
Offshore Duval and Nassau County	28%	241.4	130.3	219.6	118.6	17
Offshore Flagler and St. Johns County	47%	379.7	205.5	393.6	212.5	28
Total	100	833.1	449.8	860.8	464.8	60

Notes:
% denotes percent.
km denotes kilometers.
nm denotes nautical miles.

A breakdown of each investigation region, as well as findings from the desktop study, stakeholder meetings, and historic data review is provided in the sections below.

4.1 Nassau and Duval Counties

The region offshore Nassau and Duval Counties serves the needs for Jacksonville Harbor (Figure 11). In this region, the goal was to collect additional geophysical and geotechnical data along the unverified plus resources identified as part of the USACE SAND study and determine what impacts the existing submarine cables have on these resources. Additionally, the line plan connects the NA10-R011, NA6-R010, NA8-R010 and NA9-R010 deposit to the Georgia portion of the ASAP data in order to maximize the geologic framework context of the region and help determine the origin and evolution of any nearshore potential sediment resource deposits. BOEM proposed the following strategic questions for the Nassau and Duval region:

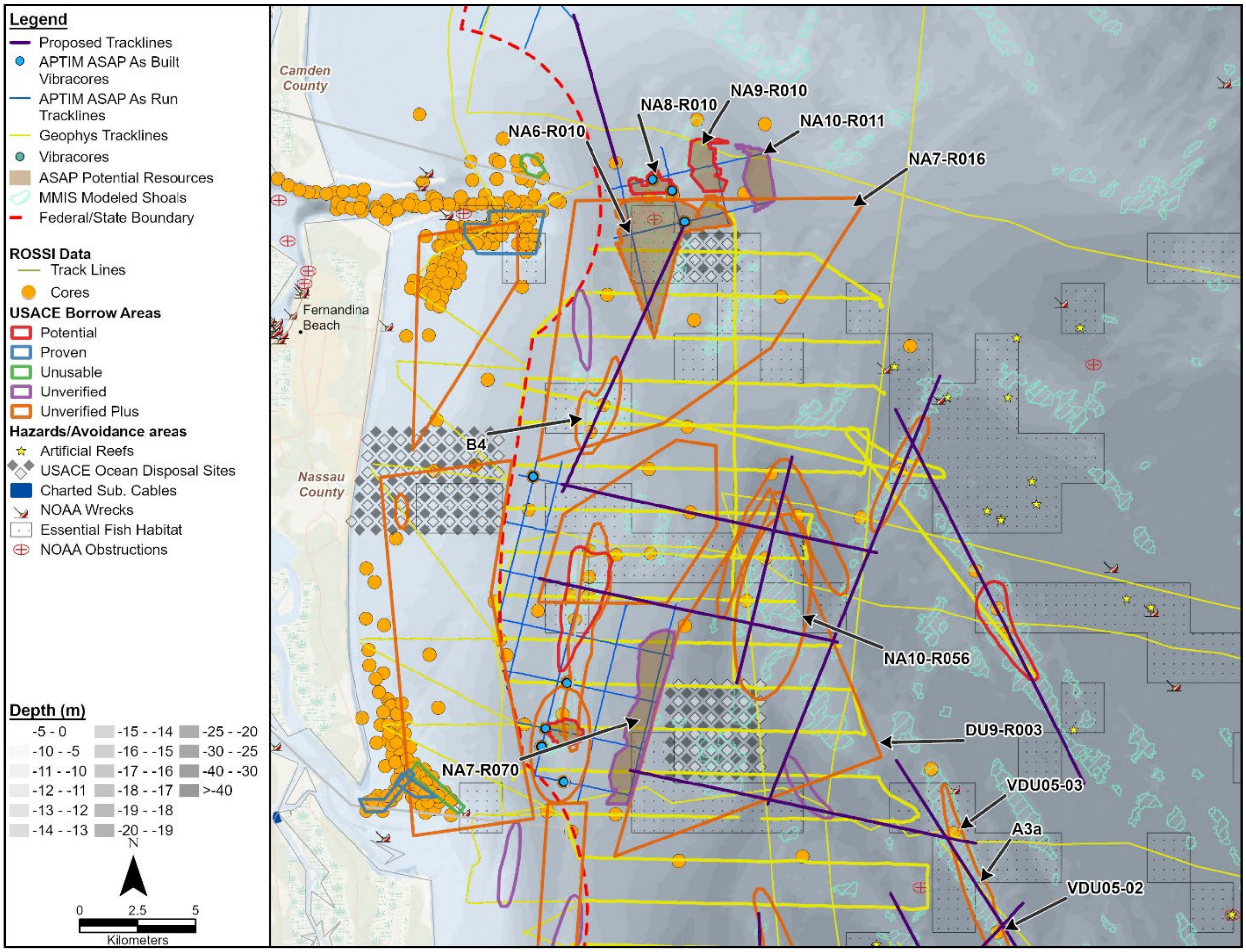
1. What is the composition, quality, and extent of the potential resource(s)?
2. Based on the resulting data collection, should any areas be recommended for further investigation by design-level survey or eliminated from further consideration?
3. What is the origin and evolution of the deposit(s)?

The proposed geophysical and geologic survey plans were designed to answer these questions, and they were presented to the stakeholder group for further input.

Along the northern portion of the Nassau region (Figure 11), the proposed line plan connects the northern identified potential borrow area outlined from the ASAP data (NA10-R011, NA6-R010, NA8-R010 and NA9-R010) to the southern identified USACE borrow area B4 in order to determine if the northern deposit extends beyond its current delineated footprint and to refine understanding of the deposit properties within B4. The proposed line plan was also aimed at extending the identified ASAP NA7-R070 borrow area further east and connecting it to the surrounding unverified plus resource (DU9-R003) and further southeast to A3a. Moreover, as requested by the FDEP and BOEM, the line plan aimed at further constraining the various unverified and unverified plus deposits identified during the SAND study and at providing a better understanding of the resources available and their boundaries. Historic geotechnical data along A3a (VDU5-03 and VDU5-02) indicated some potential for surficial sands, which is also corroborated by the Florida Geological Survey (FGS) data (04b40).

From the information gathered during the desktop study, APTIM collected an exploratory line along a bathymetric high between the unverified plus A3a and the larger A4 areas. Geotechnical data collected by Alpine Seismic Survey Inc. in 2005 (VDU05-01) indicate the potential of roughly 18 feet (5.5 meters) of surficial sands along the southern end of this bathymetric feature. The FGS line (04b39) that crosses this bathymetric high indicated a potential shoal that roughly coincides with the boundary outlined by the modeled shoal feature. By collecting geophysical data along this deposit at an angle, APTIM would be able to delineate its boundaries, verify its physical properties and correlate the chirp data to the data collected by FGS. On both this exploratory shoal, as well as A3a, by correlating the high resolution seismic sub-bottom data to the boomer data collected by FGS, not only were boundaries and internal stratigraphy of the shoal mapped, but the base of the deposit as well.

Figure 11: Proposed geophysical data offshore Nassau County



On the central portion of offshore Duval County (Figure 12), APTIM collected exploratory lines along unverified plus Borrow Areas M3a A4, A5, and M3b to achieve a multitude of goals. Current resources in the region being utilized by the USACE (F1 aka Borrow Area S) will not be able to support the growing sand need of the region; therefore, additional resources are necessary for future restoration efforts. To mitigate future sand needs and multiple use conflicts that could arise from the placement of future submarine cables, the proposed line plan targeted two potential resources that could be utilized by stakeholders. One potential resource is to the east of F1, and the second along a bathymetric ridge south of F1 along the northern edge of St. Johns region (explained in Section 4.2 below). Along the southern portion of the unverified plus A4 area, vibracores collected by Athena Technologies in 2003 indicate that a vibracore cluster to the east of USACE F1 could likely have up to 19 feet (5.8 meters) of surficial sands (CB-DUC03-36) on the northern end and 5 feet (1.5 meters) on the southern end (CB-DUC03-41). The proposed line along the southeastern end outside of A4 aimed at further constraining this potential resource and determining if the geophysical data can corroborate the geotechnical and bathymetric information provided by CB-DUC03-42, CB-DUC03-39, and CB-DUC03-45, which indicates 16 feet (4.9 meters), 6.5 feet (2.0 meters) and 9.5 feet (2.9 meters) of surficial sands respectively outside of the current A4 boundary. FGS profiles along this area (02b39 and 02b41) indicate some surficial shoals on the eastern edge of the line; however, the existing data do not cover the entire shoal (Figure 13). Review of the historic data together with the bathymetric surface indicates that this surface sand unit is likely associated with the bathymetric ridge seen in A4.

Figure 12: Proposed geophysical data offshore Duval County

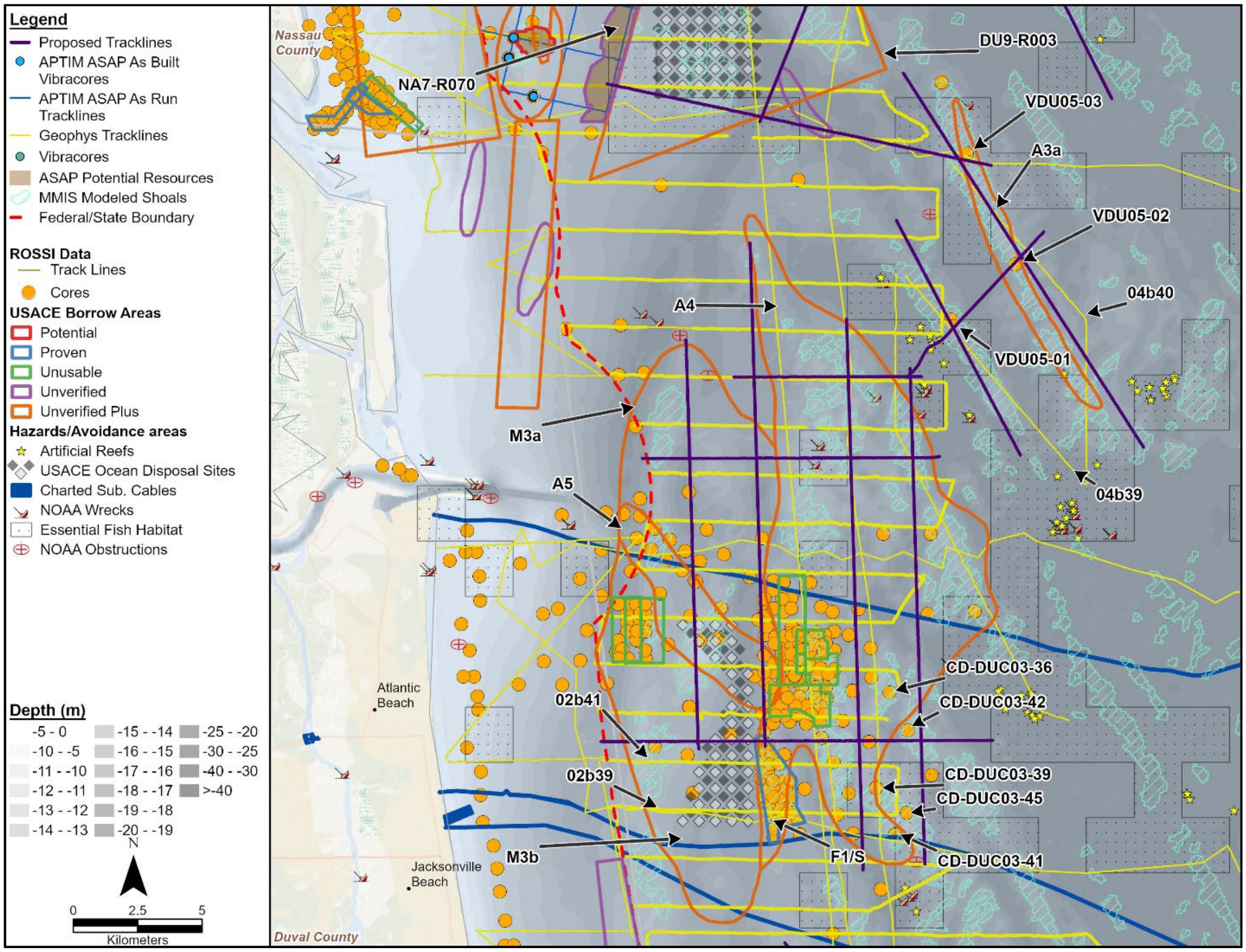
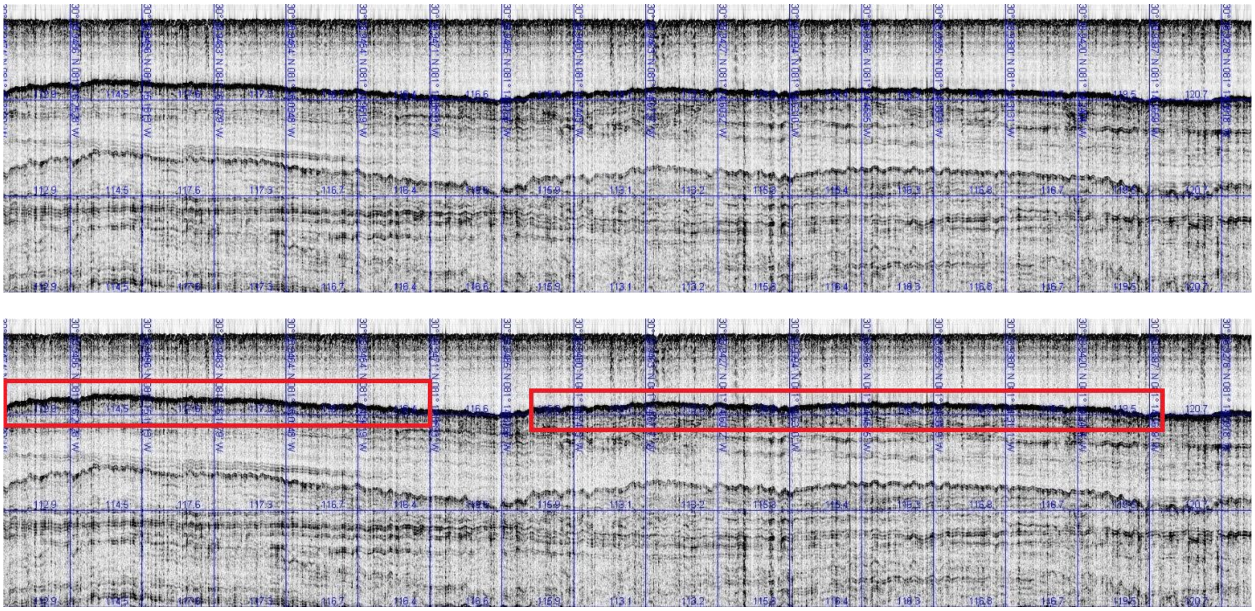


Figure 13: Easternmost edge of FGS seismic Line 02b41 (top) showing surficial shoal deposit being targeted by the proposed line plan (bottom)

Note: FGS annotation information indicate that vertical scale lines represent 65.6 feet (20 meters) using a sound velocity of 4,921.2 feet per second (1,500 meters per second) and horizontal measurements are annotated in meters between geographic fixes.



From the collection of additional geophysical and geotechnical data along these ridges, APTIM evaluated the origin and evolution of these deposits and if findings from offshore Duval County can be correlated to other similar depositional environments along the Florida coast. As previously mentioned, from the data collected, APTIM determined the extent to which the existing submarine cables in the region are affecting potential sand resources and if any future cables would have any impacts on potential resources along the southern end of Duval County region as requested by the scope of work. In the nearshore portion of the investigation region, an exploratory line across the M3a, A5, and northern edge of M3b would allow for the potential identification of a nearshore resource.

4.2 Flagler and St. Johns Counties

Flagler and St. Johns Counties have had an increase in sand needs as evidenced by accelerated use beyond what was envisioned in the SAND study. While the study did not show a sand deficit for these counties, this more rapid use indicates needs may not be met by known resources. The goal in this region was to collect additional geophysical and geotechnical data along the unverified and unverified plus areas that have been identified in the SAND report and better delineate their boundaries, potential volume, and resource potential in order to establish additional resources that can support this more realistic need going forward. BOEM proposed the following strategic questions for the Flagler and St. Johns region:

1. Do these areas show the potential for sediment resources in excess of 5 feet (1.5 meters)?
2. What are the trends and variability of the sediment among these similar shore-oblique shoal features?
3. What are the seaward extents of some of these more promising deposits?

The proposed geophysical and geologic survey plans were designed to answer these questions, and they were presented to the stakeholder group for further input.

As previously mentioned as part of the Duval and Nassau Counties line plan, the USACE Borrow Area F1 has effectively been depleted. As requested by stakeholders and BOEM, there is a significant need to identify alternative resources in the region. The first of the proposed areas is to the east of F1, and the second potential resource is south/southeast of F1, along the bathymetric ridge and modeled shoal north of borrow area SJ9-R069 offshore of northern St. Johns County (Figure 14). However, any potential resources available on this shoal, also observed in the FGS data (line SJ04, SJ01 and 04b36) (Figure 15), could likely be impacted by the placement of additional submarine cables in the region. In order to mitigate for future multiple use conflicts between submarine cables and sand deposits, BOEM had requested the resource potential of this deposit be investigated.

Figure 14: Proposed geophysical data offshore St. Johns County

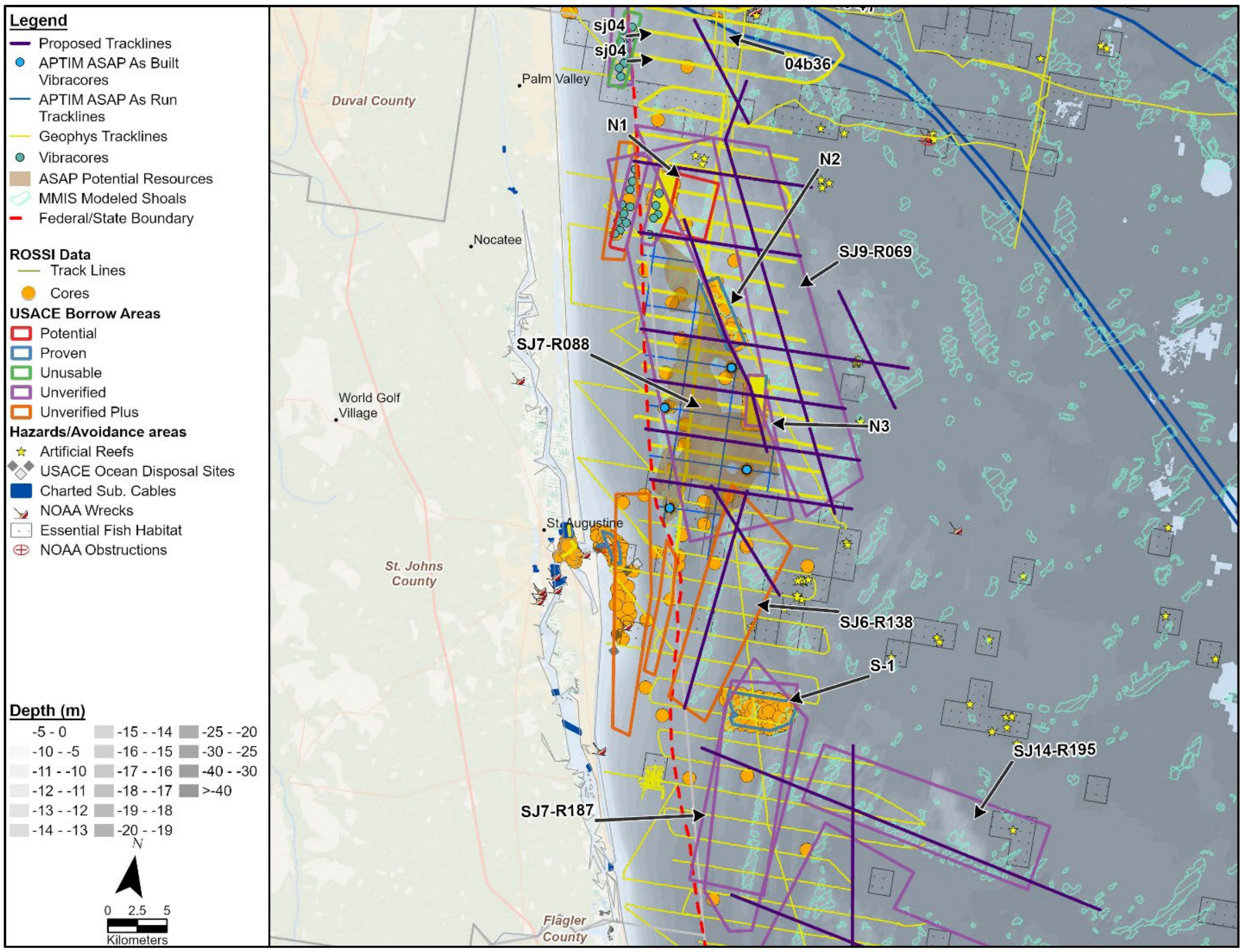
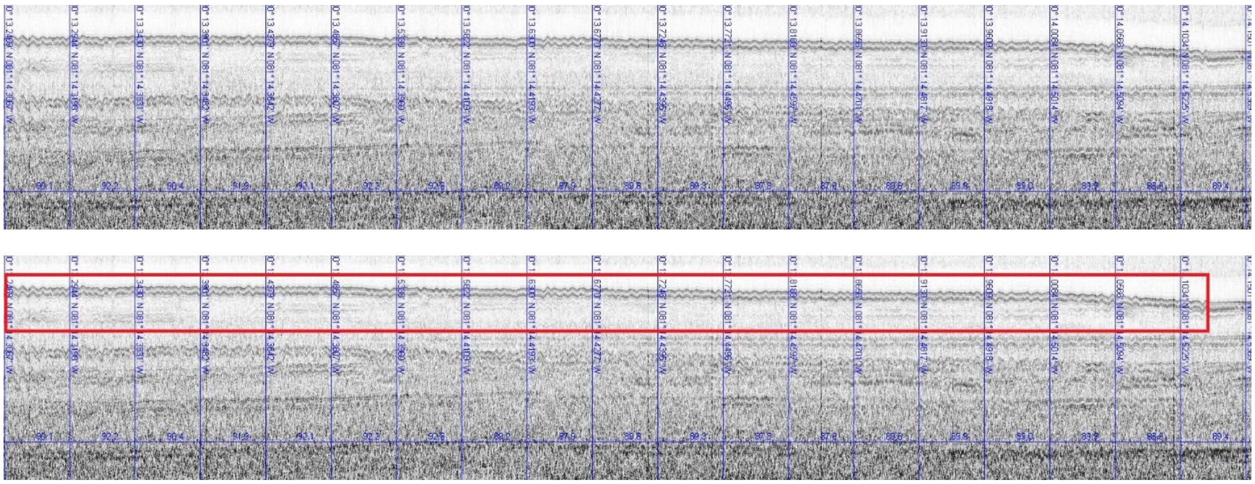


Figure 15: Southern edge of FGS Line 04b36 (top) with northern edge of shoal highlighted in red (bottom)

Note: FGS annotation information indicate that vertical scale lines represent 65.6 feet (20 meters) using a sound velocity of 4,921.2 feet per second (1,500 meters per second) and horizontal measurements are annotated in meters between geographic fixes.



The two lines placed along this bathymetric high could be correlated to the existing FGS data to further constrain the eastern and western boundaries of the potential deposit, while the chirp data would assist in delineating any internal stratigraphy of the deposit. Together, the two datasets would provide a better understanding of this bathymetric high and if it would be a viable resource once F1 is depleted.

Further south, the proposed line plan provided additional geophysical data coverage of the ASAP borrow area SJ7-R088 and aimed at further constraining the potential resource and determined if it expanded further onto unverified USACE Borrow Area SJ9-R069. Additionally, based on requests from the county as well as their consultant, Olsen, the plan along the northern portion of St. Johns County region sought to map the areas in between known borrow areas N1, N2 and N3 to assess the potential to expand their boundaries beyond their current footprint, which the FGS data appears to support. Along the southern portion of St. Johns County region, the proposed line plan aimed at delineating the potential resource identified as the Unverified Borrow Area SJ6-R138. Based on information provided by the USACE as well as county representatives and Olsen, further constraining the deposit's properties along SJ6-R138 would be beneficial for the St. Augustine Beach area, which is currently relying on S-1 as its offshore sand resource.

On the southern end of St. Johns County region and northern Flagler County region (Figure 16) there are several unverified resources that appear to follow an offshore bathymetric ridge which is also seen on the FGS seismic data. As stated by both the county as well as Olsen engineers during stakeholder engagement, the nearshore resources are highly variable and have a limited amount of beach compatible sediments, and the currently developed limits of the 3A resource in central Flagler County region is not enough to support future needs. APTIM's proposed exploratory line plan offshore the central portion of the study area aimed at targeting both the unverified USACE borrow areas as well as modeled shoals along these bathymetric ridges. The widely spaced lines along SJ7-R187, SJ14-R195, FL12-R024, FL8-R082 and FL15-R088 were intended to provide an overall understanding of the geology of the region and if any of these deposits can be used as part of the county's long term management plan. Review of the FGS data along these deposits indicated several shoals throughout the region, which would require significant data coverage to accurately determine their boundaries and properties. The proposed highly reconnaissance-level line plan was intended as an initial exploration of the area that could later be correlated to the FGS data and further mapped as a potential resource.

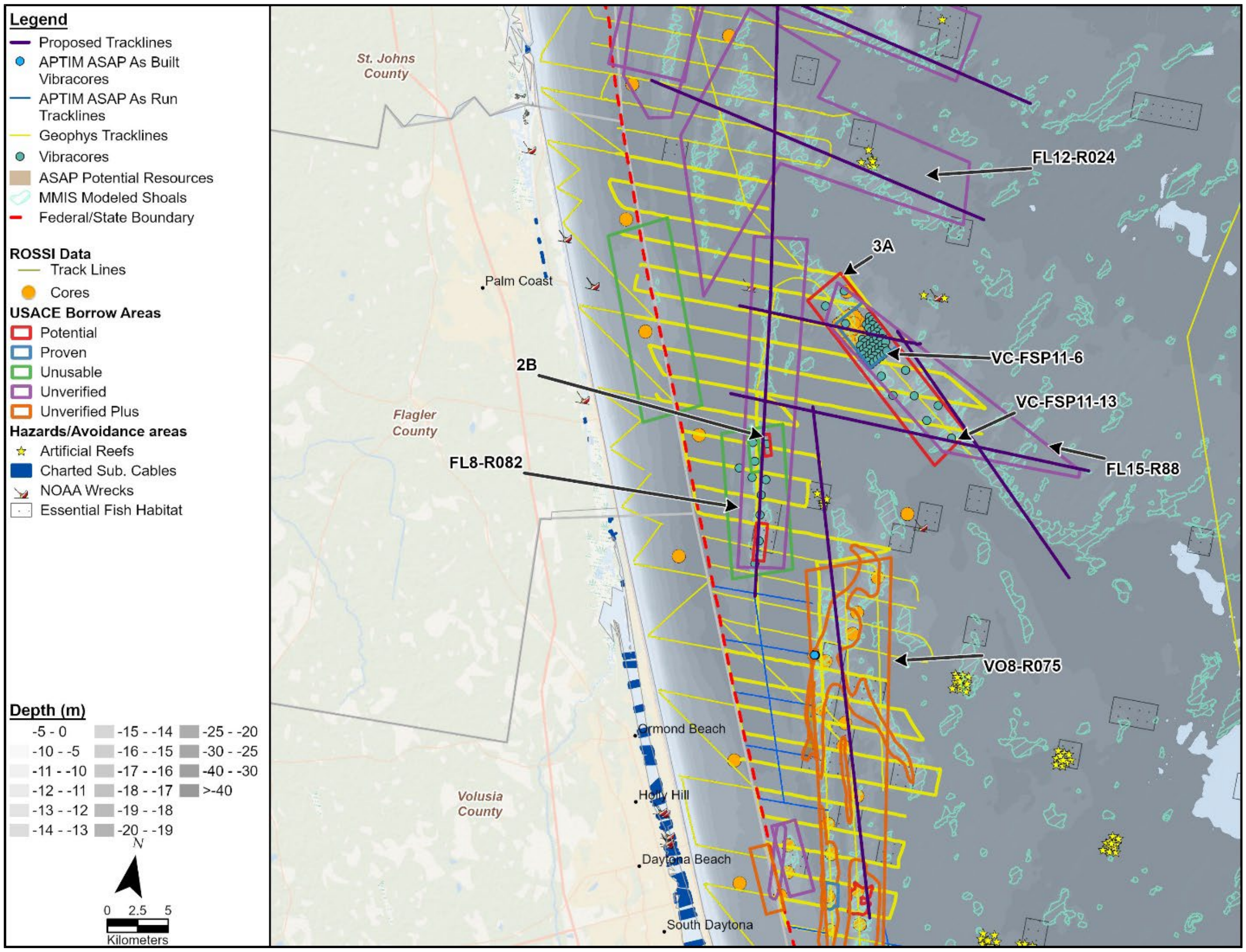
Along central and southern Flagler County region, additional exploratory lines aimed at delineating the area north of the 2B USACE borrow area. This would assist in determining if that deposit extends further north along the modeled shoal identified by BOEM's MMIS and encompassed by the Unverified Borrow Area FL8-R082. Additionally, the FGS data would assist in the delineation of the western and eastern boundaries of the deposit.

Further offshore Flagler County, exploratory lines south of Proven resource 3A, across Unverified Borrow Area FL15-R088 and along the modeled shoal associated with the ridge further south from these established deposits could provide additional resources for south Flagler County for future planning needs. Geotechnical data collected by USACE on the southern portion of FL15-R088 and Area 3 indicated that the bathymetric ridge sampled by VC-FSP11-6 though VC-FSP11-13 has up to 10 feet (3.0 meters) of sand, which if further constrained by the geophysical data that could be developed into a potential resource beyond the delineated boundary seen in the FGS data.

Similar to the other two study areas, in Flagler and St. Johns regions there is the need to better understand the geologic origin and evolution of the potential deposits outlined above, and also determine the potential for sand in excess of 5 feet (1.5 meters), the trend and variability of the shore-oblique shoals, and how far seaward these deposits can be extended. Previous work has noted the variability of the shoal orientations and the apparent superposition of northeast-southwest trending features on top of larger northwest-southeast shoals, which may indicate different mechanisms and timing of generation (e.g., Swift et al., 1975; Hayes and Nairn, 2004; Lobo et al., 2010; Thieler et al., 2014). Prior investigations found highly variable sediments ranging from calcareous sands to poorly sorted silts and gravels, all at an apparently similar stratigraphic position. The relative thickness and composition have been speculated to be related to storm wave erosion of underlying stratigraphy combined with some degree of littoral drift (Meisburger and Duane, 1971).

Based on feedback received from stakeholders, APTIM collected a single geophysical line in Volusia County in VO8-R075. This exploratory line would tie in the FGS data which shows several shoals in the area and potentially extends the ASAP data. By correlating the two datasets, it would be possible to determine some of the properties of these shoals as well as their extents.

Figure 16: Proposed geophysical data offshore Flagler County



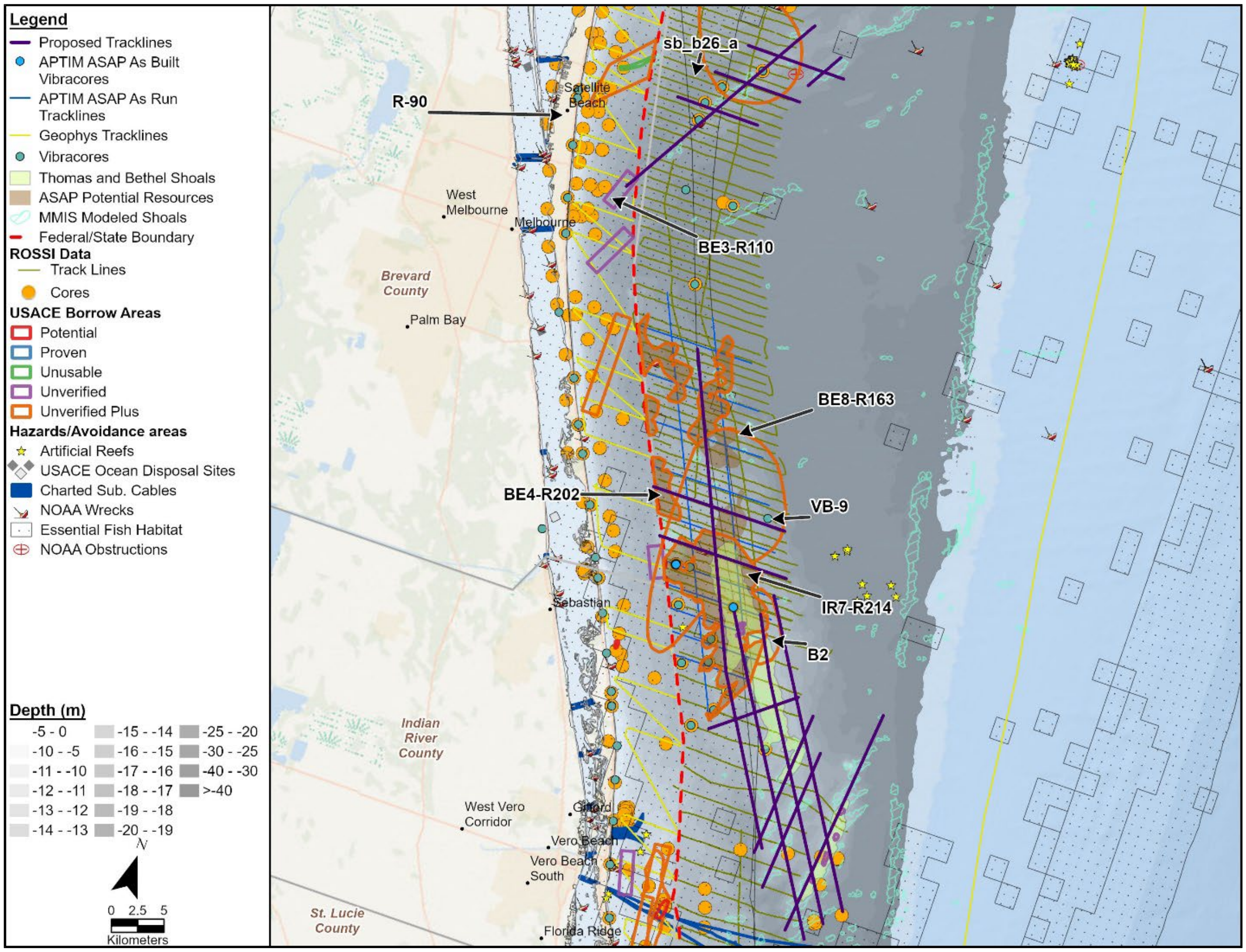
4.3 Sebastian Inlet

The region offshore Sebastian Inlet extends from offshore of the southern portion of Brevard County southwards to offshore of the northern portion of Indian River County and serves the sand needs for Indialantic and Melbourne Beach, as well as the area known as the South Beaches (Figure 17). In this region, the goal was to find a potential resource closer to South Reach and South Beaches than the current options of Canaveral Shoals II and truck-haul from an upland mine. Additionally, a nearshore resource in this region could also serve the needs of Sector 1 and Sector 2 in Indian River County. BOEM proposed the following strategic questions for the Sebastian Inlet region:

1. What is the composition, quality, and extent of the potential resource(s)?
2. Based on the resulting data collection, should any areas be recommended for further investigation by design-level survey or eliminated from further consideration?
3. What is the origin and evolution of the deposit(s)?

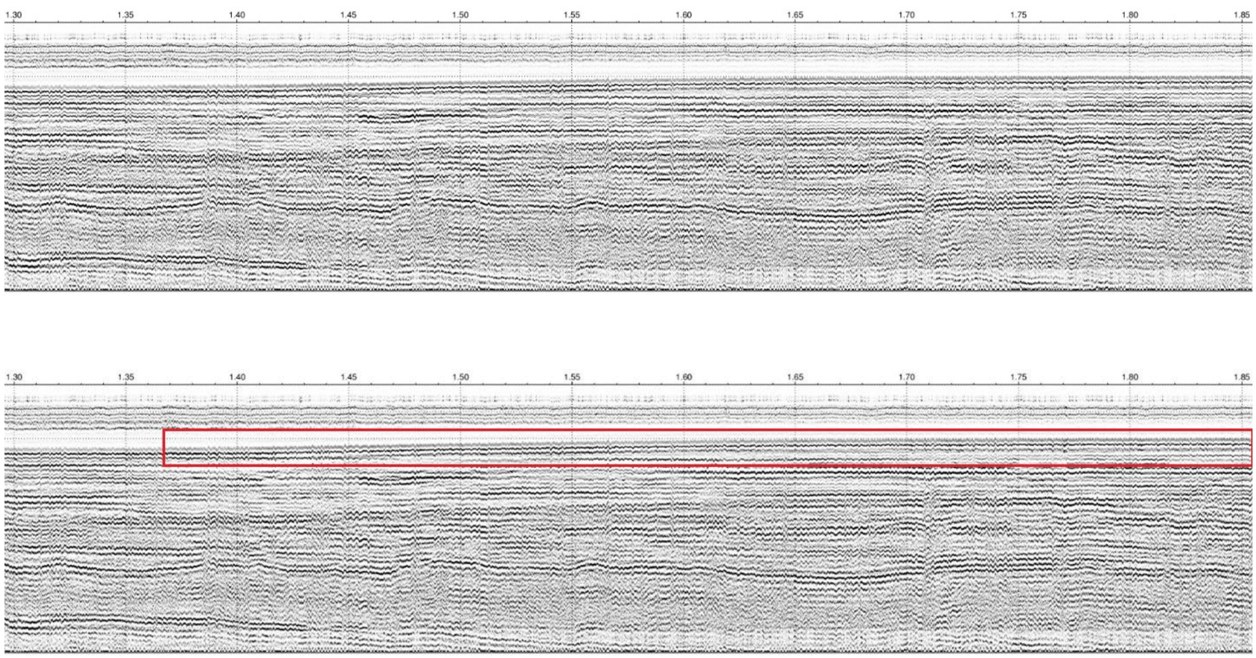
The proposed geophysical and geologic survey plans were designed to answer these questions, and they were presented to the stakeholder group for further input.

Figure 17: Proposed geophysical data offshore Sebastian Inlet



The line plan developed by APTIM, TWI, and BOEM took into account feedback provided by the Brevard County representatives, who requested data coverage along the bathymetric ridge east of the R-90 monument. The lines were exploratory in nature and aimed at further describing and delineating the deposit, while also tying in the FGS vibracores collected in 1998. A review of existing FGS geophysical data determined that sub-bottom data within the region was highly variable in its quality and vertical resolution. However, review of the seismic images available from the Data Series 652 online publication shows the region offshore R-90 has some potential surficial deposits around the targeted shoal, but the quality and vertical resolution of the dataset does not allow for the determination of the deposit's overall extent, thickness, and properties (Figure 18).

Figure 18: Seismic Line sb_b26_a (top) from FGS in Brevard County in the vicinity of R-90
Horizontal lines indicate 0.01 s in two-way travel time. On the right (east) side of the image (bottom), there is the indication of a potential shoal feature that matches the topographic high seen in the bathymetric data which is being targeted by the proposed line plan.



Another area identified during the desktop study and stakeholder engagements as being a viable resource is to the south of R-90, along the northern portion of the unverified plus resource IR7-R214 and BE8-R192, previously identified from the processing of the ASAP data by APTIM. The IR7-R214 resource is estimated as having roughly 17 million cubic yards (13 million cubic meters) of potentially beach quality sediment (APTIM, 2017) and could potentially be a significant resource for the region. With the proposed line plan, APTIM brought the northern portion of IR7-R214 and BE8-R192 closer to appraisal level spacing to further constrain the extent and characteristics of this deposit, evaluated the previously estimated volumes and composite information, and determined if this area was indeed a viable future resource that warrants additional exploration or if there are any properties that could be excluded as a potential borrow area.

Along the southern portion of IR7-R214 and to the south of the potential borrow area, the proposed geophysical data coverage sought to further constrain the southern extent of the IR7-R214 deposit and investigated if there were any correlations between this resource and the bathymetric high observed southeast of the edge of the current resource boundaries, which would allow for the expansion of the current deposit footprint to include the entire bathymetric shoal. Further south, northeast/southwest trending tie lines offshore Indian River County aimed at characterizing Bethel Shoals and the two parallel shoals to the northwest and evaluating how these deposits correlated to the overall topographic high seen within IR7-R214. APTIM was not able to locate the previously acquired seismic data collected by FGS offshore of Indian River County. The specific line configuration detailed above provided necessary details to address strategic questions 1-2, in particular by providing additional imaging and characterization of key potential resources. By establishing the potential usability of these resources, APTIM was able to address the sand needs for Indian River County and potentially establish a resource that can be used for future larger scale restoration projects, with the goal of offering an alternative to their current inland resources for nourishment operations. Additionally, the proposed survey plan informed BOEM's strategic question regarding the geologic origin and evolution of the identified resource. Closely related and informed by question 1 (characteristics and extent), the initial review of previous investigations and datasets revealed the surficial sediment characteristics of the region to be primarily a mantling of unconsolidated sediments in the form of dune fields and shoals unconformably overlying usually Miocene to Pleistocene strata (Meisburger and Duane, 1971). These shoals often take the form of a ridge morphology. A number of the larger shoals in the south end of the region have been the subject of prior sand searches and potential borrow area designation as outlined above, but questions remained as to the origin and evolution of the shoals. Prior work noted that some of these shoals contained internal stratigraphy that indicated they are relict features rather than strictly formed by Holocene shelf processes (e.g., Meisburger and Duane, 1971; Duane et al., 1972; Phelps, 2007). The line orientation over the larger shoal ridges was designed to capture any internal stratigraphy as well as expose the relation to the underlying geology to help differentiate between relict features as compared to those originating from Holocene shelf processes following transgression.

5 Geophysical and Geotechnical Data Collection Methodology

The methodology of geophysical and geotechnical data collection is explained below.

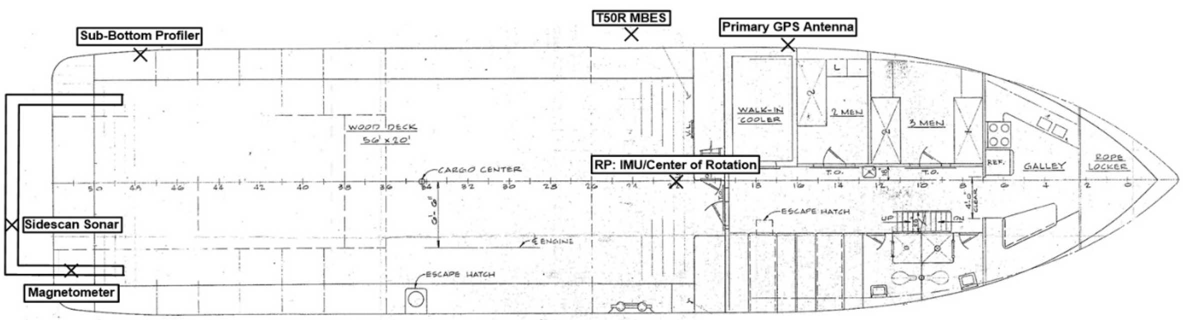
5.1 Geophysical Survey Operations and Geotechnical Site Selection

The geophysical survey operations and geotechnical site selection is explained below.

5.1.1 Systems and Equipment

Between July 7, 2023 and July 26, 2023, APTIM collected a total of 449.73 nautical miles (833.1 line-kilometers) of geophysical data on the Atlantic OCS of Florida utilizing the following systems and equipment according to the diagram presented in Figure 19 and included in Appendix C and following the mitigation procedures outlined in Appendix D.

Figure 19: *R/V Rachel K. Goodwin* Vessel Diagram



5.1.1.1 Geophysical Survey Vessel Characteristics

For the geophysical data collection efforts, APTIM used the *R/V Rachel K. Goodwin*, a United States Coast Guard (USCG) inspected and certified vessel for Phase 1 of this project. The *R/V Rachel K. Goodwin* is a 110-foot (33.5 meters) steel hulled vessel, acquired with the sole purpose of geophysical, geotechnical, and biological surveys. It comes equipped with twin 1692 Detroit diesel main engines, twin 471 Detroit diesel generators (40 Amp), one 18,000-pound capacity deck winch, a 4-inch (10 centimeters) down pole with variable mounting brackets, and a 10-ton capacity hydraulic A-frame. The *R/V Rachel K. Goodwin* is equipped with crew and client quarters as well as a full galley with two heads including showers. As a USCG inspected vessel, the *R/V Rachel K. Goodwin* safety features include fire extinguishers, life vests/survival suits, 50-man life raft, first aid kits, radar, very high frequency radios, and an emergency position indicating radio beacon with global positioning system (GPS) and more. These safety features and the level of experience and expertise from the captain and crew allows the *R/V Rachel K. Goodwin* to operate safely and efficiently, providing proficient geophysical and geotechnical support throughout project operations.

5.1.1.2 Navigation System

APTIM utilized Hypack Inc.'s Hypack 2020 software for geophysical data collection and Hypack Inc's Hysweep system for multibeam data collection. Hypack and Hysweep are state-of-the-art navigation and hydrographic surveying systems. Vessel positioning and navigation were provided by the Applanix Position Orientation System for Marine Vessels (POS MV; see Section 5.1.1.3 below). The POS MV is a highly accurate positioning device that combines Global Navigation Satellite Systems (GNSS) data with acceleration data from the Inertial Measure Unit (IMU), as well as heading to provide a complete position solution. Navigation, motion reference unit, magnetometer, and all depth sounder systems were interfaced with an onboard computer, and the data integrated in real time. The locations of the tow points on the vessel for each towed instrument, the POS MV system, and the length of cable between the tow points and each towed instrument were measured in relation to the center of mass of the vessel and entered into Hypack. The real time position of each towed instrument was calculated using the measured values and a catenary factor specific to each system's towing attitude and displayed in real time through Hypack and monitored by APTIM hydrographer. Online screen graphic displays included the pre-plotted survey lines, the live boat track across the survey area, adjustable left/right indicator, as well as other positioning information such as boat speed and line bearing. The digital data were merged with positioning data, video displayed and recorded to each of the individual acquisition computers. Hysweep was operating concurrently to Hypack and provided a visual display of the multibeam bathymetric data being collected as well as attitude corrections, so that APTIM scientists were able to visualize the data in real time for proper data quality. Each acquisition system parsed the corrected navigation string from Hypack to the incoming data; therefore, all raw data are layback corrected.

Vertical data is provided in North American Vertical Datum (NAVD) of 1988, GEOID 18. All horizontal data is provided in the Florida State Plane Coordinate System, East Zone, North American Datum (NAD) of 1983 (2011) in U.S. survey feet.

5.1.1.3 Motion Reference Unit

An Applanix POS MV Wavemaster II system was utilized to collect attitude, heading, position and velocity data for survey operations. The POS MV data were logged at 25 Hz for post-processing using POSPac Mobile Mapping Suite (POSPac MMS). 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 GNSS Azimuth Measurement System (GAMS). 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 embedded within the Hypack Multibeam Echosounder (MBES) files. POS MV data groups were logged at 25 hertz for post-processing using Applanix POSPac MMS software.

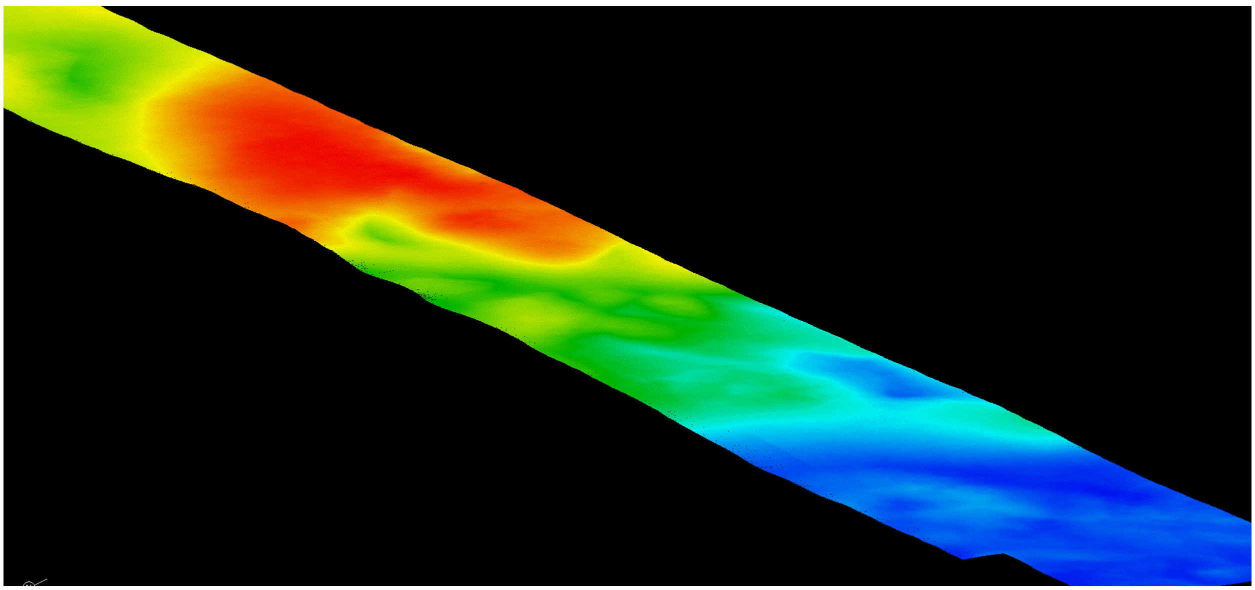
5.1.1.4 Multibeam Bathymetry Instrumentation

APTIM collected MBES data following International Hydrographic Organization S-44 Standards Order 1b. APTIM utilized a Reson SeaBat T-50 Multibeam Echosounder pole mounted on the side of the vessel for multibeam bathymetry data collection. The Reson T-50 is an all-in-one, fully flexible survey system designed for fast mobilization. It has a frequency range of 190 to 420 kilohertz, which can be adjusted to allow for optimal swath performance and reduce survey time in various conditions. The T-50 operated at 400 kilohertz providing a specified sounding footprint of 0.5º x 1.0º. Horizontal and vertical offsets from the multibeam transmitter and receiver were measured to the navigation antennas and IMU and applied in

Hypack/Hysweep and Applanix POSView. Multibeam soundings and real time sound velocity measurements at the sonar head were recorded directly to Hysweep acquisition software.

Prior to the start of bathymetric data collection, a patch test was required 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 procedures. Patch tests were performed prior to data collection in each region. Patch tests were performed over sloping grounds and/or submerged objects or artificial reefs. A sloping ground site was used in the Nassau and Duval region as shown in Figure 20.

Figure 20: Patch test bathymetry from Nassau and Duval Counties, sloping grounds



Patch test biases were calculated for latency, roll, pitch, and yaw. In brief, a patch test was performed by collecting survey lines perpendicular to a slope (or object) on the seafloor in a specific reciprocal pattern to account for latency, pitch, and yaw biases. Additional survey lines were collected over flat bottom to account for roll bias. 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 2 below. Patch test values were consistent throughout the survey and varied within acceptable limits.

Table 2: MBES Patch test results

Region	Date	Roll	Pitch	Yaw	Latency
Nassau and Duval	7/12/23	0.00º	-0.30º	2.40º	-0.05º
St. Johns and Flagler	7/19/23	0.06º	0.40º	-0.40º	-0.05º
Sebastian Inlet	7/26/23	0.07º	-0.30º	-1.50º	-0.05º

Sound velocity profiles were collected using a Valeport Swift sound velocity profiler using an Ocean Science under-way system. Sound velocity casts were taken several times daily and embedded into Hypack .HSX files and stored for later analysis.

5.1.1.5 Magnetometer Instrumentation

A Geometrics G-882 Digital Cesium Marine Magnetometer was used to perform an investigation of magnetic anomalies and to establish the presence and location of any potential underwater wrecks, cultural resources, or submerged hazards. The Geometrics G-882 magnetometer runs on 110 volts alternating current (VAC) and is capable of detecting and aiding the identification of any ferrous, ferric, or other objects that might have a distinct magnetic signature. This particular magnetometer is highly sensitive and is capable of identifying targets with less than 1 gamma. Factory set scale and sensitivity settings were used for data collection (0.004 nT/ πHz rms [nT = nanotesla or gamma]; typically, 0.02 nT peak to peak at a 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 at an altitude no greater than 19.7 feet (6 meters) above the seafloor (per BOEM guidelines) and far enough from the vessel to minimize boat interference. Navigation and horizontal positioning for the magnetometer were provided by the Applanix POS MV Wavemaster II via Hypack utilizing the Hypack towfish layback correction. The magnetometer was recorded in the native raw Hypack file format.

In order to meet BOEM's requirement of towing the magnetometer within 19.7 feet (6 meters) from the seafloor, APTIM towed the magnetometer in tandem with the sidescan sonar system to better adjust and maintain appropriate altitudes above the seafloor. When water depths become shallow enough and significant boat interference was observed in the data, APTIM modified the towing configuration so that the magnetometer was towed independently from the sidescan sonar towfish.

5.1.1.6 Sidescan Sonar Instrumentation

An EdgeTech 4200 sidescan sonar system was used to collect sidescan sonar data in the investigation area. The EdgeTech 4200 uses full-spectrum chirp technology to deliver wide-band, high-energy pulses coupled with high resolution signal to noise ratio echo data. The portable sidescan package includes a laptop computer running the Discover® acquisition software and a 300/600 kilohertz dual frequency towfish running in high-definition mode. At 300 kilohertz the maximum range scale is 754 feet (230 meters), and at 600 kilohertz the maximum range scale is 393 feet (120 meters). The sensor was towed from a marine grade oceanographic winch to allow for easy, real-time adjustments for changes in the seafloor to maintain an altitude that is 10 to 20 percent of the range of the instrument per BOEM guidelines. The sidescan sonar system was monitored and adjusted, in real-time to use the optimal settings for environmental, oceanographic, and geologic conditions in order to maximize data quality and coverage to ensure that the data being collected resolve features at a 1.6 feet (0.5 meters) resolution. Navigation and horizontal positioning for the sidescan sonar system was provided by the POS MV system via Hypack utilizing the Hypack towfish layback correction. Sidescan sonar data were collected and recorded in the system's native .jsf format.

5.1.1.7 Sub-Bottom Profiler Instrumentation

Chirp sub-bottom data were collected using an EdgeTech 3200 sub-bottom profiler system with a 512i towfish to conduct the high-resolution subsurface mapping within the upper 10 meters (33 feet). This instrumentation generates cross-sectional images of the seabed capable of resolving bed separation resolutions of 0.2 feet (0.06 meters) to 0.3 feet (0.10 meters) depending on selected pulse/ping rate. The X-STAR Full Spectrum Sonar is a versatile wideband FM sub-bottom profiler that collects digital normal incidence reflection data over many frequency ranges. This instrumentation generates cross-sectional images of the seabed. The X-STAR SB-512i transmits an FM pulse that is linearly swept over a full spectrum frequency range (also called a "chirp pulse"). The tapered waveform spectrum results in images that have virtually constant resolution with depth. The sub-bottom profiler was operated at a frequency of 0.7-12 kilohertz, 40 percent power, and with a ping rate of 8 hertz during data collection. In the majority of conditions this provides an estimated stratigraphic bed resolution of 3.94 to 11.81 inches (10 to 30 centimeters). The data were collected and recorded in the systems native, EdgeTech.jsf and standard exchange (SEG-Y) format. APTIM scientists monitored the data continuously in order to ensure the highest quality data is being collected. Additionally, APTIM adjusted the survey speed to provide optimal data collection and maintain a speed around 4 knots. Navigation and horizontal positioning for the sub-bottom system were provided by the POS MV system via Hypack utilizing the Hypack towfish layback correction.

5.1.2 Geophysical Data Processing Methodology and Initial Interpretation

The results of the geophysical survey (sub-bottom profiler, sidescan sonar, magnetometer) were processed and evaluated to develop the proposed geotechnical sampling plan. Initial geophysical interpretations were made to identify stratigraphic and geomorphic features of interest that have the potential for hosting sedimentary resources and to add to the regional geologic framework. Each proposed geotechnical sample site was cleared for archaeological and sensitive benthic habitat resource assessments by APTIM's Registered Professional Archaeologist and Environmental Protection and Compliance Lead team. A brief summary of the findings of each assessment is included below and for each study areas.

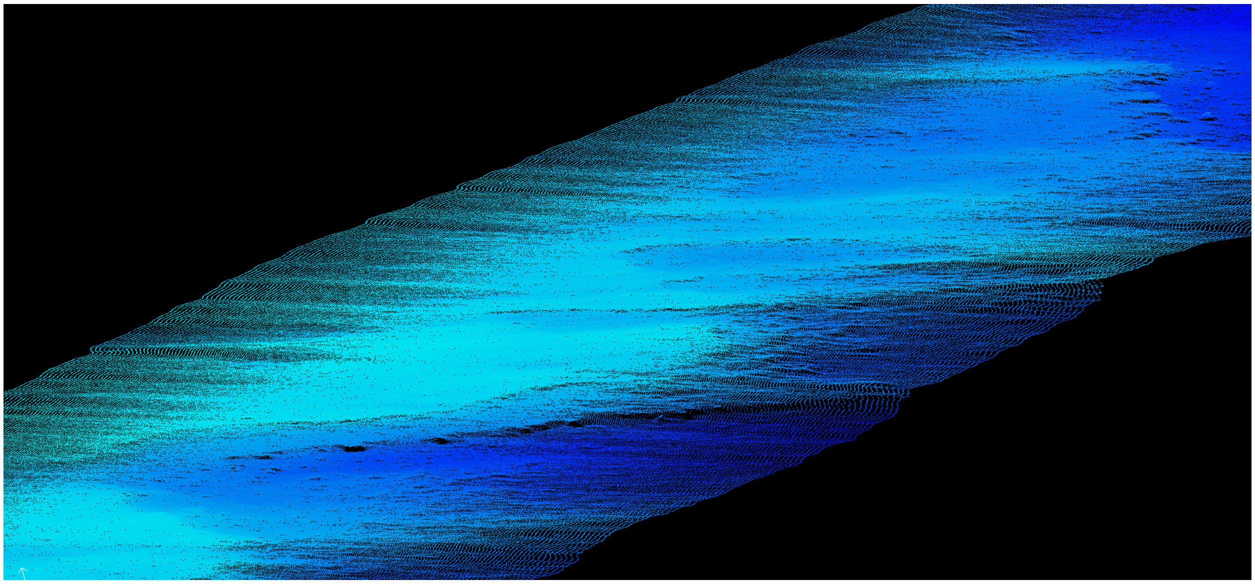
5.1.2.1 Multibeam Bathymetry

The bathymetry data collected were processed using Hypack Hysweep MBMax 64-bit editor. Applanix's POSPac MMS was used for post-processing of attitude and position data. All data were reviewed for errant soundings with the swath limited to 60 degrees on port and starboard to ensure sounding quality. Post-processed attitude and position data were exported from POSPac MMS as a smoothed best estimate trajectory 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 GEOID18. All data were saved as Hypack.HS2X files. The xyz data were sorted at 5 feet (1.5 meters) to create raster elevation files in the format of .tif. The sorted xyz files were loaded into ArcGIS Pro and the Topo to Raster tool was used to create gridded 10 feet (3.0 meters) cell raster elevation data (presented in Appendix B Map 2a-2c). These data were saved as .tif files. Two-foot (0.61 meters) contours were created from the elevation .tif files using the contour tool in ArcGIS Pro. Data are provided as ASCII XYZ including total propagated uncertainty (TPU) values in Appendix E. Raw Hypack files are provided in Appendix F, edited Hypack files are provided in Appendix E and sound velocity profiles are provided in Appendix G. Gridded raster surfaces are submitted in Appendix H.

Multibeam data were processed by APTIM staff and exported for the creation of contours as well as raster grids. Data were analyzed for TPU, total vertical uncertainty, and total horizontal uncertainty to ensure that all data met International Hydrographic Organization 1b criteria using Hypack's TPU editor as well as manual calculations of uncertainty thresholds. All data remained within order 1b standards. ASCII files and gridded results are presented with the MMIS geodatabase (Appendix H). Raster grids were used to perform the calculations across the entire swath of soundings. A cell size of 10 feet (3.0 meters) was used to create all raster surfaces. The difference between the two raster surfaces were presented as a surface where statistics could be calculated on a regional basis using the Raster Calculator tool within geographic information system (GIS). Post-processed ellipsoidal heights are negatively affected by long baselines from the vessel to the Continuously Operating Reference Stations used for the final solution and would contribute to the vertical discrepancies present. Other contributing factors include dynamic draft, sea condition, and the presence of strong and varying thermoclines.

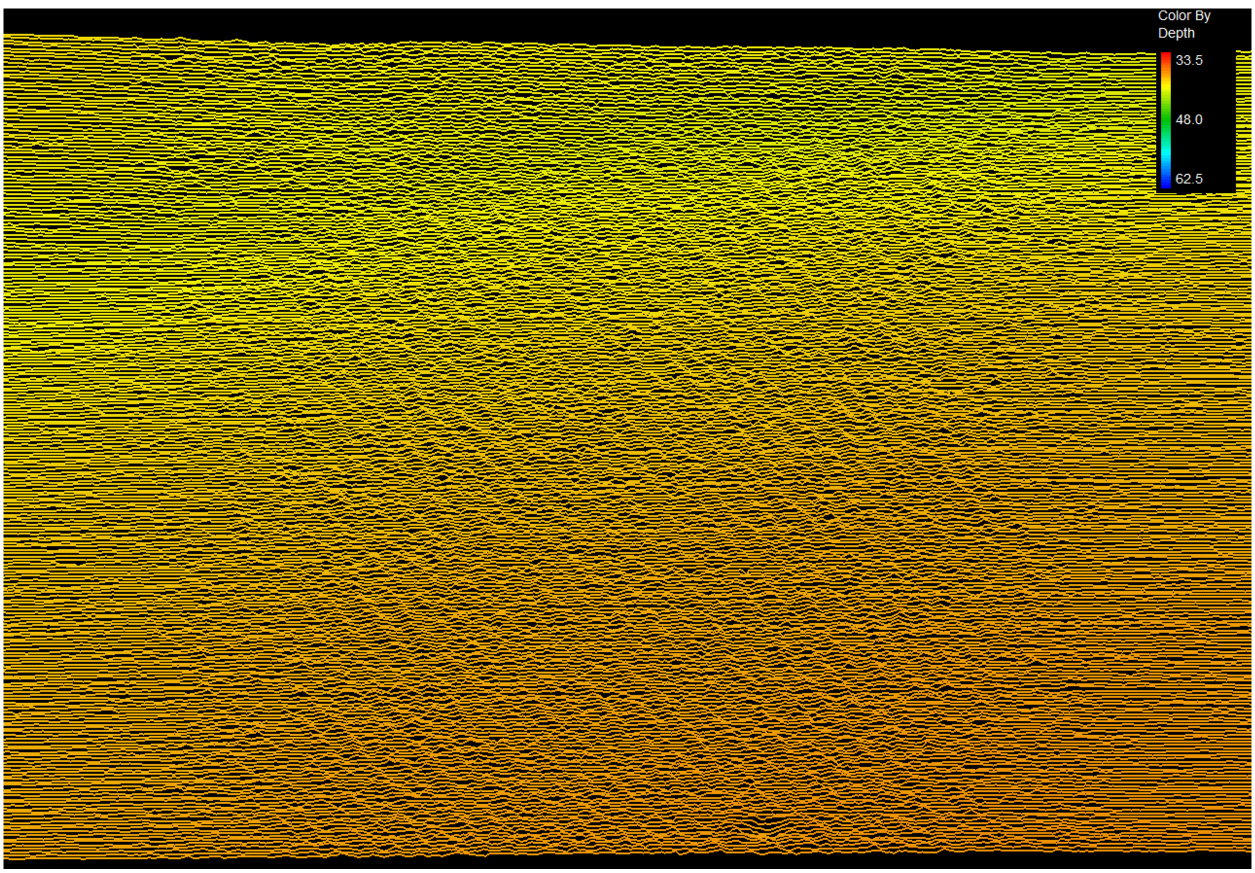
The T-50 MBES soundings were compared with side scan sonar data for feature verification and positioning. MBES soundings were able to capture depth and relief of the sea floor with high resolution to capture both potential ephemeral hardbottom features, sand ripples/waves, and other targets. An example of a high resolution MBES color model matrix at 0.5 feet (0.15 meters) cell size capturing a distinct escarpment adjacent to sand waves is presented in Figure 21 below.

Figure 21: MBES imaged escarpment and sand waves



In addition to color model matrices, Hysweep MBMax has multiple viewing options including individual sounding sweeps. This allows the user to identify errant soundings as well as bottom features. An example of MBMAX sweep window showing sand waves in *color wiggle* display is shown below in Figure 22.

Figure 22: MBES sweep window showing sand waves



5.1.2.2 Magnetometer

Magnetic field data were processed and reviewed using Hypack and Chesapeake Technologies, Inc. SonarWiz 7 software. Those data were then corrected for navigation and/or sensor errors. Errant magnetic field readings were smoothed with manual corrections such as de-spiking to improve signal quality and coherence. Additionally, edits to the towfish layback may occur, if necessary. Raw and residual magnetic fields were then interpolated and analyzed to mark the most accurate representation of magnetic anomalies along each survey trackline. When marking anomalies, attributes such as amplitude, duration, and magnetic signature were measured and determined. All magnetic anomalies and their associated attributes were then exported from Hypack and plotted in Esri's ArcGIS Pro for further analyses. All anomalies were examined in conjunction with other geophysical data products. The collective datasets were evaluated holistically while considering their spatial distribution and proximity to one another or other known features (e.g., sidescan sonar contacts, sub-bottom features of interest, or artificial reefs) to aid in interpretation and the determination of the source of anomalies, their potential relationship to their surroundings, and/or their potential archaeological significance. While reconnaissance-level survey investigations produce valuable data products, it is recommended that a close-order survey using a tighter line-spacing interval be conducted to better refine the magnetic field and the anomalies present within the survey areas. Maps with identified magnetic anomalies are presented in Appendix B Map 3a-3d and provided digitally in Appendix H.

5.1.2.3 Sidescan Sonar

Sidescan sonar data were processed using Chesapeake Technologies, Inc. SonarWiz 7 software. The raw sidescan sonar data were imported into SonarWiz 7 and then bottom tracked to remove the water column (nadir) recorded. Bottom tracking was achieved by applying an automated bottom tracking routine that determined the first return signal in the data and provided an accurate baseline representation of the seafloor that eliminated the water column from the data. In some cases, manual bottom tracking was necessary when the automated bottom tracking could not accurately determine the first return in the sidescan sonar record. For these cases, the processor manually determined the first return in the data.

An empirical gain normalization table was built including all of the sidescan sonar data files. Once the table was built, it was applied to all of the sidescan sonar data. Empirical gain normalization (EGN) is a new gain function that works extremely well in most situations and can be considered a replacement for Beam Angle Correction. EGN is a function that averages all of the sonar amplitudes in all pings in a set of sonar files by altitude and range. The amplitude values are summed and averaged by transducer (port and starboard) to produce two tables. A given sonar amplitude sample is placed in a grid location based on the geometry of the ping. On the x-axis of the grid is range, and on the y-axis of the grid is altitude. The resulting table is used to work out the beam pattern of a sonar by empirically looking at millions of samples of data.

