

JAY BIRD SHOALS BORROW SITE EXPANSION INVESTIGATION

Report Submitted To:

Village of Bald Head Island, N.C.

Report Submitted By:

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2618 Herschel Street
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October 2022

BACKGROUND

Along with the strategic use of structures, the Village of Bald Head Island's *Beach Management Plan* has been largely dependent upon episodic beach disposal activities performed in accordance with Wilmington Harbor Sand Management Plan (WHSMP) -- as implemented by the Wilmington District, (USACOE, 2000). The latter was required pursuant to Permits and Agreements associated with the 2001 Wilmington Harbor Deepening Project. According to the tenets of the WHSMP, channel maintenance beach disposal is redirected to Oak Island – every third event. Since 2000, disposal projects have occurred on average every 2 to 3 years – principally depending upon available funding. During any extended period of the time between federal disposal projects at South Beach on Bald Head Island, the Village has been required to construct locally funded sand placements of varying sizes at South Beach necessary to maintain the beach-dune system, as well as to protect public infrastructure. To date, the main sand source for such non-federal projects at South Beach (totaling almost 3M cy) has been a permitted borrow site located on the seawardmost portion of Jay Bird Shoals (JBS) (see **Figure 1**). As of this date, naturally occurring borrow site recovery has been insufficient to allow for the reutilization of the original permitted borrow site area.

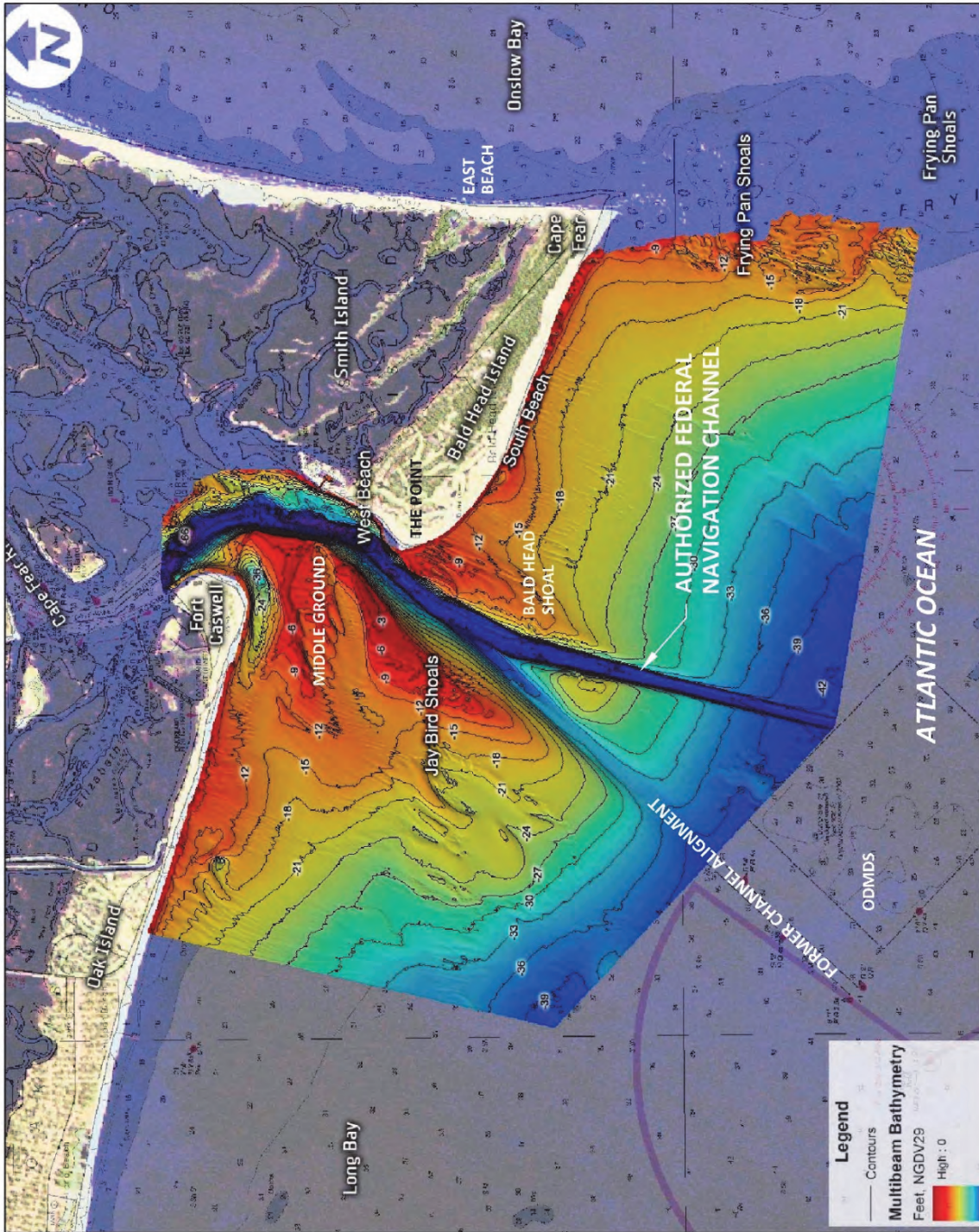


Figure 1: Location of Jaybird Shoals relative to Bald Head Island.

For purposes of developing a suitable alternate long-term sand source, the Village in 2015 initiated the geotechnical exploration, environmental analysis and marine archaeological investigation eventually required for the submittal of permits for a proposed borrow site located at Frying Pan Shoals – a large-scale depositional feature lying due south of the Cape Fear headland – and extending some 30+ miles to sea (see **Figure 1**). The latter shoal formation had been first investigated almost 50 years ago as a candidate source of sand by the U.S. Army Corps of Engineers Coastal Engineering Research Center (Meisburger, 1977). The estimated sand volume within the shoal was predicted to exceed some 1.4 billion cubic yards. As the result of being seaward of a major shoreline headland feature, Frying Pan Shoals receives sand annually from both South Beach and East Beach on Bald Head Island (see **Figure 2**). Hence, from a geological stand point it can be considered to be an ever-enlarging depositional feature. A detailed *Sand Source Investigation* (Olsen Associates, April 2016), concluded that a strategically sited borrow site located on the more dynamic portions of Frying Pan Shoals (within State Waters) would be subject to rapid physical recovery subsequent to any dredging event.

Moreover, it was determined that both the proximity of the Frying Pan Shoals borrow site to South Beach, as well as the excellent sedimentary characteristics of the shoal sands, represent essentially an “inexhaustible” source of high-quality material for beach fill construction. Based upon the frequency of federal beach disposal projects, it was estimated that a Frying Pan Shoals borrow area would need to be utilized only every 7-10 years. Nonetheless, the initial Permit Application(s) submitted by the Village sought only a one-time use – followed by years of physical and environmental monitoring sufficient to make all impact assessments necessary to justify future use. Over the last two years, mol., Village consultants have attempted to address various regulatory agency concerns – with “potential” fisheries impacts as the final issue essentially being unresolved by early 2022. Over that period of time, various agency personnel have continually recommended that the Village continue to utilize Jay Bird shoals as the source of sand for any necessary non-federal sand placement projects at South Beach – as they had in the past (see **Figure 3**).



Figure 2: Estimated maximum annual sediment contributions to Frying Pan Shoals.

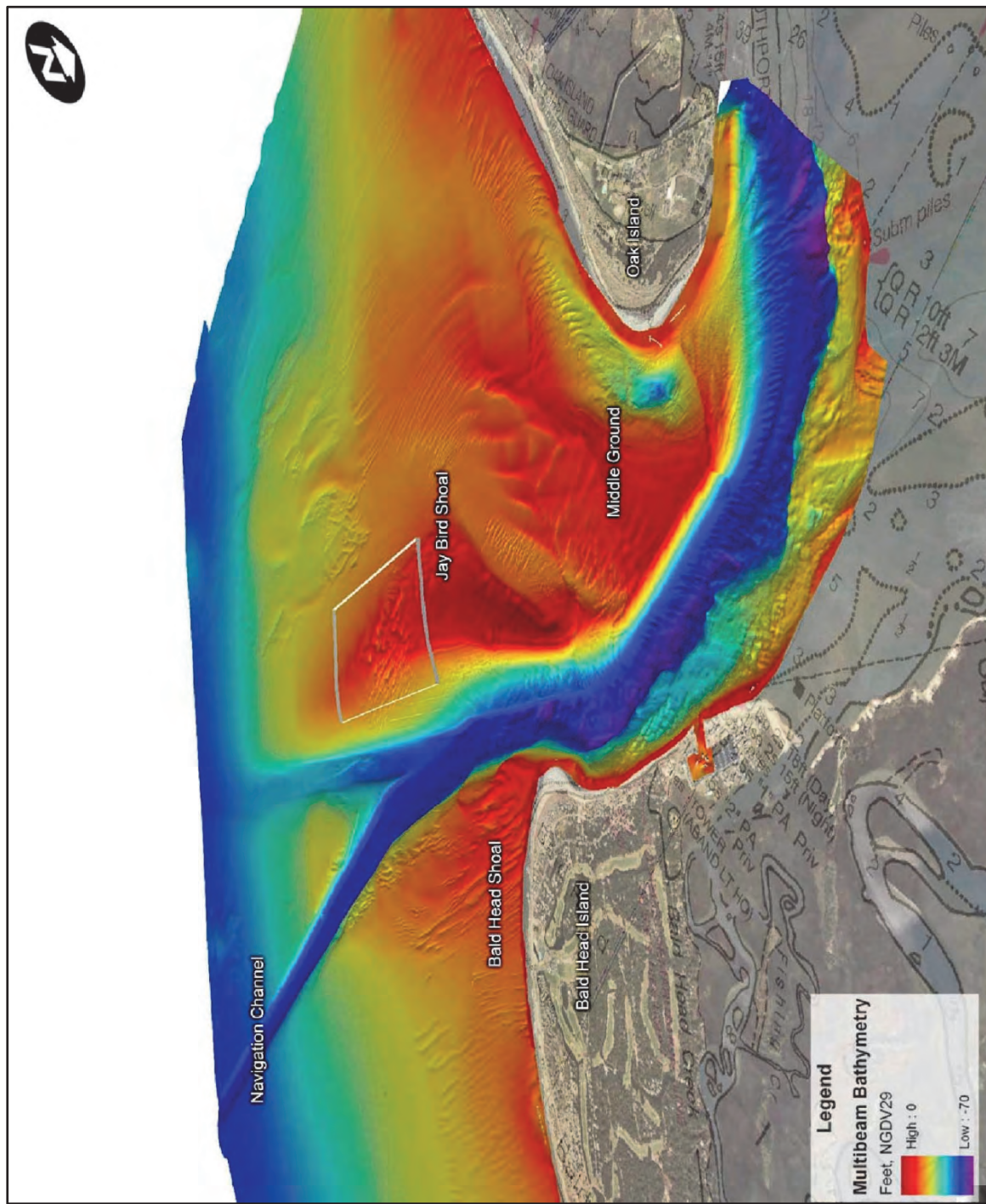


Figure 3: Oblique view of previously permitted Jay Bird Shoals borrow site.

To that end, annual survey monitoring of the Permitted Jay Bird Shoals borrow area has documented ongoing recovery of the dredged substrate – but *not* of sufficient spatial distribution and sediment depth where it would be suitable for near-term excavation by a hydraulic dredge. With the known eventual need for sand placement resulting from an upcoming South Beach disposal hiatus in/or about 2025 (*i.e.*, the period when disposal sand would be contractually redirected to Oak Island pursuant to the WHSMP), the Village has recognized that any future use of the Jay Bird Shoals borrow site, as recommended by regulatory agencies, would necessitate some level of expansion of its currently permitted limits. Accordingly, that conclusion was the genesis for the formulation and implementation of the 2022 sand source investigation discussed herein. Prior comprehensive geotechnical analyses of Jay Bird Shoals had been performed for purposes of permitting two (2) dredging events (Olsen Associates, Inc.; June 2007a) and (Olsen Associates, Inc.; August 2017).

EXISTING BORROW SITE CONDITIONS

Pursuant to permit requirements for a 2009/10 Village beach fill project, the Jay Bird Shoals borrow site has been surveyed for purposes of monitoring its eventual long-term physical recovery. Approximately 1.8 Mcy of material was excavated during the 2009/10 project and 1.1 Mcy during a subsequent 2018/19 project. **Figure 4** depicts the most recent permitted borrow site (May 2022) seabed elevations. This plot represents conditions approximately 3 years post-2018/19 project and 12 years post-2009/10 project conditions. In the plot, the full permitted borrow area limits are shown. The permitted limits are further subdivided into three sub-areas. For the 2009/10 project, only portions of Area 1 and Area 2 were excavated. For the 2018/19 project, only portions of Area 2 and Area 3 were excavated. Also plotted in the figure are the locations of two dredging exclusion zones (both located in Area 3) and a 200 ft tide gage buffer zone (Area 1 & 2). No excavation was conducted within either the exclusion or buffer zones during the 2009/10 and 2018/19 projects. **Figure 5** depicts the computed seabed elevation change during the last monitoring period (May 2021 to May 2022) (Olsen Associates, Inc., 2022).

For purposes of this sand source investigation, the typical limits of monitoring of the Jay Bird Shoal borrow site were modified in May 2022. That is to say, the limits of survey were extended to the north and west for purposes of documenting bathymetric features of interest adjacent to the prior dredged site (see **Figure 6**).

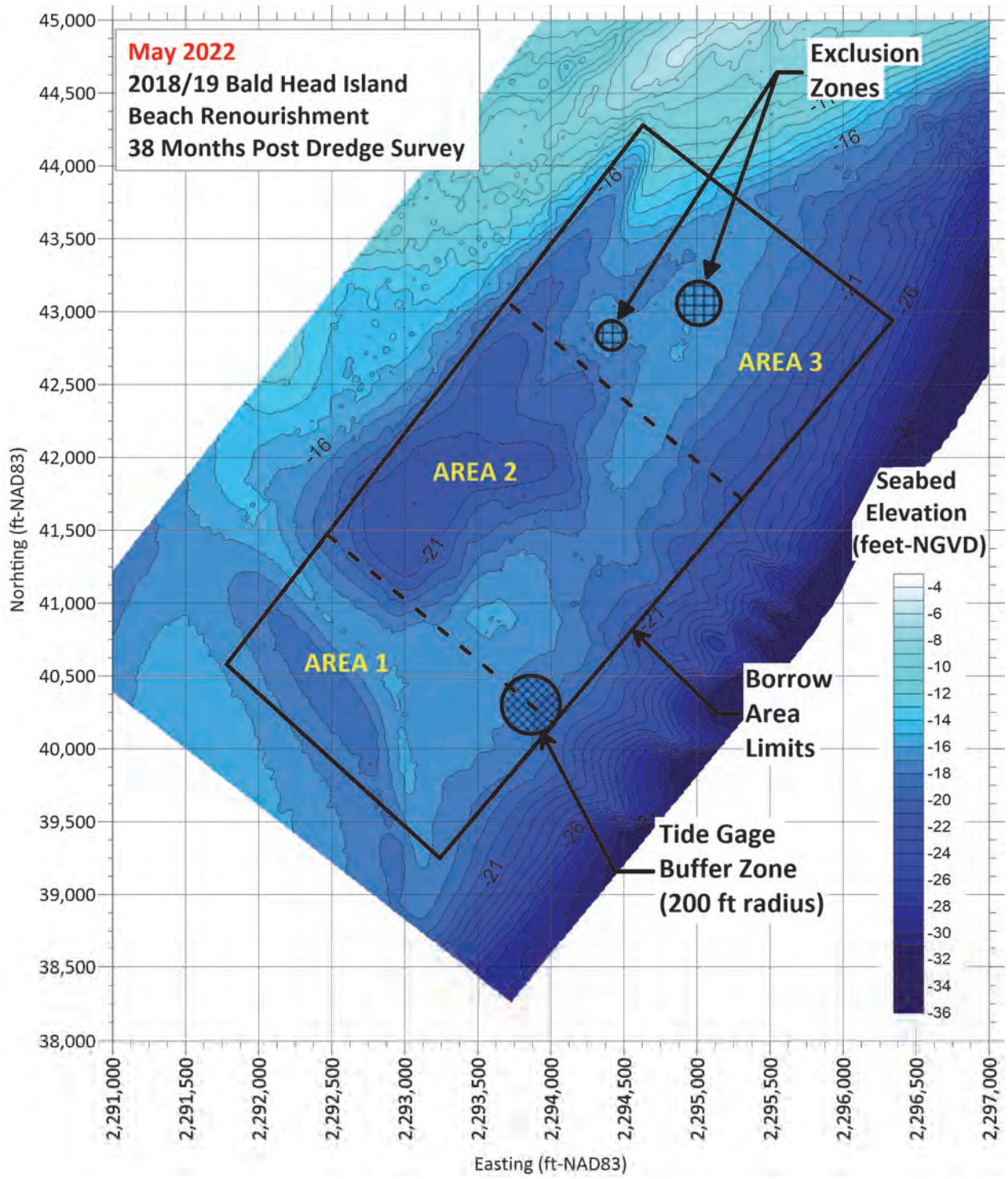


Figure 4: Jay Bird Shoals borrow site conditions in May 2022 (38 months post-dredge 2018/19 project).

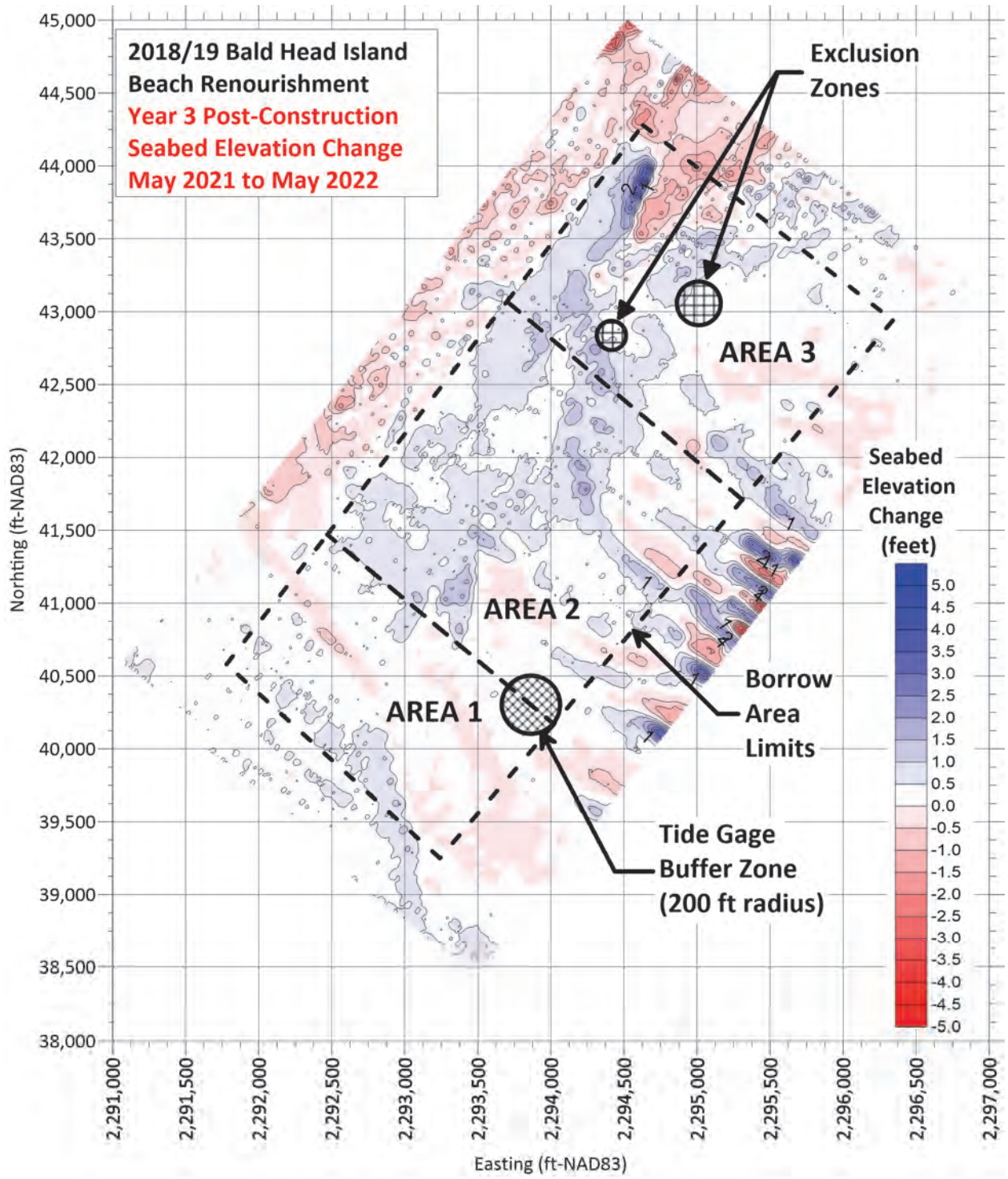


Figure 5: Jay Bird Shoals seabed elevation changes during the Year 3 Post-Construction for the 2018/19 project (May 2021 to May 2022).

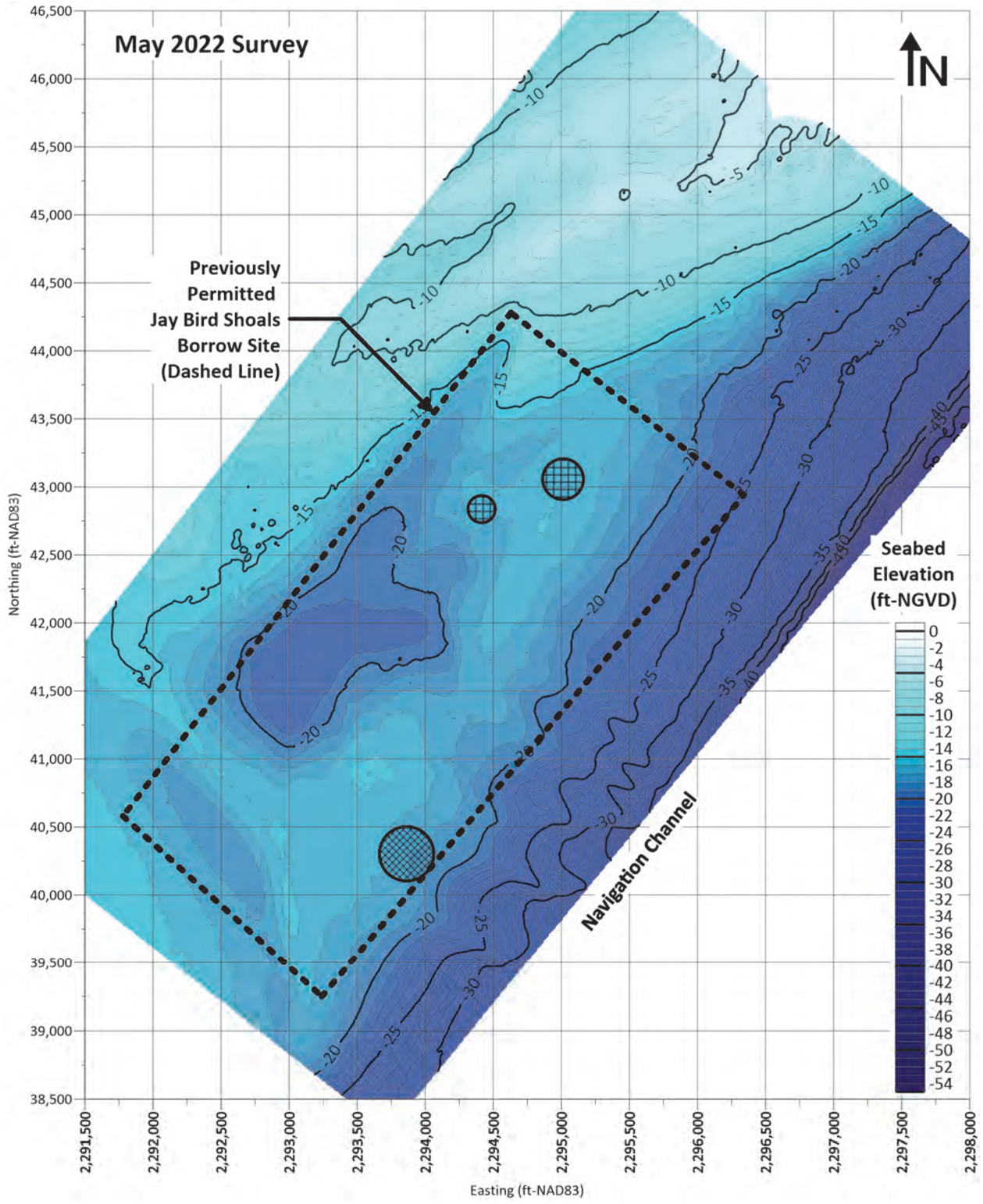


Figure 6: Existing bathymetric condition within and adjacent to the original permitted Jay Bird Shoals borrow area.

JBS BORROW AREA EXPANSION

For purposes of ensuring the integrity and accuracy of numerous prior studies required for the permitting of the original 226 A. JBS borrow site (see Olsen 2017,b), the spatial limits of an expansion area have been minimized. **Figures 7 and 8** depict the initial location and relative size of a preliminarily identified 75A expansion to the northwest of the original permitted site. Based upon today's bathymetric conditions, the available neat volume of borrow site sand within the expanded site above a design elevation of -22 ft. NGVD is approximately 1.4 Mcy. This is theoretically sufficient for the construction of a potential interim beach fill in/or about 2025 (including losses during fill placement). This assumes no exclusion area(s) due to potential marine archaeological concerns. By design, the maximum depth of excavation during dredging would be limited to -24 ft. NGVD – as in the prior two (2) dredging events. This ensures that beach quality sediments are excavated, as well as that the exposed borrow site post-construction substrate is suitable for expeditious benthic recovery (see LMG, June 2013).

GEOTECHNICAL INVESTIGATION

Having quantified *potential* sediment availability over depth, Olsen Associates, Inc., (OAI), authorized the acquisition of ten (10) VIBRACORES within and adjacent to the proposed 75A. expansion area. The locations of the intended cores are depicted by **Figure 7**. Two (2) cores were sited in previously dredged areas within Area 3 of the original site for purposes of assessing the quality of the depositional material. The firm of Athena Technologies, Inc. (Athena) was contracted to acquire the desired VIBRACORES and to log, document, and perform the requisite laboratory analyses (i.e. size characteristics, % shell, % fines, etc.). Athena completed the field work associated with VIBRACORE acquisition in early July, 2022. Each core was sampled at two discrete locations as well as a composite sample which extended over the maximum design depth of excavation (i.e. -22 ft. NGVD+2 ft. overdepth). Such composite samples were based upon the apparent absolute depth of visible, desirable material and verification of same based upon the results of the prior 2009/2010 and 2018/2019 projects at this general location. In addition to well defined grain size distribution analyses, the percentage carbonate material as well as fines were computed for each composite sample over depth. A brief report of findings as well as all data, photographs of cores, core logs, GDS curves, etc. are included as **Appendix A** to this report.

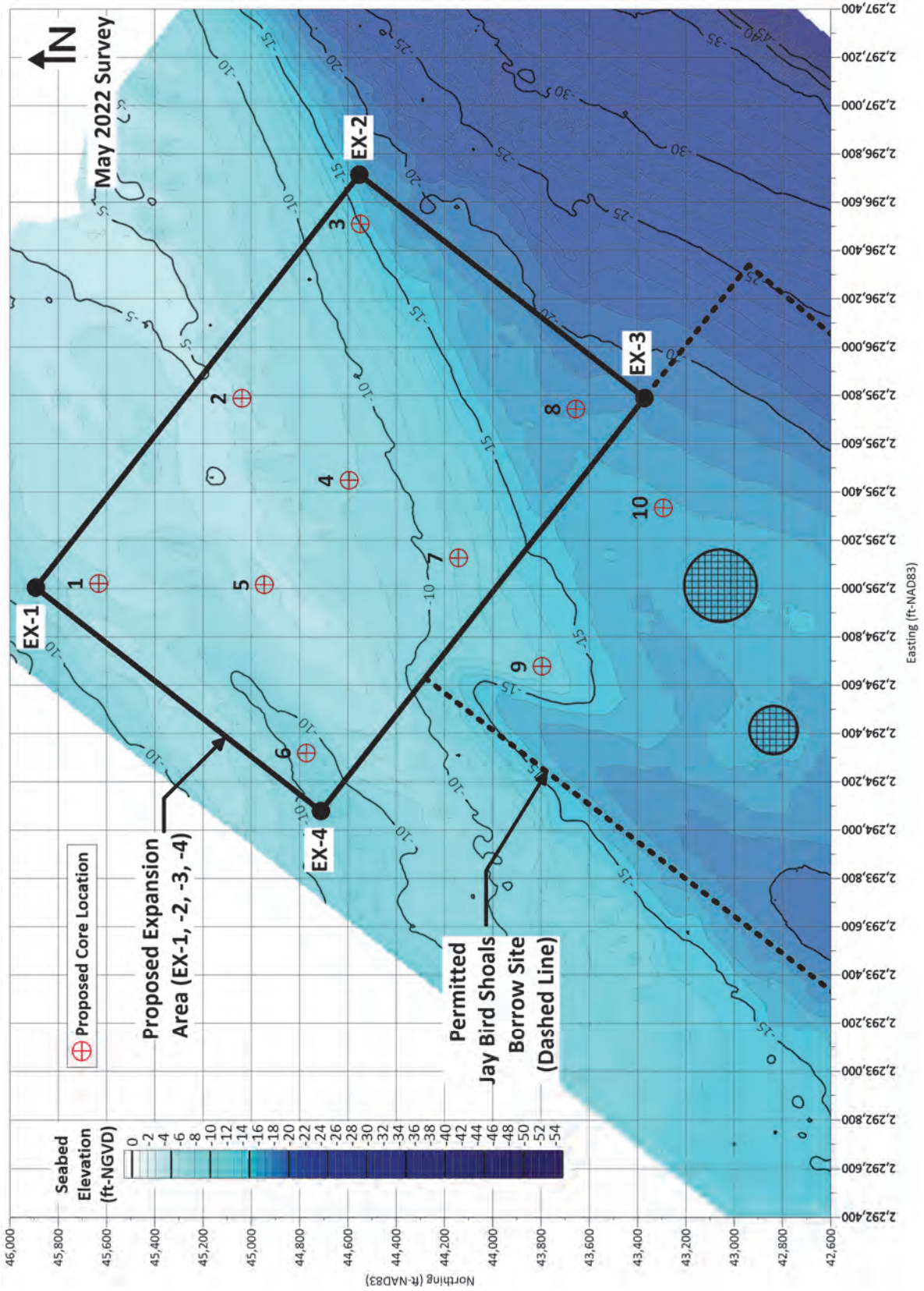


Figure 7: Jay Bird Shoals proposed expansion area and core locations.

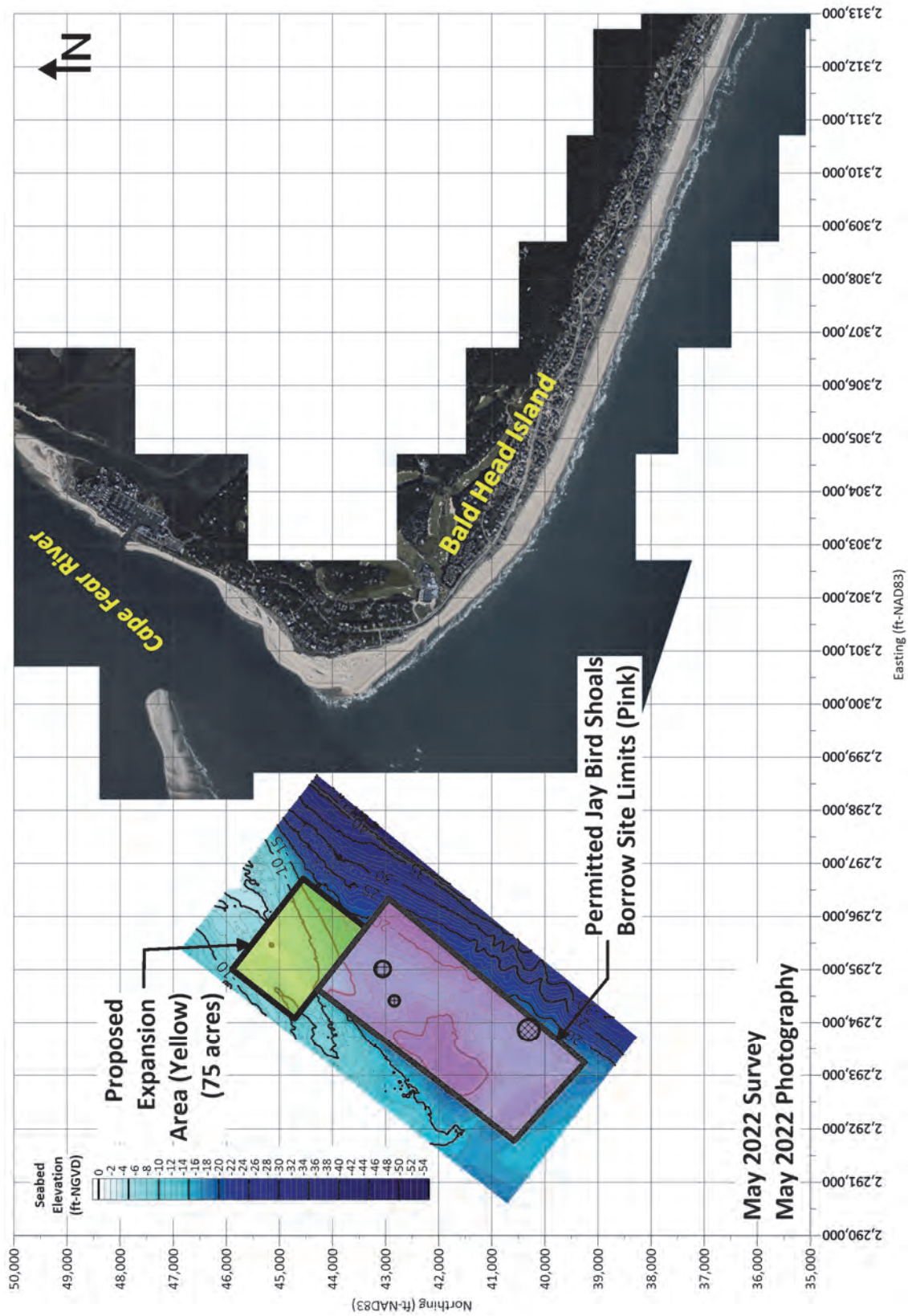


Figure 8: Proposed borrow area expansion.

Simplistically, the expansion area material considered for future placement on South Beach (above elevation -24 ft NGVD29) is predominately fine sand classified as being predominately SP. For the cores acquired within the proposed dredged area (only), the average mean grain size is .27 mm. Carbonate percentages from the composite samples ranged from 6.0% to 19.8% with an average of 9.6%. In general, the fine grained content (based upon a no. 230 sieve averaged 2.6% for all the composite samples. A summary of size and content characteristics for the eight (8) cores is included as **Table 1**. A separate summary of average values is included for all ten (10) cores taken -- although core numbers 9 and 10 are not within the original area of intended excavation.

Table 1. Expansion Area – 2022 Vibracore Sediment Characterization
Size Classification (% by Wt.)

Core No.	Gravel	Granular	Sand	Fines	CaCO3%
JBS 2022-01	.3	.7	97.2	1.8	6.9
JBS 2022-02	.8	.7	96.5	2.1	9.3
JBS 2022-03	0	.1	97.9	2.0	6.0
JBS 2022-04	0	0	97.1	2.9	7.5
JBS 2022-05	.7	.4	96.7	2.2	9.5
JBS 2022-06	.6	.8	92.8	5.8	10.2
JBS 2022-07	0	0	97.5	2.5	7.7
JBS 2022-08	1.6	3.2	93.6	1.6	19.8
JBS 2022-09	0	.3	92.4	7.3	8.5
JBS 2022-10	4.0	1.8	92.6	1.6	14.8
AVERAGE VALUE (1-8)	.5	.4	96.2	2.6	9.6
AVERAGE VALUES (1-10)	.8	.8	95.4	3.	10.0

Definition:

- Gravel: 4.76mm – 76mm
- Granular: 2mm – less than 4.76mm
- Sand: .0625mm – less than 2 mm
- Fines: Less than .0625mm

As previously well documented, it is important to understand that there are no relevant “native beach” characteristics for South Beach since it has been the recipient of the placement of over 11.5 Mcy of sediment (most from the W.H. Navigation Project channel) since 2000. In reality, the only undisturbed native beach existing on Bald Head is East Beach which faces Onslow Bay. This was recognized by the State in 2007 when the Jay Bird Shoals borrow site was first developed. Accordingly, the Village was directed to compare the borrow site characteristics to those of a limited number of composite cross-shore sediment samples for South Beach and East Beach. The latter exercise was basically for “science” – since East Beach is *not* a proposed fill area.

Standards for the determination of compatibility of borrow site material, as compared to the recipient (i.e. native) beach, are specifically defined by the State of N.C. The latter address the four (4) size classifications as well as percentage composition of calcium carbonate. Accordingly, **Table 2.** describes the sediment composition averages and grand means for both the recipient beach (measured 3 ways), as well as the eight cores representing the proposed borrow site expansion area. From these statistics, compatibility of the sediments to be borrowed can be determined.

Table 2. Sediment Characterization for Compatibility Analysis
Size Classification
(% by Wt.)

Composite Sample	Gravel	Granular	Sand	Fines	Carbonate
Expansion Area – 8 Cores	.5	.4	96.2	2.6	9.6
East Beach Composite	.37	1.37	97.75	.42	9.67%
South Beach Composite	.07	1.08	98.10	.75	7.57%
EB & SB Mean	.22	1.23	97.93	.59	8.41%

(Ref: Olsen Associates, Inc. – August 2017)

For the currently analyzed JBS expansion area being proposed for excavation, the following criteria are established by the State of N.C. for purposes of determining “compatibility” of the borrow sediments relative to those of the recipient beach:

- a) The average percentage (by weight) of *fine* grained sediment (less than 0.0625mm) shall not exceed the average percentage (by weight) of fine grained sediment of the recipient beach characterization by five (5%) percent.