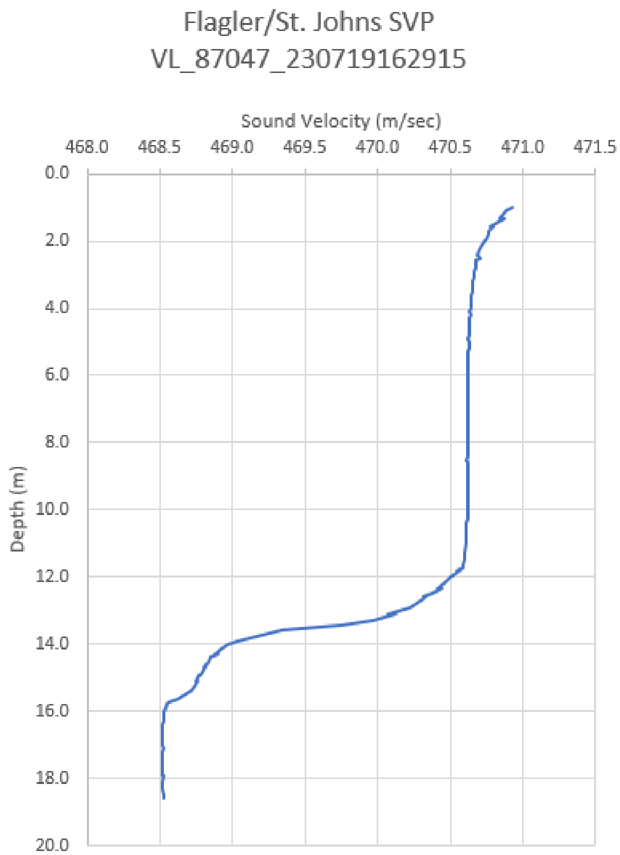
Due to the sea state and water quality conditions (thermocline) observed in portions of the survey area, a small percentage of the sidescan sonar lines contain reduced data quality, resulting in noise and striping. To try and aid in rectifying the noisy data, the Nadir Filter setting, and a De-Stripe Filter setting were utilized on those files with reduced data quality. The Nadir Filter is a special version of the automatic gain control (AGC) filter that runs only along the nadir stripe. It is designed to reduce the difference between the nadir pixel values and the values immediately outside the nadir. The De-Stripe Filter can be used to reduce the effects of a 'pitching' sonar that is characterized by a stripy pattern perpendicular to the direction of travel. This setting processes each ping by comparing the current ping brightness to a filtered version of the sonar file that has smoothed out the stripes.

After processing each line, the data were inspected and interpreted for areas of potential seafloor hazards, geomorphic features, as well as other features of interest. Each potential area of interest on a line was digitized or highlighted and a shapefile was created for that particular bottom type. While APTIM geologists utilized the backscatter intensity, distribution, and texture to make best professional interpretations regarding the interpretation of features. Further ground-truthing is recommended for confirmation of acoustic interpretation.

The widely spaced survey lines collected throughout the survey area covering the different regions were collected with the EdgeTech 4200 towfish, which provided a limited image of the seafloor. The maximum range of the system was 755 feet (230 meters) on each side, or 1,508 feet (460 meters) swath, which was insufficient to allow for full seafloor coverage or interpretation between lines given the reconnaissance-level line spacing of the survey. Therefore, the digitized features were "isolated" to individual lines but provided a general location and description of areas/features of interest. Interpreted maps with digitized features delineated from the sidescan sonar data can be found in Appendix B Maps 3a–3d. Identified sidescan sonar targets with magnetometer anomalies can be found in Appendix B Maps 4a–4d. The sidescan sonar targets are also included within a contact report in order to highlight specific imagery, size characteristics, and location information of specific targets and can be found in Appendix I. Low and high frequency sidescan sonar Sonarwiz project are submitted in Appendix J.

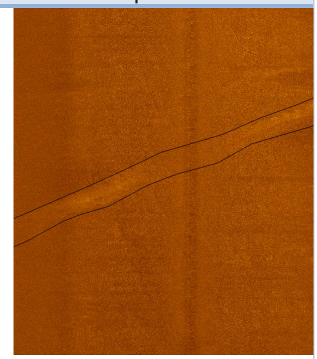
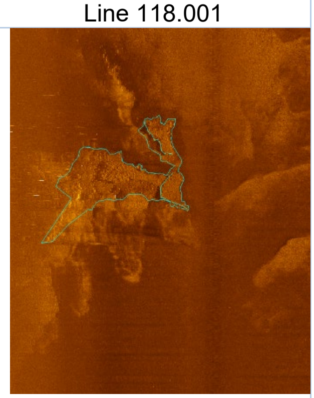
Throughout the geophysical data collection phase, a significant thermocline was observed sporadically throughout all three survey regions (shown in Appendix B Map 3a-3d). APTIM made several attempts to increase the data quality and mitigate the negative effects of the thermocline to the data by placing the towfish below the thermocline, however the drastic changes in sound velocity in the water column proved to be a challenge in some areas. As an example, Flagler/St. Johns SVP VL_87047_230719162915 (Figure 23) recorded a drastic thermocline affecting sound velocity. This profile recorded a steep change in sound velocity between 40 and 46 feet (12 to 14 meters), decreasing from 1,544 feet per second to 1,538 feet per second (470 meters per second to 468 meters per second). The observed thermocline ranged between 13 and 20 feet (4 and 6 meters) above the seafloor, and by placing the towfish below the point where the temperature and sound velocity changed, would cause the towfish to not be compliant with BOEM towing specifications, which require the system to be towed at an altitude equal to 10 to 20 percent the range of the sidescan. The EdgeTech 4200's range in the low frequency is 754.59 feet (230 meters); therefore, the towing altitude would be 75 to 150 feet (23 to 46 meters), while the high frequency range is 393.7 feet (120 meters), with a towing altitude of 40 to 79 feet (12 to 24 meters). APTIM made every attempt possible to balance both the negative impacts of the thermocline while also ensuring that the sidescan sonar data were collected within the required specifications; however, in some instances, the quality of the data was impacted by either the thermocline or proximity of the system to the seafloor.

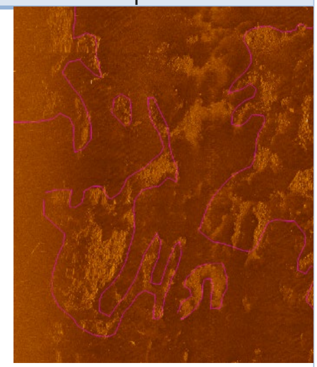
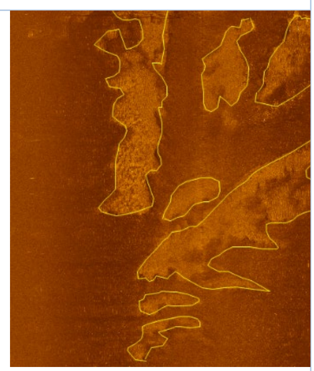
Figure 23: Flagler/St. Johns Counties SVP VL_87047_230719162915

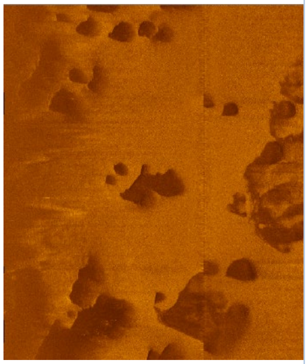
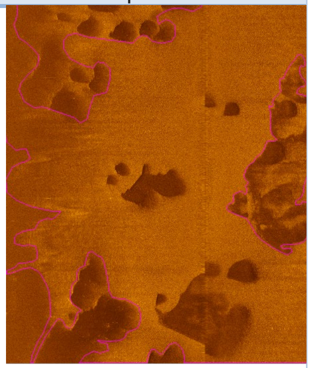
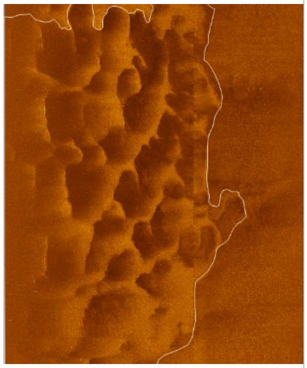


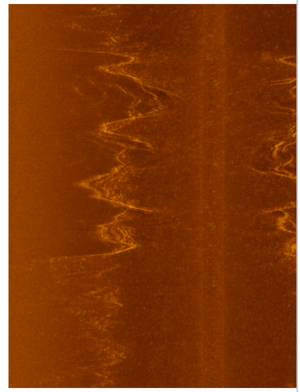
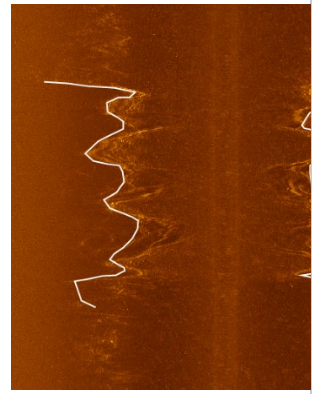
Based on the sidescan sonar interpretations, 78 contacts or targets were identified throughout the survey area. As presented in Appendix I, contacts and targets include unknown features, dolphins, sand waves, fishing associated features (anchor marks), and artificial reefs. The sidescan sonar data identified eight different bottom texture types that have been boat wake, unknown texture, hardbottom ledge, patchy hardbottom, sand, sand ripple patches, sand ripples, sand patches, and hardbottom, which are displayed in Table 3 below. Table 3 also includes an example of the effects the thermocline induces in the sidescan sonar data.

Table 3: Sidescan sonar textures
Sidescan sonar examples are from the low frequency (460 kilohertz) data collected and depict a 754.6 feet (230 meters) swath.

Bottom Feature	Description	Example	Example with Interpretation
Boat Wake	Backscatter features indicate acoustic interference from vessels.	 Line 114	 Line 114
Unknown Texture	Backscatter features areas that are observed to be prominent and minimal while unrecognized.	 Line 118.001	 Line 118.001
Hardbottom Ledge	Backscatter features indicative of small to medium course sediments observed to be in localized areas of data.	 Line 106.002	 Line 106.002

Bottom Feature	Description	Example	Example with Interpretation
Patchy Hardbottom	Backscatter features indicative of small to medium course sediments observed to be in localized areas of data.	 Line 115	 Line 115
Sand	Backscatter features indicative of medium to coarse sediments that appear to be continuous or cover a majority of the digitized area with definitive boundaries.	 Line 103	 Line 103
Sand Ripple Patches	Backscatter features indicative of medium to coarse sediments that appear to cover small parts of digitized data with definitive boarders.	 Line 137	 Line 137

Bottom Feature	Description	Example	Example with Interpretation
Sand Ripples	Backscatter features indicative of medium to coarse sediments with visible waves that appear to be continuous or cover a majority of the digitized area with definitive boundaries.	 Line 108.001	 Line 108.001
Sand Patches	Backscatter features indicative of substantial amounts of sediment coverage with consistent boundaries.	 Line 103	 Line 103
Hardbottom	High confidence areas or rock outcrops on the seafloor that appear to be continuous or cover a majority of the digitized area with definitive boundaries. High confidence is based on these features having definitive boundaries, having a signature indicative of very coarse material, and exhibiting a rugged surface.	 Line 105	 Line 105

Bottom Feature	Description	Example	Example with Interpretation
Thermocline	Acoustic interference in the form of worm-shaped high intensity reflectors observed in the outer extents of the data swath.	 Line 139	 Line 139

5.1.2.4 Sub-Bottom Profiler

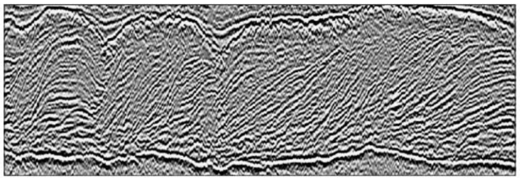
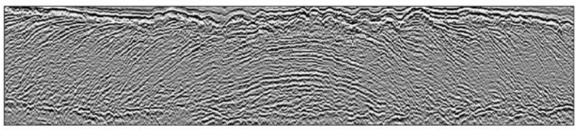
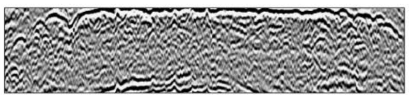
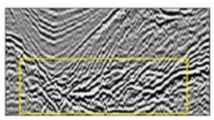
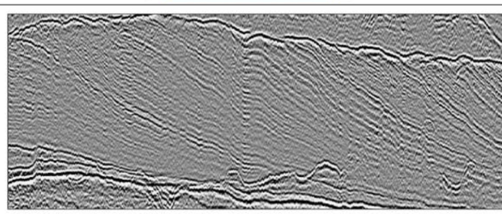
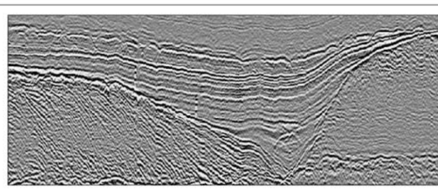
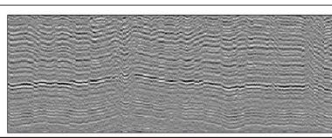
Post-collection processing of the envelope sub-bottom data was completed using Chesapeake Technology, Inc.'s SonarWiz 7 software. This software allows the user to apply specific gains and settings in order to produce enhanced sub-bottom imagery that were interpreted and digitized for specific stratigraphic facies relevant to the project goals.

The first data processing step was to calculate the approximate depth of the reflector below the sound source by converting the two-way travel time (the time in milliseconds that it takes for the "chirp pulse" to leave the source, hit the reflector and return to the source) to feet by utilizing an approximate value for the speed of sound through both the water and underlying geology. For this survey, a detailed hydrographic and geologic sound velocity structure was not available, so APTIM geophysicists used an estimated sound velocity of 5.2 feet per millisecond (1.6 meters per millisecond) to convert two-way travel time to feet. This estimate of the composite sound velocity is based on several assumptions including the speed of sound through water which is typically 4.9 feet per millisecond (1.5 meters per millisecond) as well as on the speed of sound through the sediment which can vary from 5.2 feet per millisecond (1.6 meters per millisecond) for unconsolidated sediment to 5.6 feet per millisecond (>1.7 meters per millisecond) for limestone. APTIM then processed the imagery to reduce noise effects (commonly due to the vessel, sea state, or other natural and anthropogenic phenomenon) and enhance stratigraphy. This was done using the processing features available in SonarWiz; AGC, swell filter, and a User-Defined Gain Control (UGC). The SonarWiz AGC is similar to the Discover-SB® AGC feature, where the data are normalized in order to remove the extreme high and low returns, while enhancing the contrast of the middle returns. In order to appropriately apply the swell filter and UGC functions, the sub-bottom data were bottom tracked to produce an accurate baseline representation of the seafloor. Once this was done, through a process of automatic bottom tracking (based on the high-amplitude signal associated with the seafloor) and manual digitization, the swell filter and UGC were applied to the data. The swell filter is based on a ping averaging function that removes vertical changes in the data due to towfish movement caused by the sea state. The swell filter was increased or decreased depending on the period and frequency of the sea surface wave conditions; however, special care was taken during this phase to not remove, or smooth over geologic features that are masked by the sea state noise. The final step was to apply the UGC. The SonarWiz UGC feature allows the user to define amplitude gains based on either the depth below the source, or the depth below the seafloor. For this survey, the UGC was adjusted so that the gain would increase with depth below the imaged seafloor (and not the source), mimicking a Time Varying Gain. The user was able to remove the noise within the water column, increase the contrast within the stratigraphy, and increase the amplitude of the stratigraphy with depth, accounting for some of the signal attenuation normally associated with sound penetration over time. A blank water column function was also applied to eliminate any features such as schools of fish under the chirp system which produce reflected artifacts within the water column.

Bottom tracked chirp sub-bottom profile lines were opened in SonarWiz to digitally display the recorded subsurface stratigraphy. Using the software's Sonar File Manager, color-coded vibracore descriptions were added directly to the chirp sub-bottom profiles following the color scheme outlined below. Using the color-coded vibracore descriptions as a guide, the chirp sub-bottom stratigraphy was interpreted and the stratigraphic reflector that best correlated to the bottom of the sand layer was digitized within SonarWiz to create a color-coded boundary. These boundaries appear on the subsequent chirp sub-bottom imagery to allow for an easy, visual reference for the boundary representing the bottom of the sand unit. In areas lacking geotechnical data, the digitization was conducted utilizing the intersection feature within SonarWiz and cross-referencing lines to trace the bottom of sand unit. Additionally historic vibracores were also color-coded and plotted onto the seismic data to assist with the delineation of the sand unit when necessary. This boundary was used within SonarWiz to compute the thickness of the available sand by calculating the distance between the digitized seafloor and the bottom of digitized sand unit.

Interpretations of processed sub-bottom profiler data were used to identify significant seismic reflection horizons that serve as the boundaries for different seismic facies packages even in the absence of supporting vibracore analysis. Horizons can represent unconformities such as the basal scour surface of an incising fluvial channel, the gradational change in lithology arising from environmental change such as estuarine flooding, or more detailed internal stratigraphic architecture such as the presence of clinoforms, lap surfaces, or other geometric signatures that can be used to hypothesize depositional environment and help predict lithologic composition without additional geologic ground truth (Reijenstein et al., 2011; Figure 24). These principles were used to interpret the processed sub-bottom profiler data to help develop regional conceptual models, such as the spatial extent of paleovalleys and mapping the occurrence of shallow basement stratigraphy.

Figure 24: Example classification scheme for sub-bottom profiler data based on seismic geometry and acoustic facies (modified from Reijenstein et al. [2011])

2-D Seismic Facies	Reflection Character / Sedimentologic Interpretation
	**Convex-up lateral accretion surfaces. High-amplitude inclined seismic facies** Point-bar lateral accretion surfaces as seen in a dip-view cross section; Convex-up geometry with downdip increase in slope: 0.49° to 0.62° (point-bar tops) and 0.48° to 3.74° (basal point bar).
	**Convex-up bidirectional downlap; High-amplitude inclined seismic facies** Point-bar lateral accretion surfaces as seen in a strike-view cross section
	**Low-amplitude chaotic seismic facies** Reworked point-bar top deposits
	**High-amplitude channel lag seismic facies** Basal coarse-grained channel lag
	**Concave-up clinoforms; Low-amplitude inclined seismic facies** Clinoform deltaic mouth bar deposits; Concave-up geometry with downdip decrease in slope: 1.76° to 2.04° (clinoform tops) and 0.37° to 0.91° (basal section)
	**High-amplitude, confined, laterally continuous reflections; Seismic terminations onlap against valley walls** Early transgressive estuarine muddy facies
	**Low-amplitude (transparent), laterally continuous seismic facies** Open marine muddy facies

Moreover, as part of the seismic data interpretation process, APTIM plotted the sidescan interpretations onto the seismic project to assist in the delineation of additional features. The ubiquitous presence of hardbottom on the Florida east coast has been previously documented, and it is most commonly interpreted as a surface feature. However, by corroborating the seismic with the sidescan data, it is possible to trace the surficial exposed unit throughout the investigation regions.

5.1.2.4.1 Seismic Feature Delineation and Interpretation

The delineation and interpretation of the consolidated sediments, paleochannels and depositional packages in each of the study areas were conducted by utilizing both the vibracores as well as interpretations from the sidescan sonar data. Most of the sub-surface features identified in these regions are large paleochannels and outcropping ancient, lithified strata bounded by either chaotic/semi-transparent acoustic facies or laminated variable amplitude seismic facies. Throughout the study areas, features indicative of outcropping strata, which lacked surficial expression, corroborating sidescan sonar data, and/or full acoustic impedance were digitized as consolidated sediments. This unit is a layer that is variable in its properties and "level" of acoustic impedance and seismic signal attenuation. Along track seismic digitizations are presented in Appendix B Map 5a-5c, seismic data interpretations are included as a digital web project (Appendix K). SonarWiz project is included in the digital Appendix L. Raw .segys are submitted in Appendix F, processed .segys and exported ascii files are in Appendix E.

5.1.2.5 Marine Archaeological Assessment

Prior to the collection of vibracores, APTIM's qualified marine archaeologist evaluated the collected geophysical data, in conjunction with information gathered as part of the literature review, desktop study, and background research, to ensure that no potential submerged cultural resources would be adversely impacted during coring activities. This was accomplished by clearing each proposed vibracore location using an archaeological clearance buffer (a circular buffer with a 164.05 feet [50 meters] radius) to ensure no significant magnetic anomalies, sidescan sonar contacts, or sub-bottom features of interest are within a site's area of potential effect.

The report included maps with as-run tracklines, proposed vibracore sites and their clearance buffers, magnetic anomalies, sidescan sonar contacts, sidescan mosaics, and bathymetric contours. Chirp sub-bottom profile images were also provided for each core location to ensure that no potentially significant paleolandforms or subsurface features of interest, would be adversely impacted during operations. The report also included a table with all identified magnetic anomalies and their characteristics, such as amplitude, duration, and magnetic signature, associated features identified in the sidescan sonar or chirp sub-bottom data, and an anomaly interpretation/assessment. Additionally, a sidescan sonar contact report was provided as part of the report including a description of the contact size, characteristics, attributes, interpretation, and assessment. A summary table with avoidance requirements and mitigation measures following the environmental protection compliance plan was also included. A digital appendix with shapefiles for all identified contacts, anomalies, and features near proposed sampling sites with their associated attributes was included as part of the geological sampling plan.

5.1.2.6 Sensitive Benthic Habitat Resources Assessment

An analysis of sensitive benthic habitats was conducted by APTIM as part of the geophysical data processing. The results of the habitat assessment consisted of maps showing identified features (with labels), habitat boundaries, avoidance buffers, proposed vibracore locations, and bathymetric contours submitted as part of the geological sampling plan.

5.1.2.7 Geotechnical Planning

Geotechnical planning for Nassau, Duval, Flagler, St. Johns, Brevard Counties and Sebastian Inlet are explained below.

5.1.2.7.1 Nassau and Duval Counties

BOEM identified three strategic questions for the Nassau/Duval Counties focus area:

1. What is the composition, quality, and extent of any potential resources identified?
2. Based on the resulting data collection, should any areas be recommended for further investigation by design-level survey or eliminated from further consideration?
3. What is the geologic origin and evolution of the resource deposits identified?

Additionally, a series of focused targets were identified by BOEM and during the stakeholder engagement process, the details of which are below. Initial analysis of the geophysical survey results were used to identify priority geological sampling locations that addressed the regional strategic questions and BOEM/stakeholder needs.

The Nassau County region (Figure 25) exhibits numerous distinct stratigraphic and surficial features such a complex network of subsurface paleochannels occasionally overlain by surficial sedimentary units that appear to be composed of high-sand content sediments based on historic core analysis. The analysis of geophysical data collected offshore Nassau County indicates variability in the composition and geotechnical properties of the larger surficial deposits targeted in the region, as well as patterns of thickening and thinning that indicate areas where there are no surficial sedimentary units overlying the transgressive ravinement surface and ancient relict strata (Figure 26). Review of the FGS geophysical data of the region and vibracores collected by the USACE in 2003 show that this region is highly variable with portions of the ridge being characterized as silty sands with pockets of sand, while the multibeam bathymetry data provided by Olsen confirmed the variable nature of these deposits.

Initial interpretation of the collected geophysical data indicated that the presence and depth of the transgressive ravinement is not uniform, and there may occur deposits of relict ancient strata close to the modern seafloor with a potential to preserve such records of coastal evolution, which the proposed geological sampling strategy targeted.

Figure 25: Proposed geologic sites offshore Nassau County

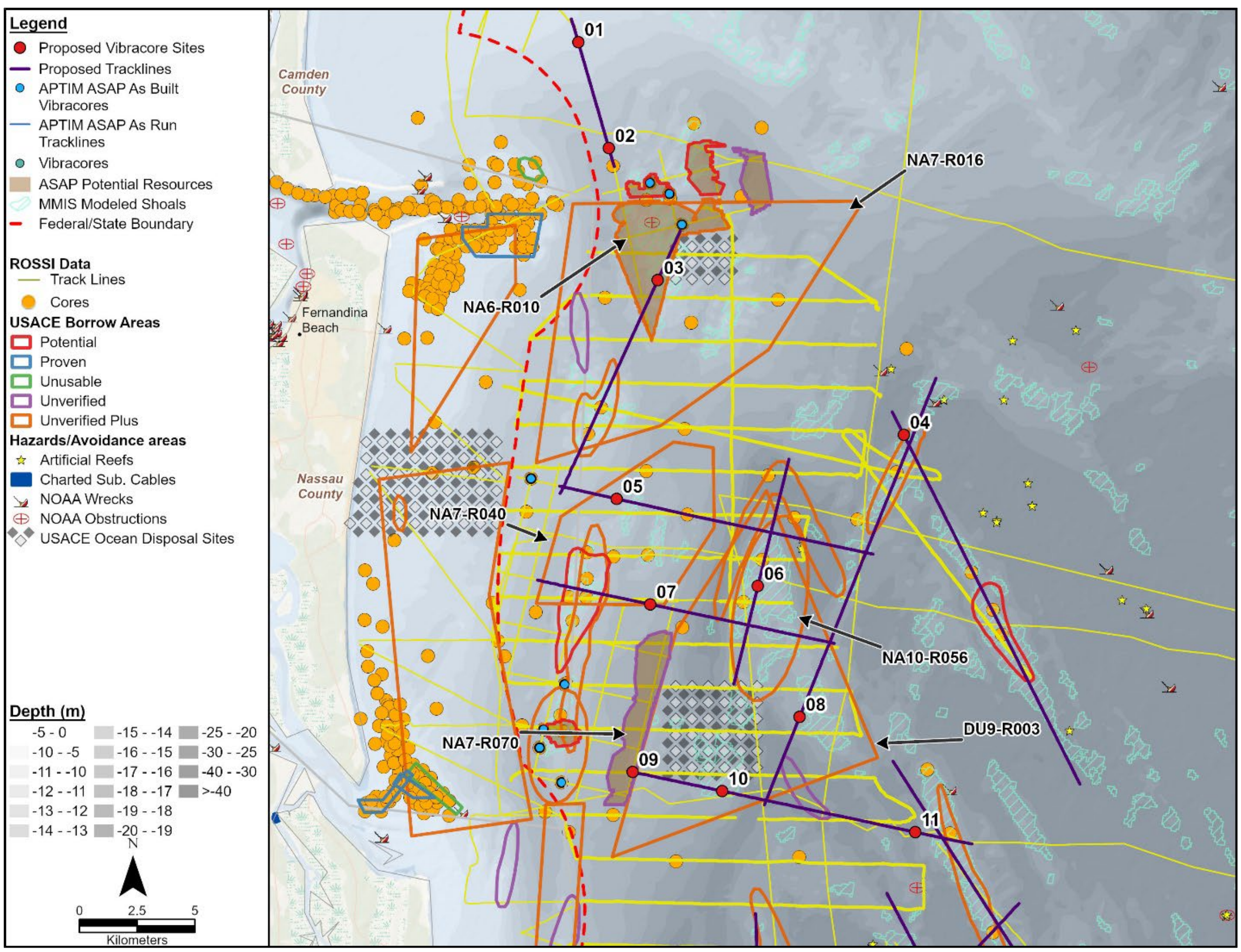
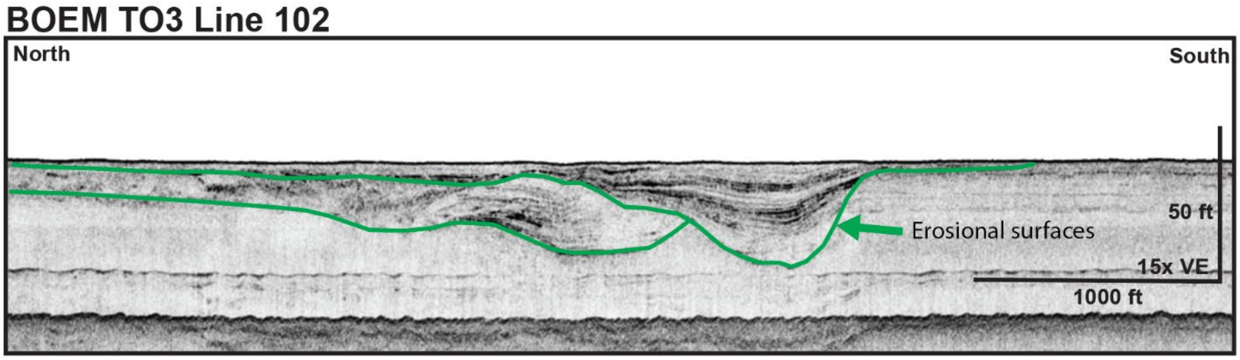


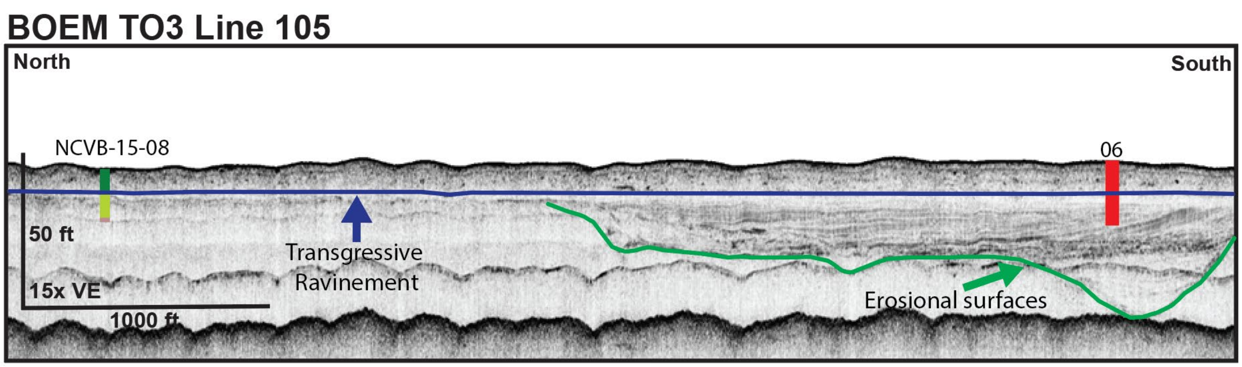
Figure 26: Sub-bottom profile section Line from Line 102 imaging a paleochannel complex outcropping at the seafloor with minimal to no surficial sedimentation present



In the northern portion of the surveyed area, the seismic data indicates the occasional presence of an intermediate acoustically transparent facies seismic unit overlying a sharp unconformity that serves as the primary boundary between the surficial units and the extensive underlying paleochannels found within the area. This observation indicated the potential presence of a thin to moderately thick potential sand-bearing deposit that overlies the subsurface paleochannel features and the more acoustically chaotic surficial units referred to as shoals in prior investigations (Figure 27).

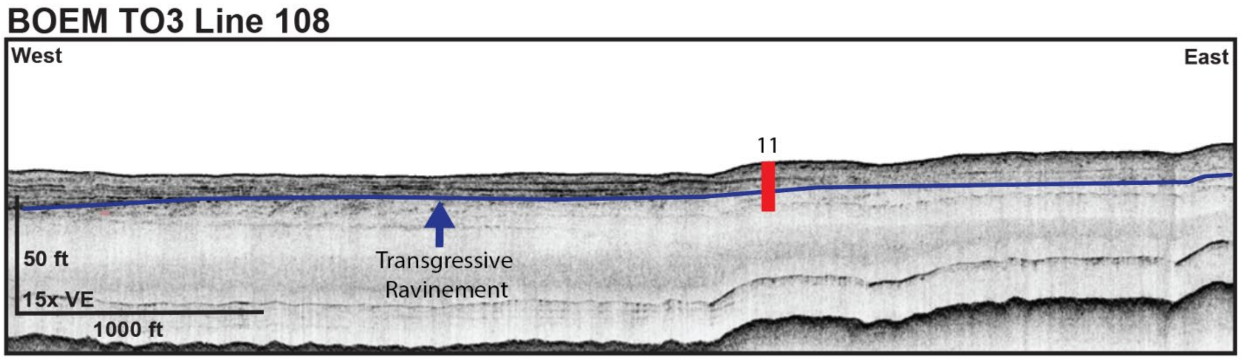
Figure 27: Proposed Vibracore 06 targeting a potential sand layer bounded by a mottled surficial unit and moderate amplitude paleochannel with steeply dipping reflectors

A vibracore (NCVB-15-08) taken in 2015 by Athena Technologies identifies the surficial and the transparent seismic unit as fine sand (displayed in green).



Within the Nassau County region, historic vibracores within the unverified plus borrow areas NA7-R016, NA7-R040, and NA10-R056 highlight an expansive network of sand-rich surficial units, referred to as shoals in prior investigations, which were deposited overtop a network of paleochannels of unknown lithology. Historic vibracores within these previously identified resources targeted the thickest portion of the surficial units, leaving data gaps along the troughs and flanks of these deposits. To further constrain their lateral extent as well as inform understanding of the underlying geologic framework, vibracores in this region were positioned along the flanks of shoals and edges of paleochannels to maximize sampling of the different acoustic facies and seismic units within the area, as illustrated in Figure 28.

Figure 28: Proposed Vibracore 11 targeting the pinch out of a mottled shoal feature and the flank of a near surface paleochannel



Vibracores 01, 02, 05, and 11 have been strategically selected to advance the geologic framework and provide constraints for the historic data. Proposed vibracores 04, 06, and 08 were specifically chosen to validate both the identified shoal type (geotechnical composition and properties) and its lateral extent while vibracores 03, 07, 09, and 10 were selected in order to augment understanding of the geotechnical properties of unverified plus borrow areas NA6-R010, DU9-R003, NA7-R040 and unverified borrow area NA7-R070 identified by USACE. A comprehensive description of the vibracores can be found in Table 4, and their spatial distribution is shown in Figure 25.

The seismic data interpretation within the Duval region (Figure 29) shows acoustically opaque shoals primarily composed of fine to moderately coarse sand bodies as indicated by the historic vibracores in the region. These shoals exhibit an average height ranging from 7 to 18 feet (2.1-5.5 meters) thick and are frequently positioned above extensive, low amplitude paleochannel fill. Notably, certain areas display steeply dipping reflectors along the flanks of the paleochannels, as well as low amplitude prograding surfaces with less than 10 feet (3 meters) of overburden (Figure 30). The vibracores in these areas hold the potential to yield valuable insights into the underlying geologic framework of the region and constrain the evolution of these deposits.

Figure 29: Proposed geologic sites offshore Duval County

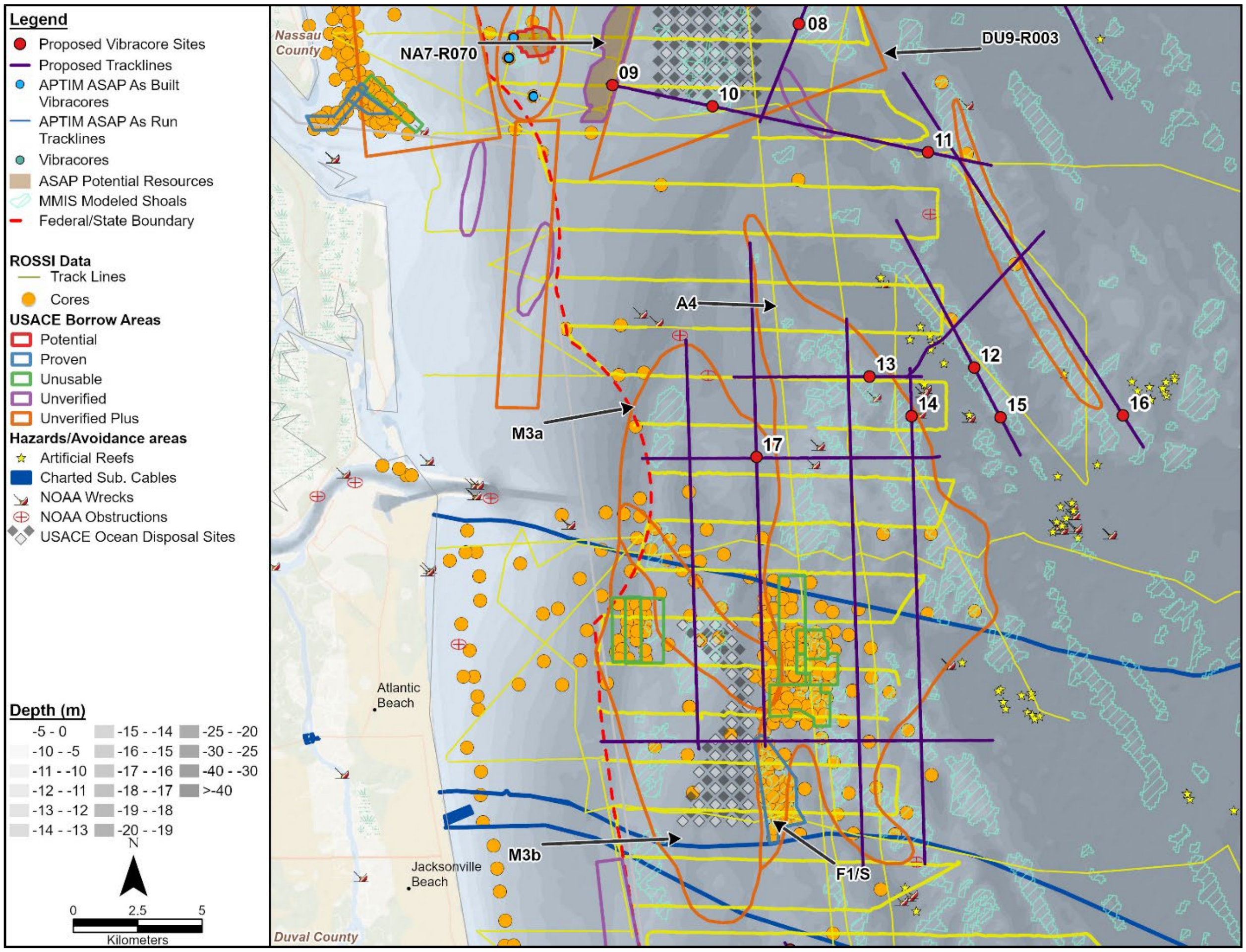
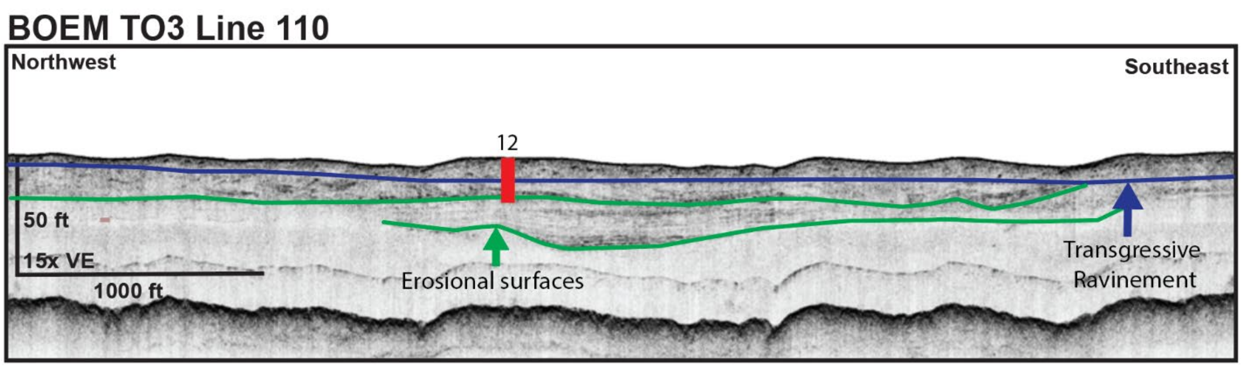


Figure 30: Proposed Vibracore 12 targeting the prograding surface (blue) bounded by a mottled surficial unit and a low amplitude paleochannel fill



The historic vibracores distributed within and in proximity to the unverified plus borrow areas M3a, M3b, A4 offer a limited understanding of the heterogeneous stratigraphy and sediment composition of these deposits. The vibracores in this area were designed to augment the existing historic dataset by targeting the flanks and troughs of the shoals, as well as the peripheries of USACE Borrow Areas to more accurately delineate the boundaries of these borrow areas. Vibracore 12 was selected to advance the geologic framework and provide a better understanding of the prograding seismic unit seen throughout the region while also supplying constraints for historic data. Vibracores 13, 15, and 16 targeted the composition of the shoal and its potential variability in geotechnical properties and will aid APTIM and TWI in answering the strategic questions proposed by BOEM in relation to what the composition, quality and extent of these potential resources are. Simultaneously, vibracores 14 and 17 were designated to validate the presence of unverified plus USACE Borrow Areas (M3a, A4) and provide additional constraints on their boundaries. Targeted facies and resources being sampled with each vibracore are presented in Table 4 and their locations are shown in Figure 29.

Table 4: Proposed geologic vibracores offshore Nassau and Duval Counties. USACE Borrow Areas that the proposed vibracore samples are also provided

Vibracore Number	Final as-built name	Target sediment or layer
01	BOEMVC-2024-FL-01	Mottled surficial sediment unit (10 ft [3 m] thick) overlying unknown transparent package
02	BOEMVC-2024-FL-02	Moderate amplitude near surface paleovalley fill with steeply dipping reflectors
03	BOEMVC-2024-FL-03	Mottled shoal feature over top thin, transparent layer and semi-transparent paleochannel fill. BA: NA6-R010/NA7R016/NA6-R011
04	BOEMVC-2024-FL-04	Thin, mottled crest of shoal (8 ft [2.4 m]) over top transparent surficial unit. BA: A1
05	BOEMVC-2024-FL-05	Thin, mottled surficial sediment unit overtop semi-transparent surficial unit and bounded by potential paleochannel fill with semi-transparent fill and steeply dipping reflectors. BA: NA7-R040
06	BOEMVC-2024-FL-06	Mottled/chaotic shoal facies (10 ft [3 m] thick) overtop thin, transparent surficial unit and potential paleochannel fill. The paleochannel fill consists of hazy semi-transparent fill with steeply dipping reflectors. BA: NA10-R056/DU9-R003
07	BOEMVC-2024-FL-07	Mottled/semi-transparent flat area overlying a high amplitude basal unconformity and chaotic paleochannel fill. BA: NA7-R040
08	BOEMVC-2024-FL-08	Thin, mottled/chaotic shoal crest feature overtop transparent surficial layer. BA: DU9-R003
09	BOEMVC-2024-FL-09	Mottled/semi-transparent flat feature overtop semi-transparent surficial unit. BA: NA7-R070/NA5-R073
10	BOEMVC-2024-FL-10	Mottled/chaotic shoal facies (~ 8 ft thick) (2.4 m) overtop transparent surficial sediment unit and semi-transparent hazy paleovalley fill (20' thick) (6.1m). BA: DU9-R003
11	BOEMVC-2024-FL-11	Chaotic shoal facies (~ 8 ft [2.4 m] thick) with separated by a discontinuity and a thin prograding surface (5 ft [1.5 m] thick) overlying medium amplitude basal unconformity and hazy paleovalley fill (20 ft [6.1 m] thick)
12	BOEMVC-2024-FL-12	Mottled shoal feature overlying a low amplitude flank of paleochannel consisting of semi-transparent medium amplitude fill. A semi-transparent package exists beneath the flank of the paleochannel
13	BOEMVC-2024-FL-13	Thin, chaotic pinch out of shoal feature overlying transparent surficial sediment unit (12 ft [3.6 m] thick) and a low amplitude hazy paleochannel fill. BA: A4
14	BOEMVC-2024-FL-14	Semi-transparent surficial sediment unit (10 ft [3 m] thick) overlying flank of paleovalley fill. Paleovalley fill consists semi opaque (20 ft [6.1 m] thick). BA: A4
15	BOEMVC-2024-FL-15	Mottled/chaotic pinch out of shoal feature
16	BOEMVC-2024-FL-16	Mottled/chaotic and hazy shoal feature overtop low amplitude surficial unit
17	BOEMVC-2024-FL-17	Mottled/chaotic surficial sediment unit overlying thin, prograding surface. BA: M3a

5.1.2.7.2 Flagler and St. Johns Counties

BOEM identified three strategic questions for the Flagler/St. Johns Counties focus area:

1. Do these areas show the potential for sediment resources in excess of 5 feet (1.5 meters)?
2. What are the trends and variability of the sediment among these similar shore-oblique shoal features?

3. What are the seaward extents of some of these more promising deposits?

The results of the initial geophysical analysis informed the selection of proposed geological sampling locations that would aid in addressing these questions as well as providing for focused investigation of specific resource targets identified by BOEM and by local stakeholders.

The analysis of geophysical data in St. Johns County (Figure 31) indicates that the region has variable surficial sediment units that range in thickness from 5 feet (1.5 meters) to over 20 feet (6.1 meters), overlying complex antecedent shelf strata that ranges from acoustically opaque to being composed of significant paleochannel complexes. The surficial units, or shoals, are not homogenous in their internal architecture and acoustic facies, or in their orientation relative to the modern coastline. Previous work has noted the variability of the shoal orientations and the apparent superposition of northeast-southwest trending features on top of larger northwest-southeast shoals, which may indicate different mechanisms and timing of generation (Swift et al., 1975; Hayes and Nairn, 2004; Lobo et al., 2010; Thieler et al., 2014). Prior investigations found highly variable sediments ranging from calcareous sands to poorly sorted silts and gravels, all at apparently similar stratigraphic positions. The relative thickness and composition have been speculated to be related to storm wave erosion of underlying stratigraphy combined with some degree of littoral drift (Meisburger and Duane, 1971). In some locations the stratigraphic architecture of the bathymetric high indicated the high is composed of amalgamated relict strata (Figure 32), while in others the shoal had a transparent to chaotic acoustic facies overlying a reflector that likely corresponded to the transgressive ravinement (Figure 33). Analogous to the facies observed in Nassau County, certain paleochannels exhibited steeply dipping reflectors along their flanks with minimal overburden, while others were filled by low-amplitude, laminated strata.

Figure 31: Proposed geologic sites offshore St. Johns County

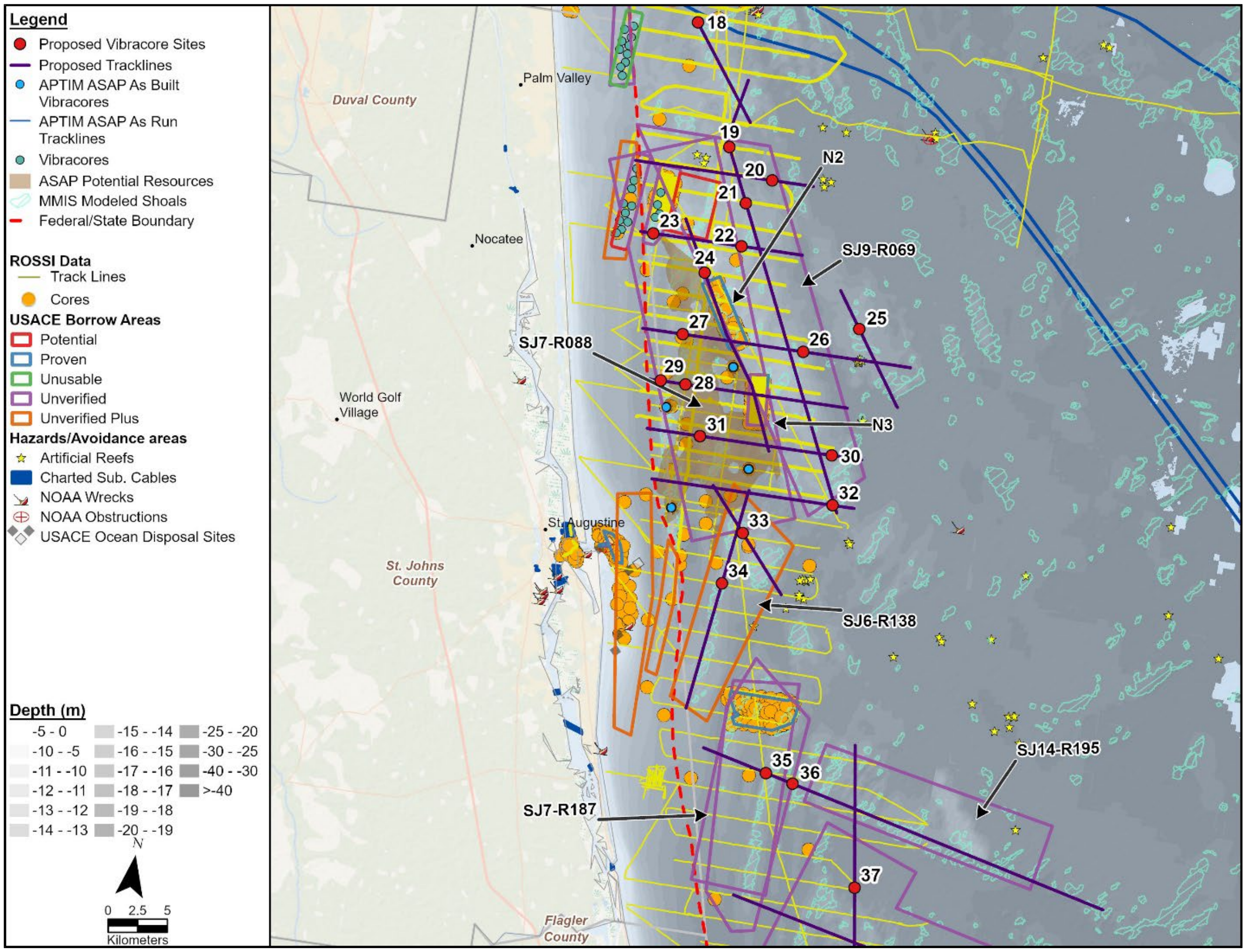


Figure 32: Sub-bottom profile section from Line 124 imaging a complex internal architecture corresponding to a bathymetric high, or shoal

The surficial unit is composed of numerous potential cut-and-fill channel patterns.

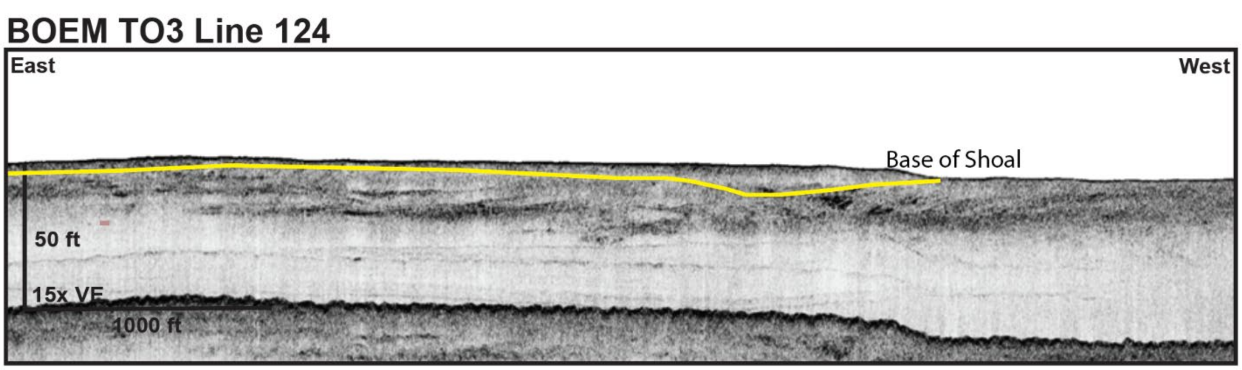
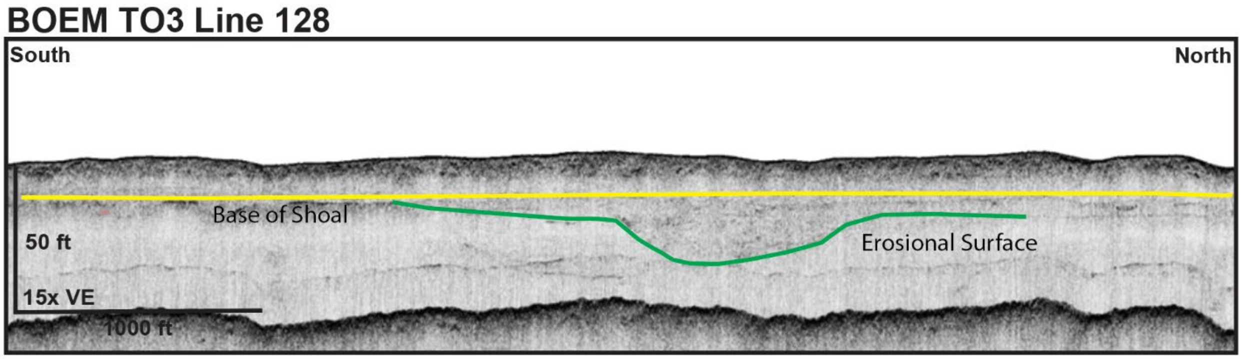


Figure 33: Sub-bottom profile section from Line 128 imaging a shoal with transparent to chaotic acoustic facies overlying a hard high amplitude return



Historic vibracores are limited to the area around the established USACE Borrow Areas N2 and N3, contributing to the delineation and identification of these deposits; however, creating a gap in the historic data coverage elsewhere in St. Johns County. Those data collected as part of the 2015 ASAP project identified the SJ7-R088 resource, which has the potential of being expanded further east. The proposed vibracores in this region aim to validate several USACE unproven borrow areas and refine the current established boundaries of potential borrow areas.

Vibracores 18, 21, 26, 28, and 29 were aimed to advance the geologic framework of the region by targeting specific features and units observed throughout the region, while vibracores 19, 22, 23, 25, 32, and 33 targeted specific shoal features and verified the composition and extent of the deposits and helped answer what the potential resource thickness is for these resources. Vibracores 20, 24, 27, 31, 33, and 34 were selected to verify unproven USACE borrow area SJ9-R069 and unverified plus borrow area SJ6-R138 and further define their boundaries and resource thicknesses. A detailed description of these vibracores is available in Table 5 and shown in Figure 31.

The geophysical data interpretation within the Flagler County region (Figure 34) indicates the presence of a substantial shoal system characterized by mottled and chaotic sediment, situated above an extensive network of large paleochannels. Similar to the region offshore of St. Johns County, these shoals are extensive but not uniform in extent or character, with some regions showing no surficial sedimentary accumulations above the potential transgressive ravinement (Figure 35). These paleochannels exhibit variable thicknesses ranging from 10 feet (3 meters) to greater than 40 feet (12.2 meters). The vibracores target specific geological units, like the flanks of near surface paleochannels or acoustically transparent units, which are traditionally sandy bodies (Figure 36).

Figure 34: Proposed geologic sites offshore Flagler County

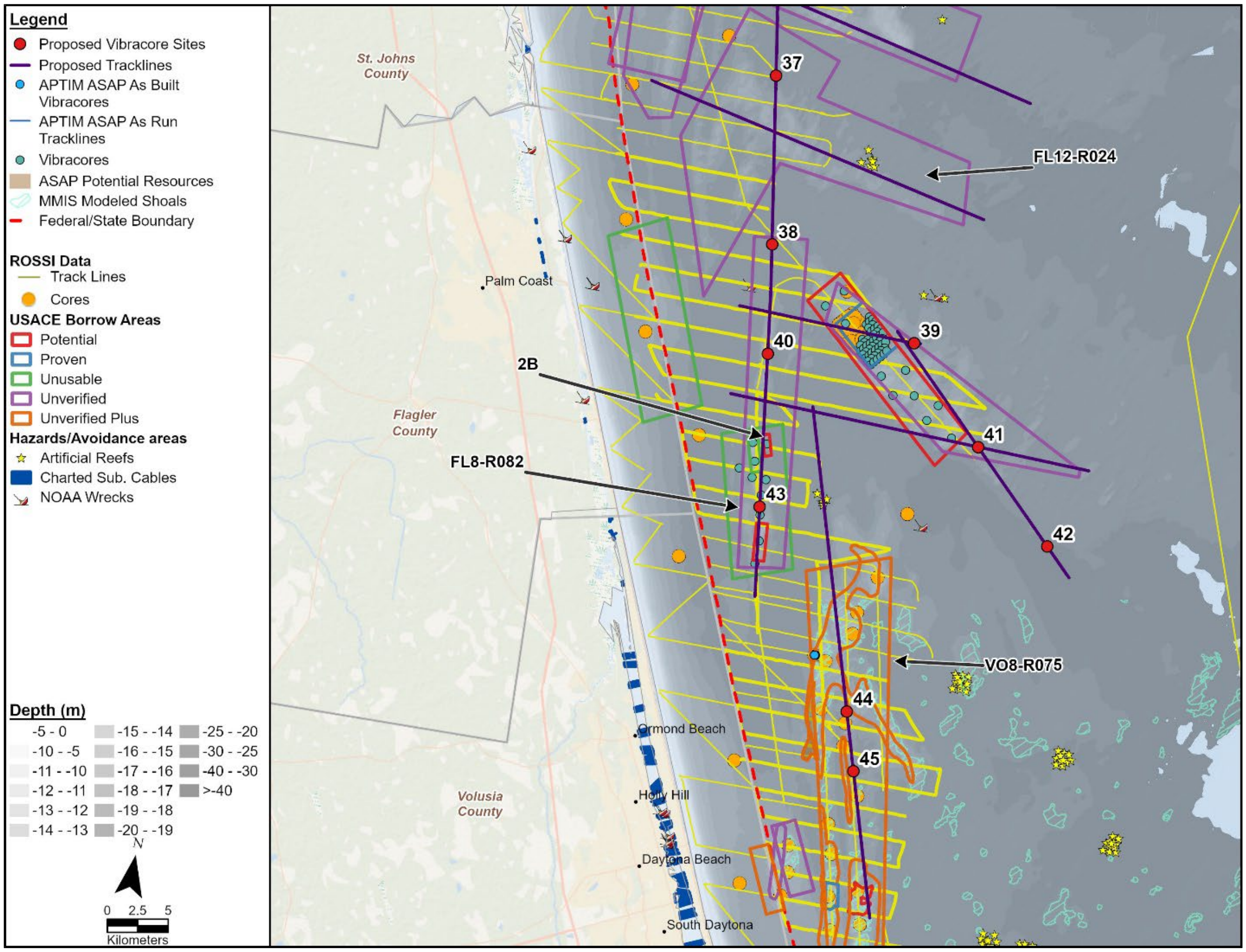


Figure 35: Sub-bottom profile section from line 137 offshore of Flagler County imaging a trough between adjacent shoal complexes and the absence of visible surficial sedimentary accumulations

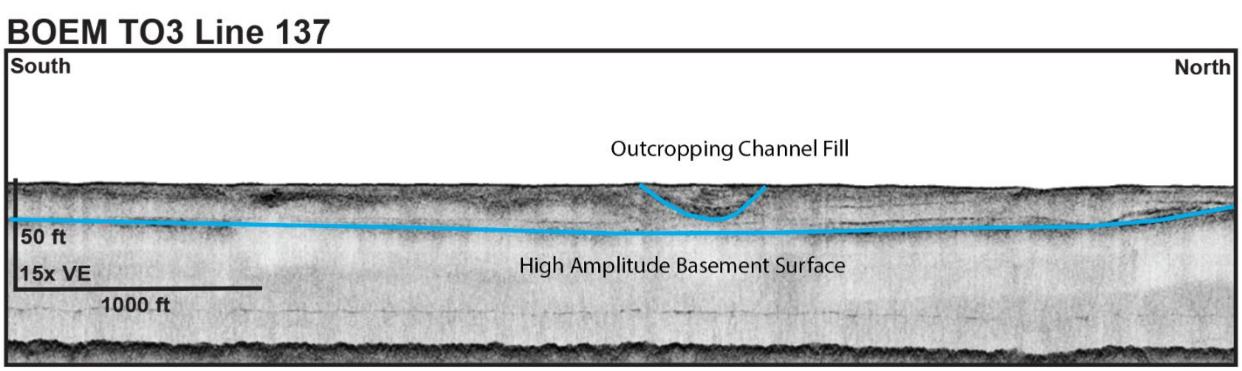
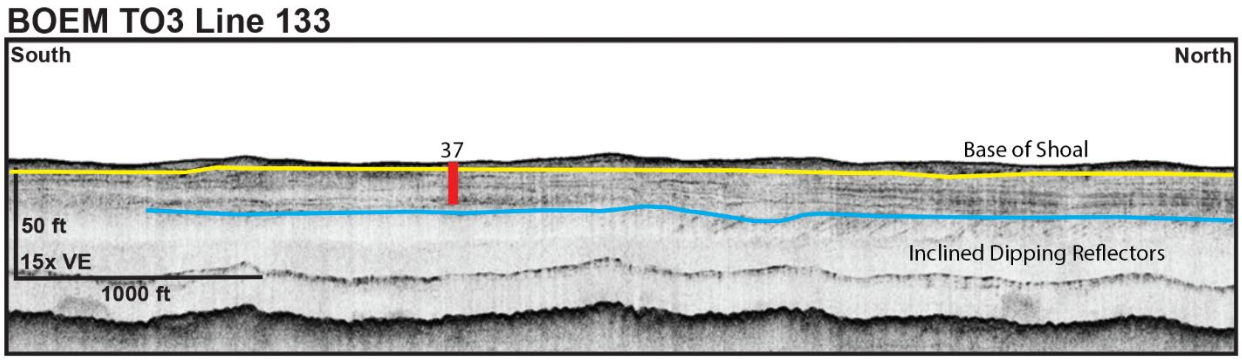


Figure 36: Proposed Vibracore 37 targeting the flank of a paleochannel and an unknown, sandy, transparent layer

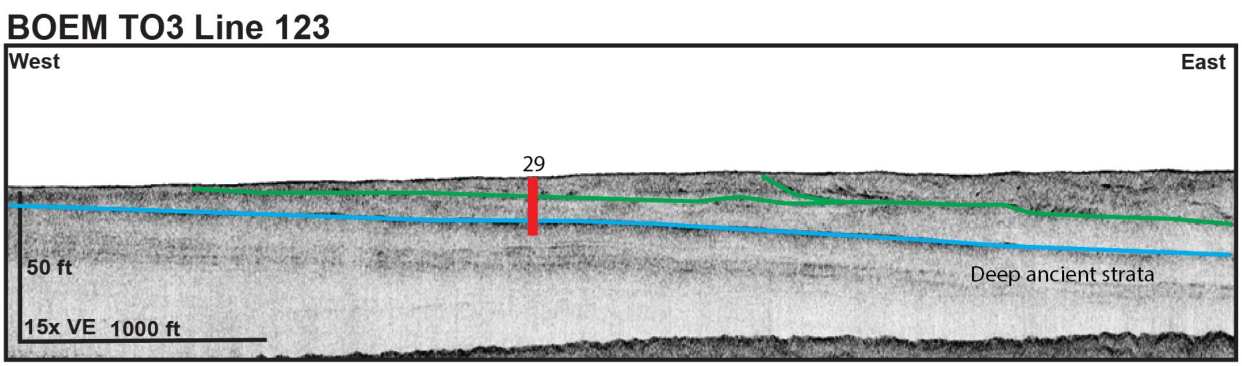
The prograding surface terminates along the bottom of a high amplitude, chaotic unit.



Within this region, a majority of historic vibracores are in the vicinity of unverified borrow area SJ7-R187, as well as unverified plus borrow areas FL8-R082 and VO8-R075 and the proven borrow area FL15-R088 with the remaining geotechnical data sampling individual modeled shoals in the region. Since most of the resources in the region have been sampled, APTIM and TWI focused on targeting areas such as unverified borrow areas SJ14-R195, FL12-R024, and unverified plus borrow area VO8-R075 to further confirm and constrain the deposits and help answer the strategic questions presented by BOEM within the area. These vibracores were strategically positioned along the flanks of paleochannels and within the troughs of sand shoals (Figure 37), aiming to augment the understanding of the historic geology in these areas and characterize trends and variability of these shoal features, as well as their potential seaward extent.

Figure 37: Proposed Vibracore 29 targeting three distinct packages

Flank of a paleochannel overtop a descending surficial unit and a semi-transparent interlayered package.



Vibracores 41 and 45 aimed to provide a better understanding of geologic history and augment the historic data, while proposed vibracores 40, 42, and 43 assisted in further determining shoal composition and extent. Vibracores 35, 36, 37, 38, 39, and 44 targeted specific potential resources and unverified borrow areas, to better constrain their boundaries and available resources. Targeted facies and resources being sampled for each vibracore are provided in Table 5 and their positions are shown in Figure 34.

Table 5: Proposed geologic vibracores offshore Flagler and St. Johns Counties

Vibracore Number	Final as-built name	Target sediment or layer
18	BOEMVC-2024-FL-18	Mottled/chaotic shoal feature (30 ft [9.1 m] thick)
19	BOEMVC-2024-FL-19	Chaotic/semi-transparent infill of material between two shoal features. BA: SJ9-R069
20	BOEMVC-2024-FL-20	Chaotic opaque flat area seaward of shoal feature that could help define unverified borrow area. Low amplitude basal unconformity separating chaotic layer and transparent potential paleochannel infill. BA: SJ9-R069
21	BOEMVC-2024-FL-21	Flank of mottled/chaotic potential paleochannel fill with steeply dipping reflectors (10 ft [3 m] thick) overtop an unknown transparent package (10 ft [3 m] thick). BA: SJ9-R069
22	BOEMVC-2024-FL-22	Thin, mottled semi-transparent shoal facies (8 ft [2.4 m] thick) overlying transparent package and potential paleochannel fill. Paleochannel fill consists of low amplitude, chaotic fill (6 ft [1.8 m] thick).BA: SJ-3/SJ7-R088
23	BOEMVC-2024-FL-23	Chaotic/mottled crest of modeled shoal overtop high amplitude surficial unit blanking geologic packages beneath. BA: SJ9-R069
24	BOEMVC-2024-FL-24	High amplitude mottled shoal feature (15 ft [4.6 m] thick) overtop potential paleochannel fill. Paleochannel fill consists of moderate to low amplitude interlayered sediment. BA: SJ7-R088/SJ9-R069
25	BOEMVC-2024-FL-25	Chaotic/mottled crest of shoal feature
26	BOEMVC-2024-FL-26	Thin, semi-transparent shoal facies (5 ft [1.5 m] thick) overtop strong amplitude, chaotic surficial sediment unit with steeply dipping reflectors (15 ft [4.6 m] thick). BA: SJ7-R088
27	BOEMVC-2024-FL-27	Mottled/chaotic shoal facies (10 ft [3 m] thick) overtop low amplitude hazy sediment unit and high amplitude surficial unit. BA: SJ9-R069
28	BOEMVC-2024-FL-28	High intensity chaotic surficial sediment unit overtop high amplitude descending surficial sediment unit and a semi-transparent interlayered package 3 distinct packages targeted. BA: SJ7-R088
29	BOEMVC-2024-FL-29	Trough between two mottled shoal features where each shoal pinches out. Overtop potential paleochannel fill. Paleochannel fill consists of high intensity interlayered sediment. BA: SJ7-R088
30	BOEMVC-2024-FL-30	Thin, mottled shoal feature (5 ft [1.5 m] thick) over top transparent unknown package (8 ft [2.4] thick) overlying large potential paleochannel fill (40 ft [12.2] thick). The paleochannel fill consists of moderate amplitude, hazy, interlayered sediment with slightly dipping reflectors. BA: SJ7-R088
31	BOEMVC-2024-FL-31	Chaotic/mottled shoal feature semi-transparent infill. BA: SJ9-R069
32	BOEMVC-2024-FL-32	Chaotic/mottled crest of shoal feature
33	BOEMVC-2024-FL-33	Mottled, high intensity shoal feature (10 [3 m] thick) overtop thin, transparent unknown package (7 ft [2.1 m] thick). BA: SJ6-R138
34	BOEMVC-2024-FL-34	Thin, mottled/chaotic shoal facies overtop unknown transparent package, bounded by potential paleochannel fill. The paleochannel fill consists of chaotic moderate amplitude fill with steeply dipping reflectors and an unknown transparent package along the southern flank. BA-SJ6-R138
35	BOEMVC-2024-FL-35	Thin, chaotic shoal feature (5 ft [1.5 m] thick) overtop unknown transparent package (8 ft [2.4 m] thick) overlying high intensity paleochannel fill (7 ft [2.1 m] thick) and an unknown semi-transparent, hazy package beneath the western flank. BA: SJ7-R187
36	BOEMVC-2024-FL-36	Pinch out of a thin, mottled shoal feature overtop unknown semi-transparent package and potential paleochannel fill. Paleochannel fill consists of low increasing to high intensity amplitude. BA: SJ7-R187
37	BOEMVC-2024-FL-37	Thin, strong amplitude surficial sediment unit (3 ft [1 m] thick) overtop potential paleochannel fill and a prograding surface. The paleochannel fill consists of moderate amplitude fill with slightly dipping reflectors. BA: FL12-R024
38	BOEMVC-2024-FL-38	Thin, mottled shoal feature overtop potential paleochannel fill with steeply dipping reflectors. The paleochannel fill consists transparent hazy fill. BA: FL8R082

Vibracore Number	Final as-built name	Target sediment or layer
39	BOEMVC-2024-FL-39	Thin, mottled/chaotic shoal feature overtop semi-transparent unknown package and a potential paleochannel fill that has been incised by an additional channel. The potential paleochannel fill is a mix of steeply dipping low amplitude fill and a transparent unknown package. BA: FL15-R088
40	BOEMVC-2024-FL-40	Thin, mottled shoal feature overtop an unknown transparent package and potential paleochannel that incised a larger paleochannel. The paleochannel fill consists of moderate to low amplitude fill with slightly dipping reflectors. BA: FL8-R082
41	BOEMVC-2024-FL-41	Chaotic shoal feature (10 ft [3 m] thick) over top unknown transparent package. BA: FL15-R088
42	BOEMVC-2024-FL-42	Chaotic/mottled flank of shoal feature overtop unknown transparent infill
43	BOEMVC-2024-FL-43	Thin, semi-transparent crest of shoal feature overtop transparent unknown package overtop the flank of potential paleochannel fill and another unknown transparent package. The paleochannel fill consists of strong amplitude interlayered fill. BA: FL8-R082/Area 2
44	BOEMVC-2024-FL-44	Chaotic shoal feature (8 ft [2.4 m] thick) overtop potential paleochannel fill (25 ft [7.6 m] thick). Paleochannel fill consists of transparent hazy fill. BA:VO8-R075
45	BOEMVC-2024-FL-45	Thin, semi-transparent surficial sediment unit (4 ft [1.2 m] thick) overtop flank of paleochannel (5 ft [1.5 m] thick), and faint amplitude basal unconformity overtop moderate amplitude prograding surface (12 ft [3.6 m] thick). BA: VO8-R075

Note: USACE BA that the proposed vibracore will be sampling are also identified.

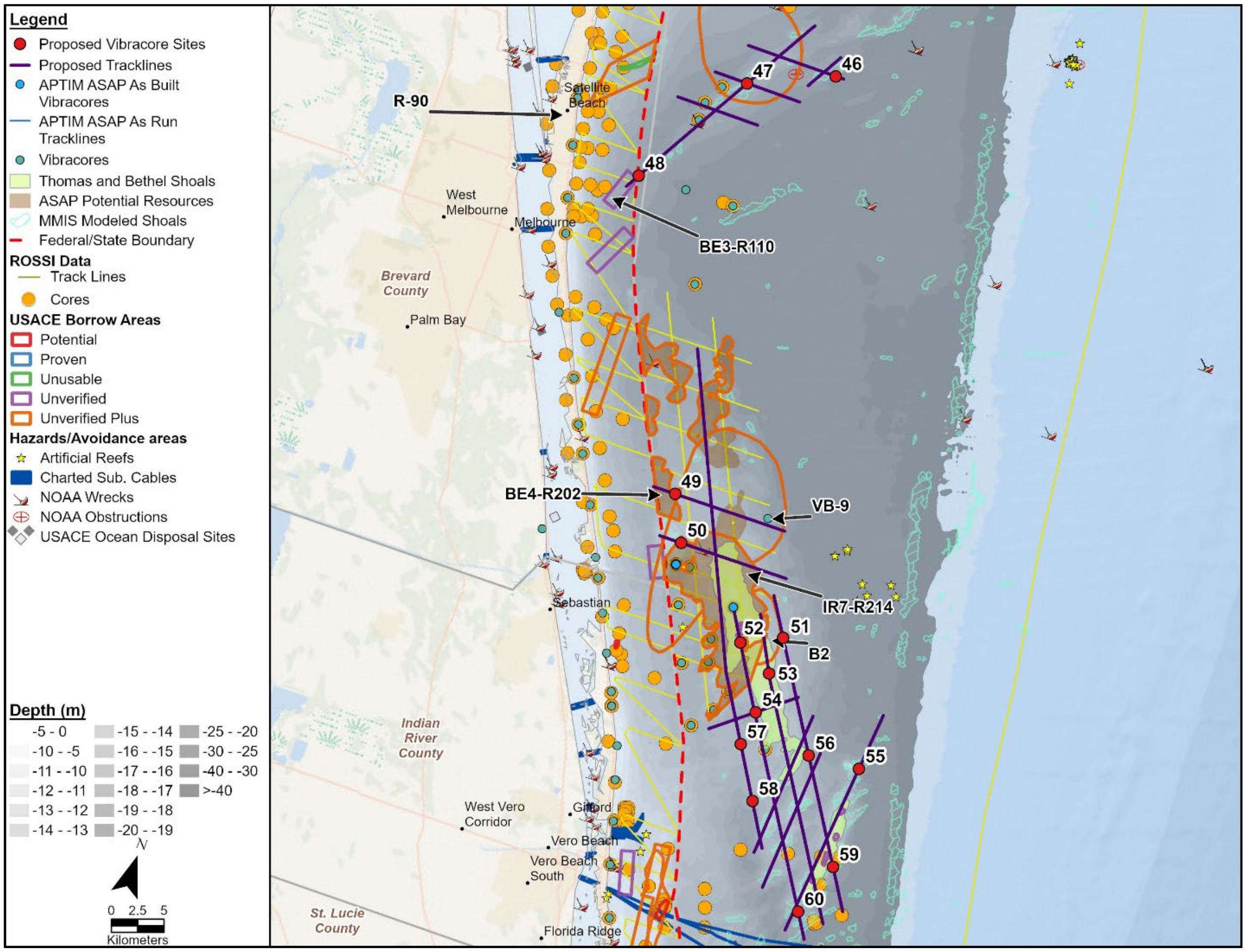
5.1.2.7.3 Sebastian Inlet

BOEM identified three strategic questions for the Sebastian Inlet focus area:

1. What is the composition, quality, and extent of any potential resources identified?
2. Based on the resulting data collection should any areas be recommended for further investigation by design-level survey or eliminated from further consideration?
3. What is the geologic origin and evolution of the resource deposits identified?

The results of the initial geophysical analysis, combined with historic data review, informed the selection of proposed geological sampling locations that would aid in addressing these questions as well as providing for focused investigation of specific resource targets identified by BOEM (Figure 38).

Figure 38: Proposed geologic sites offshore Sebastian Inlet



The geophysical data interpretation within the northern extent of the Sebastian Inlet survey region indicated the presence of thin, mottled shoals, approximately 10 feet (3 meters) thick, overlaying small to medium-sized paleochannel complexes (greater than 25 feet thick [greater than 7.6 meters]) and areas of layered antecedent strata (Figure 39). Additionally, review of the sidescan data indicated the presence of several exposed hardbottom areas, while the seismic data showed potential areas of consolidated sediments. The geomorphology in the southern region is discernable from the northern region by the large extensive Thomas and Bethel Shoals. Seismic data analysis and information gleaned from the historic vibracores collected in these areas revealed that these shoals are composed of variable sand in thicknesses of up to 40 feet (12.2 meters) (Figure 40).

Figure 39: Sub-bottom profiler section of Line 140 showing a thin surficial sedimentary deposit overlying a high-to-medium amplitude surface separating surficial sediments from the underlying layered stratigraphy

Multiple units are observed in the surficial sediment deposit.

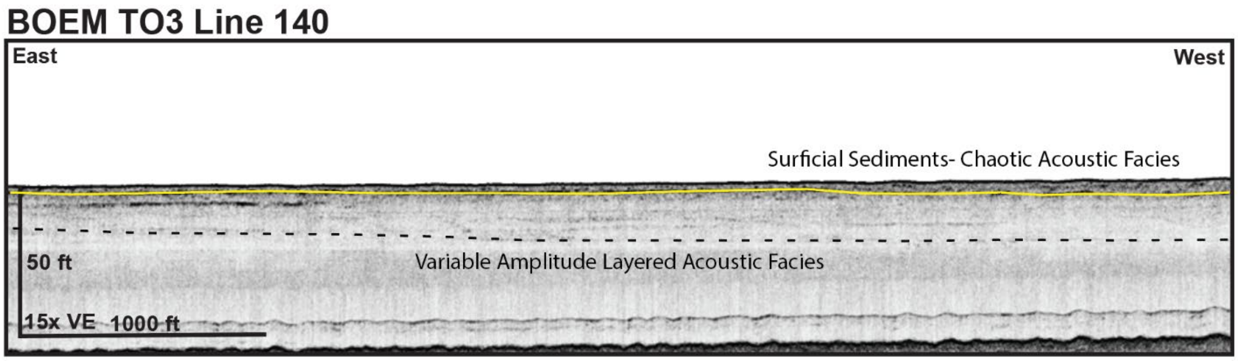
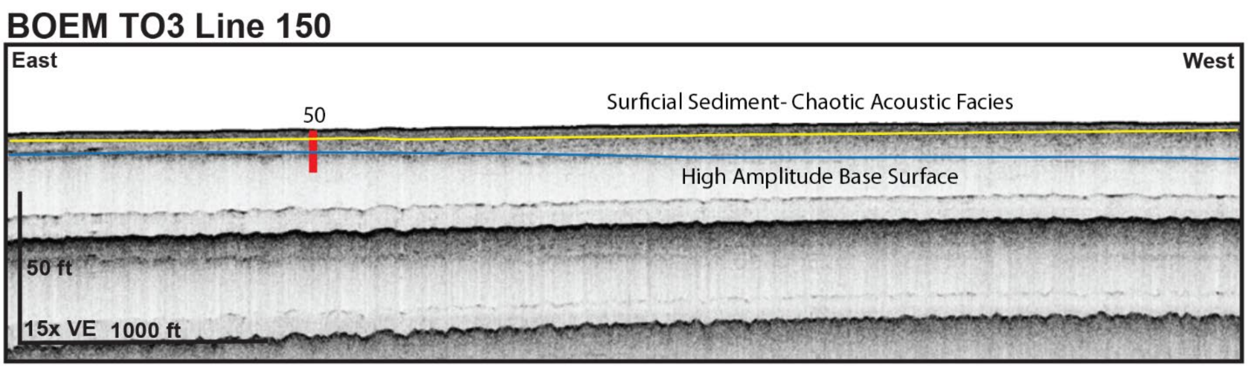


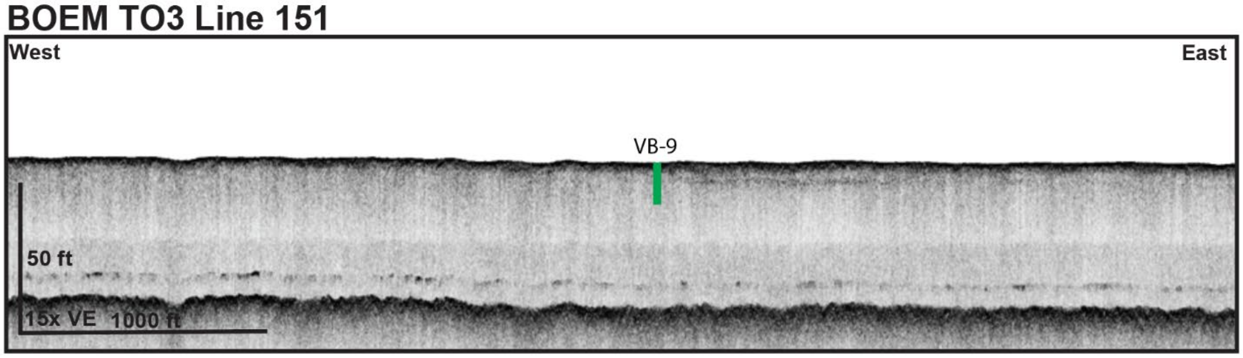
Figure 40: Proposed Vibracore 50 targeting the crest of a modeled shoal west of Thomas Shoal

Given the high amplitude return and blanking out the units beneath the boundary and historic vibracores in this area it is likely that the crest of the shoal is composed of shell hash.



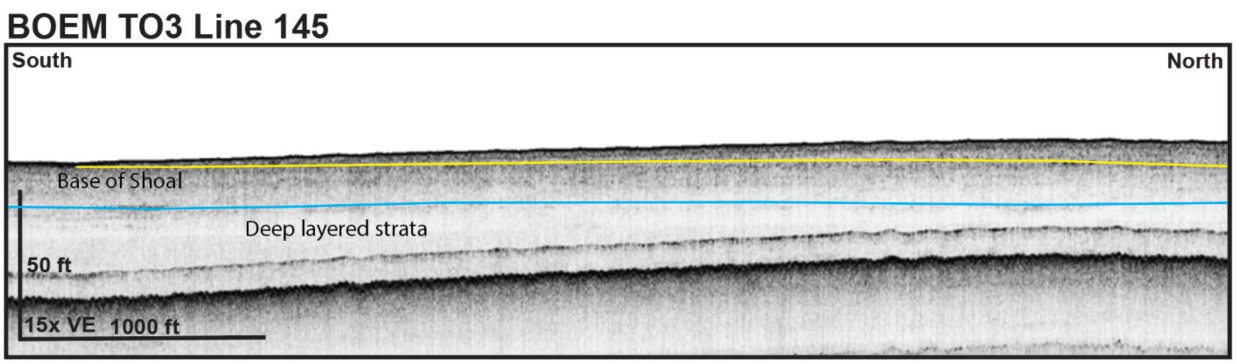
The historic vibracores in the area are mostly focused around the unverified plus borrow area IR7-R214 and the northern section of Thomas Shoal, with fewer vibracores identified in the southern study area around Bethel Shoal. However, the geotechnical properties noted and analyzed in the historic vibracores in the area did not appear to correlate to the acoustic signatures observed in the newly collected seismic data. This discrepancy in the acoustic signal and the historic ground-truthed geotechnical data are evident with historic vibracores VB-9 collected by FGS in 1998 where sedimentological properties in the vibracore logs described the unit as sand while the acoustic signal observed in the recently collected seismic data are non-diagnostic (Figure 41).

Figure 41: Archival vibracore VB-9 located on line 151
The archival core indicates significant sand presence, with little acoustic indications of potential unit boundaries or extent.



Given how dynamic this area can be, it is plausible that the shoals migrate often by way of storm systems or natural processes (tides, currents etc.), it is likely that the top of the historic vibracore is not sampling the same unit as what is being shown in the new seismic data. The proposed vibracore locations in this area are strategically positioned to help discern the differences in the acoustic seismic signal and the description of the geotechnical properties of the vibracores, delineate the boundary of Bethel Shoal, and offer a foundation for identifying future borrow areas. Initial geophysical interpretation showed the potential presence of numerous depositional units that compose what have been previously referred to as the shoals, with an underlying relict strata that varies in acoustic character (Figure 42). Additionally, three vibracores were allocated to the area offshore monument R-90 along the offshore bathymetric ridge which will help verify, constrain, and characterize the resource requested by stakeholders from Brevard County.

Figure 42: Portion of Bethel Shoal imaged by Line 145, showing the presence of multiple units overlying the deeper layered stratigraphy



Vibracores 46, 47, 57, and 58 were selected to advance the geologic framework and constrain historic data by targeting specific features, deposits, and stratigraphic units, while vibracores 52, 54, 55, 56, 59, and 60 verified the composition, quality, and extent of these identified shoals. Vibracores 48, 49, 50, and 51 were aimed to further constrain unverified plus USACE Borrow Areas IR7-R214, BE4-R202, B2 and unverified borrow area BE3-R110 and further delineate their boundaries and geotechnical properties. The targeted sedimentary units for each vibracore are detailed in Table 6 and illustrated in Figure 38.

Table 6: Proposed geologic sites offshore Sebastian Inlet

Vibracore Number	Final as-built name	Target sediment or layer
46	BOEMVC-2024-FL-46	Pinch out of shoal feature (10 ft [3 m] thick); low amplitude, mottled/chaotic feature overtop transparent facie
47	BOEMVC-2024-FL-47	Mottled surficial sediment unit (12 ft [3.6 m] thick) overtop semi-transparent interlayered unit. BA: A2
48	BOEMVC-2024-FL-48	Thin, mottled surficial sediment unit overtop semi-transparent interlayered package bounded by an unknown transparent unit. BA: BE3-R110
49	BOEMVC-2024-FL-49	Thin, chaotic, acoustically opaque surficial sediment unit (5 ft [1.5 m] thick) overtop potential paleochannel fill. Paleochannel fill consists of transparent to semi-transparent interlayered sediment (20 ft [6.1 m] thick). BA: BE4-R202/BE4-R190
50	BOEMVC-2024-FL-50	Large opaque, chaotic crest of shoal feature (10 ft [3 m] thick) overtop high amplitude surficial unit. The high amplitude return appears to blank out geologic unit beneath the shoal. BA: IR7-R214/IR7-R218
51	BOEMVC-2024-FL-51	Opaque chaotic shoal feature that blanks out the units beneath it. BA: B2
52	BOEMVC-2024-FL-52	Mottled/chaotic shoal feature (17 ft [5.2 m] thick) overtop high amplitude surficial unit. BA: IR7-R214/IR7-R218
53	BOEMVC-2024-FL-53	Crest of shoal feature. Chaotic, over 30 ft (9.1 meters) thick.
54	BOEMVC-2024-FL-54	Mottled/chaotic pinch out shoal feature (16 ft [4.9 m] thick).
55	BOEMVC-2024-FL-55	Chaotic shoal feature (15 ft [4.6 m] thick) over top a prograding surface with steeply dipping reflectors (10 ft [3 m] thick).
56	BOEMVC-2024-FL-56	Thin, chaotic shoal feature (5 ft [1.5 m] thick) over top moderate amplitude surficial unit and bounded by a semi-transparent, chaotic unknown package (15 ft [4.6 m] thick).
57	BOEMVC-2024-FL-57	Thin, semi-transparent surficial sediment unit (3 ft [1 m]) overtop potential paleochannel fill. Paleochannel fill consists of semi-transparent fill with steeply dipping reflectors.
58	BOEMVC-2024-FL-58	Thin, transparent surficial sediment unit overtop a semi-transparent, hazy unknown package.
59	BOEMVC-2024-FL-59	Thin, mottled pinch out shoal feature (10 ft [3 m] thick) over top high amplitude surficial unit and bounded underneath by a semi-transparent unknown package (10 ft [3 m] thick).
60	BOEMVC-2024-FL-60	Large opaque shoal feature (15 ft [4.6 m] thick) overlays a semi-transparent unknown package (5 ft [1.5 m] thick).

Note: USACE BA that the proposed vibracore will be sampling are also identified.

5.2 Geotechnical Data Collection

Prior to data collection, proposed geotechnical sample sites were assessed and cleared for archaeological and sensitive benthic habitat resources (Sections 5.1.2.5 and 5.1.2.6). During geotechnical sampling operations, a qualified geologist monitored the acquired information in real time to maximize data quality and make any necessary adjustments to the sampling methodology, if needed. Additionally, the geologist onboard ensured that the collected data were compatible with the historic data identified in the area as part of the Task 1 desktop study.

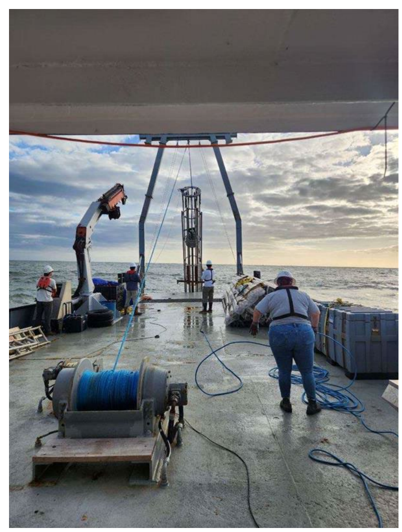
5.2.1 Systems and Equipment

Between April 25 and June 16, 2024, APTIM collected 60 vibracores utilizing the following vessel and equipment.

5.2.1.1 Geologic Survey Vessel Characteristics

APTIM used the *R/V Rachel K. Goodwin*, a USCG inspected and certified vessel, for the geologic survey. The *R/V Rachel K. Goodwin* is a 110-foot (33.5 meters) steel hulled vessel, outfitted with the sole purpose of geophysical, geotechnical, and biological surveys. It comes equipped with a 10-ton capacity 27-foot (8.2 meters) hydraulic A-Frame, twin 1692 Detroit diesel main engines, twin 471 Detroit diesel generators (40 Amp), one 18,000-pound capacity deck winch, a 4-inch (10.16 centimeters) down pole with variable mounting brackets. The *R/V Rachel K. Goodwin* is equipped with crew and client quarters as well as a full galley with two heads including showers. As a USCG inspected vessel, the *R/V Rachel K. Goodwin* safety features include fire extinguishers, life vests/survival suits, 50-man life raft, first aid kits, radar, very high frequency radios, and an emergency position indicating radio beacon. These safety features and the level of experience and expertise from the captain and crew allows the *R/V Rachel K. Goodwin* to operate safely and efficiently, providing proficient geotechnical support throughout project operations.

5.2.1.2 Vibracore System Characteristics



APTIM utilized the SEAS VC-700 Vibracoring System, configured to collect undisturbed sediment cores up to 20 feet (6 meters) in length. The VC-700 is a single core electric vibracoring system operational to depths of 3,281 feet (1,000 meters). The electric vibracore is the most versatile of vibracore systems, with the ability to retrieve deep core samples with no pressure constraints as found with pneumatic vibracores. The self-contained, free-standing electronically operated vibracore unit contains a VC-700 vibrator head (4.4 kilowatts) configured to 415 VAC or 220 VAC 3-phase power, allowing for a user to operate the vibracorer at fluctuating vibration frequencies to penetrate through otherwise unyielding strata. A 688 feet (210 meters) long 4-core Hydrofirm sea cable provides power to the drive unit of the vibracore from the surface control system, located on vessel.

The vibracore unit was winch and A-Frame deployed and retrieved from the *R/V Rachel K. Goodwin*. The vibracorer's light weight modular construction allowed for a safe and efficient deployment and retrieval to and from the survey vessel. The vessel "live boated" at all geologic sample locations to reduce and mitigate any potential bottom disturbance.

As part of the geotechnical operations APTIM utilized an underwater camera with lights installed on the vibracore frame to allow for the operator to determine/adjust the proper vibrating frequency to preserve the integrity of the sample as well as have the ability to know exactly what is happening with the vibracore sample. APTIM also utilized a penetrometer, which provided information on the rate/speed of penetration. When recovery was less than 80 percent of the expected penetration, the liner was removed, a new liner inserted, and a second and third attempt performed (as necessary). During geotechnical field operations, if upon completion of the second attempt, the refusal penetration was similar to the first attempt and was corroborated by collected seismic data (getting refusal at specific horizons), the third attempt was waived, and the site was considered complete. Upon collection of the vibracores and removal of the vibracore barrel, APTIM geologists measured, marked, and cut the liner of each vibracore into 5-foot (1.52 meters) sections to prepare the cores for transport. The vibracores were then transported to APTIM's accredited geotechnical laboratory in Boca Raton, Florida, where they were processed according to the American Society for Testing and Materials (ASTM) standards.

APTIM utilized an Odom Hydrographic Systems, Inc.'s E20, a single frequency portable hydrographic echo sounder operating at 200 kHz for bathymetric data collection during the vibracore collection. The final top of vibracore elevations were derived from MBES data collected during the geophysical phase of the project. This allowed APTIM to represent the top of vibracore elevation more accurately by applying post-processed tide correction at each vibracore location. Trimble Differential GPS receivers were used to provide real time navigation to the helm and record vibracore sample site locations during the geological sampling survey. All vibracore activities adhered to the proper ASTM and USACE standards (ASTM D4823-95 [2019]).

5.3 Geological Interpretation Methodology

Geological interpretation methodology is described below.

5.3.1 Geotechnical Data Sampling and Processing

Upon collection of the vibracores and removal of the vibracore tube, APTIM geologists measured, marked, and cut each vibracore into 5-foot (1.52 meters) 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 ASTM Standard Materials Designation D2488-17e1 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 FDEP's Offshore Sand Search Guidelines (FDEP, 2010). Logging was consistent with USACE ENG Form 1836.

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 and sampled halves of the vibracore sections were then placed in labeled plastic sleeves and stored at APTIM to be available for additional review and sampling as needed. Archive vibracore halves were wrapped with plastic wrap prior to placement in the plastic sleeves, to reduce shifting of the sediments during storage and future transfer. The vibracore log descriptions were entered into the gINT software program.

The split vibracores were photographed in 2.0 feet (0.6 meters) intervals using a Ricoh WG-6 20-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 percent 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 FDEP Offshore Sand Search Guidelines. The photographs were downloaded from the camera in.jpg format, formatted for consistency, and then exported into the finalized.pdf format. Vibracore photographs, logs, curves, reports, carbonate and torvane results are presented in Appendix M (both attached to the report and digital), digital penetrometer logs are presented in Appendix N, and geotechnical field notes are presented in Appendix O.

5.3.1.1 Mechanical Sieve Analysis

The sediment subsamples were analyzed to determine color and grain size distribution. During sieve analysis, the wet, 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 FDEP's Offshore Sand Search Guidelines. Grain size was determined through sieve analysis in accordance with ASTM Standard Materials Designation D6913/D6913M-17 for particle size analysis of soils. This method covers the quantitative determination of the distribution of sand particles. Sediment finer than the No. 200 sieve (3.75 phi) was analyzed following ASTM Standard Materials Designation D1140-17. 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 FDEP requirements (FDEP, 2010). Weights retained on each sieve were recorded cumulatively. The sieve stack used for mechanical analysis is provided in Table 7. 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 granulometric reports, grain size distribution curves, and logs (Appendix M). Final gINT projects are also submitted in Appendix P.

Table 7: Granulometric analysis mesh sizes by Unified Soils Classification System (USCS) Classification based on the ASTM D2487/2488 Standards

Table 7 A presents the classifications for gravel, B presents the classification for Sands and C the classification for Fines.

A1: Coarse Gravel

Sieve Number	Sieve Size (phi)	Sieve Size (mm)
3/4	-4.25	19.03

A2: Fine Gravel

Sieve Number	Sieve Size (phi)	Sieve Size (mm)
5/8	-4.00	16.00
7/16	-3.50	11.20
5/16	-3.00	8.00
3 ½	-2.50	5.60
4	-2.25	4.75

B1: Coarse Sand

Sieve Number	Sieve Size (phi)	Sieve Size (mm)
5	-2.00	4.00
7	-1.50	2.80
10	-1.00	2.00

B2: Medium Sand

Sieve Number	Sieve Size (phi)	Sieve Size (mm)
14	-0.50	1.40
18	0.00	1.00
25	0.50	0.71
35	1.00	0.50

B3: Fine Sand

Sieve Number	Sieve Size (phi)	Sieve Size (mm)
45	1.50	0.36
60	2.00	0.25
80	2.50	0.18
120	3.00	0.13
170	3.50	0.09
200	3.75	0.08

C1: Silty/Clay

Sieve Number	Sieve Size (phi)	Sieve Size (mm)
230	4.00	0.06

Notes:
mm denotes millimeter.

5.3.1.2 Composition/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 granulometric reports and grain size distribution curves.

5.3.1.3 Field Vane Shear Tests

Field vane shear tests were conducted during vibracore logging in accordance with ASTM Standard Test Methods of Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil (D4648/D4648M-16). These tests were used to characterize the clay material.

5.3.2 Surficial Sand Delineation and Quantification

As part of the project scope, APTIM was tasked with evaluating the collected seismic data to delineate any potential sand resources present in the study area that could be further mapped and used for future restoration efforts. To augment the understanding of the area and further delineate these deposits, APTIM also utilized the geophysical and geotechnical data collected in 2015 as part of the BOEM ASAP project. The previous interpretations conducted as part of the APTIM 2017 study were re-assessed utilizing the newly acquired data and incorporated into the surficial sand delineation/quantification evaluation. In order to accomplish this assessment, APTIM correlated the geotechnical and seismic data to develop a sediment resource thickness surface that would then be clipped according to bathymetric expressions observed in the NOAA Coastal Relief Model (CRM). The methodology used for the resource delineation and quantification are presented in the sections below.

5.3.2.1 Seismic and Geotechnical Data Correlation

To meet the various project goals, APTIM developed a project specific color-coding scheme for the layers within each vibracore. The scheme is based on a point deduction system, where specific characteristics such as mean grain size, shell content or color cause a layer to lose points. The final score then determines what color the layer should be classified as. A sampled layer would start with a score according to its fine percentage (based on percent passing the #230 or 4 phi sieve) outlined in Table 8. From the initial score, points were deducted based on mean grain size (mm), layer qualifiers, the descriptive terms, and color.

Table 8: Vibracore sample point allocation based on fine content

% Fine[1]	Points
5%	10
5–10%	9
10–15%	8
15–20%	7
20–25%	6
>25%	5

[1]based on the percent passing the #230 sieve.

For each layer from which a sample was collected and analyzed, points were deducted from the initial score based on properties that would typically make the layer non-beach compatible and/or negatively affect the overall vibracore composite (Table 9). The number of points deducted was based primarily on how far the sediment within a layer deviates from a conservative assumption of the characteristics of beach compatible sediment. Samples that are either too coarse-grained or too fine-grained based on their mean grain size (mm) had points deducted. Points were also deducted based on the sand layer qualifiers such as silty, shelly, or clayey, which indicate that a sample is 35 to 50 percent of that material. Additionally, the components of each layer were reviewed for little (10 to 20 percent) or some (20 to 35 percent) non-beach compatible components (shell, rock fragments, clay, silt, wood etc.). If a layer was partially lithified or lithified, it also had points deducted. Lastly, wet Munsell color values were also reviewed for potential beach compatibility. Darker colors are typically considered less beach compatible, so they had more points deducted than lighter colors.

Table 9: Sample point deductions based on properties, qualities, and color

Mean (mm)	Points
0.51 mm>	-1
0.21–.50	0
<0.20 mm	-1

Qualifier	Points
Shelly/Shell/ Gravely	-3
Clayey/Silty	-2
Clayey Shell Hash	-2

Percentage non-beach compatible components	Points
Trace (0%–10%)	0
Little (10%–20%)	-0.5
Some (20%–35%)	-1
Lithified/partially lithified	-5

Munsell Value (wet)	Points
6–8	0
5	-0.5
2.5–4	-1

A color was then assigned to the interpreted layer based on the final score according to Table 10, where layers that are potentially more beach compatible are classified as green, while clays are color coded as red and less compatible sand layers are color coded as yellows and oranges.

Table 10: Final vibracore sample point system and color-coding scheme

Color	Total points
Dark Green	9.1–10
Green	8.1–9
Light Green	7.1–8
Yellow	5.1–7
Orange	3.1–5
Red	2.1–3
Dark Red	<2

Unsampled layers, which likely did not meet sand needs were color coded according to Table 11 where the layer descriptor, qualifiers, and Unified Soils Classification System (USCS) were used to determine the final points allocated to the layer.

Table 11: Unsampled vibracore point allocations

Color	Total points
Clay	1
Clayey Sand	3
Clayey Shell Hash	2
Clayey Silt	1
GM	3
Gravely Sand	3
GW	3
Sand	5
Sandy Clay	2
SC	4
Shell	3
Shell Hash	3
Shelly Clay	2
Shelly Sand	3
Silty Clay	1
Silty Sand	2
SW	4

5.3.2.2 Surficial Sand Delineation

With the assistance of the plotted vibracores, APTIM was able to evaluate the available surficial sands in each of the regions and generate an isopach for each analyzed area in order to identify future potential sand resources that are greater than 3 feet (0.91 meters) and 5 feet (1.52 meters) thick. Using the seafloor and the reflector representing non-beach-compatible material (i.e., high silt, clay, or shell content) boundary, the thickness of the sediment unit was calculated and exported in order to develop an isopach (sediment thickness) of each of the five study areas. X/Y/Thickness files were imported into Golden Software Inc.'s Surfer software program and adjustments were made to the digitization whenever discrepancies occurred, such as obvious differences in thicknesses between adjacent/intersecting lines or consecutive files (roll overs). A final thicknesses file was exported for each region in Surfer and smoothed into an isopach surface within ArcGIS in order to remove any anomalies that occurred due to the line spacing and gridding interpolation. Due to the wide line spacing, surfaces were generated using a grid node spacing of 100 feet (30.48 meters). All generated surfaces were then smoothed in ArcGIS Pro using the Focal Statistics geoprocessing tool using a circle neighborhood with three cells (radius and unit type) computing the mean statistic. From the generated sand surfaces, APTIM then used the NOAA CRM surface to assist in identifying regional patterns and to delineate a polygon around the collected data that would exclude any potential erroneous areas that were generated from the gridding tool interpolating between areas without any data coverage. The sand isopach surface was then clipped to the generated polygon to eliminate any artifacts that would interfere with the interpretation and review of the data. Maps depicting the sediment thickness (feet) above the base of the sediment body, which is typically also the transgressive ravinement can be found in Appendix B Map 6a–6c (submitted digitally in Appendix H). It is worth mentioning again that the isopach surface created in ArcGIS is only a reconnaissance level model since it is interpolating between the widely spaced reconnaissance lines and therefore is not expected to be completely accurate.

Geophysical data collected under this study followed a reconnaissance-level design, where geophysical survey lines are oriented and spaced in a way that maximizes spatial coverage and can identify key regional features and resources where relatively little may have been identified previously. The results of a reconnaissance survey are typically used to plan additional appraisal or design-level surveys to fully characterize and quantify specific sand and sediment resources. Interpretation and crossline interpolation of key acoustic reflectors, interpreted as geologic surfaces, and of likely continuous sedimentologic units was carried out wherever possible, but the relatively large line spacing does potentially introduce more uncertainty into these correlations and volumes presented, compared to a smaller-scale, high density design survey. In several instances there were identified seismic facies and vibracore samples of units that could represent beach-compatible sand resources; however, were not able to be regionally mapped and correlated at the reconnaissance scale.

Also, given the limited number of vibracores sampling the subsurface material, the interpretation of the overall sediment type and quality is highly dependent upon the chirp sub-bottom acoustic response. Therefore, most of the digitization excluded areas where the subsurface stratigraphy had a signal that was not indicative of clean sands. It is possible however, that some of these areas could prove to be sand when sampled. Further geophysical and geologic sampling would refine these stratigraphic interpretations and thickness estimates.

Granulometric curves and reports, descriptive logs, and photographs of vibracore data were used to compile sediment characteristics and vibracore composite statistics in the study areas that had surficial sands greater than 3 feet (0.91 meters) and 5 feet (1.52 meters) per the scope of work.

6 Integrated Geophysical and Geologic Interpretation

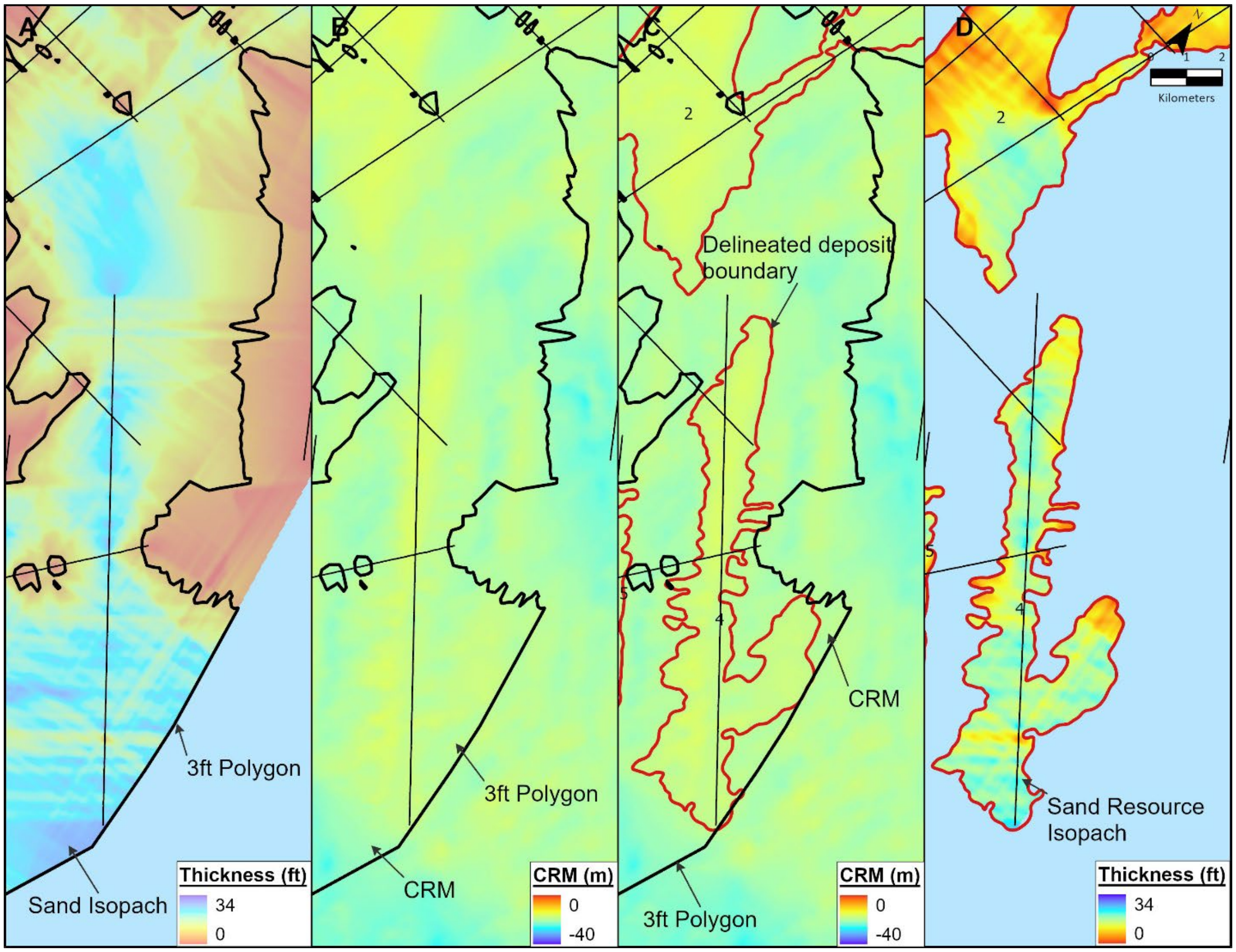
The integrated geophysical and geological datasets were interpreted in order to address each region's specific strategic questions as well as identify and characterize any potential surficial or sub-surface sediment resource deposits that may be suitable for future coastal restoration efforts. Additionally, these data were used to provide a geologic framework for portions of the region to assist in future determinations of potential sediment resources and to provide a better understanding of the evolution of the Florida east coast. Below are results of the overall regional surficial sand resource quantification conducted across the Florida study area as well as specific results and interpretations for each of the three identified study areas.

6.1 Surficial Sand Resource Quantification

Based on the surface sand delineations created by correlating the seismic and vibracore data, APTIM identified potential deposits that had thicknesses greater than 3 feet (0.91 meters) and 5 feet (1.52 meters) within the investigation areas. To meet the project needs, APTIM first clipped the thickness surface discussed in the section above to exclude everything thinner than 3 feet (0.91 meters) and 5 feet (1.52 meters) thick. The remaining data boundary was then converted to a polygon within ArcGIS Pro to assist in correlating the various datasets. APTIM then utilized the NOAA CRM for the study area to identify depositional patterns that likely correlated with the surficial sand polygon created from the isopach data. As part of this review, APTIM used patterns of topographic highs observed within the CRM model and generated isopachs to best identify the boundaries of the shoals.

Within ArcGIS Pro, polygons representing the areas that had a sand isopach thickness greater than 3 feet (0.91 meters) and 5 feet (1.52 meters) were generated using the Raster to Polygon (Figure 43, Panel A). This tool allowed APTIM to correlate the potential resource boundaries of the interpreted areas to the CRM model (Figure 43, Panel B). By comparing the 3 feet (0.91 meters) polygon to the CRM, APTIM was able to better understand how the observed sand isopach thicknesses correlates to the bathymetric highs seen in the CRM and use the collected geophysical and geologic data to better understand the shallower areas seen in the CRM surface. Additionally, this visual surface comparison allowed for the identification of areas outside the surveyed area where the sand surface showed artifacts of the widely spaced lines and the gridding tool interpolating between data points. From comparing the surfaces and the 3 feet (0.91 meters) polygon, APTIM was able to delineate a deposit boundary that would best represent the sand resource identified in the seismic data (Figure 43, Panel C). The sand isopach surface was then clipped to each of the individual identified boundaries and a final sand resource isopach was generated (Figure 43, Panel D). This surface was then used for subsequent calculations of potential resource volumes. It is important to note that there are some caveats to this assessment. In instances where the seismic data indicated a thickness greater than 3 feet (0.91 meters) and/or a vibracore indicated the presence of sand but the CRM data did not indicate any significant bathymetric shoal or observable trend, and/or the deposit did not have a current vibracore sample, deposits were not included as part of the final resource volumes presented as part of this report. Moreover, due to the correlation between the different datasets in order to determine the boundaries of the deposit, some of the final sand thickness isopachs might include sand thicknesses less than 3 feet (0.91 meters). Additional data coverage and further analysis of the depositional patterns within the CRM model would be required in order to resolve these areas, however that was not included as part of the scope of work.

Figure 43: Surface sand delineation based on the Coastal Relief Model and seismic isopach thickness



By visually correlating the CRM data, the clipped surface, as well as geophysical data coverage, APTIM was able to identify 22 potential deposits in the study areas (and Appendix B Map 7a–7c). Volumes and composite statistics were calculated for each of the potential deposits identified. It is important to note that these are based on reconnaissance data and require additional data coverage in order to more accurately delineate the deposit and correlate it to the bathymetric data.

Composite mean grain size and percent silt content were computed for each vibracore within each of the regions by calculating the weighted average (sample weighted by effective lengths of the sampled layer above the elevation of base of suitable material). The final product of this calculation was a composite vibracore sample with weights for each phi interval. The composite statistics for each region were compiled by averaging the weighted results for all cores within the vertical and lateral limits of the regions. It should be noted that the final composite values for each region are only an estimate based on very limited, widely spaced geologic samples, and that additional vibracores should be taken during a secondary offshore design-level investigation in order to more confidently determine the beach-compatibility of the preliminary borrow areas. These areas are presented in Appendix B Map 7a-7c.

Volumes for each of the identified resources were calculated by utilizing the surface volume tool within ArcGIS Pro. Due to the variability in the thickness grid created after removing the areas that do not correlate to bathymetric shoals in the CRM surface, the volume of potential sediment in the deposit was calculated above a 3 feet (0.91 meters) plane to ensure that only the volume that could be dredged are included in the final calculations. The same method was used along identified resources where strategic questions required significant volumes greater than 5 feet (1.52 meters). These volumes and areas are also reported in Table 12 and Table 13 with the first set of numbers being 3 feet (0.91 meters) and the second being 5 feet (1.52 meters). Areas reported in the table below are the regions of space between the specified plane height of 3 feet (0.91 meters) (or 5 feet [1.52 meters]) and the portions of the surface that are above the plane that had corroborating geotechnical information and therefore do not represent all the identified CRM polygon areas included in the MMIS deliverable.

The provided areas of likely beach compatible resources consisted of a conservative estimate of beach compatibility and constituted gross volumes of potentially available resources. The volumes discussed in the below section refer to estimated gross volumes in excess of 3 feet (0.9 meters).

Table 12: Identified resources estimated gross volumes excess of 3 feet (0.9 meters)
*Indicates resource does not have a USACE borrow area associated with it.

Area	ID Res.	VC	Area (acre)	Area (km2)	Volume (mcy)	Volume (mcm)	Mean Grain Size (mm)	Mean Grain Size (phi)	% Silt	Sorting (mm)	Sorting (phi)
N/D[1]	1 (NA7-R016)	N/A	1,000	200	2.2	0.1	N/A	N/A	N/A	N/A	N/A
N/D	2 (DU9-R003)	2024-04 2024-06 2024-08	8,700	7,000	65.2	39.6	2.29	0.21	2.54	1.03	0.49
N/D	3 (DU9-R003)	2024-10	500	400	2.22	0.7	2.01	0.24	2.02	1.07	0.48
N/D	4 (A3a)	2024-11 2024-16	6,100	6,000	82.4	62.5	2.03	0.24	1.92	1.21	0.44
N/D	5*	2024-12 2024-15	1,300	1,300	17.9	13.5	2.2	0.21	1.75	0.89	0.54
N/D	6 (A4)	2024-13 2024-14 2024-17	5,800	5,200	53.4	35.5	2.09	0.23	2.95	0.94	0.53
N/D	7 (A5)	Historic Cores	500	500	4.2	2.5	N/A	N/A	N/A	N/A	N/A
N/D	8 (A4)	Historic Cores	3,700	3,000	30.6	19.6	N/A	N/A	N/A	N/A	N/A
F/SJ[2]	9*	2024-18	2,700	2,300	17.2	9.1	1.67	0.31	1.58	1.12	0.47
F/SJ	10 (SJ9-R06 SJ7-R088)	2024-22 2024-23 2024-24 2024-28 2024-26 2024-30 2024-32 2024-31 2015 VC17 2015 VC19 2015 VC16	49,600	39,600	434.1	291.3	2.15	0.22	2.43	0.87	0.55
F/SJ	11*	2024-25	5,300	5,300	113.1	95.8	1.77	0.29	1.72	1.08	0.48
F/SJ	12 (SJ7-R187)	2024-35	500	300	2.4	1.1	2.33	0.19	3.05	0.88	0.55
F/SJ	13 (SJ14-R195)	2024-36	9,500	9,100	100.2	69.8	2.37	0.19	4.72	1.02	0.5
F/SJ	14 (FL12-R024)	None	13,200	9,800	102.0	64.3	N/A	N/A	N/A	N/A	N/A
F/SJ	15 (FL8-R82)	2024-38	38	0/0	0.05	0	1.96	0.25	1.72	1.08	0.48

Area	ID Res.	VC	Area (acre)	Area (km2)	Volume (mcy)	Volume (mcm)	Mean Grain Size (mm)	Mean Grain Size (phi)	% Silt	Sorting (mm)	Sorting (phi)
F/SJ	16 (FL8-R82)	2024-40	900	800	7.5	4.6	2.32	0.2	3.17	0.93	0.53
F/SJ	17 (FL15-R088)	2024-39 2024-41	12,200	10,500	113.5	76.4	2.19	0.21	3.08	0.97	0.52
F/SJ	18 (FL8-R82)	2024-43	300	200	1.2	0.4	2.33	0.19	2.30	0.83	0.57
F/SJ	19 (VO8-R075)	2024-44	1,500	1,300	8.5	3.8	2.27	0.2	2.49	0.76	0.6
SebI[3]	20 (A2)	2024-47	5,200	4,100	30.2	15.0	1.65	0.31	2.91	0.85	0.56
SebI	21*	2024-46	1,000	800	6.8	3.7	1.85	0.27	7.90	1.27	0.42
SebI	22 (IR7-R214)	2024-50 2024-52 2024-53 2024-54 2024-55 2024-56 2024-59 2024-60 2015-VC04 2015-VC03	37,000	36,00	682.6	563.6	1.12	0.46	2.60	1.21	0.44

[1]Nassau/Duval [2] Flagler/St. Johns [3] Sebastian Inlet
km² denotes square kilometers.
mcy denotes million cubic yards.
mm denotes millimeters.

Table 13: Identified resources estimated gross volumes in excess of 5 feet (1.5 meters)
*Indicates that resource does not have a USACE borrow area associated with it.

Area	ID Res.	VC	Area (acre)	Area (km2)	Volume (mcy)	Volume (mcm)	Mean Grain Size (mm)	Mean Grain Size (phi)	% Silt	Sorting (mm)	Sorting (phi)
N/D[1]	1 (NA7-R016)	N/A	4	0.8	1.6	0.1	N/A	N/A	N/A	N/A	N/A
N/D	2 (DU9-R003)	2024-04 2024-06 2024-08	35	28	49.9	30.3	2.29	0.21	2.54	1.03	0.49
N/D	3 (DU9-R003)	2024-10	2	1	1.7	0.5	2.01	0.24	2.02	1.07	0.48
N/D	4 (A3a)	2024-11 2024-16	24	24	63.0	47.8	2.03	0.24	1.92	1.21	0.44
N/D	5*	2024-12 2024-15	5	5	13.6	10.3	2.2	0.21	1.75	0.89	0.54
N/D	6 (A4)	2024-13 2024-14 2024-17	23	21	40.8	27.1	2.09	0.23	2.95	0.94	0.53
N/D	7 (A5)	Historic Cores	2	2	3.2	1.9	N/A	N/A	N/A	N/A	N/A
N/D	8 (A4)	Historic Cores	14	12	23.4	15.0	N/A	N/A	N/A	N/A	N/A
F/SJ[2]	9*	2024-18	10	9	13.1	6.9	1.67	0.31	1.58	1.12	0.47
F/SJ	10 (SJ9-R069 SJ7-R088)	2024-22 2024-23 2024-24 2024-28 2024-26 2024-30 2024-32 2024-31 2015 VC17 2015 VC19 2015 VC16	200	160	331.9	222.7	2.15	0.22	2.43	0.87	0.55
F/SJ	11*	2024-25	21	21	86.4	73.2	1.77	0.29	1.72	1.08	0.48
F/SJ	12 (SJ7-R187)	2024-35	2	1	1.8	0.7	2.33	0.19	3.05	0.88	0.55
F/SJ	13 (SJ14-R195)	2024-36	38	36	76.6	53.4	2.37	0.19	4.72	1.02	0.5
F/SJ	14 (FL12-R024)	None	53	39	78.0	49.2	N/A	N/A	N/A	N/A	N/A
F/SJ	15 (FL8-R82)	2024-38	0	0	0.04	0	1.96	0.25	1.72	1.08	0.48

Area	ID Res.	VC	Area (acre)	Area (km2)	Volume (mcy)	Volume (mcm)	Mean Grain Size (mm)	Mean Grain Size (phi)	% Silt	Sorting (mm)	Sorting (phi)
F/SJ	16 (FL8-R82)	2024-40	3	3	5.7	3.5	2.32	0.2	3.17	0.93	0.53
F/SJ	17 (FL15-R088)	2024-39 2024-41	49	42	86.8	58.4	2.19	0.21	3.08	0.97	0.52
F/SJ	18 (FL8-R82)	2024-43	1	0.81	0.9	0.3	2.33	0.19	2.30	0.83	0.57
F/SJ	19 (VO8-R075)	2024-44	6	5	6.5	2.9	2.27	0.2	2.49	0.76	0.6
SebI[3]	20 (A2)	2024-47	21	16	23.1	11.5	1.65	0.31	2.91	0.85	0.56
SebI	21*	2024-46	4	3	5.2	2.8	1.85	0.27	7.90	1.27	0.42
SebI	22 (IR7-R214)	2024-50 2024-52 2024-53 2024-54 2024-55 2024-56 2024-59 2024-60 2015-VC04 2015-VC03	149	147	521.9	430.9	1.12	0.46	2.60	1.21	0.44

[1]Nassau/ Duval [2] Flagler/ St. Johns [3] Sebastian Inlet
km^2 denotes square kilometers.
mcm denotes million cubic meters.
mm denotes millimeters.

6.2 Regional Interpretation and Discussion

This study provides new interpretations and updated potential sediment resource inventories for the three Florida Atlantic OCS focus areas: Nassau and Duval Counties, Sebastian Inlet, and Flagler and St. Johns Counties. The following section details specific observations, discussion, and recommendations resulting from the combined geological and geophysical investigation. This report provides a holistic assessment for each region including updated potential sediment resource inventories, avoidances and/or hazards that could limit seafloor use, new analyses of seafloor morphology and texture, and local stratigraphic analyses with a specific focus on sediment resource origin and evolution.

6.2.1 Nassau and Duval Counties

The Nassau and Duval region represents the northernmost portion of the Florida Shelf investigated in this project. This investigation was designed to address regional strategic questions as well as focused analysis of previously identified potential borrow areas and/or bathymetric highs (Figure 44 and Figure 45). This region contains numerous potential borrow areas with various levels of confidence, but the linkages between adjacent borrow areas, their potential for expansion, and their geologic origin remains unclear and is a major goal of this study.

Figure 44: Collected data offshore Nassau County

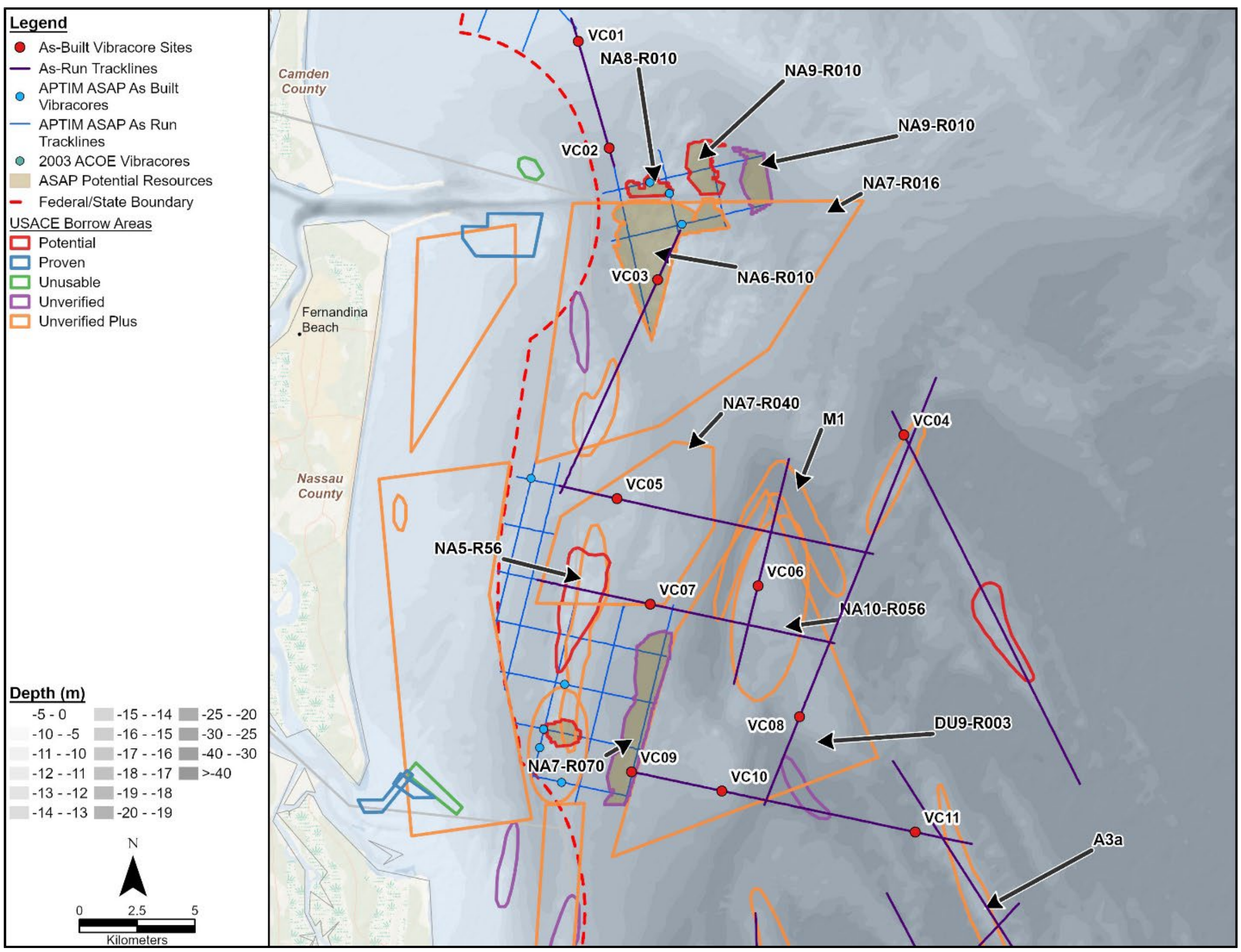
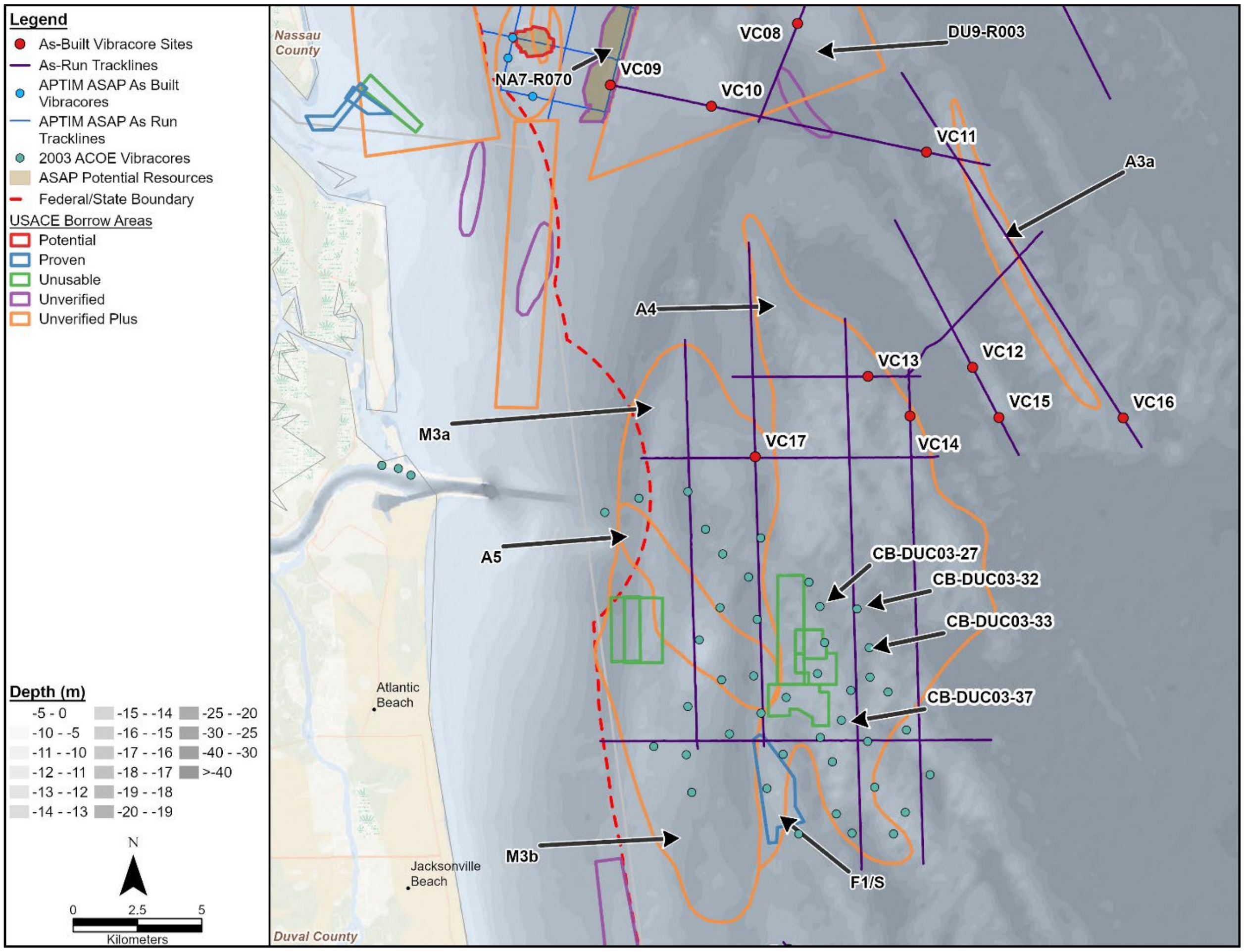


Figure 45: Collected data offshore Duval County



The Nassau and Duval region contained 190 magnetic anomalies in total. These anomalies consisted of 60 monopolar, 103 dipolar, and 27 multicomponent anomalies. Their amplitudes ranged from 5 to 2099.5 nT, durations from 9.6 to 662.2 feet (2.9 to 201.8 meters), and 70 of the anomalies were interpreted to be potentially associated with sidescan sonar contacts or known features. One hundred and twenty (120) of the anomalies within the Nassau and Duval region are described as unknown/modern debris.

Sidescan sonar interpretations in the region characterized the seafloor as being mostly sandy with isolated pockets of hardbottom. Sand was observed throughout the whole region with no recognizable pattern. Exposed hardbottom and a 63 feet (19.20 meters) tugboat “The Reliance”, associated with Florida artificial reefs, was observed on Line 111 and Line 111.005. A total of 16 sidescan sonar contacts were identified within the Nassau and Duval region and represent multiple artificial reefs (The Reliance and Montgomery Reef), anchor scour marks, dolphins, seafloor relief/trenching, multiple unknown high intensity features and potential Electronic Navigational Chart (ENC) wreck 597.

The Nassau/Duval region had previously been reported as hosting numerous surficial sedimentary units (including prominent bathymetric highs, or shoals, as well as thinner shelf veneers) that overlies a shallow stratigraphic architecture formed by a complex history of deposition and erosion by prior coastal systems (Meisburger and Field, 1976). Recent modern to Quaternary deposits are interpreted to lie unconformably on older calcareous units such as Eocene limestones that are occasionally present at the seafloor within the inner shelf. The more recent Quaternary deposits appeared similar to the well-studied fluvial/coastal deposits located offshore southern Georgia (Long et al., 2021).

Geophysical and geotechnical data collected within the Nassau and Duval region corroborates the various USACE identified resources and indicated that numerous of these previously separate areas are likely of a similar origin, and can be expanded in area and potential volumes. This study identified several surficial sedimentary units (Appendix B Maps 8a-8c) in the region that were able to be correlated across reconnaissance geophysical data. Many of the previously identified shoal complexes are contained within the boundaries of these mapped units, but the units themselves often are larger than just the most prominent bathymetric highs (Figure 46). These units were mapped on the basis of seismic facies continuity and the presence of regionally correlated seismic horizons at their base (Figure 47). The northernmost shoal complex within Nassau County included the previously identified potential borrow areas NA8-R010, NA9-R010, NA10-R011 and NA6-R010 (Figure 46, all identified from the 2015 ASAP data), which were further sampled with BOEMVC-2024-FL-03 and trackline 102. These borrow areas all appear similar in acoustic and geotechnical facies with the bathymetric high corresponding to a surficial sedimentary unit with transparent to chaotic acoustic facies. New and archival cores (BOEMVC-2024-FL-03, BOEM-2015-VC26, FL-BOEM-2015-VC27 and FL-BOEM-2015-VC28) indicate this facies correspond potentially resource grade sand. The entirety of the surficial unit and borrow areas appeared to exist above the transgressive ravinement, indicating a likely marine origin following Holocene transgression. Core BOEMVC-2024-FL-03 penetrated below the interpreted transgressive ravinement and sampled 2 to 3 feet (0.6 to 0.9 meters) of clay, corresponding to the layered channel fill seismic facies. This supports the interpretation of the underlying paleochannel complexes representing the earlier history of fluvial and coastal systems active in what is now the shelf and is similar to the stratigraphic successions observed in southern Georgia (Meisburger and Field, 1976; Long et al., 2021).

In between the northernmost shoal complex and the central shoals and borrow areas (B4, NA7-R040) there exists a relatively featureless bathymetric low. These lows appear to correlate with areas of minimal to no surficial sediment deposition, with relict strata, paleochannels, and deeper basement stratigraphy outcropping at the seafloor (Figure 47). This supports earlier interpretations that found extensive but concentrated inner shelf sand and sediments within the region, separated by areas of erosion or non-deposition potentially related to continued scouring and transport (Meisburger and Field, 1976). Moving south along Line 102 the shoal associated with potential borrow area B4 becomes a prominent bathymetric high, with a similar character to the upper component of the northern shoals and archival cores indicating potential restoration compatible sediment up to 10 feet (3.0 meters). The shoal associated with B4 appears to have a more complex internal facies compared to the northern units despite having a very similar sedimentological composition. While much of the shoal appears homogenous and sand-rich above the transgressive ravinement with layered fine-grained channel fill below, in other areas archival cores indicated relatively thick (3 to 5 feet [1 to 1.5 meters]) sand-rich units below the erosional boundary (Figure 47). This is likely the result of the underlying paleochannel complexes being highly variable in lithology due to their compound nature but does indicate future efforts should be careful to full constrain the variability of environment potentially captured in a single succession.

Borrow Area NA7-R040 was sampled with vibracores BOEMVC-2024-FL-05 and BOEMVC-2024-FL-07, which indicate the surficial thin sand unit has sands with a higher fine content (silt/clay) and is likely not beach compatible. However, historic vibracores closer to B5 and NA5-R056 in the deposit indicate that the southwestern portion of NA7-R040 could be sandier than the north/northeast portion of the deposit. Towards the east, within deposits NA10-R056 and M1, seismic Line 105 along with FL-BOEM-2015-VC06 indicate that the topographic high associated with NA10-R056 could be a potential resource; however, sidescan data at the northern edge of line 105, within M1, shows exposed consolidate sediments which indicates the potential for hardbottom in the area. Overall, DU9-R003, sampled by historic cores NCVB-15-08 and NCVB-15-13 and BOEMVC-2024-FL-06, BOEMVC-2024-FL-08, BOEMVC-2024-

FL-09 and BOEMVC-2024-FL-10 show that DU9-R003 has the potential to have some beach compatible resources (Figure 46).

Figure 46: Identified resources offshore Nassau County

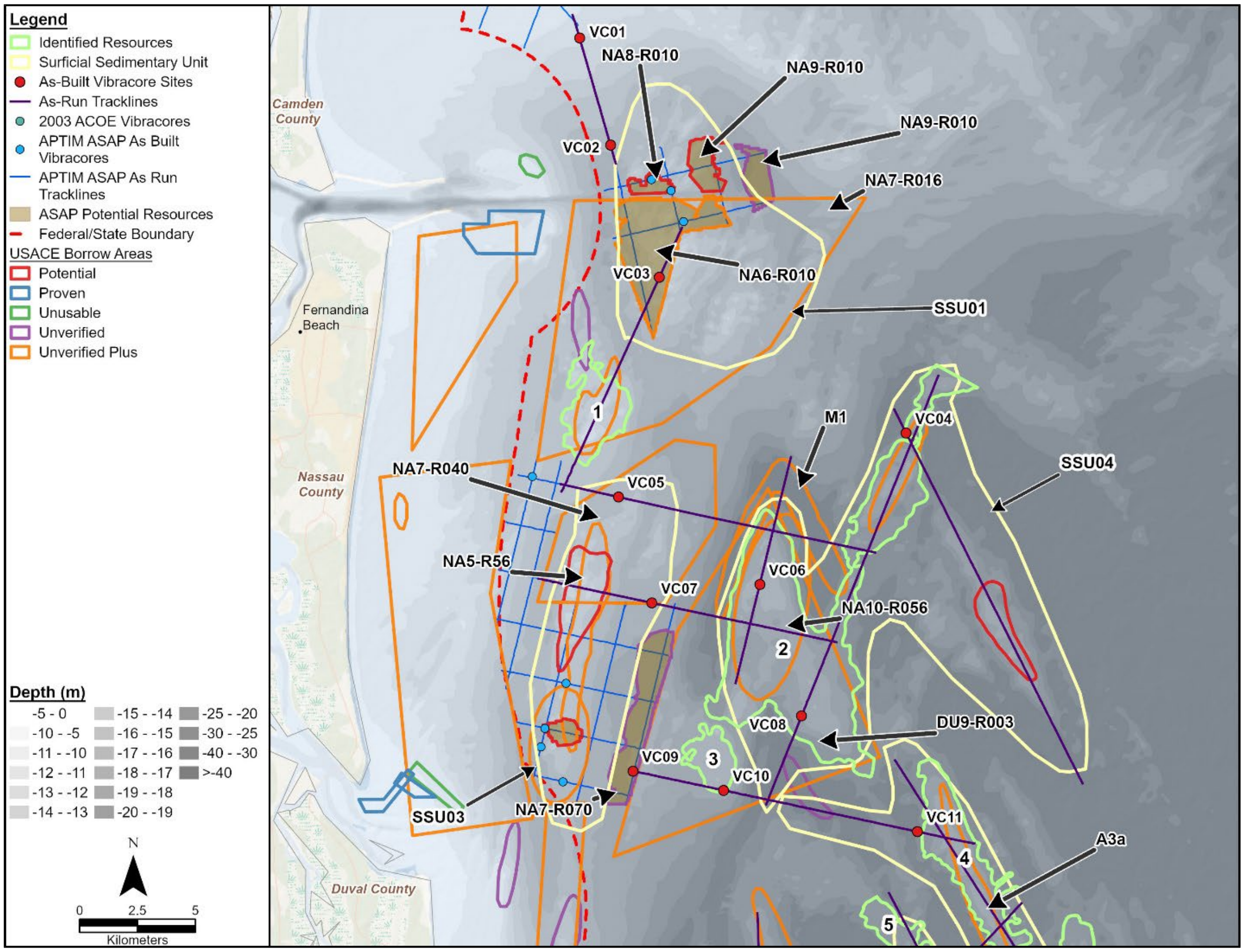
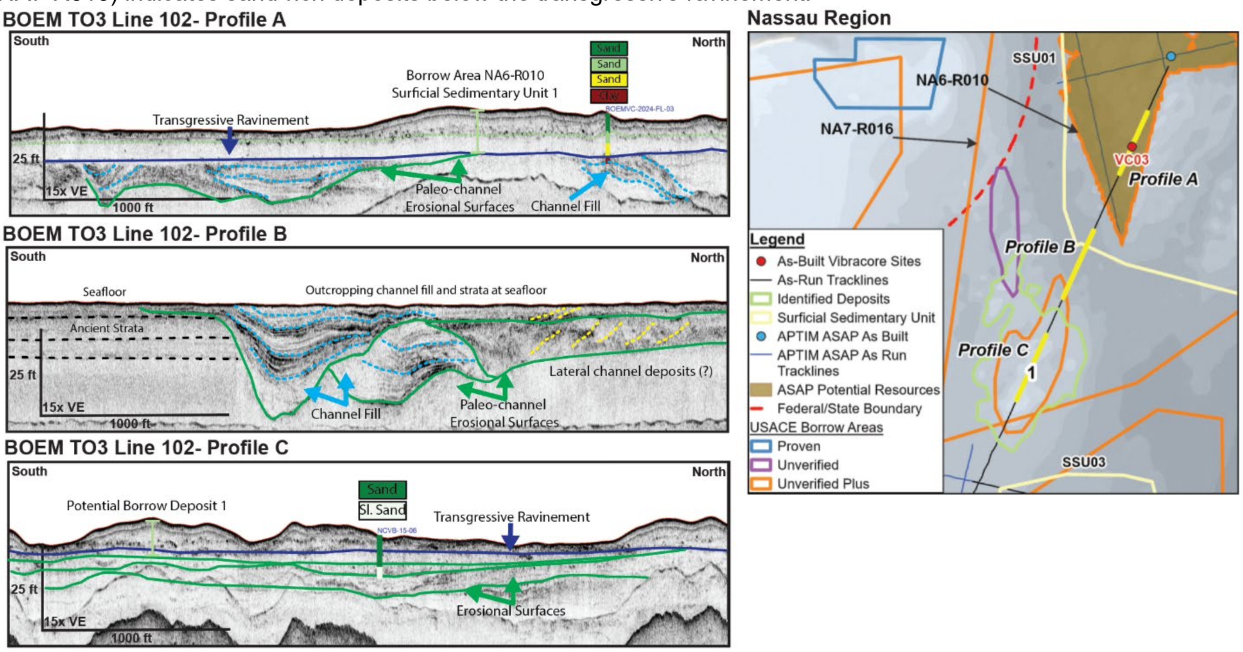


Figure 47: BOEM TO3 Line 102 over Potential Borrow Areas NA6-R010 and B4
Profile A shows NA6-R010 composed of sand-rich shoal facies atop the transgressive ravinement which truncates an underlying paleochannel complex- note the entirety of the sand facies exists above the ravinement. Profile B illustrates typical outcropping relict strata at seafloor in bathymetric lows between shoals. Profile C shows position of Identified Resource 1 (BA NA7-R016) located above paleochannel complex. Note that Identified Resource 1 (BA NA7-R016) indicates sand-rich deposits below the transgressive ravinement.