- Determination

• Borrow Site Av	2.6%
• Recipient Beach	
▪ SB Mean	.75%
▪ EB Mean	.42%
▪ Grand Mean for all transects	.59%

- **Result – Borrow site material complies with standard.**

- b) The average percentage (by weight) of *granular* sediment (greater than 2mm and less than 4.76mm) in the borrow site shall not exceed the average percentage (by weight) of coarse-sand sediment of the recipient beach characterization plus five (5%) percent.

- Determination

• Borrow Site Av	.4%
• Recipient Beach	
▪ SB Mean	1.08%
▪ EB Mean	1.37%
▪ Grand Mean for all transects	1.23%

- **Result – Borrow site material complies with standard.**

- c) The average percentage (by weight) of *gravel* (greater than or equal to 4.76mm) in the borrow site shall not exceed the average percentage (by weight) of gravel-sized sediment of the recipient beach characterization plus five (5%) percent.

- Determination

• Borrow Site Av	.5%
• Recipient Beach	
▪ SB Mean	.07%

- EB Mean .37%
- Grand Mean for all transects .22%

• **Result – Borrow site material complies with standard**

d) The average percentage (by weight) of *calcium carbonate* in the borrow site shall not exceed the average percentage (by weight) of calcium carbonate sediment of the recipient beach characterization plus fifteen (15%) percent.

▪ Determination

- Borrow Site Av 9.6%
- Recipient Beach
 - SB Mean 7.57%
 - EB Mean 9.67%
 - Grand Mean for all transects 8.41%

▪ **Result – Borrow site material complies with standard.**

SUBMERGED CULTURAL RESOURCE INVESTIGATION

In order to determine the proposed borrow site expansion project’s effects on potentially significant submerged cultural resources, OAI contracted with Tidewater Atlantic Research, Inc. (TAR) of Washington, North Carolina to conduct a magnitude and acoustic survey. The remote-sensing investigation conducted by TAR archaeologists was designed to provide accurate and reliable identification, assessment and documentation of submerged cultural resources in the study area. A copy of the TAR report in its entirety is included as **Appendix B** to this document.

Field research for the project was conducted on 31 August 2022 and 1 September 2022. The survey was carried out with both magnetic and acoustic remote-sending equipment. Analysis of the JBS survey data identified a total of 26 magnetic anomalies (see **Figure 9**). Analysis of the data indicates that a cluster of four anomalies have collective signature characteristics that could represent historic vessel remains. Because JBS has a high potential for historically significant shipwrecks, those four anomalies are buffered and recommended for avoidance -- or additional investigation if the avoidance buffer could be impacted or if anomaly identification is desirable to allow dredging.

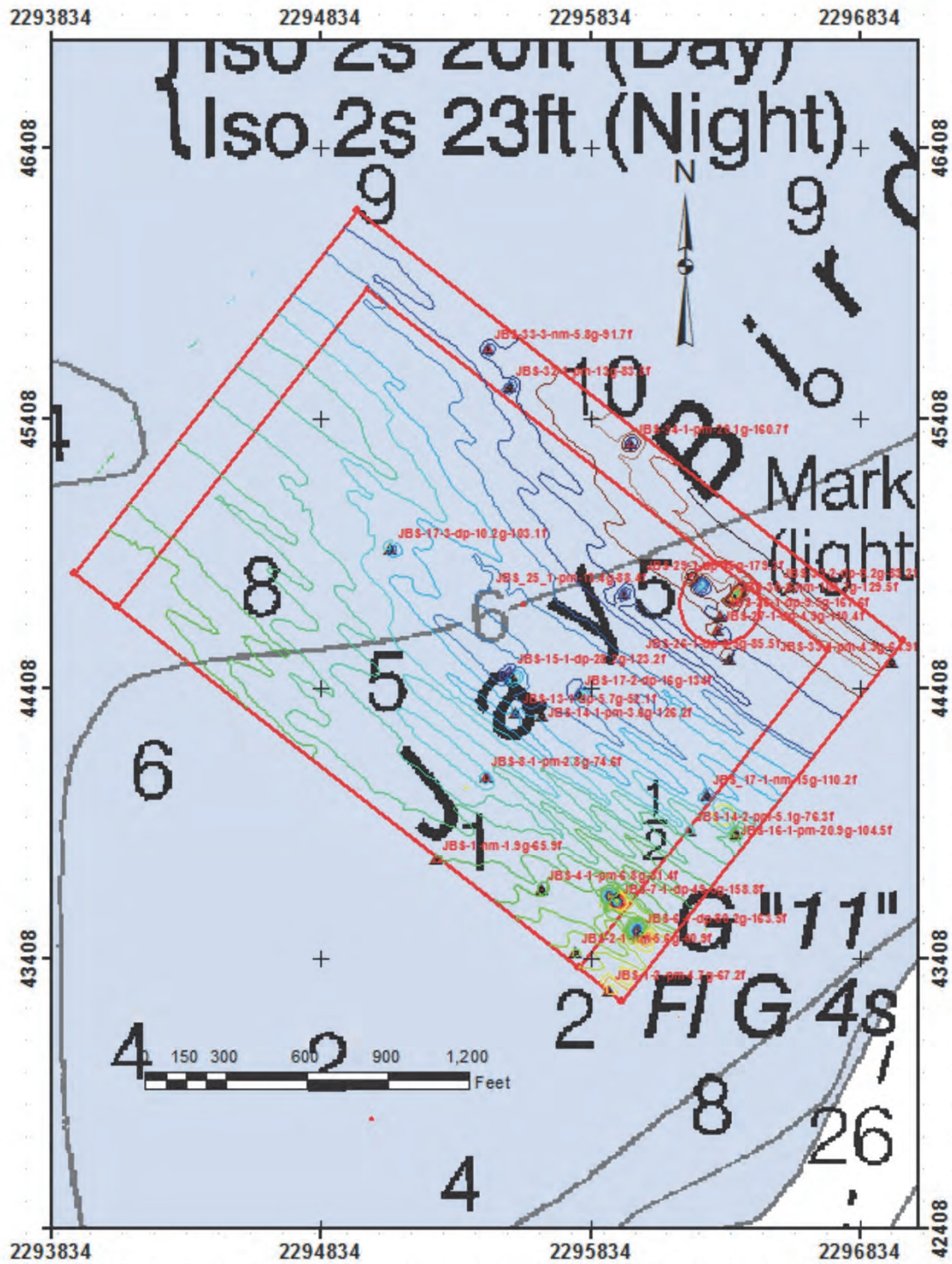


Figure 9: Survey area magnetic contours, anomalies, and avoidance buffer.

Nine of the remaining 22 anomalies are located in the 200-foot perimeter buffer which is hereby adopted by the project engineer. One magnetic anomaly is located outside the survey area. The 12 unbuffered anomalies inside the borrow area are not considered to be potentially significant. Those anomalies appear to be generated by modern debris such as fish and crab traps, pipes, small diameter rods, cable, wire rope, chain, small boat anchors, and possibly ordinance associated with fortifications on Bald Head Island (BHI) and Oak Island. None of the magnetic anomalies had an associated acoustic signature.

Analysis of the sidescan sonar data identified only one acoustic target. The signature for that target represents a linear object on the bottom surface. No magnetic anomaly is associated with the target. It likely represents a piling or navigation reference dayboard. Analysis of the sub-bottom profiler data identified no geological features or targets associated with the magnetic anomalies.

As graphically depicted by **Figure 9**, the limits of the archaeological survey extended 200 ft. (min) beyond the original 75 A expansion area limits demarcated by OAI. To that end, no anomalies were noted along the northwestern segment of the 200 ft. buffer area and only a few minor anomalies were mapped along a portion of the northeastern segment of the survey. Hence, OAI coordinated with TAR to expand the originally proposed borrow area dimensions by approximately 200 ft. and 100 ft. respectively in those two areas. It was the project engineer's opinion that by allowing dredging to occur in such areas with a greater depth of sediment – it would reduce the need for the dredge company to excavate the area closest to the navigation channel where a higher density of unknown (albeit minor) magnetic anomalies were detected. The principal investigator for TAR, Dr. Gordon Watts agreed with the project engineer's assessment in this regard. Accordingly, the originally proposed 75 A borrow site (**Figure 7**) was revised as shown in **Figure 10**. Both Federal and State permit applications will be based upon this final expansion area footprint which now encompasses 72.8 A.

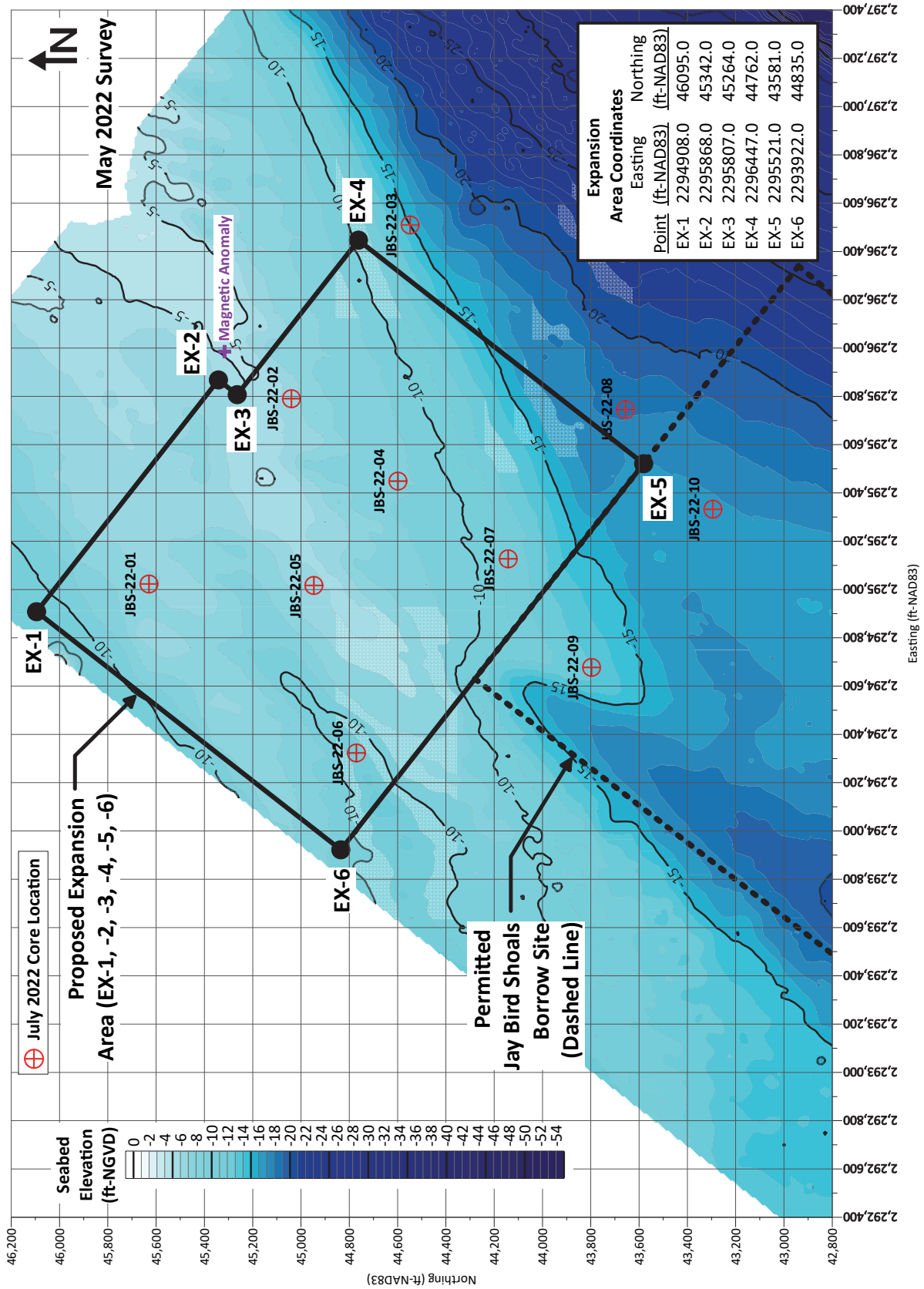


Figure 10: Jaybird Shoals expansion area and core locations.

CONCLUSIONS/RECOMMENDATIONS

It is recommended that the Village of Bald Head Island seek a modification of CAMA 91-14 and USACE No. SAW-2012-00040 sufficient to expand a portion of a previously developed borrow site located at Jay Bird Shoals. The intended project volume required is estimated at 1 Mcy, mol. All sand would be placed on the two ends of S. Beach. The proposed timing of the work would be between 1 November and 1 April of the following year. Work would be performed by a cutter suction dredge with direct deposit on S. Beach by pipeline. It is anticipated that a submerged pipeline can cross the federal navigation project without the need for burial, *i.e.* seabed placement below the authorized channel depth of -44ft. MLW.

As discussed herein, the footprint of the 72.8 A expansion area was slightly revised to minimize direct or indirect impacts to potential cultural resources. Prior dredging projects at Jay Bird Shoals had done similarly based upon marine archaeological investigations by Tidewater Atlantic Research, Inc. (TAR, 2007). Permits for a subject 1 Mcy, mol “placement volume” (measured in place), will seek a borrow site design depth of -22 ft. NGVD29, with a conventional 2 ft. overdepth “tolerance”. Direct placement of hydraulic fill on South Beach will be by pipeline utilizing a 24”-30” cutter suction dredge. Although the permitted area is 72.8 A, the design plans will encourage most excavation to occur along the northwesternmost portion of the site so as to reduce the actual acreage of seabed disturbed.

Based upon prior numerical modeling investigations of various Jay Bird Shoals borrow site configurations (Olsen Associates, Inc., 2007b and Olsen Associates, Inc., Feb. 2013), it is the project engineer’s opinion that the expansion of the Jay Bird Shoals discussed herein will not result in any meaningful changes to the areawide Wave Climate or littoral transport rates or patterns.

REFERENCES

Land Management Group, Inc. (2013). “*Fourth Annual Biological Monitoring Report*”, Report prepared for Village of Bald Head Island. Land Management Group, Inc., 3805 Wrightsville Avenue, Suite 15, Wilmington, NC 28403. 11 pp plus tables, figures and app. (June 2013).

Meisburger, E.P., 1977. “*Sand Resources on the Inner Continental Shelf of the Cape Fear Region, N.C.*,” U.S. Army Corps of Engineers, CERC, Ft. Belvoir, VA, Misc. Report No. 77-1.

Olsen Associates, Inc. (2007a). “Bald Head Island, N.C., “*Beach Restoration Project – Sand Search Investigation*”. Olsen Associates, Inc., 2618 Herschel Street, Jacksonville, FL 32204. 40 pp plus app. (June 2007).

Olsen Associates, Inc. (2007b). “Bald Head Island, N.C., “*Beach Restoration Project – Analysis of Potential Impacts of Borrow Site to the Local Wave Climate*”. Olsen Associates, Inc., 2618 Herschel Street, Jacksonville, FL 32204. 34 pp plus app. (December 2007).

Olsen Associates, Inc. (2013). “*Analysis of Potential Impacts to Wave Climate from Dredging the Offshore Borrow Area at Jay Bird Shoals, N.C.*” Olsen Associates, Inc., 2618 Herschel Street, Jacksonville, FL 32204. 26 pp plus app. (February 11, 2013).

Olsen Associates, Inc. (2016). “Bald Head Island, N.C., “*Frying Pan Shoals, Sand Search Investigation*”, Report prepared for Village of Bald Head Island. Olsen Associates, Inc., 2618 Herschel Street, Jacksonville, FL 32204. 38 pp plus app. (April 2016).

Olsen Associates, Inc. (August 2017). “Bald Head Island, N.C., “*Jay Bird Shoals – Borrow Site Re-Evaluation*”, Report prepared for Village of Bald Head Island. Olsen Associates, Inc., 2618 Herschel Street, Jacksonville, FL 32204.

Olsen Associates, Inc. (August 2022). “Bald Head Island, N.C., “*Beach Monitoring Program Report No. 20 (May 2021 – April 2022)*”, Report prepared for Village of Bald Head Island. Olsen Associates, Inc., 2618 Herschel Street, Jacksonville, FL 32204.

Tidewater Atlantic Research, Inc. (2007). “An Archaeological Remote Sensing Survey and Target Assessment on Jay Bird Shoal off Smith Island Channel, Cape Fear River, Brunswick, County, North Carolina.” Tidewater Atlantic Research, Inc., P.O. Box 2494, Washington, NC 27889. 41 pp plus app (17 October 2022).

APPENDIX A

Geotechnical Vibracore Report
Jay Bird Shoals, Bald Head Island

By

Athena Technologies, Inc.

September, 2022



GEOTECHNICAL VIBRACORE REPORT

2022 GEOTECHNICAL INVESTIGATION JAY BIRD SHOALS BORROW AREA EXPANSION BRUNSWICK COUNTY, NORTH CAROLINA

September 2022

Prepared for:

Olsen Associates, Inc.
2618 Herschel Street
Jacksonville, FL 32204

Prepared by:

Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458



GEOTECHNICAL VIBRACORE REPORT

2022 GEOTECHNICAL INVESTIGATION JAY BIRD SHOALS BORROW AREA EXPANSION BRUNSWICK COUNTY, NORTH CAROLINA

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Appendix B:	Grain Size Distribution Data
Appendix C:	Grain Size Data Summary Graphs

Section 1: Introduction

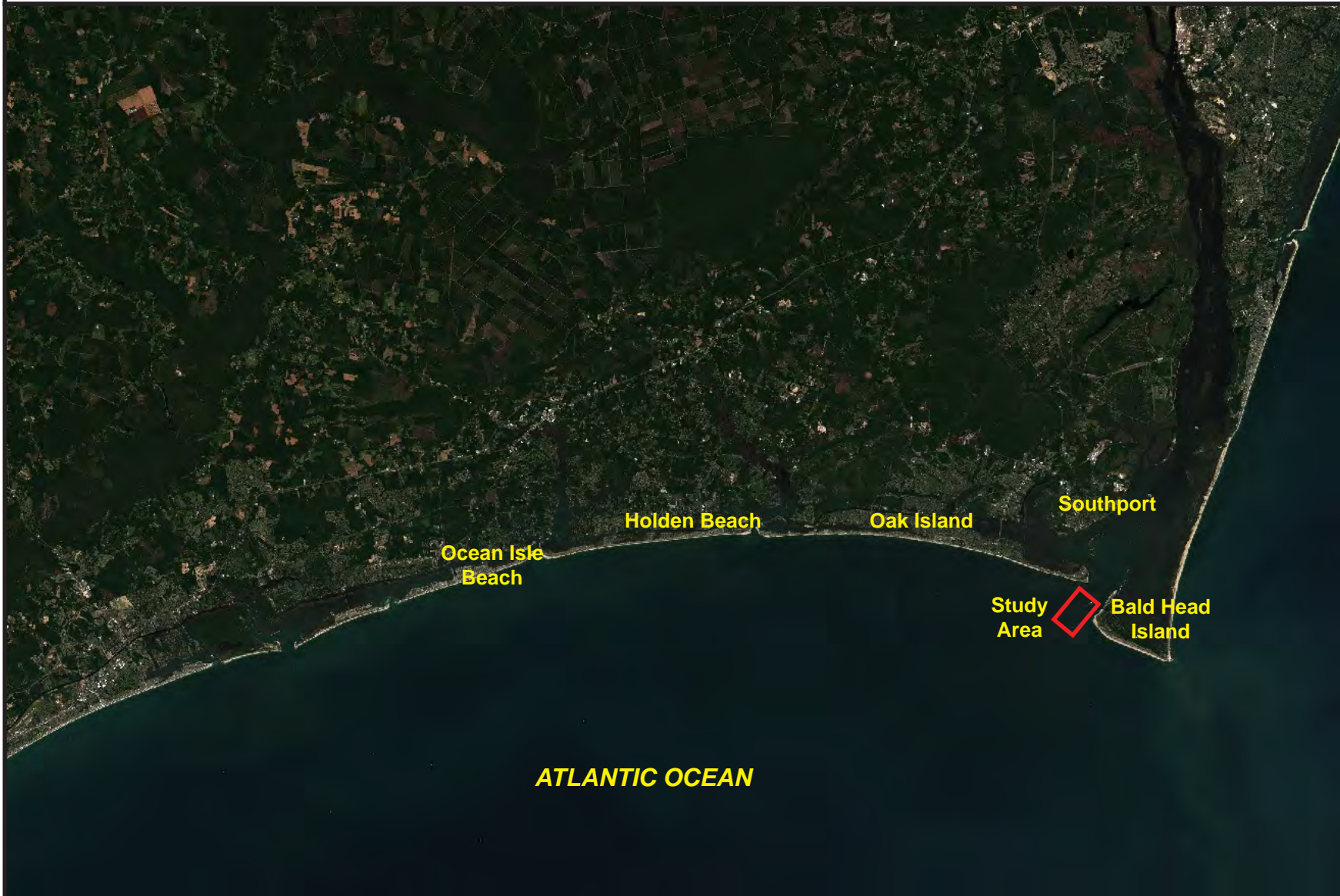
Athena Technologies, Inc. (Athena) was contracted by Olsen Associates, Inc. (OAI) of Jacksonville, Florida to collect geotechnical vibracore samples in the vicinity of Jay Bird Shoals, which is located west of Bald Head Island in Brunswick County, North Carolina (**Figure 1**). The scope of the project included the collection of 10 geotechnical vibracores. Two of the vibracores were positioned in the existing permitted borrow site at Jay Bird Shoals, and the remaining 8 vibracores were located in a proposed expansion area. The scope of services also included geological logging, core photography, vibracore sub-sampling, contracting laboratory analyses, and geotechnical reporting. Vibracore sampling was conducted in July 2022; a summary of the vibracore collection methodology and findings of the geotechnical investigation are presented below.

Section 2: Methodology

Athena utilized the 35-foot research vessel, *Artemis*, to act as the sampling platform for this project. *Artemis* was equipped with all required US Coast Guard (USCG) safety gear and was operated by a USCG-certified, 100 Ton Master Captain. A Trimble Differential Global Positioning System (sub-meter accuracy) interfaced with HYPACK was utilized for primary navigation. Horizontal coordinates were recorded in North American Datum of 1983 State Plane Coordinate System, North Carolina (Zone 3200), U.S. Survey Feet. Real-time tide elevation data was obtained using a Champion TKO Global Navigation Satellite System receiver interfaced with the North Carolina Continuously Operating Reference Station Network, which served as the base station.

During field operations, *Artemis* was immobilized over the desired sample sites (provided by OAI) using a triple-point anchor system. Once on station, the coordinates at the vessel location were compared with the coordinates for the desired sample location to ensure accurate vessel positioning. Upon satisfactory positioning, a water depth was collected via lead line or fathometer and final horizontal coordinates were recorded at each station. Tide elevation data were also recorded in the field and were referenced to North American Vertical Datum of 1988. Elevation data were subsequently converted to National Geodetic Vertical Datum of 1929 (NGVD 29) using the National Oceanic and Atmospheric Administration's (NOAA) VDatum software program (Version 4.4.2). A summary of the data conversion has been included as **Table 1**. The tide elevation data was utilized to determine the sediment surface elevation at each sample location.

FIGURE 1: Study Area Location Map 2022 Geotechnical Investigation, Jay Bird Shoals Borrow Area Expansion, Brunswick County, North Carolina



NOTES:

- Vibracores were collected in July 2022


 VIBRACORE STUDY AREA



IMAGE SOURCE:
Sentinel 2
ESA

Athena Technologies, Inc.
PO Box 68
McClellanville, SC 29458
843-887-3844

A custom-designed and fabricated vibracore system was utilized to collect the geotechnical cores. The system consists of a generator with a mechanical vibrator attached via cable. The vibrator is attached directly to a 3-inch diameter, galvanized sample barrel. The sample barrel was lowered until the bottom of the barrel was directly above the sediment surface. The vibracore machine was turned on and the sample barrel was allowed to penetrate to a depth of -24 feet NGVD 29, or to refusal. Vibracore penetration was recorded from the deck using marked drill stems. Once the sample barrel reached the desired depth, the machine was turned off and the sample barrel was retrieved using an electric winch. The recovered core length was measured following core retrieval, and percent recovery was verified. The cores were then capped, labeled, and cut into 5-foot sections. A vibracore summary table containing final location coordinates, elevation data, and penetration and recovery lengths has been included as **Table 2**, and a vibracore location map has been included as **Figure 2**.

The completed cores were opened longitudinally at Athena's core processing facility in McClellanville, South Carolina. The cores were photographed after opening and were logged by Athena's geologist in accordance with protocol outlined in ASTM D 2488 and ASTM D 2487. Draft core logs and photo-mosaic images of the cores were provided to OAI for selection of sediment sub-sample intervals. Upon receipt of sub-sample selections from OAI, Athena extracted and shipped the sub-samples to Terracon Consultants, Inc. (Terracon) in Jacksonville, Florida. Terracon is a USACE-certified geotechnical laboratory. One composite sub-sample and 2 discrete sub-samples were collected from each core. The sub-samples were analyzed for grain size distribution in accordance with ASTM D 6913 using the following sieve sizes: 3/4 in., 5/8 in., 7/16 in., 5/16 in., No. 3.5, No. 4, No. 5, No. 7, No. 10, No. 14, No. 18, No. 25, No. 35, No. 45, No. 60, No. 80, No. 120, No. 170, No. 200, and No. 230. Visual estimation of shell content was also conducted on all sub-samples using the Terry and Chilingar method (1955), and the composite samples were analyzed for carbonate content using the Twenhofel and Tyler acid digestion method (1941). Vibracore logs were developed using gINT (Version 8.2), and laboratory analytical data were incorporated into the gINT project file for statistical evaluation. A tabular summary of grain size data is presented in **Table 3**. Core photographs and logs have been included in **Appendix A**, and grain size distribution curves and granulometric reports have been included as **Appendix B**. Graphs depicting percent accessory components (i.e., carbonate, gravel, silt/clay, etc.) and grain size distribution parameters (e.g., mean grain size, percent passing the No. 230 sieve, etc.) have been included as **Appendix C**.

**FIGURE 2: Vibracore Location Map
2022 Geotechnical Investigation,
Jay Bird Shoals Borrow Area Expansion,
Brunswick County, North Carolina**



NOTES:

- Vibracores were collected in July 2022
- Station prefix "JBS-22-" removed for clarity.

 **PROPOSED EXPANSION AREA**

 **VIBRACORE LOCATION**




0 1000 2000

Feet

IMAGE SOURCE:
GoogleEarth

Athena Technologies, Inc.
PO Box 68
McClellanville, SC 29458
843-887-3844

Section 3: Discussion

The vibracore study area (depicted on **Figure 1**) is located approximately 1 mile to the west of Bald Head Island, near the entrance to the Cape Fear River. More specifically, the vibracores were positioned southwest of the aerially exposed portion of Jay Bird Shoals, which is located northwest of the federal navigation channel entering the Cape Fear River. The mean tidal range at the study area is approximately 4.5 feet, and tidal current velocities in the channel adjacent to the study area range from 0.5 to greater than 1.5 knots during peak tidal exchange periods (National Oceanic and Atmospheric Administration).

Sediment surface elevations ranged from -6.3 to -17.7 feet NGVD 29 at sample locations in the study area. Vibracore penetration depths ranged from 10.0 feet to 19.3 feet below sediment surface and recovered core depths ranged from -19.9 to -27.5 feet NGVD 29. Upon review of the data set, the cores can generally be grouped according to water depths and energy regimes from which they were collected around the study area; shallow, intermediate, and deep sample locations. Observations regarding each grouping of cores is presented below.

Shallow Cores (JBS-22-01, -02, -05, and -06)

- Sediment surface elevations ranged from -7 to -11 feet NGVD 29.
- Cores were generally characterized by a dominance of fine-grained quartz sand with minimal silt/clay-sized constituents in the analyzed composite intervals. Silt/clay-lined burrow traces were also commonly observed in these cores.
- The average mean grain size from composite sub-samples from these cores was 0.26 millimeters (mm), while the average carbonate content percentage was 9.0%.
- The average percentage of fine-grained constituents (i.e., silt and/or clay-sized material) was 2.96%.

Intermediate Cores (JBS-22-03, -04, -07 and -09)

- Sediment surface elevations ranged from -10 to -15 feet NGVD 29.
- Tidally influenced bedding characteristics, as evidenced by the presence of interbedded quartz sand and fine-grained silt/clay, were noted below a surficial fine-grained sand interval. The depth at which the fine-grained tidal bedding was first encountered in the cores ranged from approximately -17 to -23 feet NGVD 29.
- The average mean grain size in composite sub-samples from these cores was 0.17 mm, while the average carbonate content percentage was 7.4%.
- The average percentage of fine-grained constituents was 3.67% and there was negligible amounts of gravel and granule-sized constituents in the sub-samples.
- Although a majority of these cores terminated in sandy intervals (USCS = SP), core JBS-22-07 terminated in a fat clay (USCS = CH) interval greater than 3 feet in thickness. The CH interval was encountered at a depth of approximately -24' NGVD 29, though smaller CH and clayey sand (USCS = SC) intervals were first noted at approximately -21 feet NGVD 29 in that core.

Deep Cores (JBS-22-08 and -10)

- Cores JBS-22-08 and -10 were located in deepest water depths where sediment surface elevations were below -17' NGVD 29.
- These cores were dominated by fine to medium-grained quartz sand with relatively high percentages of shell content.
- Composite sub-samples from those cores reported the highest mean grain size and highest percentages of carbonate content, gravel-sized constituents and granule-sized constituents among all the cores. The average carbonate content from composite samples from the 2 locations was 17.3% and average mean grain size was 0.48 mm.

- The average percentage of fine-grained was 1.61%; very little fine-grained tidal bedding was observed in these cores.
- The coarser-grained sediment characteristics in these 2 cores is likely due to the fact that they were positioned closest to the high current velocities in the main navigation channel.

Discussion Regarding Laboratory Analyses

It should be noted that hydrometer analysis was not conducted on the fine-grained fraction of the sub-samples. As a result, the relative percentages of silt- and clay-sized particles in each sub-sample was not established. In response, the laboratory assigned a default designation of “silt” and a liquid limit of greater than 50% to all material passing the No. 200 sieve. Lacking sufficient laboratory data to differentiate between silt- and clay-sized particles, the USCS classification assigned by Athena’s geologist took precedence, when a discrepancy was noted between the laboratory USCS designation and the USCS designation in the associated core log.

Section 4: References

ASTM D 2487-11, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM International, West Conshohocken, PA. 2011.

ASTM D 2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), ASTM International, West Conshohocken, PA. 2000.

ASTM D 6913-04, Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis, ASTM International, West Conshohocken, PA. 2004.

National Oceanic and Atmospheric Administration, Center for Operational Oceanographic Products and Services, Station ID: 8658901 Bald Head Island, Cape Fear River, NC. Accessed on 30 August 2022. Obtained from:
<https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=8658901>

National Oceanic and Atmospheric Administration, Center for Operational Oceanographic Products and Services, Station ID: CFR1626 Bald Head Shoal. Accessed on 30 August 2022. Obtained from:
<https://tidesandcurrents.noaa.gov/noaacurrents/Predictions?id=CFR1626>.

Terry, R. D. and Chilingar, C. V., Summary of "Concerning some additional aids in studying sedimentary formations" by M. S. Shvetsov. *Journal of Sedimentary Petrology*, v. 25, pp. 214-229. 1955.

Twenhofel, W.H. and Tyler S.A., *Methods of Study of Sediments*, McGraw-Hill, New York, p. 183. 1941.

TABLES



1293 Graham Farm Road, PO Box 68
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(843) 887-3800
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TABLE 1 - Elevation Data Conversion Summary
Olsen Associates, Inc.
2022 Geotechnical Investigation
Jay Bird Shoals Borrow Area Expansion
Brunswick County, North Carolina

Station ID	Data Conversion Input Parameters ^[1]			Data Conversion Output Parameters ^[2]		
	East (x)	North (y)	Elevation (ft NAVD 88)	Latitude	Longitude	Elevation (ft NGVD 29)
JBS-22-01	45628.13	2295027.53	1.66	33.871222	-78.028523	2.81
JBS-22-02	45037.75	2295796.15	1.27	33.869579	-78.026010	2.42
JBS-22-03	44547.99	2296515.45	-0.52	33.868214	-78.023657	0.63
JBS-22-04	44598.57	2295455.88	-1.26	33.868381	-78.027145	-0.11
JBS-22-05	44945.79	2295026.10	3.38	33.869347	-78.028549	4.53
JBS-22-06	44768.94	2294325.98	-1.06	33.868880	-78.030861	0.09
JBS-22-07	44140.78	2295131.85	-2.35	33.867132	-78.028227	-1.20
JBS-22-08	43656.45	2295748.75	-2.23	33.865785	-78.026211	-1.08
JBS-22-09	43797.80	2294681.54	-2.67	33.866202	-78.029721	-1.52
JBS-22-10	43297.10	2295334.73	-2.27	33.864809	-78.027585	-1.12
Notes	[1] = Horizontal coordinates were recorded in the field and were referenced to North American Datum of 1983, State Plane Coordinate System, North Carolina (Zone 3200), US Survey Feet. Elevation data were also collected in the field using a Spectra SP80 Global Navigation Satellite System receiver interfaced with the North Carolina Continuously Operating Reference Station network, and were referenced to North American Vertical Datum of 1988.					
	[2] = Coordinate and elevation conversion performed by the National Oceanic and Atmospheric Administration's Vertical Datum Online Transformation Tool (VDatum) software, Version 4.4.2					
	ft NAVD 88 = Feet relative to North American Vertical Datum of 1988					
	ft NGVD 29 = Feet relative to National Geodetic Vertical Datum of 1929					

TABLE 2 - Geotechnical Vibracore Summary
Olsen Associates, Inc.
2022 Geotechnical Investigation
Jay Bird Shoals Borrow Area Expansion
Brunswick County, North Carolina

Boring ID	Collection Date	Time	East (x)	North (y)	Water Depth (ft)	Tide Elevation (ft NGVD 29)	Sediment Surface Elevation (ft NGVD 29)	Bottom Elevation of Recovered Core (ft NGVD 29)	Penetration (ft)	Recovery (ft)	Notes
JBS-22-01	7/11/2022	16:11	2295022.79	45629.44	11.4	2.8	-8.6	-24.1	17.2	15.5	
JBS-22-02	7/11/2022	15:21	2295790.28	45039.62	9.5	2.4	-7.1	-23.9	19.3	16.8	
JBS-22-03	7/11/2022	14:28	2296509.99	44548.06	15.2	0.6	-14.6	-27.5	15.2	12.9	
JBS-22-04	7/11/2022	13:54	2295448.97	44598.66	9.5	-0.1	-9.6	-24.9	18.0	15.3	
JBS-22-05	7/11/2022	17:00	2295016.76	44946.78	10.8	4.5	-6.3	-19.9	16.9	13.6	Made 3 coring attempts; surging waves and excessive boat movement resulted in unsafe conditions and bent sample barrel, we accessed the location at high tide because conditions were too shallow at lower parts of the tidal cycle; 3rd core retained for processing and location abandoned.
JBS-22-06	7/11/2022	13:14	2294323.07	44770.52	11.4	0.1	-11.3	-26.1	17.8	14.8	
JBS-22-07	7/11/2022	12:45	2295127.02	44141.92	11.5	-1.2	-12.7	-27.0	16.2	14.3	
JBS-22-08	7/11/2022	11:54	2295744.80	43655.87	16.5	-1.1	-17.6	-25.7	10.0	8.1	
JBS-22-09	7/11/2022	11:31	2294677.37	43796.77	11.4	-1.5	-12.9	-27.0	16.0	14.1	
JBS-22-10	7/11/2022	10:45	2295332.62	43294.35	16.6	-1.1	-17.7	-26.4	10.3	8.7	
Notes	ft = feet										
	NGVD 29 = National Geodetic Vertical Datum of 1929										

TABLE 3 - Grain Size Data Summary
Olsen Associates, Inc.
2022 Geotechnical Investigation
Jay Bird Shoals Borrow Area Expansion
Brunswick County, North Carolina

Boring ID	Sample ID	Sample Interval		Laboratory USCS Classification	Percent Gravel-Sized Fraction ^[1]	Percent Granule-Sized Fraction ^[2]	Percent Sand-Sized Fraction ^[3]	Percent Fine-Grained Fraction ^[4]	Visual Percent Shell ^[5]	Percent Carbonate ^[6]	Mean Grain Size ^[7] (mm)	Grain Size Diameter				
		Depth Interval (ft bss)	Depth Interval (ft NGVD 29)									D 90 (mm)	D 85 (mm)	D 50 (mm)	D 15 (mm)	D 10 (mm)
JBS-22-01	C1	0 to 15.4	-8.6 to -24.0	SP	0.29	0.72	97.17	1.83	4	6.9	0.24	0.50	0.36	0.21	0.14	0.13
	S1	5.1	-13.7	SP	0.16	0.04	98.31	1.49	11	N/A	0.22	0.38	0.33	0.20	0.14	0.13
	S2	10.3	-18.9	SP	0.11	0.85	97.80	1.24	4	N/A	0.23	0.41	0.33	0.20	0.14	0.13
JBS-22-02	C1	0 to 16.8	-7.1 to -23.9	SP	0.75	0.66	96.54	2.05	11	9.3	0.26	0.69	0.50	0.21	0.14	0.13
	S1	5.6	-12.7	SP	0.04	0.12	98.50	1.35	4	N/A	0.22	0.36	0.32	0.20	0.14	0.14
	S2	11.2	-18.3	SP	0.00	0.09	96.15	3.75	3	N/A	0.19	0.30	0.26	0.18	0.13	0.13
JBS-22-03	C1	0 to 9.4	-14.6 to -24.0	SP	0.00	0.08	97.88	2.04	2	6.0	0.16	0.23	0.21	0.16	0.13	0.11
	S1	3.1	-17.7	SP	0.00	0.18	97.90	1.93	6	N/A	0.18	0.24	0.23	0.17	0.13	0.13
	S2	6.3	-20.9	SP	0.00	0.00	97.60	2.40	6	N/A	0.16	0.23	0.21	0.15	0.13	0.11
JBS-22-04	C1	0 to 7.4	-9.6 to -17.0	SP	0.00	0.02	97.10	2.88	4	7.5	0.19	0.31	0.26	0.17	0.13	0.11
	S1	4.8	-14.4	SP	0.00	0.09	98.00	1.91	1	N/A	0.19	0.28	0.25	0.18	0.13	0.13
	S2	9.6	-19.2	SP-SM	0.00	0.05	92.93	7.01	0	N/A	0.16	0.23	0.22	0.15	0.12	0.10
JBS-22-05	C1	0 to 13.6	-6.3 to -19.9	SP	0.66	0.42	96.74	2.17	13	9.5	0.28	0.69	0.56	0.23	0.15	0.14
	S1	4.5	-10.8	SP	0.05	0.32	97.51	2.12	10	N/A	0.22	0.37	0.32	0.20	0.14	0.13
	S2	9.1	-15.4	SP	0.00	0.37	98.54	1.09	18	N/A	0.42	0.99	0.88	0.42	0.19	0.17
JBS-22-06	C1	0 to 12.7	-11.3 to -24.0	SP-SM	0.56	0.83	92.84	5.77	5	10.2	0.26	0.71	0.53	0.20	0.13	0.11
	S1	4.2	-15.5	SP	0.03	0.41	98.08	1.49	3	N/A	0.26	0.49	0.41	0.24	0.15	0.14
	S2	8.5	-19.8	SP	0.15	0.41	98.52	0.92	2	N/A	0.18	0.28	0.24	0.16	0.13	0.13
JBS-22-07	C1	0 to 7.3	-12.7 to -20.0	SP	0.00	0.04	97.50	2.46	4	7.7	0.18	0.29	0.25	0.17	0.13	0.11
	S1	2.4	-15.1	SP	0.00	0.05	98.69	1.26	2	N/A	0.18	0.27	0.24	0.17	0.13	0.13
	S2	4.9	-17.6	SP	0.00	0.11	97.35	2.53	3	N/A	0.16	0.26	0.23	0.15	0.11	0.10
JBS-22-08	C1	0 to 6.4	-17.6 to -24.0	SP	1.64	3.18	93.57	1.60	15	19.8	0.55	1.40	1.21	0.61	0.19	0.16
	S1	2.1	-19.7	SP	6.58	7.61	85.05	0.75	26	N/A	0.90	3.04	1.93	0.80	0.39	0.33
	S2	4.3	-21.9	SP	1.01	5.44	93.30	0.25	24	N/A	0.85	1.77	1.50	0.87	0.45	0.37

TABLE 3 - Grain Size Data Summary
Olsen Associates, Inc.
2022 Geotechnical Investigation
Jay Bird Shoals Borrow Area Expansion
Brunswick County, North Carolina

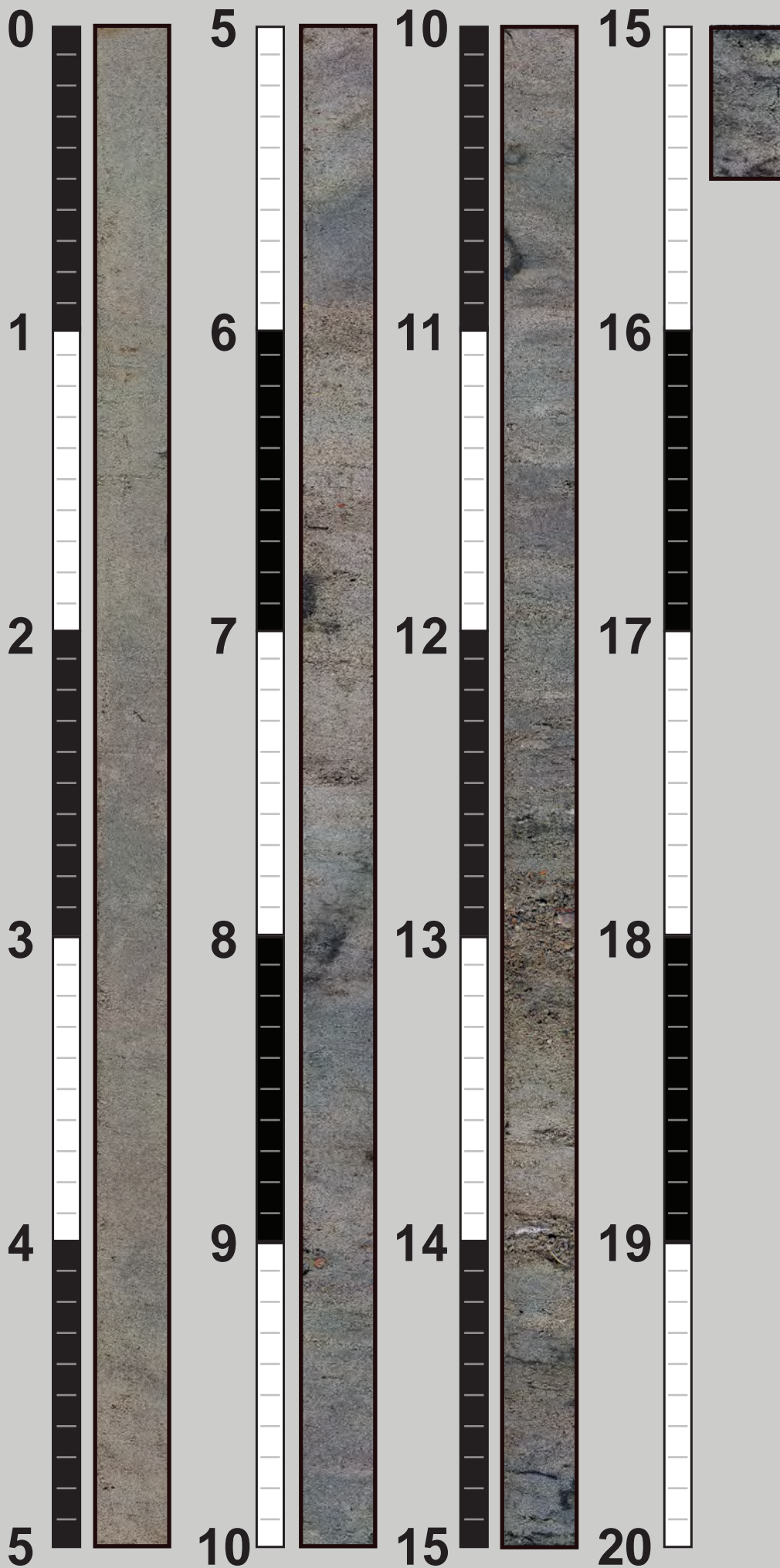
Boring ID	Sample ID	Sample Interval		Laboratory USCS Classification	Percent Gravel-Sized Fraction ^[1]	Percent Granule-Sized Fraction ^[2]	Percent Sand-Sized Fraction ^[3]	Percent Fine-Grained Fraction ^[4]	Visual Percent Shell ^[5]	Percent Carbonate ^[6]	Mean Grain Size ^[7] (mm)	Grain Size Diameter				
		Depth Interval (ft bss)	Depth Interval (ft NGVD 29)									D 90 (mm)	D 85 (mm)	D 50 (mm)	D 15 (mm)	D 10 (mm)
JBS-22-09	C1	0 to 11.1	-12.9 to -24.0	SP-SM	0.04	0.31	92.35	7.30	9	8.5	0.16	0.23	0.21	0.15	0.10	0.09
	S1	3.7	-16.6	SP	0.00	0.14	97.68	2.18	4	N/A	0.17	0.23	0.22	0.16	0.13	0.13
	S2	7.4	-20.3	SP-SM	0.00	0.32	89.70	9.99	2	N/A	0.15	0.20	0.18	0.14	0.10	0.06
JBS-22-10	C1	0 to 6.3	-17.7 to -24.0	SP	4.01	1.83	92.55	1.61	12	14.8	0.42	1.24	0.94	0.36	0.15	0.14
	S1	2.1	-19.8	SP	0.37	0.95	97.56	1.12	7	N/A	0.26	0.69	0.53	0.21	0.15	0.14
	S2	4.2	-21.9	SP	0.00	0.08	98.94	0.98	8	N/A	0.40	0.70	0.64	0.40	0.25	0.21
Notes	ft bss = feet below sediment surface															
	ft NGVD 29 = feet relative to National Geodetic Vertical Datum of 1929															
	USCS = Unified Soil Classification System															
	[1] = Defined as the sample fraction which is greater than or equal to 4.76 millimeters (i.e., retained on sieve sizes greater than or equal to the Number 4 sieve).															
	[2] = Defined as the sample fraction which is greater than or equal to 2 millimeters and less than 4.76 millimeters (i.e., retained on sieve sizes between the Number 5 and Number 10 sieves).															
	[3] = Defined as the sample fraction which is greater than or equal to 0.0625 millimeters and less than 2 millimeters (i.e., retained on sieve sizes between the Number 12 and Number 230 sieves).															
	[4] = Defined as the sample fraction which is less than 0.0625 millimeters (i.e., passes the Number 230 sieve).															
	[5] = Visual percent shell determined using the Terry and Chilingar method (1955).															
	[6] = Percent carbonate determined using the Tyler and Twenhofel acid digestion method (1941).															
[7] = Mean grain size was calculated in gINT using the Moment Method.																
mm = millimeters																
N/A = Not analyzed																

APPENDIX A

Core Photographs and Logs



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Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-01

**Top Elev. (ft NAVD88): -8.6
Bottom Elev. (ft NAVD88): -24.1**

Notes:

- Photo Mosaic Image
- Photo Scale in Feet



Athena Technologies, Inc.
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McClellanville, SC 29458
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(843) 887-3800

Boring Designation JBS-22-01

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 2 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-01		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,295,023 Y = 45,629		HORIZONTAL NAD 1983	VERTICAL NGVD 29	
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES	DISTURBED 1	UNDISTURBED (UD) 2
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		DEG. FROM VERTICAL	BEARING	
6. THICKNESS OF OVERBURDEN 0.0 Ft.		14. WATER DEPTH 11.4 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING	STARTED 07-11-22 16:11	COMPLETED 07-11-22
8. TOTAL DEPTH OF BORING 17.2 Ft.		16. ELEVATION TOP OF BORING -8.6 Ft.		
		17. TOTAL RECOVERY FOR BORING 15.5 Ft.		
		18. SIGNATURE AND TITLE OF INSPECTOR Adam Freeze		

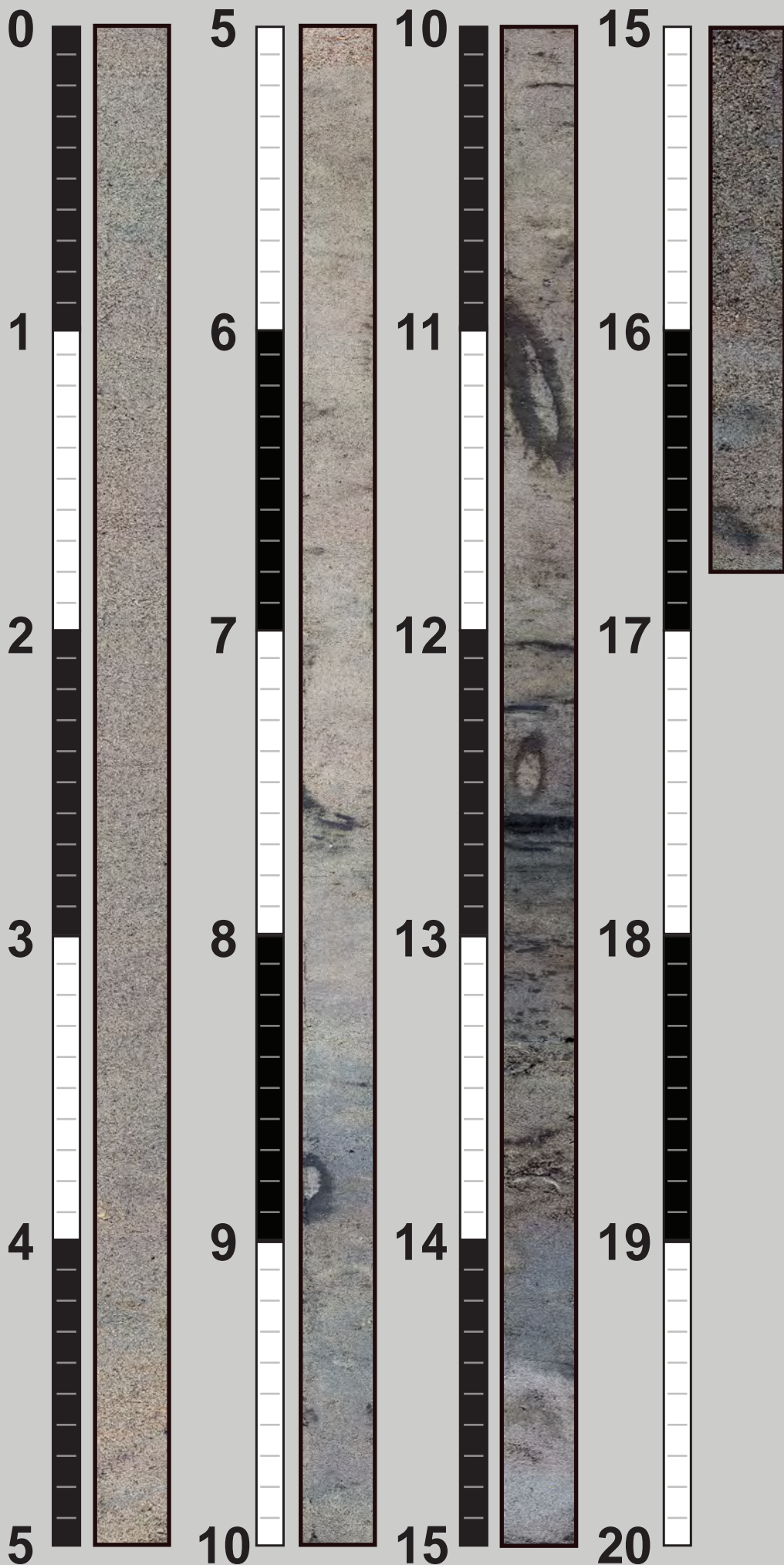
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-8.6	0.0					
			Poorly graded SAND; fine to medium quartz sand, trace fine to medium sand-sized shells in matrix occasional fine gravel-sized shells below 5.0', loose, subangular, gray (2.5Y-6/1), (SP).			
-14.5	5.9				S1	Sample #S1, Depth = 5.1' (SP), Mean (mm): 0.22, Phi Sorting: 0.66 Shell: 11% Fines (#230) - 1.49
-15.8	7.2				C1	Sample #C1, Depth = 0.0' - 15.4' (SP), Mean (mm): 0.24, Phi Sorting: 0.85 Shell: 4% Carbonate: 6.9% Fines (#230) - 1.82
			Poorly graded SAND; fine grading to fine to medium quartz sand, trace inorganic clay in occasional burrows, clay-lined burrow trace at 10.7-10.9', trace fine to coarse sand-sized shells in matrix & in layers below 10.9', loose, subangular, gray (2.5Y-6/1), (SP).		S2	Sample #S2, Depth = 10.3' (SP), Mean (mm): 0.23, Phi Sorting: 0.79 Shell: 4% Fines (#230) - 1.25

FLORIDA DEP ROSS OAI JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).G.F.J. FL DEP ROSS.GDT 8/31/22

DRILLING LOG (Cont. Sheet)			INSTALLATION		SHEET 2 OF 2 SHEETS	
PROJECT Jay Bird Shoals Borrow Area Expansion			COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	VERTICAL NGVD 29
LOCATION COORDINATES X = 2,295,023 Y = 45,629			ELEVATION TOP OF BORING -8.6 Ft.			
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-21.5	12.9				C1	
-22.8	14.2		Poorly graded SAND; medium quartz sand, few fine sand to coarse gravel-sized shells in matrix & in layer at base, loose, subangular, grayish brown (2.5Y-5/2), (SP).			
-23.6	15.0		Poorly graded SAND; fine to medium quartz sand, trace fine to coarse sand-sized shells in matrix, trace inorganic clay in occasional burrows & flaser beds, loose, subangular, grayish brown (2.5Y-5/2) grades to, gray (2.5Y-5/1), (SP).			
-24.1	15.5		Poorly graded SAND; fine quartz sand, trace inorganic/organic clay in matrix, burrows & laminations, trace fine to coarse sand-sized shells, loose, subangular, olive gray (5Y-4/2), (SP).			
			End of Boring			

FLORIDA DEP ROSS OAI - JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS GDT 8/31/22

15
20
25



Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-02

**Top Elev. (ft NAVD88): -7.1
Bottom Elev. (ft NAVD88): -23.9**

Notes:
- Photo Mosaic Image
- Photo Scale in Feet



Athena Technologies, Inc.
1293 Graham Farm Road
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(843) 887-3800

Boring Designation JBS-22-02

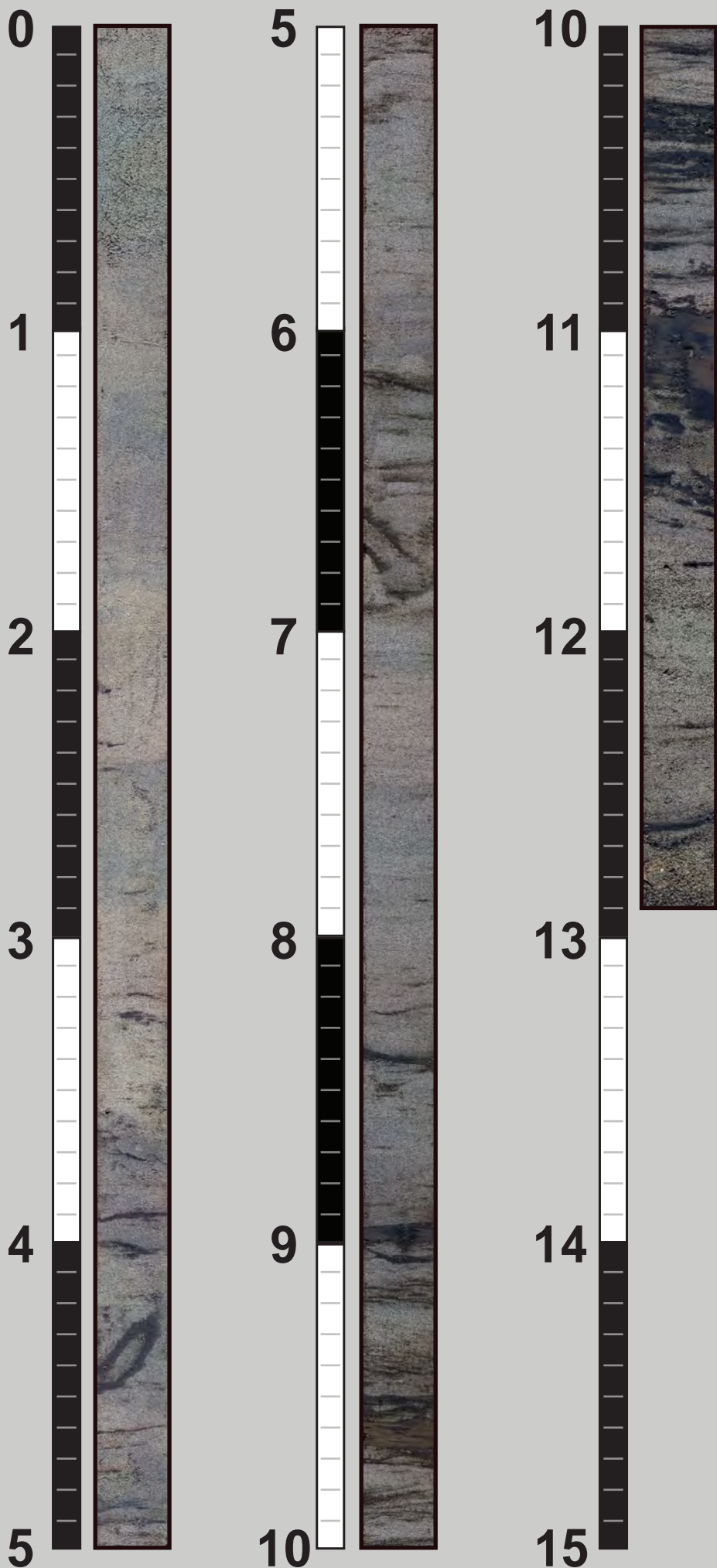
DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 2 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-02		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,295,790 Y = 45,040		HORIZONTAL NAD 1983	VERTICAL NGVD 29	
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES	DISTURBED 1	UNDISTURBED (UD) 2
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		DEG. FROM VERTICAL	BEARING	
6. THICKNESS OF OVERBURDEN 0.0 Ft.		14. WATER DEPTH 9.5 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING	STARTED 07-11-22 15:21	COMPLETED 07-11-22
8. TOTAL DEPTH OF BORING 19.3 Ft.		16. ELEVATION TOP OF BORING -7.1 Ft.		
		17. TOTAL RECOVERY FOR BORING 16.8 Ft.		
		18. SIGNATURE AND TITLE OF INSPECTOR Adam Freeze		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-7.1	0.0					
-12.3	5.2		Poorly graded SAND; fine to medium quartz sand, few fine to coarse sand-sized shells in matrix, occasional fine gravel-sized shells, loose, subangular, olive gray (5Y-5/2), (SP).			
-19.3	12.2		Poorly graded SAND; fine quartz sand, trace inorganic clay in burrows, clay-lined Callianassa major burrow traces at 8.7-8.9' & 10.8-11.5', trace fine to coarse sand-sized shells, loose, subangular, light brownish gray (2.5Y-6/2), (SP).		S1	Sample #S1, Depth = 5.6' (SP), Mean (mm): 0.22, Phi Sorting: 0.67 Shell: 4% Fines (#230) - 1.34
					C1	Sample #C1, Depth = 0.0' - 16.8' (SP), Mean (mm): 0.26, Phi Sorting: 1.01 Shell: 11% Carbonate: 9.3% Fines (#230) - 2.05
					S2	Sample #S2, Depth = 11.2' (SP), Mean (mm): 0.19, Phi Sorting: 0.56 Shell: 3% Fines (#230) - 3.76

FLORIDA DEP ROSS OAI JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).G.F.J. FL DEP ROSS.GDT 8/31/22

DRILLING LOG (Cont. Sheet)			INSTALLATION		SHEET 2 OF 2 SHEETS	
PROJECT Jay Bird Shoals Borrow Area Expansion			Village Of Bald Head Island			
LOCATION COORDINATES X = 2,295,790 Y = 45,040			COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	VERTICAL NGVD 29
			ELEVATION TOP OF BORING -7.1 Ft.			
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-20.4	13.3	[Pattern]	Poorly graded SAND; fine quartz sand, trace inorganic clay in burrows & laminations, clay-lined Callianassa major burrow trace at 12.3-12.6', organic silt present at 12.6', trace fine to medium sand-sized shells, notable mica, loose, subangular, dark gray (5Y-4/1), (SP). <i>(continued)</i>		C1	
-20.9	13.8					
-22.1	15.0		Poorly graded SAND; fine to medium quartz sand, few fine sand to coarse gravel-sized shells, trace inorganic clay in laminations, loose, subangular, olive gray (5Y-5/2), (SP).			
-23.9	16.8		Poorly graded SAND; fine quartz sand, trace fine to coarse sand-sized shells, loose, subangular, notable mica, gray (5Y-5/1) grades to, gray (5Y-6/1), (SP). Poorly graded SAND; medium quartz sand, few fine sand to fine gravel-sized shells in matrix, trace inorganic clay in burrow at base, loose, subangular, grayish brown (2.5Y-5/2), (SP).			
End of Boring						

FLORIDA DEP ROSS OAI - JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).G.F.J. FL DEP ROSS GDT 8/31/22



Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-03

**Top Elev. (ft NAVD88): -14.6
Bottom Elev. (ft NAVD88): -27.5**

Notes:
- Photo Mosaic Image
- Photo Scale in Feet



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
www.athenatechnologies.com
(843) 887-3800

Boring Designation JBS-22-03

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 2 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		10. COORDINATE SYSTEM/DATUM NC State Plane
2. BORING DESIGNATION JBS-22-03		LOCATION COORDINATES X = 2,296,510 Y = 44,548		HORIZONTAL NAD 1983 VERTICAL NGVD 29
3. DRILLING AGENCY Athena Technologies, Inc.		CONTRACTOR FILE NO.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER
4. NAME OF DRILLER P. McClellan		12. TOTAL SAMPLES 1		DISTURBED 1 UNDISTURBED (UD) 2
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		DEG. FROM VERTICAL		BEARING
6. THICKNESS OF OVERBURDEN 0.0 Ft.		13. TOTAL NUMBER CORE BOXES		14. WATER DEPTH 15.2 Ft.
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING		STARTED 07-11-22 14:28 COMPLETED 07-11-22
8. TOTAL DEPTH OF BORING 15.2 Ft.		16. ELEVATION TOP OF BORING -14.6 Ft.		17. TOTAL RECOVERY FOR BORING 12.9 Ft.
		18. SIGNATURE AND TITLE OF INSPECTOR Adam Freeze		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-14.6	0.0					
-18.2	3.6		Poorly graded SAND; fine quartz sand, trace inorganic/organic clay in occasional burrows, trace fine sand-sized shells, notable mica, loose, subangular, olive gray (5Y-5/2), (SP).		S1	Sample #S1, Depth = 3.1' (SP), Mean (mm): 0.18, Phi Sorting: 0.43 Shell: 6% Fines (#230) - 1.91
-23.5	8.9		Poorly graded SAND; fine quartz sand, trace inorganic/organic clay in burrows & laminations, clay-lined Callianassa major burrow traces at 4.2-4.5' & 6.6-6.8', notable mica, loose, subangular, olive gray (5Y-5/2) and, very dark grayish brown (2.5Y-3/2), (SP).		C1	Sample #C1, Depth = 0.0' - 9.4' (SP), Mean (mm): 0.16, Phi Sorting: 0.39 Shell: 2% Carbonate: 6.0% Fines (#230) - 2.05
-25.5	10.9		Poorly graded SAND; fine quartz sand interbedded with inorganic/organic clay in laminations & layers, trace fine sand-sized shells, loose, subangular, olive gray (5Y-5/2) and, dark olive gray (5Y-3/2), (SP-SC).		S2	Sample #S2, Depth = 6.3' (SP), Mean (mm): 0.16, Phi Sorting: 0.37 Shell: 6% Fines (#230) - 2.41
-25.9	11.3		Clayey SAND; fine quartz sand, some inorganic/organic clay, clean sand in burrows, loose/soft, very dark grayish brown (2.5Y-3/2), (SC).			

FLORIDA DEP ROSS OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS GDT, 8/31/22

DRILLING LOG (Cont. Sheet)			INSTALLATION		SHEET 2 OF 2 SHEETS	
PROJECT Jay Bird Shoals Borrow Area Expansion			COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	VERTICAL NGVD 29
LOCATION COORDINATES X = 2,296,510 Y = 44,548			ELEVATION TOP OF BORING -14.6 Ft.			
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-27.5	12.9		Poorly graded SAND; fine to medium quartz sand, trace fine sand to fine gravel-sized shells, trace inorganic/organic clay in burrows & in lamination at 12.6', coarse gravel-sized shell at 12.8', loose, subangular, grayish brown (2.5Y-5/2), (SP). (continued)			
			End of Boring			

FLORIDA DEP ROSS OAI - JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), G.P.J. FL DEP ROSS GDT 8/31/22

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Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-04

**Top Elev. (ft NAVD88): -9.6
Bottom Elev. (ft NAVD88): -24.9**

Notes:

- Photo Mosaic Image
- Photo Scale in Feet



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Boring Designation JBS-22-04

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 2 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-04		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,295,449 Y = 44,599		HORIZONTAL NAD 1983	VERTICAL NGVD 29	
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES	DISTURBED 1	UNDISTURBED (UD) 2
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		DEG. FROM VERTICAL	BEARING	
6. THICKNESS OF OVERBURDEN 0.0 Ft.		14. WATER DEPTH 9.5 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING	STARTED 07-11-22 13:54	COMPLETED 07-11-22
8. TOTAL DEPTH OF BORING 18.0 Ft.		16. ELEVATION TOP OF BORING -9.6 Ft.		
		17. TOTAL RECOVERY FOR BORING 15.3 Ft.		
		18. SIGNATURE AND TITLE OF INSPECTOR Adam Freeze		

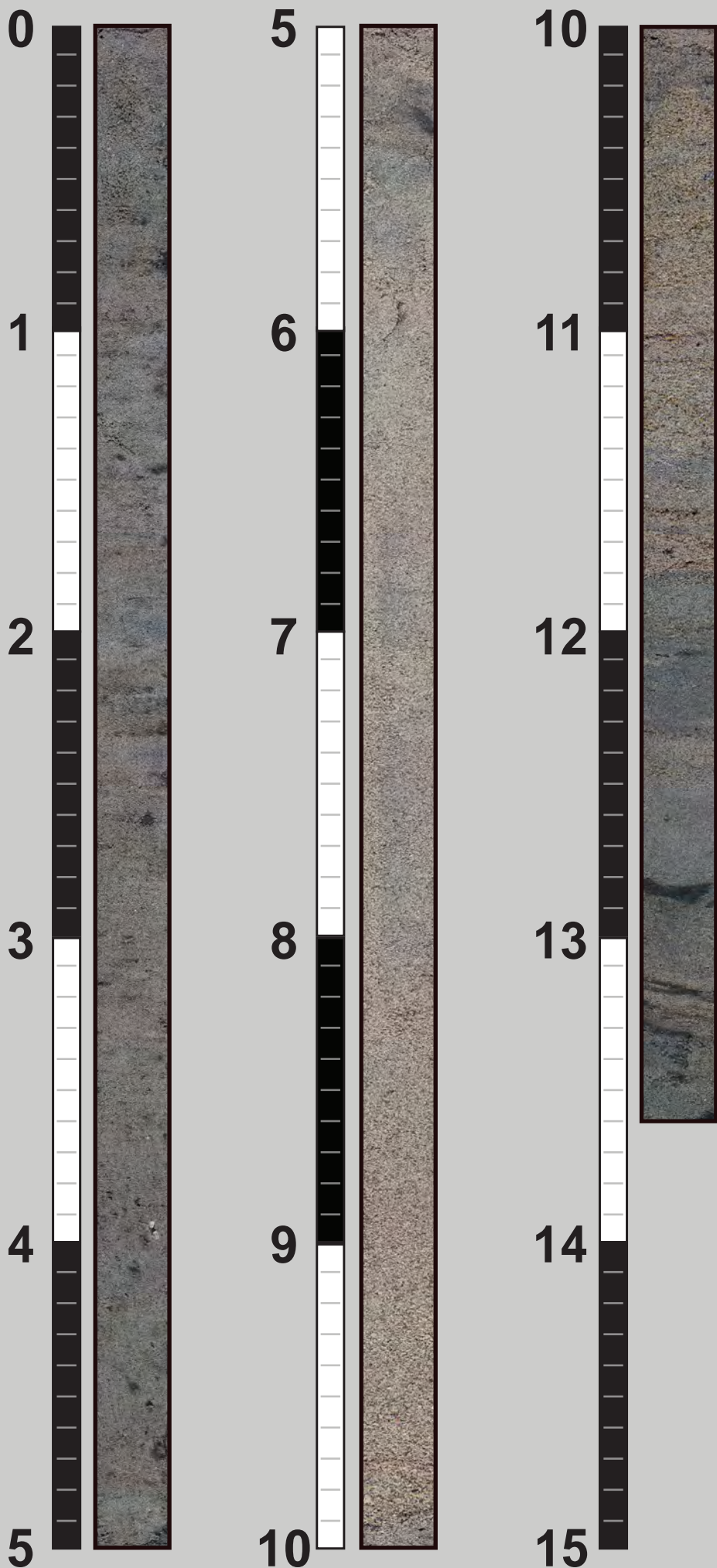
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-9.6	0.0					
-11.5	1.9		Poorly graded SAND; fine quartz sand, trace fine to medium sand-sized shells in matrix, loose, subangular, gray (2.5Y-6/1), (SP).			
-15.2	5.6		Poorly graded SAND; fine to medium grading to fine quartz sand, trace inorganic clay in burrows, trace fine to coarse sand-sized shells in matrix & in layer at top, occasional fine gravel-sized shells to 2.4', loose, subangular, grayish brown (2.5Y-5/2), (SP).		C1	Sample #C1, Depth = 0.0' - 7.4' (SP), Mean (mm): 0.19, Phi Sorting: 0.62 Shell: 4% Carbonate: 7.5% Fines (#230) - 2.88
-16.9	7.3		Poorly graded SAND; fine quartz sand, trace inorganic/organic clay in flaser beds, laminations & layers, notable mica, loose, subangular, olive gray (5Y-5/2) grades to, olive gray (5Y-4/2), (SP).		S1	Sample #S1, Depth = 4.8' (SP), Mean (mm): 0.19, Phi Sorting: 0.48 Shell: 1% Fines (#230) - 1.93
-17.7	8.1		Clayey SAND; fine quartz sand, little inorganic/organic clay, clean sand in burrows, loose/soft, very dark gray (2.5Y-3/1), (SC).			
-20.6	11.0		Poorly graded SAND with clay; fine quartz sand, few inorganic/organic clay in matrix, burrows, laminations & in layers below 10.1', sand grain size increases slightly below 10.4', loose, subangular, olive gray (5Y-4/2) and, very dark grayish brown (2.5Y-3/2), (SP-SC).		S2	Sample #S2, Depth = 9.6' (SP-SM), Mean (mm): 0.16, Phi Sorting: 0.40 Shell: 0% Fines (#230) - 7.01
			Poorly graded SAND; medium quartz sand, few fine to coarse sand-sized shells in matrix, loose, subangular, grayish brown (2.5Y-5/2), (SP).			