In Duval County (Figure 48) USACE borrow area NA7-R070 delineated based on the seismic data from the BOEM ASAP project was sampled by BOEMVC-2024-FL-09 and characterized as having mostly finer-grained sands similar to that found in FL-BOEM-2015-VC21. Further towards the east along Line 108, BOEMVC-2024-FL-10 in DU9-R003 and BOEMVC-2024-FL-11 collected on the edge of the A3a deposit, indicated that those deposits contain less fine-grained sediments and are likely more beach-compatible than NA7-R070. Although BOEMVC-2024-FL-11, taken along the flanks of the shoal deposit, only has roughly 5 feet (1.5 meters) of beach compatible resources, it can be extrapolated to help characterize A3a which, together with BOEMVC-2024-FL-16 indicates that there is roughly 82.4 million cubic yards (63 million cubic meters) of potential resources on A3a.

The exploratory line collected along the long axis of Potential Deposit 5 located between A3a and A4 was sampled by BOEMVC-2024-FL-15 and BOEMVC-2024-FL-12. Results indicate this narrow deposit may be roughly 9 feet (2.7 meters) thick and surrounded by consolidated sediments. Additional work would be required to further characterize the deposit but estimates of the potential resource volume could reach 17.9 million cubic yards (13.6 million cubic meters) on this shoal. Area A4, bounded in the northeast by exposed hardbottom, appears to be variable in its sand quality, but has the potential to have roughly 53.4 million cubic yards (40.8 million cubic meters) of resources in its northern area near vibracores BOEMVC-2024-FL-13 and BOEMVC-2024-FL-14. Along the central portion of A4, the seismic data indicated the presence of several small shoals. The extent of these deposits would require additional geophysical and geotechnical data to constrain it, as several of the historic cores (CB-DUC03-27, CB-DUC03-32, CB-DUC03-33, and CB-DUC03-37) show evidence for shallow limestone across the area. Along the southern portion of A4, outside of the USACE Borrow Area, the seismic data corroborated the presence of a larger deposit around CB-DUC03-42, CB-DUC03-39, and CB-DUC03-45, which could be a potential replacement for the current F1 borrow area which is being depleted. However, when the geophysical data are correlated to the CRM data, it appears that the bathymetric high associated with the potential resource could be impacted by the submarine cables coming out of Jacksonville/Neptune Beach. As expected, the area closer to shore within M3a, A5, and M3b is also highly variable with small shoals that have seismic characteristics indicating small, localized deposits. These would require additional geophysical and geotechnical data to further verify their properties, but these small shoals could be a resource for future smaller nourishment projects. It is important to note that when processing vibracore BOEMVC-2024-FL-17 located in the M3a USACE borrow area, samples taken below 5 feet (1.5 meters) showed evidence of burning during low temperature drying, which would likely require additional testing and/or environmental mitigations if the area were to be developed into a potential resource.

Figure 48: Identified resources offshore Duval County

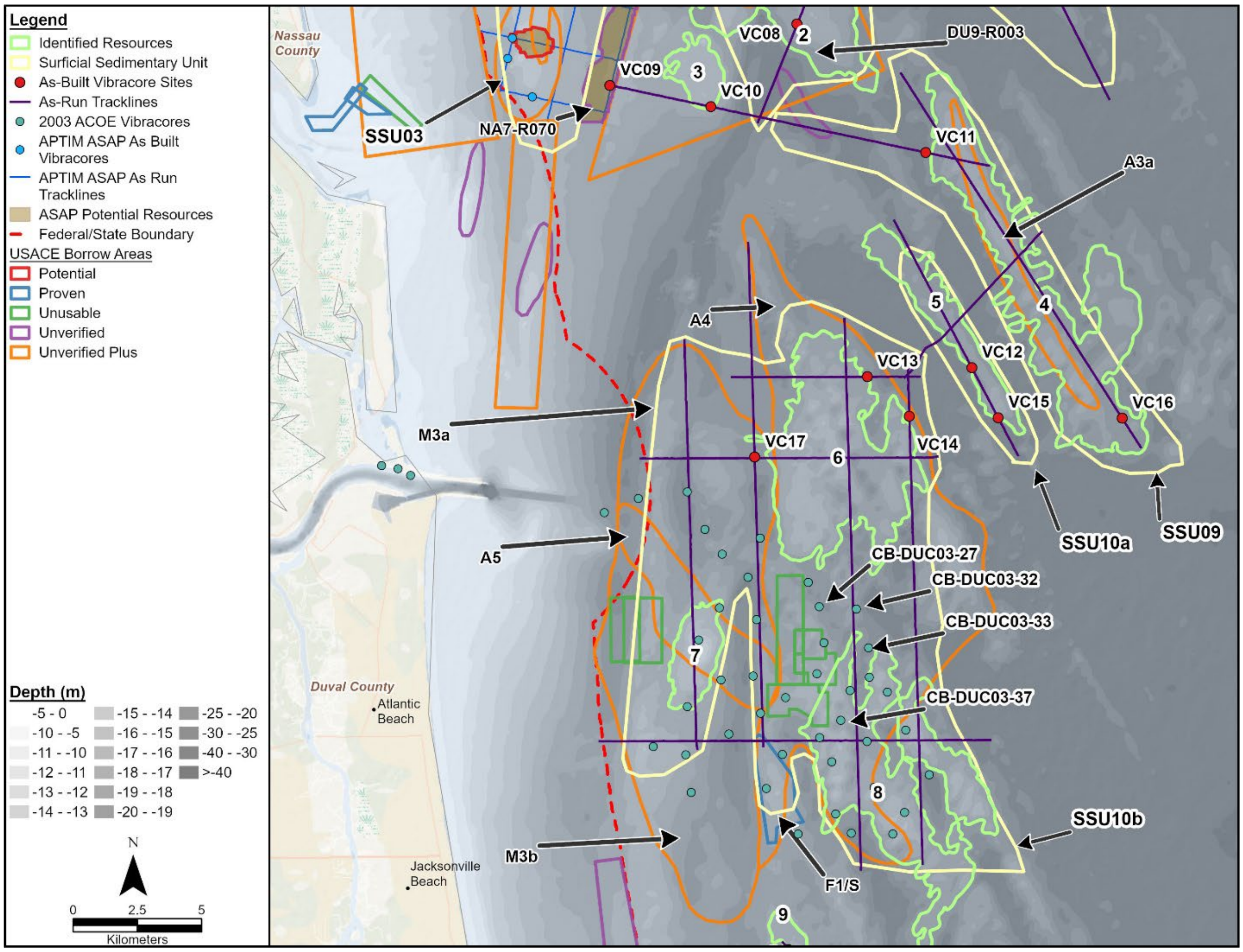
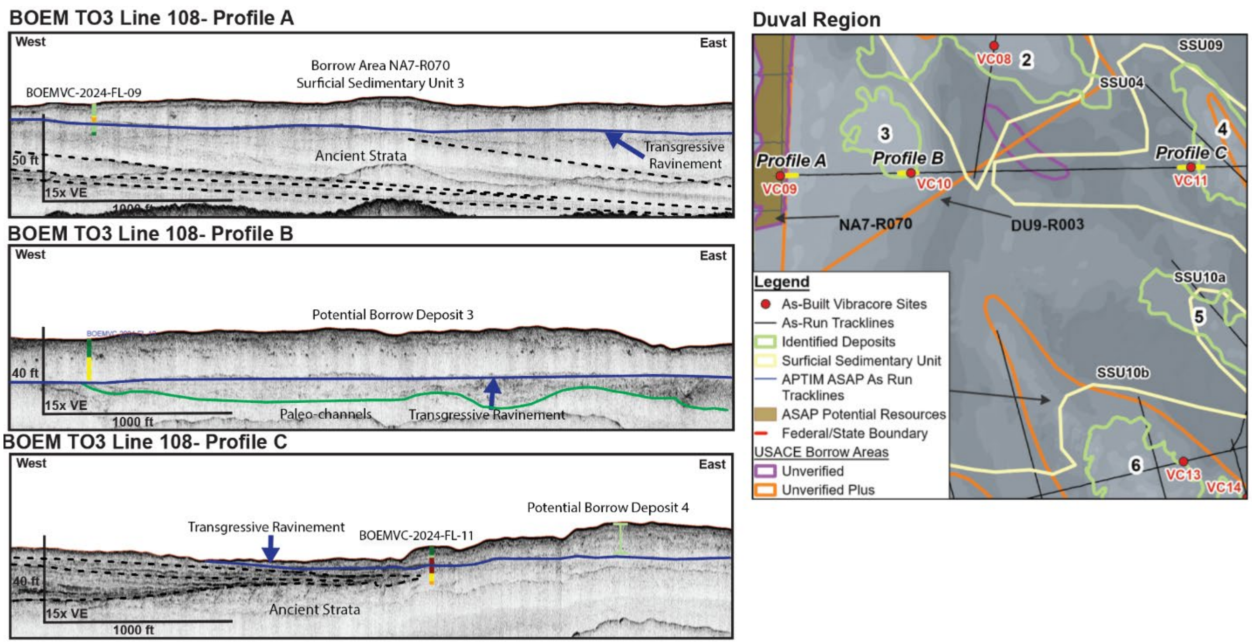


Figure 49: BOEM TO3 Line 108 over Potential Borrow Areas NA7-R070 and Identified Resource 3 and 4

Profile A shows NA7-R070 composed of sand-rich shoal facies atop the transgressive ravinement which truncates a deep layered ancient stratigraphy- note the entirety of the sand facies exists above the ravinement. Profile B over Identified Resource 3 (BA DU9-R003) illustrates typical sand-rich shoal deposits above the transgressive ravinement. Profile C shows position of Identified Resource 4 (BA A3a) located above ancient stratigraphy and adjacent to outcropping estuarine or valley fill.



Nassau and Duval Counties Regional Strategic Questions

1. What is the composition, quality, and extent of any potential resources identified?

The identified resources in the Nassau and Duval region (1-8) consisted mostly of sand shoals with varying sand quality ranging from as fine as 2.29 phi (0.20 millimeters) to as coarse as 2.01 phi (0.25 millimeters). Most identified resources (besides resource 5) coincide in some way with existing identified USACE Borrow Areas. Additionally, Identified Resource 8 (BA A4) indicated the potential for additional beach compatible sands outside of the established USACE boundary. Exploratory data collected between A4 and A3a provided a new potential resource that is closer to shore than A3a.

2. Based on the resulting data collection should any areas be recommended for further investigation by design-level survey or eliminated from further consideration?

Although the region is highly variable in its sand composition, Identified Resources 4 (BA A3a), 5, 6 (BA A4), and 8 (BA A4) could likely benefit from additional mapping and sampling to further constrain their sand boundaries. Resource 4 (BA A3a), although further from shore, appeared to have a large volume potential that could be utilized in upcoming years. Identified Resource 5 could benefit from additional data to further determine its potential volume and how it relates to Identified Resources 4 (BA A3a) and 6 (BA A4). Identified Resource 8 (BA A4) would be an easy replacement for current borrow area F1 that is being used for several renourishment projects and likely to be depleted soon; however, historic cores indicated the presence of shallow limestone that would require additional mapping to further define the boundary of the usable sand. Geotechnical data collected in the NA7-R070 resource identified from the ASAP geophysical data likely eliminated that area as a potential resource due to the high fine content in BOEMVC-2024-FL-09. Additionally, geotechnical data collected in NA7-R040 (BOEMVC-2024-FL-05 and BOEMVC-2024-FL-07) indicated that the deposit is likely not beach compatible due to the higher content of fines (silt/clay) in the sampled shoal.

3. What is the geologic origin and evolution of the resource deposits identified?

All newly identified and delineated sediment resources are surficial sedimentary deposits that closely align with the presence of bathymetric highs, or shoals. These shoals primarily appeared to be the result of shelf oceanographic processes, with variable sand content and acoustic facies of the surficial unit sitting atop a sharp erosional boundary, likely the transgressive ravinement. The shallow stratigraphy below these deposits is highly variable between layered strata, shallow acoustic basement, and ubiquitous paleochannels or erosional valleys representing a long history of cut and fill processes. The majority of the surficial units and potential resource deposits have a fairly similar geophysical acoustic facies of transparent to chaotic character that often represents sand-rich units, which is confirmed by available geologic sampling. The variability in sand (from fine to coarse) and the presence of interbedding is also typical of shelf sedimentary processes. Some of the potential resource deposits have more than one internal unit, with some of the shoals appearing relatively uniform above the interpreted ravinement while others have an internal layered facies indicating their origin as a mostly reworked relict unit.

6.2.2 Flagler and St. Johns Counties

The Flagler and St. Johns region is also located on the northern Florida shelf, immediately south of the Nassau and Duval region (Figure 50 and Figure 51). This investigation was designed to address regional strategic questions, investigate whether several modeled shoals and bathymetric highs are potential sediment resources, and recommend areas for further analysis. The regional shelf geology is broadly similar to that observed northward, with numerous shoal complexes overlying a high density of stratigraphic paleochannels, valleys, and other units with highly variable preservation.

Figure 50: Collected data offshore St. Johns County

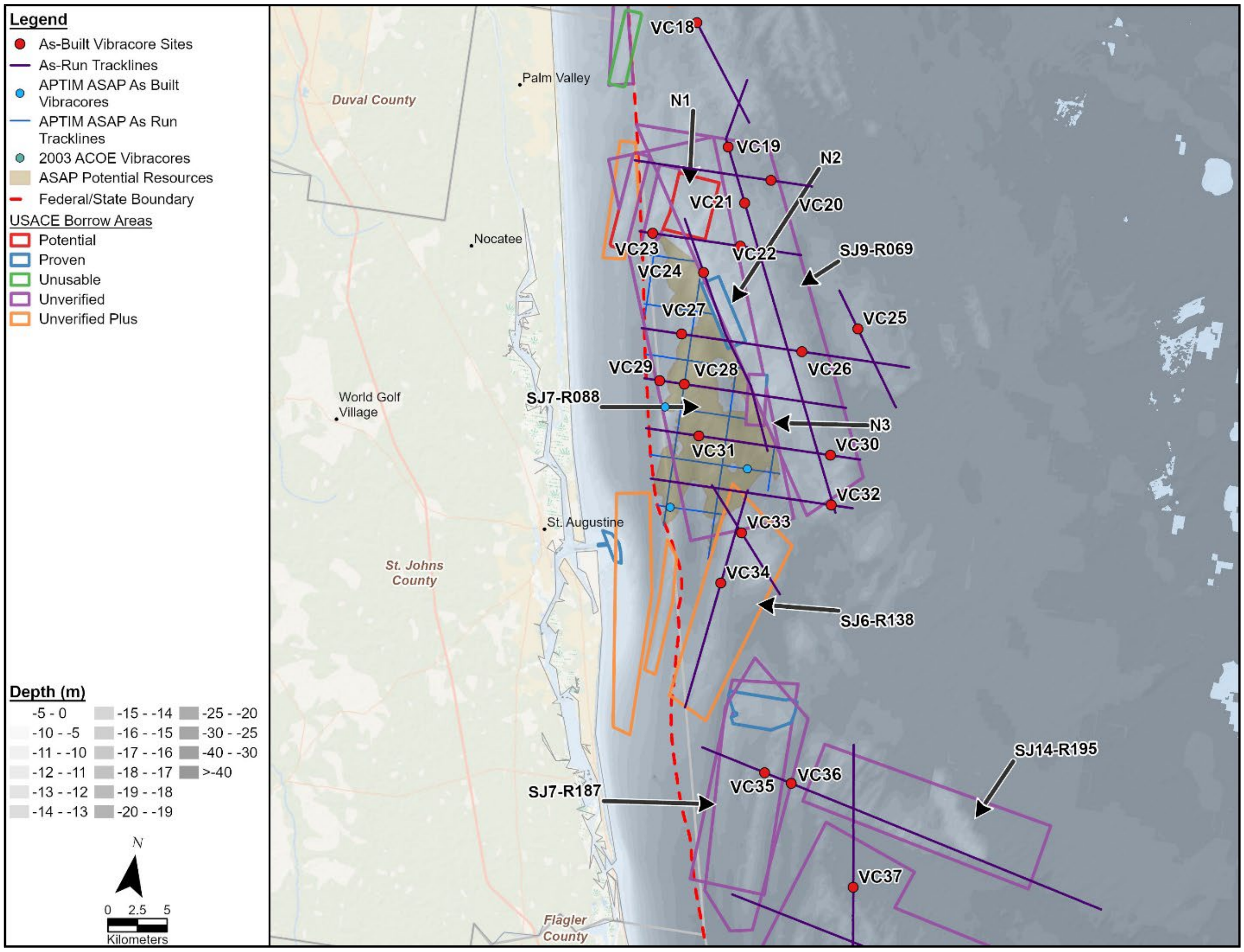
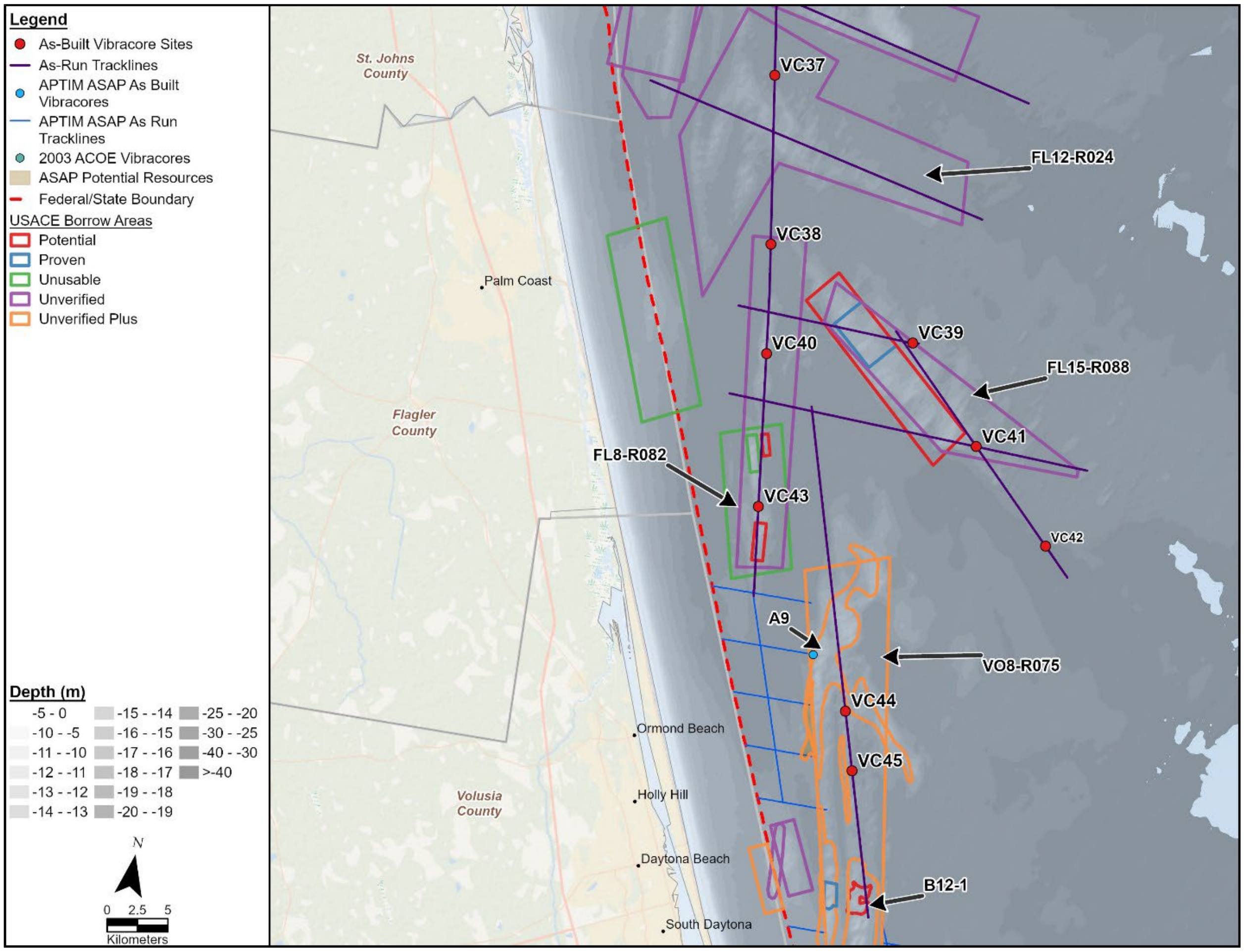


Figure 51: Collected data offshore Flagler County



The Flagler and St. Johns region contains 37 magnetic anomalies in total. These anomalies consist of 12 monopolar, 23 dipolar, and 2 multicomponent anomalies. Their amplitudes range from 5.28 to 558.65 nT, durations from 12.1 to 169.98 feet (3.69 to 51.81 meters), and four (4) of the anomalies were interpreted to be potentially associated with sidescan sonar contacts or known features. Thirty-three of the anomalies within the Flagler and St. Johns region are described as unknown/modern debris.

Sidescan sonar interpretations in the region characterized the seafloor as being mostly sand, including patches of sand and sand ripples with isolated pockets of fine grain sediments (silts/mud). Sand was observed throughout the whole study area. Sand ripples were observed running shore-parallel continuously along line 128. An artificial reef known as Streeks Reef East, was observed on Line 137. A total of 16 sidescan sonar contacts were identified within the Flagler and St. Johns region including those associated with Streeks Reef East and multiple unknown high intensity features.

Offshore northern St. Johns County, seismic Line 119 and vibracore BOEMVC-2024-FL-18 (Figure 52) indicated that the bathymetric high sampled south of currently charted submarine cables could be sandy in nature. When combined with the potential resource along the southern part of Duval County (east of Borrow Area F1), this indicated the installation of new submarine cables in this region could be in conflict with access to future sand resources.

Similar to the Nassau and Duval region, there are several resources already identified in the St. Johns and Flagler region that were further sampled with the geophysical and geotechnical data collected during this study. Offshore St. Johns County, several USACE Borrow Areas have already been identified, the biggest of those being SJ7-R88 (identified from the ASAP data) and SJ9-R069. Within SJ9-R069 geophysical and geotechnical data adjacent to borrow areas N1, N2, and N3 were collected to help determine if the current footprint of those deposits could be expanded. Vibracore BOEMVC-2024-FL-24 north of N2, shows roughly 13 feet (4.0 meters) of beach compatible resources and targets the same bathymetric high as N1, N2, and N3. Additional geotechnical data within SJ7-R88 and SJ9-R069 confirms the variability of the deposit within the existing footprint, with some portions of the bathymetric high being sandier than others as shown by the northern portion of SJ9-R069 (sampled by BOEMVC-2024-FL-22) appears to have a smaller volume of beach-compatible resources than the southern portion of the delineated borrow area (sampled by BOEMVC-2024-FL-30 and BOEMVC-2024-FL-32). Seismic Line 122, 123, and 124 collected between SJ7-R88 and SJ9-R069, supports that SJ7-R88 and SJ9-R069 have similar geotechnical properties and that the boundary delineating both resources could be combined and then adjusted to better highlight the viable resources within the region by using the new data and the CRM data to identify the sand resource bathymetric high.

Vibracores taken closer to shore (BOEMVC-2024-FL-28, BOEMVC-2024-FL-29, and BOEMVC-2024-FL-31) as well as additional nearshore geophysical data, support the original assumptions that the area closer to shore does not have any significant sand resources and is mostly a thin (2 feet [0.6 meters]) sand layer over a fine-grained sand/clay unit.

The offshore shoal seaward of SJ9-R069 was explored by seismic Lines 124 and 125 and vibracore BOEMVC-2024-FL-25. Initial results suggest this area could have roughly 113.1 million cubic yards (86.4 million cubic meters) of sand when correlated to the CRM model. Given the high variability in sand quality found in resources closer to shore, it is expected that significant additional geophysical and geotechnical data are required to further constrain and more reliably estimate the usable volume in this shoal (Figure 53).

Figure 52: Identified resources offshore St. Johns County

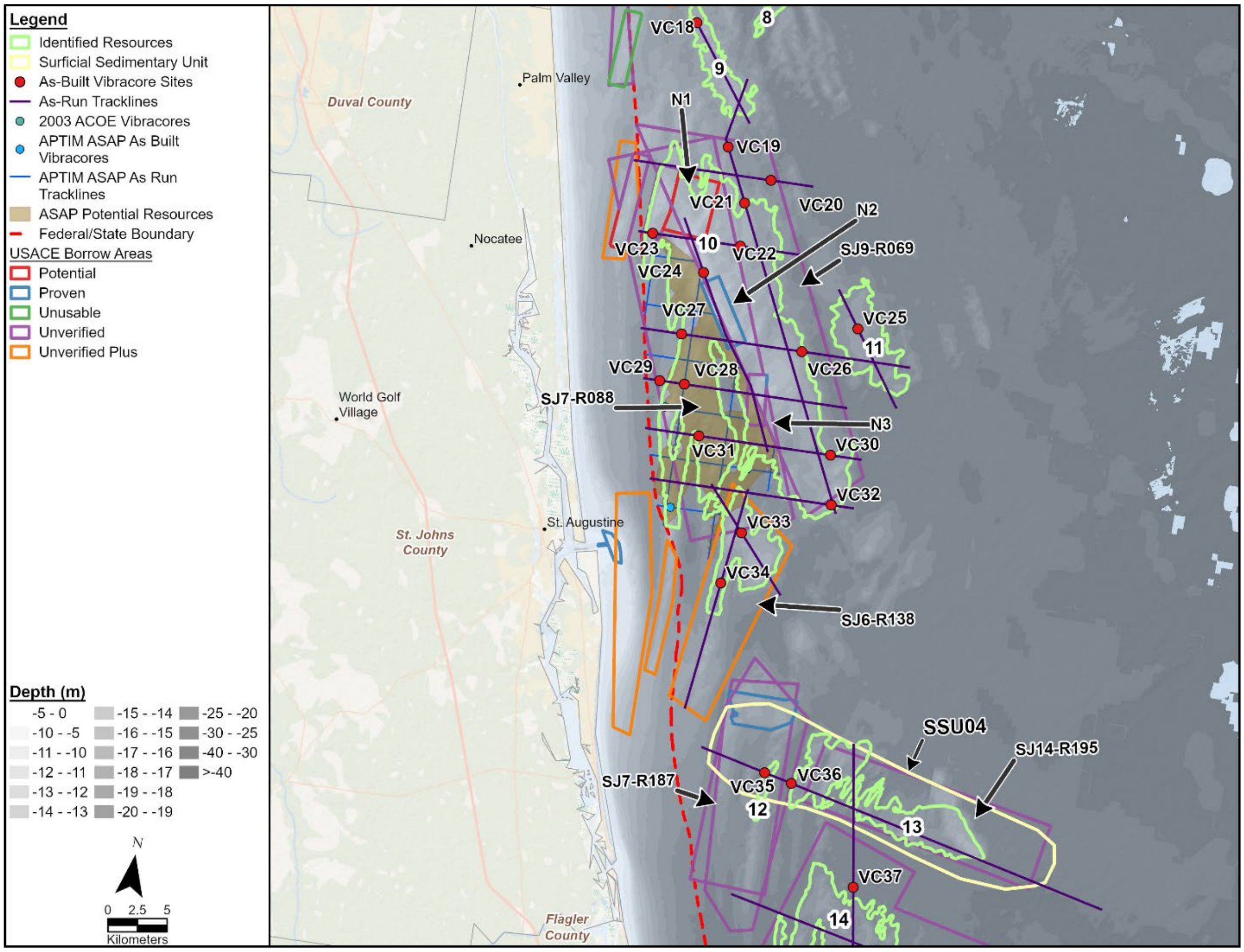
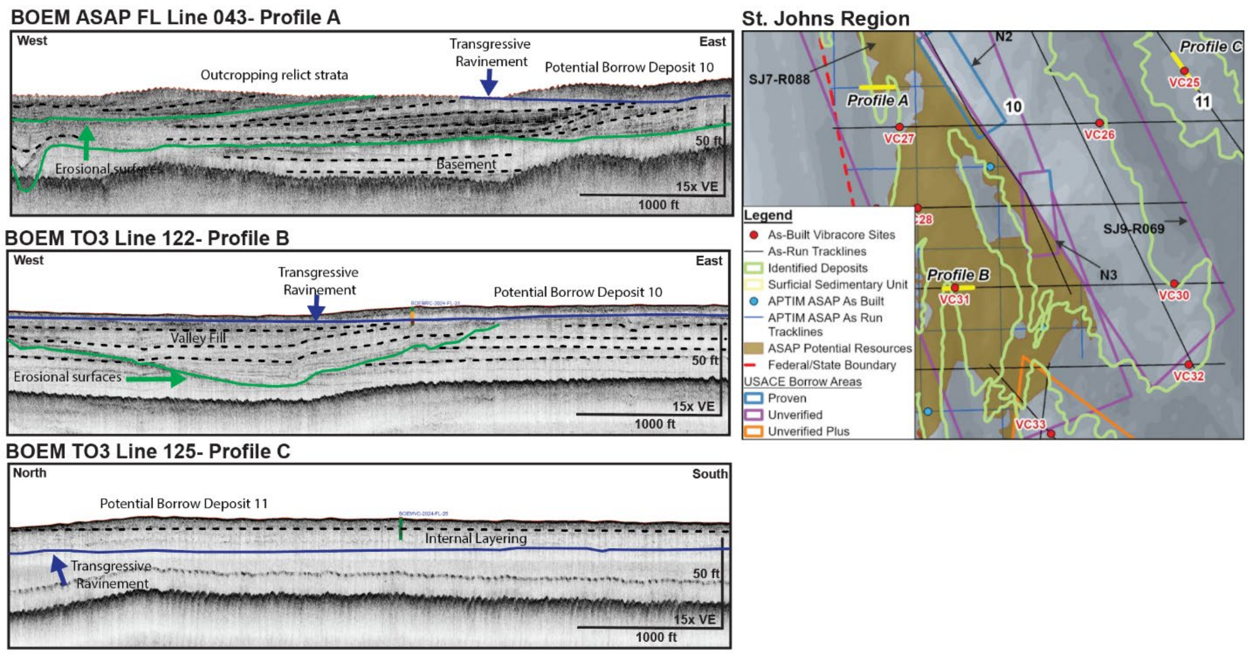


Figure 53: BOEM ASAP Line 043 and TO3 Line 122 over Identified Resource 10 (BA SJ9-R069/SJ7-R088), TO3 Line 125 over Identified Resource 11

Profile A shows the presence of outcropping relict strata immediately west of Identified Resource 10 (BA SJ9-R069/SJ7-R088). Resource 10 (BA SJ9-R069/SJ7-R088) sits atop the underlying paleochannels and valley fill, separated by the transgressive ravinement. Profile B illustrates the variable thickness but consistent sandy nature of the shoals in this area, sitting above clay-filled paleochannels and valleys that become exposed at the surface closer to the modern coast. Profile C is an example of the newly defined Identified Resource 11 with a 20-30 feet (6.1-9.1 meters) thick surficial sedimentary unit bounded below by the transgressive ravinement.



Within SJ6-R138, seismic line 129 and 130 as well as vibracores BOEMVC-2024-FL-33 and BOEMVC-2024-FL-34 indicate that the beach compatible sand within the delineated USACE boundary is localized to the northern part of the deposit, with the thicker unit closer to BOEMVC-2024-FL-33 (~11 feet [3.35 meters]) and thinning towards BOEMVC-2024-FL-34 (~5 feet [1.52 meters]). When geophysical and geotechnical data are correlated to the CRM, it is likely that the usable sand resource is bounded by the -59 feet (-18 meters) contour.

Within the Flagler County region (Figure 54), seismic and geotechnical data indicate that the targeted shoal deposits are overtop paleochannel systems filled with clays and fine-grained sands. Overall, the sand shoals are isolated to specific areas with the channel systems likely exposed at the seafloor in the areas between the shoals. Due to the complexity of the region, additional reconnaissance geophysical data would be required to further constrain these deposits and properly delineate their boundaries.

Within the shoal complex off of southern St. Johns County a series of previously identified borrow areas had been defined, identified as SJ7-R187 and SJ14-R195. Seismic stratigraphic mapping indicates that the proven borrow area of SJ7-R187 and the potential area of SJ7-R195 both fall within a surficial sedimentary unit containing at its center the shore-oblique shoal field (Figure 55). Vibracore BOEMVC-2024-FL-35 taken in SJ7-R187 targeted a small shoal with a potential gross volume of 2.4 million cubic yards (1.8 million cubic meters) when correlated to the CRM model. Stratigraphic and bathymetric analyses indicate there is minimal additional resource occurrence to the north or south of the SJ7-R187 proven borrow area. To the west, the bathymetric highs appear to be related to relict stratigraphy of variable lithology rather than shelf sand deposits. However, BOEMVC-2024-FL-36 and seismic data indicate that between SJ7-R187 and SJ14-R195 there is a continuous surficial sedimentary unit containing potential resource deposits designated 12 (BA SJ7-R187) and 13 (BA SJ14-R195) (this study), and the existing footprint of the USACE Borrow Areas can likely be expanded. Data collected in USACE borrow area SJ14-R195, indicates that the portions of the sand deposits associated with the topographic highs are beach compatible; however, the thickness of the sand deposits varies throughout the area with the northeastern portion being 3 to 5 feet (0.9 to 1.5 meters) thick and the southwest portion 10 to 15 feet (3 to 4.5 meters). There is the potential of roughly 100.2 million cubic yards (76.6 million cubic meters) of resources in the area that are concentrated in pockets due to the variable thicknesses, with the larger resource along the central part of SJ14-R195, when correlated to the CRM model.

Figure 54: Identified resources offshore Flagler County

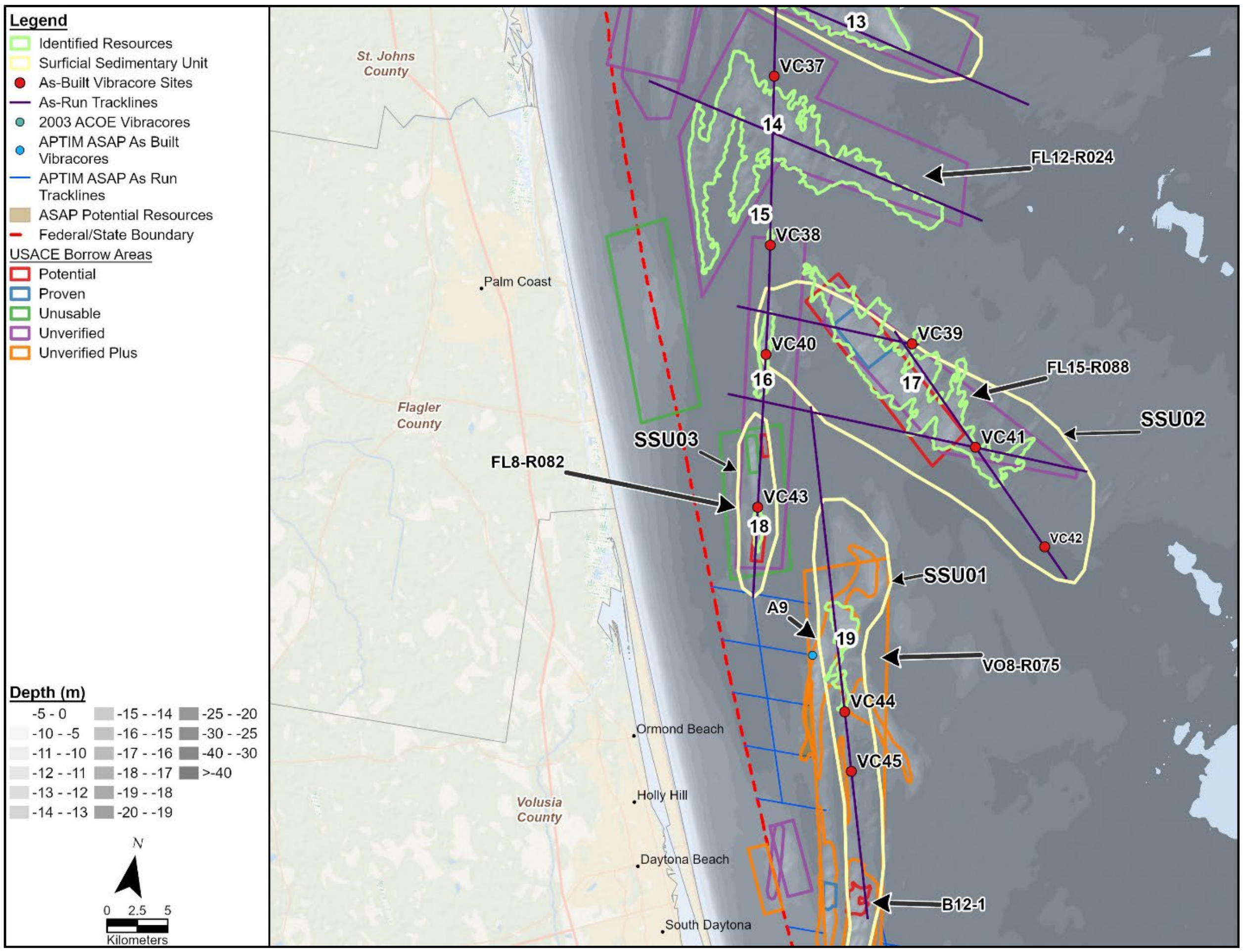
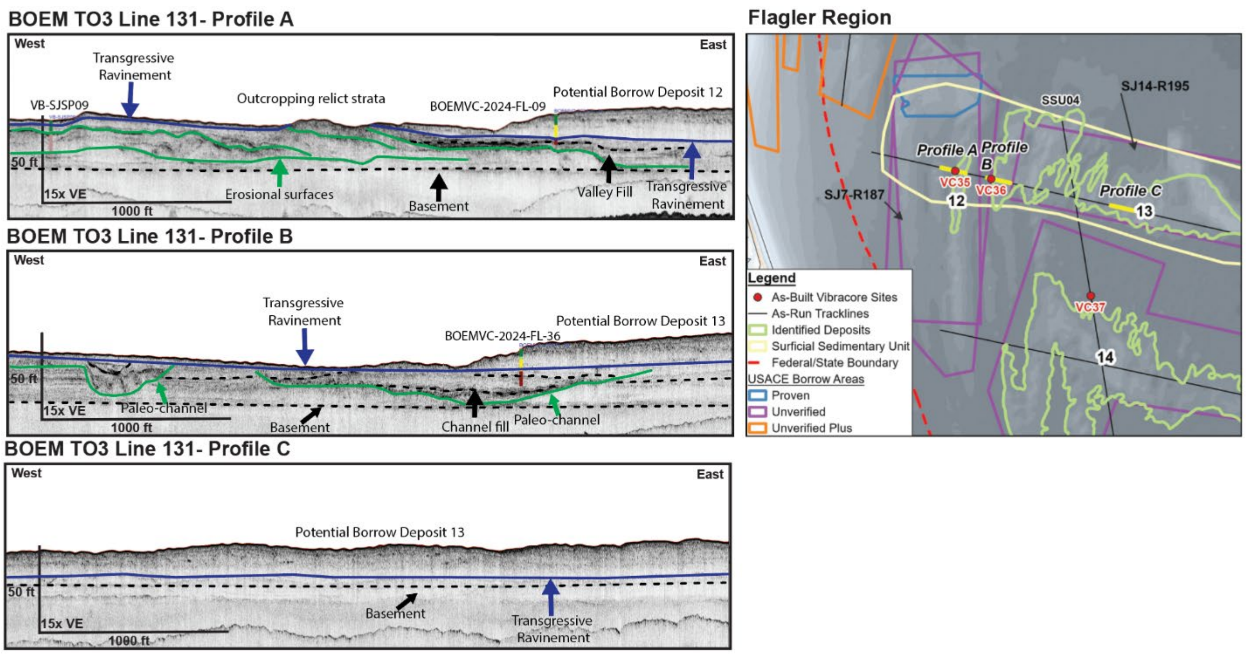


Figure 55: BOEM TO3 Line 131 over Borrow Areas SJ7-R187, SJ14-R195 and Identified Resources 12 and 13

Profile A shows the presence of outcropping relict strata and thin modern sediments west of Identified Resource 12 (BA SJ7-R187). The main shoal sand body is separated from underlying channel fill deposits by a well-defined transgressive ravinement. Profile B is an example of the variable thickness along the axis of the shore-oblique shoals, where the shelf sands thin rapidly before thickening. Identified Resource 13 (BA SJ14-R195) appears uniformly to overlie the transgressive ravinement and extends seaward.



The overall surficial sedimentary unit that contains the above potential resources is defined both by a clear erosional boundary between the uppermost sand-rich shoals from shallow basement lithology to the west as well as highly variable paleochannel and inlet complexes throughout the study area. The shoals and surficial units dramatically thin moving shore-parallel off the crest, with the inter-shoal bathymetric lows containing outcropping relict strata or thin (1 to 4 feet [0.3 to 1.2 meters]) veneers of surficial sediment. The consistent observation of shallow seaward dipping basement stratigraphy to the west of the central and southern shoal complexes may indicate an underlying structural control on the preservation of clastic deposits available to be reworked and source the modern marine shoal fields.

Within unverified borrow area FL12-R024, geophysical and geotechnical data indicate that, similar to the northern area, the shoals are located overtop paleochannel systems. The sand resource boundary interpreted from the seismic data would require additional geotechnical data to further determine its properties and if the shoal is indeed beach compatible, however the correlation between the CRM model and the calculated isopach indicates that the area could be a significant resource.

Further south, in FL8-R082, vibracores BOEMVC-2024-FL-38 and BOEMVC-2024-FL-40 indicate that there are a couple of small, isolated shoals within the unverified borrow area. Estimated gross volumes within these potential resources are 0.05 and 7.5 million cubic yards (0.041 and 5.7 million cubic meters), respectively. Further south, within potential borrow area 2C, seismic line 133 and vibracore BOEMVC-2024-FL-43 indicate that the resource likely correlates with the -59 feet (-18 meters) bathymetric contour and potentially extends further north than the current 2C boundary indicates.

On the northeastern edge of FL15-R088 seaward of Area 3A, an active borrow area, vibracore BOEMVC-2024-FL-39 shows the beginning of what appears to be a large shoal deposit that was not fully mapped with seismic line 136, and may indicate additional resources extending beyond the currently delineated boundary of FL15-R088. Within the southern portion FL15-R088, seismic line 134 and 135 and vibracore BOEMVC-2024-FL-41 indicate a potential resource with the gross volume of 113.5 million cubic yards (86.8 million cubic meters). Further south, outside of the identified USACE Borrow Areas, BOEMVC-2024-FL-42 targets the landward flank of a shoal; however, due to the orientation of the line and the reconnaissance spacing it is hard to delineate the lateral extents of the deposit in order to calculate a potential volume.

Similar to the northern Flagler County region, seismic data indicate that shoal features within V08-R075 overlie paleochannel systems and these shoal deposits pinch in and out throughout the line, with the larger potential resources to the north. Geotechnical data show the presence of several small shoals within what is the A9 footprint, which comprises the associated bathymetric high. BOEMVC-2024-FL-45 indicates that the areas between the shoals may not be beach compatible; however, BOEMVC-2024-FL-44 and FL-BOEM-2015-VC10 indicate at least 8 feet (2.4 meters) of quality sands in some of these shoal features. Overall, the northern portion of borrow area A9 has a consistent shoal feature that pinches out heading south into the middle of the borrow area and comes back in the southern region. The portion of seismic line 137.001 that is within borrow area B12-1 coincides with a small shoal seen at the end of the seismic line. Additional geophysical and geotechnical data along the north/central and southern parts of V08-R075 would be beneficial in further constraining these resources.

Flagler and St. Johns Regional Strategic Questions

1. Do these areas show the potential for sediment resources in excess of 5 feet (1.5 meters)?

This study identified numerous potential resources exceeding 5 feet (1.5 meters) thickness offshore both Flagler and St. Johns region. Importantly, these resources are located along both the typical shore-parallel shoals as well as the shore-oblique shoal complexes present offshore Flagler County. These resources consist primarily of surficial sand shoals with variable grain size ranging from as fine as 2.37 phi (0.19 millimeters) to as coarse as 1.67 phi (0.31 millimeters). Along the northern area of the region offshore St. Johns County, most of the identified features are thicker than 5 feet (1.5 meters), with the most promising regions further offshore according to the interpolated data using the CRM (resources 10 [BA SJ9-R069/SJ7-R088] and 11). The furthest offshore region mapped as part of this survey indicates the presence of sand that is roughly 16 feet (4 meters) thick in resource 11. Similar to St. Johns County, the thicker sand resources off Flagler County are located further offshore. The shore-oblique deposits identified (12-17) indicate that there is a high variability in the sediment composition of these resources. However, based on the data collected, the seaward-most portion of the identified resources indicates a thickness up to 10 to 12 feet (3.0 to 3.6 meters) in resources 14 (BA FL12-R024) and 17 (BA FL15-R088) in some portions of the deposit.

2. What are the trends and variability of the sediment among these similar shore-oblique shoal features?

The shoal fields located in the Flagler and St. Johns region have surficial morphology that can be grouped into two general types: shore-parallel and shore-oblique. This study investigated three shore-oblique shoals in the center of the study area to investigate their potential as resource deposits and the underlying geologic processes. The three shoals each correspond to a local surficial sedimentary unit that is correlated but more extensive than the bathymetric highs of each. These shoals thin rapidly to the north and south and are separated from each other by areas of minimal modern shelf sedimentation and complex outcropping relict strata. The shore-oblique shoals have a variable internal stratigraphic architecture ranging from homogenous sand deposits of shelf origin to bathymetric highs containing severely eroded and reworked relict landforms related to earlier depositional systems. The core of the shore-oblique shoals consistently appears to be of modern shelf origin and overlie a clearly defined transgressive ravinement. These most-promising resource deposits appear to thin landward and disappear entirely, while they appear to extend seaward out of the current region of geophysical investigation, while the inter-shoal bathymetric lows contain outcropping relict strata or thin (1-4 feet [0.3-1.2 meters]) veneers of surficial sediment. The surficial sedimentary unit containing the newly identified potential resources is consistently located above a clear erosional boundary, likely the transgressive ravinement, that separates the sand-rich surficial sediments from both shallow basement lithology and highly variable subsurface paleochannel and inlet complexes. The consistent observation of shallow seaward dipping basement stratigraphy to the west of the central and southern shoal complexes may indicate an underlying structural control on the preservation of clastic deposits available to be reworked and source the modern marine shoal fields.

3. What are the seaward extents of some of these more promising deposits?

As mapped and delineated with the data collected during this study, the thickest sand resources are located further offshore. From the correlation of the geophysical, geotechnical and CRM, it is likely that the sand resource correlates with the 52.5 to 65.6 feet (16 to 20 meters) bathymetric contour of the model. Because these resources are variable in their composition and beach compatibility, additional data should be collected in order to further verify the composition of the resources, but they could be present 14 to 17 miles (22.5 to 27.3 kilometers) offshore.

Identified resources located offshore Flagler and St. Johns Counties are hosted within broad surficial sedimentary units, shoals, and wave fields ubiquitous across this portion of the shelf. These surficial deposits vary greatly in thickness, from thin (sub-meter) veneers to shoals over 6m thick. These deposits also exhibit two general internal architectures:

1. Uniform facies overlying a sharp erosional unconformity, and
2. Variable internal structure within the topographic high of the shoal complex, including preserved channel forms and layering.

Also present throughout the region are numerous shallow stratigraphic paleochannels, inlets, and other features exhibiting highly variable sedimentary facies and apparent preservation. This indicates potentially two endmembers of the resource deposit origin:

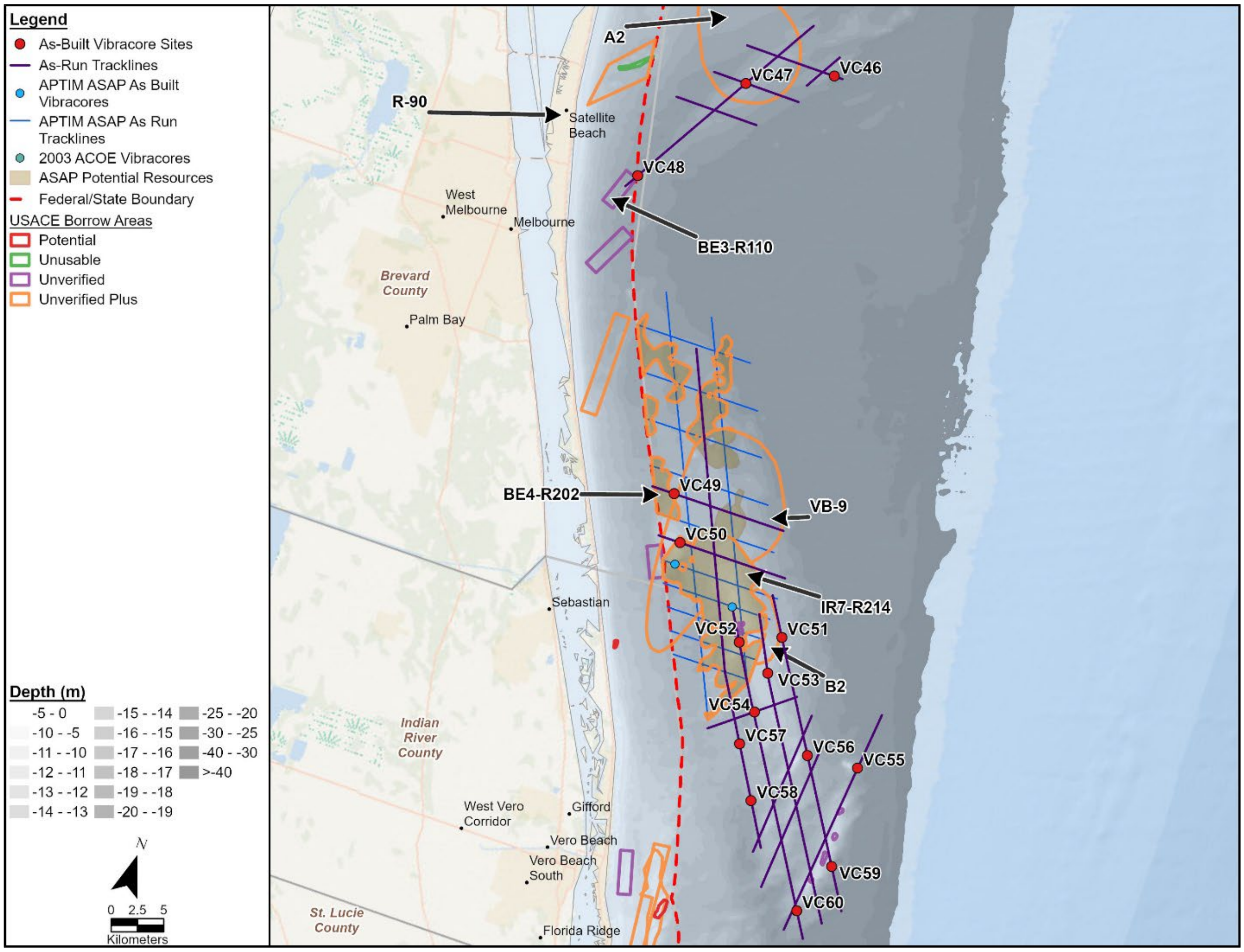
1. Resulting from marine oceanographic processes, and
2. Partially eroded and reworked relict landforms of earlier depositional environments.

The surficial units to the north along Identified Resource 10 (BA SJ9-R069/SJ7-R088) and 11 appear to represent both types of shoal formation, with potential relict stratigraphy located landward and shelf-transport deposits located seaward. The southern identified resources (12-19) appear uniformly to be of shelf origin, with no observed internal structure. These shelf deposits were likely sourced from ravinement and reworking of sand-rich deposits contained within the underlying paleochannel complexes.

6.2.3 Sebastian Inlet

The Sebastian Inlet region is located on the central Florida shelf south of Cape Canaveral (Figure 56). This location is marked by a dramatic narrowing of the continental shelf and the presence of several morphologically different shoal complexes reflecting differing geologic origins. The uppermost shelf stratigraphy in this region is marked by relatively shallow Eocene or Oligocene limestones, with variable thicknesses of clastic deposits that could host potential sand resources (Duane and Meisburger, 1971). Similar to the other regions, there are numerous potential resources and bathymetric highs that have little historic data, and the following investigation is intended to more fully characterize and expand resource inventories within an area of critical need.

Figure 56: Collected data offshore Sebastian Inlet Region



The Sebastian Inlet region contains 21 magnetic anomalies in total. These anomalies consist of 10 monopolar, 9 dipolar, and 2 multicomponent anomalies. Their amplitudes range from 5.2 to 492.01 nT, durations from 11.99 to 2158.84 feet (3.65-658.01 meters), and three of the anomalies were interpreted to be potentially associated with sidescan sonar contacts or known features. Eighteen (18) of the anomalies within the Sebastian Inlet region are described as unknown/modern debris.

Sidescan sonar interpretations in the region characterize the seafloor as being mostly sand, including patches of sand and sand ripples with isolated pockets of fine grain sediments (silts/mud). Sand ripples were observed the most throughout the whole region. A small section of hardbottom was interpreted on line 150. A wreck was observed on line 142.002 and was identified as ENC wreck 200404. A total of 46 sidescan sonar contacts were identified within the Sebastian Inlet region and represent a wreck, seafloor relief, and multiple unknown high intensity features.

Sand delineations in the Sebastian Inlet region further supported the identification of several deposits and identified some additional potential resources (Figure 57). The exploratory lines collected offshore monument R-90 corroborated the unverified plus USACE borrow area A2 (Figure 58). On the eastern side of seismic line 140, vibracore BOEMVC-2024-FL-46 indicates that the deposit could extend further offshore, past the original boundary of A2. Due to the limited reconnaissance data, APTIM is unable to identify the continuity from A2 to the new potential resource by only using the CRM model; therefore, they are being presented as separate deposits. Further south, within BE3-R110, seismic and geotechnical data indicate that the borrow area could have a higher shell content than other areas. The surface unit of BOEMVC-2024-FL-48 indicates that the area has a sandy shell hash layer followed by a thick clay unit. Since the surficial unit was only 0.2 feet (0.06 meters) thick, APTIM was not able to discern the corresponding seismic reflector to further trace the deposit into BE3-R110; however, it is likely that the deposit targeted by the borrow area could have a higher shell content. Additionally, with the placement of BOEMVC-2024-FL-48, APTIM was able to identify that BE3-R110 does not extend significantly past the federal/state boundary.

Figure 57: Identified resources in the Sebastian Inlet region

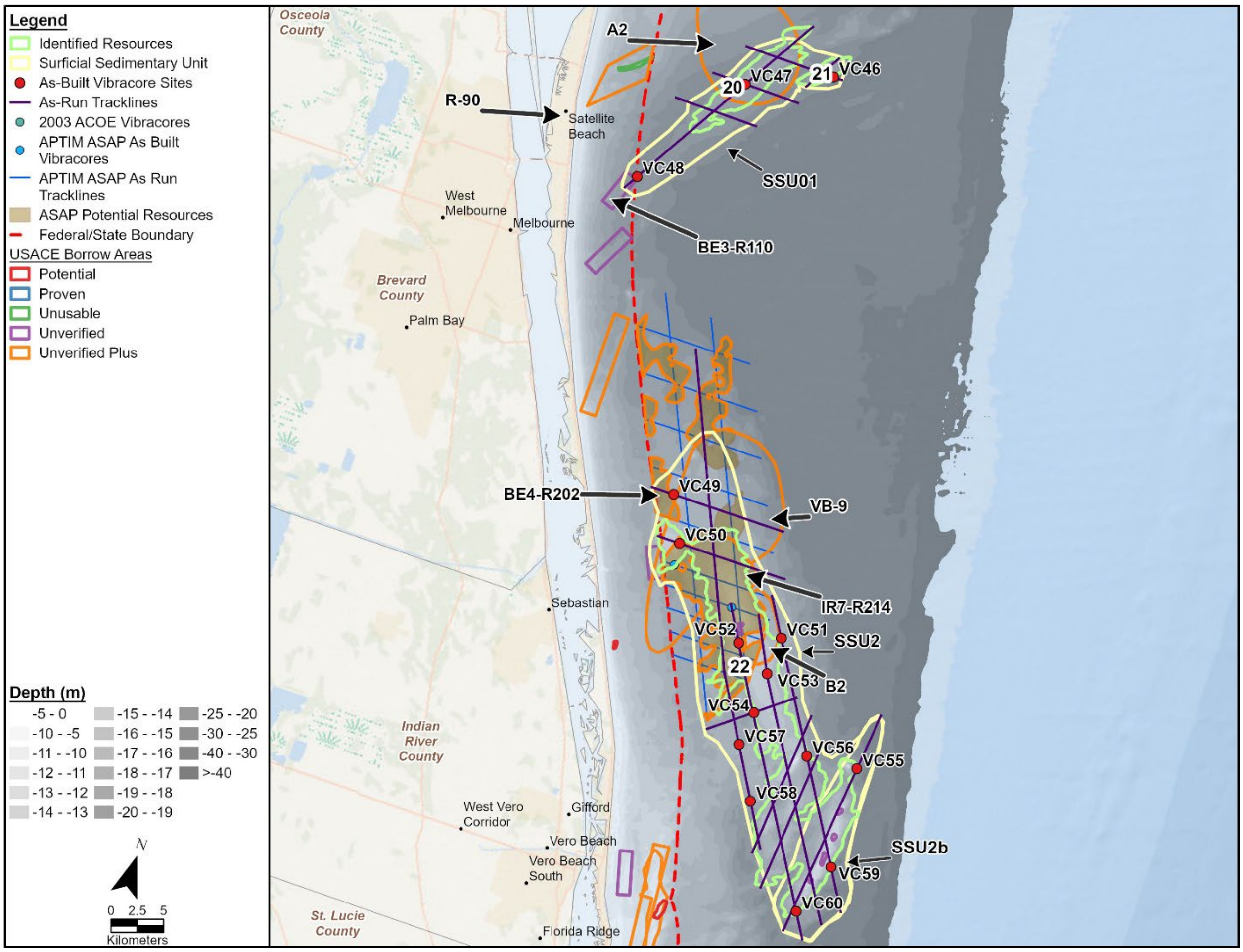
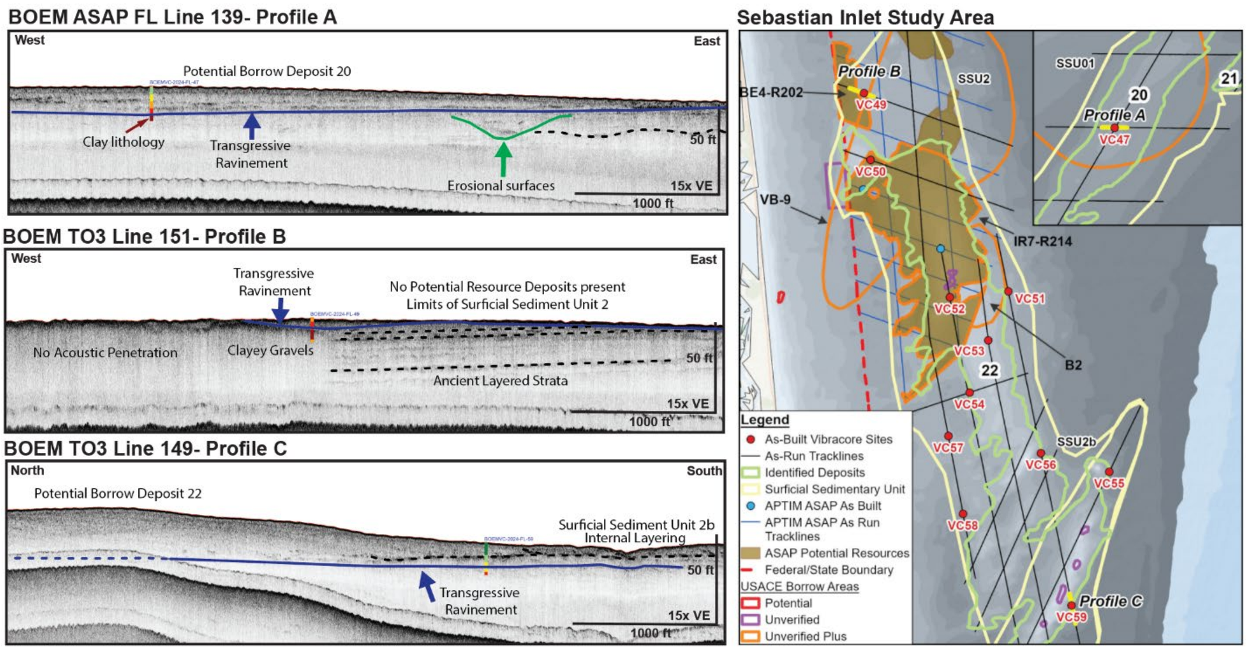


Figure 58: BOEM TO3 Line 139 over Identified Resource 20 (BA A2), Line 151 illustrating absence of resource and outcropping ancient strata, and Line 149 showing Identified Resource 22 (IR7-R214)

Profile A shows the typical stratigraphy of the northernmost sand shoal and associated resource, with some internal structure atop a well-defined transgressive ravinement. Profile B shows the dominance of shallow ancient stratigraphy and associated clay and gravel rich deposits, potentially indicating presence of the Miocene Hawthorne group. Profile C shows the southernmost extent of the sand-rich shoal and Identified Resource 22 (BA IR7-R214), with the extension of the Surficial Sediment Unit 2B further south but with a different acoustic facies than that sampled in core 59.



Further south in Brevard region, additional geotechnical data in close proximity to resources identified from the ASAP data indicate that those preliminary boundaries are probably shelly in their composition. BOEMVC-2024-FL-49 east of BE4-R202 indicates that the small shoal seen in the seismic data is a shell hash layer, with a 5 percent fine content and a mean size of 1.61 millimeters (-0.70 phi) (Figure 58). However, as indicated by BOEMVC-2024-FL-50 collected on the edge of IR7-R214 in Indian River County region, the average size of the shell layer is closer to 0.60 millimeters (0.70 phi) with a smaller percent fines, which is further corroborated by FL-BOEM-2015-VC04. Based on the three samples taken in the area, it is evident that the deposits and shoals seen in the Sebastian Inlet region are highly variable and would require additional sampling to further constrain the usable portions of the deposit.

Along the offshore region of Indian River County, the additional geophysical and geotechnical data collected south of the ASAP study area aimed at further identifying and constraining the southern portion of IR7-R214 and Bethel Shoals. From correlating the additional data to the ASAP data as well as the CRM surfaces, it is evident that IR7-R214 and Bethel Shoals could be a single deposit with volumes up to 682.6 million cubic yards (521.9 million cubic meters) of resources. Composite statistics on this identified resource indicate a high shell content, with some pockets of sand as observed with BOEMVC-2024-FL-59. In order for IR7-R214 and Bethel Shoals to be proved up and verified as a potential resource, additional geotechnical data would be required in order to determine if the resource is beach compatible. If the composite values were to be established as beach compatible, all of Bethel Shoals and IR7-R214 could have upwards of 682.6 million cubic yards (521.9 million cubic meters) of resource available.

Sebastian Inlet Regional Strategic Questions

1. What is the composition, quality, and extent of any potential resources identified?

The identified resources in the Sebastian Inlet region (20 to 22) consist mostly of sand shoals with varying sand quality ranging from as fine as 1.85 phi (0.28 millimeters) to as coarse as 1.12 phi (0.46 millimeters) with resource 22 (BA IR7-R214) having a higher shell content. Exploratory lines collected offshore the R90 monument in Brevard County proved there are two potential resources in the region that could be small in nature. Resources identified offshore Indian River County show that there is a large potential sand resource with a higher shell content than other areas. Additional data would be required to characterize the resource and determine potential compatibility. If indeed this shoal is proven to be a viable resource, it would be a significant resource for the county with up to 682 million cubic yards (521 million cubic meters) of resources.

2. Based on the resulting data collection, should any areas be recommended for further investigation by design-level survey or eliminated from further consideration?

Given the size of the area, Identified Resource 22 (BA IR7-R214) would likely benefit from additional data collection to further constrain the shell content in the area and how it would impact the overall composite. Identified resources 20 (BA A2) and 21 are likely smaller, but could be further delineated as a potential resource closer to the northern portion of Brevard County.

3. What is the geologic origin and evolution of the resource deposits identified?

The deposits identified in this region generally are located within two surficial sedimentary units that have a variable shelf morphology (ranging from ridges to flat highs to apparent wave fields) but are nearly uniformly bounded below by a flat erosional unconformity interpreted as the transgressive ravinement. The consistent position of these deposits above this ravinement supports their interpretation as being likely marine in origin due to oceanographic processes following Holocene transgression. Unlike the other study areas, there is little evidence for shallow stratigraphic channels, inlets, or other units that may have provided a source of sand to the shelf during transgression. The northeast-southwest orientation of the surficial sedimentary unit hosting Identified Resource 20 (BA A2) and 21 may indicate some relation to the adjacent Canaveral Shoals. It is possible that they are related to the Holocene retreat of the Cape Canaveral massif, which is a process well studied elsewhere but not investigated in detail in the Florida Atlantic (Swift, 1975; Swift et al., 1978). Regardless of their initial origin and material sourcing, the identified resources are likely to be controlled entirely by recent and future oceanographic and shelf current conditions.

7 Conclusions

In 2021, the BOEM MMP, within the DOI, contracted APTIM under an ID/IQ to support the identification, characterization, and delineation of OCS sand to further MMP's development of a National Offshore Sand Inventory, as well as other marine minerals in support of development of a future National Offshore Critical Mineral Inventory. Under this ID/IQ, APTIM is tasked with assisting BOEM in the identification and characterization of sediment resource areas, determining the locations of potential OCS hard/critical minerals, and collecting baseline data to better understand and characterize potential physical, chemical, biological, and cultural impacts from marine mineral extraction. The third task order issued under the ID/IQ Contract No. 140M0121D0006 is to conduct geophysical and geological data acquisition and analysis on the Atlantic OCS offshore northeast and central Florida and conduct a desktop analysis offshore of southeast Florida.