FLORIDA DEP ROSS OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS GDT, 8/31/22

DRILLING LOG (Cont. Sheet)			INSTALLATION		SHEET 2 OF 2 SHEETS	
PROJECT Jay Bird Shoals Borrow Area Expansion			Village Of Bald Head Island			
LOCATION COORDINATES X = 2,295,449 Y = 44,599			COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	VERTICAL NGVD 29
			ELEVATION TOP OF BORING -9.6 Ft.			
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-22.4	12.8		Poorly graded SAND; fine to medium quartz sand, trace inorganic/organic clay in layer at top, trace fine to medium sand-sized shells, loose, subangular, gray (2.5Y-5/1) and, black (2.5Y-2.5/1), (SP).			
-23.1	13.5		Sandy fat CLAY; little fine quartz sand in matrix & laminations, medium plasticity, soft, possibly OH, black (2.5Y-2.5/1), (CH).			
-23.4	13.8		Poorly graded SAND; medium grading to fine quartz sand, trace inorganic clay in occasional burrows, fine to coarse sand-sized shells, loose, subangular, gray (2.5Y-5/1), (SP).			
-24.9	15.3					
End of Boring						

FLORIDA DEP ROSS OAI - JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).G.F.J. FL DEP ROSS.GDT 8/31/22

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Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-05

**Top Elev. (ft NAVD88): -6.3
Bottom Elev. (ft NAVD88): -19.9**

Notes:
- Photo Mosaic Image
- Photo Scale in Feet



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Boring Designation JBS-22-05

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 2 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-05		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,295,017 Y = 44,947		HORIZONTAL NAD 1983	VERTICAL NGVD 29	
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES	DISTURBED 1	UNDISTURBED (UD) 2
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		DEG. FROM VERTICAL	BEARING	
6. THICKNESS OF OVERBURDEN 0.0 Ft.		14. WATER DEPTH 10.8 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING	STARTED 07-11-22 17:00	COMPLETED 07-11-22
8. TOTAL DEPTH OF BORING 16.9 Ft.		16. ELEVATION TOP OF BORING -6.3 Ft.		
		17. TOTAL RECOVERY FOR BORING 13.6 Ft.		
		18. SIGNATURE AND TITLE OF INSPECTOR Adam Freeze		

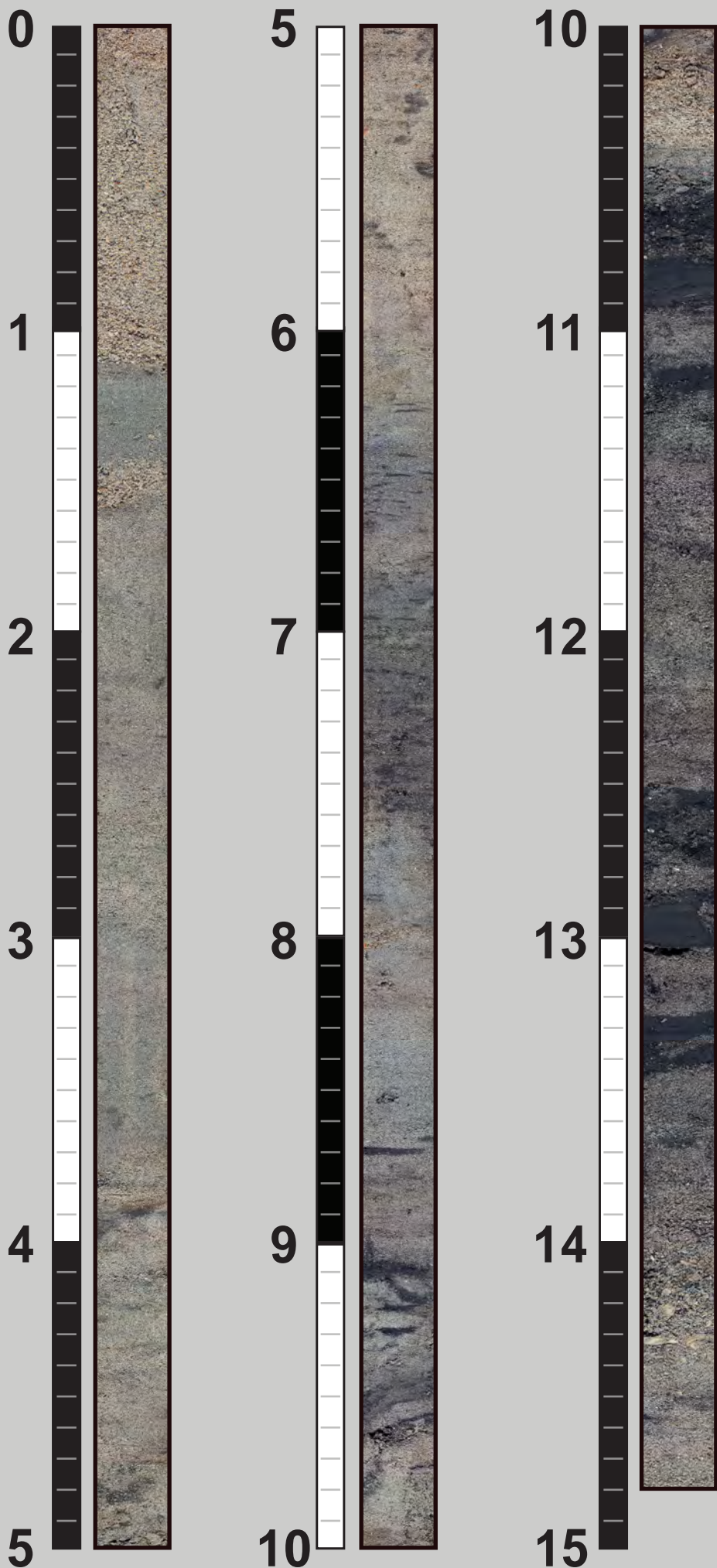
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-6.3	0.0					
-11.7	5.4		Poorly graded SAND; fine quartz sand, trace inorganic clay in burrows, trace fine to coarse sand-sized shells in matrix, occasional fine gravel-sized shells, loose, subangular, olive gray (5Y-5/2), (SP).		S1	Sample #S1, Depth = 4.5' (SP), Mean (mm): 0.22, Phi Sorting: 0.73 Shell: 10% Fines (#230) - 2.13
-18.2	11.9		Poorly graded SAND; fine grading to medium quartz sand, few fine to medium sand-sized shells in matrix, occasional fine gravel-sized shells, shell % increases with depth, loose, subangular, light olive gray (5Y-6/2) grades to, light brownish gray (2.5Y-6/2), (SP).		C1	Sample #C1, Depth = 0.0' - 13.6' (SP), Mean (mm): 0.28, Phi Sorting: 0.97 Shell: 13% Carbonate: 9.5% Fines (#230) - 2.17
			Poorly graded SAND; fine quartz sand, trace inorganic clay in occasional burrows, trace		S2	Sample #S2, Depth = 9.1' (SP), Mean (mm): 0.42, Phi Sorting: 0.96 Shell: 18% Fines (#230) - 1.09

FLORIDA DEP ROSS OAI - JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ - FL DEP ROSS.GDT 8/31/22

DRILLING LOG (Cont. Sheet)			INSTALLATION		SHEET 2 OF 2 SHEETS	
PROJECT Jay Bird Shoals Borrow Area Expansion			Village Of Bald Head Island			
LOCATION COORDINATES X = 2,295,017 Y = 44,947			COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	VERTICAL NGVD 29
			ELEVATION TOP OF BORING -6.3 Ft.			
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-19.1	12.8	[Pattern]	fine to coarse sand-sized shells, loose, subangular, light olive gray (5Y-6/2), (SP). <i>(continued)</i>		C1	
-19.9	13.6		Poorly graded SAND; fine quartz sand, trace inorganic clay in burrows, laminations & in layer at top, trace fine to medium sand-sized shells, loose, subangular, olive gray (5Y-5/2), (SP).			
			End of Boring			

FLORIDA DEP ROSS OAI - JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).G.P.J. FL DEP ROSS.GDT 8/31/22

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Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-06

**Top Elev. (ft NGVD29): -11.3
Bottom Elev. (ft NGVD29): -26.1**

Notes:
- Photo Mosaic Image
- Photo Scale in Feet



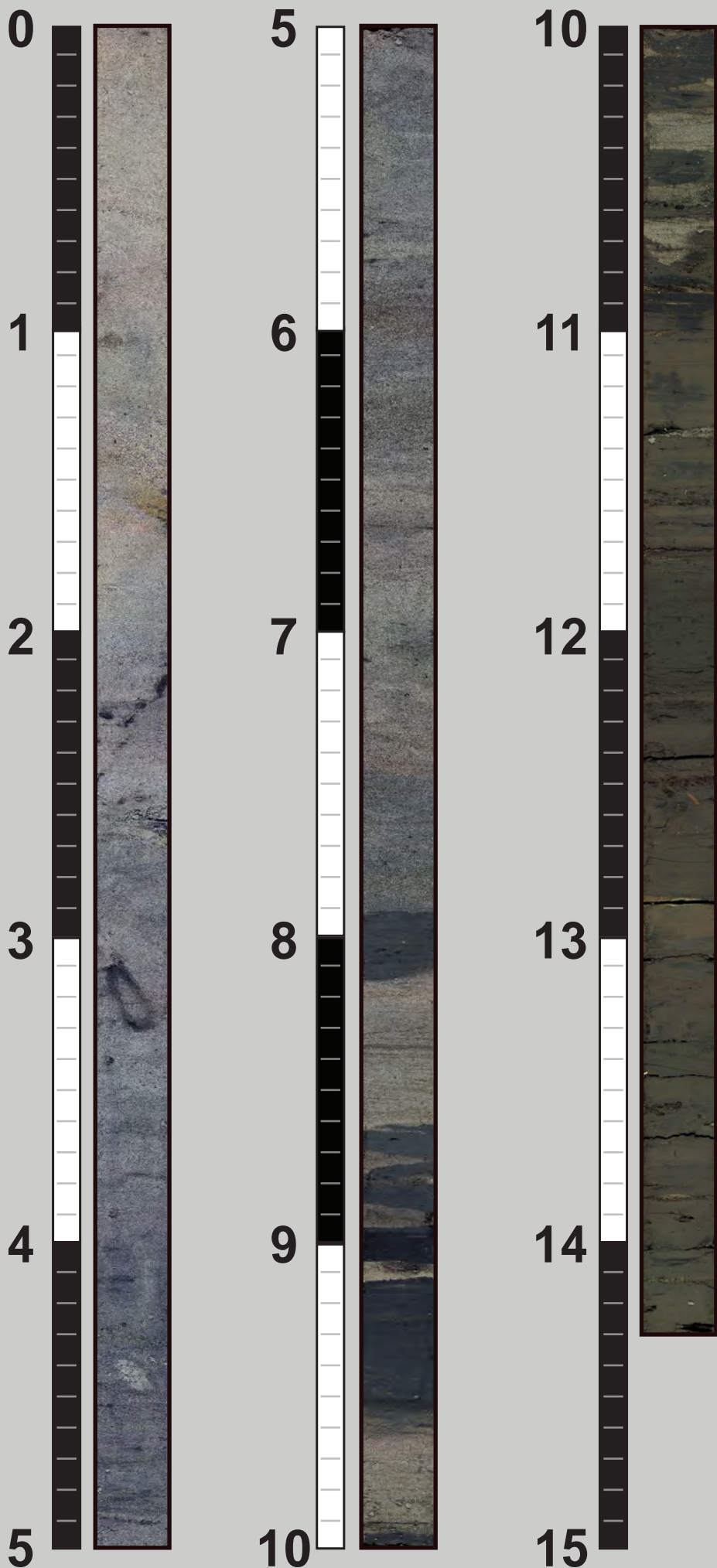
Athena Technologies, Inc.
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McClellanville, SC 29458
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Boring Designation JBS-22-06

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 2 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-06		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,294,323 Y = 44,771		HORIZONTAL NAD 1983	VERTICAL NGVD 29	
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
4. NAME OF DRILLER P. McClellan		12. TOTAL SAMPLES DISTURBED: 1 UNDISTURBED (UD): 2		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		13. TOTAL NUMBER CORE BOXES		
DEG. FROM VERTICAL		14. WATER DEPTH 11.4 Ft.		
BEARING		15. DATE BORING STARTED: 07-11-22 13:14 COMPLETED: 07-11-22		
6. THICKNESS OF OVERBURDEN 0.0 Ft.		16. ELEVATION TOP OF BORING -11.3 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		17. TOTAL RECOVERY FOR BORING 14.8 Ft.		
8. TOTAL DEPTH OF BORING 17.8 Ft.		18. SIGNATURE AND TITLE OF INSPECTOR Graham Schertz		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-11.3	0.0					
-12.4	1.1		Poorly graded SAND; fine to medium quartz sand, few fine sand to fine gravel-sized shells in matrix, loose, subangular, light brownish gray (2.5Y-6/2), (SP).			
-17.3	6.0		Poorly graded SAND; fine quartz sand, trace fine to medium sand-sized shells in matrix, occasional fine gravel-sized shells below 3.5', trace inorganic clay in occasional burrows, loose, subangular, grayish brown (2.5Y-5/2), (SP).		S1	Sample #S1, Depth = 4.2' (SP), Mean (mm): 0.26, Phi Sorting: 0.75 Shell: 3% Fines (#230) - 1.47
-20.9	9.6		Poorly graded SAND; fine quartz sand, trace inorganic clay in matrix, burrows & flaser beds, trace fine to medium sand-sized shells in matrix, notable mica, loose, subangular, bioturbated, gray (2.5Y-5/1) and, very dark gray (2.5Y-3/1), (SP).		C1	Sample #C1, Depth = 0.0' - 12.7' (SP-SM), Mean (mm): 0.26, Phi Sorting: 1.04 Shell: 5% Carbonate: 10.2% Fines (#230) - 5.76
-21.8	10.5		Poorly graded SAND; fine to medium quartz sand, few fine sand to fine gravel-sized shells, trace inorganic clay in burrow at 10.0', loose, subangular, gray (2.5Y-5/1), (SP).			
-22.5	11.2		Poorly graded SAND with clay; fine to medium quartz sand, few inorganic clay in matrix & layers, trace fine to coarse sand-sized shells, loose, subangular, very dark gray (2.5Y-3/1) and, gray (2.5Y-5/1), (SP-SC).		S2	Sample #S2, Depth = 8.5' (SP), Mean (mm): 0.18, Phi Sorting: 0.69 Shell: 2% Fines (#230) - 0.92
-23.8	12.5		Poorly graded SAND; medium quartz sand, few fine sand to fine gravel-sized shells in			

FLORIDA DEP ROSS OAI JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).G.F.J. FL DEP ROSS.GDT 8/31/22



Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-07

**Top Elev. (ft NGVD29): -12.7
Bottom Elev. (ft NGVD29): -27.0**

Notes:
- Photo Mosaic Image
- Photo Scale in Feet




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1293 Graham Farm Road
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Boring Designation JBS-22-07

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 2 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-07		10. COORDINATE SYSTEM/DATUM NC State Plane		
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
4. NAME OF DRILLER P. McClellan		12. TOTAL SAMPLES DISTURBED: 1 UNDISTURBED (UD): 2		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		13. TOTAL NUMBER CORE BOXES		
6. THICKNESS OF OVERBURDEN 0.0 Ft.		14. WATER DEPTH 11.5 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING STARTED: 07-11-22 12:45 COMPLETED: 07-11-22		
8. TOTAL DEPTH OF BORING 16.2 Ft.		16. ELEVATION TOP OF BORING -12.7 Ft.		
		17. TOTAL RECOVERY FOR BORING 14.3 Ft.		
		18. SIGNATURE AND TITLE OF INSPECTOR Adam Freeze		

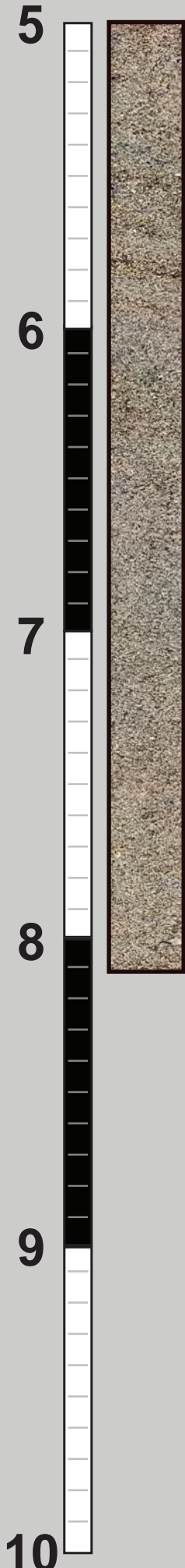
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-12.7	0.0					
-14.8	2.1		Poorly graded SAND; fine quartz sand, trace fine to coarse sand-sized shells in matrix, loose, subangular, olive gray (5Y-5/2), (SP).			
					S1	Sample #S1, Depth = 2.4' (SP), Mean (mm): 0.18, Phi Sorting: 0.47 Shell: 2% Fines (#230) - 1.26
					C1	Sample #C1, Depth = 0.0' - 7.3' (SP), Mean (mm): 0.18, Phi Sorting: 0.53 Shell: 4% Carbonate: 7.7% Fines (#230) - 2.45
					S2	Sample #S2, Depth = 4.9' (SP), Mean (mm): 0.16, Phi Sorting: 0.53 Shell: 3% Fines (#230) - 2.54
-20.6	7.9					
-20.8	8.1		Clayey SAND, very dark gray (2.5Y-3/1), (SC).			
-21.3	8.6		Poorly graded SAND; fine quartz sand, trace fine sand-sized shells, notable mica, loose, subangular, grayish brown (2.5Y-5/2), (SP).			
-22.2	9.5		Sandy fat CLAY; little fine quartz sand in matrix & layers, trace organic silt/material in matrix, medium plasticity, soft, possibly OH, very dark gray (2.5Y-3/1), (CH).			
-22.7	10.0					
-23.5	10.8		Poorly graded SAND; fine quartz sand, trace inorganic clay in occasional burrows, trace fine sand-sized shells, notable mica, loose, subangular, grayish brown (2.5Y-5/2), (SP).			
			Clayey SAND; fine quartz sand, some inorganic/organic clay in layers and laminations, trace organic silt in clay intervals, trace fine sand-sized shells, notable mica, loose/soft, dark olive gray (5Y-3/2) and, grayish brown (2.5Y-5/2), (SC).			

FLORIDA DEP. ROSS OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS GDT, 8/31/22

DRILLING LOG (Cont. Sheet)			INSTALLATION		SHEET 2 OF 2 SHEETS	
PROJECT Jay Bird Shoals Borrow Area Expansion			COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	VERTICAL NGVD 29
LOCATION COORDINATES X = 2,295,127 Y = 44,142			ELEVATION TOP OF BORING -12.7 Ft.			
ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-27.0	14.3		Fat CLAY with sand; few fine quartz sand in matrix & laminations, organic material present throughout, clay % increases with depth, medium plasticity, soft, possibly OH, black (2.5Y-2.5/1), (CH). (continued)			
			End of Boring			

FLORIDA DEP ROSS OAI - JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ - FL DEP ROSS.GDT 8/31/22

15
20
25



Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-08

**Top Elev. (ft NGVD29): -17.6
Bottom Elev. (ft NGVD29): -25.7**

Notes:
- Photo Mosaic Image
- Photo Scale in Feet



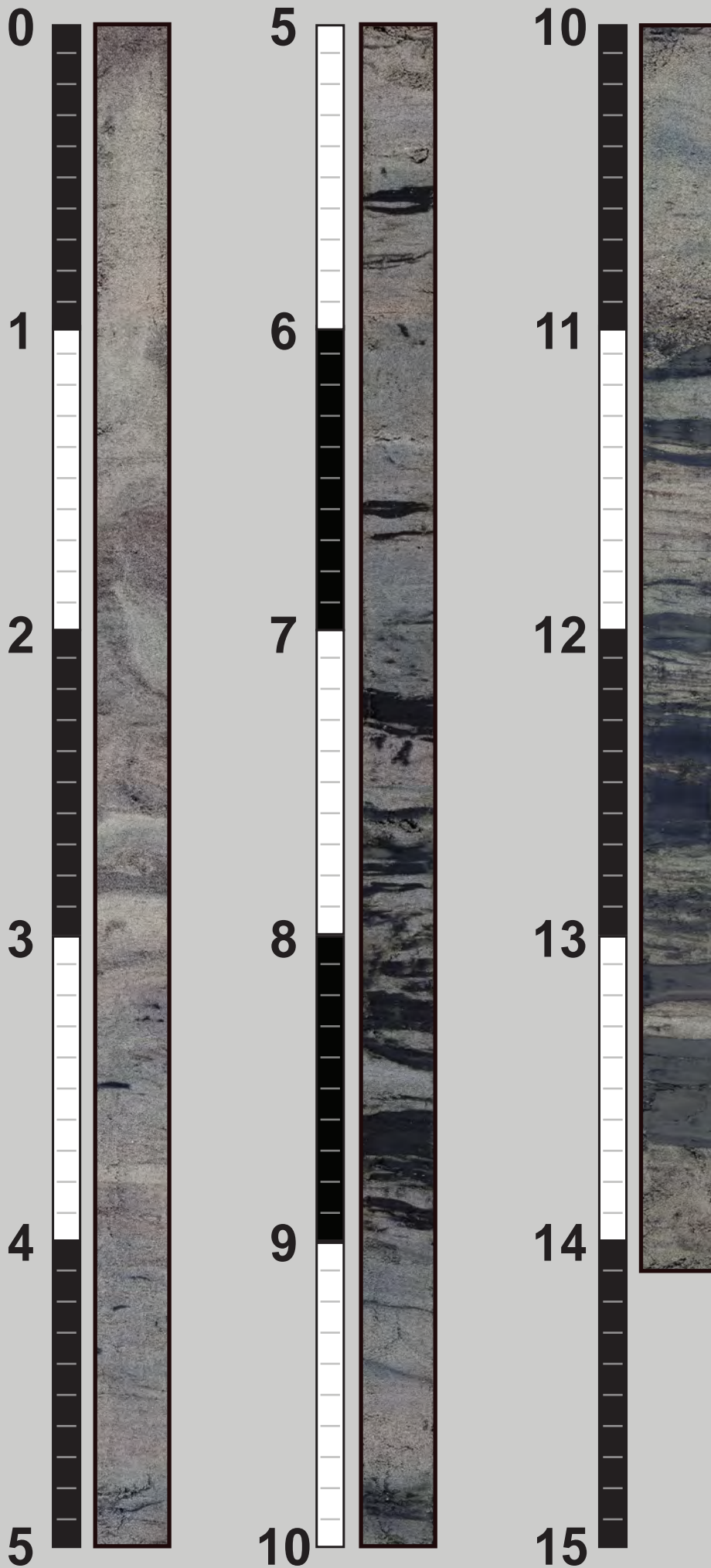
Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
www.athenatechnologies.com
(843) 887-3800

Boring Designation JBS-22-08

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 1 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-08		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,295,745 Y = 43,656		HORIZONTAL NAD 1983	VERTICAL NGVD 29	
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES	DISTURBED 1	UNDISTURBED (UD) 2
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		DEG. FROM VERTICAL	BEARING	
6. THICKNESS OF OVERBURDEN 0.0 Ft.		14. WATER DEPTH 16.5 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING	STARTED 07-11-22 11:54	COMPLETED 07-11-22
8. TOTAL DEPTH OF BORING 10.0 Ft.		16. ELEVATION TOP OF BORING -17.6 Ft.		
		17. TOTAL RECOVERY FOR BORING 8.1 Ft.		
		18. SIGNATURE AND TITLE OF INSPECTOR Adam Freeze		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-17.6	0.0					
-19.1	1.5	●	Poorly graded SAND; fine quartz sand, trace inorganic clay in burrows, trace fine to coarse sand-sized shells in matrix, loose, subangular, olive gray (5Y-5/2), (SP).			
-20.2	2.6		Poorly graded SAND; medium quartz sand, little fine sand to coarse gravel-sized shells in matrix, loose, subangular, grayish brown (2.5Y-5/2), (SP).		S1	Sample #S1, Depth = 2.1' (SP), Mean (mm): 0.90, Phi Sorting: 1.28 Shell: 26% Fines (#230) - 0.77
-21.2	3.6		Poorly graded SAND; medium quartz sand, few fine sand to fine gravel-sized shells, trace inorganic clay in occasional laminations, loose, subangular, grayish brown (2.5Y-5/2), (SP).		C1	Sample #C1, Depth = 0.0' - 6.4' (SP), Mean (mm): 0.55, Phi Sorting: 1.25 Shell: 15% Carbonate: 19.8% Fines (#230) - 1.60
-25.7	8.1		Poorly graded SAND; medium to coarse grading to medium quartz sand, few fine to coarse sand-sized shells in matrix, occasional fine gravel-sized shells, sand size decreases slightly with depth, loose, subangular, light olive brown (2.5Y-5/3) grades to, grayish brown (2.5Y-5/2), (SP).		S2	Sample #S2, Depth = 4.3' (SP), Mean (mm): 0.85, Phi Sorting: 0.91 Shell: 24% Fines (#230) - 0.22
			End of Boring			

FLORIDA DEP ROSS OAI JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).G.F.J. FL DEP ROSS.GDT 8/31/22



Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-09

**Top Elev. (ft NAVD88): -12.9
Bottom Elev. (ft NAVD88): -27.0**

Notes:

- Photo Mosaic Image
- Photo Scale in Feet



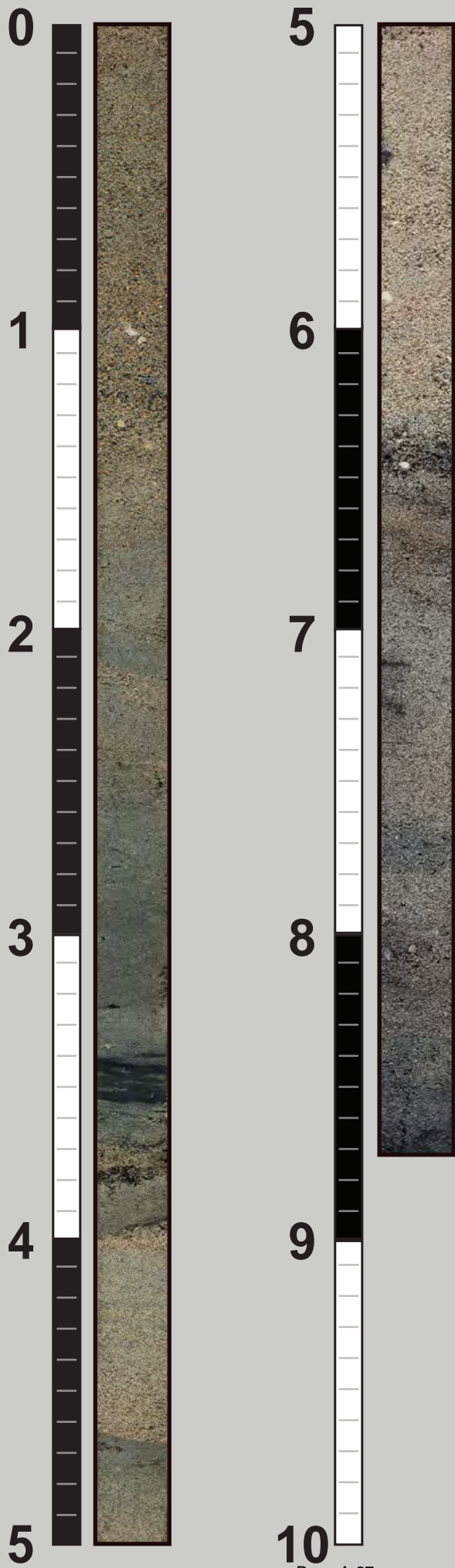
Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
www.athenatechnologies.com
(843) 887-3800

Boring Designation JBS-22-09

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 2 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-09		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,294,677 Y = 43,797		HORIZONTAL NAD 1983	VERTICAL NGVD 29	
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES	DISTURBED 1	UNDISTURBED (UD) 2
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		DEG. FROM VERTICAL	BEARING	
6. THICKNESS OF OVERBURDEN 0.0 Ft.		14. WATER DEPTH 11.4 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING	STARTED 07-11-22 11:31	COMPLETED 07-11-22
8. TOTAL DEPTH OF BORING 16.0 Ft.		16. ELEVATION TOP OF BORING -12.9 Ft.		
		17. TOTAL RECOVERY FOR BORING 14.1 Ft.		
		18. SIGNATURE AND TITLE OF INSPECTOR Graham Schertz		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-12.9	0.0		Poorly graded SAND; fine quartz sand, trace fine sand-sized shells in matrix (primarily below 1.6'), trace inorganic clay in occasional burrows below 1.9', notable mica, loose, subangular, olive gray (5Y-5/2), (SP).			
-16.0	3.1		Poorly graded SAND; fine quartz sand, trace inorganic/organic clay in rip-ups, flaser beds, burrows & laminations, trace fine sand-sized shells, gravel-sized shell at 5.4', loose, subangular, olive gray (5Y-5/2), (SP).		S1	Sample #S1, Depth = 3.7' (SP), Mean (mm): 0.17, Phi Sorting: 0.45 Shell: 4% Fines (#230) - 2.20
-20.1	7.2		Poorly graded SAND with clay; fine quartz sand interbedded with inorganic/organic clay layers, notable mica, loose, subangular, olive gray (5Y-5/2) and, dark olive gray (5Y-3/2), (SP-SC).		C1	Sample #C1, Depth = 0.0' - 11.1' (SP-SM), Mean (mm): 0.16, Phi Sorting: 0.63 Shell: 9% Carbonate: 8.5% Fines (#230) - 7.31
-21.9	9.0		Poorly graded SAND; fine quartz sand, trace inorganic clay in occasional burrows & laminations, trace fine to medium sand-sized shells in matrix at base, sand size increases at 10.8', loose, subangular, olive gray (5Y-5/2), (SP).		S2	Sample #S2, Depth = 7.4' (SP-SM), Mean (mm): 0.15, Phi Sorting: 0.46 Shell: 2% Fines (#230) - 9.98
-24.0	11.1		Clayey SAND; fine quartz sand interbedded with inorganic/organic clay layers, loose/soft, dark olive gray (5Y-3/2) and, olive gray (5Y-5/2), (SC).			

FLORIDA DEP. ROSS OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), G.F.J. FL DEP. ROSS GDT 8/31/22



Olsen Associates, Inc.

**2022 Geotechnical Investigation,
Jay Bird Shoals
Borrow Area Expansion,
Brunswick County,
North Carolina**

JBS-22-10

**Top Elev. (ft NGVD29): -17.7
Bottom Elev. (ft NGVD29): -26.4**

Notes:
- Photo Mosaic Image
- Photo Scale in Feet



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1293 Graham Farm Road
McClellanville, SC 29458
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(843) 887-3800

Boring Designation JBS-22-10

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER Village Of Bald Head Island	SHEET 1 OF 1 SHEETS
1. PROJECT Jay Bird Shoals Borrow Area Expansion Brunswick County, NC		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION JBS-22-10		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,295,333 Y = 43,294		HORIZONTAL NAD 1983	VERTICAL NGVD 29	
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL <input type="checkbox"/> AUTO HAMMER <input type="checkbox"/> MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES	DISTURBED 1	UNDISTURBED (UD) 2
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING <input checked="" type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED		DEG. FROM VERTICAL	BEARING	
6. THICKNESS OF OVERBURDEN 0.0 Ft.		14. WATER DEPTH 16.6 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		15. DATE BORING	STARTED 07-11-22 10:45	COMPLETED 07-11-22
8. TOTAL DEPTH OF BORING 10.3 Ft.		16. ELEVATION TOP OF BORING -17.7 Ft.		
		17. TOTAL RECOVERY FOR BORING 8.7 Ft.		
		18. SIGNATURE AND TITLE OF INSPECTOR Adam Freeze		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-17.7	0.0					
-19.1	1.4		Poorly graded SAND; medium quartz sand, few fine sand to fine gravel-sized shells, occasional coarse gravel-sized shells, loose, subangular, grayish brown (2.5Y-5/2), (SP).			
-20.3	2.6		Poorly graded SAND; fine to medium quartz sand, trace fine to coarse sand-sized shells in matrix & layers, loose, subangular, gray (2.5Y-5/1), (SP).		S1	Sample #S1, Depth = 2.1' (SP), Mean (mm): 0.26, Phi Sorting: 0.94 Shell: 7% Fines (#230) - 1.12
-21.6	3.9		Poorly graded SAND; fine quartz sand, trace inorganic clay in lenticular bedding at 3.4-3.6', medium quartz sand & organic material in layer at 3.8', notable mica, loose, subangular, gray (2.5Y-5/1) and, dark gray (2.5Y-4/1), (SP).		C1	Sample #C1, Depth = 0.0' - 6.3' (SP), Mean (mm): 0.42, Phi Sorting: 1.44 Shell: 12% Carbonate: 14.8% Fines (#230) - 1.61
-24.2	6.5		Poorly graded SAND; medium quartz sand, few fine sand to fine gravel-sized shells in matrix, coarse gravel-sized shells below 5.9' & in layer at base, clay rip-up at 5.4', loose, subangular, grayish brown (2.5Y-5/2), (SP).		S2	Sample #S2, Depth = 4.2' (SP), Mean (mm): 0.40, Phi Sorting: 0.67 Shell: 8% Fines (#230) - 0.99
-25.7	8.0		Poorly graded SAND; medium quartz sand, trace fine to coarse sand-sized shells, occasional fine gravel-sized shells, inorganic clay present in occasional burrows, loose, subangular, olive gray (5Y-5/2), (SP).			
-26.4	8.7		Poorly graded SAND with clay; fine to medium quartz sand, few inorganic clay in matrix & in layer at base, trace fine sand to fine gravel-sized shells, loose, subangular, dark gray (5Y-4/1) grades to, dark gray (5Y-4/1), (SP-SC).			
			End of Boring			

FLORIDA DEP ROSS OAI - JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).G.F.J. FL DEP ROSS.GDT 8/31/22

APPENDIX B

Grain Size Distribution Data



1293 Graham Farm Road, PO Box 68
McClellanville, South Carolina 29458
(843) 887-3800
www.athenatechnologies.com

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-01 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,023	Northing (ft): 45,629	Coordinate System: NC State Plane	Elevation (ft): -8.6 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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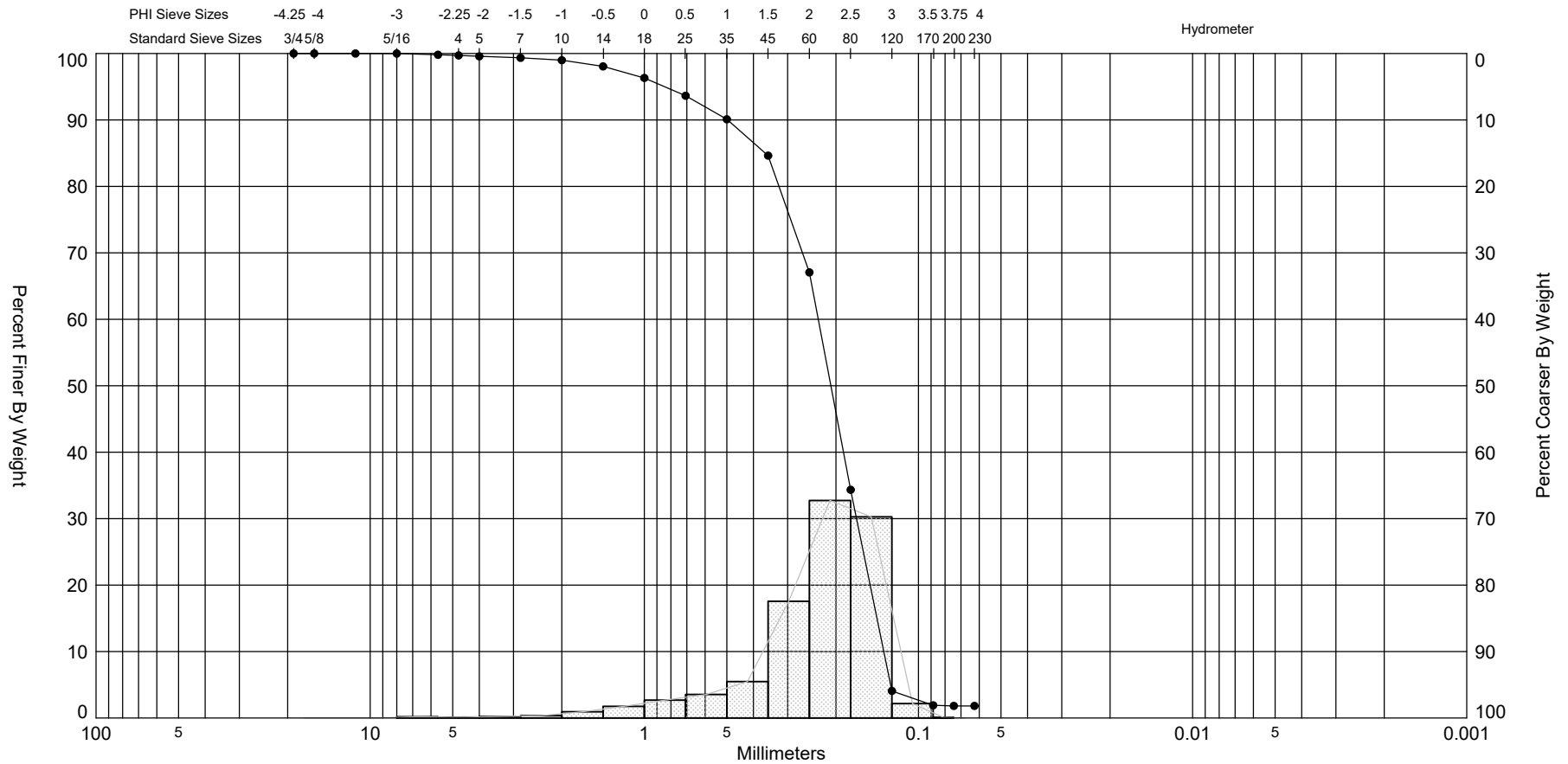
Dry Weight (g): 157.72	Wash Weight (g): 154.84	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.82 #230 - 1.82	Organics (%):	Carbonates (%): 6.9	Shells (%): 4
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.30	0.19	0.30	99.81
#4	-2.25	4.76	0.15	0.10	0.45	99.71
#5	-2.00	4.00	0.21	0.13	0.66	99.58
#7	-1.50	2.83	0.36	0.23	1.02	99.35
#10	-1.00	2.00	0.57	0.36	1.59	98.99
#14	-0.50	1.41	1.47	0.93	3.06	98.06
#18	0.00	1.00	2.74	1.74	5.80	96.32
#25	0.50	0.71	4.22	2.68	10.02	93.64
#35	1.00	0.50	5.59	3.54	15.61	90.10
#45	1.50	0.35	8.63	5.47	24.24	84.63
#60	2.00	0.25	27.71	17.57	51.95	67.06
#80	2.50	0.18	51.61	32.72	103.56	34.34
#120	3.00	0.13	47.74	30.27	151.30	4.07
#170	3.50	0.09	3.40	2.16	154.70	1.91
#200	3.75	0.07	0.14	0.09	154.84	1.82
#230	4.00	0.06	0.00	0.00	154.84	1.82


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.98	2.80	2.65	2.26	1.77	1.52	0.25
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.06	0.24	0.85	-1.96	8.28	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ FL DEP ROSS.GDT 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-01 #C1	—●—	-8.6	SP	#200 - 1.82 #230 - 1.82		6.9	2.26	2.06	-1.96	8.28	0.85	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
											Easting (X, ft):	2,295,023	
											Northing (Y, ft):	45,629	
											Horizontal System:	NAD 1983	
											Vertical System:	NGVD 29	
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion

Sample Name: JBS-22-01 #S1

Analysis Date: 08-12-22

Analyzed By: CRM

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
2,295,023	45,629	NC State Plane	-13.7 NGVD 29

USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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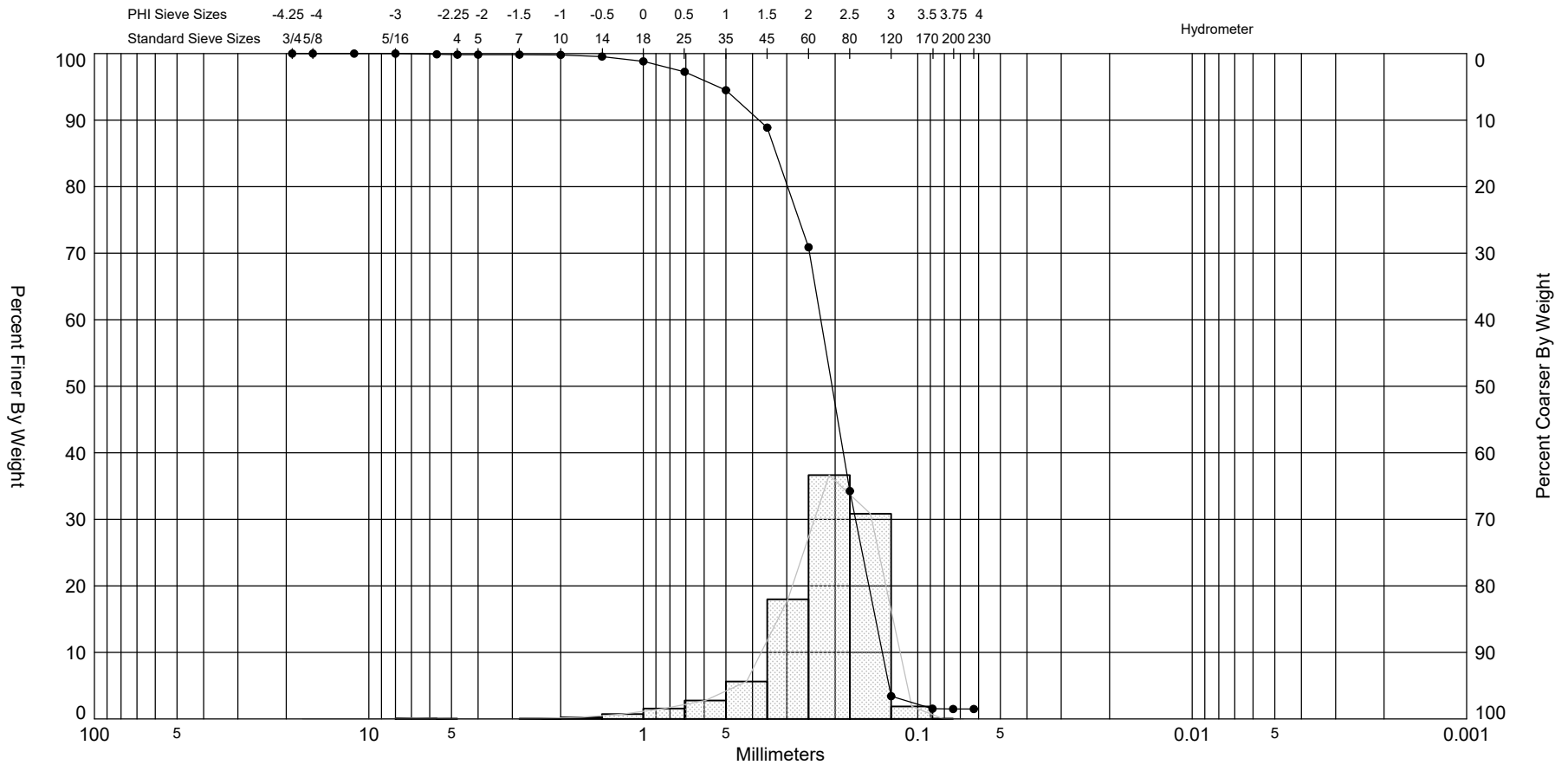
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
154.52	152.22			#200 - 1.49 #230 - 1.49			11

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.17	0.11	0.17	99.89
#4	-2.25	4.76	0.08	0.05	0.25	99.84
#5	-2.00	4.00	0.00	0.00	0.25	99.84
#7	-1.50	2.83	0.00	0.00	0.25	99.84
#10	-1.00	2.00	0.06	0.04	0.31	99.80
#14	-0.50	1.41	0.38	0.25	0.69	99.55
#18	0.00	1.00	1.11	0.72	1.80	98.83
#25	0.50	0.71	2.43	1.57	4.23	97.26
#35	1.00	0.50	4.28	2.77	8.51	94.49
#45	1.50	0.35	8.69	5.62	17.20	88.87
#60	2.00	0.25	27.78	17.98	44.98	70.89
#80	2.50	0.18	56.62	36.64	101.60	34.25
#120	3.00	0.13	47.64	30.83	149.24	3.42
#170	3.50	0.09	2.91	1.88	152.15	1.54
#200	3.75	0.07	0.07	0.05	152.22	1.49
#230	4.00	0.06	0.00	0.00	152.22	1.49


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.97	2.80	2.65	2.29	1.89	1.64	0.91
Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
Statistics	2.17	0.22	0.66	-1.85	9.59	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS, GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-01 #S1	—●—	-13.7	SP	#200 - 1.49 #230 - 1.49			2.29	2.17	-1.85	9.59	0.66	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL												Analysis Date:	08-12-22
Depths and elevations based on measured values												Analyzed By:	CRM
												Easting (X, ft):	2,295,023
												Northing (Y, ft):	45,629
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion

Sample Name: JBS-22-01 #S2

Analysis Date: 08-12-22

Analyzed By: CRM

Easting (ft): 2,295,023	Northing (ft): 45,629	Coordinate System: NC State Plane	Elevation (ft): -18.9 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-5/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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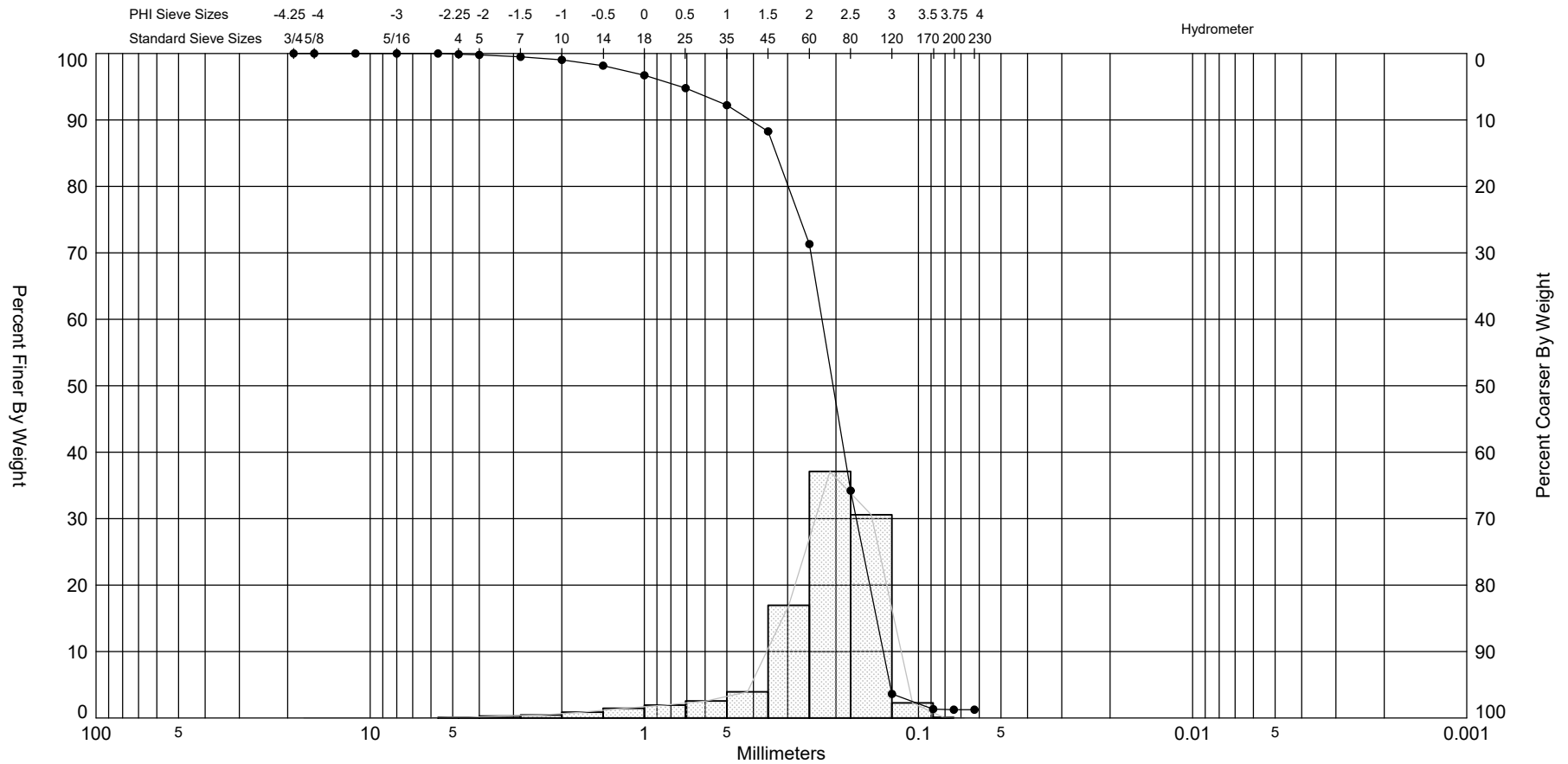
Dry Weight (g): 147.63	Wash Weight (g): 145.80	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.25 #230 - 1.25	Organics (%):	Carbonates (%):	Shells (%): 4
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.16	0.11	0.16	99.89
#5	-2.00	4.00	0.15	0.10	0.31	99.79
#7	-1.50	2.83	0.43	0.29	0.74	99.50
#10	-1.00	2.00	0.68	0.46	1.42	99.04
#14	-0.50	1.41	1.28	0.87	2.70	98.17
#18	0.00	1.00	2.14	1.45	4.84	96.72
#25	0.50	0.71	2.85	1.93	7.69	94.79
#35	1.00	0.50	3.79	2.57	11.48	92.22
#45	1.50	0.35	5.82	3.94	17.30	88.28
#60	2.00	0.25	25.04	16.96	42.34	71.32
#80	2.50	0.18	54.79	37.11	97.13	34.21
#120	3.00	0.13	45.16	30.59	142.29	3.62
#170	3.50	0.09	3.37	2.28	145.66	1.34
#200	3.75	0.07	0.14	0.09	145.80	1.25
#230	4.00	0.06	0.00	0.00	145.80	1.25


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.98	2.80	2.65	2.29	1.89	1.63	0.45
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.12	0.23	0.79	-2.14	9.16	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-01 #S2	—●—	-18.9	SP	#200 - 1.25 #230 - 1.25			2.29	2.12	-2.14	9.16	0.79	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
							Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800					Easting (X, ft):	2,295,023
												Northing (Y, ft):	45,629
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-02 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,790	Northing (ft): 45,040	Coordinate System: NC State Plane	Elevation (ft): -7.1 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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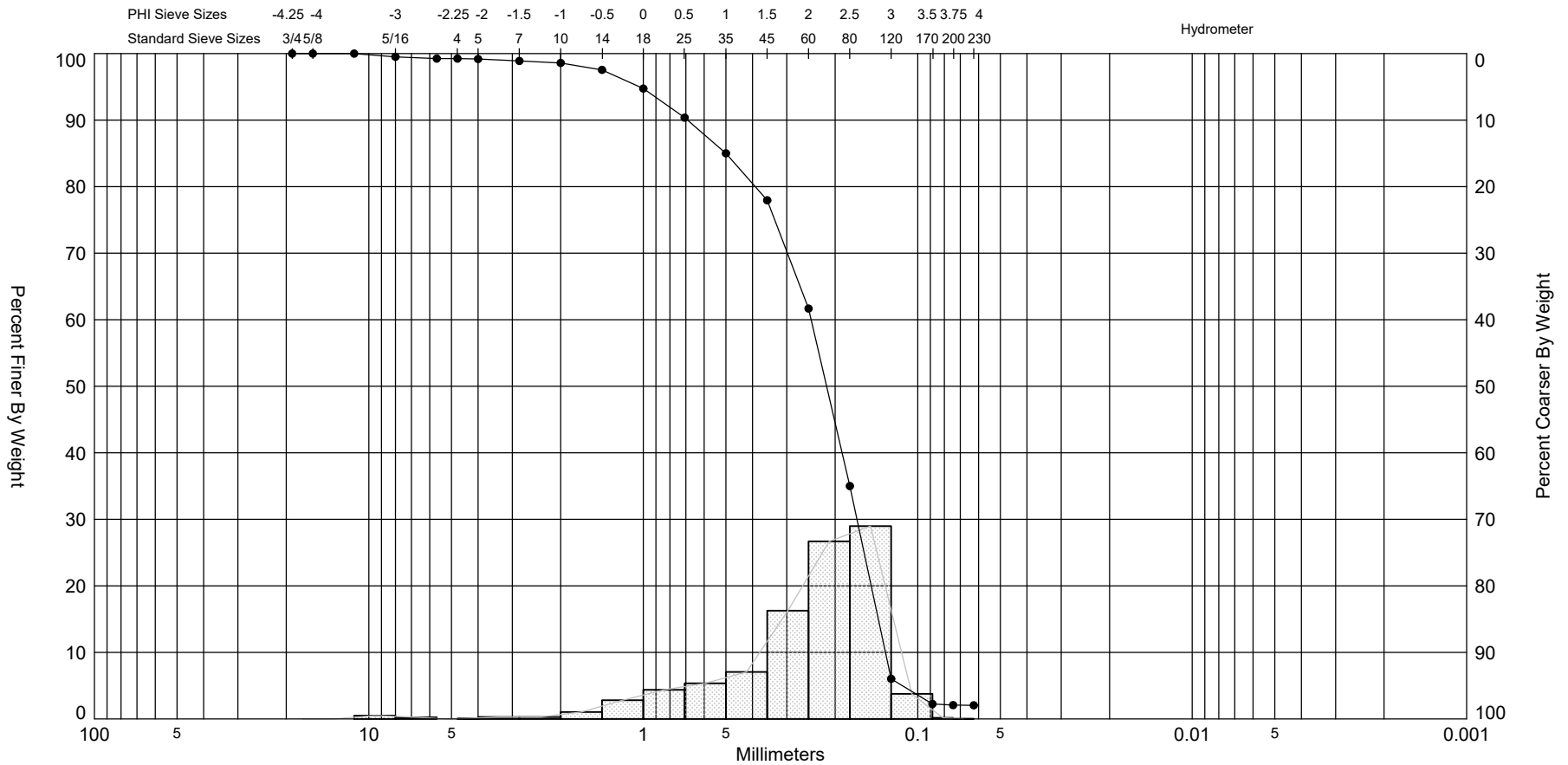
Dry Weight (g): 156.86	Wash Weight (g): 153.64	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 2.08 #230 - 2.05	Organics (%):	Carbonates (%): 9.3	Shells (%): 11
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.77	0.49	0.77	99.51
#3.5	-2.50	5.66	0.41	0.26	1.18	99.25
#4	-2.25	4.76	0.00	0.00	1.18	99.25
#5	-2.00	4.00	0.11	0.07	1.29	99.18
#7	-1.50	2.83	0.45	0.29	1.74	98.89
#10	-1.00	2.00	0.47	0.30	2.21	98.59
#14	-0.50	1.41	1.63	1.04	3.84	97.55
#18	0.00	1.00	4.41	2.81	8.25	94.74
#25	0.50	0.71	6.86	4.37	15.11	90.37
#35	1.00	0.50	8.40	5.36	23.51	85.01
#45	1.50	0.35	11.08	7.06	34.59	77.95
#60	2.00	0.25	25.52	16.27	60.11	61.68
#80	2.50	0.18	41.85	26.68	101.96	35.00
#120	3.00	0.13	45.45	28.97	147.41	6.03
#170	3.50	0.09	5.93	3.78	153.34	2.25
#200	3.75	0.07	0.26	0.17	153.60	2.08
#230	4.00	0.06	0.04	0.03	153.64	2.05


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.14	2.83	2.67	2.22	1.59	1.07	-0.05
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	1.94	0.26	1.01	-1.78	7.53	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ FL DEP ROSS.GDT 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-02 #C1	—●—	-7.1	SP	#200 - 2.08 #230 - 2.05		9.3	2.22	1.94	-1.78	7.53	1.01	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL												Analysis Date:	08-12-22
Depths and elevations based on measured values												Analyzed By:	CRM
												Easting (X, ft):	2,295,790
												Northing (Y, ft):	45,040
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-02 #S1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,790	Northing (ft): 45,040	Coordinate System: NC State Plane	Elevation (ft): -12.7 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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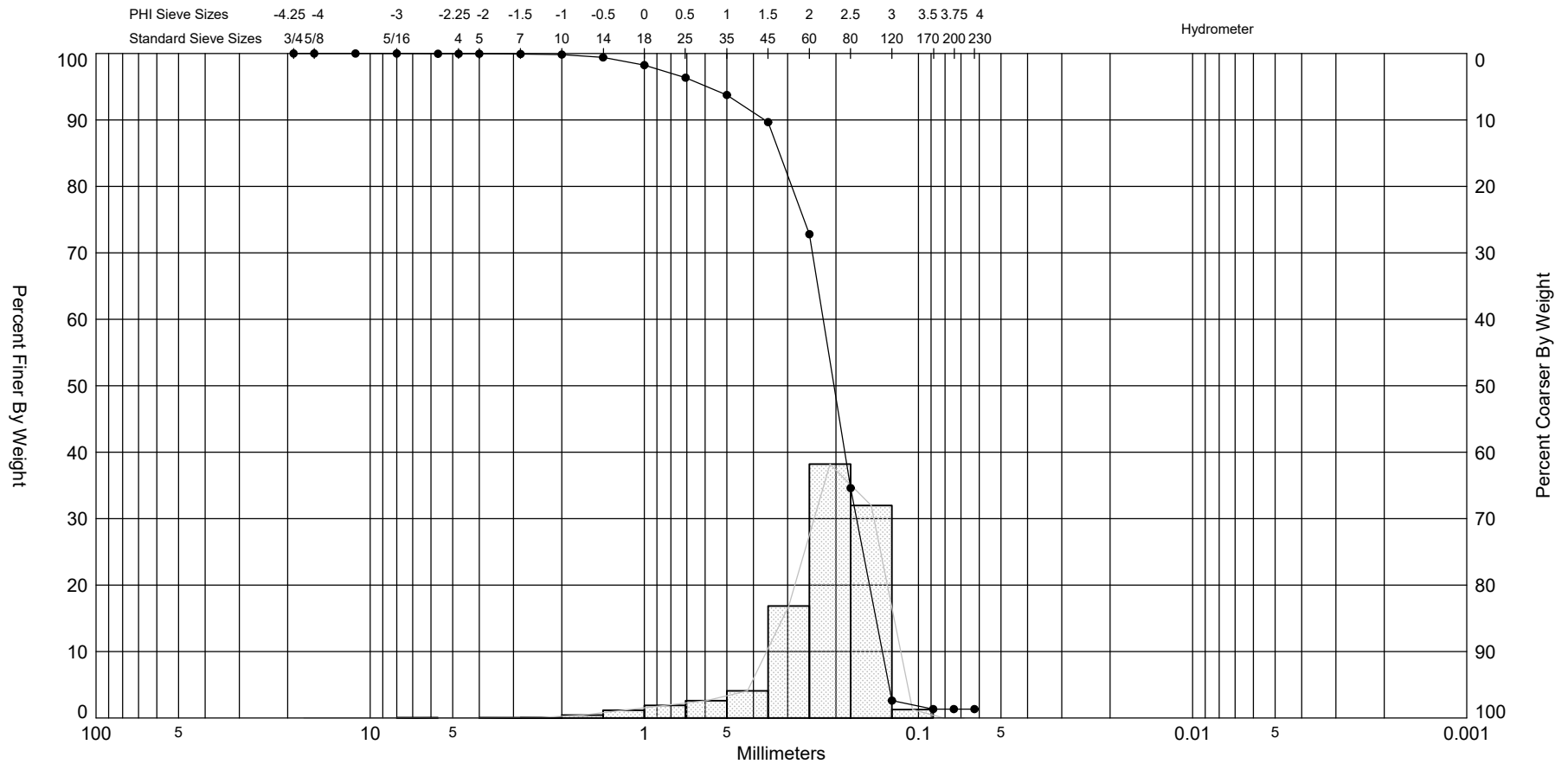
Dry Weight (g): 138.26	Wash Weight (g): 136.39	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.34 #230 - 1.34	Organics (%):	Carbonates (%):	Shells (%): 4
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.05	0.04	0.05	99.96
#4	-2.25	4.76	0.00	0.00	0.05	99.96
#5	-2.00	4.00	0.00	0.00	0.05	99.96
#7	-1.50	2.83	0.05	0.04	0.10	99.92
#10	-1.00	2.00	0.11	0.08	0.21	99.84
#14	-0.50	1.41	0.60	0.43	0.81	99.41
#18	0.00	1.00	1.60	1.16	2.41	98.25
#25	0.50	0.71	2.62	1.89	5.03	96.36
#35	1.00	0.50	3.59	2.60	8.62	93.76
#45	1.50	0.35	5.65	4.09	14.27	89.67
#60	2.00	0.25	23.31	16.86	37.58	72.81
#80	2.50	0.18	52.83	38.21	90.41	34.60
#120	3.00	0.13	44.21	31.98	134.62	2.62
#170	3.50	0.09	1.77	1.28	136.39	1.34
#200	3.75	0.07	0.00	0.00	136.39	1.34
#230	4.00	0.06	0.00	0.00	136.39	1.34


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.96	2.79	2.65	2.30	1.94	1.67	0.76
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.17	0.22	0.67	-1.86	8.02	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ FL DEP ROSS.GDT 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-02 #S1	—●—	-12.7	SP	#200 - 1.34 #230 - 1.34			2.3	2.17	-1.86	8.02	0.67	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL												Analysis Date:	08-12-22
Depths and elevations based on measured values												Analyzed By:	CRM
												Easting (X, ft):	2,295,790
												Northing (Y, ft):	45,040
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-02 #S2
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,790	Northing (ft): 45,040	Coordinate System: NC State Plane	Elevation (ft): -18.3 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g): 158.51	Wash Weight (g): 152.56	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 3.84 #230 - 3.76	Organics (%):	Carbonates (%):	Shells (%): 3
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.03	0.02	0.03	99.98
#7	-1.50	2.83	0.05	0.03	0.08	99.95
#10	-1.00	2.00	0.07	0.04	0.15	99.91
#14	-0.50	1.41	0.32	0.20	0.47	99.71
#18	0.00	1.00	0.78	0.49	1.25	99.22
#25	0.50	0.71	1.22	0.77	2.47	98.45
#35	1.00	0.50	1.44	0.91	3.91	97.54
#45	1.50	0.35	2.84	1.79	6.75	95.75
#60	2.00	0.25	19.19	12.11	25.94	83.64
#80	2.50	0.18	58.50	36.91	84.44	46.73
#120	3.00	0.13	59.08	37.27	143.52	9.46
#170	3.50	0.09	8.43	5.32	151.95	4.14
#200	3.75	0.07	0.48	0.30	152.43	3.84
#230	4.00	0.06	0.13	0.08	152.56	3.76

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.42	2.91	2.79	2.46	2.12	1.99	1.53
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.37	0.19	0.56	-1.83	10.32	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-03 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,296,510	Northing (ft): 44,548	Coordinate System: NC State Plane	Elevation (ft): -14.6 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-5/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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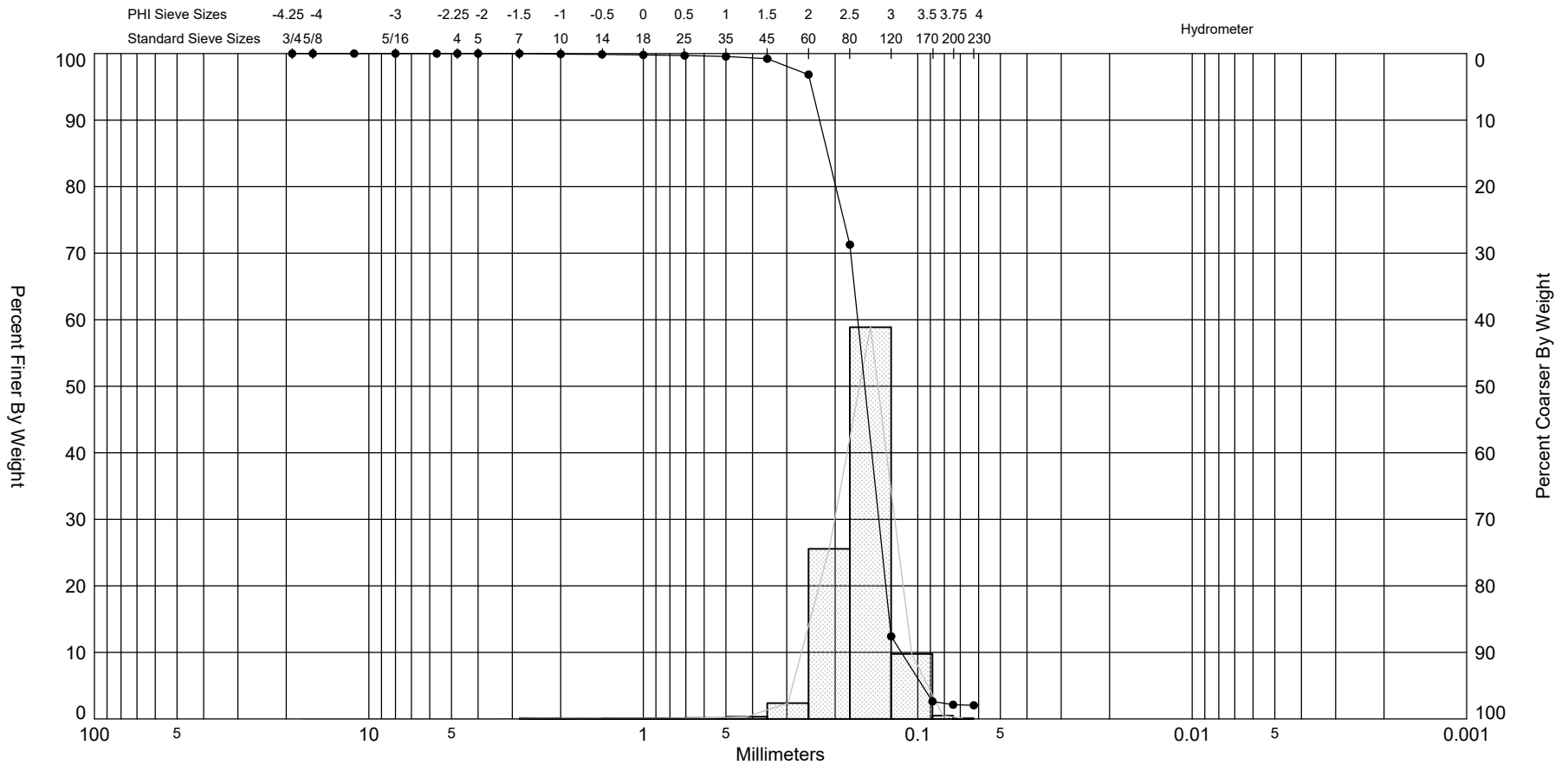
Dry Weight (g): 160.48	Wash Weight (g): 157.20	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 2.14 #230 - 2.05	Organics (%):	Carbonates (%): 6.0	Shells (%): 2
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.00	0.00	0.00	100.00
#7	-1.50	2.83	0.00	0.00	0.00	100.00
#10	-1.00	2.00	0.13	0.08	0.13	99.92
#14	-0.50	1.41	0.06	0.04	0.19	99.88
#18	0.00	1.00	0.15	0.09	0.34	99.79
#25	0.50	0.71	0.15	0.09	0.49	99.70
#35	1.00	0.50	0.22	0.14	0.71	99.56
#45	1.50	0.35	0.54	0.34	1.25	99.22
#60	2.00	0.25	3.82	2.38	5.07	96.84
#80	2.50	0.18	41.02	25.56	46.09	71.28
#120	3.00	0.13	94.47	58.87	140.56	12.41
#170	3.50	0.09	15.70	9.78	156.26	2.63
#200	3.75	0.07	0.79	0.49	157.05	2.14
#230	4.00	0.06	0.15	0.09	157.20	2.05


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.38	2.97	2.89	2.68	2.43	2.25	2.04
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.63	0.16	0.39	-1.99	17.7	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS, GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-03 #C1	—●—	-14.6	SP	#200 - 2.14 #230 - 2.05		6.0	2.68	2.63	-1.99	17.7	0.39	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL												Analysis Date:	08-12-22
Depths and elevations based on measured values												Analyzed By:	CRM
												Easting (X, ft):	2,296,510
												Northing (Y, ft):	44,548
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-03 #S1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,296,510	Northing (ft): 44,548	Coordinate System: NC State Plane	Elevation (ft): -17.7 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/1	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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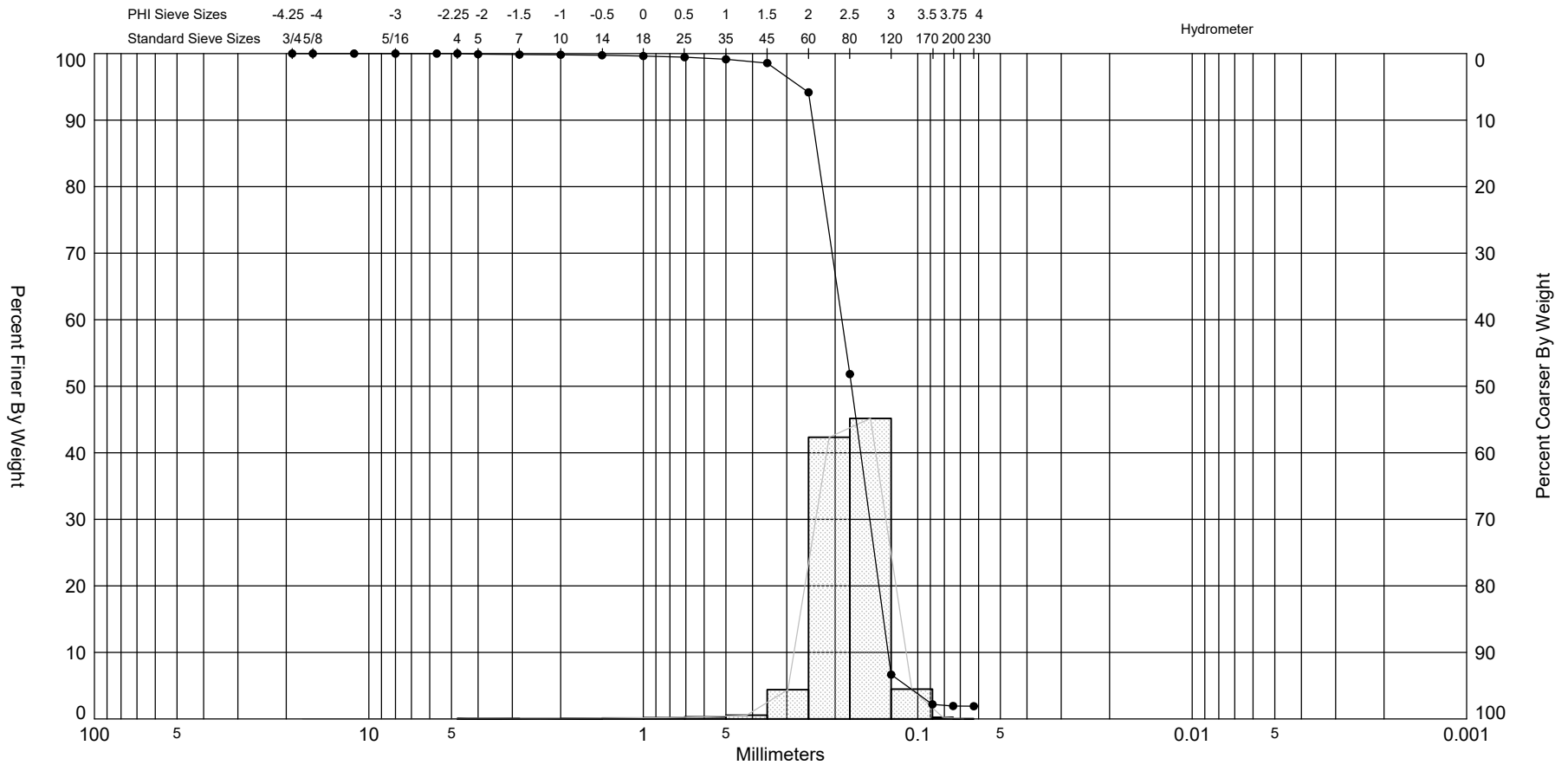
Dry Weight (g): 142.81	Wash Weight (g): 140.06	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.94 #230 - 1.91	Organics (%):	Carbonates (%):	Shells (%): 6
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.13	0.09	0.13	99.91
#7	-1.50	2.83	0.08	0.06	0.21	99.85
#10	-1.00	2.00	0.04	0.03	0.25	99.82
#14	-0.50	1.41	0.10	0.07	0.35	99.75
#18	0.00	1.00	0.17	0.12	0.52	99.63
#25	0.50	0.71	0.26	0.18	0.78	99.45
#35	1.00	0.50	0.44	0.31	1.22	99.14
#45	1.50	0.35	0.81	0.57	2.03	98.57
#60	2.00	0.25	6.29	4.40	8.32	94.17
#80	2.50	0.18	60.46	42.34	68.78	51.83
#120	3.00	0.13	64.51	45.17	133.29	6.66
#170	3.50	0.09	6.38	4.47	139.67	2.19
#200	3.75	0.07	0.35	0.25	140.02	1.94
#230	4.00	0.06	0.04	0.03	140.06	1.91


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.19	2.90	2.80	2.52	2.23	2.12	1.91
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.48	0.18	0.43	-2.85	25.95	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS, GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-03 #S1	—●—	-17.7	SP	#200 - 1.94 #230 - 1.91			2.52	2.48	-2.85	25.95	0.43	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
											Easting (X, ft):	2,296,510	
											Northing (Y, ft):	44,548	
											Horizontal System:	NAD 1983	
											Vertical System:	NGVD 29	
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-03 #S2
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,296,510	Northing (ft): 44,548	Coordinate System: NC State Plane	Elevation (ft): -20.9 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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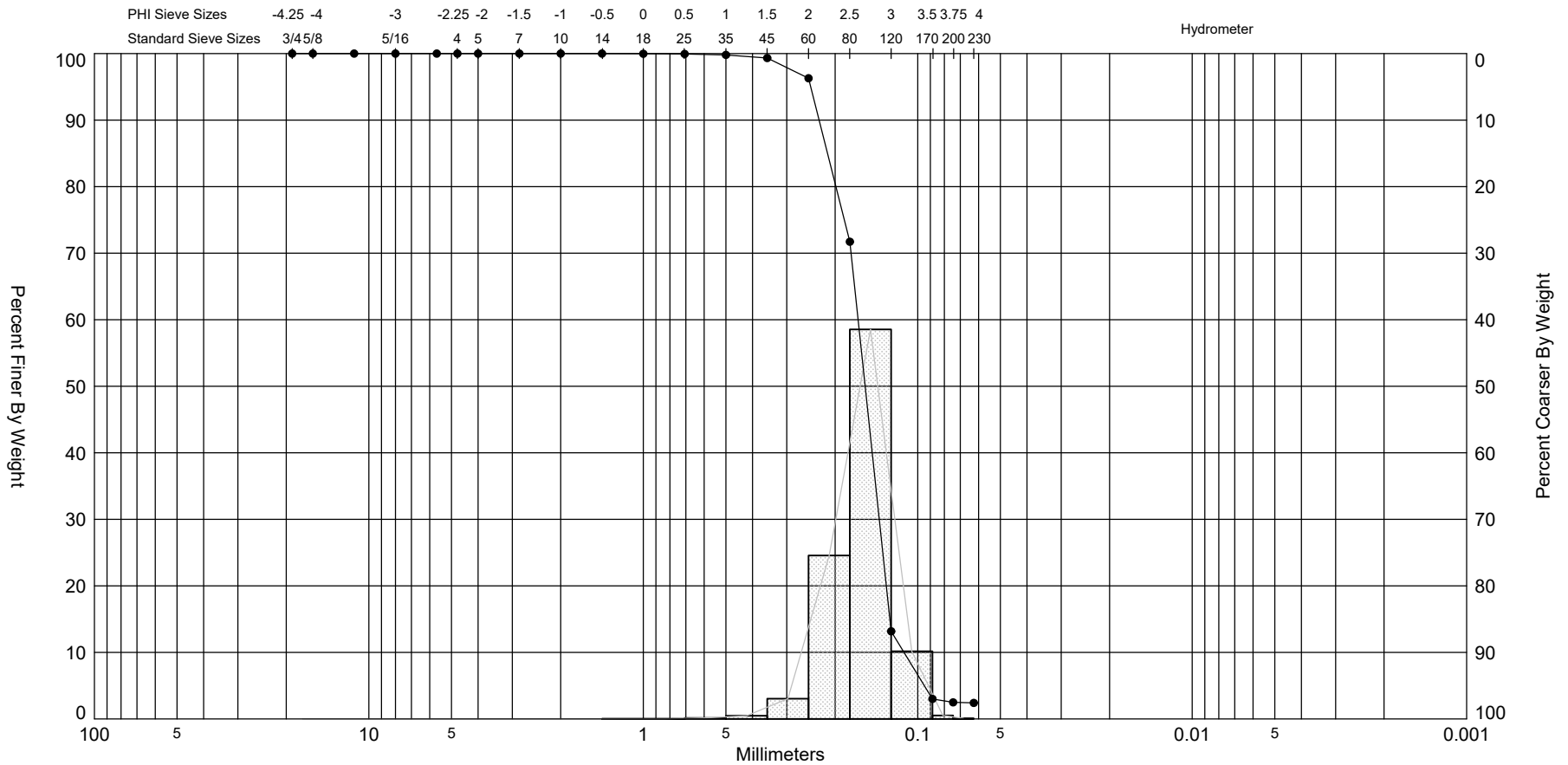
Dry Weight (g): 149.24	Wash Weight (g): 145.66	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 2.49 #230 - 2.41	Organics (%):	Carbonates (%):	Shells (%): 6
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.00	0.00	0.00	100.00
#7	-1.50	2.83	0.00	0.00	0.00	100.00
#10	-1.00	2.00	0.00	0.00	0.00	100.00
#14	-0.50	1.41	0.00	0.00	0.00	100.00
#18	0.00	1.00	0.05	0.03	0.05	99.97
#25	0.50	0.71	0.05	0.03	0.10	99.94
#35	1.00	0.50	0.21	0.14	0.31	99.80
#45	1.50	0.35	0.70	0.47	1.01	99.33
#60	2.00	0.25	4.54	3.04	5.55	96.29
#80	2.50	0.18	36.67	24.57	42.22	71.72
#120	3.00	0.13	87.38	58.55	129.60	13.17
#170	3.50	0.09	15.16	10.16	144.76	3.01
#200	3.75	0.07	0.78	0.52	145.54	2.49
#230	4.00	0.06	0.12	0.08	145.66	2.41


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.40	2.98	2.90	2.69	2.43	2.25	2.03
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.64	0.16	0.37	-0.83	6.51	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-03 #S2	—●—	-20.9	SP	#200 - 2.49 #230 - 2.41			2.69	2.64	-0.83	6.51	0.37	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
											Easting (X, ft):	2,296,510	
											Northing (Y, ft):	44,548	
											Horizontal System:	NAD 1983	
											Vertical System:	NGVD 29	
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-04 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,449	Northing (ft): 44,599	Coordinate System: NC State Plane	Elevation (ft): -9.6 NGVD 29
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USCS: SP	Munsell: Moist - 2.5Y-5/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g): 162.97	Wash Weight (g): 158.27	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 3.01 #230 - 2.88	Organics (%):	Carbonates (%): 7.5	Shells (%): 4
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.00	0.00	0.00	100.00
#7	-1.50	2.83	0.00	0.00	0.00	100.00
#10	-1.00	2.00	0.03	0.02	0.03	99.98
#14	-0.50	1.41	0.42	0.26	0.45	99.72
#18	0.00	1.00	0.88	0.54	1.33	99.18
#25	0.50	0.71	1.64	1.01	2.97	98.17
#35	1.00	0.50	2.37	1.45	5.34	96.72
#45	1.50	0.35	3.73	2.29	9.07	94.43
#60	2.00	0.25	18.32	11.24	27.39	83.19
#80	2.50	0.18	49.18	30.18	76.57	53.01
#120	3.00	0.13	64.81	39.77	141.38	13.24
#170	3.50	0.09	15.33	9.41	156.71	3.83
#200	3.75	0.07	1.34	0.82	158.05	3.01
#230	4.00	0.06	0.22	0.13	158.27	2.88