APTIM and TWI approached this third task order following sequential research, survey, and interpretation procedures. The first task was to conduct a desktop study for each region to compile previous datasets and geologic context and to work closely with BOEM on determining regional and project goals for each of the identified areas. Based on the results of this desktop study a comprehensive geophysical and geological survey plan was created and reviewed with stakeholders. APTIM collected 449.73 nautical miles (833.1 line-kilometers) of geophysical data and 60 vibracores along the Atlantic OCS offshore northeast and central Florida following the incorporation of stakeholder input. Upon the completion of data collection, APTIM processed, analyzed, and interpreted all geophysical and geological data to determine the potential available surficial sand volume, where possible, within area as well as contribute to the conceptual geologic framework of each region.

Offshore the Nassau and Duval region, the APTIM team further constrained the A3a USACE borrow area (resource 4 [BA A3a]) and calculated a potential gross volume of 82 million cubic yards (63 million cubic meters) of sand. Between the A3a and A4 borrow areas, a new resource (5) was identified which may contain roughly 17 million cubic yards (13 million cubic meters) of potential sand resources. Additionally, the new data were able to further constrain potentially usable resources highlighted by borrow areas A4, A5, M3a and M3b (resources 6 [BA A4], 7 [BA A5], and 8 [BA A4]). Moreover, the historic vibracores along the southern end of A4 were used to delineate resource 8 (BA A4) which could be used as a potential replacement to the F1 borrow area.

Offshore the St. Johns and Flagler Counties, the APTIM Team was able to re-define the several USACE Borrow Areas around N1, N2, and N3, as well as SJ7-R088 and SJ9-R069, and identify roughly 434 million cubic yards (331 million cubic meters) of potential sediment resources across all USACE delineations. Offshore Flagler County, the shore-oblique shoals mapped as part of this study provided additional geophysical and geotechnical on several unverified USACE resources that could assist with reviewing their classification and determining if unverified borrow areas could be moved up in their class. With the collected geophysical and geotechnical data, APTIM was able to estimate that some of these shore-oblique deposits have up to 113 million cubic yards (86 million cubic meters) of sand (resource 17 [BA FL15-R088]) when geophysical and geotechnical data were correlated with the CRM model.

Offshore Sebastian Inlet, additional geophysical and geotechnical data within the footprint of the 2015 ASAP data allowed for further delineation of the resource identified and extension of it towards Bethel Shoals. Identified Resource 22 (BA IR7-R214) was identified as having roughly 682 million cubic yards (521 million cubic meters) of resources within that area. This area will likely require some additional data to further verify the variability of the shell content throughout the shoal. To the north, offshore Brevard County, exploratory lines collected off the R90 monument yielded a couple of small potential deposits, which could be further explored.

As part of this investigation, the APTIM team was able to further constrain and sample 18 USACE Borrow Areas and identify 4 additional potential resources based on the reconnaissance geophysical and geotechnical data collection. The verified deposits were corroborated with the CRM model to further constrain and define the potential boundaries of the shoals. Exploratory geophysical and geotechnical data collected over potential resources yielded additional resources that could be utilized in future investigation and further utilized in coastal restoration projects. Geophysical data along the identified and verified deposits indicate that the sand resources are associated with bathymetric highs, with the observed paleochannels consisting mostly of a fine-grained infill (fine sands or clays).

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Appendix A: Southeast Florida Desktop Analysis Report

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida - Appendix A: Southeast Desktop Study

Final: February 2025

U.S. Department of the Interior
Bureau of Ocean Energy Management
Headquarters, Sterling, VA

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida- Appendix A: Southeast Desktop Study

Final: February 2025

Authors:
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Introduction and Approach

In 2021, the Bureau of Ocean Energy Management (BOEM), Marine Minerals Program (MMP), within the Department of the Interior (DOI) contracted Aptim Federal Services, LLC (APTIM) under an Indefinite Delivery/Indefinite Quantity (ID/IQ) to support the identification, characterization, and delineation of Outer Continental Shelf (OCS) sand. This furthers MMP's development of a National Offshore Sand Inventory, as well as other marine minerals in support of development of a future National Offshore Critical Mineral Inventory. Under this ID/IQ, APTIM is tasked with assisting BOEM in the identification and characterization of sediment resource areas. This will determine the locations of potential OCS hard/critical minerals, and collect baseline data to better understand and characterize potential physical, chemical, biological, and cultural impacts from marine mineral extraction. This will provide BOEM with information on where marine minerals are located, the volume and/or quality that may be available for use, and determine measures to minimize impacts from resource exploration or extraction. Resource evaluation and robust baseline datasets support BOEM in the leasing and development of OCS minerals, assessing potential environmental impacts and necessary mitigation and minimization measures, and continuing to successfully partner with stakeholders and communities who may benefit from OCS mineral resources. Accurate inventory of potential sand resources along the OCS is critical for enabling economically efficient and successful implementation of many shore protection, habitat restoration, and beach nourishment programs, and for relevant management agencies and communities to engage in realistic long-term planning.

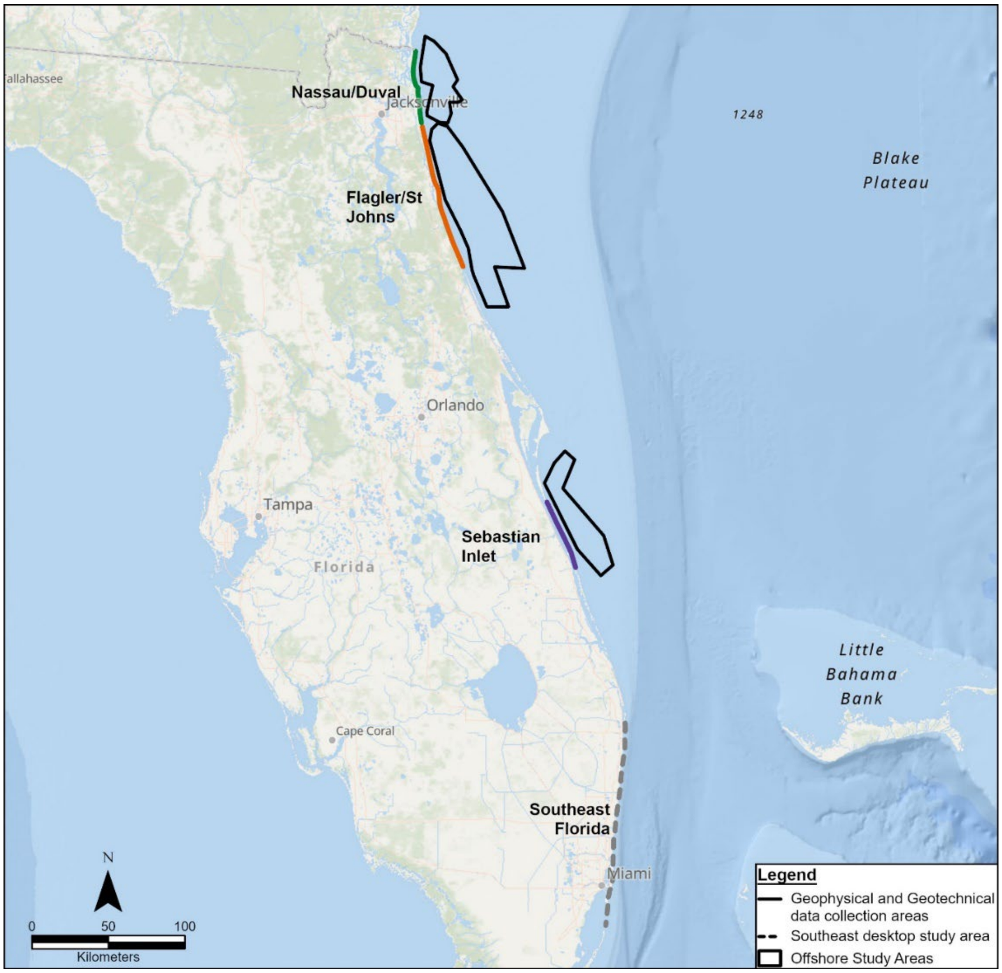
The U.S. Army Corps of Engineers (USACE) South Atlantic Coastal Study and associated South Atlantic Division, Sand Availability and Needs Determination Study (SAND) evaluated current and future beach resiliency projects along the Florida Atlantic coast to assess specific project sediment needs, what sediment resources are currently identified that could support project construction and maintenance, and help define priority areas where sediment needs are outpacing known supply and would benefit from new strategic investigations. A key BOEM priority is to continue supporting the South Atlantic Coastal Study and SAND programs through resource evaluation programs including new geological and geophysical data collection, detailed desktop studies, and scientific investigations aiding in the delineation and characterization of OCS minerals that may be suited for coastal resiliency projects. Accurate knowledge of the likely occurrence, distribution, and origin of offshore sediment resources also directly supports the BOEM responsibility for providing equitable and sustainable stewardship of OCS minerals.

This report outlines the result of the Southeast Florida desktop investigation conducted under the third Task Order (140M0122F0020) issued under the ID/IQ Contract No. 140M0121D0006: Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida (Figure 1). The Florida study area was divided into four regions based on prior assessments of sediment resource needs and BOEM strategic priorities. These regions are:

1. Offshore Sebastian Inlet (including Brevard and northern Indian River counties)
2. Offshore Duval and Nassau Counties
3. Offshore Flagler and St. Johns Counties (also potentially serving Volusia County)
4. Southeast Florida (within 200 miles [321.9 km] of Miami)

Offshore data collection was conducted within Regions 1-3, while Region 4 was limited to a desktop investigation. These high-priority regions were selected either because projected demand for OCS sediment resources outpaces known resources, as identified by the USACE South Atlantic Division SAND program, or recent active project sediment requirements are far outpacing earlier projected demand for OCS resources or identified as having offshore data gaps by the National Oceanic and Atmospheric Administration (NOAA) community mapping coordination program (SeaSketch). The southeast Florida Region was the focus of a desktop study to evaluate the potential sand resource presence up to 656.2 feet (200 meters) water depth, what existing studies or datasets may exist that could be used to evaluate these potential resources, and reprocess these datasets, if possible. This task order defined a series of strategic questions to be addressed by this desktop analysis.

Figure 1. Task Order 3 Investigation Regions Along Northeast and Central Florida



Southeast Florida Study Region – The area offshore of Miami, from West Palm Beach to Biscayne Bay, has a significantly different OCS morphology and geologic framework than Regions 1 through 3. The significant narrowing of the shallow OCS, presence of the southeast Florida reef track, and complex cross-shelf sediment transport down the continental slope to the Miami Terrace translated to major technical and scientific challenges in identifying and developing OCS sediment resources in an area with large sediment resource needs (SE Florida SAND). The study conducted a desktop analysis intended to evaluate potential sediment resource occurrence in water depths up to 656.2 feet (200 meters) (far beyond the typically applied 98.4 feet [30 meters] range used in current OCS borrow area design), evaluated what knowledge and/or data gaps limit such analysis, and identified any existing datasets that could be re-processed, interpreted, or otherwise used to address this long-term strategic question. The study addressed the following questions in the desktop analysis, and delivered an assessment of the highest-potential data to BOEM for further consideration:

1. What data exist?
2. What is the accessibility of these data?

3. What additional processing is necessary to utilize these data?

The specified desktop analysis required an initial literature review to identify potential geophysical datasets previously collected in the region. As part of this review, a high-level summary of potential observations and/or conceptual models of sand transport and storage within the 656.2 feet (200 meters) zone was compiled.

1 Summary of Potential Sand Resource Occurrence in Southeast Florida Region

Offshore southeast Florida, from West Palm Beach to Biscayne Bay, is very narrow compared to the northern Florida Atlantic OCS, with little geographic area available for the storage of potential sand resources (USACE Southeast Florida SAND). Prior work has helped identify that numerous pathways and mechanisms exist for the transport of sandy material from the beach and nearshore across the shelf to the deepwater and out of reach of current dredging practices (USACE Southeast Florida SAND; Finkl and Andrews, 2008). Initial assessment of the potential for sand resources to exist beyond the shallow shelf (~98.4 feet [~30 meters]) can be aided through existing studies and data collection that were not intended for sediment resource exploration. These include benthic habitat assessments, framework geological studies, hydrogeologic aquifer mapping, and others. This compilation indicates potential transport mechanisms of sand to the deepwater and several conceptual models of where these sands may be trapped and accumulated on the continental slope up to 656.2 feet (200-meter) water depths. Importantly, the reports and studies described here highlight the previously unrecognized potential for significant sand deposition and storage within buried seafloor depressions located along the outer shelf and upper slope.

1.1 Regional Setting

The southeast Florida offshore continental shelf is approximately 1.8- 2.5 miles (3 to 4 kilometers) wide offshore of Miami-Dade County (Figure 2), where the shallow-water shelf (0 to 98.4 feet [0 to 30 meters]) transitions in the south to the steep East Florida Escarpment (~98.4 to 656.2 feet [~30 to 200 meters]) before grading to the broad Miami Terrace platform (656.2 to 1,312.3 miles [200 to 400-meter] depths). To the north, offshore of Broward and Palm Beach Counties, the shallow OCS links to the broader Florida-Hatteras Slope (~98.4 to 3,280.83 miles [~30 to 1,000 meters]) and the deepwater Florida Straits (Uchipi, 1968; Finkl and Andrews, 2008; Banks; 2008). The Miami Terrace is an outcropping element of the Florida Platform, composed of Jurassic to Miocene shallow-water carbonates (Sheridan et al., 1981). The western edge of the Terrace and the upper Florida-Hatteras slope is built by slope sedimentary sequences representing margin growth from the late Miocene to Quaternary (Mullins and Neumann, 1979; Cunningham et al., 2024). Long-term progradation of the continental slope began with mixed siliciclastic deltaic and slope systems including the Long Key and Peace River formations that then transitioned back to carbonate sedimentation by the late Pliocene (McNeill et al., 2004). These are overlain by Pliocene to modern carbonate sediments derived from the re-establishment of carbonate forming processes along the Florida reef tract and associated offshore sediment transport (McNeill et al., 2004; Cunningham et al., 2024). These Pliocene-Quaternary sequences form large, 328.1s of feet (100s of meters) thick clinothems at the modern shelf-slope transition that have been defined as part of the Stock Island Formation (McNeill et al., 2004).

Figure 2. Shaded Relief 3D View of Continental Shelf and Slope Bathymetry Offshore of Southeast Florida

Location of stratigraphic profile in Figure 3 is marked by yellow line. Modified from Finkl and Andrews, 2008.

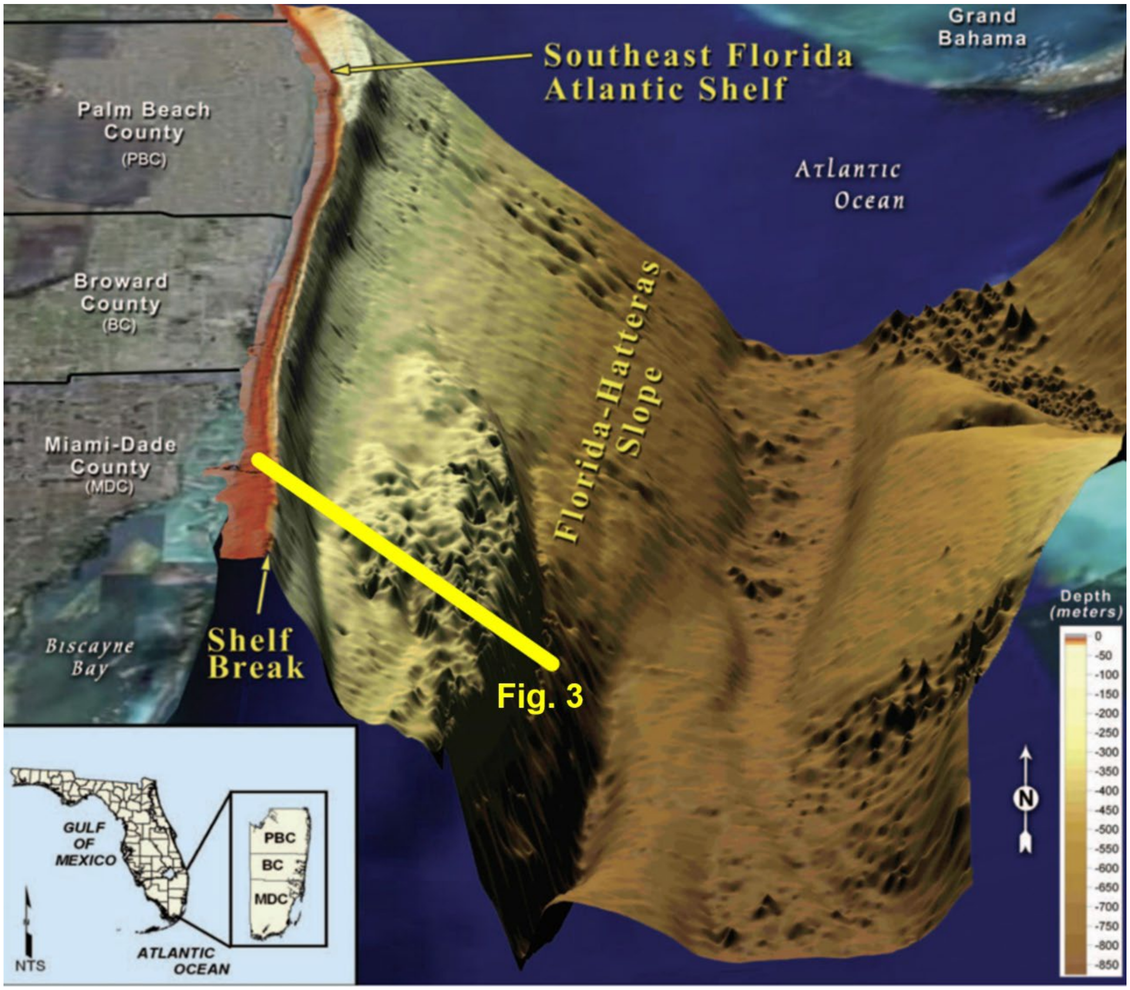
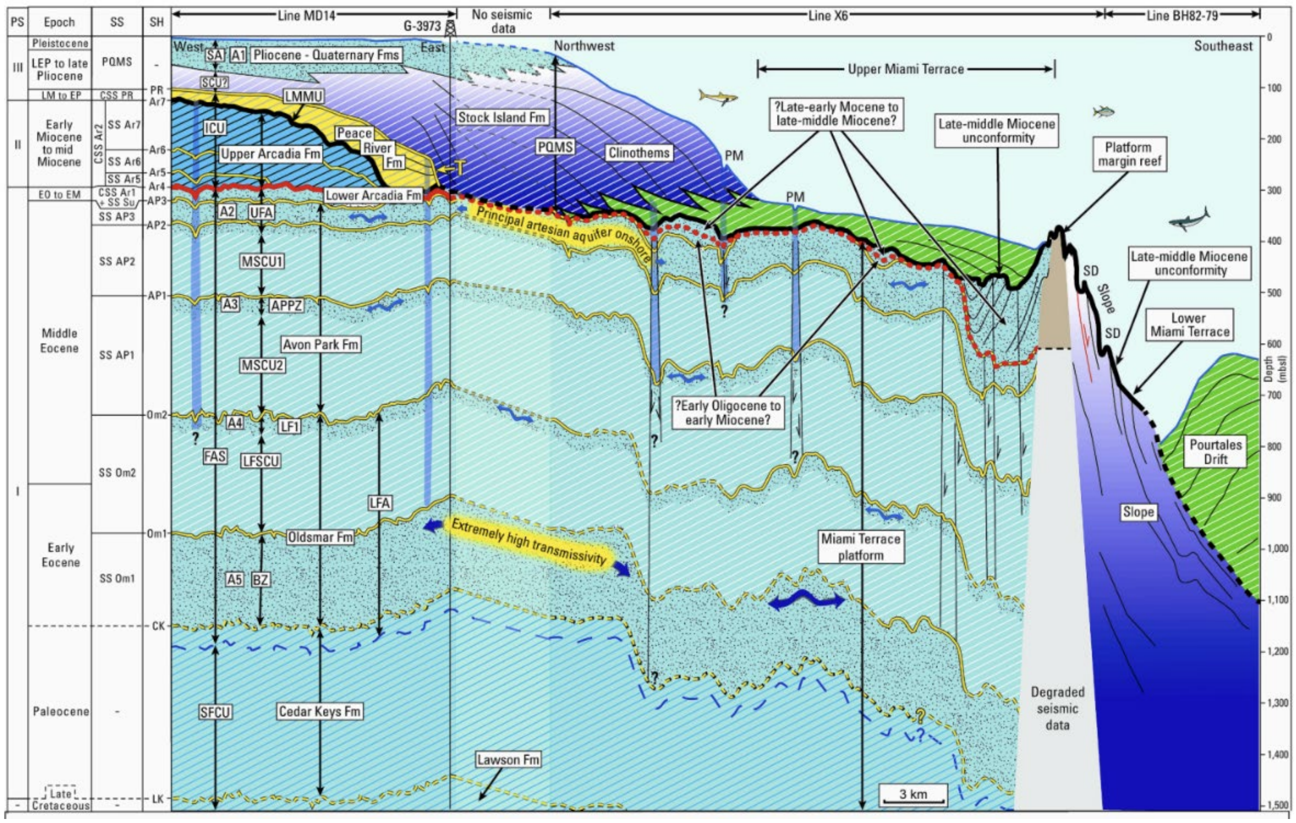


Figure 3. Conceptual Profile of Florida Atlantic Margin Stratigraphy from the Shallow OCS to the Outer Miami Terrace
Modified from Cunningham et al., 2004.



The western edge of the southeast Florida region of interest (98.4 to 656.2 feet [30 to 200 meter] to water depths) is partly defined by the relict Pleistocene to Holocene coral reefs known as the southeast Florida Reef Tract, a 77.6 mile (~125 kilometers) lineament of parallel reef complexes stretching from southern Miami-Dade County to north of Palm Beach County (Banks et al., 2007; Figure 4).Figure 4). Up to three shore-parallel ridge and reef systems are located along the southeast Florida Reef Tract, interrupted, and incised by cross-cutting reef gaps that provide sediment transport pathways from the inner shelf to deeper water (Finkl and Andrews., 2008; Banks et al., 2007). Adjacent to the reef ridges and rubble zones are numerous sandy deposits of varying thickness as well as erosional hardgrounds (Duane and Meisburger, 1969). These sand-rich deposits have previously been investigated and used as borrow areas, indicating potentially economic volumes of storage in the ridge zone and indicating likely sand transport beyond this domain to the upper slope and terrace beyond (Finkl and Andrews, 2008; Walker et al., 2008; Banks et al., 2008; Figure 5).

Figure 4. Location of the Southeast Florida Reef Tract and 3D View of OCS Bathymetry
Modified from Banks et al., 2008.

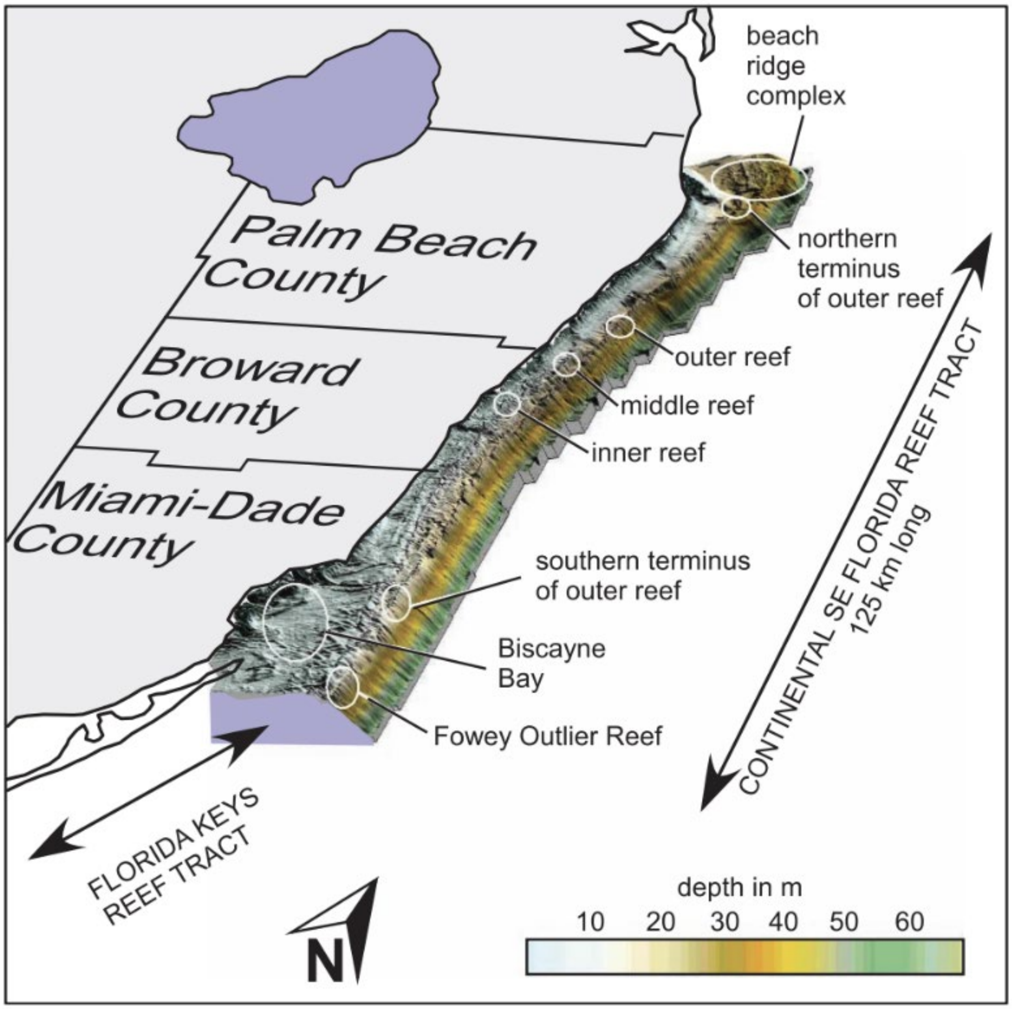
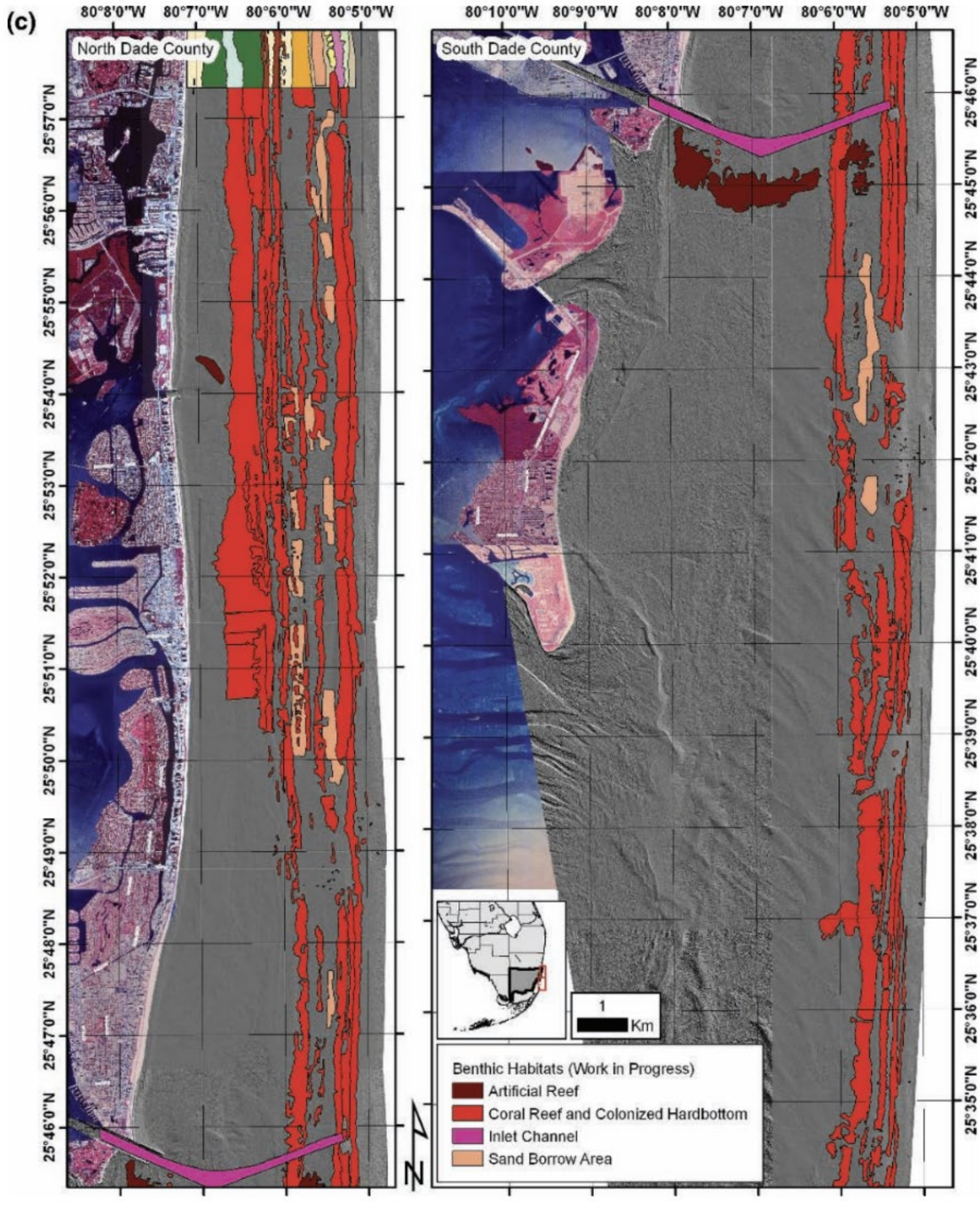
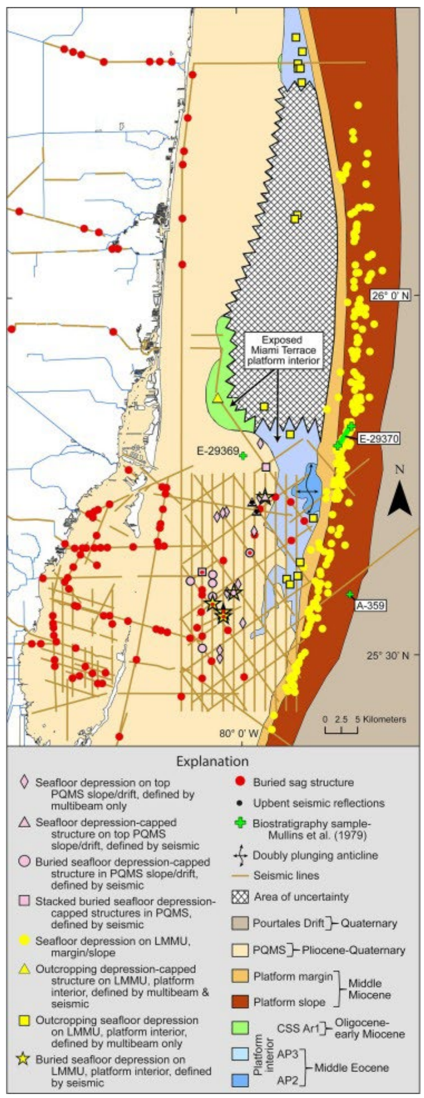


Figure 5. Habitat Map of Offshore Miami-Dade County Showing Ridge and Reef Complexes (Red) and Sand Borrow Areas (Tan)
Modified from Banks et al. 2008.



The Florida Terrace surface represents outcropping Eocene to Miocene carbonate strata that have been heavily eroded and reworked (Uchipi, 1969; Land and Paull, 2000). This surface has been found to host highly variable karst paleo-topography (Mullins and Neumann, 1979), including numerous sinkholes and seafloor depressions that can reach widths of over 1 kilometer such as the Miami Pockmark (Land and Paull, 2000; Reed et al., 2005; Cunningham et al., 2024). Notably, these sinkholes have been interpreted as being entirely marine in origin rather than the result of subaerial exposure and meteoric precipitation (Reed et al., 2005), either partially or completely infilled by a combination of sand likely transported from the shelf and upper slope as well as marine carbonates (Land and Paull, 2000; Cunningham et al., 2024). Hundreds of seafloor depressions have been observed in multibeam bathymetry along the continental slope and Miami Terrace, while recent geophysical investigations have found tens of potentially infilled sags or depressions with minimal modern bathymetric expression located in 98.4 to 656.2 feet (30 to 200 meters) –water depths offshore of the southeast Florida region (Cunningham et al., 2013; Figure 6). 2013; Figure 6).

Figure 6. Interpreted Seafloor Map of Offshore Miami-Dade County Showing Location of Seafloor Depressions Identified On Geophysical or Bathymetric Data
Modified from Cunningham et al., 2024.



1.2 Potential Mechanisms for Sand Transport and Storage

Prior studies have indicated the challenges in fully accounting for sand within the southeast Florida littoral system (e.g., Dean, 1991). Attempts at calculating modern sediment budgets find large deficits in observable nearshore fluxes that have been ascribed to transient storage and current direction reversals, deposition in human-modified inlet and shore stabilization infrastructure, and poorly constrained seaward transport (Dean and O'Brien, 1987). The narrow shelf, bounded by the linear ridges of the southeast Florida Reef Tract, itself has minimal opportunities for the deposition and accumulation of large sand volumes, which has led to challenges in meeting current and future beach nourishment requirements (USACE Southeast Florida SAND). Constraining the potential pathways and ultimate fate of sands removed from the shallow-water shelf could aid in future sand resource projects if aligned with advances in deep-water dredging practices. The USACE Southeast Florida Sediment Morphodynamics study (SEFMOD) was conducted to better understand sediment transport pathways and timescales within the Miami-Dade area of Southeast Florida, and provides much needed constraints on the fate of beach nourishment sands (USACE SEFMOD). This transport study found significant near-term storage of beach sands within the nearshore, with potential transport and export to the deeper shelf and beyond on longer timescales. This recent work, together with other compiled reports and studies, highlight the potential for cross-shelf sand transport as well as several mechanisms and opportunities for the trapping and storage of potential sand resources.

High-resolution, spatially continuous bathymetric mapping of the outer shelf along the southeast Florida Reef Tract found that the linear reefs marking the edge of the Florida escarpment and slope are commonly incised by myriad channels representing collapse, hydrodynamic current erosion, and potential paleo-rivers (Finkl and Andrews, 2008; Banks et al., 2008; Figure 7). These channels and cuts are covered with sand, indicating their role in providing conduits for inner-shelf and shoreface sands transported seaward (Walker et al., 2008; Figure 8). A benthic habitat mapping program offshore of Miami-Dade County found that over 10 percent of the 92.7 square miles (240 square kilometers) mapped area contained surficial sands in greater than 65.6 feet (20-meter) water depth, typically coincident with these likely transport pathways (Walker, 2009). These observations support the hypothesized loss of sand from the littoral cells of southeast Florida and indicate the relative abundance of potential sand conduits to the continental slope and upper Miami Terrace as introduced in Section 1.1.

Figure 7. Example Southeast Florida Continental Shelf Bathymetry (Panel A) and Interpreted Geomorphologic Map (Panel B)

Potential sand transport pathways to the upper slope are show as black arrows. Modified from Finkl and Andrews, 2008.

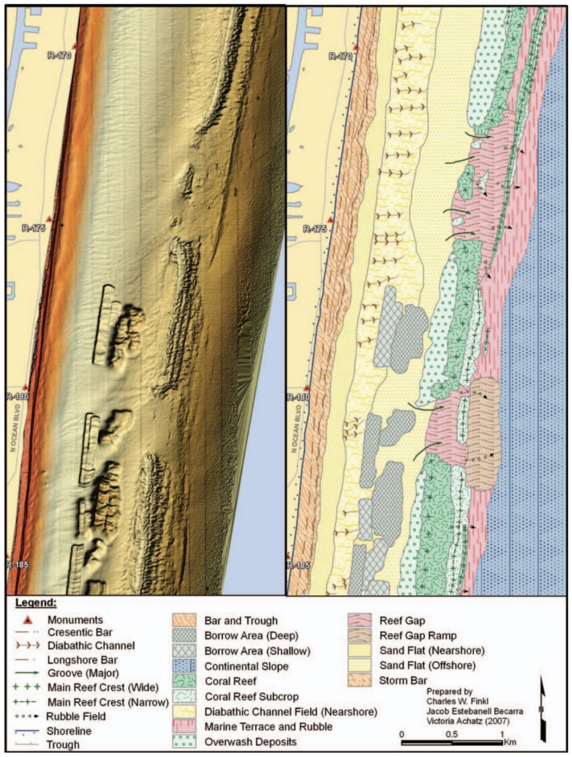
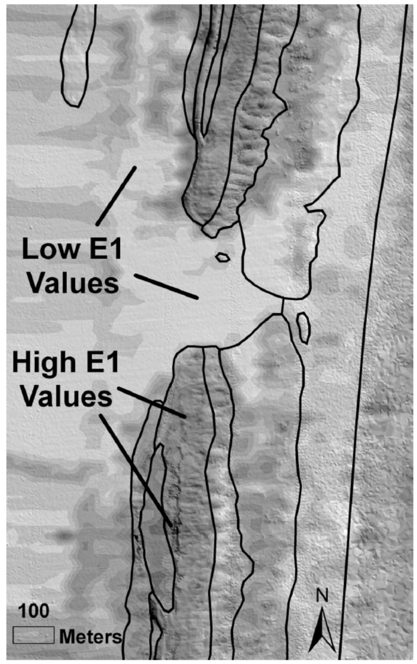


Figure 8. Backscatter Reflectivity Mapping of Seafloor Adjacent to Cut in Shore-Parallel Ridge and Reef Structure
Low E1 values indicate sandy surficial sediments located within the center of the cross-reef channel. Modified from Walker et al., 2008.



Sedimentary processes along carbonate platforms such as southeast Florida have been well studied and indicate the relative dominance of down-slope sediment transport once sediment sourced from the shallow, low-gradient platform (such as the southeast Florida shallow shelf) is carried to the shelf-slope break (Betzler et al., 2014). Sediments are efficiently carried by density flows from the margin to deepwater, forming sediment-rich currents that can be depositional or erosional depending on local slope gradients and runout distance, with higher slopes often observed to be more erosional (Principaud et al, 2018). Slope deposition of platform sediments is a requirement for the observed Pliocene to Quaternary architecture of seaward progradational clinoforms (McNiell et al., 2004; Cunningham et al., 2024), but the timescale and punctuated transport event occurrence associated with long-term margin growth are difficult to closely link to decadal scale coastal sediment budgets. Remote operated vehicle (ROV) based habitat mapping at site-clearance geohazard resolution was carried out offshore of Miami-Dade in water depths between 328.1 to 984.2 feet (100 to 300 meters) and found ubiquitous surficial sand cover on the upper slope beyond the cuts in the southeast Florida Reef Tract, providing additional evidence for efficient sand transport to the region of interest (Messing et al., 2006; Figure 9). Figure 9). The USACE SEFMOD tracer study found that while the majority of beach sediments tracked within the Miami-Dade area are stored within the nearshore, there are pathways for sediment to be mobilized and transported through reef cuts and to the deeper shelf and upper continental slope that is the focus of this study (USACE SEFMOD). These results may indicate the importance of transport timescale in constraining the fate of sands across Southeast Florida, with nearshore and surf areas playing a primary role on near-term (1-5 year) timescales, but still significant sediment transport offshore occurring on longer timescales and in response to more punctuated transport events, such as storms (USACE SEFMOD; Figure 10).

Figure 9. Benthic Habitat Map Offshore of Miami-Dade County in 328.1 to 984.2 feet (100 to 300 meters) Water Depths Based on ROV Video Survey and Side-scan Sonar
Yellow indicates unconsolidated, sandy sediments in between outcropping hardbottom. Modified from Messing et al., 2006.

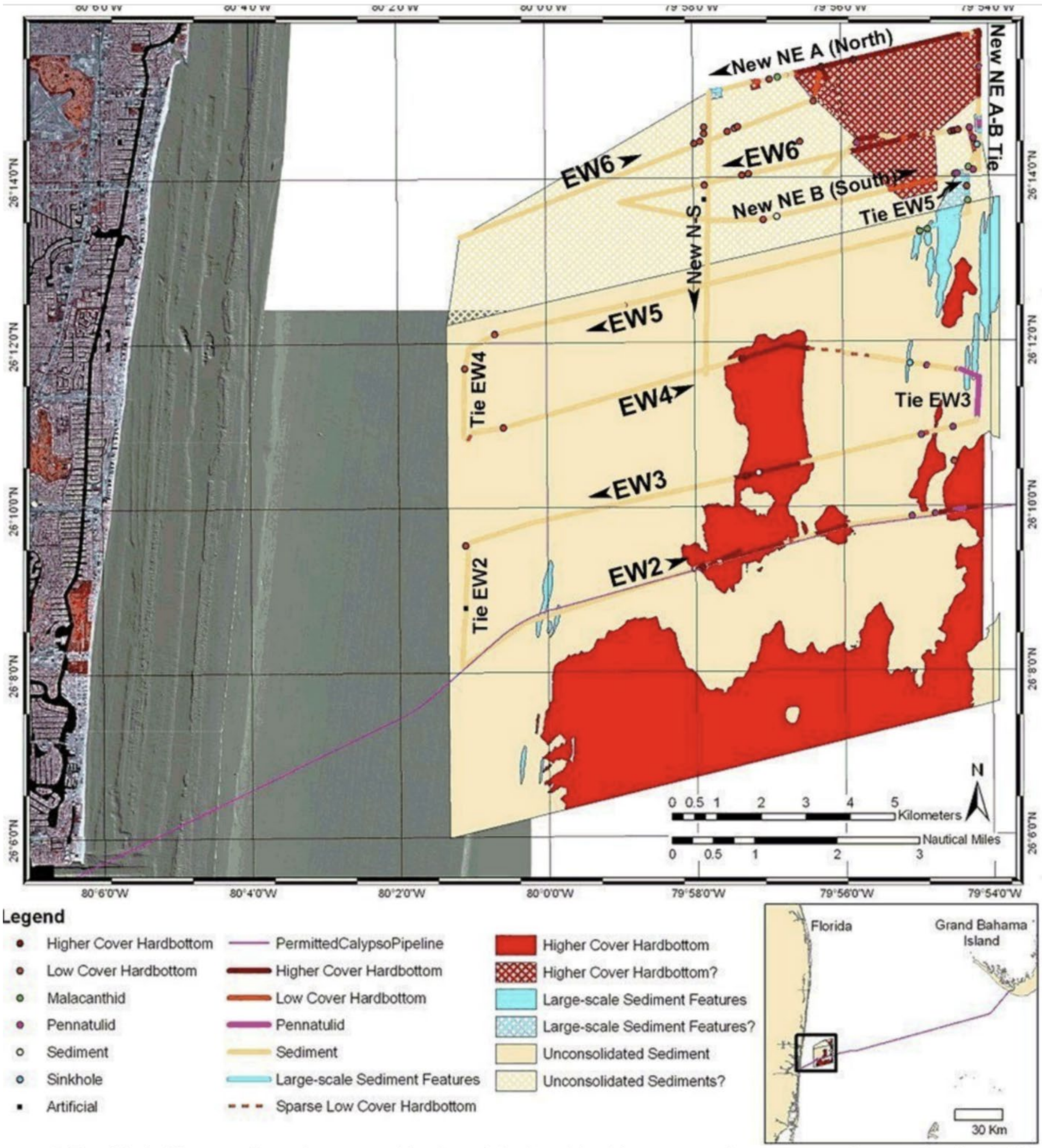
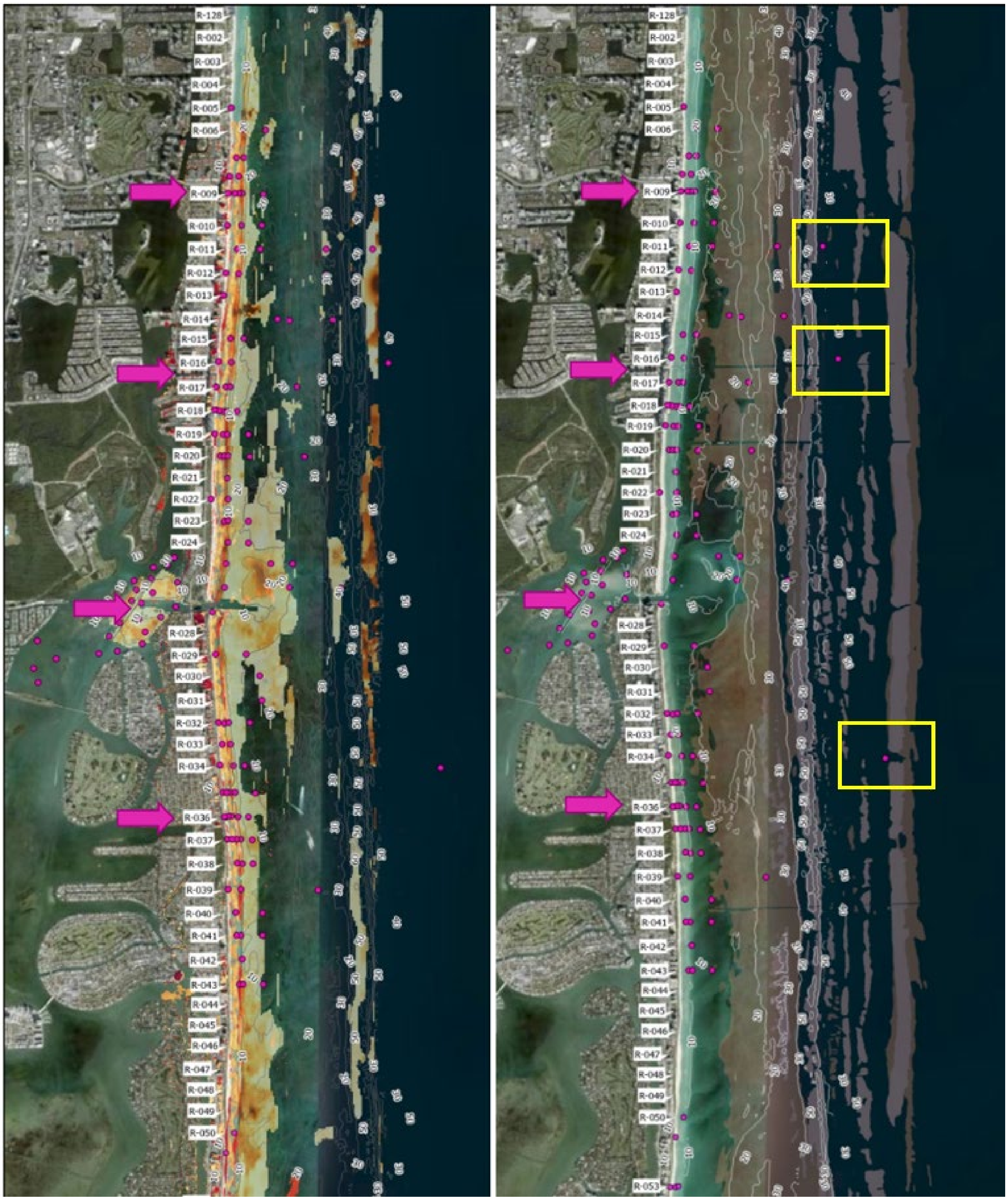


Figure 10. Results of USACE SEFMOD Tracer Study Offshore of Miami-Dade Region Baker's Haulover Inlet

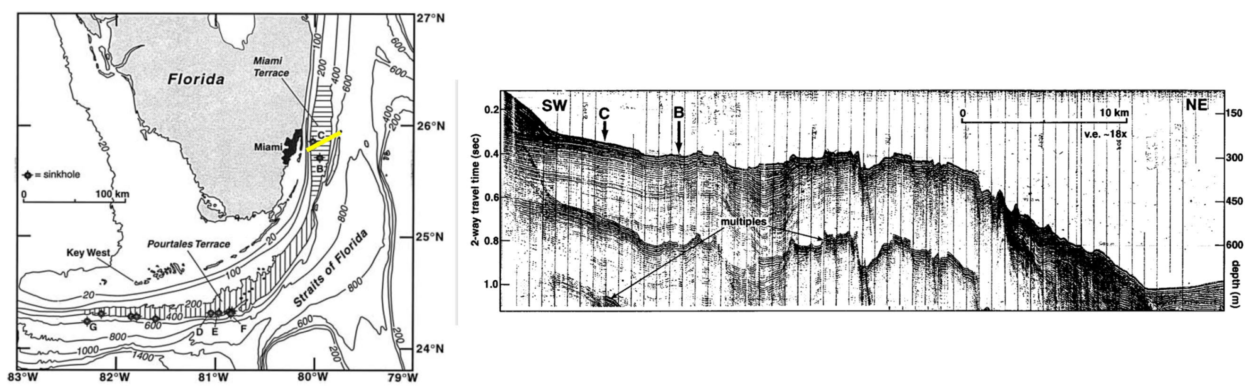
Pink dots indicate observed sand tracer location. Yellow boxes highlight sand tracer transported towards reef cuts and to deeper water shelf. Figure modified from USACE SEFMOD.



Prediction of significant sand resource deposits in depths up to 656.2 feet (200 meters) requires not only the transport of sandy sediments as supported by previous studies but also mechanisms for the trapping and storage of sands on relatively high-gradient slopes. While surficial sands are commonly present along the continental margin of southeast Florida, it is less clear what their thickness and volumetric potential might be. Slope deposition by density-flows can leave veneers of sand while the majority of the down-slope sediment flux continues to bypass the region, leaving thick accumulations of sand primarily within the core of submarine channel systems which are not present on the southeast Florida slope (Prather et al., 2017). However, another opportunity for accumulation of thick sand deposits in this region exists in the form of seafloor depressions and sinkholes that are becoming increasingly commonly observed across the southeast Florida continental shelf and slope (Land and Paull, 2000; Reed et al., 2014; Cunningham et al., 2015; Cunningham et al., 2024). Initial characterization of these depressions indicates that they can extend over a kilometer in diameter, with modern relief of tens of meters and internal sediment accumulations of hundreds of meters (Shinn et al., 1996; Land and Paull, 2000; Cunningham et al., 2024; Figure 11).

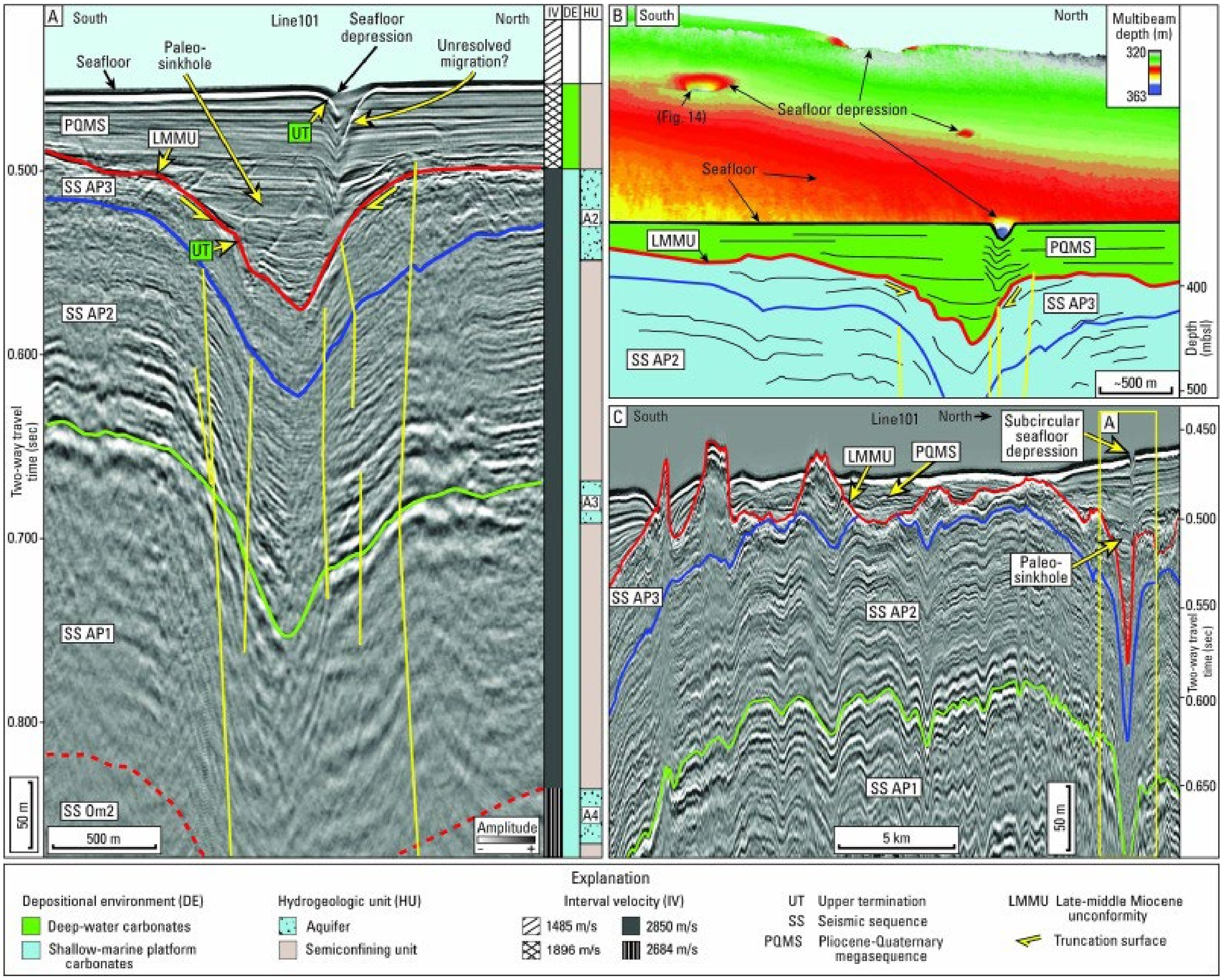
Figure 11. Location of Seafloor Depressions Along Southeast Florida and Initial Geophysical Characterization of ~656.2 feet (200 meters) of Sediment Accumulation in One Depression Along the Southeast Florida Margin

Modified from Land and Paull, 2000.



Geophysical mapping helped provide the initial evidence for the occurrence and structure of these modern seafloor depressions and sinkholes (Land and Paull, 2000), which have been ubiquitously mapped in recent multibeam bathymetry surveys (Cunningham et al., 2024). However, careful investigation of geophysical data also indicates that paleo-depressions, or sinkholes that have since been completely infilled leaving no bathymetric expression, are also widely distributed offshore of southeast Florida in water depths between 98.4 to 656.2 feet (~30 to 200 meters) (Cunningham et al., 2015; Cunningham et al., 2024). The presence of these paleo-features downslope of the cuts in the shelf edge reef and ridge structures (Banks et al., 2008) suggests that the source of sediment that infilled and smoothed over these large, deep-seated sinkholes was sand and sediments sourced from the shallow-water platform. While poorly sampled by cores, geophysical evidence suggests that these features could have initiated in the Miocene-Pliocene Era and been infilled beginning with the growth of margin sedimentation in the Pleistocene to Quaternary Era; thus, reflecting sedimentary processes broadly similar to those observed in modern southeast Florida (Cunningham et al., 2024; Figure 11).

Figure 12. Seismic Line Across Small Seafloor Depression Along the Western Miami Terrace Showing Infilling of Large Collapse Structure
Modified from Cunningham et al., 2024.



Results of this synthesis indicate that there exists potential sand resources offshore of southeast Florida that could be viable if dredging allows access up to 200-meter water depths. Morphological mapping, habitat surveys, and other data sources all indicate widespread and sustained sand transport seaward from the inner continental shelf, across the bounding southeast Florida reef tract, and down-slope towards the bottom of the Florida Straits. While much of the sand and sediment is likely bypassing the upper slope region of interest and depositing either along the deep (>656.2 feet [200 meters]) Miami Terrace or further down the Florida-Hatteras Slope to the north, the increasing recognition of modern and relict seafloor depressions provides a novel storage mechanism to capture sands in potentially viable thicknesses and volumes.

2 Data Types and Relevance to Deepwater Sand Resources

The literature and report review identified several categories of study and associated data that could prove useful for characterizing offshore sand resource potential. The desktop analysis identified the following major geophysical/remote sensing/visual data categories and their potential utility in addressing the goals of this task.

- **Geophysical Data:** This category includes any instrumentation or surveys that provide characterization of the sub-bottom stratigraphy. These data are valuable for identifying sand-bearing sedimentary facies, mapping thickness and extent of potential deposits, and constraining the stratigraphic and geologic framework of identified deposits. Examples used in compiled reports include 3D seismic, 2D multichannel seismic, sub-bottom profiler data, and ROV echosounder.
- **Bathymetric Data:** This category includes multibeam or lidar bathymetric data collected for the purposes of navigation, benthic habitat, geohazard characterization, or other uses. These data can help constrain sediment transport pathways, potential seafloor relief or structures that may influence the movement or trapping of sand, and the relative activity and deposition rates of seafloor sediments if multiple surveys over time exist. Examples used in compiled reports include multibeam.
- **Other Data:** This category includes surveys sidescan sonar, acoustic backscatter imaging, ROV video surveys, diver surveys, mapping benthic habitat, geotechnical characterization, or site clearance studies. These data help constrain the location of potential surficial sands, and relative position to bounding structures such as sinkholes or reefs. Examples used in compiled reports include marine hazard surveys interpreting seafloor substrate from ROV videos, benthic habitat mapping, and potential seafloor sinkhole morphology.

3 Results of Desktop Data Inventory

The name, year, author, data type, report/data link for datasets identified in relevant reports and databases, and notes on availability were compiled and are provided in the digital Attachment 1. The majority of publicly available data is multibeam bathymetry and backscatter surveys provided by NOAA National Centers for Environmental Information. Geophysical data availability is particularly poor, with no high-priority datasets able to be located and reprocessed during the course of this task. The majority of studies found that reported geophysical results were found to not be associated with public or trackable data, in some cases the data appearing to have not been archived in any capacity. In others, public record links exist but appear to be incomplete or still in the process of being archived by workers and agencies. These records and studies should be a high priority for incorporation into MMIS once available.

4 Summary and Path Forward

The results of this task indicate that significant evidence exists in prior reports, studies, and surveys for both the offshore transport of sand as well as newly proposed methods for its capture and storage in deposits that likely warrant future investigation. Geophysical data was found to be of high-utility in prior work for the characterization of sediment traps in the form of seafloor depressions or sinkholes, while bathymetry and benthic habitat mapping was most useful for constraining sediment transport pathways and where sediments are likely to be leaving the southeast Florida shallow-water shelf. Despite the promising results and conceptual models provided by the literature compilation, the underlying geophysical datasets used in the majority of publications were not able to be located for further processing and analysis.

Geophysical data capable of imaging the sedimentary facies, deposit thickness, and potential sand volumes over previously identified potential storage locations would greatly enhance future resource assessments in the southeast Florida region.

1. ***What data exist?***
   This task identified numerous reports and studies conducted offshore of southeast Florida in the form of geophysical surveys, marine benthic habitat mapping, offshore renewable energy siting studies, and pipeline pre-construction characterization. These range from peer-reviewed literature to agency documents, and digital versions of relevant reports are provided. Additionally, public databases such as NOAA NCEI provide a large number of bathymetry and backscatter datasets over the area of interest spanning decades. A large number of studies and reports providing interpreted products, figures, and maps were identified and digital versions compiled.

2. ***What is the accessibility of these data?***
   Following the initial results of the desktop analysis and literature review digital Attachment 1, it was decided to prioritize locating and accessing the underlying geophysical datasets referenced in U.S. Geological Survey (USGS) studies and reports including Cunningham et al., 2013; 2015, the Miami-Dade 2019 Geophysical Program, the USGS 1994 Field Activity referenced in Locker et al., 1995, the site characterization surveys referenced in the 2014 Department of Energy offshore hydrokinetic test site, and the site characterization surveys referenced in the Calypso Liquified Natural Gas terminal planning documents and associated environmental characterization. No publicly available data were located for the above prioritized studies—in some cases no data appears to have ever been archived, while in others the public data repository appears incomplete. No datasets were recovered for further processing. The USGS and Miami-Dade Geophysical datasets referenced in Cunningham et al., 2024 represent the highest priority datasets for further sand resource characterization and may be publicly available in the near future.

3. ***What additional processing is necessary to utilize these data?***
   No datasets were located with the ability to assess further utility.