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.44	2.97	2.85	2.54	2.14	1.96	1.38
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.42	0.19	0.62	-1.53	7.45	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-04 #S1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,449	Northing (ft): 44,599	Coordinate System: NC State Plane	Elevation (ft): -14.4 NGVD 29
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USCS: SP	Munsell: Moist - 2.5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g): 149.60	Wash Weight (g): 146.75	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.99 #230 - 1.93	Organics (%):	Carbonates (%):	Shells (%): 1
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.05	0.03	0.05	99.97
#7	-1.50	2.83	0.00	0.00	0.05	99.97
#10	-1.00	2.00	0.09	0.06	0.14	99.91
#14	-0.50	1.41	0.17	0.11	0.31	99.80
#18	0.00	1.00	0.32	0.21	0.63	99.59
#25	0.50	0.71	0.30	0.20	0.93	99.39
#35	1.00	0.50	0.69	0.46	1.62	98.93
#45	1.50	0.35	1.67	1.12	3.29	97.81
#60	2.00	0.25	17.75	11.86	21.04	85.95
#80	2.50	0.18	60.44	40.40	81.48	45.55
#120	3.00	0.13	58.02	38.78	139.50	6.77
#170	3.50	0.09	6.72	4.49	146.22	2.28
#200	3.75	0.07	0.44	0.29	146.66	1.99
#230	4.00	0.06	0.09	0.06	146.75	1.93

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.20	2.88	2.76	2.44	2.14	2.02	1.62
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.4	0.19	0.48	-1.67	12.33	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS, GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-04 #S2
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,449	Northing (ft): 44,599	Coordinate System: NC State Plane	Elevation (ft): -19.2 NGVD 29
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USCS: SP-SM	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g): 155.83	Wash Weight (g): 144.90	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 7.07 #230 - 7.01	Organics (%):	Carbonates (%):	Shells (%): 0
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.00	0.00	0.00	100.00
#7	-1.50	2.83	0.00	0.00	0.00	100.00
#10	-1.00	2.00	0.08	0.05	0.08	99.95
#14	-0.50	1.41	0.04	0.03	0.12	99.92
#18	0.00	1.00	0.14	0.09	0.26	99.83
#25	0.50	0.71	0.23	0.15	0.49	99.68
#35	1.00	0.50	0.39	0.25	0.88	99.43
#45	1.50	0.35	0.92	0.59	1.80	98.84
#60	2.00	0.25	4.66	2.99	6.46	95.85
#80	2.50	0.18	38.93	24.98	45.39	70.87
#120	3.00	0.13	85.84	55.09	131.23	15.78
#170	3.50	0.09	12.90	8.28	144.13	7.50
#200	3.75	0.07	0.67	0.43	144.80	7.07
#230	4.00	0.06	0.10	0.06	144.90	7.01

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
	3.00	2.92	2.69	2.42	2.24	2.02
Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
Statistics	2.61	0.16	0.4	-1.84	14.1	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS, GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-05 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,017	Northing (ft): 44,947	Coordinate System: NC State Plane	Elevation (ft): -6.3 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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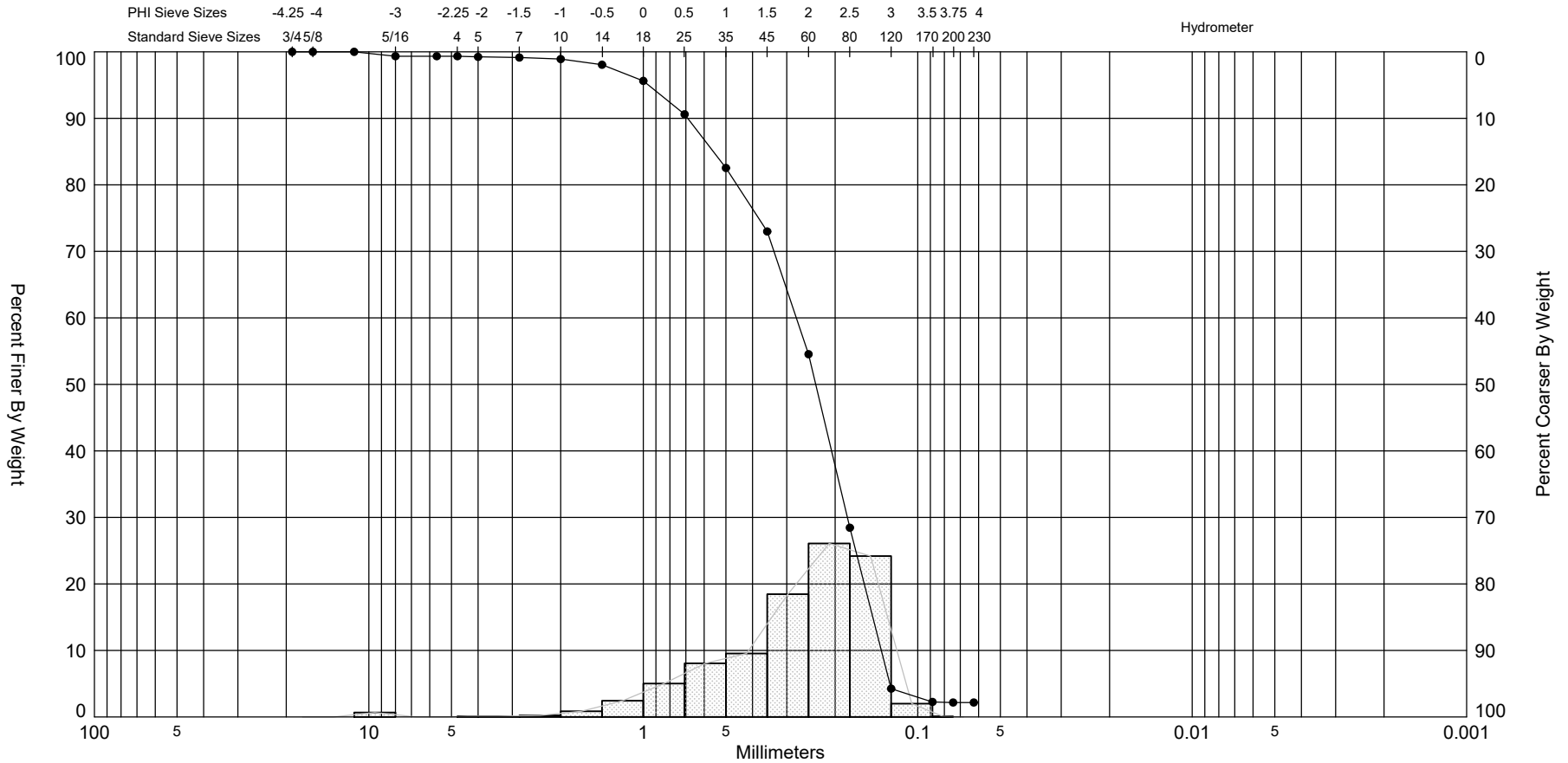
Dry Weight (g): 153.69	Wash Weight (g): 150.35	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 2.17 #230 - 2.17	Organics (%):	Carbonates (%): 9.5	Shells (%): 13
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	1.02	0.66	1.02	99.34
#3.5	-2.50	5.66	0.00	0.00	1.02	99.34
#4	-2.25	4.76	0.00	0.00	1.02	99.34
#5	-2.00	4.00	0.15	0.10	1.17	99.24
#7	-1.50	2.83	0.15	0.10	1.32	99.14
#10	-1.00	2.00	0.35	0.23	1.67	98.91
#14	-0.50	1.41	1.31	0.85	2.98	98.06
#18	0.00	1.00	3.74	2.43	6.72	95.63
#25	0.50	0.71	7.71	5.02	14.43	90.61
#35	1.00	0.50	12.41	8.07	26.84	82.54
#45	1.50	0.35	14.67	9.55	41.51	72.99
#60	2.00	0.25	28.35	18.45	69.86	54.54
#80	2.50	0.18	40.10	26.09	109.96	28.45
#120	3.00	0.13	37.17	24.19	147.13	4.26
#170	3.50	0.09	3.08	2.00	150.21	2.26
#200	3.75	0.07	0.14	0.09	150.35	2.17
#230	4.00	0.06	0.00	0.00	150.35	2.17

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.98	2.76	2.57	2.09	1.39	0.91	0.06
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	1.84	0.28	0.97	-1.62	7.47	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ FL DEP ROSS.GDT 8/31/22



Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-05 #S1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,017	Northing (ft): 44,947	Coordinate System: NC State Plane	Elevation (ft): -10.8 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-5/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g): 146.33	Wash Weight (g): 143.23	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 2.13 #230 - 2.13	Organics (%):	Carbonates (%):	Shells (%): 10
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.08	0.05	0.08	99.95
#4	-2.25	4.76	0.00	0.00	0.08	99.95
#5	-2.00	4.00	0.00	0.00	0.08	99.95
#7	-1.50	2.83	0.26	0.18	0.34	99.77
#10	-1.00	2.00	0.21	0.14	0.55	99.63
#14	-0.50	1.41	0.79	0.54	1.34	99.09
#18	0.00	1.00	1.71	1.17	3.05	97.92
#25	0.50	0.71	3.03	2.07	6.08	95.85
#35	1.00	0.50	3.38	2.31	9.46	93.54
#45	1.50	0.35	5.94	4.06	15.40	89.48
#60	2.00	0.25	25.70	17.56	41.10	71.92
#80	2.50	0.18	47.67	32.58	88.77	39.34
#120	3.00	0.13	48.82	33.36	137.59	5.98
#170	3.50	0.09	5.45	3.72	143.04	2.26
#200	3.75	0.07	0.19	0.13	143.23	2.13
#230	4.00	0.06	0.00	0.00	143.23	2.13

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.13	2.85	2.71	2.34	1.91	1.66	0.68
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.19	0.22	0.73	-1.85	8.28	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion

Sample Name: JBS-22-05 #S2

Analysis Date: 08-12-22

Analyzed By: CRM

Easting (ft): Northing (ft):
2,295,017 44,947

Coordinate System: Elevation (ft):
NC State Plane -15.4 NGVD 29

USCS: Munsell: Comments:
SP Moist - 5Y-6/2 Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL

Dry Weight (g): Wash Weight (g): Pan Retained (g): Sieve Loss (%): Fines (%): Organics (%): Carbonates (%): Shells (%):
158.41 156.68 #200 - 1.09 18
 #230 - 1.09

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.02	0.01	0.02	99.99
#7	-1.50	2.83	0.16	0.10	0.18	99.89
#10	-1.00	2.00	0.41	0.26	0.59	99.63
#14	-0.50	1.41	3.12	1.97	3.71	97.66
#18	0.00	1.00	11.15	7.04	14.86	90.62
#25	0.50	0.71	24.68	15.58	39.54	75.04
#35	1.00	0.50	28.70	18.12	68.24	56.92
#45	1.50	0.35	22.23	14.03	90.47	42.89
#60	2.00	0.25	25.55	16.13	116.02	26.76
#80	2.50	0.18	23.49	14.83	139.51	11.93
#120	3.00	0.13	16.20	10.23	155.71	1.70
#170	3.50	0.09	0.91	0.57	156.62	1.13
#200	3.75	0.07	0.06	0.04	156.68	1.09
#230	4.00	0.06	0.00	0.00	156.68	1.09

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.84	2.36	2.06	1.25	0.50	0.21	-0.31
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	1.24	0.42	0.96	-0.07	2.18	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-06 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,294,323	Northing (ft): 44,771	Coordinate System: NC State Plane	Elevation (ft): -11.3 NGVD 29
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USCS: SP-SM	Munsell: Moist - 5Y-5/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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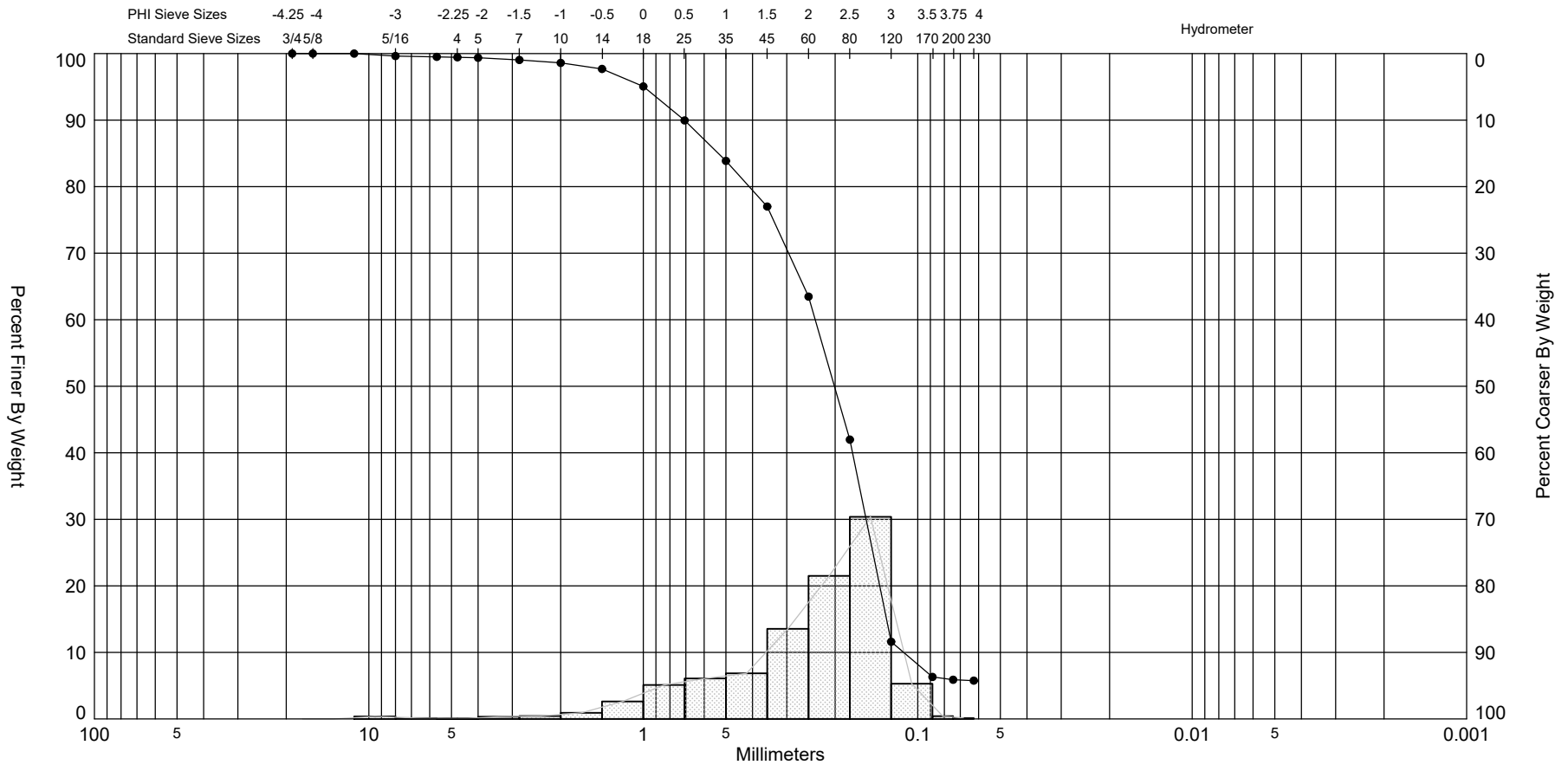
Dry Weight (g): 137.77	Wash Weight (g): 129.82	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 5.89 #230 - 5.76	Organics (%):	Carbonates (%): 10.2	Shells (%): 5
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.51	0.37	0.51	99.63
#3.5	-2.50	5.66	0.17	0.12	0.68	99.51
#4	-2.25	4.76	0.09	0.07	0.77	99.44
#5	-2.00	4.00	0.09	0.07	0.86	99.37
#7	-1.50	2.83	0.46	0.33	1.32	99.04
#10	-1.00	2.00	0.60	0.44	1.92	98.60
#14	-0.50	1.41	1.26	0.91	3.18	97.69
#18	0.00	1.00	3.63	2.63	6.81	95.06
#25	0.50	0.71	7.04	5.11	13.85	89.95
#35	1.00	0.50	8.37	6.08	22.22	83.87
#45	1.50	0.35	9.45	6.86	31.67	77.01
#60	2.00	0.25	18.65	13.54	50.32	63.47
#80	2.50	0.18	29.60	21.49	79.92	41.98
#120	3.00	0.13	41.85	30.38	121.77	11.60
#170	3.50	0.09	7.29	5.29	129.06	6.31
#200	3.75	0.07	0.58	0.42	129.64	5.89
#230	4.00	0.06	0.18	0.13	129.82	5.76


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
	2.93	2.78	2.31	1.57	0.99	0.01
Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
Statistics	1.96	0.26	1.04	-1.52	6.12	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-06 #C1	—●—	-11.3	SP-SM	#200 - 5.89 #230 - 5.76		10.2	2.31	1.96	-1.52	6.12	1.04	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
							Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800					Easting (X, ft):	2,294,323
												Northing (Y, ft):	44,771
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-06 #S1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,294,323	Northing (ft): 44,771	Coordinate System: NC State Plane	Elevation (ft): -15.5 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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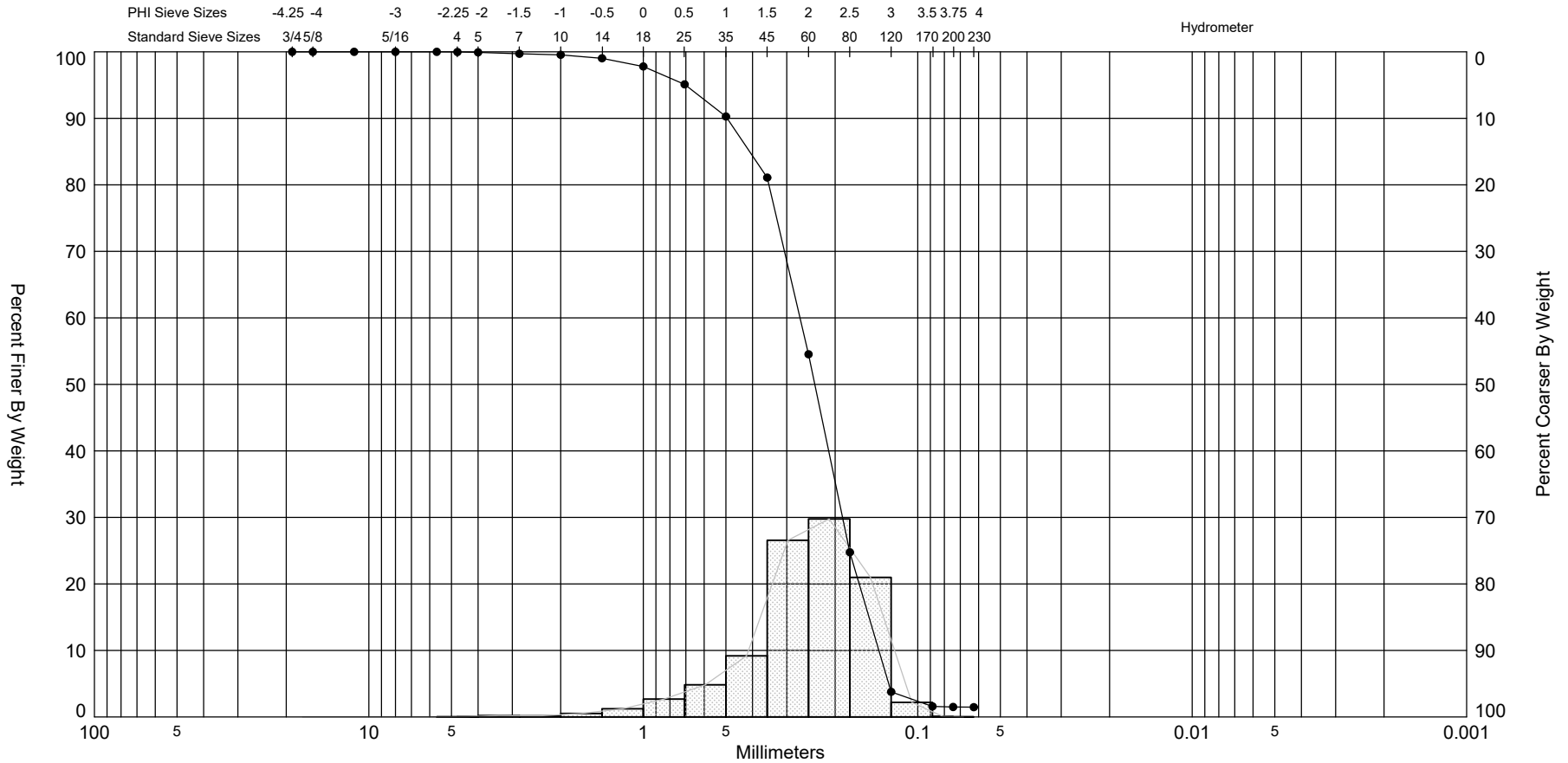
Dry Weight (g): 154.81	Wash Weight (g): 152.51	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.50 #230 - 1.47	Organics (%):	Carbonates (%):	Shells (%): 3
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.05	0.03	0.05	99.97
#5	-2.00	4.00	0.07	0.05	0.12	99.92
#7	-1.50	2.83	0.32	0.21	0.44	99.71
#10	-1.00	2.00	0.24	0.16	0.68	99.55
#14	-0.50	1.41	0.80	0.52	1.48	99.03
#18	0.00	1.00	1.91	1.23	3.39	97.80
#25	0.50	0.71	4.17	2.69	7.56	95.11
#35	1.00	0.50	7.48	4.83	15.04	90.28
#45	1.50	0.35	14.22	9.19	29.26	81.09
#60	2.00	0.25	41.11	26.56	70.37	54.53
#80	2.50	0.18	46.08	29.77	116.45	24.76
#120	3.00	0.13	32.48	20.98	148.93	3.78
#170	3.50	0.09	3.39	2.19	152.32	1.59
#200	3.75	0.07	0.14	0.09	152.46	1.50
#230	4.00	0.06	0.05	0.03	152.51	1.47


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.97	2.71	2.50	2.08	1.61	1.34	0.51
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	1.96	0.26	0.75	-1.28	5.92	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ FL DEP ROSS.GDT 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-06 #S1	—●—	-15.5	SP	#200 - 1.50 #230 - 1.47			2.08	1.96	-1.28	5.92	0.75	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
							Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800					Easting (X, ft):	2,294,323
												Northing (Y, ft):	44,771
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-06 #S2
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,294,323	Northing (ft): 44,771	Coordinate System: NC State Plane	Elevation (ft): -19.8 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-5/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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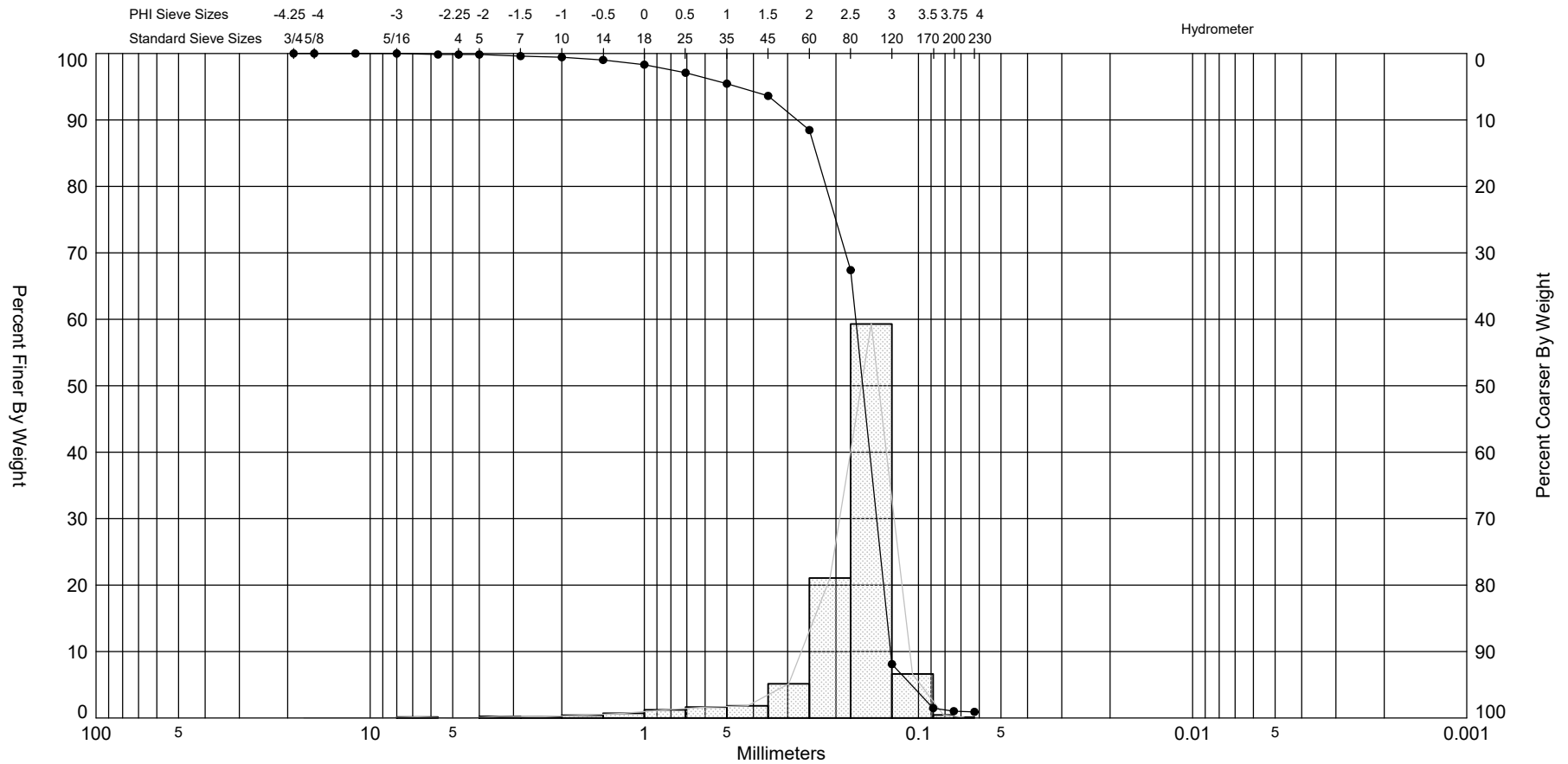
Dry Weight (g): 145.80	Wash Weight (g): 144.46	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.03 #230 - 0.92	Organics (%):	Carbonates (%):	Shells (%): 2
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.22	0.15	0.22	99.85
#4	-2.25	4.76	0.00	0.00	0.22	99.85
#5	-2.00	4.00	0.00	0.00	0.22	99.85
#7	-1.50	2.83	0.35	0.24	0.57	99.61
#10	-1.00	2.00	0.25	0.17	0.82	99.44
#14	-0.50	1.41	0.60	0.41	1.42	99.03
#18	0.00	1.00	1.03	0.71	2.45	98.32
#25	0.50	0.71	1.78	1.22	4.23	97.10
#35	1.00	0.50	2.39	1.64	6.62	95.46
#45	1.50	0.35	2.68	1.84	9.30	93.62
#60	2.00	0.25	7.51	5.15	16.81	88.47
#80	2.50	0.18	30.72	21.07	47.53	67.40
#120	3.00	0.13	86.45	59.29	133.98	8.11
#170	3.50	0.09	9.66	6.63	143.64	1.48
#200	3.75	0.07	0.66	0.45	144.30	1.03
#230	4.00	0.06	0.16	0.11	144.46	0.92


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.23	2.93	2.86	2.65	2.32	2.11	1.13
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.48	0.18	0.69	-3.05	16.12	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: 0A1, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-06 #S2	—●—	-19.8	SP	#200 - 1.03 #230 - 0.92			2.65	2.48	-3.05	16.12	0.69	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
							Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800					Easting (X, ft):	2,294,323
												Northing (Y, ft):	44,771
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-07 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,127	Northing (ft): 44,142	Coordinate System: NC State Plane	Elevation (ft): -12.7 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-5/1	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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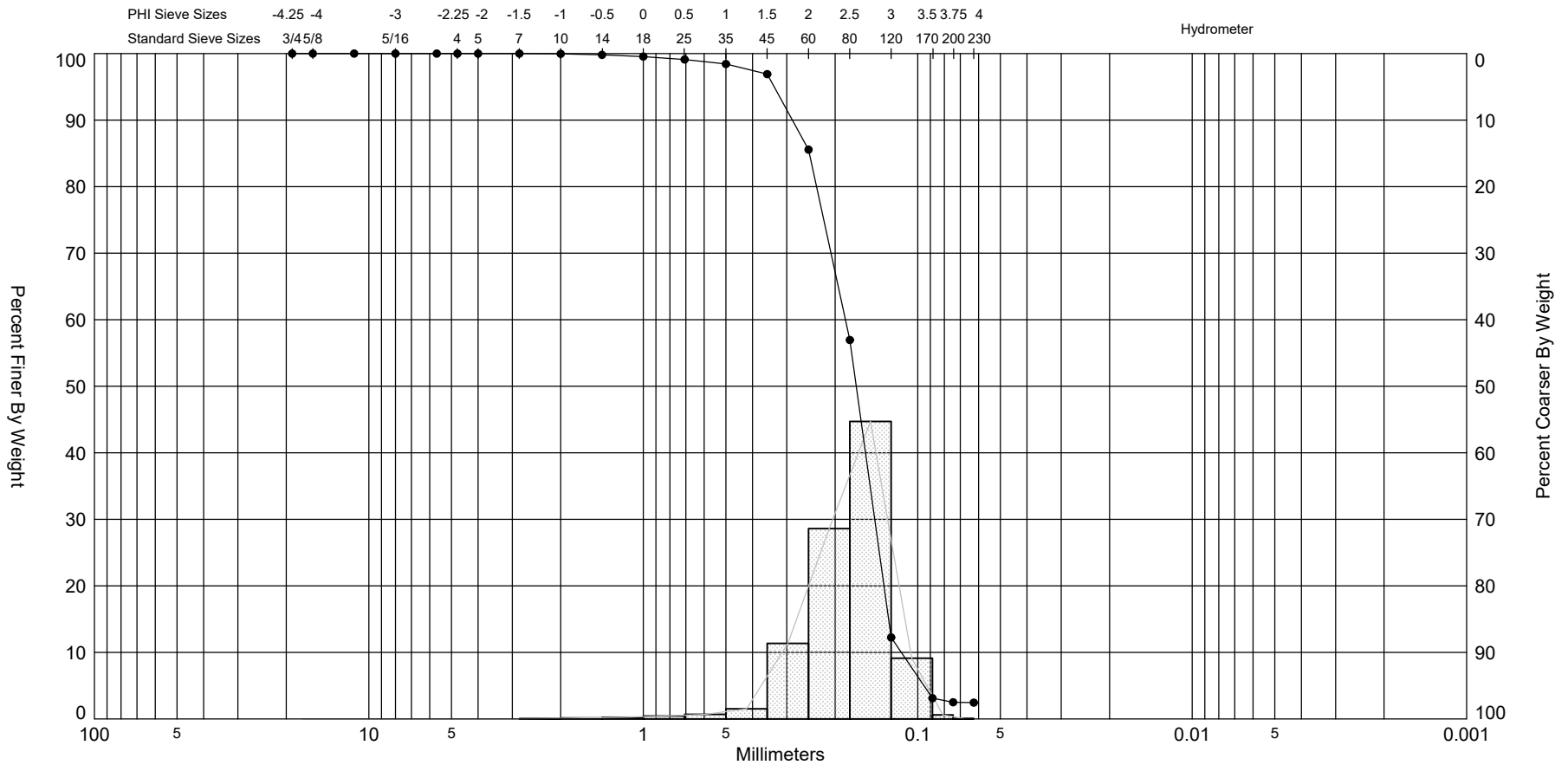
Dry Weight (g): 138.38	Wash Weight (g): 134.98	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 2.51 #230 - 2.45	Organics (%):	Carbonates (%): 7.7	Shells (%): 4
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.00	0.00	0.00	100.00
#7	-1.50	2.83	0.00	0.00	0.00	100.00
#10	-1.00	2.00	0.06	0.04	0.06	99.96
#14	-0.50	1.41	0.21	0.15	0.27	99.81
#18	0.00	1.00	0.36	0.26	0.63	99.55
#25	0.50	0.71	0.61	0.44	1.24	99.11
#35	1.00	0.50	0.94	0.68	2.18	98.43
#45	1.50	0.35	2.10	1.52	4.28	96.91
#60	2.00	0.25	15.70	11.35	19.98	85.56
#80	2.50	0.18	39.59	28.61	59.57	56.95
#120	3.00	0.13	61.85	44.70	121.42	12.25
#170	3.50	0.09	12.63	9.13	134.05	3.12
#200	3.75	0.07	0.85	0.61	134.90	2.51
#230	4.00	0.06	0.08	0.06	134.98	2.45


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.40	2.96	2.86	2.58	2.18	2.03	1.58
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.48	0.18	0.53	-1.5	8.52	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ FL DEP ROSS.GDT 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-07 #C1	—●—	-12.7	SP	#200 - 2.51 #230 - 2.45		7.7	2.58	2.48	-1.5	8.52	0.53	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
											Easting (X, ft):	2,295,127	
											Northing (Y, ft):	44,142	
											Horizontal System:	NAD 1983	
											Vertical System:	NGVD 29	
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-07 #S1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,127	Northing (ft): 44,142	Coordinate System: NC State Plane	Elevation (ft): -15.1 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/1	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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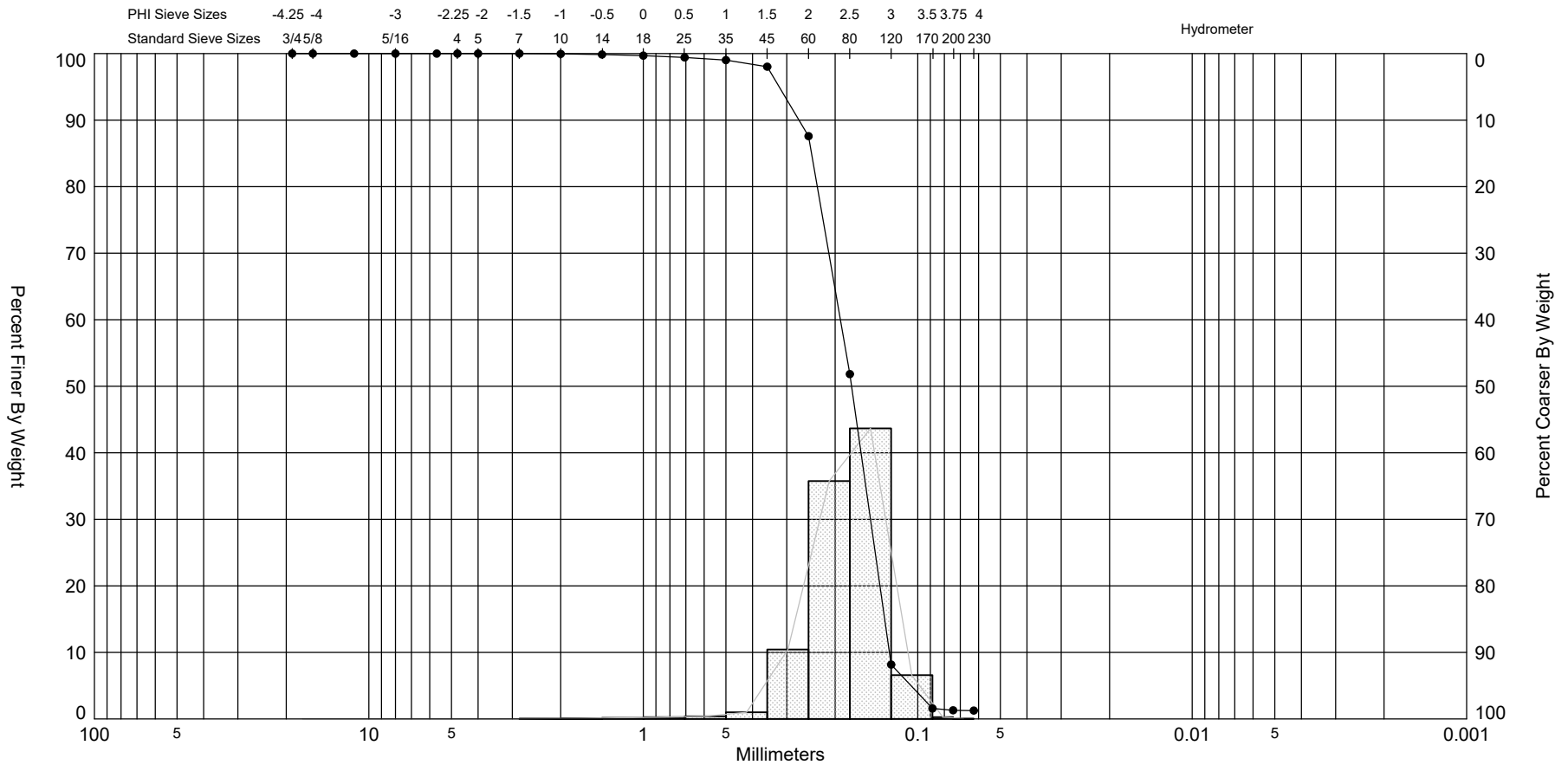
Dry Weight (g): 137.32	Wash Weight (g): 135.59	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.30 #230 - 1.26	Organics (%):	Carbonates (%):	Shells (%): 2
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.00	0.00	0.00	100.00
#7	-1.50	2.83	0.00	0.00	0.00	100.00
#10	-1.00	2.00	0.07	0.05	0.07	99.95
#14	-0.50	1.41	0.12	0.09	0.19	99.86
#18	0.00	1.00	0.23	0.17	0.42	99.69
#25	0.50	0.71	0.37	0.27	0.79	99.42
#35	1.00	0.50	0.55	0.40	1.34	99.02
#45	1.50	0.35	1.36	0.99	2.70	98.03
#60	2.00	0.25	14.33	10.44	17.03	87.59
#80	2.50	0.18	49.11	35.76	66.14	51.83
#120	3.00	0.13	59.96	43.66	126.10	8.17
#170	3.50	0.09	9.05	6.59	135.15	1.58
#200	3.75	0.07	0.38	0.28	135.53	1.30
#230	4.00	0.06	0.06	0.04	135.59	1.26


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.24	2.91	2.81	2.52	2.18	2.05	1.65
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.46	0.18	0.47	-1.42	9.55	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-07 #S1	—●—	-15.1	SP	#200 - 1.30 #230 - 1.26			2.52	2.46	-1.42	9.55	0.47	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
											Easting (X, ft):	2,295,127	
											Northing (Y, ft):	44,142	
											Horizontal System:	NAD 1983	
											Vertical System:	NGVD 29	
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion

Sample Name: JBS-22-07 #S2

Analysis Date: 08-12-22

Analyzed By: CRM

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
2,295,127	44,142	NC State Plane	-17.6 NGVD 29

USCS: SP	Munsell: Moist - 5Y-4/1	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
122.30	119.20			#200 - 2.71 #230 - 2.54			3

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.04	0.03	0.04	99.97
#7	-1.50	2.83	0.06	0.05	0.10	99.92
#10	-1.00	2.00	0.04	0.03	0.14	99.89
#14	-0.50	1.41	0.10	0.08	0.24	99.81
#18	0.00	1.00	0.17	0.14	0.41	99.67
#25	0.50	0.71	0.37	0.30	0.78	99.37
#35	1.00	0.50	0.62	0.51	1.40	98.86
#45	1.50	0.35	1.52	1.24	2.92	97.62
#60	2.00	0.25	10.11	8.27	13.03	89.35
#80	2.50	0.18	25.22	20.62	38.25	68.73
#120	3.00	0.13	60.78	49.70	99.03	19.03
#170	3.50	0.09	18.47	15.10	117.50	3.93
#200	3.75	0.07	1.49	1.22	118.99	2.71
#230	4.00	0.06	0.21	0.17	119.20	2.54

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.46	3.10	2.94	2.69	2.35	2.13	1.66
Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
Statistics	2.6	0.16	0.53	-1.78	11.53	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-08 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,745	Northing (ft): 43,656	Coordinate System: NC State Plane	Elevation (ft): -17.6 NGVD 29
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USCS: SP	Munsell: Moist - 2.5Y-5/3	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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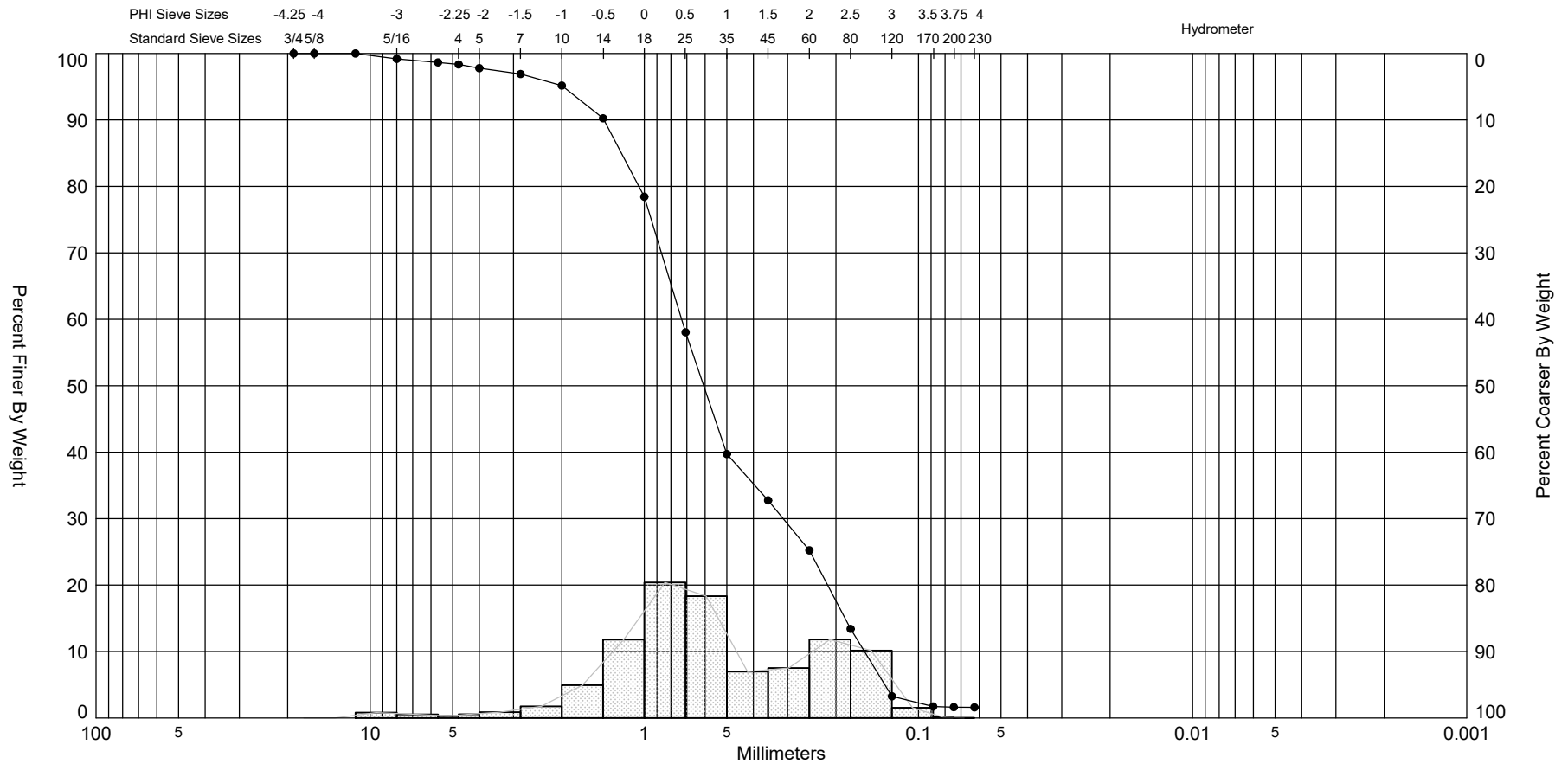
Dry Weight (g): 147.23	Wash Weight (g): 144.87	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.63 #230 - 1.60	Organics (%):	Carbonates (%): 19.8	Shells (%): 15
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	1.19	0.81	1.19	99.19
#3.5	-2.50	5.66	0.79	0.54	1.98	98.65
#4	-2.25	4.76	0.44	0.30	2.42	98.35
#5	-2.00	4.00	0.82	0.56	3.24	97.79
#7	-1.50	2.83	1.30	0.88	4.54	96.91
#10	-1.00	2.00	2.56	1.74	7.10	95.17
#14	-0.50	1.41	7.26	4.93	14.36	90.24
#18	0.00	1.00	17.38	11.80	31.74	78.44
#25	0.50	0.71	30.02	20.39	61.76	58.05
#35	1.00	0.50	26.99	18.33	88.75	39.72
#45	1.50	0.35	10.26	6.97	99.01	32.75
#60	2.00	0.25	11.07	7.52	110.08	25.23
#80	2.50	0.18	17.40	11.82	127.48	13.41
#120	3.00	0.13	14.93	10.14	142.41	3.27
#170	3.50	0.09	2.27	1.54	144.68	1.73
#200	3.75	0.07	0.14	0.10	144.82	1.63
#230	4.00	0.06	0.05	0.03	144.87	1.60


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.91	2.39	2.01	0.72	0.08	-0.24	-0.98
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	0.86	0.55	1.25	-0.25	3.19	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-08 #C1	—●—	-17.6	SP	#200 - 1.63 #230 - 1.60		19.8	0.72	0.86	-0.25	3.19	1.25	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL												Analysis Date:	08-12-22
Depths and elevations based on measured values												Analyzed By:	CRM
												Easting (X, ft):	2,295,745
												Northing (Y, ft):	43,656
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-08 #S1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,745	Northing (ft): 43,656	Coordinate System: NC State Plane	Elevation (ft): -19.7 NGVD 29
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USCS: SP	Munsell: Moist - 2.5Y-5/3	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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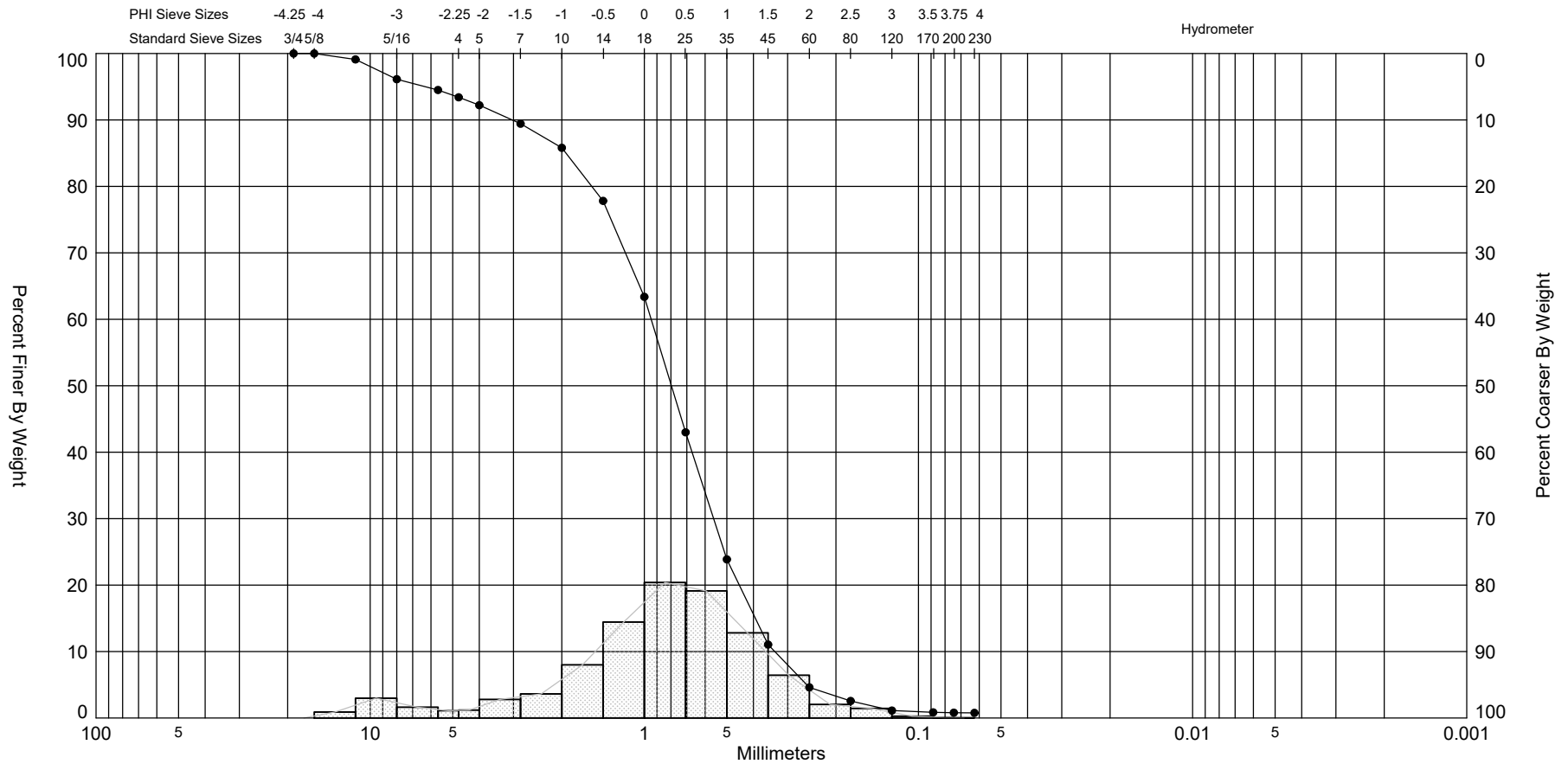
Dry Weight (g): 156.57	Wash Weight (g): 155.39	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 0.80 #230 - 0.77	Organics (%):	Carbonates (%):	Shells (%): 26
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	1.39	0.89	1.39	99.11
5/16	-3.00	8.00	4.66	2.98	6.05	96.13
#3.5	-2.50	5.66	2.53	1.62	8.58	94.51
#4	-2.25	4.76	1.73	1.10	10.31	93.41
#5	-2.00	4.00	1.87	1.19	12.18	92.22
#7	-1.50	2.83	4.37	2.79	16.55	89.43
#10	-1.00	2.00	5.67	3.62	22.22	85.81
#14	-0.50	1.41	12.51	7.99	34.73	77.82
#18	0.00	1.00	22.61	14.44	57.34	63.38
#25	0.50	0.71	31.93	20.39	89.27	42.99
#35	1.00	0.50	29.94	19.12	119.21	23.87
#45	1.50	0.35	20.07	12.82	139.28	11.05
#60	2.00	0.25	10.09	6.44	149.37	4.61
#80	2.50	0.18	3.21	2.05	152.58	2.56
#120	3.00	0.13	2.26	1.44	154.84	1.12
#170	3.50	0.09	0.42	0.27	155.26	0.85
#200	3.75	0.07	0.08	0.05	155.34	0.80
#230	4.00	0.06	0.05	0.03	155.39	0.77


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
1.97	1.31	0.97	0.33	-0.40	-0.89	-2.65
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	0.15	0.90	1.28	-0.83	3.99	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-08 #S1	—●—	-19.7	SP	#200 - 0.80 #230 - 0.77			0.33	0.15	-0.83	3.99	1.28	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL												Analysis Date:	08-12-22
Depths and elevations based on measured values												Analyzed By:	CRM
												Easting (X, ft):	2,295,745
												Northing (Y, ft):	43,656
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-08 #S2
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,745	Northing (ft): 43,656	Coordinate System: NC State Plane	Elevation (ft): -21.9 NGVD 29
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USCS: SP	Munsell: Moist - 2.5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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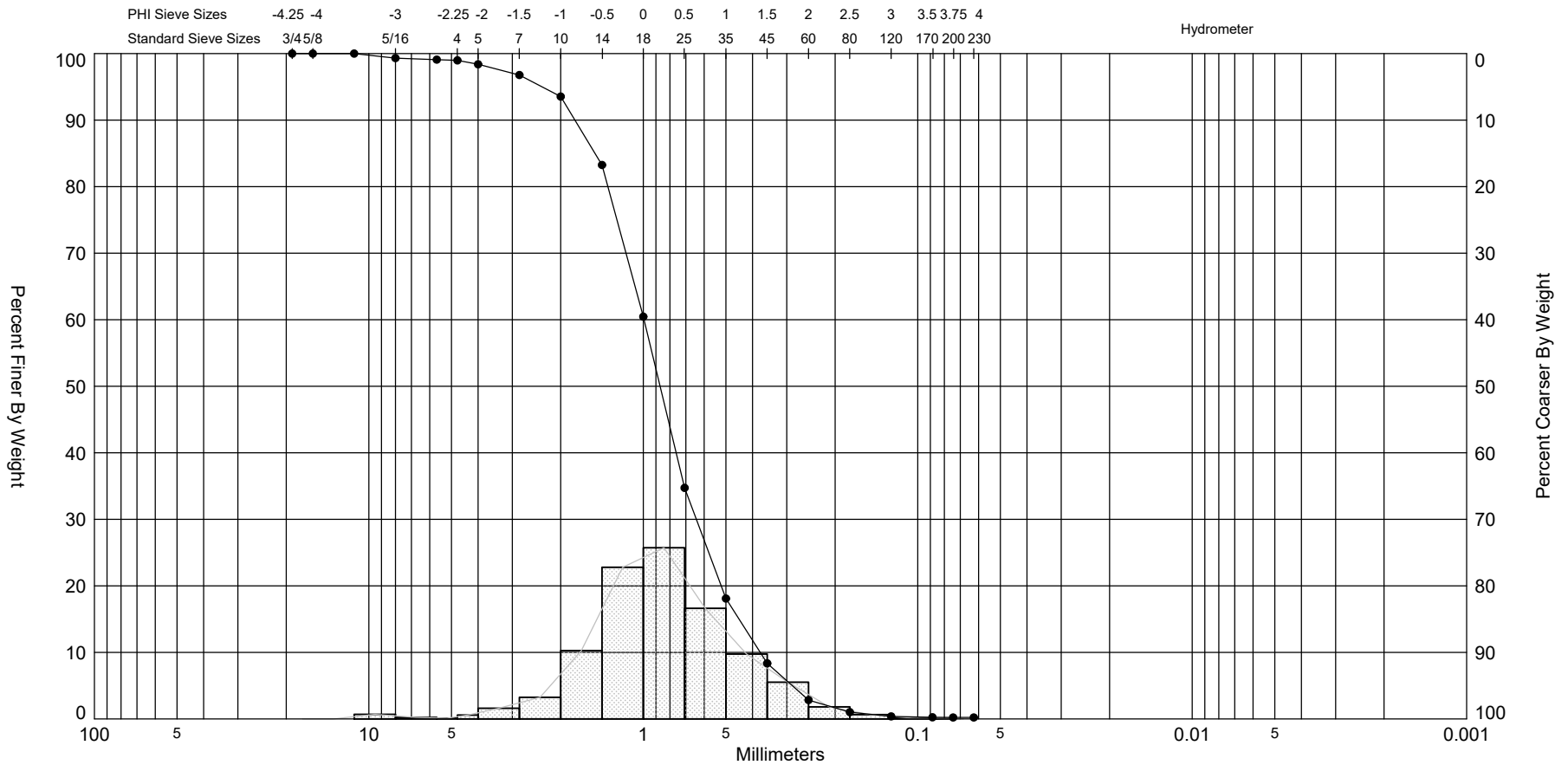
Dry Weight (g): 151.03	Wash Weight (g): 150.65	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 0.22 #230 - 0.22	Organics (%):	Carbonates (%):	Shells (%): 24
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	1.03	0.68	1.03	99.32
#3.5	-2.50	5.66	0.34	0.23	1.37	99.09
#4	-2.25	4.76	0.16	0.11	1.53	98.98
#5	-2.00	4.00	0.89	0.59	2.42	98.39
#7	-1.50	2.83	2.43	1.61	4.85	96.78
#10	-1.00	2.00	4.89	3.24	9.74	93.54
#14	-0.50	1.41	15.52	10.28	25.26	83.26
#18	0.00	1.00	34.43	22.80	59.69	60.46
#25	0.50	0.71	38.86	25.73	98.55	34.73
#35	1.00	0.50	25.12	16.63	123.67	18.10
#45	1.50	0.35	14.71	9.74	138.38	8.36
#60	2.00	0.25	8.33	5.52	146.71	2.84
#80	2.50	0.18	2.75	1.82	149.46	1.02
#120	3.00	0.13	0.96	0.64	150.42	0.38
#170	3.50	0.09	0.19	0.13	150.61	0.25
#200	3.75	0.07	0.04	0.03	150.65	0.22
#230	4.00	0.06	0.00	0.00	150.65	0.22


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
1.80	1.11	0.79	0.20	-0.32	-0.54	-1.23
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	0.23	0.85	0.91	-0.22	4.37	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-08 #S2	—●—	-21.9	SP	#200 - 0.22 #230 - 0.22			0.2	0.23	-0.22	4.37	0.91	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
							Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800					Easting (X, ft):	2,295,745
												Northing (Y, ft):	43,656
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-09 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,294,677	Northing (ft): 43,797	Coordinate System: NC State Plane	Elevation (ft): -12.9 NGVD 29
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USCS: SP-SM	Munsell: Moist - 2.5Y-5/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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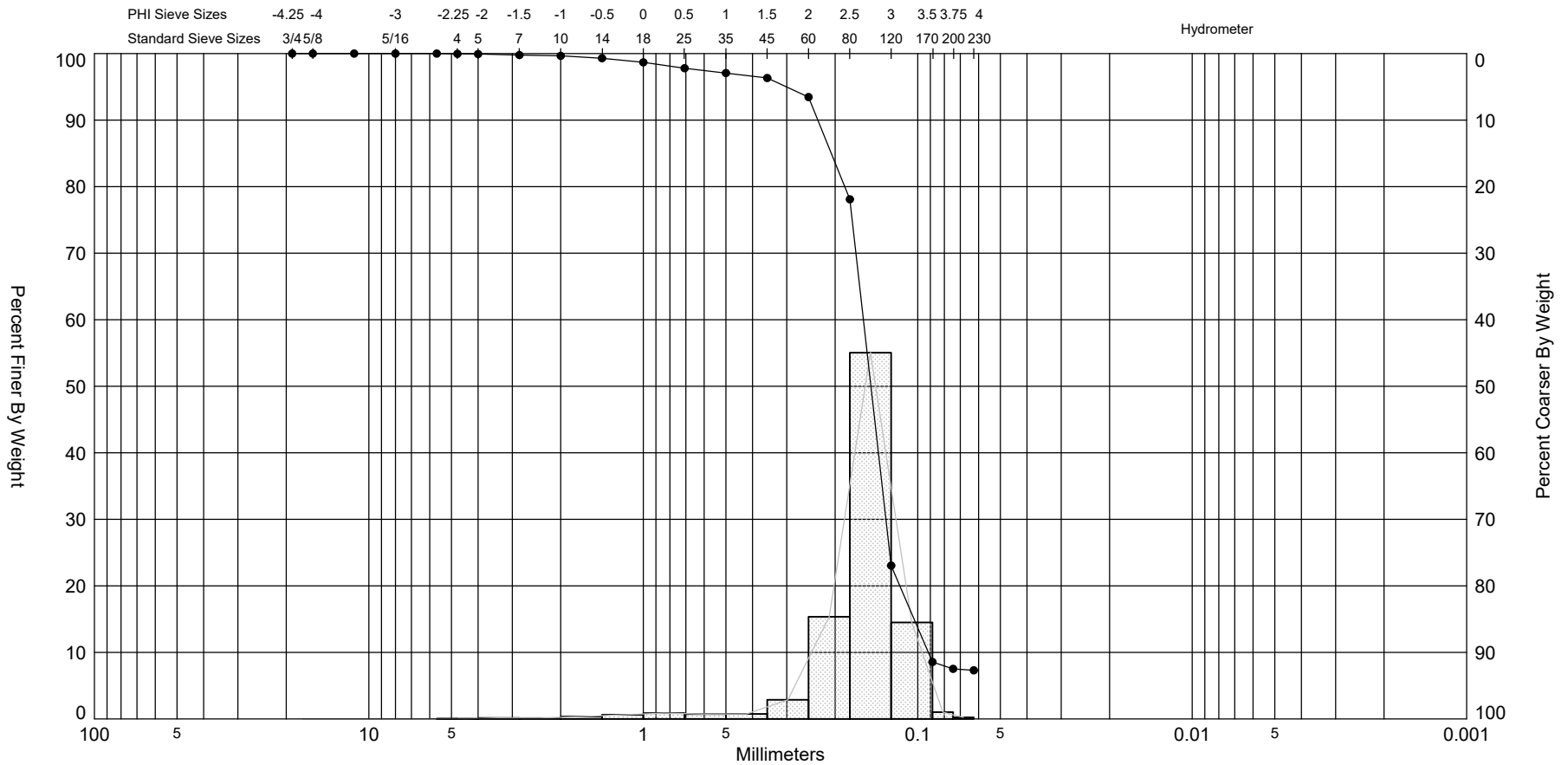
Dry Weight (g): 144.05	Wash Weight (g): 133.54	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 7.53 #230 - 7.31	Organics (%):	Carbonates (%): 8.5	Shells (%): 9
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.06	0.04	0.06	99.96
#5	-2.00	4.00	0.05	0.03	0.11	99.93
#7	-1.50	2.83	0.22	0.15	0.33	99.78
#10	-1.00	2.00	0.18	0.12	0.51	99.66
#14	-0.50	1.41	0.52	0.36	1.03	99.30
#18	0.00	1.00	0.89	0.62	1.92	98.68
#25	0.50	0.71	1.27	0.88	3.19	97.80
#35	1.00	0.50	1.05	0.73	4.24	97.07
#45	1.50	0.35	1.07	0.74	5.31	96.33
#60	2.00	0.25	4.13	2.87	9.44	93.46
#80	2.50	0.18	22.12	15.36	31.56	78.10
#120	3.00	0.13	79.30	55.05	110.86	23.05
#170	3.50	0.09	20.88	14.49	131.74	8.56
#200	3.75	0.07	1.49	1.03	133.23	7.53
#230	4.00	0.06	0.31	0.22	133.54	7.31

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
	3.24	2.98	2.76	2.53	2.31	1.73
Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
Statistics	2.62	0.16	0.63	-3.15	17.73	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ FL DEP ROSS.GDT 8/31/22



Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-09 #S1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,294,677	Northing (ft): 43,797	Coordinate System: NC State Plane	Elevation (ft): -16.6 NGVD 29
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USCS: SP	Munsell: Moist - 2.5Y-5/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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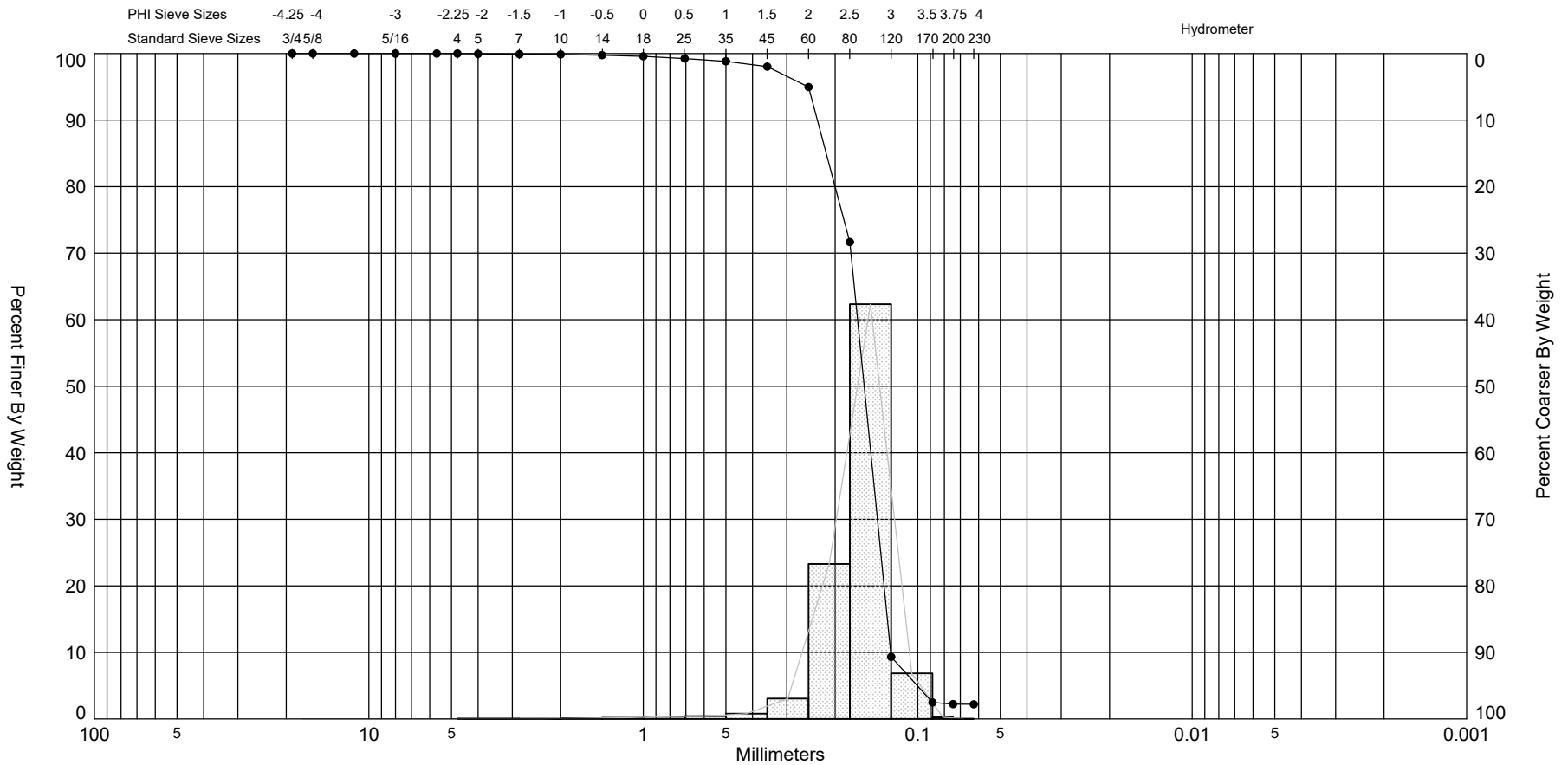
Dry Weight (g): 150.19	Wash Weight (g): 146.91	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 2.23 #230 - 2.20	Organics (%):	Carbonates (%):	Shells (%): 4
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.08	0.05	0.08	99.95
#7	-1.50	2.83	0.08	0.05	0.16	99.90
#10	-1.00	2.00	0.05	0.03	0.21	99.87
#14	-0.50	1.41	0.17	0.11	0.38	99.76
#18	0.00	1.00	0.26	0.17	0.64	99.59
#25	0.50	0.71	0.49	0.33	1.13	99.26
#35	1.00	0.50	0.63	0.42	1.76	98.84
#45	1.50	0.35	1.20	0.80	2.96	98.04
#60	2.00	0.25	4.61	3.07	7.57	94.97
#80	2.50	0.18	35.00	23.30	42.57	71.67
#120	3.00	0.13	93.63	62.34	136.20	9.33
#170	3.50	0.09	10.29	6.85	146.49	2.48
#200	3.75	0.07	0.37	0.25	146.86	2.23
#230	4.00	0.06	0.05	0.03	146.91	2.20


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.32	2.95	2.87	2.67	2.43	2.24	2.00
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	2.59	0.17	0.45	-3.27	24.8	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-09 #S1	—●—	-16.6	SP	#200 - 2.23 #230 - 2.20			2.67	2.59	-3.27	24.8	0.45	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL												Analysis Date:	08-12-22
Depths and elevations based on measured values												Analyzed By:	CRM
												Easting (X, ft):	2,294,677
												Northing (Y, ft):	43,797
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-09 #S2
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,294,677	Northing (ft): 43,797	Coordinate System: NC State Plane	Elevation (ft): -20.3 NGVD 29
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USCS: SP-SM	Munsell: Moist - 2.5Y-5/1	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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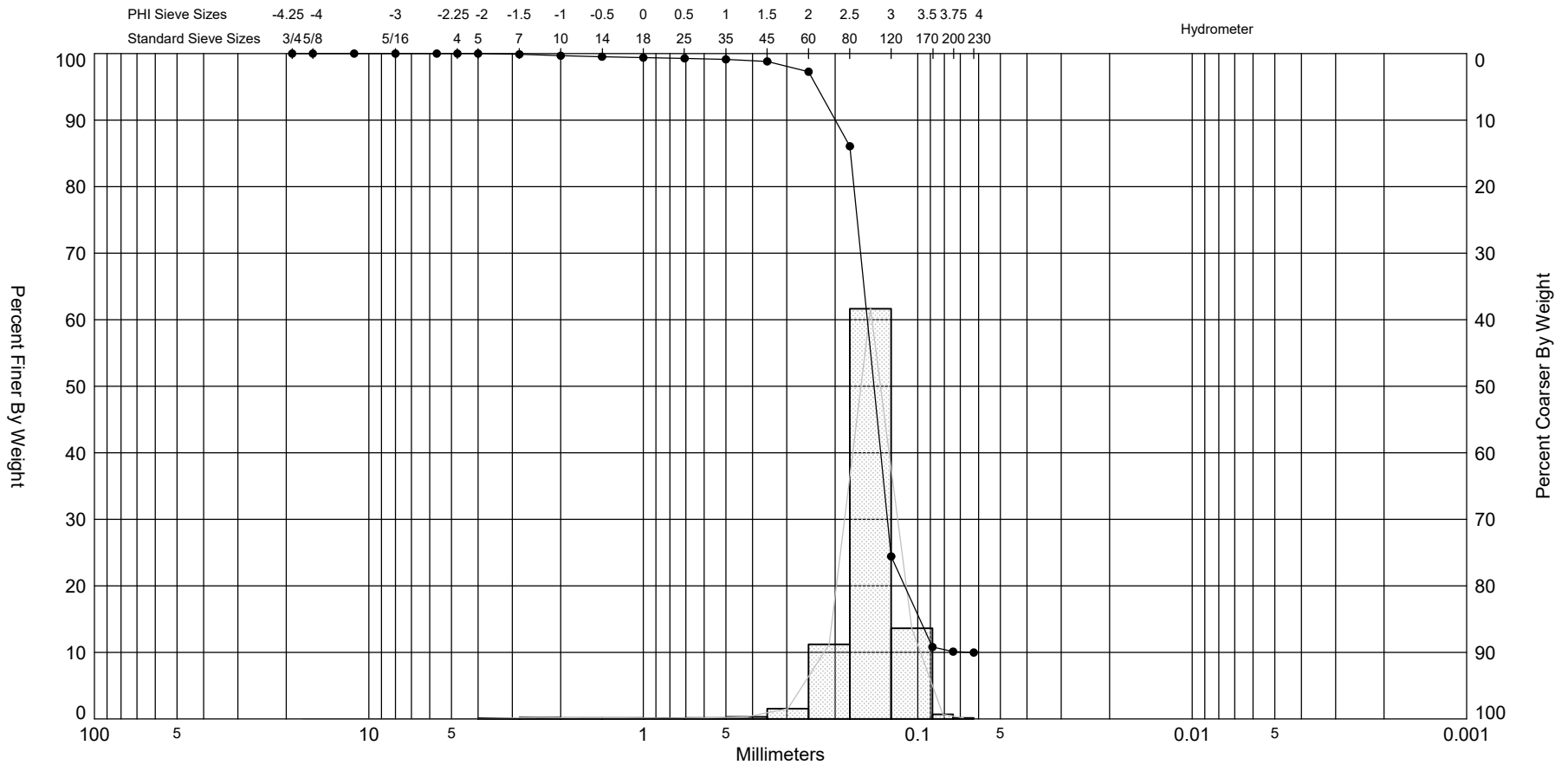
Dry Weight (g): 129.75	Wash Weight (g): 116.79	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 10.12 #230 - 9.98	Organics (%):	Carbonates (%):	Shells (%): 2
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.00	0.00	0.00	100.00
#7	-1.50	2.83	0.14	0.11	0.14	99.89
#10	-1.00	2.00	0.27	0.21	0.41	99.68
#14	-0.50	1.41	0.19	0.15	0.60	99.53
#18	0.00	1.00	0.18	0.14	0.78	99.39
#25	0.50	0.71	0.14	0.11	0.92	99.28
#35	1.00	0.50	0.20	0.15	1.12	99.13
#45	1.50	0.35	0.40	0.31	1.52	98.82
#60	2.00	0.25	2.01	1.55	3.53	97.27
#80	2.50	0.18	14.53	11.20	18.06	86.07
#120	3.00	0.13	79.98	61.64	98.04	24.43
#170	3.50	0.09	17.67	13.62	115.71	10.81
#200	3.75	0.07	0.90	0.69	116.61	10.12
#230	4.00	0.06	0.18	0.14	116.79	9.98


Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
	3.31	3.00	2.79	2.59	2.52	2.10
Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
Statistics	2.72	0.15	0.46	-4.14	34.74	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022), GPJ, FL DEP ROSS, GDT 8/31/22

SIEVE ANALYSIS: OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT, 8/31/22



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
JBS-22-09 #S2	—●—	-20.3	SP-SM	#200 - 10.12 #230 - 9.98			2.79	2.72	-4.14	34.74	0.46	Project Name:	Jay Bird Shoals Borrow Area Expansion
Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL											Analysis Date:	08-12-22	
Depths and elevations based on measured values											Analyzed By:	CRM	
											Easting (X, ft):	2,294,677	
											Northing (Y, ft):	43,797	
											Horizontal System:	NAD 1983	
											Vertical System:	NGVD 29	
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-10 #C1
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,333	Northing (ft): 43,294	Coordinate System: NC State Plane	Elevation (ft): -17.7 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-6/2	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g): 143.30	Wash Weight (g): 140.99	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.64 #230 - 1.61	Organics (%):	Carbonates (%): 14.8	Shells (%): 12
----------------------------------	-----------------------------------	-------------------	-----------------	--	---------------	--------------------------------	--------------------------

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	2.43	1.70	2.43	98.30
5/16	-3.00	8.00	2.69	1.88	5.12	96.42
#3.5	-2.50	5.66	0.35	0.24	5.47	96.18
#4	-2.25	4.76	0.27	0.19	5.74	95.99
#5	-2.00	4.00	0.46	0.32	6.20	95.67
#7	-1.50	2.83	0.61	0.43	6.81	95.24
#10	-1.00	2.00	1.55	1.08	8.36	94.16
#14	-0.50	1.41	3.13	2.18	11.49	91.98
#18	0.00	1.00	7.45	5.20	18.94	86.78
#25	0.50	0.71	14.86	10.37	33.80	76.41
#35	1.00	0.50	19.66	13.72	53.46	62.69
#45	1.50	0.35	19.32	13.48	72.78	49.21
#60	2.00	0.25	14.20	9.91	86.98	39.30
#80	2.50	0.18	24.43	17.05	111.41	22.25
#120	3.00	0.13	26.76	18.67	138.17	3.58
#170	3.50	0.09	2.65	1.85	140.82	1.73
#200	3.75	0.07	0.13	0.09	140.95	1.64
#230	4.00	0.06	0.04	0.03	140.99	1.61

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.96	2.67	2.42	1.47	0.55	0.13	-1.39
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	1.26	0.42	1.44	-1.36	5.34	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion