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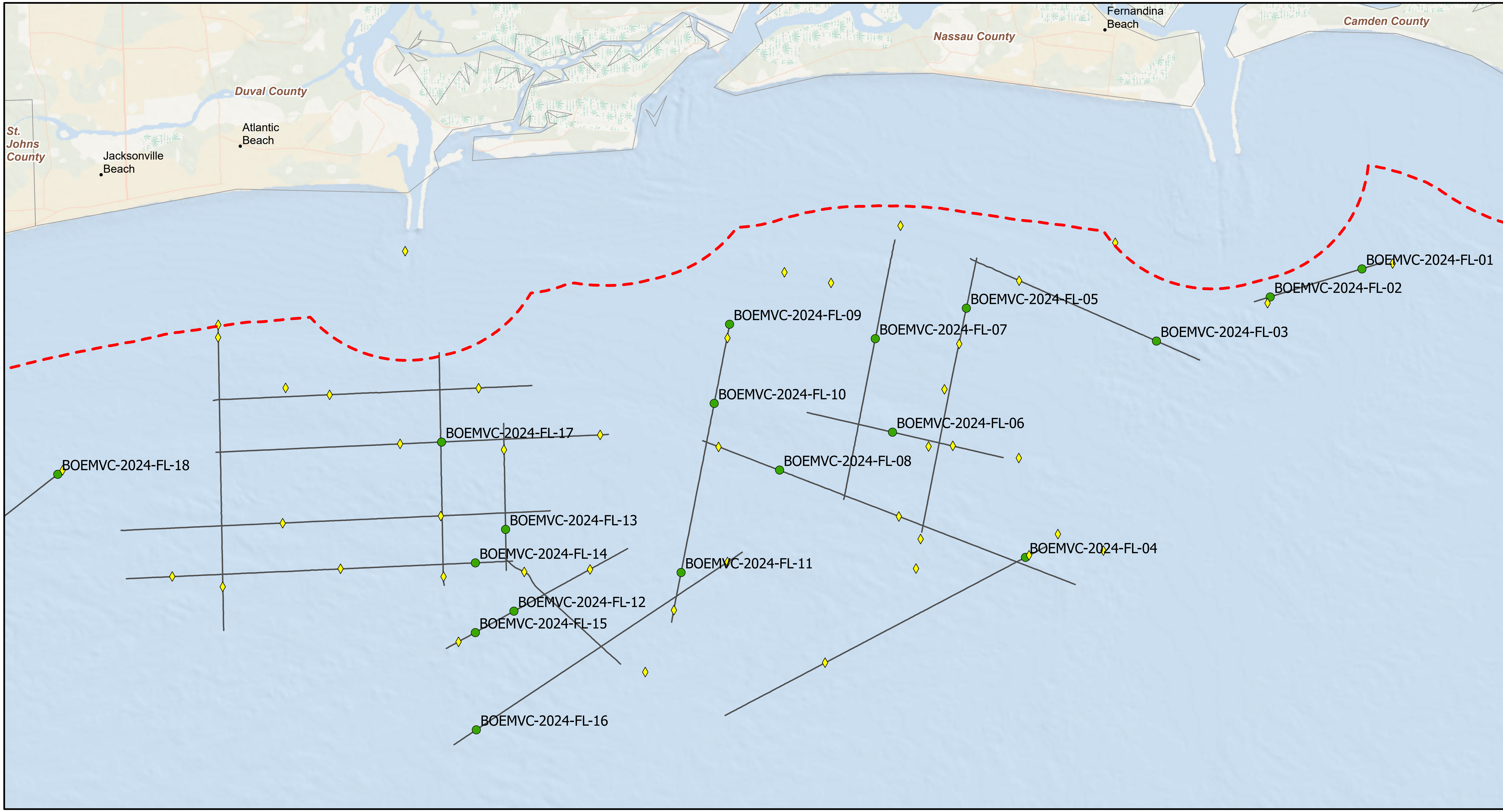
Attachment 1: Identified datasets (Digital only)

Appendix B: Map Series

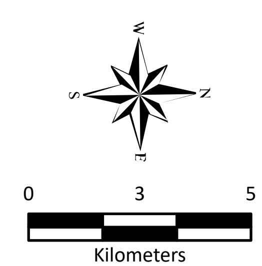


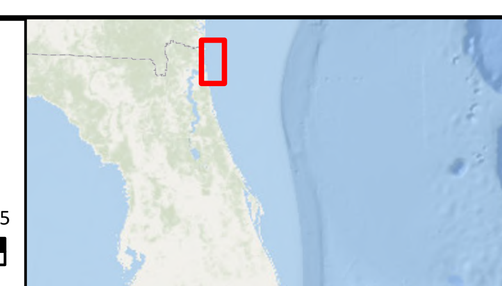
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

Legend:

- Sound Velocity Casts
- As-Built Vibracores
- As-Run Geophysical Lines
- Federal/State Boundary



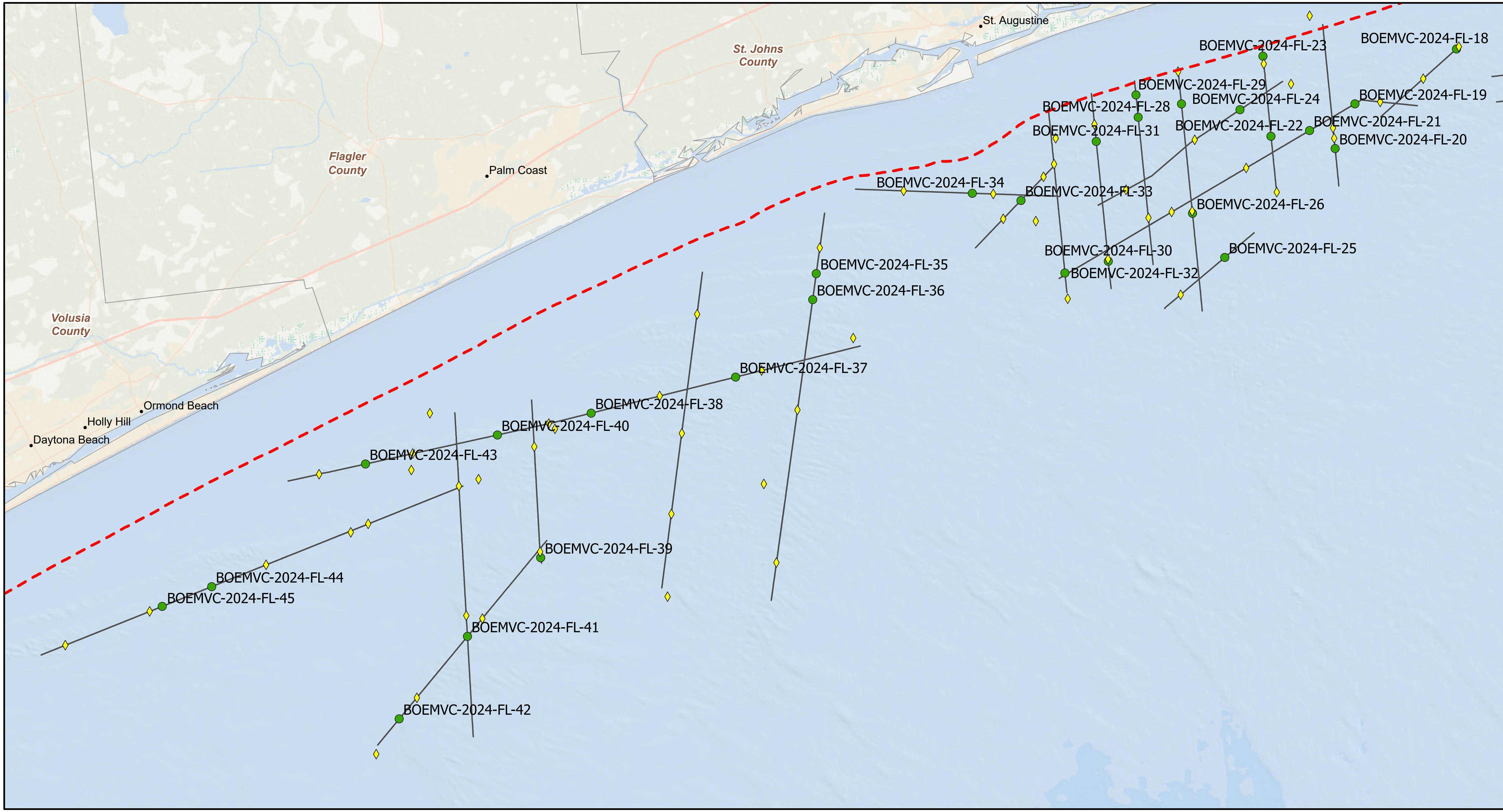


BOEM Task Order 3: Appendix B: Report Map Series As Run and As Built- Nassau Duval

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 1a



Notes:
1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

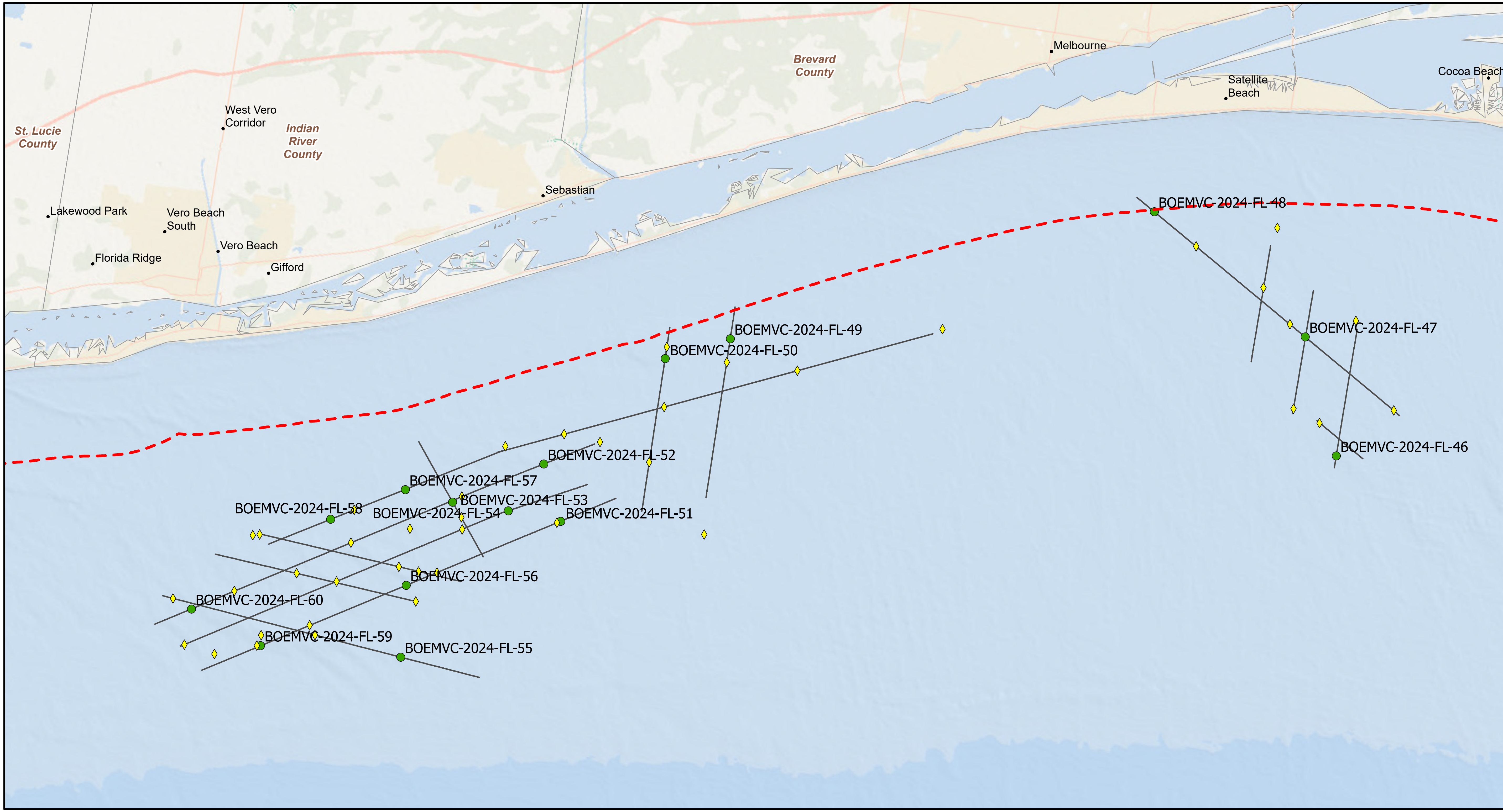
Legend:
- Sound Velocity Casts
- As-Built Vibracores
- As-Run Geophysical Lines
- Federal/State Boundary

BOEM Task Order 3: Appendix B: Report Map Series As Run and As Built- Flagler St. Johns

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025 | Drawn by: AH | Contract Number 140M0121D0006 | **Map No.: 1b**



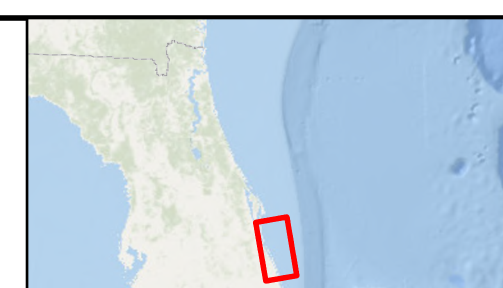
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

Legend:

- Sound Velocity Casts
- As-Built Vibracores
- As-Run Geophysical Lines
- Federal/State Boundary

0 3 5
Kilometers

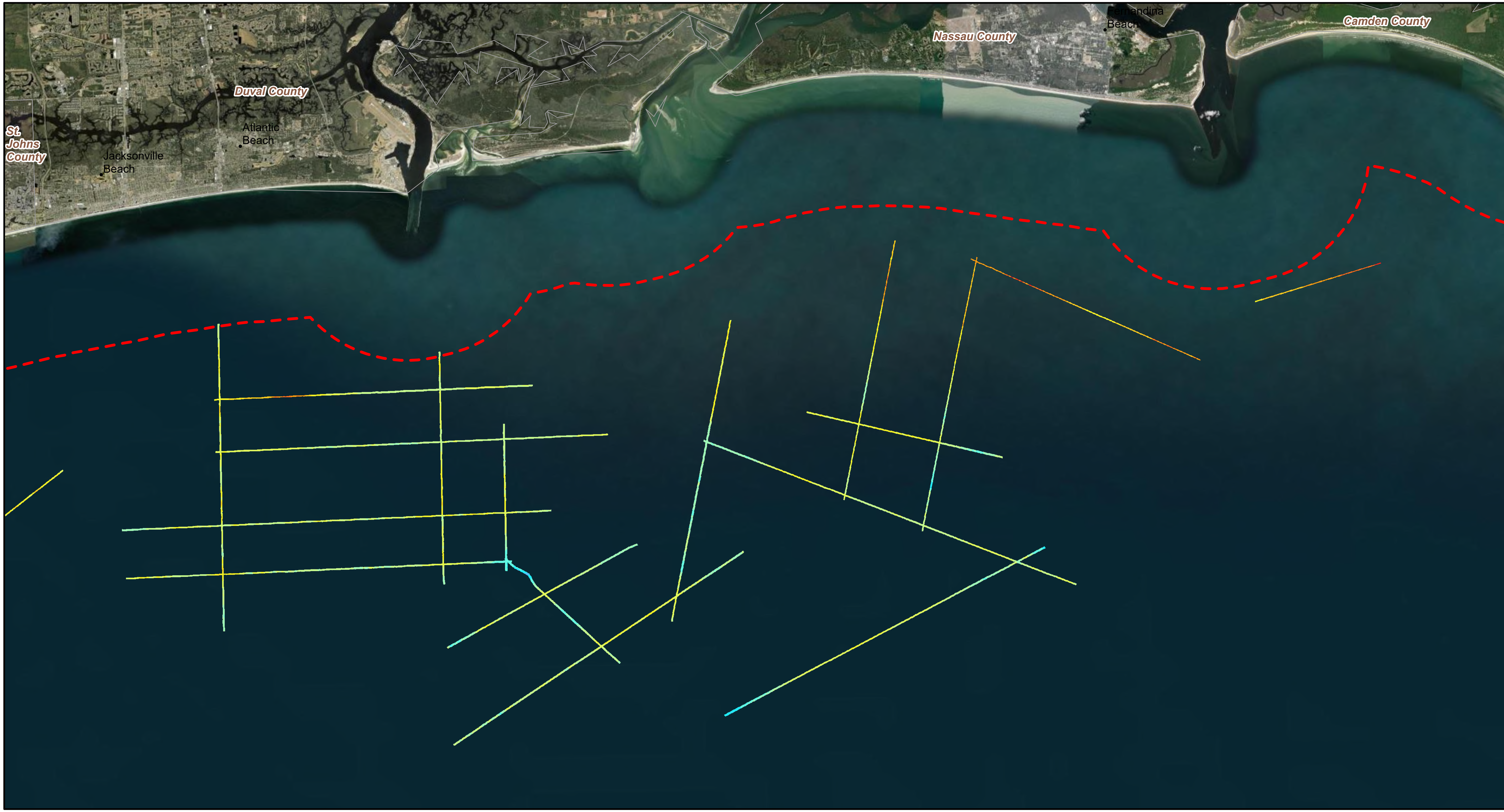


BOEM Task Order 3: Appendix B: Report Map Series As Run and As Built- Sebastian Inlet

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 1c



Notes:

1. Background is the ESRI's World Imagery basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

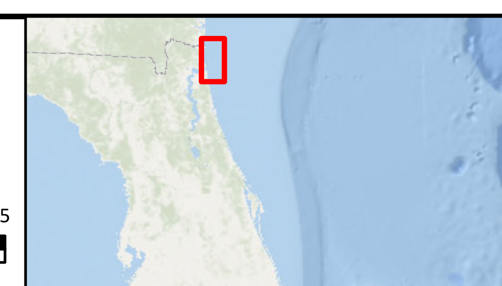
Legend:

Federal/State Boundary

Elevation (NAVD88, ft):

<-90
-90- -85
-85- -80
-80- -75
-75- -70
-70- -65
-65- -60
-60- -55
-55- -50
-50- -45
-45- -40
-40- -35
-35- -30
-30- -25

0 3 5
Kilometers

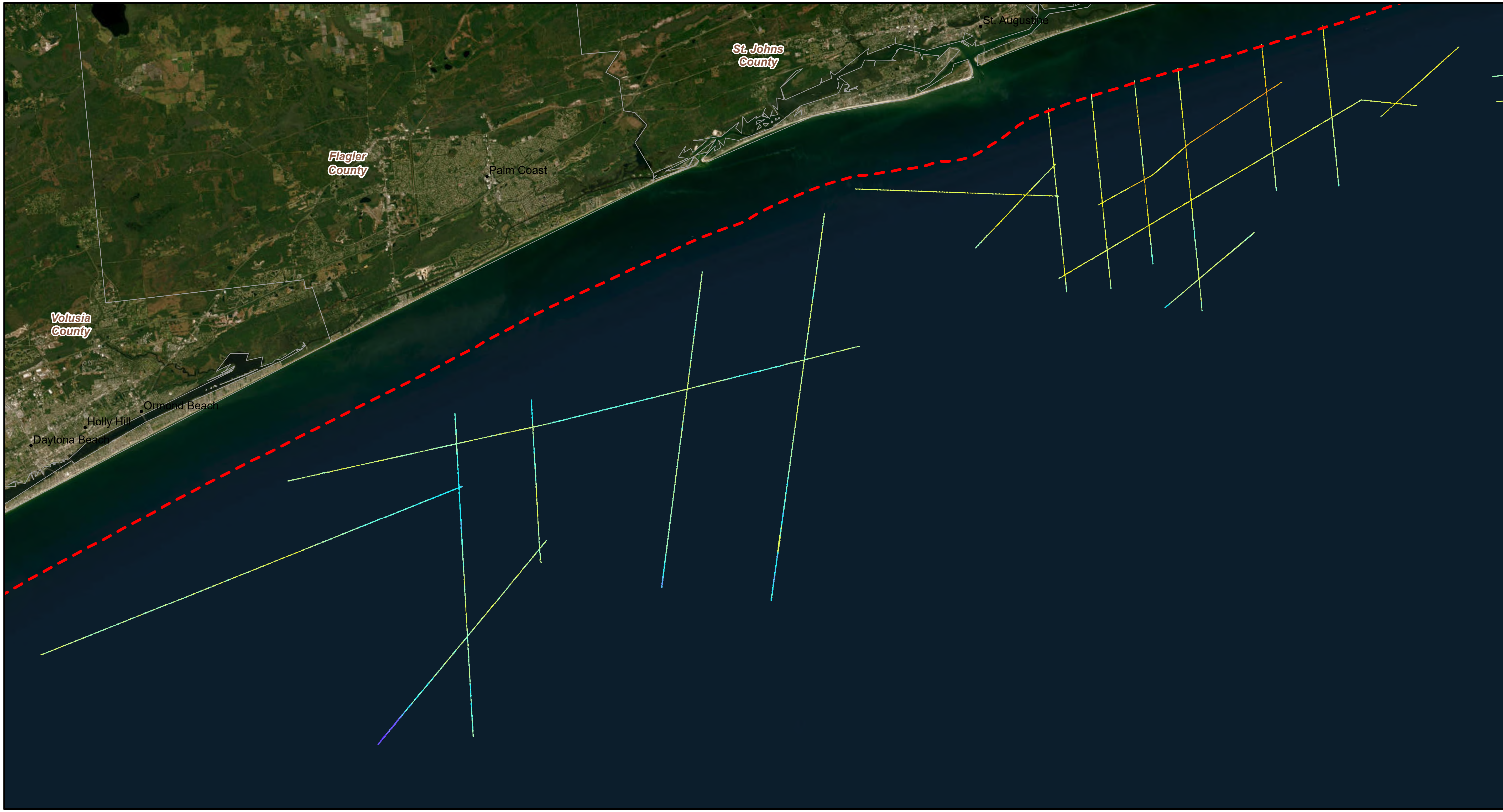


BOEM Task Order 3: Appendix B: Report Map Series
Bathymetry Surface- Nassau Duval

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 2a



Notes:

1. Background is the ESRI's World Imagery basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

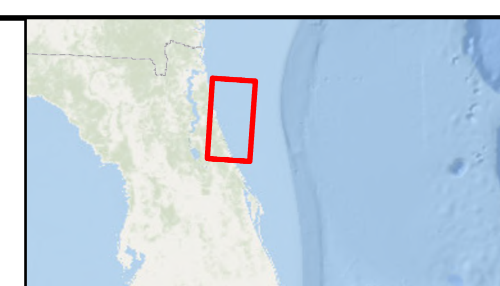
Legend:

Federal/State Boundary

Elevation (NAVD88, ft):

<-90	-65- -60	-35- -30
-90- -85	-60- -55	-30- -25
-85- -80	-55- -50	
-80- -75	-50- -45	
-75- -70	-45- -40	
-70- -65	-40- -35	

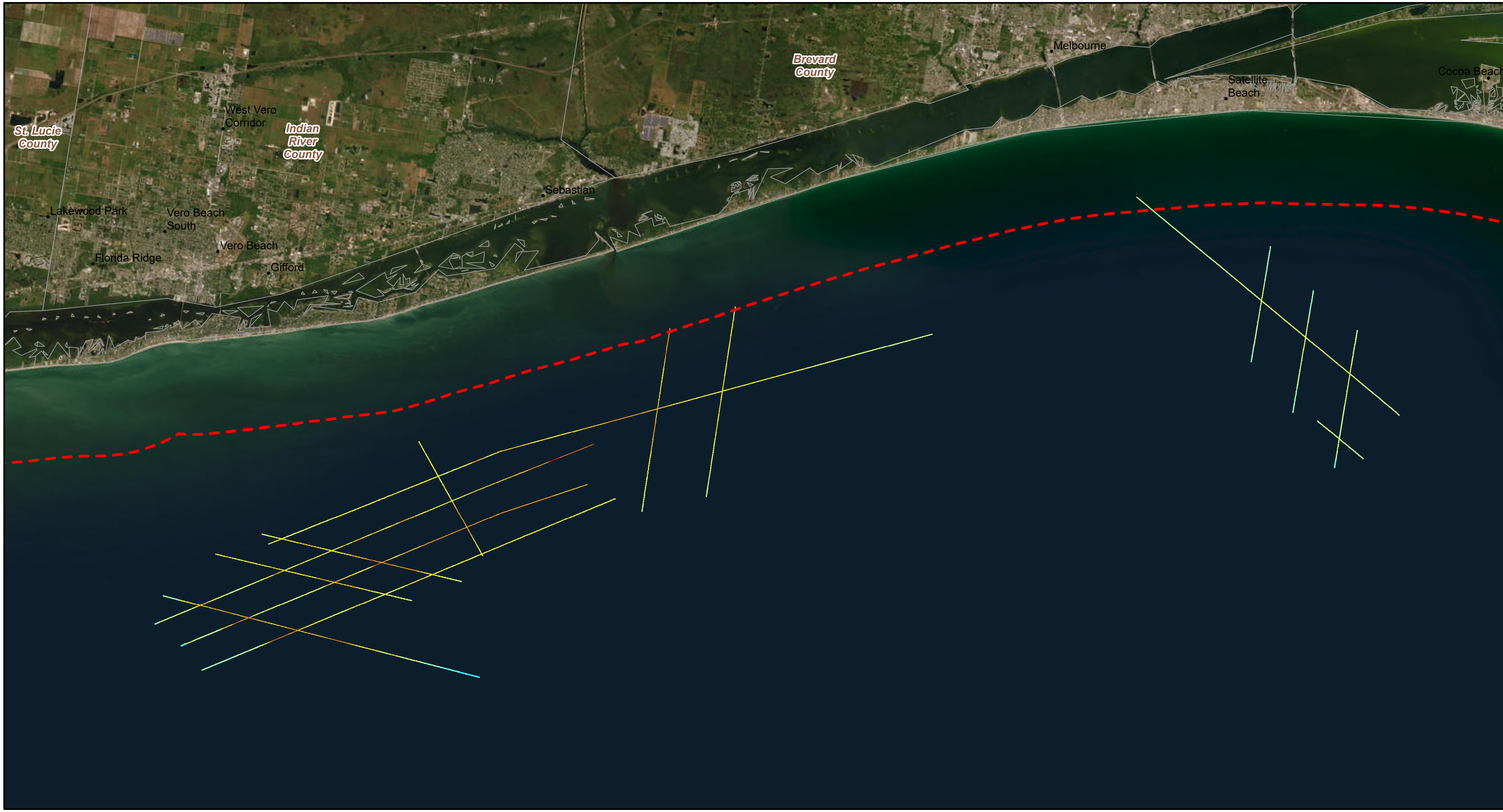
0 3 5
Kilometers



BOEM Task Order 3: Appendix B: Report Map Series
Bathymetry Surface- Flagler St. Johns
Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025 | Drawn by: AH | Contract Number 140M0121D0006 | **Map No.: 2b**



Notes:

1. Background is the ESRI's World Imagery basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

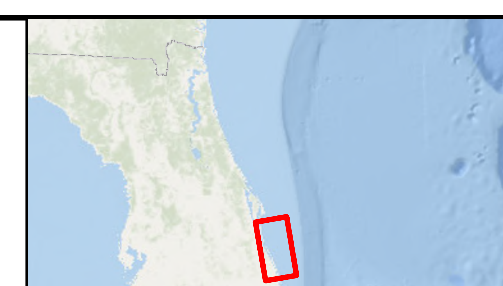
Legend:

Federal/State Boundary

Elevation (NAVD88, ft):

<-90
-90- -85
-85- -80
-80- -75
-75- -70
-70- -65
-65- -60
-60- -55
-55- -50
-50- -45
-45- -40
-40- -35
-35- -30
-30- -25

0 3 5
Kilometers



BOEM Task Order 3: Appendix B: Report Map Series
Bathymetry Surface- Sebastian Inlet

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
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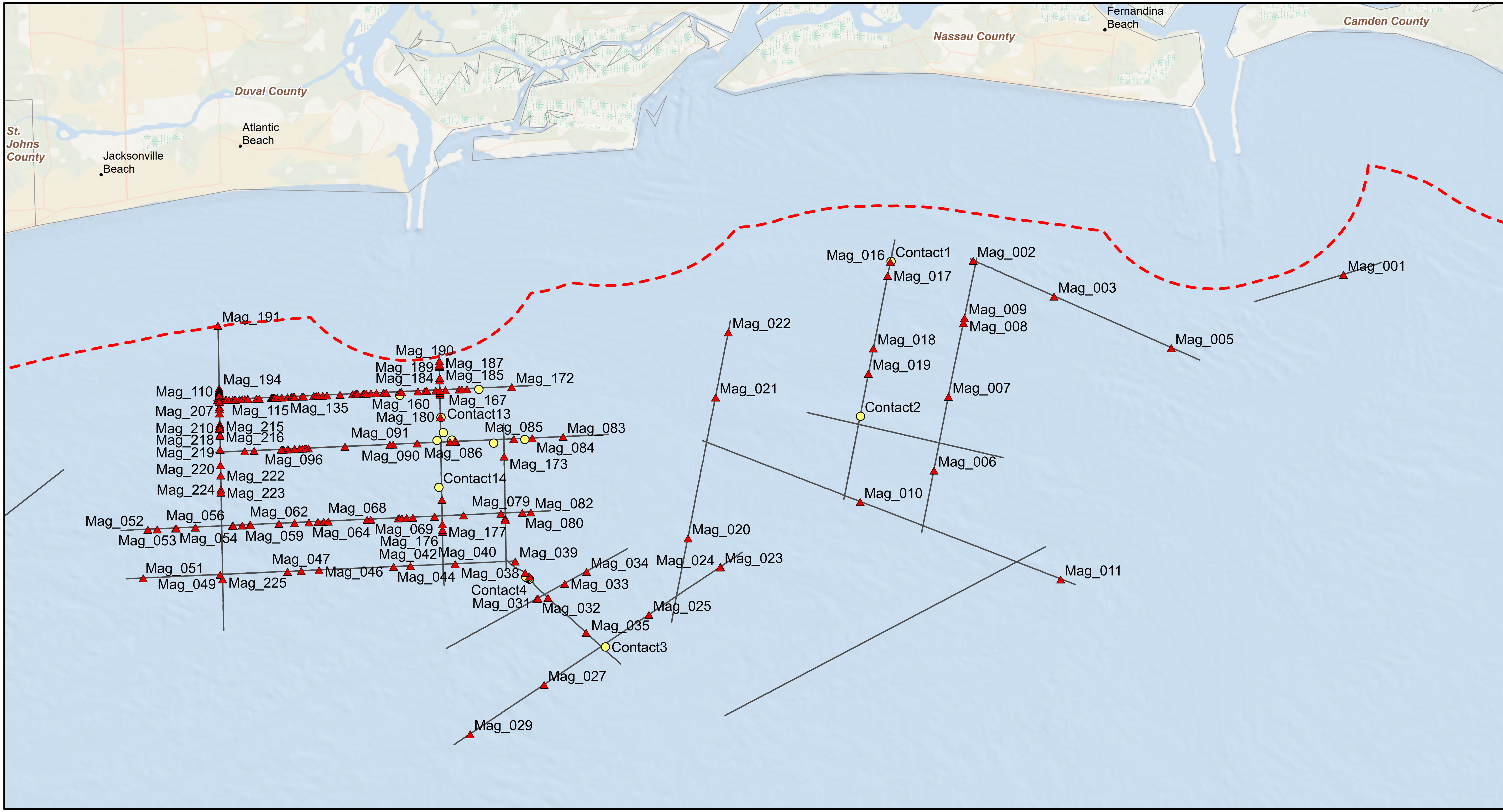
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 2c



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- Magnetic Anomalies
- Sidescan Sonar Contacts
- Sidescan Sonar Data Impacted by Thermocline
- As-Run Geophysical Lines
- Federal/State Boundary

0 3 5
Kilometers

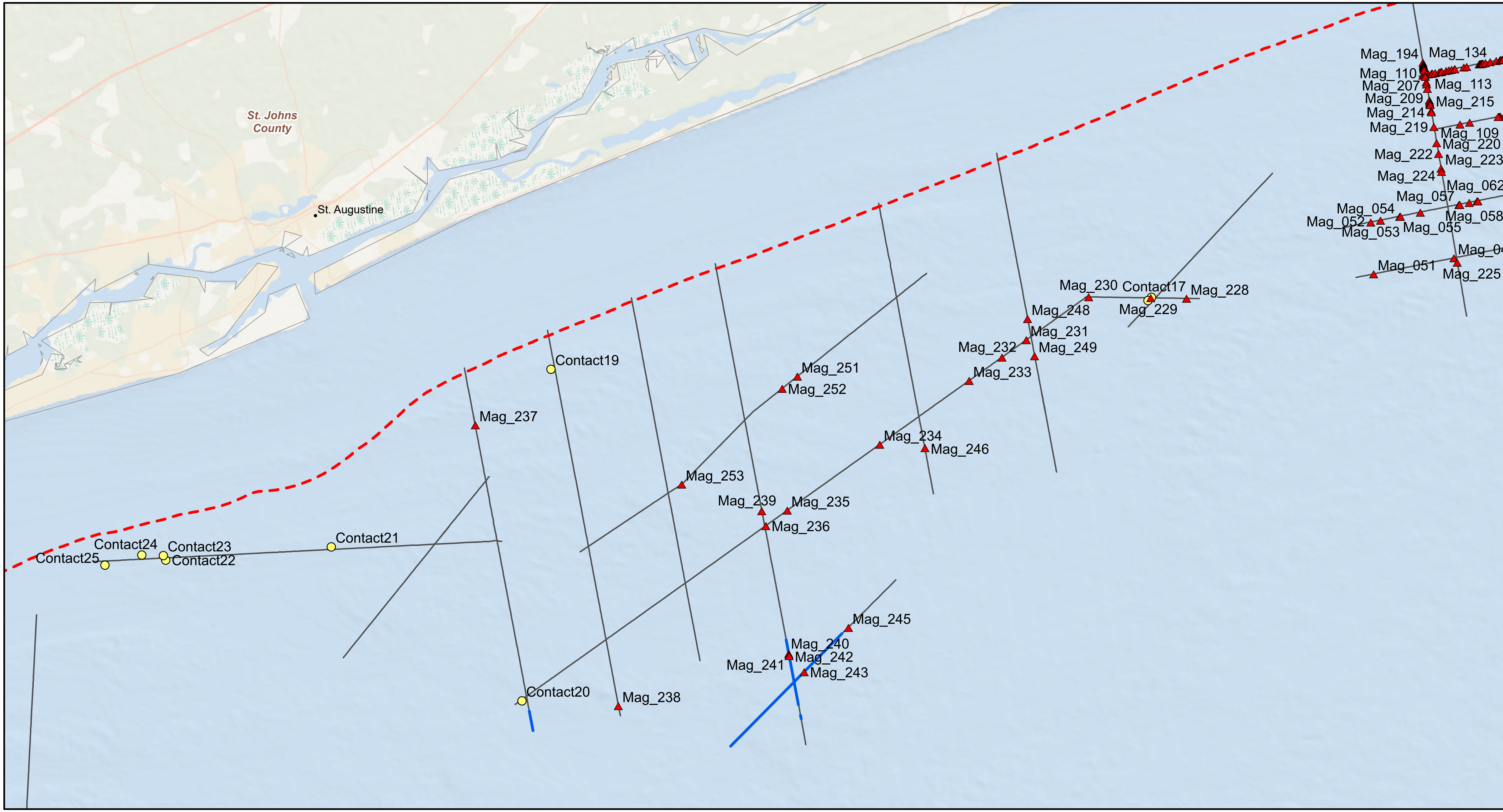
BOEM Task Order 3: Appendix B: Report Map Series
Sidescan Sonar Contact and Magnetic Anomalies
Nassau Duval

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/24/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 3a



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- Magnetic Anomalies
- Sidescan Sonar Contacts
- Sidescan Sonar Data Impacted by Thermocline
- As-Run Geophysical Lines
- Federal/State Boundary

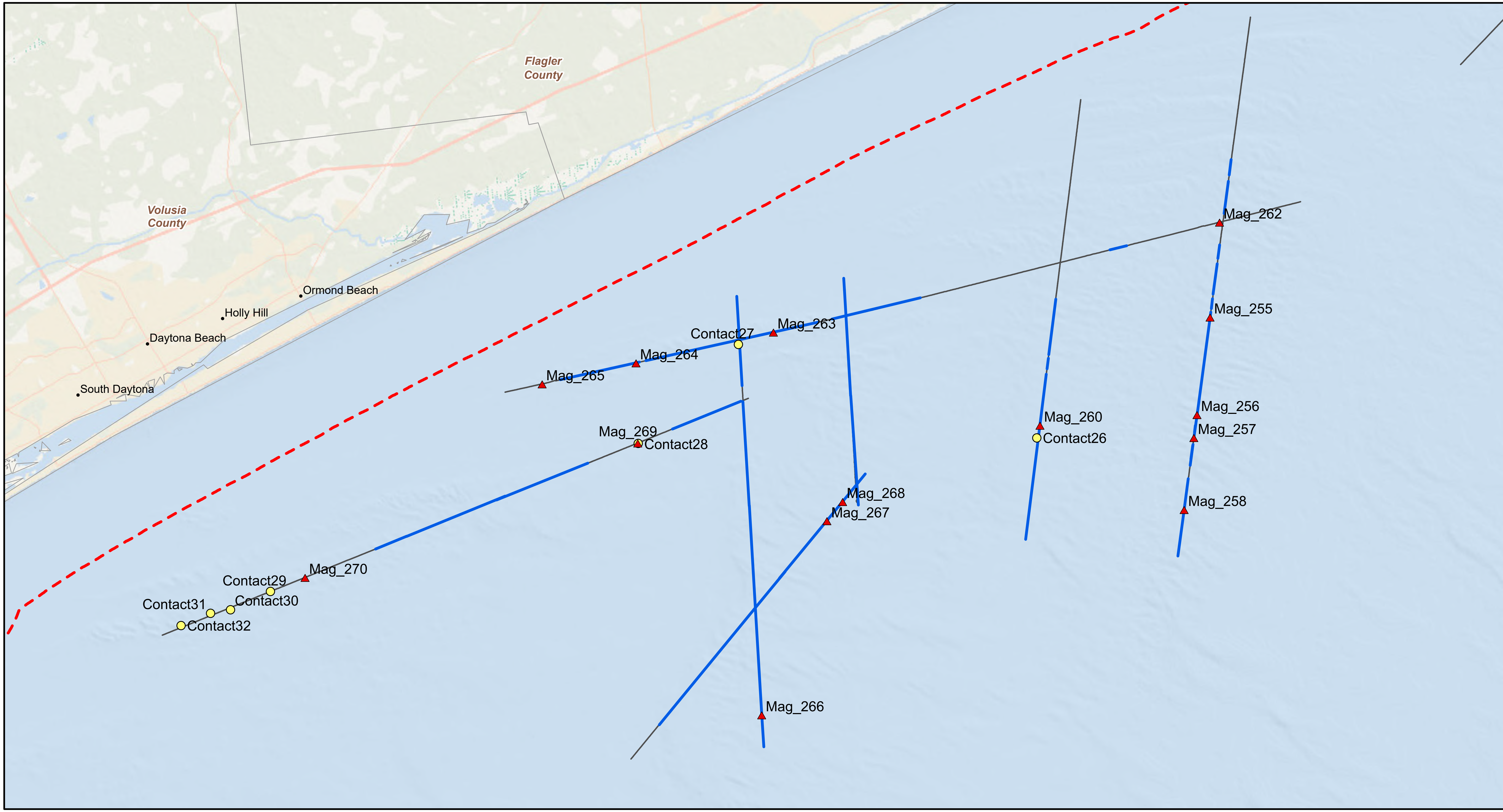
0 3 5
Kilometers

BOEM Task Order 3: Appendix B: Report Map Series
Sidescan Sonar Contact and Magnetic Anomalies
St. Johns

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/24/2025	Drawn by: AH	Contract Number 140M0121D0006	**Map No.: 3b**



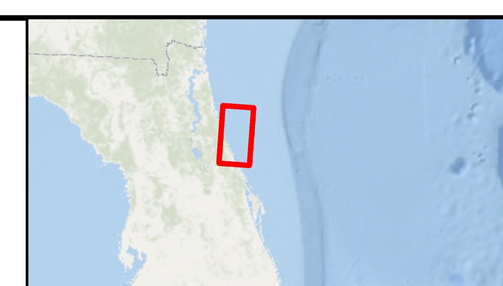
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- Magnetic Anomalies
- Sidescan Sonar Contacts
- Sidescan Sonar Data Impacted by Thermocline
- As-Run Geophysical Lines
- Federal/State Boundary

0 3 5
Kilometers



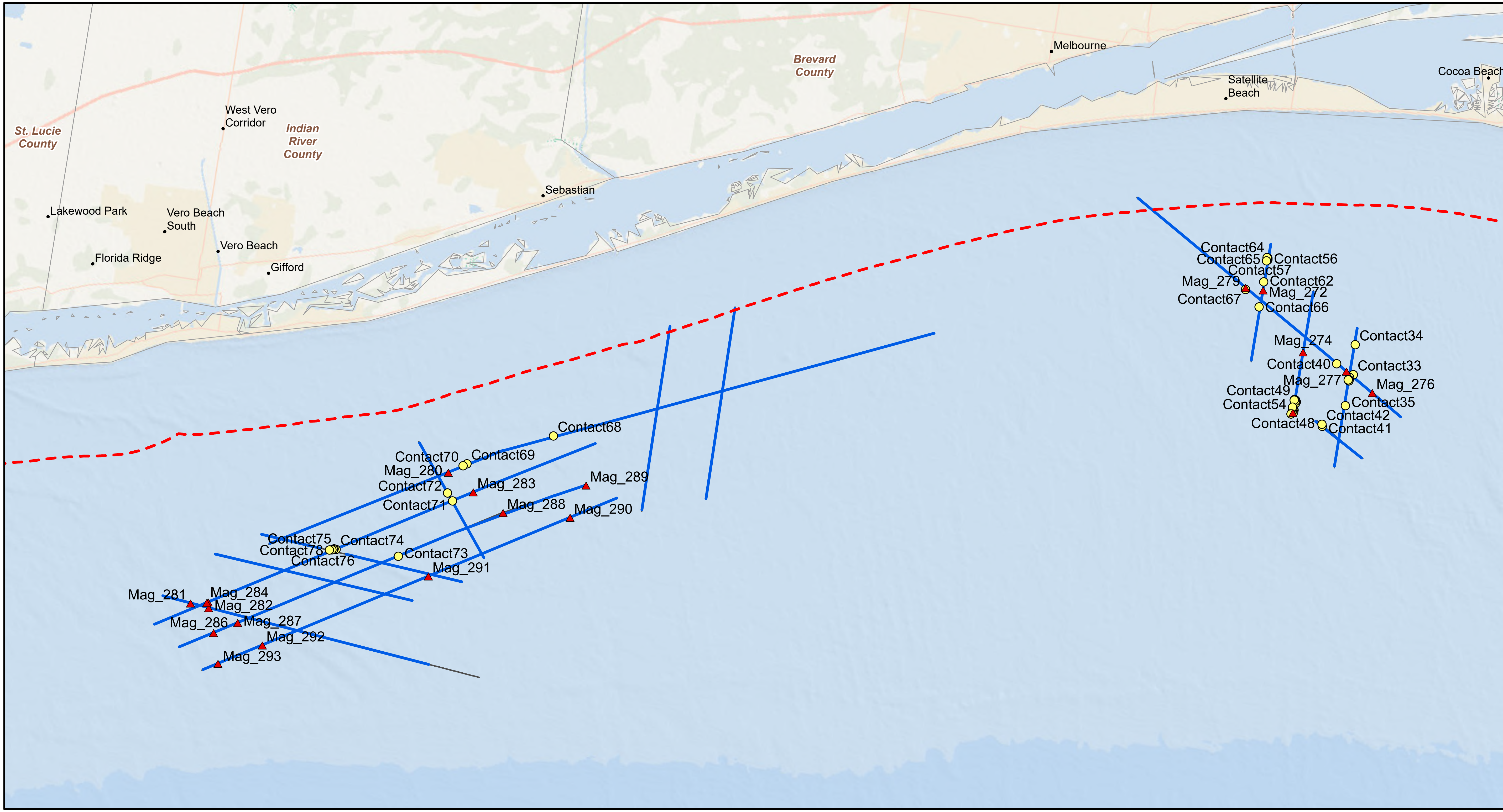
BOEM Task Order 3: Appendix B: Report Map Series
Sidescan Sonar Contact and Magnetic Anomalies
Flagler

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/24/2025	Drawn by: AH	Contract Number 140M0121D0006	**Map No.: 3c**



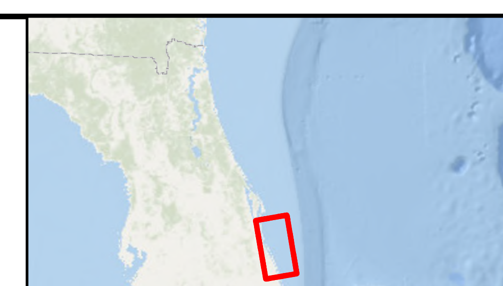
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- Magnetic Anomalies
- Sidescan Sonar Contacts
- Sidescan Sonar Data Impacted by Thermocline
- As-Run Geophysical Lines
- Federal/State Boundary

0 3 5
Kilometers



BOEM Task Order 3: Appendix B: Report Map Series
Sidescan Sonar Contact and Magnetic Anomalies
Sebastian Inlet
Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
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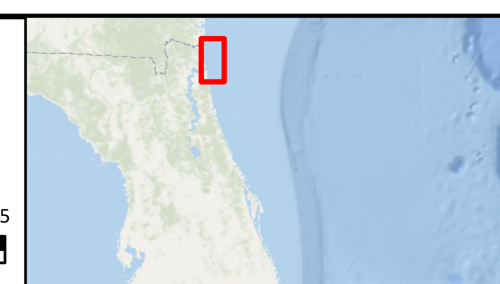
Tampa, FL 33619
APTIM.com

Date: 01/24/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 3d



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- Boat Wake
- Hardbottom
- Patchy Hardbottom
- Sand
- Sand Patches
- Sand Ripple Patches
- Sand Ripples
- Unknown Texture
- Federal/State Boundary

0 3 5
Kilometers

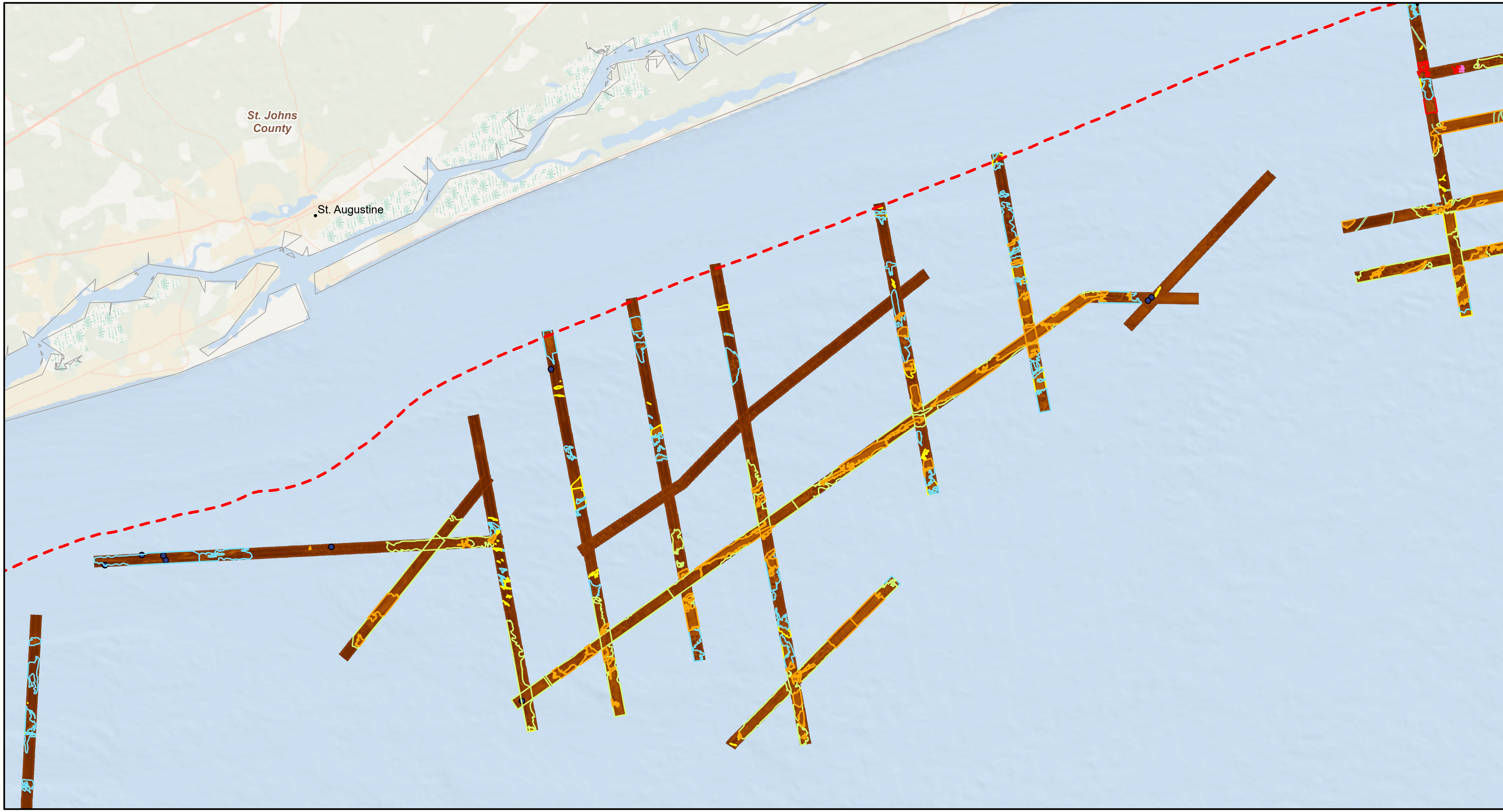
BOEM Task Order 3: Appendix B: Report Map Series
Sidescan Sonar Mosaic and Delineations - Nassau Duval

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 4a



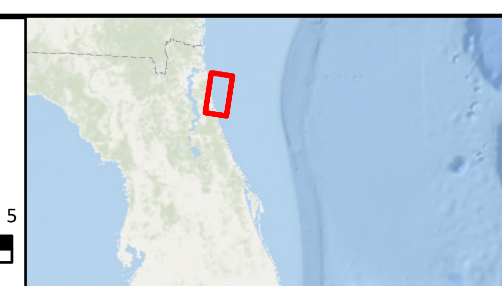
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- Boat Wake
- Hardbottom
- Patchy Hardbottom
- Sand
- Sand Patches
- Sand Ripple Patches
- Sand Ripples
- Unknown Texture
- Federal/State Boundary

0 3 5
Kilometers



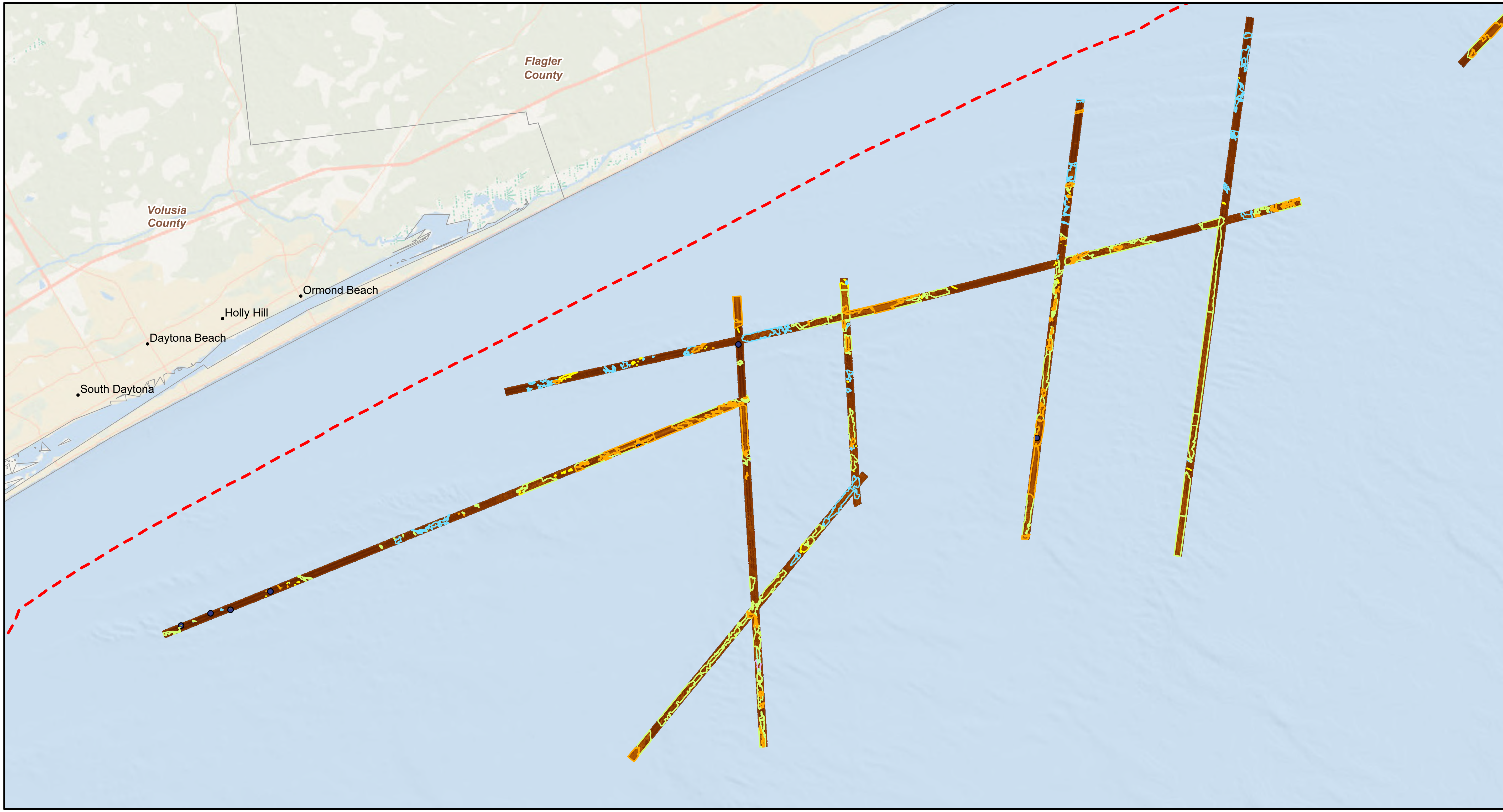
BOEM Task Order 3: Appendix B: Report Map Series
Sidescan Sonar Mosaic and Delineations - St. Johns

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 4b

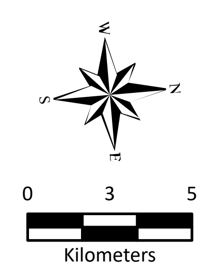


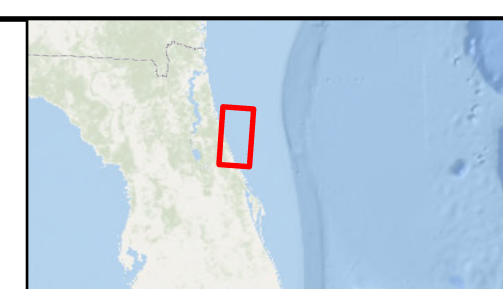
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- Sand
- Sand Patches
- Sand Ripple Patches
- Sand Ripples
- Federal/State





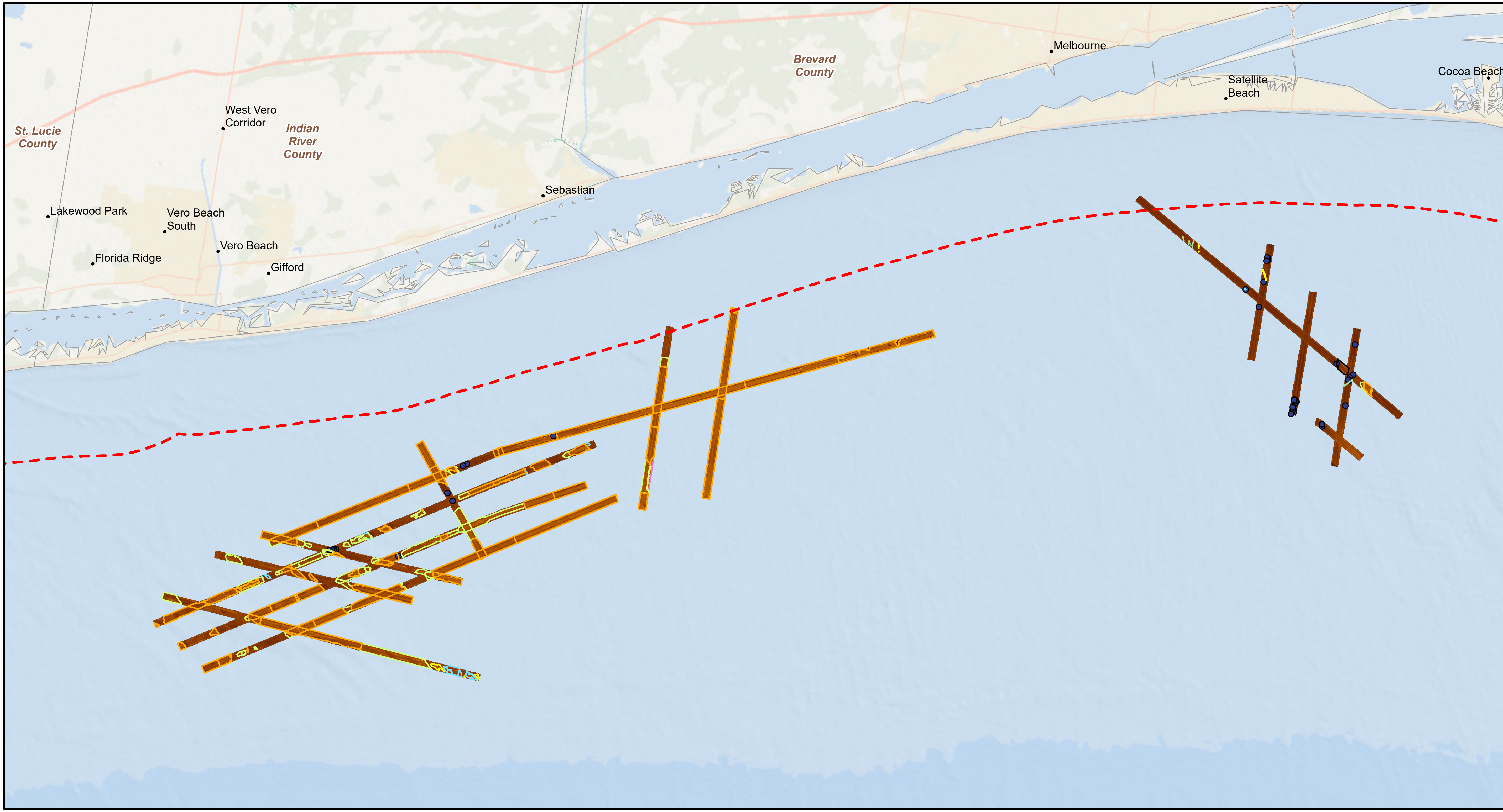
BOEM Task Order 3: Appendix B: Report Map Series
Sidescan Sonar Mosaic and Delineations - Flagler

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 4c

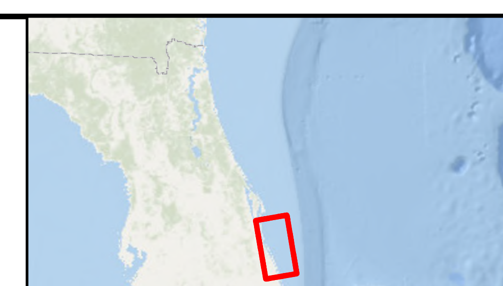


Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- Boat Wake
- Hardbottom
- Sand
- Sand Patches
- Sand Ripple Patches
- Sand Ripples
- Unknown Texture
- Federal/State Boundary

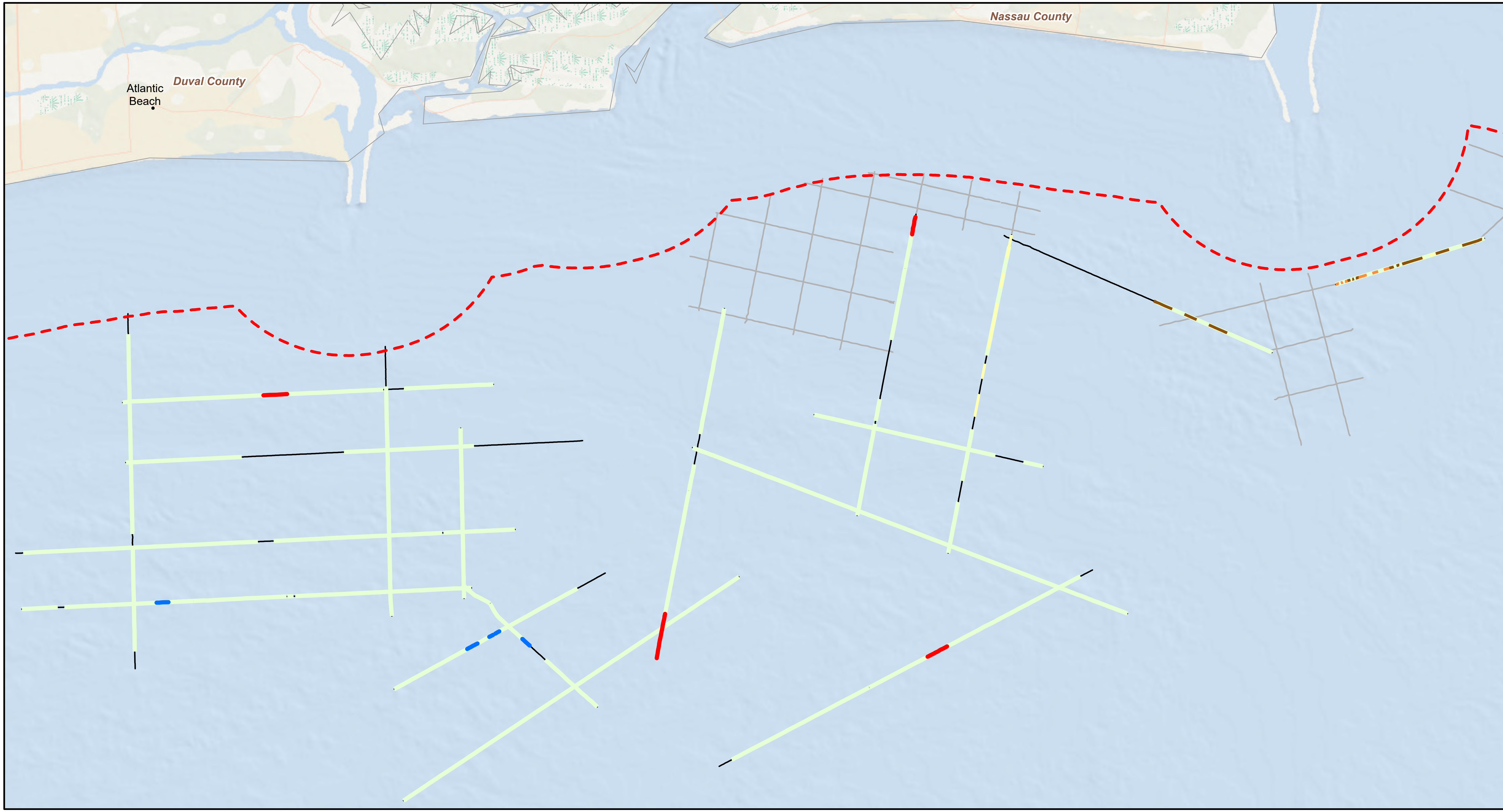


BOEM Task Order 3: Appendix B: Report Map Series
Sidescan Sonar Mosaic and Delineations - Sebastian Inlet

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025 | Drawn by: AH | Contract Number 140M0121D0006 | **Map No.: 4d**



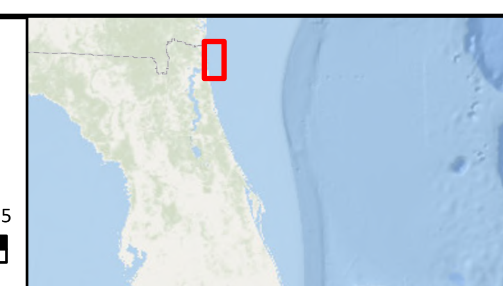
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- As-Run Geophysical Lines
- APTIM ASAP As Run Tracklines
- Federal/State Boundary
- Channel
- Deep basement stratigraphy
- Valley
- Clay
- Prograding Deposit
- Surficial Sedimentary Unit

0 3 5
Kilometers



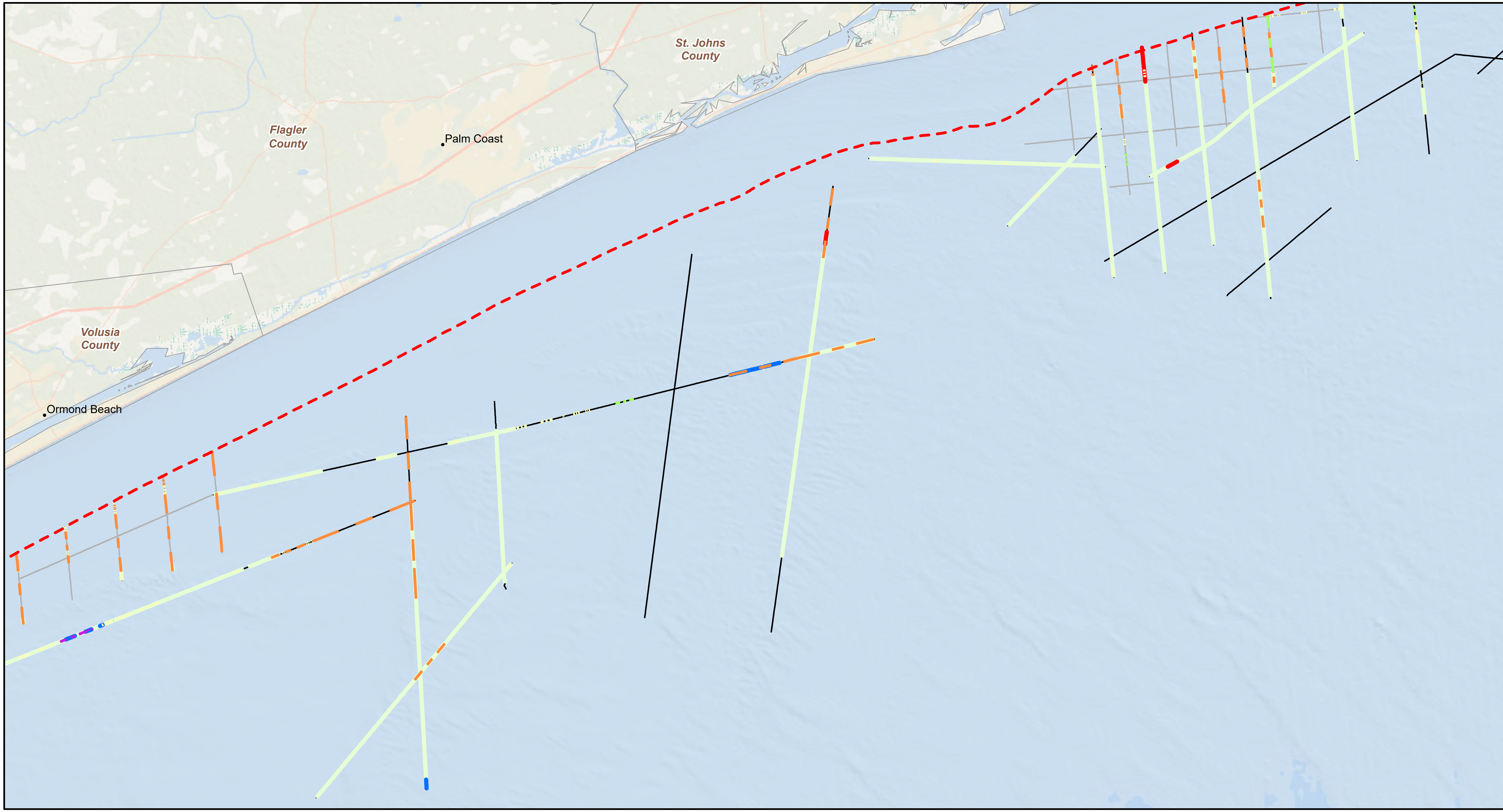
BOEM Task Order 3: Appendix B: Report Map Series
Seismic Features- Nassau Duval

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	**Map No.: 5a**

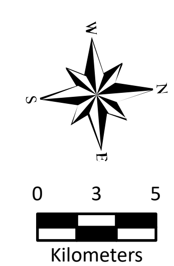


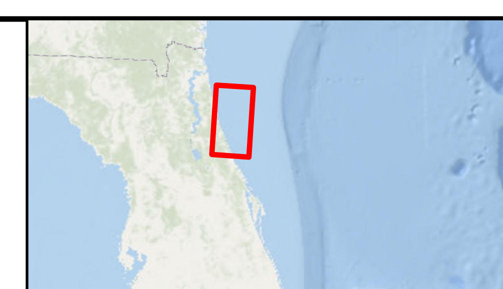
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- As-Run Geophysical Lines
- APTIM ASAP As Run Tracklines
- Federal/State Boundary
- Beach deposit
- Channel
- Deep basement stratigraphy
- Regional erosional surface
- Clay
- Prograding Deposit
- Surficial Sedimentary Unit



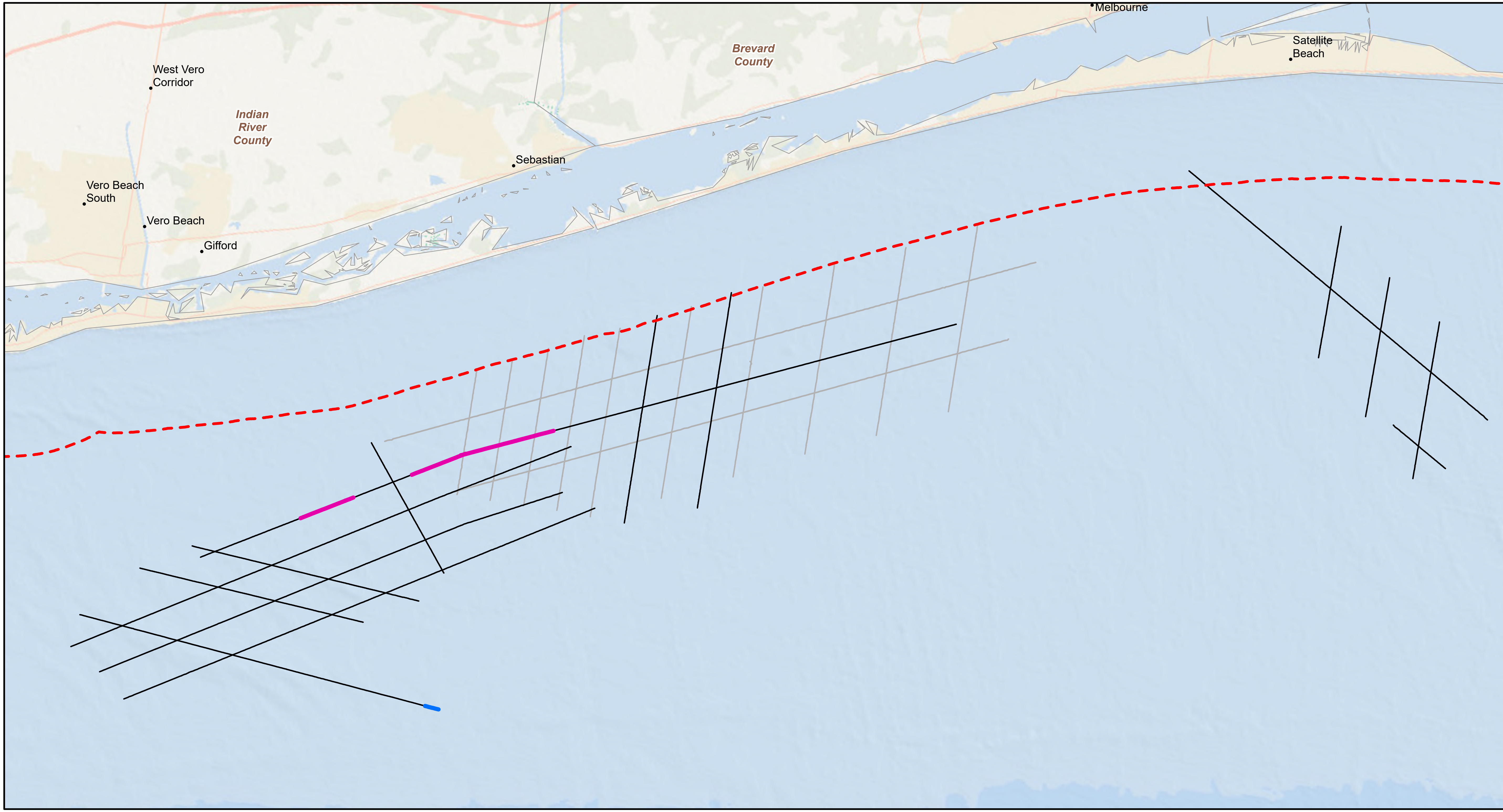


BOEM Task Order 3: Appendix B: Report Map Series
Seismic Features- Flagler St. Johns

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 5b



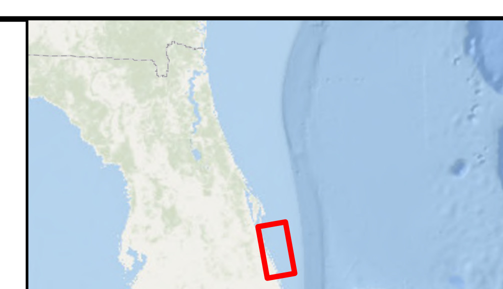
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- As-Run Geophysical Lines
- APTIM ASAP As Run Tracklines
- Federal/State Boundary
- Prograding Deposit
- Shell Hash

0 3 5
Kilometers



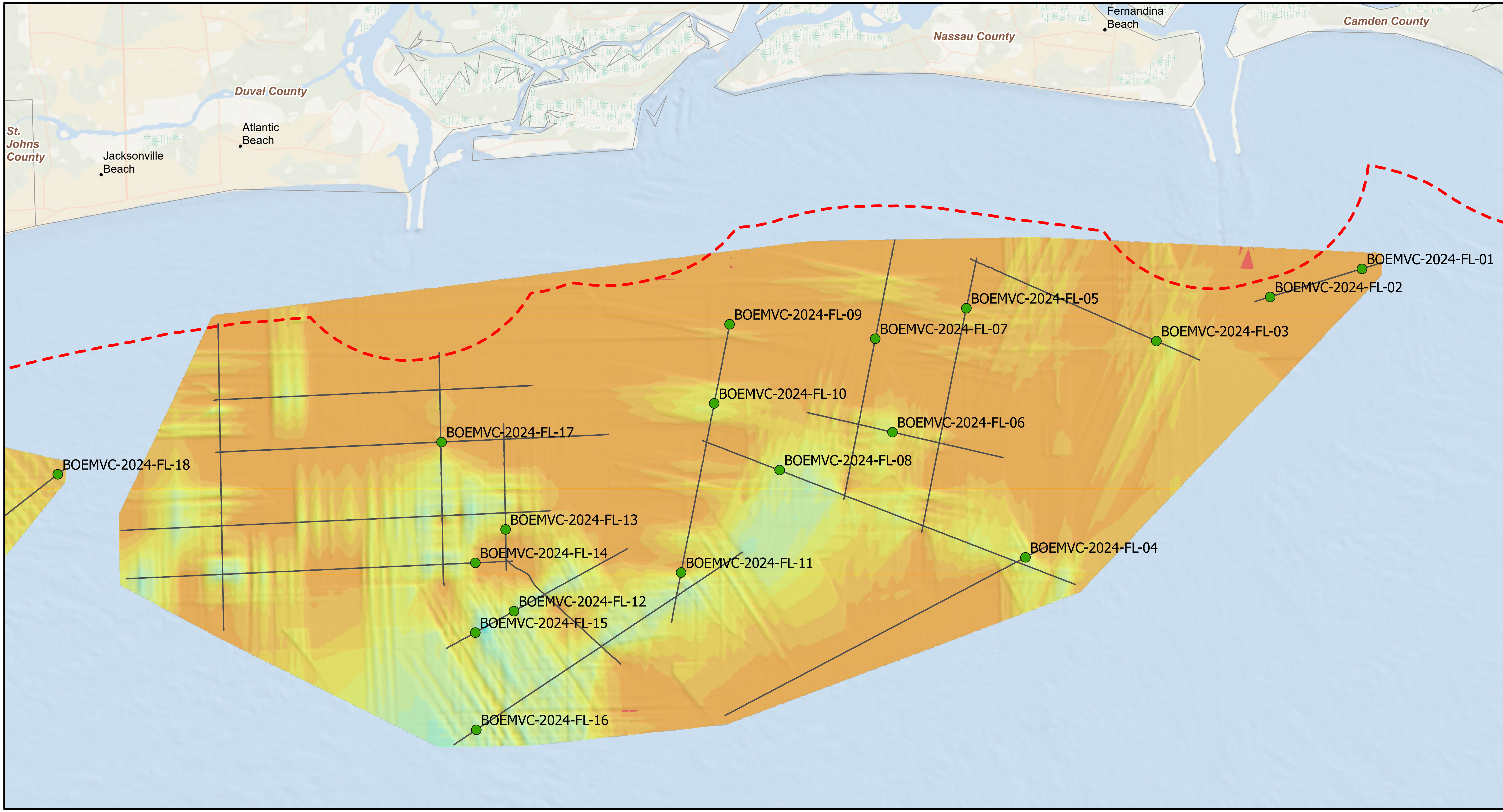
BOEM Task Order 3: Appendix B: Report Map Series
Seismic Features- Sebastian Inlet

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	**Map No.: 5c**



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

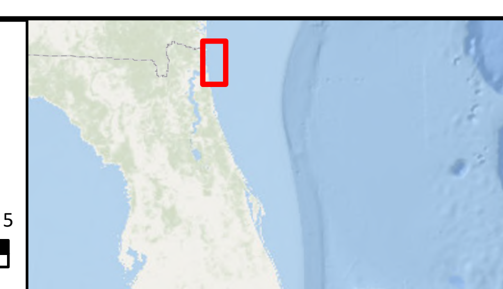
Legend:

- As-Run Geophysical Lines
- As-Built Vibracores
- Federal/State Boundary

Sand Thickness (ft):

0	10 - 12	22 - 24	34 - 36
0 - 2	12 - 14	24 - 26	
2 - 4	14 - 16	26 - 28	
4 - 6	16 - 18	28 - 30	
6 - 8	18 - 20	30 - 32	
8 - 10	20 - 22	32 - 34	

0 3 5
Kilometers



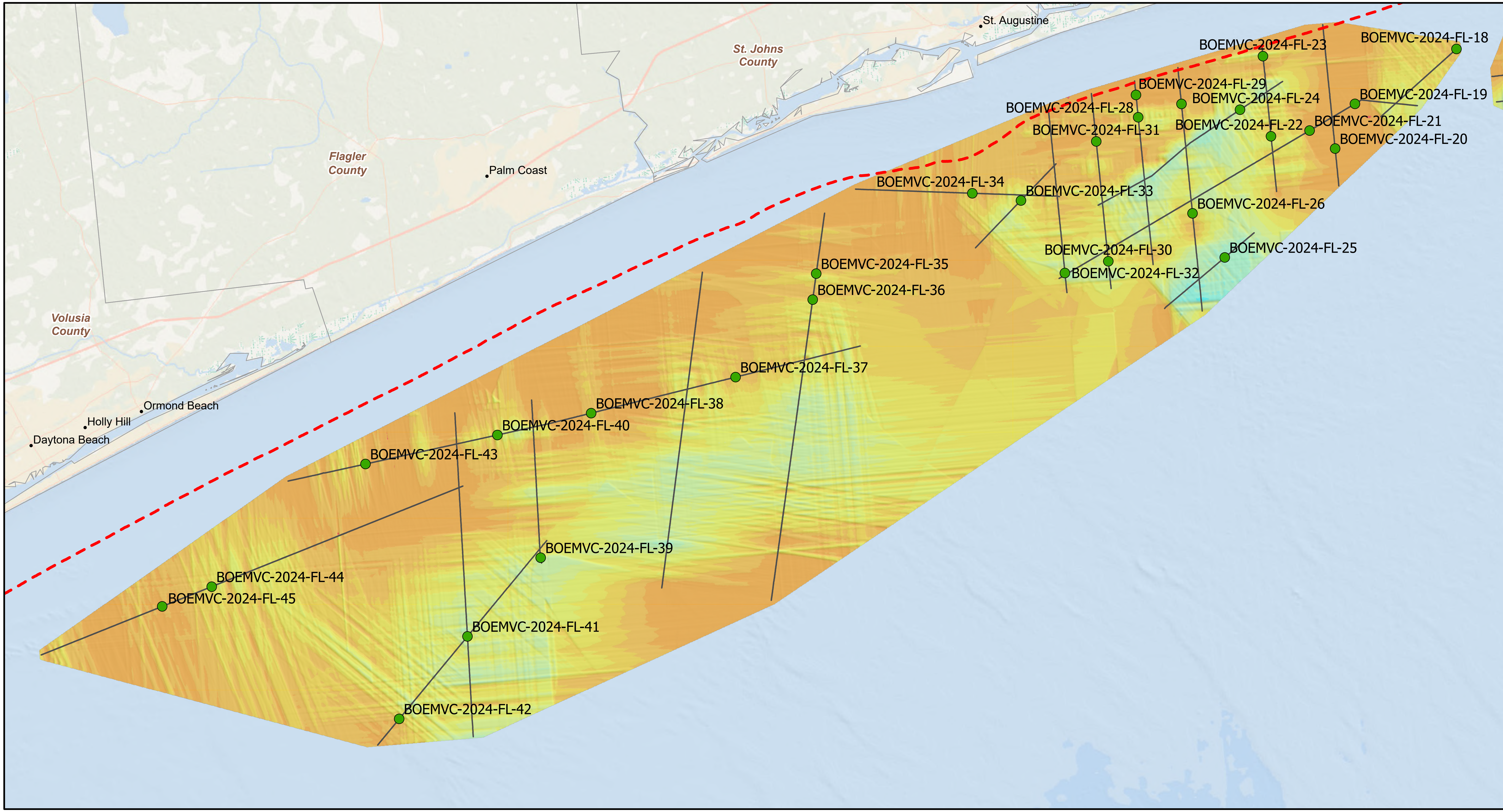
BOEM Task Order 3: Appendix B: Report Map Series
Surface Sand Delineation- Nassau Duval

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 6a



Notes:
1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

Legend:
- As-Run Geophysical Lines
- As-Built Vibracores
- Federal/State Boundary

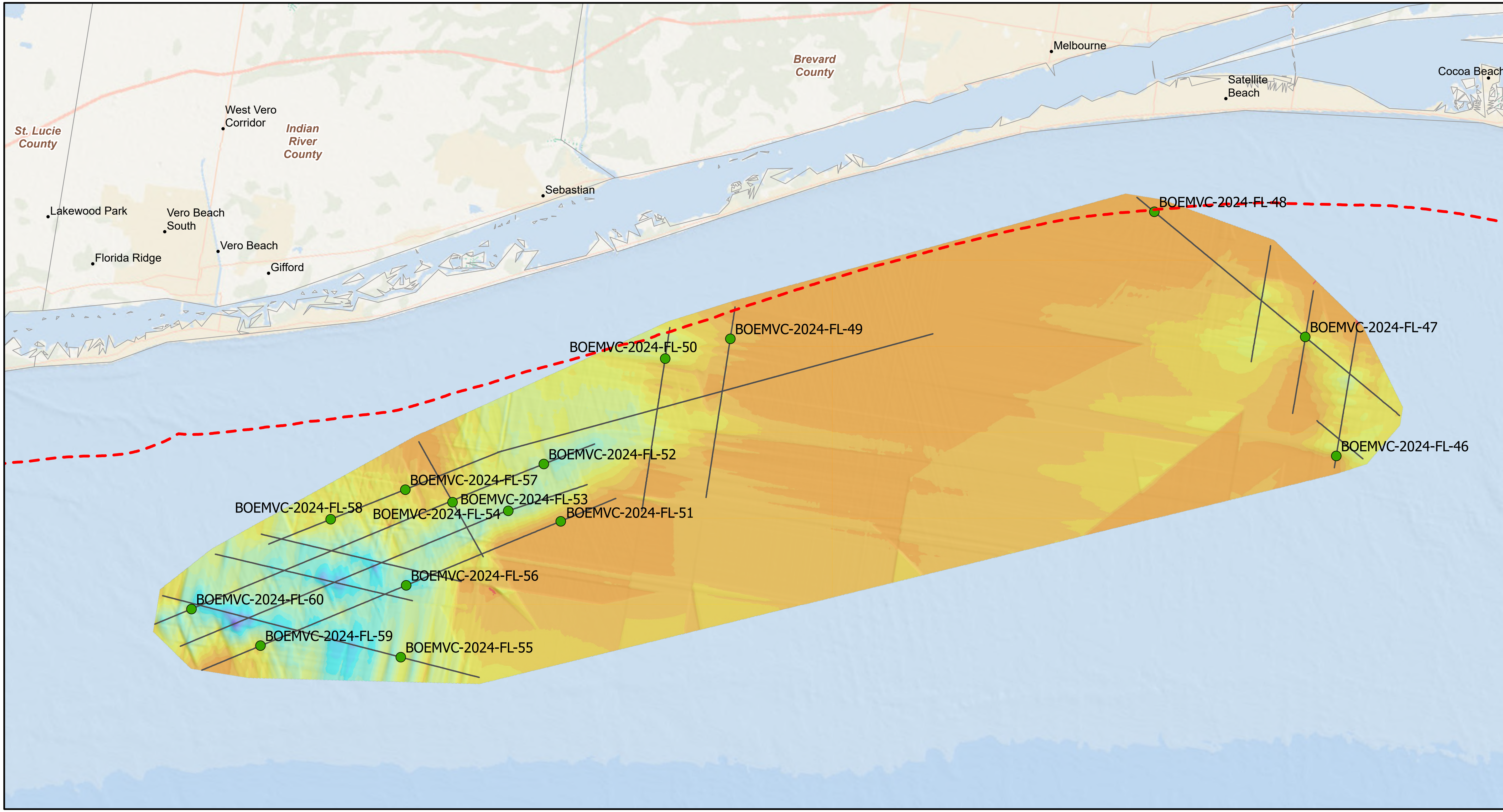
Sand Thickness (ft):
0; 0 - 2; 2 - 4; 4 - 6; 6 - 8; 8 - 10; 10 - 12; 12 - 14; 14 - 16; 16 - 18; 18 - 20; 20 - 22; 22 - 24; 24 - 26; 26 - 28; 28 - 30; 30 - 32; 32 - 34; 34 - 36

0 3 5
Kilometers

BOEM Task Order 3: Appendix B: Report Map Series
Surface Sand Delineation- Flagler St. Johns
Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	**Map No.: 6b**



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

Legend:

- As-Run Geophysical Lines
- As-Built Vibracores
- Federal/State Boundary

Sand Thickness (ft):

0	10 - 12	22 - 24	34 - 36	
0 - 2	12 - 14	24 - 26		
2 - 4	14 - 16	26 - 28		
4 - 6	16 - 18	28 - 30		
6 - 8	18 - 20	30 - 32		
8 - 10	20 - 22	32 - 34		

0 3 5
Kilometers

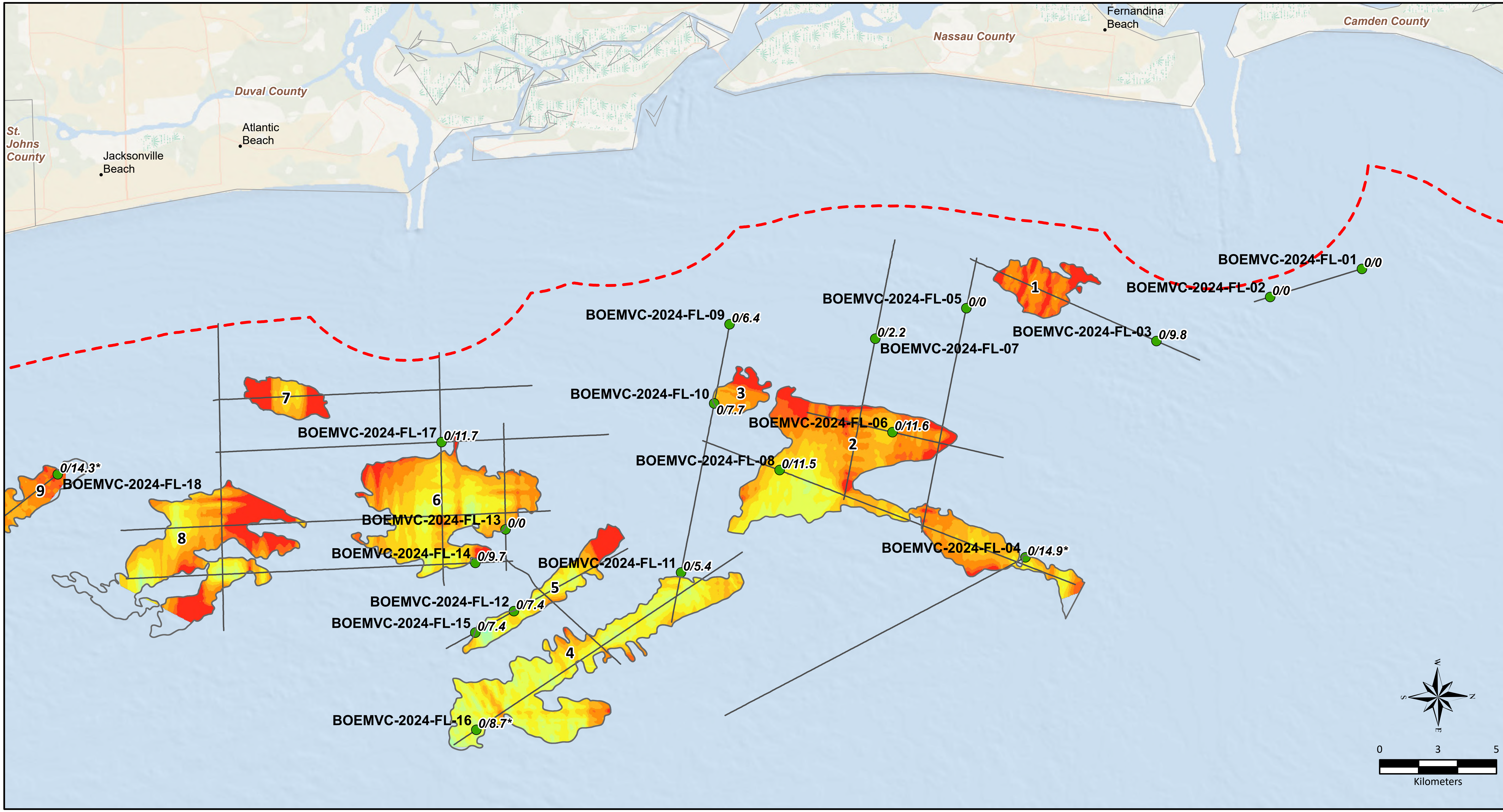
BOEM Task Order 3: Appendix B: Report Map Series
Surface Sand Delineation- Sebastian Inlet

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 6c



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

Legend:

- As-Run Geophysical Lines
- As-Built Vibracores
- Potential Deposits
- Federal/State Boundary

Sand Thickness derived from Coastal Relief Model data (ft):

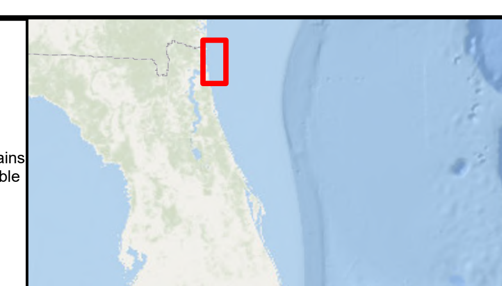
0.3 - 3	10 - 12	20 - 22	30 - 32
3.1 - 4	12 - 14	22 - 24	32 - 34
4 - 6	14 - 16	24 - 26	
6 - 8	16 - 18	26 - 28	
8 - 10	18 - 20	28 - 30	

0/0

Overburden thickness (ft)

Sand thickness (ft)

* indicates sand layer contains some non-beach compatible material.



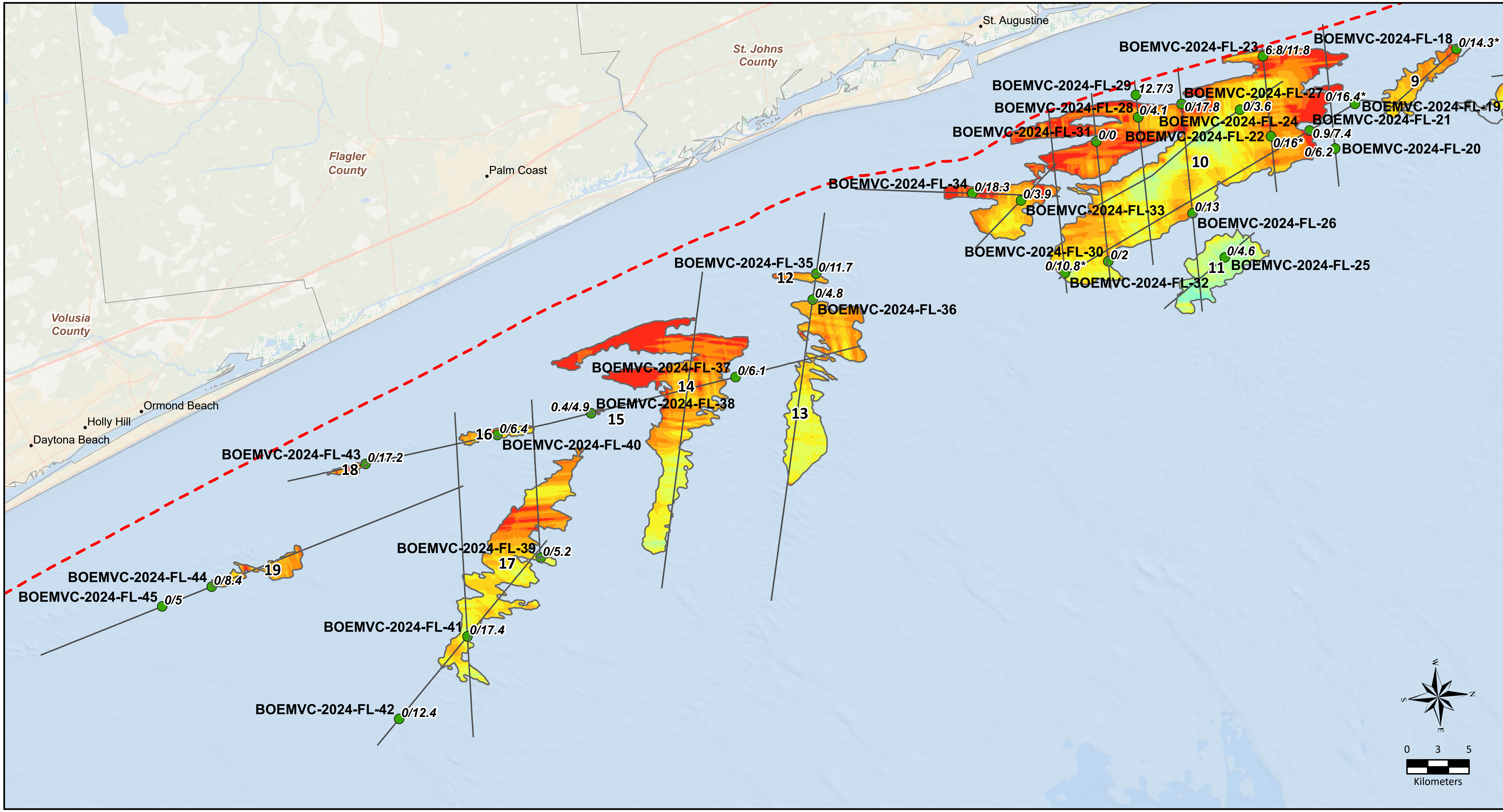
BOEM Task Order 3: Appendix B: Report Map Series
Surface Sand CRM Deposits- Nassau Duval

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/22/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 7a



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

Legend:

- As-Run Geophysical Lines
- As-Built Vibracores
- Potential Deposits
- Federal/State Boundary

Sand Thickness derived from Coastal Relief Model data (ft):

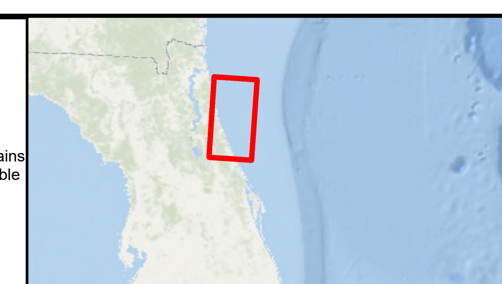
0.3 - 3, 3.1 - 4, 4 - 6, 6 - 8, 8 - 10, 10 - 12, 12 - 14, 14 - 16, 16 - 18, 18 - 20, 20 - 22, 22 - 24, 24 - 26, 26 - 28, 28 - 30, 30 - 32, 32 - 34

0/0

Overburden thickness (ft)

Sand thickness (ft)

* indicates sand layer contains some non-beach compatible material.



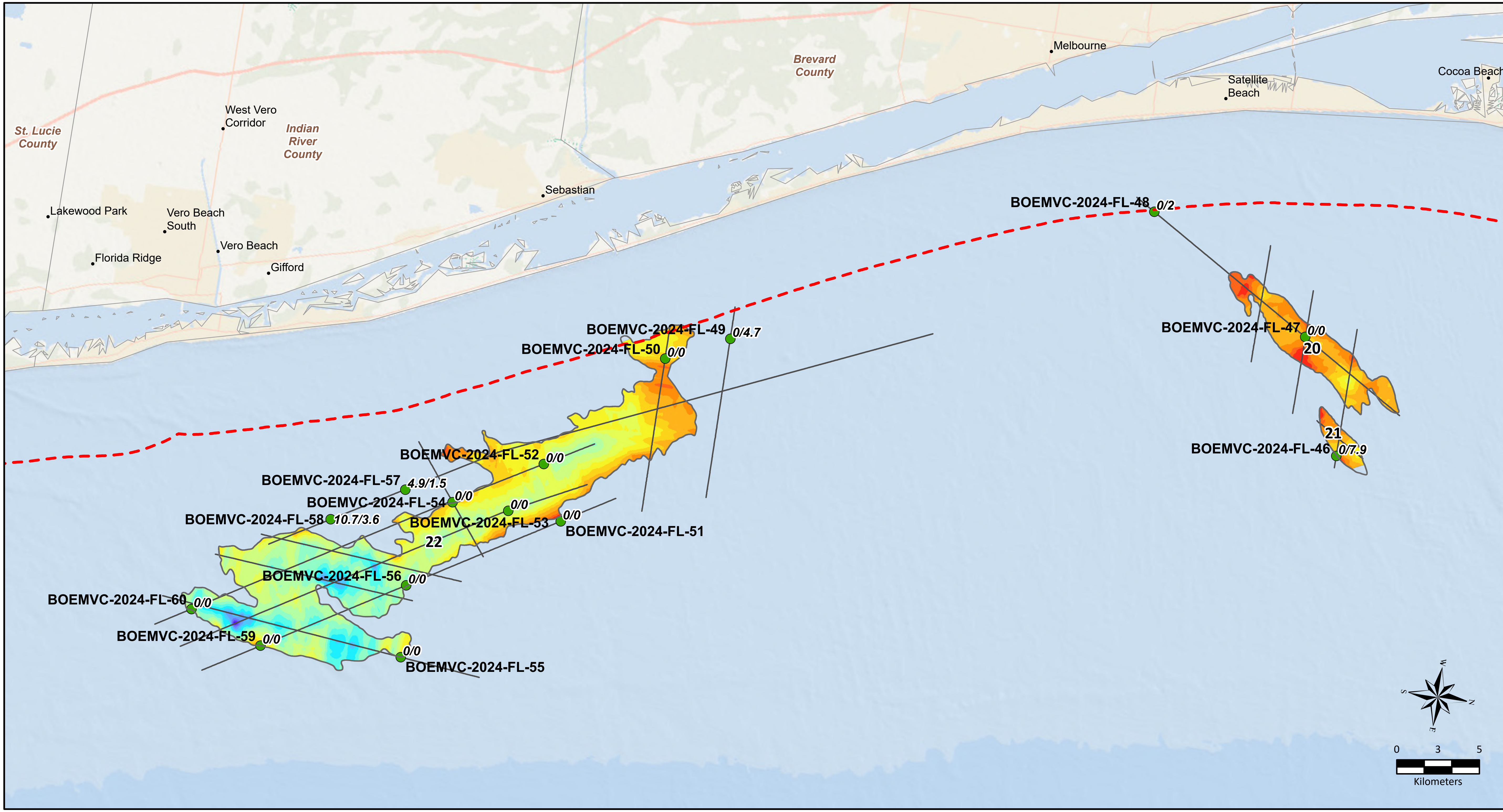
BOEM Task Order 3: Appendix B: Report Map Series
Surface Sand CRM Deposits- Flagler St. Johns

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/22/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 7b



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.
3. Geotechnical data collected by APTIM between April 25 and June 16, 2024

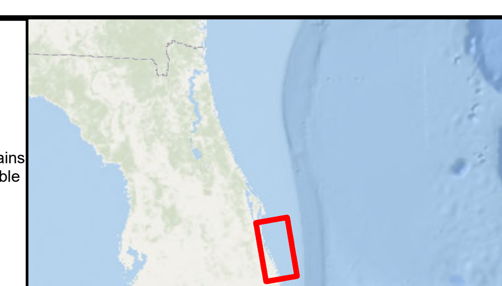
Legend:

- As-Run Geophysical Lines
- As-Built Vibracores
- Potential Deposits
- Federal/State Boundary

Sand Thickness derived from Coastal Relief Model data (ft):

0.3 - 3
3.1 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
20 - 22
22 - 24
24 - 26
26 - 28
28 - 30
30 - 32
32 - 34

0/0
Overburden thickness (ft)
Sand thickness (ft)
* indicates sand layer contains some non-beach compatible material.

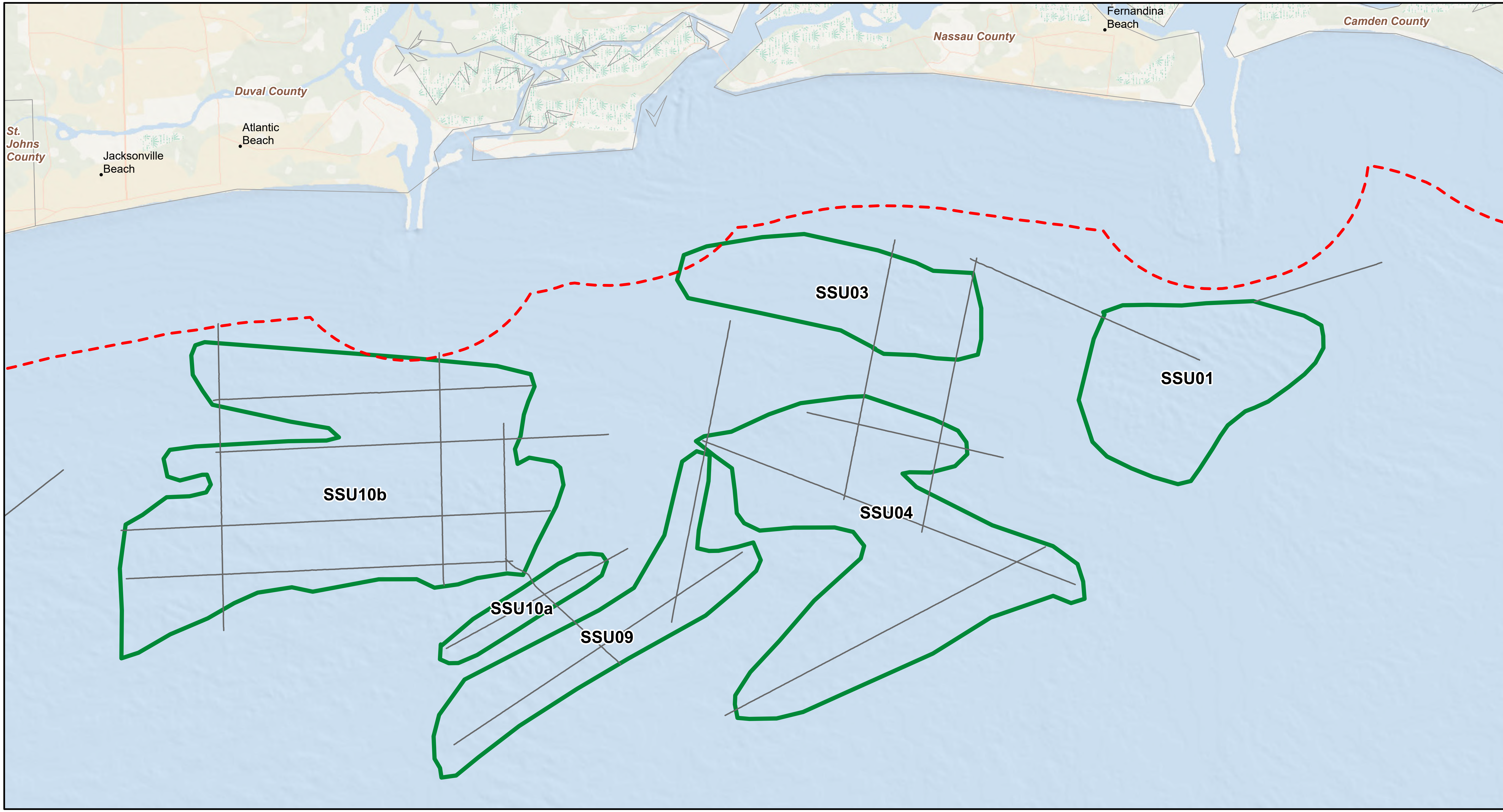


BOEM Task Order 3: Appendix B: Report Map Series
Surface Sand CRM Deposits- Sebastian Inlet

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/22/2025	Drawn by: AH	Contract Number 140M0121D0006	Map No.: 7c



Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

As-Run Geophysical Lines
Federal/State Boundary
Surficial Sedimentary Unit

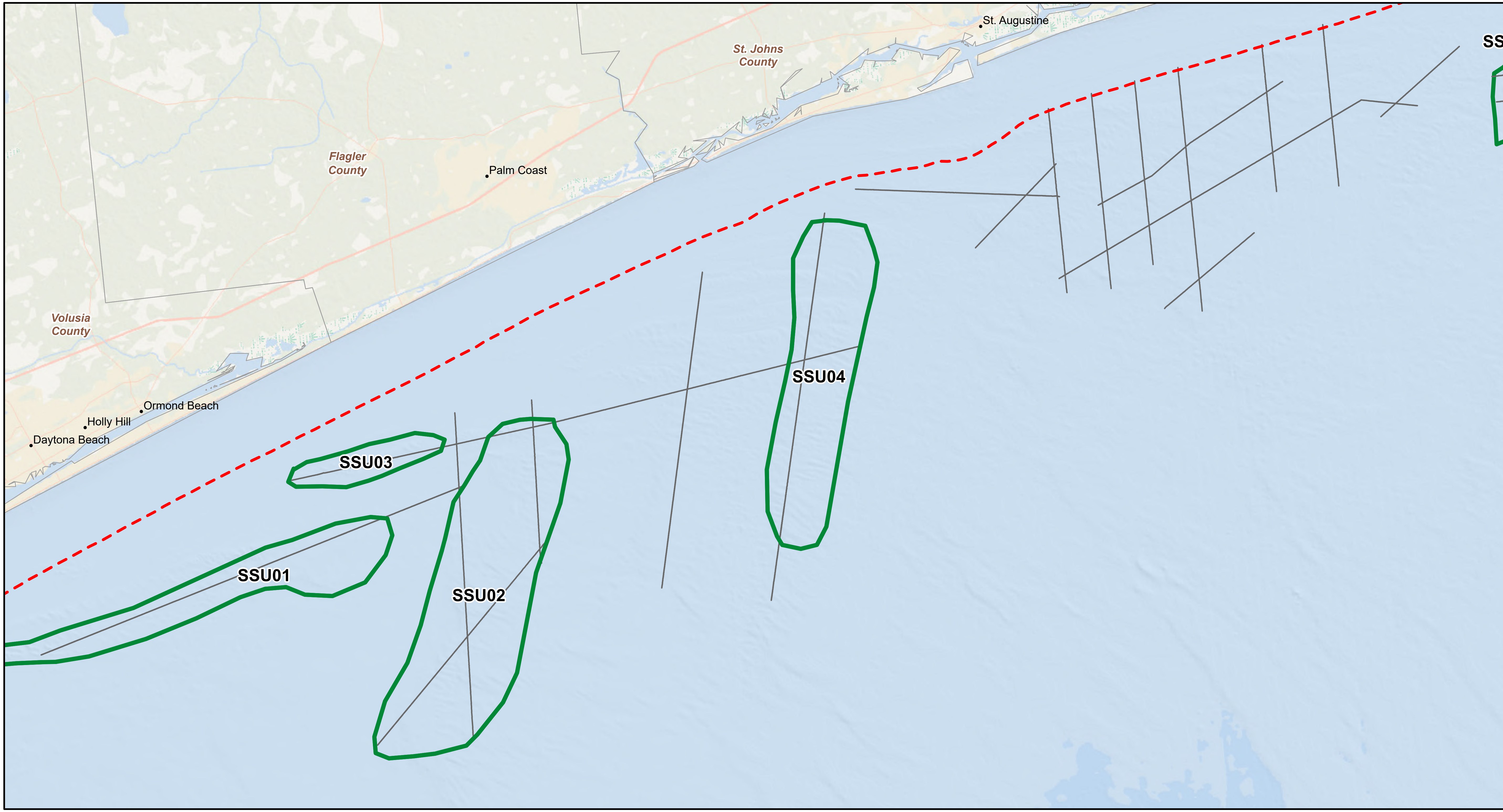
0 3 5
Kilometers

BOEM Task Order 3: Appendix B: Report Map Series
Geologic Framework- Nassau Duval

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025 | Drawn by: AV | Contract Number 140M0121D0006 | **Map No.: 8a**



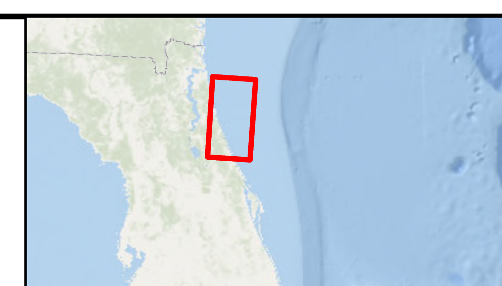
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

As-Run Geophysical Lines
Federal/State Boundary
Surficial Sedimentary Unit

0 3 5
Kilometers



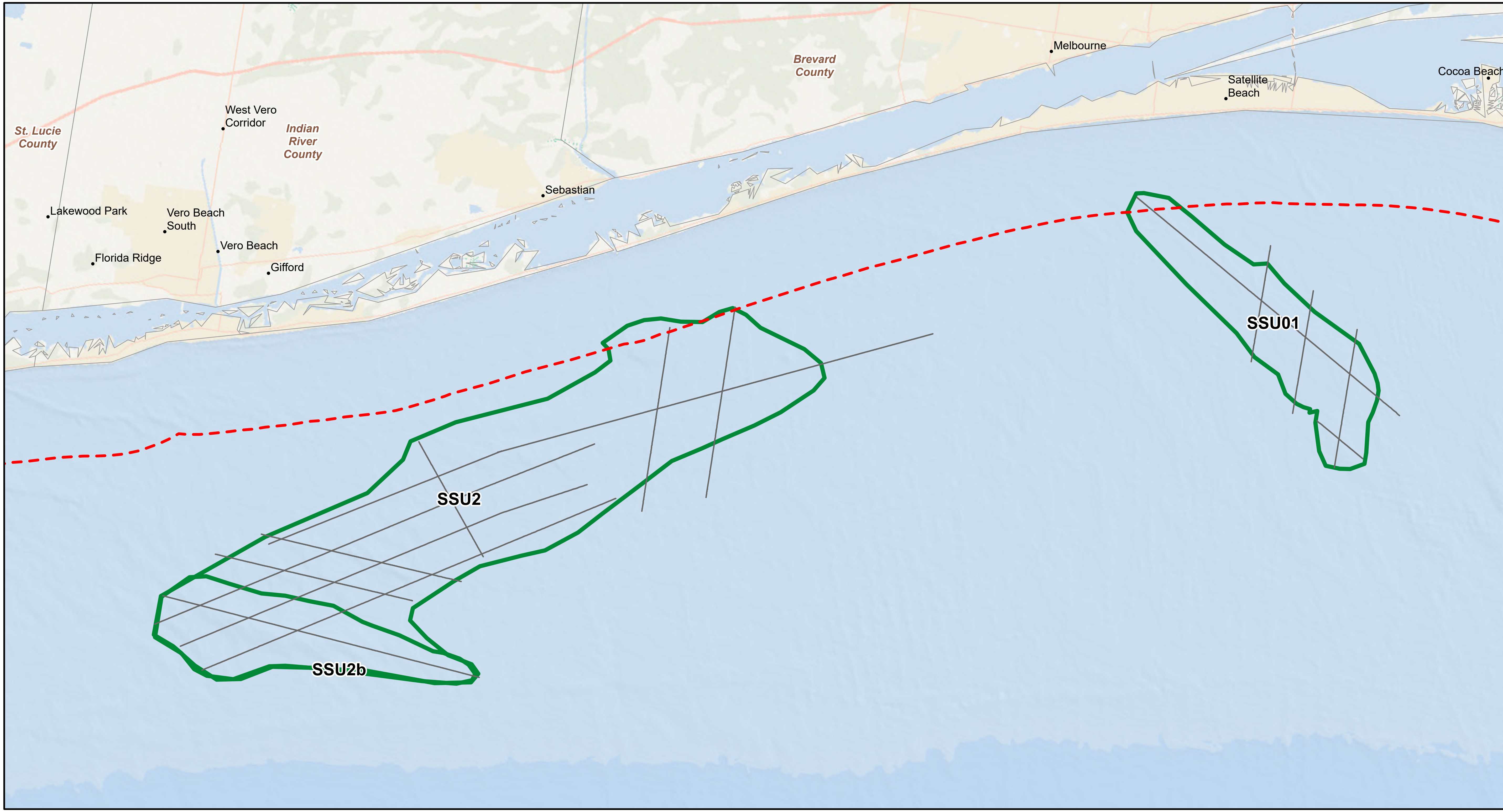
BOEM Task Order 3: Appendix B: Report Map Series
Geologic Framework- Flagler St. Johns

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

APTIM

725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AV	Contract Number 140M0121D0006	Map No.: 8b



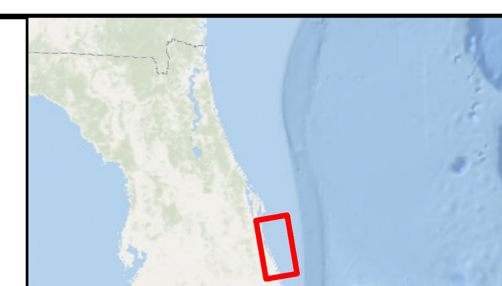
Notes:

1. Background imagery is the ESRI's World Ocean basemap.
2. Geophysical data collected by APTIM between July 7, and July 26, 2023.

Legend:

- As-Run Geophysical Lines
- Federal/State Boundary
- Surficial Sedimentary Unit

0 3 5
Kilometers



BOEM Task Order 3: Appendix B: Report Map Series
Geologic Framework- Sebastian Inlet

Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

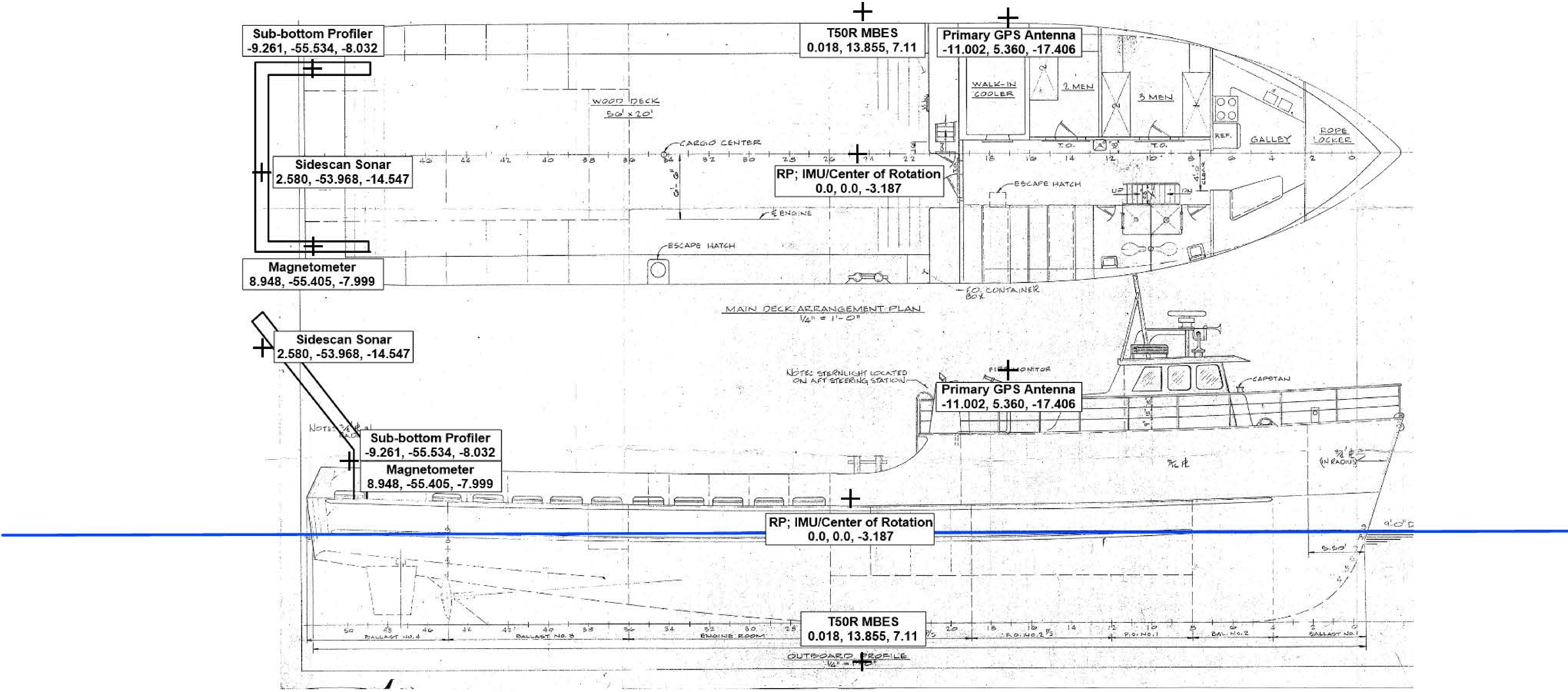
APTIM
725 US Highway 301 South
Tampa, FL 33619
APTIM.com

Date: 01/27/2025	Drawn by: AV	Contract Number 140M0121D0006	Map No.: 8c

Appendix C: Vessel Diagram

R/V Rachel K. Goodwin Offsets via Measured Relative to Permanent Shipboard Benchmarks. Offsets are relative to Reference Point (RP) or Waterline	Starboard Positive	Forward Positive	Down Positive w.r.t. RP (ft)	Down Positive w.r.t Waterline (ft)
RP; Center of Rotation	0	0	0	-3.187
T50R Multi-Beam Echosounder	-13.855	0.018	10.297	7.11
Primary GPS Antennae	-11.002	5.36	-14.219	-17.406
Sub-Bottom Profiler Tow Point	-9.261	-55.534	-4.845	-8.032
Sidescan Sonar Tow Point	2.58	-53.968	-11.36	-14.547
Magnetometer Tow Point	8.948	-55.405	-4.812	-7.999

BOEM TO3 Geophysical Survey
Vessel Diagram
R/V Rachel K. Goodwin
(not to scale)



Appendix D: Mitigation Procedures

Geophysical and Geologic Mitigation Measures and Survey Requirements

While impacts to marine mammals were not expected, the following mitigation protocols were implemented to reduce the already small chance of High Resolution Geophysical (HRG) survey impacts to marine mammals. These protocols reflected the most recent federal regulatory coordination document to address HRG systems, the Final Environmental Assessment on Sand Survey Activities for BOEM's Marine Mineral Program produced by BOEM (May 2019), specifically Appendix B: Survey Requirements and Mitigation Measures.

1 Observer Requirements

During geophysical and geological survey operations a National Marine Fisheries Service (NMFS)-approved, trained Protected Species Observer (PSO) maintained a vigilant watch for marine mammals, sea turtles, and protected fish (e.g., sturgeon and smalltooth sawfish) while both acoustic exclusion and vessel strike exclusion zones apply during survey operations. The exclusion zone was monitored by one PSO during both geophysical and geological survey operations. A NMFS-approval of PSO, who is in compliant with the training requirements specified in NMFS's national standard, will was dedicated to performing visual observer duties while on shift.

The PSO monitored the acoustic exclusion zone during sand survey activities using chirp (sub-bottom profiler sound source operating below 180 kHz) and vibracore. PSOs visually monitored the acoustic exclusion zone with a 328-ft (100-m) radius zone around the sound source or each vibracore location. The PSO conducted visual monitoring of acoustic exclusion zones 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. The PSOs operated under the following guidelines:

- Other than brief alerts to make personnel aware of maritime hazards, no additional duties were assigned to observers during their watch.
- A watch was not longer than six continuous hours. At least two PSOs were on board vessels to monitor the acoustic exclusion zone when daily survey activities exceed six hours.
- A break of at least two hours occurred between six-hour watches; no other duties were assigned during this period.

One PSO monitored during daylight hours (dawn to dusk, i.e., from about 30 minutes before sunrise to 30 minutes after sunset) when vibracoring or for geophysical surveys using sources below 180 kHz. When conditions deteriorate (e.g., fog, rain, darkness) during daylight hours such that the observations were not possible, visual observations resumed as soon as conditions permit. Ongoing activities continued, but they were not initiated under such conditions (i.e., without appropriate pre activity monitoring). When operating during reduced visibility, observers monitored the waters around the acoustic exclusion zone using shipboard lighting, enhanced vision equipment, or night-vision equipment.

APTIM's PSO monitored the acoustic exclusion zone for chirp (i.e., sound sources operating below 180 kHz) and vibracores for all marine mammals and sea turtles prior to start-up and continued until operations ceased. Operators immediately shutdown the sound source or vibracoring operations if any non-delphinid marine mammal was detected within the acoustic exclusion zone or appeared to be entering it. 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. Immediate shutdown of the vibracore also occurred if any sea turtle was detected entering or within the acoustic exclusion zone.

Subsequent restart of the equipment only occurred following a confirmation that the exclusion zone was clear of all marine mammals and sea turtles.

Operators were not required to shutdown sound sources operating below 180 kHz or vibracoring for delphinids approaching the vessel (or vessel's towed equipment) that indicates a "voluntary approach" on behalf of the animal. A "voluntary approach," or a clear approach toward the vessel by the animal(s), was determined by the PSO. When the PSO determined that the animal(s) is actively trying to avoid the vessel or the towed equipment, the operator immediately shutdown the acoustic sources or vibracore. 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. The PSO on duty filled out and submitted daily logs and operation logs which include information on:

- Vessel name
- observers' names, affiliations, and resumes
- date
- time and latitude/longitude when daily visual survey began
- time and latitude/longitude when daily visual survey ended
- average environmental conditions during visual surveys including
- wind speed and direction
- sea state (glassy, slight, choppy, rough, or Beaufort scale)
- swell (low, medium, high, or swell height in meters)
- overall visibility (poor, moderate, good)
- species (or identification to lowest possible taxonomic level)
- certainty of identification (sure, most likely, best guess)
- total number of animals
- number of calves and juveniles (if applicable/distinguishable)
- description (as many distinguishing features as possible) of each individual seen, including length, shape, color and pattern, scars or marks, shape and size of dorsal fin, shape of head, and blow characteristics
- whether or not a shutdown was required
- direction of animal's travel relative to the vessel (drawing preferable)
- behavior (as explicit and detailed as possible; note any observed changes in behavior) and activity of vessel when sighting occurred.

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

Based on the expected time of year for these surveys, and their location, APTIM was not operating in a Seasonal Management Area (SMA) or a Dynamic Management Area (DMA). Regardless, APTIM did not operate any active acoustics sources below 30 kHz in the northeast critical habitat and northeast SMAs (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 SMAs (November 15 through April 15) unless authorized separately by BOEM. Any operations that do occur in these areas during the specified times occurred during daylight hours only.

APTIM utilized the Early Warning System, Sighting Advisory System, and Mandatory Ship Reporting System while operating in the North Atlantic right whale critical habitat, SMAs, DMAs when necessary.

If, during the course of the geophysical survey, a DMA was established, use of all sound sources operating below 30 kHz in that DMA would have been discontinued within 24 hours of the DMA establishment. Any geophysical surveys in proximity of DMA boundaries remained beyond the distance of the acoustic exclusion zone (100 m [328 ft]) from the boundary. Any necessary exceptions or deviations would require BOEM approval.

3 Vibracore Sampling Protocol

During geotechnical operations APTIM did not operate the vibrahead until the vibracore platform made contact with the seabed and core barrel made contact with the seafloor to minimize sound level. The vibrahead was not operated when vibracore platform was being retrieved.

All seafloor sampling occurred within the effective coverage of geophysical data and not within the nadir or other gaps of sidescan sonar survey data. During vibracoring, vibracore penetration rates were monitored to help ensure minimum sampling in geologic units not indicative of surface sands and may be host to pre-historic or other cultural resources. During operations, any geologic or other information of archaeological interest were noted and photographed.

4 Vessel Strike Avoidance Protocol

APTIM subcontractors providing vessel services, maintained vessel speed at ≤18.5 km/hr (10 kn) in North Atlantic right whale areas or if one is sighted and 9.3 km/hr (5 kn) during nighttime transits in areas where sea turtles are present.

When transiting, APTIM reduced vessel speeds as safety allows to 18.5 km/hr (10 kn) or less when mother/calf pairs, pods, or large assemblages of North Atlantic right whales were observed. Additionally, APTIM abided by the 18.5 km/hr (10 kn) speed restriction in SMAs even when whales are not sighted in the Northeast feeding areas of Cape Cod Bay, Off Race Point and Great South Channel between January 1–May 15, March 1–April 30 and April 1–July 31, respectively, as well as in the mid-Atlantic migratory route from Block Island, Rhode Island to Savannah, Georgia, between November 1–April 30 and the Southeast Calving and Nursery Grounds in South Georgia and North Florida between November 15–April 15.

APTIM maintained a minimum distance of 500 m (1,640 ft) from North Atlantic right whales, 100 m (328 ft) from other whales, seals, and manatees and 50 m (164 ft) from delphinid cetaceans, sea turtles, and protected fish. If the vessel came within of 500 m (1,640 ft) from North Atlantic right whales while underway, APTIM's vessel operator steered a course away from the right whale at 18.5 km/hr (10 kn) or less until reaching the minimum separation distance. If a right whale was spotted in the path of the vessel or within 100 m (328 ft) of the vessel underway, the operator reduced speed and shifted engines to neutral. The operator only re-engage engines after the right whale has moved out of the path of the vessel and was more than 100 m (328 ft) away. If the right whale is 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/hr (10 kn) or less. The operator also followed this procedure if a right whale was spotted while a vessel is stationary. Whenever possible, a vessel remained parallel to the whale's course while transiting, avoiding abrupt changes in direction until it has left the area.

The survey vessel stayed at least 328 ft (100 m) away from other whales (i.e., not right whales), seals, or manatees and complied with other relevant manatee construction conditions when operating within the species' range. The vessel stayed at least 164 ft (50 m) away from delphinid cetaceans, at least 164 ft (50 m) away from sea turtles or other protected species whenever possible and did not re-engage engines until the animals are clear of the 50-m (164-ft) exclusion area. The survey complied with other relevant sea turtle and smalltooth sawfish construction conditions summarized below when operating within the species' ranges. During transits vessel speed did exceed 5 kn (9.3 km/hr) in areas where sea turtles are most likely to be present. The vessel followed routes of deep water whenever possible, and if whales, seals, or manatees were encountered during transit, the vessel did attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

4.1 Sea Turtle and Smalltooth Sawfish "Construction" Conditions

All APTIM personnel were alerted to the potential presence and need to avoid sea turtles and smalltooth sawfish, as well as the fact that there are penalties for harming, harassing, or killing these species. All vessels operated at "no wake/idle" speeds at all times while in water depths where the draft of the vessel provides less than a 4-ft (1.2-m) clearance from the bottom. If a sea turtle or smalltooth sawfish was observed within the acoustic exclusion zone of an active sound source or vibracore or 50 m (164 ft) of a moving vessel, APTIM implemented protections consistent with PSO shutdown requirements and stayed at least 164 ft (50 m) away from sea turtles or other protected species whenever possible. APTIM did not re-engage engines until the animals were clear of the 50-m (164-ft) exclusion area.

4.2 Bottom Avoidance Requirements

Prior to commencing geological operations APTIM took the necessary precautions to avoid munitions and ordnance, including unexploded shells and depth charges, that were present in military operating areas, ordnance disposal areas, or historical firing fans, co-located with the authorized area. APTIM avoided anchoring, geological sampling, and any other seafloor-disturbing activities in the vicinity of sensitive benthic habitat and associated communities, including live/hard bottom, topographic features, rippled scour depressions, cobbled seafloor, reef tract, and Habitat Areas of Particular Concern by at least 500 m (1,640 ft). APTIM avoided geological sampling near archaeological resources by a minimum of 50 m (164 ft). All associated anchoring, if any, avoided archaeological resources by 100 m (328 ft). If any archaeological resource was discovered while conducting operations, operations that would continue to affect the discovery were immediately halted.

APTIM provided as part of the GSP site-specific information to determine the presence of potential sensitive benthic resources and archaeological resources which was provided to BOEM prior to undertaking any seafloor-disturbing activities, including anchoring, unless required for safety or emergency purposes. APTIM's qualified maritime archaeologist determined whether any potential archaeological resources are present in the authorized area before vibracoring, grab sampling, and/or associated anchoring could occur.

The qualified maritime archaeologist met the Secretary of the Interior's Professional Qualifications Standards for Archaeology (48 FR 44738-44739) and has demonstrable, professional experience in interpretation of marine geophysical data, and demonstrate familiarity/experience with the archaeology of the Study Area.

All seafloor sampling occurred within the effective coverage of geophysical data and did not occur within the nadir or other gaps of sidescan sonar survey data. During vibracoring, vibracore penetration rates were monitored to help ensure minimum sampling in geologic units not indicative of surface sands and may be host to pre-historic or other cultural resources. During operations, any geologic or other information of archaeological interest were noted and photographed.

If benthic habitat and archaeological resources were not identified in advance of vibracoring and included in the geological sampling plan, APTIM would utilize live boating during sampling operations to avoid unnecessary seafloor anchoring and disturbance. If unavoidable, APTIM would anchor in emergency situations or unexpected field situations and utilized a minimum-sized anchor/anchor array and be restricted to an area cleared, previously or in real-time, of sensitive habitat, cultural resources, and shallow hazards.

4.3 Marine Pollution Control Plan

APTIM conducted all activities under a marine pollution control plan included in the Project Management Plan (PMP) submitted prior to field operations, which addresses the marine debris awareness requirements below. APTIM prepared for and took all necessary precautions to prevent discharges of waste or hazardous materials that may impair water quality.

All vessels had sufficient fuel spill response equipment and supplies available onboard to contain and recover the maximum scenario fuel spill keyed to the proposed operations and disclosed in the marine pollution control plan. To reduce the likelihood of accidental fuel spills, APTIM fueled the vessels in port at a docking facility only; no at-sea cross-vessel fueling was conducted. All vessel operations were compliant with USCG regulations and the United States Environmental Protection Agency (USEPA)'s Vessel General Permit, as applicable.

4.4 Marine Debris Awareness Program

All survey participants were educated on marine trash and debris awareness elimination as required by NTL 2015-G03. All APTIM employees and subcontractors were aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment. Intentional marine littering is subject to strict laws such as the International Convention for the Prevention of Pollution from Ships Annex V and the Marine Plastic Pollution Research and Control Act, as well as regulations imposed by various agencies such as USCG and USEPA.

The deliberate discharge of containers and other similar materials (i.e., trash and debris) into the marine environment is prohibited. APTIM employees were required to identify equipment, tools, containers (especially drums), and other materials with durable markings.

4.5 Navigation and Commercial Fisheries Operations Conflict Minimization Requirements

Consistent with applicable USCG regulations, all vessels employed by APTIM greater than 20 m (65 ft) regardless of operational status were equipped with Automatic Information System and broadcasted vessel's identity, type, position, course, speed, and navigational status during surveying activities.

Vessels had the appropriate USCG-approved day shapes (mast head 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 was present in the authorized area, the operator 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 were avoided by a minimum of 30 m (100 ft). Fishing gear were not be relocated or otherwise disturbed.

Appendix E: Processed Data Files (Digital only)

Appendix F: Raw Geophysical Data (Digital only)

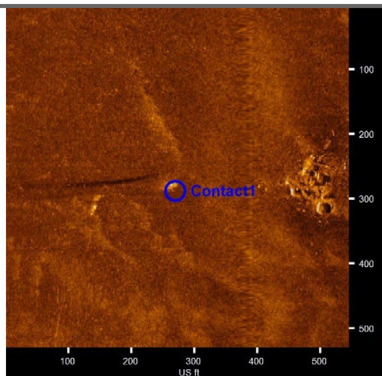
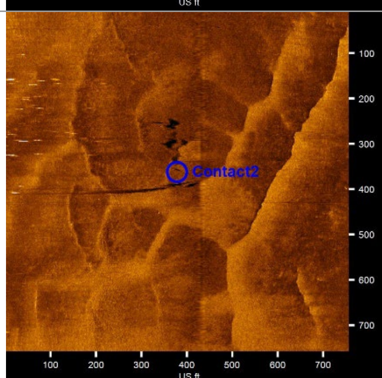
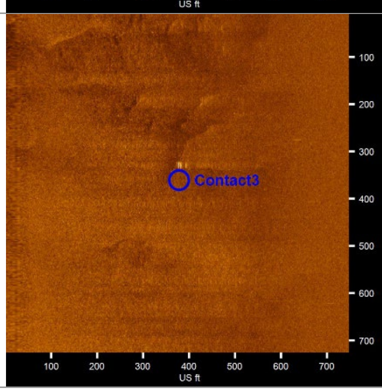
Appendix G: Sound Velocity Profiles (Digital only)

Appendix H: MMIS geodatabase (Digital only)

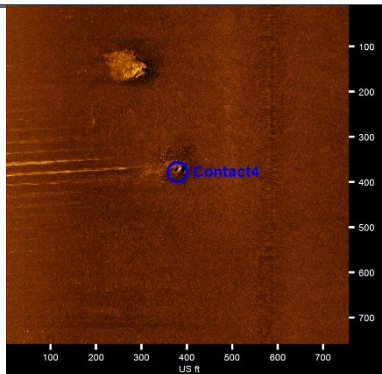
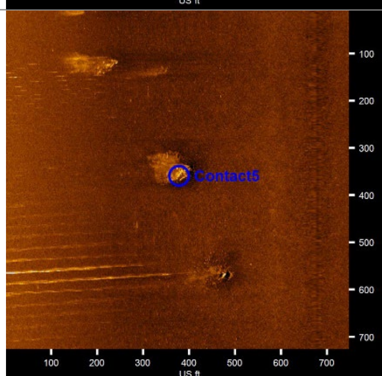
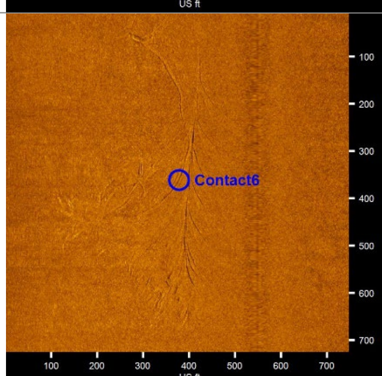
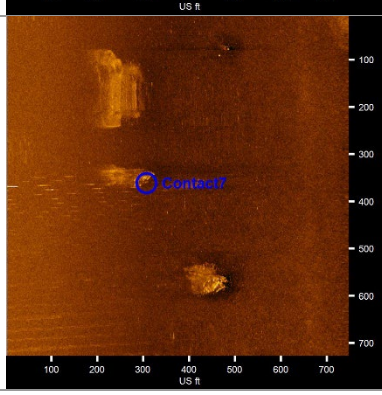
Appendix I: Sidescan Contact Report

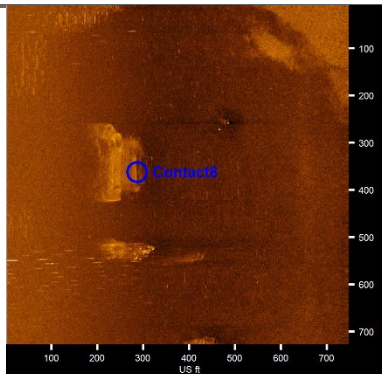
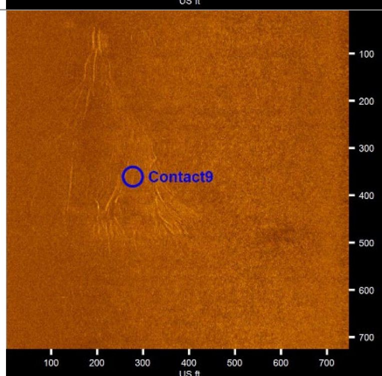
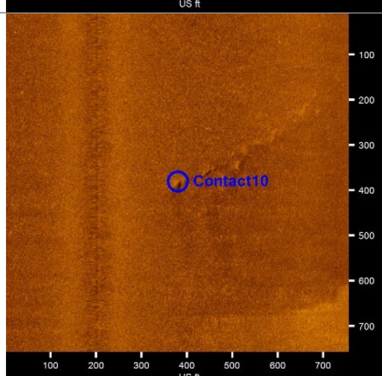
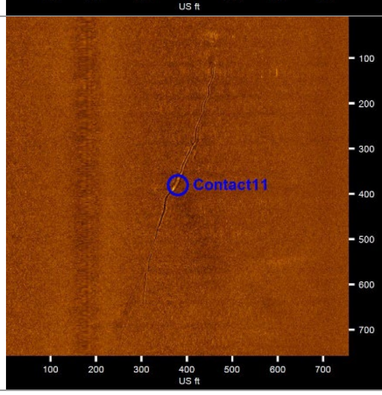
Geophysical and Geological Data Acquisition and Analysis on the Atlantic Outer Continental Shelf of Florida

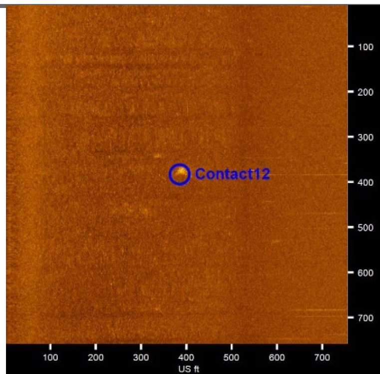
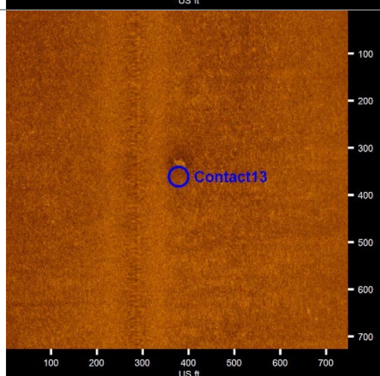
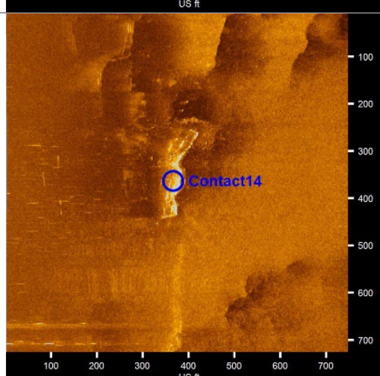
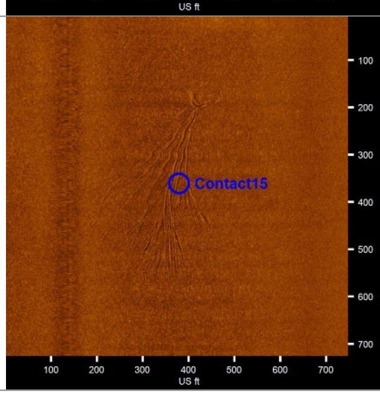
BOEM Task Order 3

Target Image	Target Info	User Entered Info
	**Contact1** ● Sonar Time at Target: 7/12/2023 6:19:09 PM ● Click Position (X) 543068.98 (Y) 2272222.52 (Projected) 30.5832359108 -81.3594162760 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230712_Line_107.jsf ● Ping Number: 6766 ● Heading: 97.500 Degrees ● Line Name: BOEM_SSS_20230712_Line_107	**Dimensions and attributes** ● Target Width: 16.25 US ft ● Target Height: 27.48 US ft ● Target Length: 41.95 US ft ● Target Shadow: 238.47 US ft ● Mag Anomaly: Mag_016 ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Unknown feature with a point of high intensity
	**Contact2** ● Sonar Time at Target: 7/12/2023 7:10:51 PM ● Click Position (X) 564765.42 (Y) 2267541.33 (Projected) 30.5705371705 -81.2904290188 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230712_Line_107.001.jsf ● Ping Number: 16414 ● Heading: 98.700 Degrees ● Line Name: BOEM_SSS_20230712_Line_107.001	**Dimensions and attributes** ● Target Width: 24.55 US ft ● Target Height: 37.04 US ft ● Target Length: 143.19 US ft ● Target Shadow: 388.54 US ft ● Classification1: Dolphins ● Area: Nassau/Duval ● Description: Dolphin shadows near the nadir gap
	**Contact3** ● Sonar Time at Target: 7/14/2023 7:11:11 AM ● Click Position (X) 596555.11 (Y) 2231137.04 (Projected) 30.4706284628 -81.1892233289 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_111.jsf ● Ping Number: 4858 ● Heading: 225.300 Degrees ● Line Name: BOEM_SSS_20230714_Line_111	**Dimensions and attributes** ● Target Width: 24.26 US ft ● Target Length: 16.28 US ft ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Unknown feature with a point of high intensity

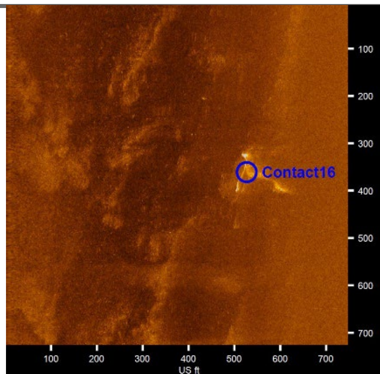
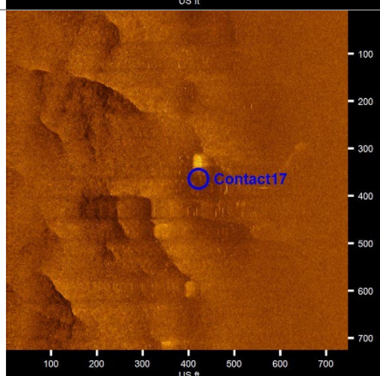
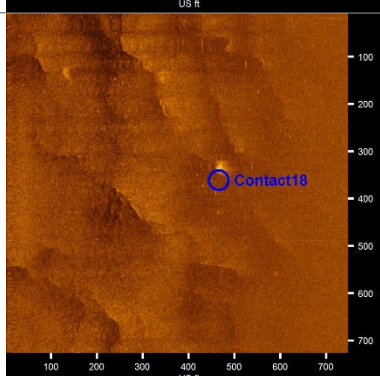
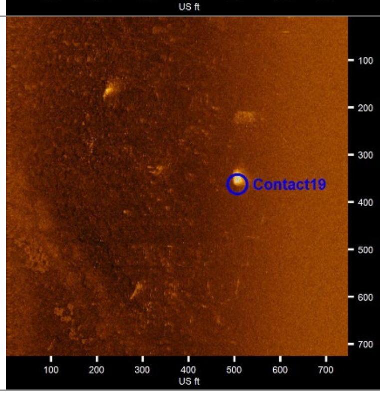
Sidescan Sonar Contact Report

Target Image	Target Info	User Entered Info
	**Contact4** ● Sonar Time at Target: 7/14/2023 7:45:15 AM ● Click Position (X) 586842.54 (Y) 2220632.26 (Projected) 30.4416966148 -81.2199885983 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_111.jsf ● Ping Number: 11212 ● Heading: 245.700 Degrees ● Line Name: BOEM_SSS_20230714_Line_111	**Dimensions and attributes** ● Target Width: 101.02 US ft ● Target Length: 74.70 US ft ● Classification1: Artificial Reef ● Area: Nassau/Duval ● Description: Montgomery Reef - Fourth of Four Loads This Grant, First For Mr Reef (142 culverts)
	**Contact5** ● Sonar Time at Target: 7/14/2023 7:45:49 AM ● Click Position (X) 586698.11 (Y) 2220449.47 (Projected) 30.4411932408 -81.2204457823 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_111.jsf ● Ping Number: 11318 ● Heading: 238.300 Degrees ● Line Name: BOEM_SSS_20230714_Line_111	**Dimensions and attributes** ● Target Width: 95.47 US ft ● Target Length: 64.82 US ft ● Classification1: Artificial Reef ● Area: Nassau/Duval ● Description: MR Site -Reliance - 63' Tugboat, the "Reliance"
	**Contact6** ● Sonar Time at Target: 7/14/2023 2:14:31 PM ● Click Position (X) 567198.31 (Y) 2220328.83 (Projected) 30.4407423655 -81.2823233306 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_114.jsf ● Ping Number: 83842 ● Heading: 179.000 Degrees ● Line Name: BOEM_SSS_20230714_Line_114	**Dimensions and attributes** ● Target Width: 170.86 US ft ● Target Length: 590.11 US ft ● Classification1: Anchor Marks ● Area: Nassau/Duval ● Description: Anchor scour marks
	**Contact7** ● Sonar Time at Target: 7/14/2023 7:46:22 AM ● Click Position (X) 586623.79 (Y) 2220221.25 (Projected) 30.4405653527 -81.2206802188 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_111.jsf ● Ping Number: 11422 ● Heading: 238.500 Degrees ● Line Name: BOEM_SSS_20230714_Line_111	**Dimensions and attributes** ● Target Width: 113.75 US ft ● Target Length: 37.63 US ft ● Classification1: Artificial Reef ● Area: Nassau/Duval ● Description: MR Site -Reliance - 63' Tugboat, the "Reliance"

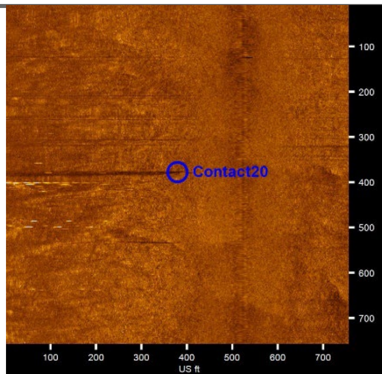
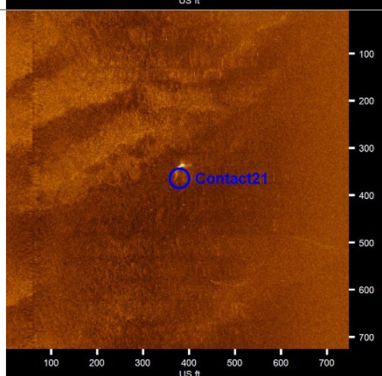
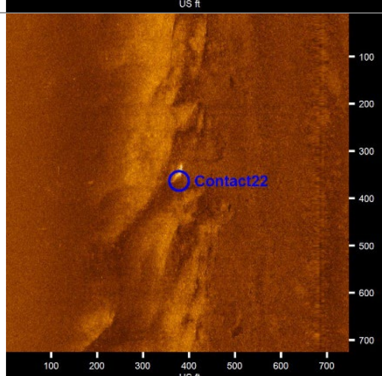
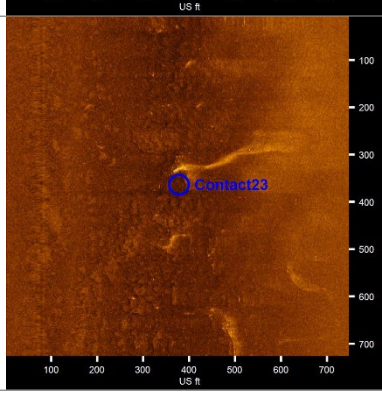
Target Image	Target Info	User Entered Info
	**Contact8** ● Sonar Time at Target: 7/14/2023 7:46:50 AM ● Click Position (X) 586532.32 (Y) 2220121.70 (Projected) 30.4402911351 -81.2209698497 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_111.jsf ● Ping Number: 11507 ● Heading: 220.400 Degrees ● Line Name: BOEM_SSS_20230714_Line_111	**Dimensions and attributes** ● Target Width: 142.18 US ft ● Target Length: 111.90 US ft ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Unknown feature with an area of high intensity
	**Contact9** ● Sonar Time at Target: 7/14/2023 2:26:04 PM ● Click Position (X) 567632.99 (Y) 2215942.95 (Projected) 30.4286861273 -81.2809094001 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_114.jsf ● Ping Number: 85998 ● Heading: 180.900 Degrees ● Line Name: BOEM_SSS_20230714_Line_114	**Dimensions and attributes** ● Target Width: 221.40 US ft ● Target Length: 453.36 US ft ● Classification1: Anchor Marks ● Area: Nassau/Duval ● Description: Anchor scour marks
	**Contact10** ● Sonar Time at Target: 7/14/2023 5:47:51 PM ● Click Position (X) 560041.50 (Y) 2213996.06 (Projected) 30.4232789842 -81.3049795813 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_115.001.jsf ● Ping Number: 123647 ● Heading: 357.200 Degrees ● Line Name: BOEM_SSS_20230714_Line_115.001	**Dimensions and attributes** ● Target Width: 312.81 US ft ● Target Height: 1.97 US ft ● Target Length: 186.71 US ft ● Target Shadow: 8.12 US ft ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Seafloor relief
	**Contact11** ● Sonar Time at Target: 7/14/2023 2:41:36 PM ● Click Position (X) 567107.30 (Y) 2210084.80 (Projected) 30.4125751928 -81.2825309568 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_114.001.jsf ● Ping Number: 88896 ● Heading: 181.000 Degrees ● Line Name: BOEM_SSS_20230714_Line_114.001	**Dimensions and attributes** ● Target Width: 174.76 US ft ● Target Length: 620.29 US ft ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Seafloor trenching

Target Image	Target Info	User Entered Info
	**Contact12** ● Sonar Time at Target: 7/14/2023 8:40:47 PM ● Click Position (X) 566031.62 (Y) 2208901.96 (Projected) 30.4093154822 -81.2859339081 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_117.001.jsf ● Ping Number: 155911 ● Heading: 270.400 Degrees ● Line Name: BOEM_SSS_20230714_Line_117.001	**Dimensions and attributes** ● Target Width: 33.35 US ft ● Target Length: 31.30 US ft ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Unknown feature with point of high intensity
	**Contact13** ● Sonar Time at Target: 7/14/2023 8:45:38 PM ● Click Position (X) 563884.64 (Y) 2208606.80 (Projected) 30.4084888411 -81.2927422272 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_117.001.jsf ● Ping Number: 156817 ● Heading: 268.000 Degrees ● Line Name: BOEM_SSS_20230714_Line_117.001	**Dimensions and attributes** ● Target Width: 35.37 US ft ● Target Length: 29.32 US ft ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Unknown feature with a point of high intensity
	**Contact14** ● Sonar Time at Target: 7/14/2023 8:22:21 PM ● Click Position (X) 573711.42 (Y) 2208140.86 (Projected) 30.4072738411 -81.2615660403 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_117.jsf ● Ping Number: 152472 ● Heading: 266.500 Degrees ● Line Name: BOEM_SSS_20230714_Line_117	**Dimensions and attributes** ● Target Width: 104.05 US ft ● Target Length: 186.01 US ft ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Potential ENC wreck 597
	**Contact15** ● Sonar Time at Target: 7/14/2023 2:47:14 PM ● Click Position (X) 567119.75 (Y) 2207995.34 (Projected) 30.4068301857 -81.2824748979 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_114.001.jsf ● Ping Number: 89947 ● Heading: 177.900 Degrees ● Line Name: BOEM_SSS_20230714_Line_114.001	**Dimensions and attributes** ● Target Width: 203.04 US ft ● Target Length: 381.40 US ft ● Classification1: Anchor Marks ● Area: Nassau/Duval ● Description: Anchor scour marks

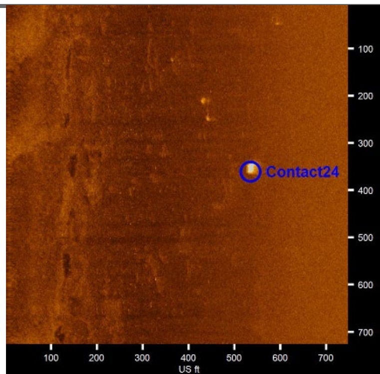
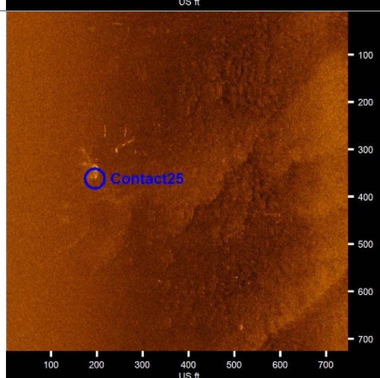
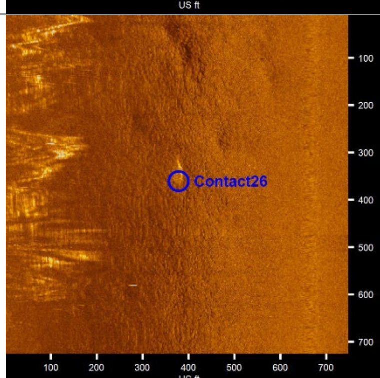
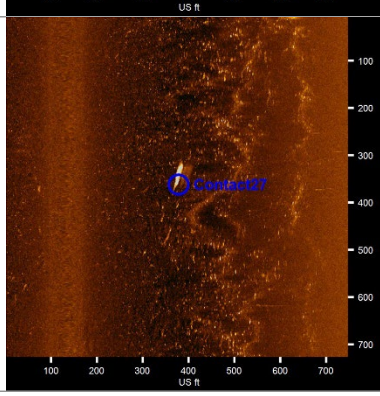
Sidescan Sonar Contact Report

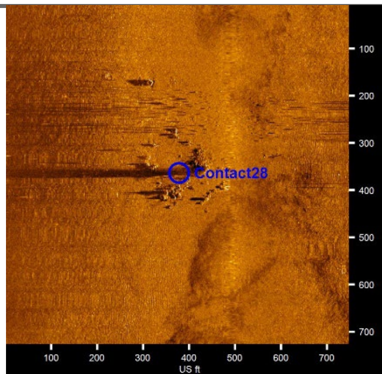
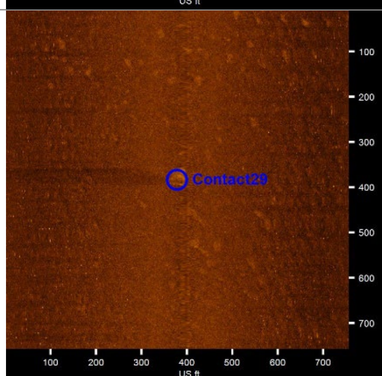
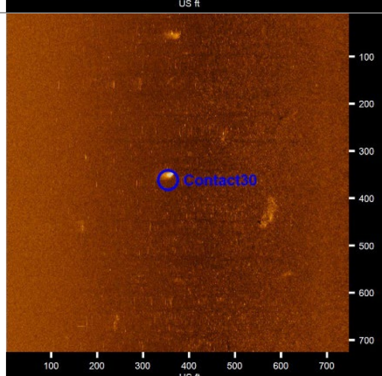
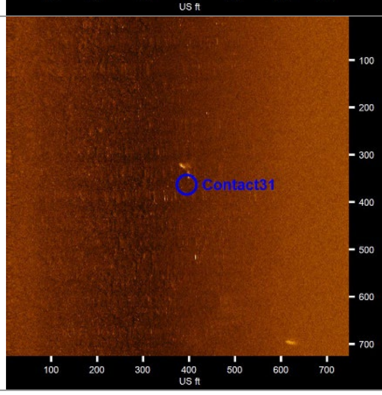
Target Image	Target Info	User Entered Info
	**Contact16** ● Sonar Time at Target: 7/14/2023 5:18:53 PM ● Click Position (X) 560685.26 (Y) 2202870.77 (Projected) 30.3926941175 -81.3028426888 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230714_Line_115.001.jsf ● Ping Number: 118243 ● Heading: 359.000 Degrees ● Line Name: BOEM_SSS_20230714_Line_115.001	**Dimensions and attributes** ● Target Width: 111.23 US ft ● Target Length: 90.13 US ft ● Classification1: Unknown Feature ● Area: Nassau/Duval ● Description: Unknown feature with an area of high intensity
	**Contact17** ● Sonar Time at Target: 7/15/2023 1:28:42 PM ● Click Position (X) 583818.53 (Y) 2136894.04 (Projected) 30.2114326884 -81.2290483517 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230715_Line_119.001.jsf ● Ping Number: 60602 ● Heading: 141.500 Degrees ● Line Name: BOEM_SSS_20230715_Line_119.001	**Dimensions and attributes** ● Target Width: 36.37 US ft ● Target Length: 39.77 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact18** ● Sonar Time at Target: 7/15/2023 1:30:14 PM ● Click Position (X) 584161.32 (Y) 2136366.07 (Projected) 30.2099828509 -81.2279597637 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230715_Line_119.001.jsf ● Ping Number: 60889 ● Heading: 140.800 Degrees ● Line Name: BOEM_SSS_20230715_Line_119.001	**Dimensions and attributes** ● Target Width: 37.38 US ft ● Target Length: 42.83 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact19** ● Sonar Time at Target: 7/16/2023 8:06:37 AM ● Click Position (X) 579837.96 (Y) 2057013.96 (Projected) 29.9917637141 -81.2411166634 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20220716_Line_122.jsf ● Ping Number: 14171 ● Heading: 87.300 Degrees ● Line Name: BOEM_SSS_20220716_Line_122	**Dimensions and attributes** ● Target Width: 31.33 US ft ● Target Length: 37.69 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity

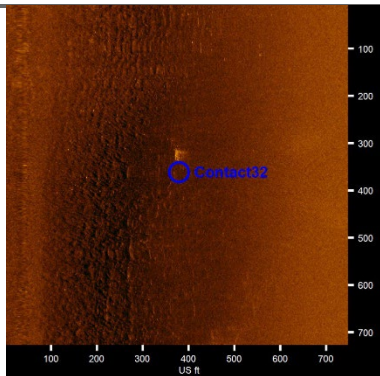
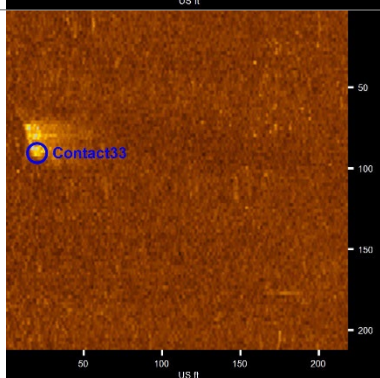
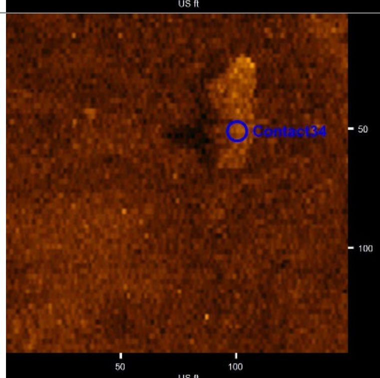
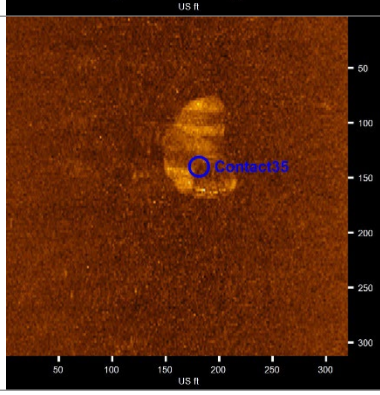
Sidescan Sonar Contact Report

Target Image	Target Info	User Entered Info
	**Contact20** ● Sonar Time at Target: 7/15/2023 6:41:11 PM ● Click Position (X) 622436.53 (Y) 2045851.33 (Projected) 29.9612466557 -81.1065185481 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230715_Line_120.005.jsf ● Ping Number: 118905 ● Heading: 155.800 Degrees ● Line Name: BOEM_SSS_20230715_Line_120.005	**Dimensions and attributes** ● Target Height: 29.54 US ft ● Target Shadow: 413.08 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: A long shadow with no visible object
	**Contact21** ● Sonar Time at Target: 7/17/2023 3:16:58 PM ● Click Position (X) 598111.68 (Y) 2024423.34 (Projected) 29.9022398416 -81.1832272862 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20220717_Line_130.001.jsf ● Ping Number: 94978 ● Heading: 185.200 Degrees ● Line Name: BOEM_SSS_20220717_Line_130.001	**Dimensions and attributes** ● Target Width: 45.47 US ft ● Target Length: 44.49 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact22** ● Sonar Time at Target: 7/17/2023 4:12:20 PM ● Click Position (X) 596151.63 (Y) 2002545.70 (Projected) 29.8420718225 -81.1892997377 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20220717_Line_130.002.jsf ● Ping Number: 105307 ● Heading: 192.100 Degrees ● Line Name: BOEM_SSS_20220717_Line_130.002	**Dimensions and attributes** ● Target Width: 32.34 US ft ● Target Length: 47.30 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact23** ● Sonar Time at Target: 7/17/2023 4:13:03 PM ● Click Position (X) 595511.46 (Y) 2002343.95 (Projected) 29.8415141314 -81.1913178986 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20220717_Line_130.002.jsf ● Ping Number: 105442 ● Heading: 188.400 Degrees ● Line Name: BOEM_SSS_20220717_Line_130.002	**Dimensions and attributes** ● Target Width: 261.68 US ft ● Target Length: 102.52 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with an area of high intensity

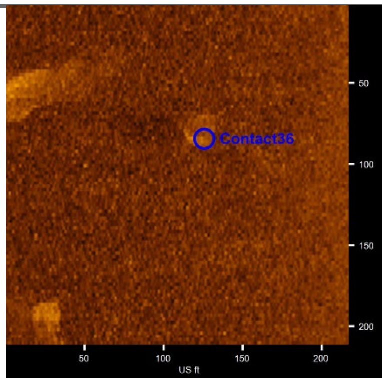
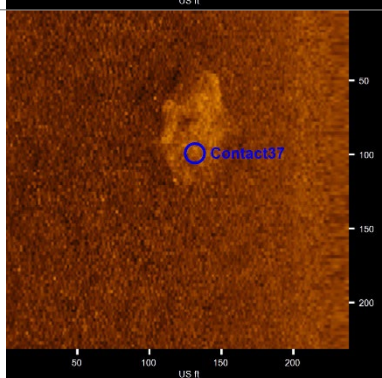
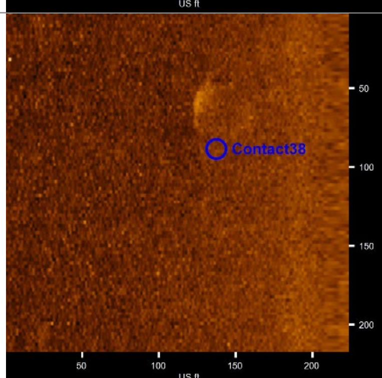
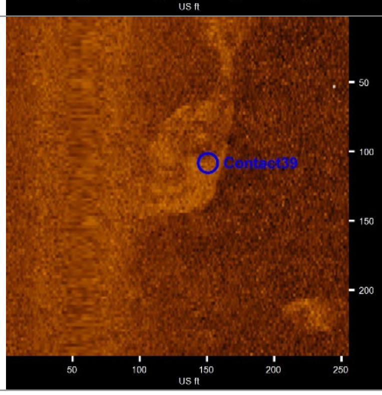
Sidescan Sonar Contact Report

Target Image	Target Info	User Entered Info
	**Contact24** ● Sonar Time at Target: 7/17/2023 4:20:20 PM ● Click Position (X) 594957.07 (Y) 1999542.46 (Projected) 29.8338079992 -81.1930517229 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20220717_Line_130.002.jsf ● Ping Number: 106801 ● Heading: 185.000 Degrees ● Line Name: BOEM_SSS_20220717_Line_130.002	**Dimensions and attributes** ● Target Width: 23.43 US ft ● Target Length: 26.13 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact25** ● Sonar Time at Target: 7/17/2023 4:33:04 PM ● Click Position (X) 595453.28 (Y) 1994512.84 (Projected) 29.8199797139 -81.1914603658 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20220717_Line_130.002.jsf ● Ping Number: 109175 ● Heading: 189.500 Degrees ● Line Name: BOEM_SSS_20220717_Line_130.002	**Dimensions and attributes** ● Target Width: 37.39 US ft ● Target Length: 71.69 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact26** ● Sonar Time at Target: 7/18/2023 10:43:31 AM ● Click Position (X) 676656.45 (Y) 1937151.43 (Projected) 29.6623659390 -80.9354861461 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230718_Line_132.001.jsf ● Ping Number: 44213 ● Heading: 280.100 Degrees ● Line Name: BOEM_SSS_20230718_Line_132.001	**Dimensions and attributes** ● Target Width: 25.25 US ft ● Target Length: 51.91 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact27** ● Sonar Time at Target: 7/19/2023 10:37:31 AM ● Click Position (X) 654068.84 (Y) 1882168.25 (Projected) 29.5111809972 -81.0065953548 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230719_Line_134.jsf ● Ping Number: 43564 ● Heading: 92.000 Degrees ● Line Name: BOEM_SSS_20230719_Line_134	**Dimensions and attributes** ● Target Width: 30.32 US ft ● Target Length: 71.49 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity

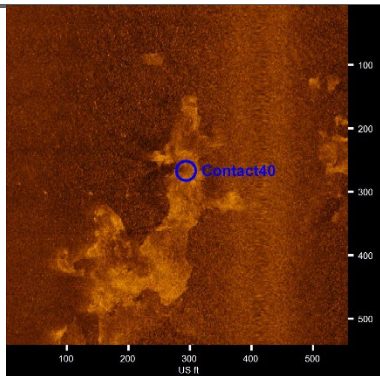
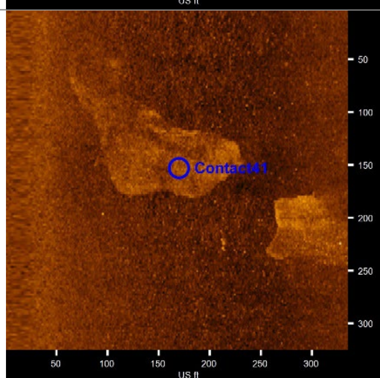
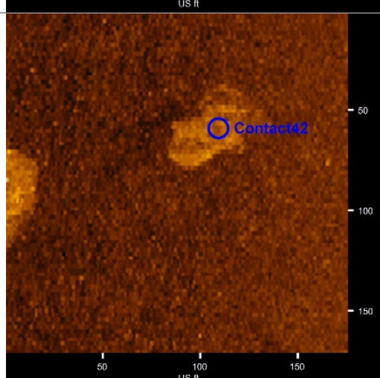
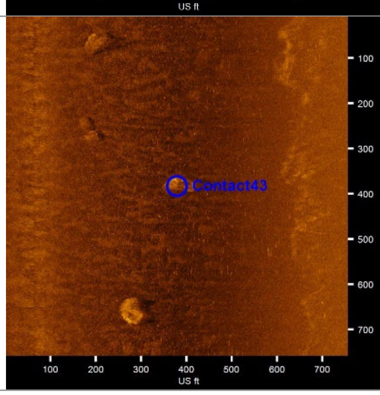
Target Image	Target Info	User Entered Info
	**Contact28** ● Sonar Time at Target: 7/20/2023 8:24:24 PM ● Click Position (X) 671184.00 (Y) 1861574.62 (Projected) 29.4545406770 -80.9528132980 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230720_Line_137.001.jsf ● Ping Number: 15308 ● Heading: 162.600 Degrees ● Line Name: BOEM_SSS_20230720_Line_137.001	**Dimensions and attributes** ● Target Width: 161.51 US ft ● Target Height: 21.08 US ft ● Target Length: 281.13 US ft ● Target Shadow: 434.67 US ft ● Mag Anomaly: Mag_269 ● Classification1: Artificial Reef ● Area: Flagler ● Description: Streeks Reef East - Second of Two Drops, Eastern Side, Junction Boxes
	**Contact29** ● Sonar Time at Target: 7/21/2023 10:15:09 AM ● Click Position (X) 693227.68 (Y) 1789501.45 (Projected) 29.2562946980 -80.8837740541 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230721_Line_137.003.jsf ● Ping Number: 39034 ● Heading: 163.100 Degrees ● Line Name: BOEM_SSS_20230721_Line_137.003	**Dimensions and attributes** ● Target Width: 44.46 US ft ● Target Height: 35.03 US ft ● Target Length: 37.59 US ft ● Target Shadow: 354.56 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact30** ● Sonar Time at Target: 7/21/2023 10:36:19 AM ● Click Position (X) 696045.60 (Y) 1781646.01 (Projected) 29.2346836776 -80.8749631506 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230721_Line_137.003.jsf ● Ping Number: 42984 ● Heading: 163.000 Degrees ● Line Name: BOEM_SSS_20230721_Line_137.003	**Dimensions and attributes** ● Target Width: 45.50 US ft ● Target Height: 4.18 US ft ● Target Length: 18.24 US ft ● Target Shadow: 51.52 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact31** ● Sonar Time at Target: 7/21/2023 10:45:51 AM ● Click Position (X) 696390.36 (Y) 1777801.71 (Projected) 29.2241105140 -80.8738951286 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230721_Line_137.004.jsf ● Ping Number: 44764 ● Heading: 162.500 Degrees ● Line Name: BOEM_SSS_20230721_Line_137.004	**Dimensions and attributes** ● Target Width: 12.18 US ft ● Target Height: 2.21 US ft ● Target Length: 43.80 US ft ● Target Shadow: 26.26 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity

Target Image	Target Info	User Entered Info
	**Contact32** ● Sonar Time at Target: 7/21/2023 11:01:10 AM ● Click Position (X) 698231.67 (Y) 1772019.74 (Projected) 29.2082040356 -80.8681428290 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230721_Line_137.004.jsf ● Ping Number: 47620 ● Heading: 163.600 Degrees ● Line Name: BOEM_SSS_20230721_Line_137.004	**Dimensions and attributes** ● Target Width: 24.43 US ft ● Target Height: 4.34 US ft ● Target Length: 34.26 US ft ● Target Shadow: 54.55 US ft ● Classification1: Unknown Feature ● Area: Flagler ● Description: Unknown feature with a point of high intensity
	**Contact33** ● Sonar Time at Target: 7/22/2023 1:13:42 PM ● Click Position (X) 835785.04 (Y) 1430939.28 (Projected) 28.2690599791 -80.4419842955 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_142.jsf ● Ping Number: 71597 ● Heading: 209.900 Degrees ● Line Name: BOEM_SSS_20230722_Line_142	**Dimensions and attributes** ● Target Width: 41.27 US ft ● Target Height: 6.20 US ft ● Target Length: 24.03 US ft ● Target Shadow: 91.96 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact34** ● Sonar Time at Target: 7/22/2023 10:15:30 AM ● Click Position (X) 829845.50 (Y) 1430359.34 (Projected) 28.2675390404 -80.4604438773 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_140.jsf ● Ping Number: 38348 ● Heading: 89.100 Degrees ● Line Name: BOEM_SSS_20230722_Line_140	**Dimensions and attributes** ● Target Width: 18.98 US ft ● Target Height: 2.87 US ft ● Target Length: 47.52 US ft ● Target Shadow: 17.78 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity
	**Contact35** ● Sonar Time at Target: 7/22/2023 10:46:00 AM ● Click Position (X) 842104.57 (Y) 1430363.65 (Projected) 28.2673952149 -80.4223609406 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_140.jsf ● Ping Number: 44038 ● Heading: 89.100 Degrees ● Line Name: BOEM_SSS_20230722_Line_140	**Dimensions and attributes** ● Target Width: 61.22 US ft ● Target Height: 5.43 US ft ● Target Length: 94.44 US ft ● Target Shadow: 42.07 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity, potential bait ball

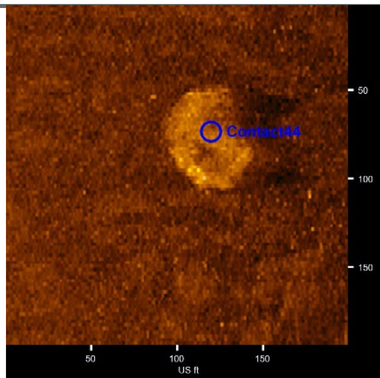
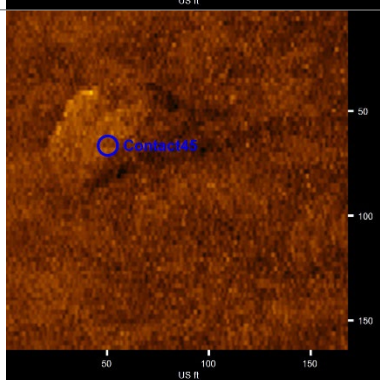
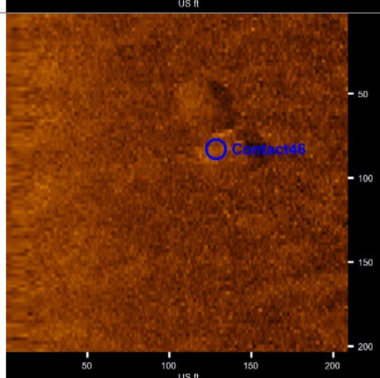
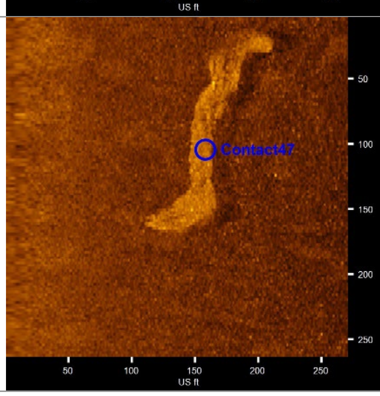
Sidescan Sonar Contact Report

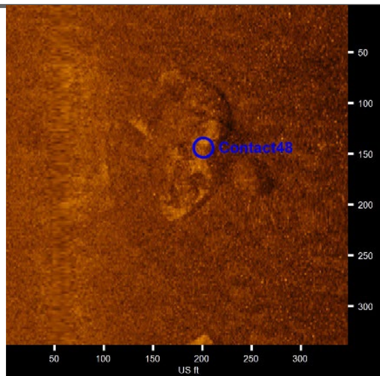
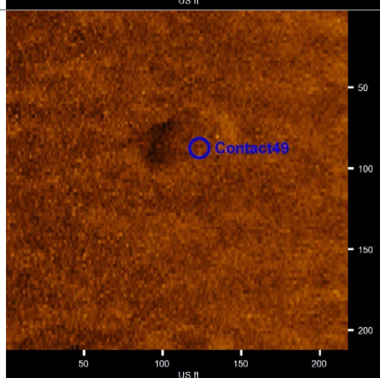
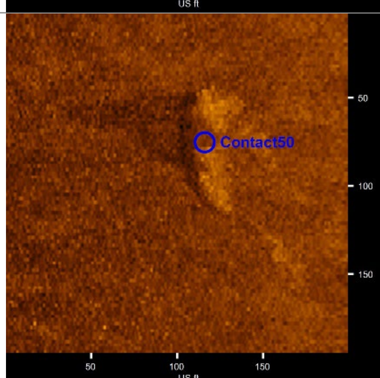
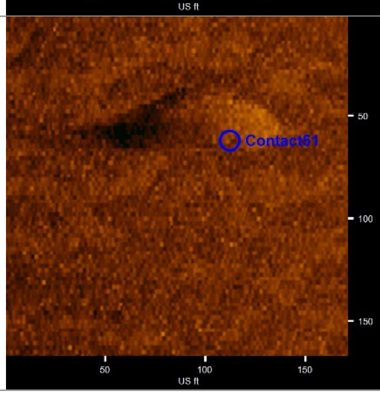
Target Image	Target Info	User Entered Info
	**Contact36** ● Sonar Time at Target: 7/22/2023 10:32:04 AM ● Click Position (X) 836444.31 (Y) 1430306.19 (Projected) 28.2673103850 -80.4399453565 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_140.jsf ● Ping Number: 41440 ● Heading: 89.000 Degrees ● Line Name: BOEM_SSS_20230722_Line_140	**Dimensions and attributes** ● Target Width: 22.31 US ft ● Target Height: 2.71 US ft ● Target Length: 20.26 US ft ● Target Shadow: 14.97 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact37** ● Sonar Time at Target: 7/22/2023 10:33:13 AM ● Click Position (X) 836903.16 (Y) 1430292.94 (Projected) 28.2672681037 -80.4385201362 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_140.jsf ● Ping Number: 41653 ● Heading: 92.000 Degrees ● Line Name: BOEM_SSS_20230722_Line_140	**Dimensions and attributes** ● Target Width: 49.90 US ft ● Target Height: 3.50 US ft ● Target Length: 80.85 US ft ● Target Shadow: 17.06 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity
	**Contact38** ● Sonar Time at Target: 7/22/2023 10:33:48 AM ● Click Position (X) 837138.70 (Y) 1430269.36 (Projected) 28.2672002397 -80.4377887703 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_140.jsf ● Ping Number: 41762 ● Heading: 92.000 Degrees ● Line Name: BOEM_SSS_20230722_Line_140	**Dimensions and attributes** ● Target Width: 39.57 US ft ● Target Height: 1.90 US ft ● Target Length: 50.85 US ft ● Target Shadow: 6.65 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity
	**Contact39** ● Sonar Time at Target: 7/22/2023 10:33:22 AM ● Click Position (X) 836966.59 (Y) 1430095.24 (Projected) 28.2667235493 -80.4383259217 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_140.jsf ● Ping Number: 41682 ● Heading: 92.900 Degrees ● Line Name: BOEM_SSS_20230722_Line_140	**Dimensions and attributes** ● Target Width: 57.17 US ft ● Target Height: 6.12 US ft ● Target Length: 145.30 US ft ● Target Shadow: 30.31 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity, potential bait ball

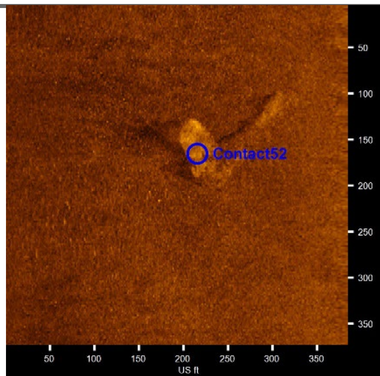
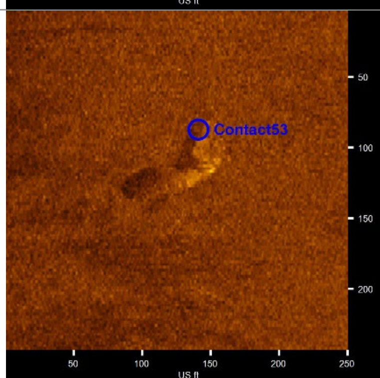
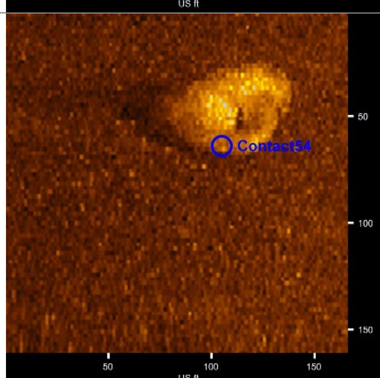
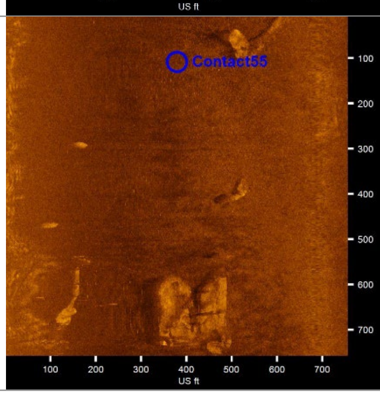
Sidescan Sonar Contact Report

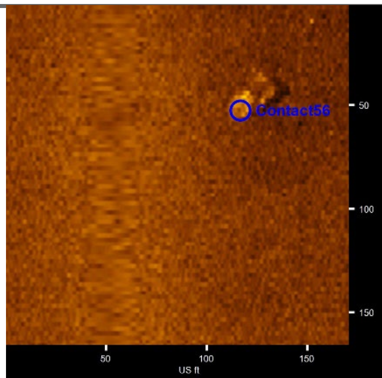
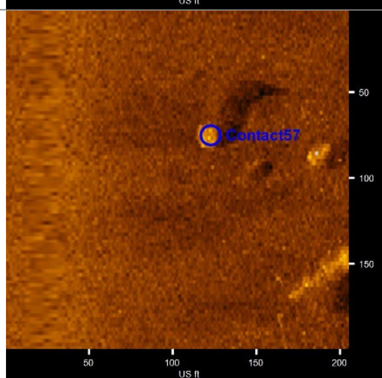
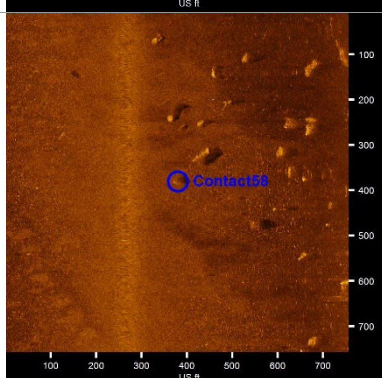
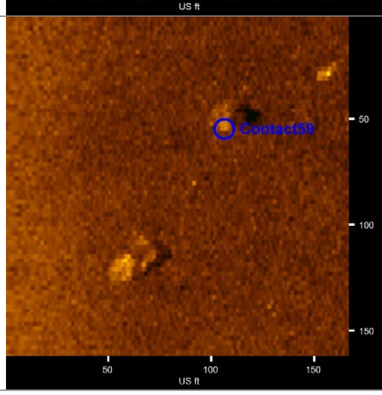
Target Image	Target Info	User Entered Info
	**Contact40** ● Sonar Time at Target: 7/22/2023 1:24:03 PM ● Click Position (X) 834173.00 (Y) 1427334.41 (Projected) 28.2591656775 -80.4470433847 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_142.jsf ● Ping Number: 73530 ● Heading: 210.100 Degrees ● Line Name: BOEM_SSS_20230722_Line_142	**Dimensions and attributes** ● Target Width: 81.27 US ft ● Target Height: 5.77 US ft ● Target Length: 337.96 US ft ● Target Shadow: 35.36 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity
	**Contact41** ● Sonar Time at Target: 7/22/2023 11:45:43 AM ● Click Position (X) 846882.95 (Y) 1426491.60 (Projected) 28.2566822281 -80.4075758359 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_141.jsf ● Ping Number: 55180 ● Heading: 33.800 Degrees ● Line Name: BOEM_SSS_20230722_Line_141	**Dimensions and attributes** ● Target Width: 123.38 US ft ● Target Height: 6.85 US ft ● Target Length: 199.77 US ft ● Target Shadow: 61.04 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity, potential bait ball
	**Contact42** ● Sonar Time at Target: 7/22/2023 11:44:54 AM ● Click Position (X) 846487.20 (Y) 1426369.63 (Projected) 28.2563520936 -80.4088069491 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_141.jsf ● Ping Number: 55028 ● Heading: 29.200 Degrees ● Line Name: BOEM_SSS_20230722_Line_141	**Dimensions and attributes** ● Target Width: 51.67 US ft ● Target Height: 2.61 US ft ● Target Length: 46.32 US ft ● Target Shadow: 14.46 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact43** ● Sonar Time at Target: 7/22/2023 8:45:15 AM ● Click Position (X) 842925.60 (Y) 1420640.04 (Projected) 28.2406411646 -80.4199551864 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 21511 ● Heading: 270.000 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 75.91 US ft ● Target Height: 3.36 US ft ● Target Length: 40.48 US ft ● Target Shadow: 43.31 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity

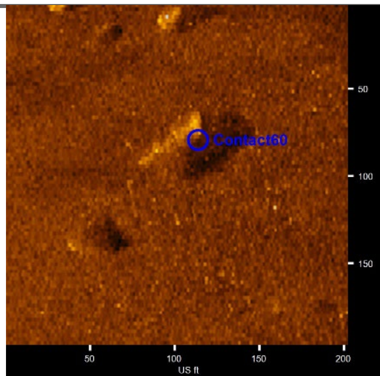
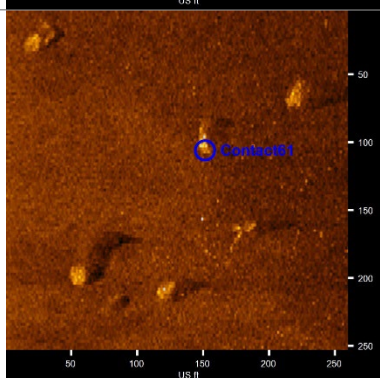
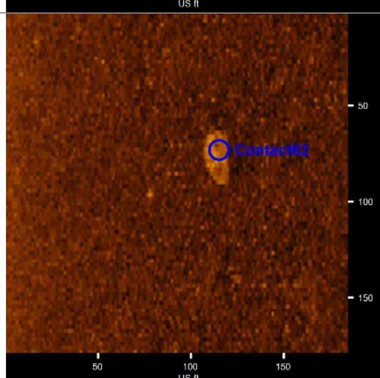
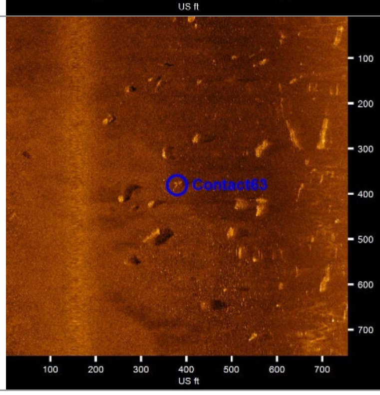
Sidescan Sonar Contact Report

Target Image	Target Info	User Entered Info
	**Contact44** ● Sonar Time at Target: 7/22/2023 8:44:34 AM ● Click Position (X) 843198.99 (Y) 1420539.57 (Projected) 28.2403612157 -80.4191075832 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 21382 ● Heading: 271.200 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 57.06 US ft ● Target Height: 3.05 US ft ● Target Length: 62.21 US ft ● Target Shadow: 26.63 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact45** ● Sonar Time at Target: 7/22/2023 8:46:04 AM ● Click Position (X) 842610.86 (Y) 1420462.60 (Projected) 28.2401572833 -80.4209353159 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 21661 ● Heading: 268.700 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 62.56 US ft ● Target Height: 8.70 US ft ● Target Length: 68.35 US ft ● Target Shadow: 63.92 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact46** ● Sonar Time at Target: 7/22/2023 8:45:33 AM ● Click Position (X) 842812.67 (Y) 1420447.73 (Projected) 28.2401137332 -80.4203087726 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 21565 ● Heading: 270.000 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 32.49 US ft ● Target Height: 2.53 US ft ● Target Length: 61.08 US ft ● Target Shadow: 12.43 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of seafloor relief
	**Contact47** ● Sonar Time at Target: 7/22/2023 8:40:54 AM ● Click Position (X) 844599.87 (Y) 1420449.79 (Projected) 28.2400957310 -80.4147582141 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 20697 ● Heading: 270.800 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 28.97 US ft ● Target Height: 1.30 US ft ● Target Length: 169.45 US ft ● Target Shadow: 7.33 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity

Target Image	Target Info	User Entered Info
	**Contact48** ● Sonar Time at Target: 7/22/2023 8:39:47 AM ● Click Position (X) 845024.78 (Y) 1420438.51 (Projected) 28.2400590542 -80.4134387359 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 20489 ● Heading: 270.700 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 100.50 US ft ● Target Height: 0.90 US ft ● Target Length: 149.11 US ft ● Target Shadow: 4.70 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity
	**Contact49** ● Sonar Time at Target: 7/22/2023 8:46:21 AM ● Click Position (X) 842499.54 (Y) 1420214.90 (Projected) 28.2394774687 -80.4212847116 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 21715 ● Heading: 268.700 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 49.83 US ft ● Target Height: 3.00 US ft ● Target Length: 53.39 US ft ● Target Shadow: 12.67 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Low intensity feature with seafloor depression
	**Contact50** ● Sonar Time at Target: 7/22/2023 8:41:44 AM ● Click Position (X) 844278.84 (Y) 1420207.07 (Projected) 28.2394324518 -80.4157588894 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 20854 ● Heading: 270.900 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 45.23 US ft ● Target Height: 11.49 US ft ● Target Length: 77.02 US ft ● Target Shadow: 66.95 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact51** ● Sonar Time at Target: 7/22/2023 8:45:59 AM ● Click Position (X) 842645.29 (Y) 1420161.89 (Projected) 28.2393297680 -80.4208328399 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 21646 ● Heading: 269.000 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 63.27 US ft ● Target Height: 8.33 US ft ● Target Length: 34.07 US ft ● Target Shadow: 67.90 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of seafloor relief

Target Image	Target Info	User Entered Info
	**Contact52** ● Sonar Time at Target: 7/22/2023 8:40:09 AM ● Click Position (X) 844878.60 (Y) 1420125.28 (Projected) 28.2391995112 -80.4138974516 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 20558 ● Heading: 271.200 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 51.38 US ft ● Target Height: 3.78 US ft ● Target Length: 127.51 US ft ● Target Shadow: 25.95 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact53** ● Sonar Time at Target: 7/22/2023 8:39:18 AM ● Click Position (X) 845201.01 (Y) 1420122.44 (Projected) 28.2391874048 -80.4128962040 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 20401 ● Heading: 271.000 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 23.69 US ft ● Target Height: 0.80 US ft ● Target Length: 74.16 US ft ● Target Shadow: 4.73 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact54** ● Sonar Time at Target: 7/22/2023 8:42:17 AM ● Click Position (X) 844067.44 (Y) 1420070.26 (Projected) 28.2390589676 -80.4164174744 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 20957 ● Heading: 271.400 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 66.54 US ft ● Target Height: 5.48 US ft ● Target Length: 45.56 US ft ● Target Shadow: 57.36 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact55** ● Sonar Time at Target: 7/22/2023 8:38:38 AM ● Click Position (X) 845459.54 (Y) 1419979.42 (Projected) 28.2387906044 -80.4120954349 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_139.jsf ● Ping Number: 20275 ● Heading: 270.600 Degrees ● Line Name: BOEM_SSS_20230722_Line_139	**Dimensions and attributes** ● Target Width: 149.46 US ft ● Target Height: 2.50 US ft ● Target Length: 163.19 US ft ● Target Shadow: 28.44 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with an area of high intensity

Target Image	Target Info	User Entered Info
	**Contact56** ● Sonar Time at Target: 7/22/2023 7:20:39 AM ● Click Position (X) 815972.17 (Y) 1410566.48 (Projected) 28.2132644085 -80.5037937844 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf ● Ping Number: 5726 ● Heading: 91.000 Degrees ● Line Name: BOEM_SSS_20230722_Line_138	**Dimensions and attributes** ● Target Width: 19.82 US ft ● Target Height: 2.03 US ft ● Target Length: 30.48 US ft ● Target Shadow: 4.61 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact57** ● Sonar Time at Target: 7/22/2023 7:20:14 AM ● Click Position (X) 815803.87 (Y) 1410530.87 (Projected) 28.2131683556 -80.5043168143 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf ● Ping Number: 5648 ● Heading: 90.400 Degrees ● Line Name: BOEM_SSS_20230722_Line_138	**Dimensions and attributes** ● Target Width: 10.47 US ft ● Target Height: 6.15 US ft ● Target Length: 46.42 US ft ● Target Shadow: 26.41 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact58** ● Sonar Time at Target: 7/22/2023 7:19:53 AM ● Click Position (X) 815659.66 (Y) 1410517.69 (Projected) 28.2131337292 -80.5047647292 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf ● Ping Number: 5581 ● Heading: 90.500 Degrees ● Line Name: BOEM_SSS_20230722_Line_138	**Dimensions and attributes** ● Target Width: 26.48 US ft ● Target Height: 2.62 US ft ● Target Length: 13.24 US ft ● Target Shadow: 11.17 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact59** ● Sonar Time at Target: 7/22/2023 7:20:50 AM ● Click Position (X) 816040.32 (Y) 1410515.24 (Projected) 28.2131227092 -80.5035828345 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf ● Ping Number: 5758 ● Heading: 90.600 Degrees ● Line Name: BOEM_SSS_20230722_Line_138	**Dimensions and attributes** ● Target Width: 13.08 US ft ● Target Height: 1.82 US ft ● Target Length: 16.50 US ft ● Target Shadow: 7.44 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity

Target Image	Target Info	User Entered Info
	**Contact60** ● Sonar Time at Target: 7/22/2023 7:20:02 AM ● Click Position (X) 815721.46 (Y) 1410450.15 (Projected) 28.2129472860 -80.5045737095 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf ● Ping Number: 5610 ● Heading: 90.300 Degrees ● Line Name: BOEM_SSS_20230722_Line_138	**Dimensions and attributes** ● Target Width: 12.42 US ft ● Target Height: 3.10 US ft ● Target Length: 46.02 US ft ● Target Shadow: 21.33 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact61** ● Sonar Time at Target: 7/22/2023 7:20:28 AM ● Click Position (X) 815895.29 (Y) 1410435.66 (Projected) 28.2129054771 -80.5040341633 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf ● Ping Number: 5691 ● Heading: 91.100 Degrees ● Line Name: BOEM_SSS_20230722_Line_138	**Dimensions and attributes** ● Target Width: 7.84 US ft ● Target Height: 1.47 US ft ● Target Length: 23.42 US ft ● Target Shadow: 10.18 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact62** ● Sonar Time at Target: 7/22/2023 7:31:44 AM ● Click Position (X) 820442.74 (Y) 1410447.43 (Projected) 28.2128859322 -80.4899144004 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf ● Ping Number: 7792 ● Heading: 90.500 Degrees ● Line Name: BOEM_SSS_20230722_Line_138	**Dimensions and attributes** ● Target Width: 13.56 US ft ● Target Height: 1.93 US ft ● Target Length: 28.09 US ft ● Target Shadow: 12.70 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact63** ● Sonar Time at Target: 7/22/2023 7:20:18 AM ● Click Position (X) 815828.43 (Y) 1410409.24 (Projected) 28.2128335648 -80.5042420833 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf ● Ping Number: 5660 ● Heading: 90.600 Degrees ● Line Name: BOEM_SSS_20230722_Line_138	**Dimensions and attributes** ● Target Width: 17.30 US ft ● Target Height: 3.66 US ft ● Target Length: 23.04 US ft ● Target Shadow: 31.48 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with multiple points of high intensity

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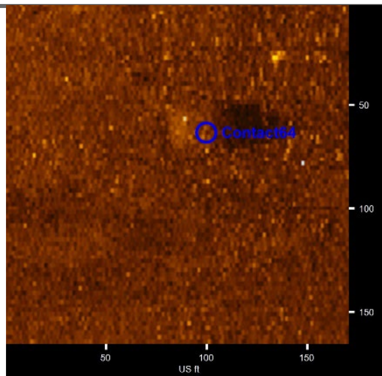
<tr><td>
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● Click Position
(X) 815564.29 (Y) 1410340.97 (Projected)
28.2126487473 -80.5050630940 (LocalLL)
● Map Projection: EPSG:6438
● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf
● Ping Number: 5537
● Heading: 90.300 Degrees
● Line Name: BOEM_SSS_20230722_Line_138</td><td>Dimensions and attributes
● Target Width: 22.37 US ft
● Target Height: 2.95 US ft
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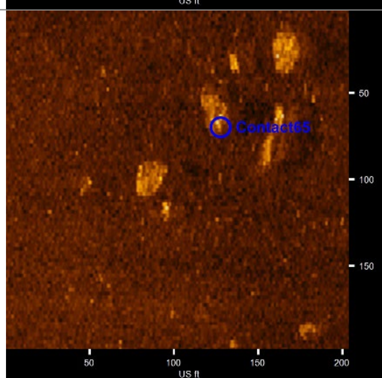
● Target Shadow: 32.50 US ft
● Classification1: Unknown Feature
● Area: Sebastian Inlet
● Description: point of seafloor relief</td></tr>
<tr><td>
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● Sonar Time at Target: 7/22/2023 7:21:19 AM
● Click Position
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28.2126093359 -80.5029939691 (LocalLL)
● Map Projection: EPSG:6438
● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf
● Ping Number: 5848
● Heading: 91.100 Degrees
● Line Name: BOEM_SSS_20230722_Line_138</td><td>Dimensions and attributes
● Target Width: 19.52 US ft
● Target Height: 1.53 US ft
● Target Length: 33.21 US ft
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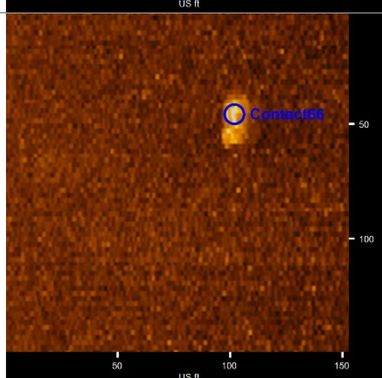
● Area: Sebastian Inlet
● Description: Unknown feature with multiple points of high intensity</td></tr>
<tr><td>
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● Sonar Time at Target: 7/22/2023 7:44:15 AM
● Click Position
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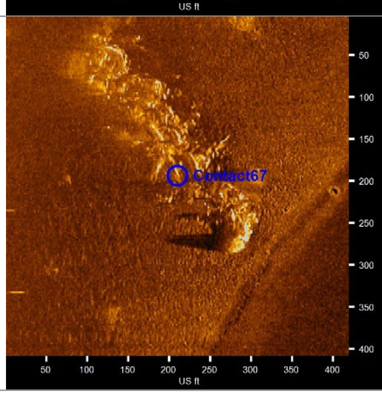
28.2125233203 -80.4742272654 (LocalLL)
● Map Projection: EPSG:6438
● Acoustic Source File: BOEM_SSS_20230722_Line_138.jsf
● Ping Number: 10128
● Heading: 88.500 Degrees
● Line Name: BOEM_SSS_20230722_Line_138</td><td>Dimensions and attributes
● Target Width: 18.43 US ft
● Target Height: 0.38 US ft
● Target Length: 23.28 US ft
● Target Shadow: 2.90 US ft
● Classification1: Unknown Feature
● Area: Sebastian Inlet
● Description: Unknown feature with a point of high intensity</td></tr>
<tr><td>
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● Sonar Time at Target: 7/22/2023 2:24:57 PM
● Click Position
(X) 822503.69 (Y) 1407132.12 (Projected)
28.2037435226 -80.4835591003 (LocalLL)
● Map Projection: EPSG:6438
● Acoustic Source File: BOEM_SSS_20230722_Line_142.002.jsf
● Ping Number: 84890
● Heading: 209.300 Degrees
● Line Name: BOEM_SSS_20230722_Line_142.002</td><td>Dimensions and attributes
● Target Width: 108.10 US ft
● Target Height: 6.81 US ft
● Target Length: 296.88 US ft
● Target Shadow: 84.87 US ft
● Mag Anomaly: Mag_279
● Classification1: Unknown Feature
● Area: Sebastian Inlet
● Description: Potential Shipwreck</td></tr>
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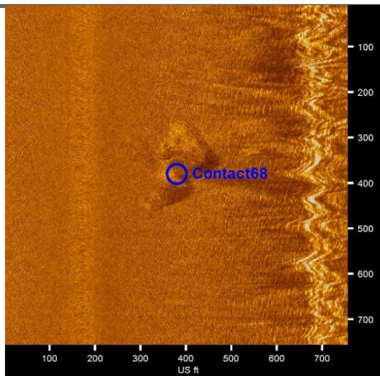
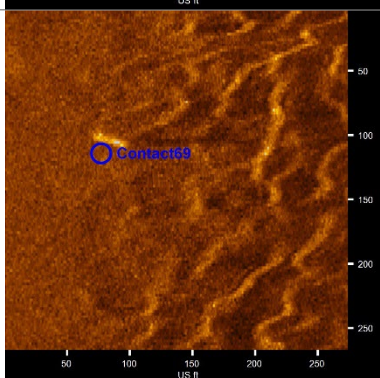
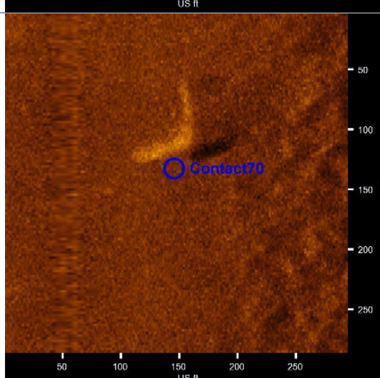
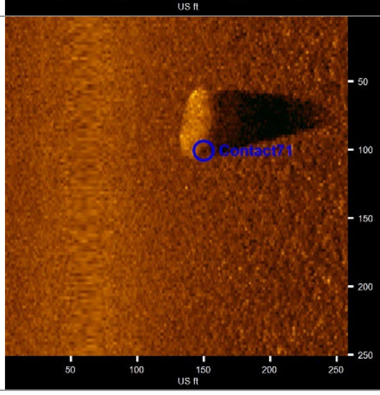
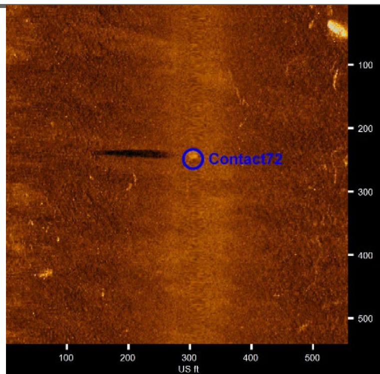
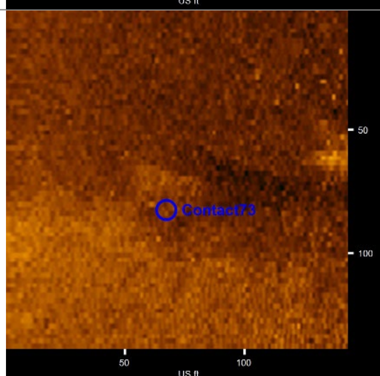
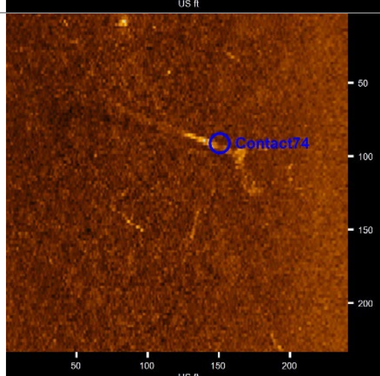
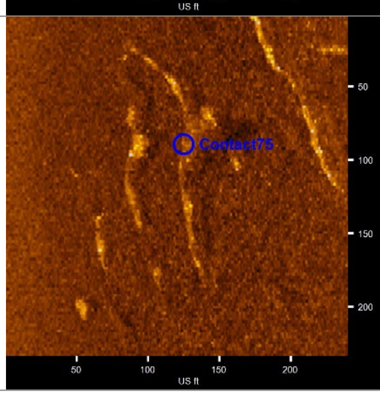
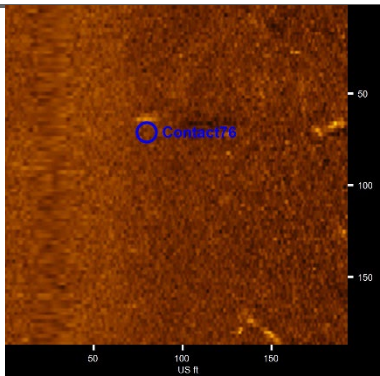
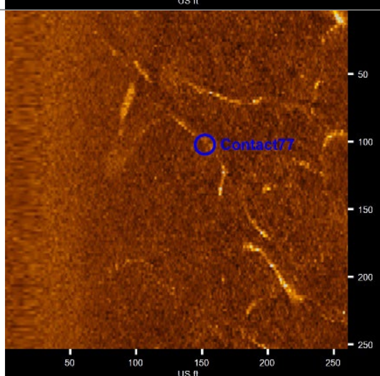
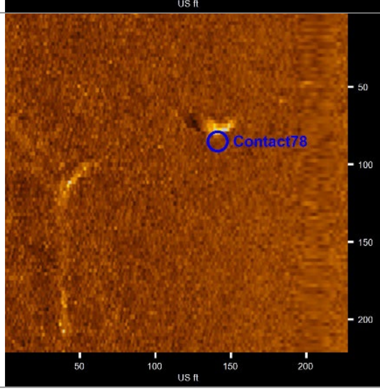
Target Image	Target Info	User Entered Info
	**Contact68** ● Sonar Time at Target: 7/22/2023 8:31:29 PM ● Click Position (X) 873126.65 (Y) 1276255.57 (Projected) 27.8430989272 -80.3286304693 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230722_Line_143.004.jsf ● Ping Number: 153271 ● Heading: 155.600 Degrees ● Line Name: BOEM_SSS_20230722_Line_143.004	**Dimensions and attributes** ● Target Width: 132.15 US ft ● Target Height: 17.40 US ft ● Target Length: 212.36 US ft ● Target Shadow: 268.91 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Low intensity area of seafloor relief
	**Contact69** ● Sonar Time at Target: 7/25/2023 9:39:50 AM ● Click Position (X) 881327.27 (Y) 1260209.48 (Projected) 27.7988390935 -80.3035373353 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230725_Line_144.jsf ● Ping Number: 29821 ● Heading: 149.400 Degrees ● Line Name: BOEM_SSS_20230725_Line_144	**Dimensions and attributes** ● Target Width: 7.78 US ft ● Target Height: 14.75 US ft ● Target Length: 27.77 US ft ● Target Shadow: 101.08 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact70** ● Sonar Time at Target: 7/25/2023 9:42:00 AM ● Click Position (X) 881832.21 (Y) 1259507.79 (Projected) 27.7969012580 -80.3019878767 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230725_Line_144.jsf ● Ping Number: 30227 ● Heading: 148.900 Degrees ● Line Name: BOEM_SSS_20230725_Line_144	**Dimensions and attributes** ● Target Width: 53.37 US ft ● Target Height: 10.86 US ft ● Target Length: 82.31 US ft ● Target Shadow: 35.46 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact71** ● Sonar Time at Target: 7/25/2023 8:12:10 AM ● Click Position (X) 889054.63 (Y) 1258563.19 (Projected) 27.7941885085 -80.2796665559 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230725_Line_152.jsf ● Ping Number: 13466 ● Heading: 233.800 Degrees ● Line Name: BOEM_SSS_20230725_Line_152	**Dimensions and attributes** ● Target Width: 22.01 US ft ● Target Height: 11.43 US ft ● Target Length: 58.13 US ft ● Target Shadow: 88.38 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity

Target Image	Target Info	User Entered Info
	**Contact72** ● Sonar Time at Target: 7/25/2023 8:16:50 AM ● Click Position (X) 887653.61 (Y) 1257328.06 (Projected) 27.7908138731 -80.2840219587 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230725_Line_152.jsf ● Ping Number: 14335 ● Heading: 230.200 Degrees ● Line Name: BOEM_SSS_20230725_Line_152	**Dimensions and attributes** ● Target Width: 20.39 US ft ● Target Height: 25.29 US ft ● Target Length: 13.65 US ft ● Target Shadow: 138.59 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with point of high intensity and shadow
	**Contact73** ● Sonar Time at Target: 7/23/2023 4:48:16 PM ● Click Position (X) 901606.58 (Y) 1249698.06 (Projected) 27.7695977130 -80.2410148053 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230723_Line_148.002.jsf ● Ping Number: 111965 ● Heading: 329.000 Degrees ● Line Name: BOEM_SSS_20230723_Line_148.002	**Dimensions and attributes** ● Target Width: 33.36 US ft ● Target Height: 12.91 US ft ● Target Length: 21.83 US ft ● Target Shadow: 59.80 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact74** ● Sonar Time at Target: 7/24/2023 8:00:09 AM ● Click Position (X) 902239.74 (Y) 1237292.18 (Projected) 27.7354653078 -80.2392941466 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230724_Line_147.002.jsf ● Ping Number: 13703 ● Heading: 146.700 Degrees ● Line Name: BOEM_SSS_20230724_Line_147.002	**Dimensions and attributes** ● Target Width: 103.14 US ft ● Target Height: 3.65 US ft ● Target Length: 32.11 US ft ● Target Shadow: 17.20 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a linear area of high intensity
	**Contact75** ● Sonar Time at Target: 7/24/2023 8:01:00 AM ● Click Position (X) 902199.75 (Y) 1236884.63 (Projected) 27.7343450353 -80.2394255647 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230724_Line_147.002.jsf ● Ping Number: 13863 ● Heading: 150.000 Degrees ● Line Name: BOEM_SSS_20230724_Line_147.002	**Dimensions and attributes** ● Target Width: 32.10 US ft ● Target Height: 2.68 US ft ● Target Length: 160.74 US ft ● Target Shadow: 16.56 US ft ● Classification1: Sand Waves ● Area: Sebastian Inlet ● Description: Multiple sand waves

Sidescan Sonar Contact Report

Target Image	Target Info	User Entered Info
	**Contact76** ● Sonar Time at Target: 7/24/2023 8:01:27 AM ● Click Position (X) 902367.37 (Y) 1236791.00 (Projected) 27.7340846594 -80.2389091981 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230724_Line_147.002.jsf ● Ping Number: 13945 ● Heading: 147.700 Degrees ● Line Name: BOEM_SSS_20230724_Line_147.002	**Dimensions and attributes** ● Target Width: 14.08 US ft ● Target Height: 11.21 US ft ● Target Length: 6.54 US ft ● Target Shadow: 36.97 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity
	**Contact77** ● Sonar Time at Target: 7/24/2023 8:02:13 AM ● Click Position (X) 902449.91 (Y) 1236493.97 (Projected) 27.7332662988 -80.2386597464 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230724_Line_147.002.jsf ● Ping Number: 14090 ● Heading: 146.300 Degrees ● Line Name: BOEM_SSS_20230724_Line_147.002	**Dimensions and attributes** ● Target Width: 8.24 US ft ● Target Height: 2.95 US ft ● Target Length: 147.40 US ft ● Target Shadow: 16.22 US ft ● Classification1: Sand Waves ● Area: Sebastian Inlet ● Description: Continuation of sand waves seen in Contact75
	**Contact78** ● Sonar Time at Target: 7/24/2023 3:58:14 PM ● Click Position (X) 902565.44 (Y) 1236001.39 (Projected) 27.7319095005 -80.2383120429 (LocalLL) ● Map Projection: EPSG:6438 ● Acoustic Source File: BOEM_SSS_20230724_Line_153.jsf ● Ping Number: 102906 ● Heading: 1.100 Degrees ● Line Name: BOEM_SSS_20230724_Line_153	**Dimensions and attributes** ● Target Width: 26.09 US ft ● Target Height: 2.72 US ft ● Target Length: 12.95 US ft ● Target Shadow: 6.75 US ft ● Classification1: Unknown Feature ● Area: Sebastian Inlet ● Description: Unknown feature with a point of high intensity

Appendix J: Sidescan SonarWiz Projects (Digital only)

Appendix K: Seismic Web Project (Digital only)

Appendix L: Seismic SonarWiz Project (Digital only)

Appendix M: Vibracore logs, photographs reports, curves (also digital)

Appendix N: Penetrometer Logs (Digital only)

Appendix O: Field books and geophysical logs (Digital only)

Appendix P: gINT Project (Digital only)