Sample Name: JBS-22-10 #S1

Analysis Date: 08-12-22

Analyzed By: CRM

Easting (ft): 2,295,333	Northing (ft): 43,294	Coordinate System: NC State Plane	Elevation (ft): -19.8 NGVD 29
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USCS: SP	Munsell: Moist - 5Y-7/1	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g): 155.11	Wash Weight (g): 153.38	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 1.12 #230 - 1.12	Organics (%):	Carbonates (%):	Shells (%): 7
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.53	0.34	0.53	99.66
#4	-2.25	4.76	0.05	0.03	0.58	99.63
#5	-2.00	4.00	0.41	0.26	0.99	99.37
#7	-1.50	2.83	0.43	0.28	1.42	99.09
#10	-1.00	2.00	0.64	0.41	2.06	98.68
#14	-0.50	1.41	1.38	0.89	3.44	97.79
#18	0.00	1.00	3.31	2.13	6.75	95.66
#25	0.50	0.71	7.77	5.01	14.52	90.65
#35	1.00	0.50	10.85	7.00	25.37	83.65
#45	1.50	0.35	10.11	6.52	35.48	77.13
#60	2.00	0.25	14.90	9.61	50.38	67.52
#80	2.50	0.18	60.50	39.00	110.88	28.52
#120	3.00	0.13	41.07	26.48	151.95	2.04
#170	3.50	0.09	1.35	0.87	153.30	1.17
#200	3.75	0.07	0.08	0.05	153.38	1.12
#230	4.00	0.06	0.00	0.00	153.38	1.12

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.94	2.74	2.57	2.22	1.61	0.98	0.07
Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
Statistics	1.93	0.26	0.94	-1.72	6.53	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

Granularmetric Report

Depths and elevations based on measured values



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
Office: 843-887-3800

Project Name: Jay Bird Shoals Borrow Area Expansion
Sample Name: JBS-22-10 #S2
Analysis Date: 08-12-22
Analyzed By: CRM

Easting (ft): 2,295,333	Northing (ft): 43,294	Coordinate System: NC State Plane	Elevation (ft): -21.9 NGVD 29
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USCS: SP	Munsell: Moist - 2.5Y-6/3	Comments: Analysis conducted by Terracon Consultants, Inc. of Jacksonville, FL
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Dry Weight (g): 161.92	Wash Weight (g): 160.33	Pan Retained (g):	Sieve Loss (%):	Fines (%): #200 - 0.99 #230 - 0.99	Organics (%):	Carbonates (%):	Shells (%): 8
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Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	% Passing Sieve
3/4	-4.25	19.03	0.00	0.00	0.00	100.00
5/8	-4.00	16.00	0.00	0.00	0.00	100.00
7/16	-3.50	11.31	0.00	0.00	0.00	100.00
5/16	-3.00	8.00	0.00	0.00	0.00	100.00
#3.5	-2.50	5.66	0.00	0.00	0.00	100.00
#4	-2.25	4.76	0.00	0.00	0.00	100.00
#5	-2.00	4.00	0.00	0.00	0.00	100.00
#7	-1.50	2.83	0.08	0.05	0.08	99.95
#10	-1.00	2.00	0.05	0.03	0.13	99.92
#14	-0.50	1.41	0.31	0.19	0.44	99.73
#18	0.00	1.00	2.62	1.62	3.06	98.11
#25	0.50	0.71	12.52	7.73	15.58	90.38
#35	1.00	0.50	31.80	19.64	47.38	70.74
#45	1.50	0.35	49.58	30.62	96.96	40.12
#60	2.00	0.25	40.13	24.78	137.09	15.34
#80	2.50	0.18	15.32	9.46	152.41	5.88
#120	3.00	0.13	7.31	4.51	159.72	1.37
#170	3.50	0.09	0.61	0.38	160.33	0.99
#200	3.75	0.07	0.00	0.00	160.33	0.99
#230	4.00	0.06	0.00	0.00	160.33	0.99

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.60	1.99	1.81	1.34	0.89	0.66	0.20
Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis	
	1.34	0.40	0.67	0	3.2	

GRANULARMETRIC REPORT OAI, JAY BIRD SHOALS BORROW AREA EXPANSION, NC (2022).GPJ, FL DEP ROSS.GDT 8/31/22

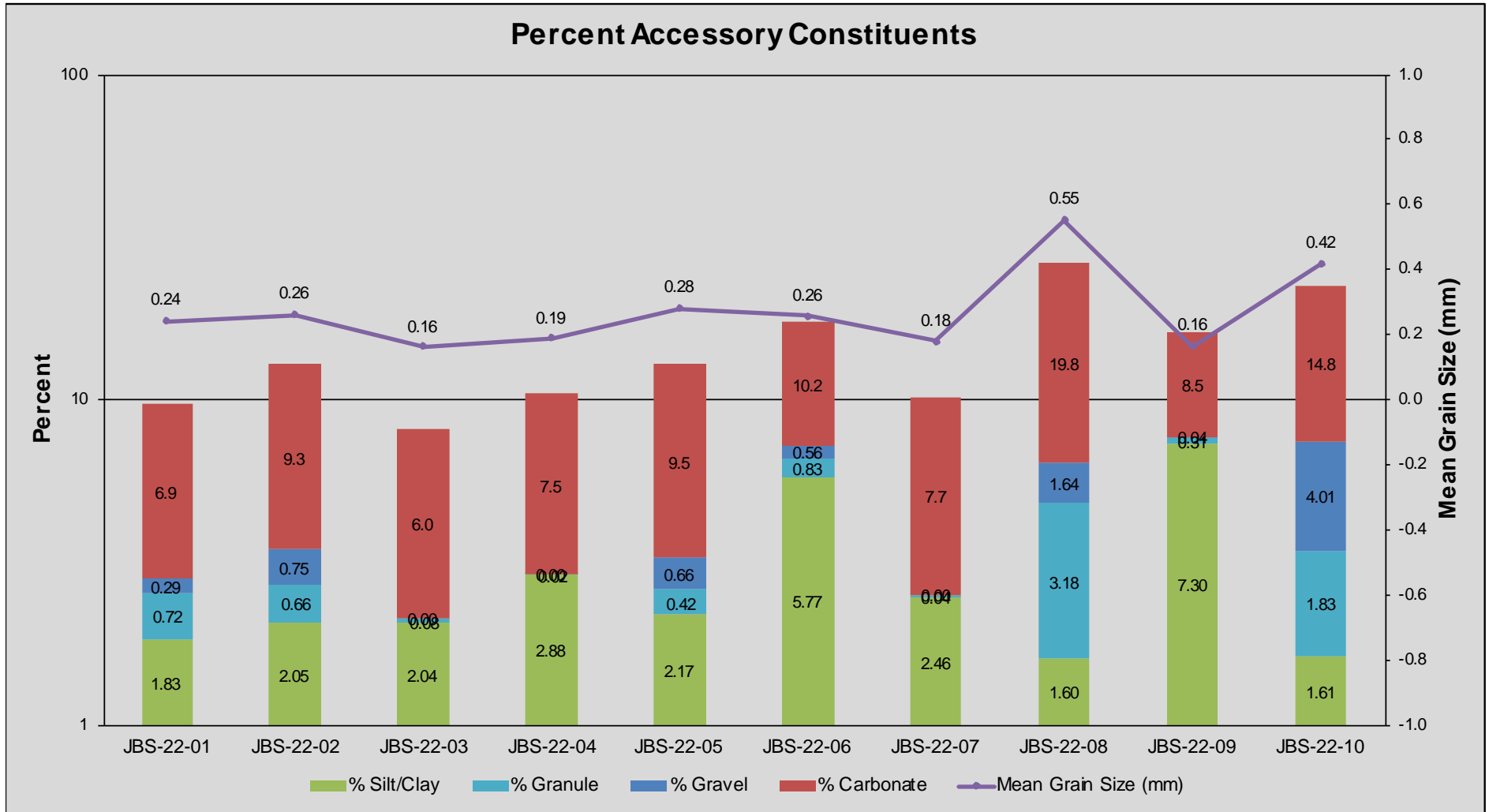
APPENDIX C

Grain Size Data Summary Graphs

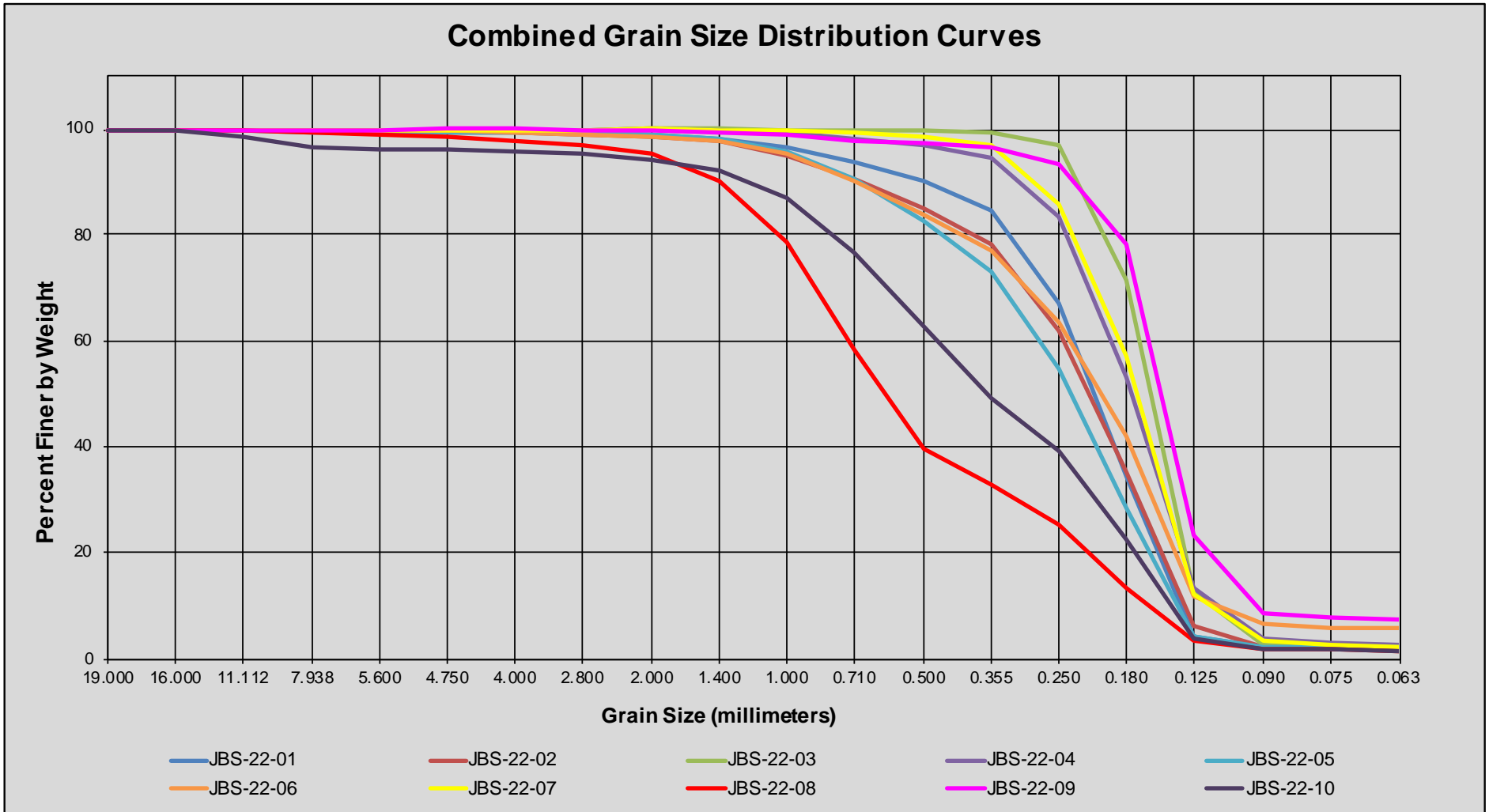


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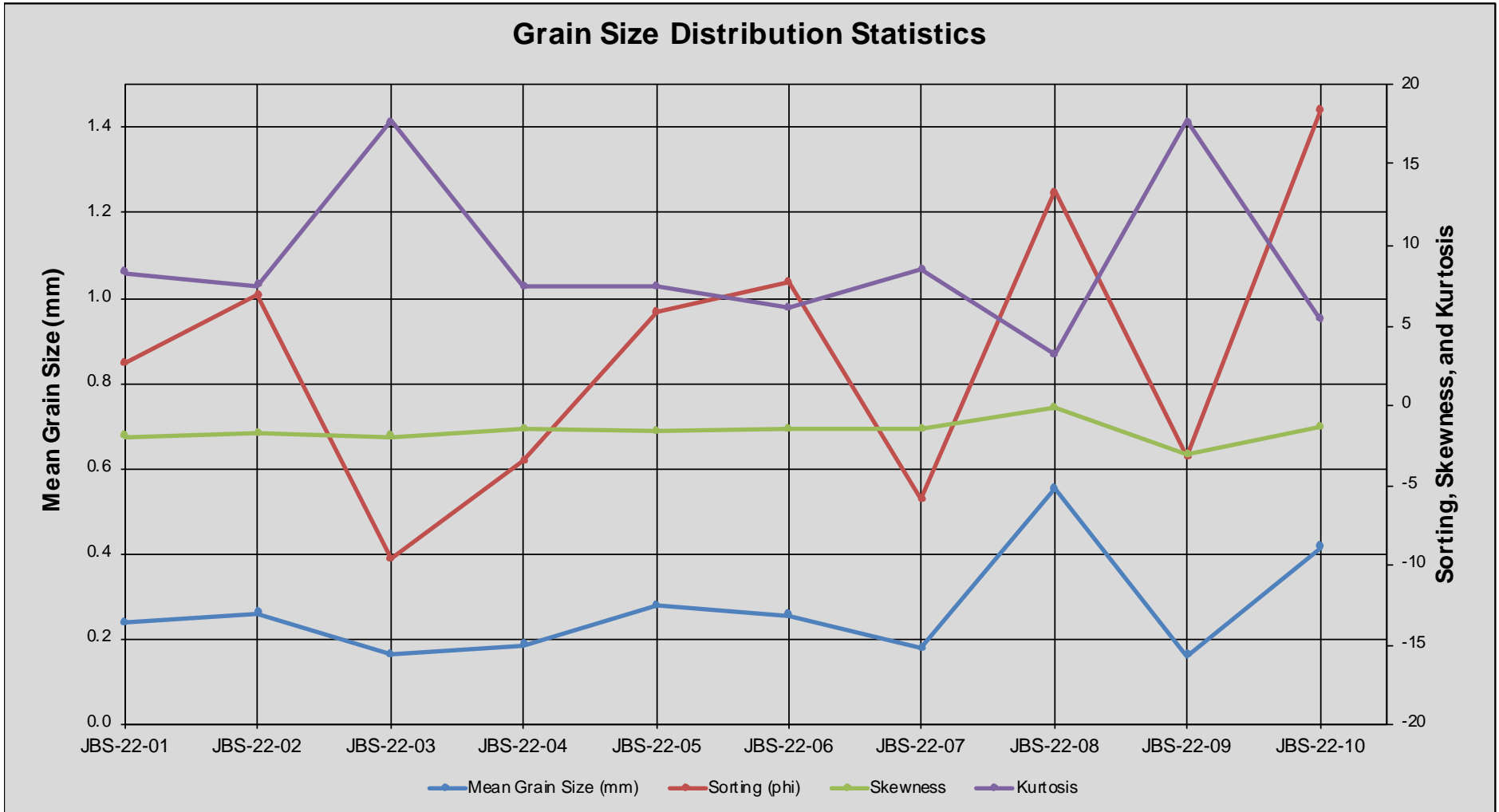
APPENDIX C - Grain Size Data Summary Graphs
Olsen Associates, Inc.
2022 Geotechnical Investigation
Jay Bird Shoals Borrow Area Expansion
Brunswick County, North Carolina



APPENDIX C - Grain Size Data Summary Graphs
Olsen Associates, Inc.
2022 Geotechnical Investigation
Jay Bird Shoals Borrow Area Expansion
Brunswick County, North Carolina



APPENDIX C - Grain Size Data Summary Graphs
Olsen Associates, Inc.
2022 Geotechnical Investigation
Jay Bird Shoals Borrow Area Expansion
Brunswick County, North Carolina



APPENDIX B

Submerged Cultural Resource
Remote-Sensing on Jay Bird Shoals

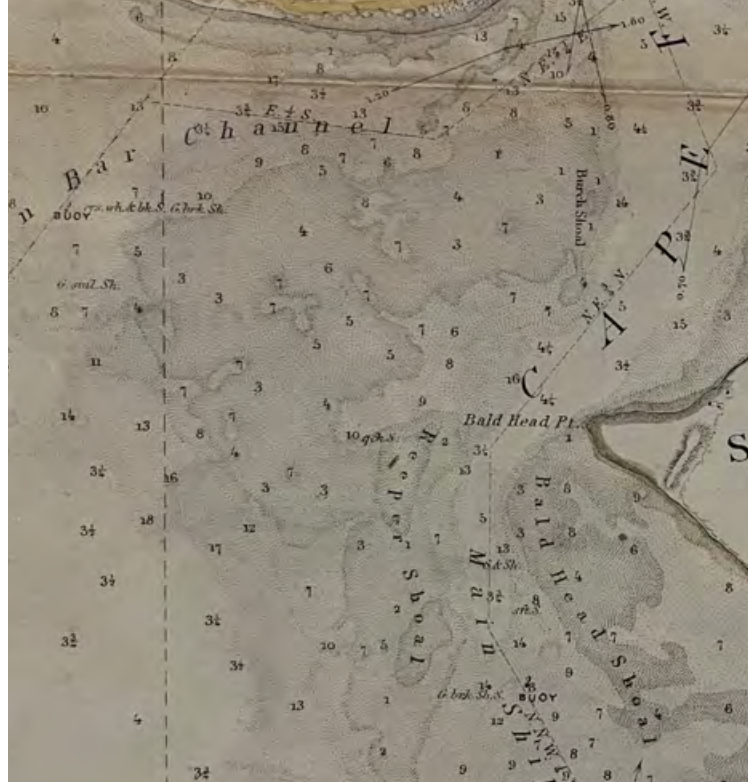
By

Tidewater Atlantic Research, Inc.

17 October 2022

Report entitled:

***A Submerged Cultural Resource Remote-Sensing Survey On Jay Bird Shoals
Off Bald Head Island, Brunswick County, North Carolina***



[Detail of 1853 U.S. Coast Survey map *Preliminary Chart of the Entrances to Cape Fear River and New Inlet North Carolina*]

Submitted to:

**Olsen Associates, Inc.
2618 Herschel Street
Jacksonville, Florida 32204**

Submitted by:

**Gordon P. Watts, Jr., Ph.D, RPA
Tidewater Atlantic Research, Inc.
P. O. Box 2494
Washington, North Carolina 27889**

Submittal Date:

17 October 2022

Abstract

Olsen Associates, Inc. (OAI) of Jacksonville, Florida is the project engineer representing the Village of Bald Head Island (VBHI), North Carolina in developing and permitting an expanded borrow site on Jay Bird Shoals (JBS) near the entrance to the Cape Fear River. Material from the JBS borrow site will be used by the VBHI for engineered beach renourishment. In order to determine the proposed project's effects on potentially significant submerged cultural resources, OAI contracted with Tidewater Atlantic Research, Inc. of Washington, North Carolina to conduct a remote-sensing survey of the proposed borrow site. Field research for the project was conducted on 31 August and 1 September 2022. The survey was carried out with both magnetic and acoustic remote-sensing equipment. Navigation and data collection was controlled by differential global positioning. Analysis of the JBS survey data identified a total of 26 magnetic anomalies. Analysis of the magnetic data indicates that a cluster of four anomalies have collective signature characteristics that could represent historic vessel remains. Because JBS has a high potential for historically significant shipwrecks, those four anomalies are recommended for avoidance or additional investigation. The remaining 22 magnetic anomalies appear to be generated by modern debris such as fish and crab traps, pipes, small diameter rods, cable, wire rope, chain, small boat anchors and possibly ordnance associated with fortifications on Bald Head Island and/or Oak Island. No additional investigation of those buffered four magnetic anomalies is recommended in conjunction with the proposed dredging unless the avoidance buffer could be impacted or anomaly identification is desirable. Nine of the remaining anomalies are located in the 200-foot perimeter buffer. One magnetic anomaly is located outside the survey area. The 12 magnetic anomalies inside the borrow area are not considered to be potentially significant. None of the magnetic anomalies have an associated acoustic signature. The one sonar target is a linear object that could represent a piling or dayboard pole.

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Introduction

Olsen Associates, Inc. (OAI) of Jacksonville, Florida is the project engineer representing the Village of Bald Head Island (VBHI), North Carolina in its efforts to expand an offshore borrow site near the island for engineered beach renourishment. The expanded sand source for material is a borrow area located approximately a mile west of Bald Head Point and adjacent to a previously utilized borrow site. In order to determine the proposed project's effects on potentially significant submerged cultural resources, OAI contracted with Tidewater Atlantic Research, Inc. (TAR) of Washington, North Carolina to conduct a magnetic and acoustic survey of the proposed borrow site extension.

The remote-sensing investigation conducted by TAR archaeologists was designed to provide accurate and reliable identification, assessment and documentation of submerged cultural resources in the study area. The assessment methodology was developed to comply with the criteria of the National Historic Preservation Act of 1966 (Public Law 89-665), the National Environmental Policy Act of 1969 (Public Law 11-190), Executive Order 11593, the Advisory Council on Historic Preservation Procedures for the protection of historic and cultural properties (36 CFR Part 800) and the updated guidelines described in 36 CFR 64 and 36 CFR 66. Results of the remote-sensing investigation were designed to furnish OA and VBHI with the remote-sensing data required to comply with the North Carolina State Historic Preservation Office (NCHPO) and North Carolina Department of Natural and Cultural Resources (NCDNCR) submerged cultural resource legislation and regulations.

Field research for the project was conducted on 31 August 2022 and 1 September 2022. The survey was carried out with both magnetic and acoustic remote-sensing equipment. Navigation and data collection was controlled by differential global positioning. Analysis of the JBS survey data identified a total of 26 magnetic anomalies. Analysis of the data indicates that a cluster of four anomalies have collective signature characteristics that could represent historic vessel remains. Because JBS has a high potential for historically significant shipwrecks, those four anomalies are buffered and recommended for avoidance or additional investigation if the avoidance buffer could be impacted or anomaly identification is desirable.

Nine of the remaining 22 anomalies are located in the 200-foot perimeter buffer. One magnetic anomaly is located outside the survey area. The 12 unbuffered anomalies inside the borrow area are not considered to be potentially significant. Those anomalies appear to be generated by modern debris such as fish and crab traps, pipes, small diameter rods, cable, wire rope, chain, small boat anchors, and possibly ordnance associated with fortifications on Bald Head Island (BHI) and Oak Island. None of the magnetic anomalies have an associated acoustic signature.

Analysis of the sidescan sonar data identified only one acoustic target. The signature for that target represents a linear object on the bottom surface. No magnetic anomaly is associated with the target. It likely represents a piling or navigation reference dayboard. Analysis of the sub-bottom profiler data identified no geological features or targets associated with the magnetic anomalies.

Project Personnel

Project survey personnel consisted of Principal Investigator Gordon P. Watts, Jr., Vessel Captain Ralph Wilbanks, and Remote-Sensing Operator Harry Pecorelli. Senior Historian Robin Arnold carried out the archival, cartographical, and literature research. Dr. Watts analyzed the remote-sensing data. Dr. Watts and Ms. Arnold prepared this document.

Project Location

The remote-sensing project area is situated on JBS, which is located at the entrance to the Cape Fear River on the west side of the navigation channel (Figure1). The potential borrow site is located near the southwest of the shoals approximately a mile west of Bald Head Point.

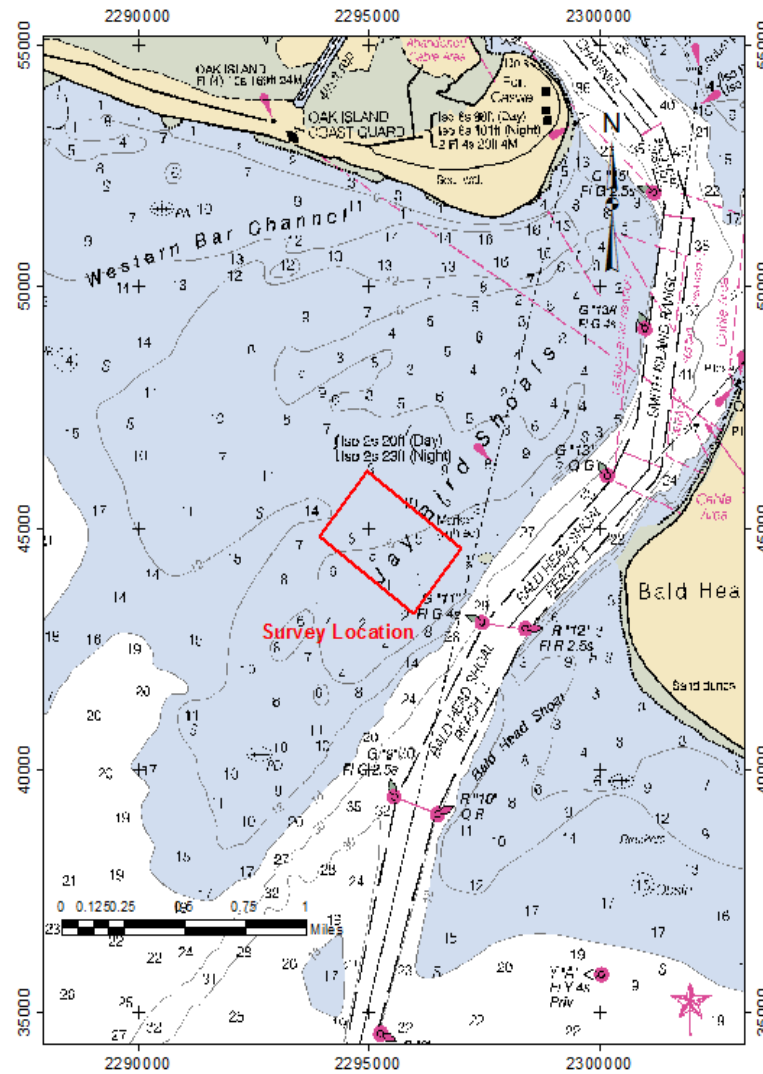


Figure 1. Project location on detail of NOAA Chart 11537-1.

The area surveyed is roughly rectangular in shape measuring 2,576 feet long and 1,700 feet wide. Water depths ranged between 6 to 33 feet. To ensure sufficient data would be available to locate any potentially significant targets in the project area, remote-sensing data were collected along 36 parallel lanes spaced on 50-foot intervals. The area surveyed included a 200-foot perimeter buffer zone so that magnetic anomalies and/or acoustic targets located along the periphery of the borrow area could be identified and the impact from dredging assessed. Survey boundaries defined in North Carolina State Plane (NCSP) coordinates [NAD-83, U S Survey Foot] are presented in Table 1.

Border Point	X Coordinates	Y Coordinate
North West	2294966.9	46181.1
North East	2296993.1	44587.7
South East	2295947.1	43247.8
South West	2293917.7	44836.7

Table 1. Survey boundaries defined by NCSP coordinates.

Research Methodology

Literature and Historical Research

The TAR historian conducted a literature search of primary/scholarly secondary sources to find significant cultural resources within the proposed project area. A background history of BHI and the lower Cape Fear region was updated. Preliminary wreck-specific information was reviewed in manuscripts and published sources that include; Wreck Logs: 5 November 1883-18 January 1906. Life Saving Station No. Cape Fear, District No. Six (Old Baldy Foundation n.d.), *Merchant Vessels of the United States* (U.S. Bureau of Navigation 1906 through U.S. Coast Guard 1970); *A Guide to Sunken Ships in American Waters* (Lonsdale and Kaplan 1964); *Encyclopedia of American Shipwrecks* (Berman 1972), *Shipwrecks of the Civil War* (Shomette 1973), *Merchant Steam Vessels of the United States 1790 - 1868* (Lytle and Holdcamper 1975), *Shipwrecks of the Americas* (Marx 1983), *Official Records of the Union and Confederate Navies in the War of the Rebellion* (National Historical Society 1987), and *The Story of Cape Fear and Bald Head Island* (Duffus 2017). Newspapers and journals digitally archived by Britishnewspaperarchive.co.uk, [Chronicling America \(Library of Congress\)](http://Chronicling America (Library of Congress)), Genealogybank.com, Fold 3, Navyrecords.org.uk, Newspapers.com, and Newspaperarchive.com were examined for site-specific terms.

In addition, the National Register of Historic Places database (maintained by the National Park Service) and the Office of Coast Survey's Automated Wreck and Obstruction Information System (AWOIS) was queried. According to the second website, "AWOIS records are not comprehensive. There are wrecks in AWOIS that do not appear on the nautical chart and wrecks on the nautical chart that do not appear in AWOIS. In 2016 the Office of Coast Survey stopped updating the AWOIS database. Reported wrecks that have been salvaged or disproved by further investigation are not included in AWOIS". Relevant shipwrecks based on primary and secondary sources are listed in Appendix A.

Personnel at the North Carolina Underwater Archaeology Branch (UAB), the North Carolina Maritime Museum (Southport), and the Brunswick County Library (Southport) were contacted [January 2022 and August 2022] for shipwreck data associated with Bald Head Island (BHI) and the lower Cape Fear River. TAR personnel interviewed archaeologists, area residents, and professional historians knowledgeable in maritime and shipwreck research to solicit their assistance to generate relevant data.

Remote-Sensing Survey

In order to reliably identify submerged cultural resources, TAR archaeologists conducted a systematic remote-sensing survey of the proposed dredge site. All survey activities were conducted from a 24-foot Parker vessel (Figure 2). In order to fulfill the requirements for survey activities in North Carolina, magnetic and acoustic remote-sensing equipment were employed. This combination of remote sensing represents the state of the art in submerged cultural resource location technology and it offers the most reliable and cost-effective method to locate and identify potentially significant magnetic anomalies and/or acoustic targets. Data collection was controlled using a differential global positioning system (DGPS). DGPS produces the highly accurate coordinates necessary to support a sophisticated navigation program and assures reliable target location.



Figure 2. Project survey vessel.

An EG&G GEOMETRICS G-881 marine cesium magnetometer, capable of plus or minus 0.001 gamma resolution, was employed to collect magnetic data in the survey area (Figure 3). To produce the most comprehensive magnetic record, data was collected at 10 samples per second. Due to shoal water within the project area, the magnetometer sensor was towed at the water surface at a speed of approximately three to four knots. Magnetic data were recorded as a data file associated with the computer navigation system. Data from the survey were contour plotted using QUICKSURF software to facilitate anomaly location and definition of target signature characteristics. All magnetic data were correlated with the acoustic remote sensing records.



Figure 3. Launching the Geometrics 881 Cesium Vapor magnetometer.

A KLEIN 3900 450/900 kHz digital sidescan sonar (interfaced with CHESAPEAKE TECHNOLOGY SONARWIZ.MAP data acquisition software) was employed to collect acoustic data in the survey area (Figure 4). Due to shoal water within the project area, the sidescan sonar transducer was deployed and maintained between 3 and 5 feet below the water surface. Acoustic data were collected using a range scale of 30 meters to provide a combination of 200% coverage and high-target signature definition. Acoustic data were recorded as a digital file with SonarWiz.MAP and tied to the magnetic and positioning data by the computer navigation system.



Figure 4. Launching the Klein 3900 sidescan sonar.

A TRIMBLE AgGPS was used to control navigation and data collection in the survey area. That system can be used to generate highly accurate coordinates for the computer navigation system. The DGPS was employed in conjunction with an onboard Compaq 2.4 GHz laptop loaded with a HYPACK navigation and data collection software program (Figure 5).



Figure 5. Bridge electronics for navigation and data collection.

All magnetic and acoustic records were tied to positioning events generated by HYPACK. Positioning data generated by the navigation system were tied to magnetometer records by regular annotations to facilitate target location and anomaly analysis. All data is related to the NCSP Coordinate System, NAD 83.

Historical Background

European settlement of the present day Cape Fear region began as early as 1526 when Lucas Vásquez de Ayllón led an expedition from Florida into the Cape Fear region. One of the Spanish vessels was recorded lost near the mouth of the Cape Fear River, referred to by the Spanish as the Jordon River. During the brief existence of the Spanish settlement, the area was known as the “Land of Ayllón” (Lee 1965:3-4). A chart drawn during the very late sixteenth century or early seventeenth century shows the location of the Cape Fear by the proximity to the Island of Bermuda (Figure 6).

The next attempt to settle the Cape Fear region came almost a century and a half later with the arrival of the English (Figure 7). Settlers from New England came to the area eager to establish a Puritan colony in the less harsh climate of the southern Colonies. Under the leadership of Captain William Hilton, a group arrived in the summer of 1662 to find a suitable location. Arriving at the river and “Cape Fear” as he called it, the group remained for three weeks during which time they purchased the surrounding area from the indigenous population. The Puritan settlers that followed during the winter of 1662 remained in the Cape Fear vicinity for only a brief time before abandoning the area (Lee 1965:4-5).



Figure 6. Detail of *Americae sive novi orbis, nova description* (courtesy of the New York Public Library [NYPL]).



Figure 7. Detail of 1639 *America Septentrionalis* identifying the “C. of Feare” (courtesy of the NYPL).

In early 1663, King Charles II granted territory south of Virginia to eight noblemen in tribute for restoring the Stuart dynasty to the monarchy. That conveyance included the area from Georgia to the Albemarle Sound region of North Carolina. The territory was divided into three counties: Albermarle [Albemarle Sound area], Clarendon [Cape Fear region] and Craven [South Carolina]. Shortly after, the Lords Proprietors received a proposal from a group of Barbadians for a settlement within the Cape Fear region. In late spring 1664, a group of 200 settlers, under the command of John Vassall, established a colony at the confluence of the Charles [modern Cape Fear] River and Town Creek (Potter 1993:5-6). The capital, Charlestown, was the first English town in Carolina (Lee 1965:5). The colony was reported to have reached a population of 800 and extended some 60 miles along the river at its zenith.

In October 1665, a second expedition by the Barbadians was launched with the intent of establishing a colony in the vicinity of Port Royal. A small fleet consisting of a frigate, sloop and a flyboat, under command of Sir John Yeamans, stopped at the Charlestown settlement after an arduous journey from Barbados. While entering the river, the flyboat, carrying the new colony's armament, ran aground on the shoals on the west side of the channel [modern JBS] and was lost (Potter 1993:9, 29). The loss of this important cargo abruptly ended the Port Royal venture. Within another two years Charlestown would also be abandoned. Difficulty in obtaining supplies, differences between the proprietors and settlers over land policies and hostilities with the Natives resulted in the colony being deserted by late 1667 (Potter 1993:10-11).

In 1726, permanent settlements on the lower Cape Fear were established by South Carolina and upper North Carolina colonists (Lee 1977:7). On the west bank of the river, about 12 miles above its mouth and several miles below a shoal in the river called "the Flats," Maurice Moore established the town of Brunswick. A shoal located at the mouth of Town Creek impeded larger ships from venturing further upstream. Situated below "the Flats" Brunswick was accessible to vessels of large or small size (Lee 1977:12). In April 1733, another community was established 15 miles upstream from Brunswick. The new settlement became known as New Town or Newton to distinguish it from the "old town" of Brunswick. In 1740, the town was incorporated and the name was changed to Wilmington (Lee 1977:12).

As hostilities with France and Spain grew during the 1740s Governor Gabriel Johnston authorized the construction of a fort along the lower Cape Fear to protect the burgeoning towns of Brunswick and Wilmington. Construction began in July 1745 on a small bluff overlooking the mouth of the river. Johnston's Fort, as it was called, was still uncompleted in 1748 when two Spanish vessels entered the river and raided Brunswick (Carson 1992:20). Efforts to finish construction intensified after the raid and in less than a year the fort was completed. The resulting structure was small and poorly constructed. It was manned by only three men and armed with four rusty cannons (Carson 1992:20; Figure 8). In 1751, the fort was assigned to double as a quarantine station.

Development based upon a maritime economy played a major role in the growth of both Wilmington and Brunswick during the eighteenth century. Vessels of varying size entered the Cape Fear from other coastal ports, the West Indies and Europe. Larger vessels, unable to cross over "the Flats," called at Brunswick, while vessels of smaller size could travel further

up the river to Wilmington. Consequently, Brunswick was established as the center for overseas shipping and Wilmington as the center for local and West Indian trade (Lee 1977:16-17). Rice, cattle, swine, lumber and naval stores made up the majority of the exports from the port district of Brunswick. Prior to the Revolution numerous ships left the Cape Fear River for other ports. The West Indies served as the main destination of these ships with English ports following a close second. A lesser number carried cargo to coastal ports, mostly in the northern colonies, but occasionally some ventured south, down the coast to Charleston (Lee 1977:33).

The Cape Fear region played a minor role in the events of the American Revolution. In June 1775, Royal Governor Martin fled from New Bern to Fort Johnston, then under the protection of the British man-of-war *Cruizer*. Growing patriot activity in the area forced the governor to relocate to the warship a month later. All portable materials were transferred to the ship and the fort's guns were spiked and pushed into the river (Carson 1992:22; Figure 9). Local forces later burned the fort and its outbuildings.

Knowing that a large number of Loyalists inhabited the interior of the colony Governor Martin initiated a plan to subjugate the region using a combination of British and Loyalist forces (Sprunt 2005:113). British reinforcements arrived off the North Carolina coast by the end of March, but by then the opportunity to subdue the colony had passed. On 27 February 1776, Colonel James Moore and the First North Carolina Continentals with a group of militias defeated a contingent of Scottish Loyalists at the battle of Moore's Creek Bridge. This battle, called the "Lexington and Concord of the south," kept the British from occupying the South at the beginning of the war (Powell 1989:180-182).

Naval operations were of limited importance in the Cape Fear region. In mid-1776, British warships began taking up regular station over the mouth of the river. In May of the following year two British men-of-war entered the river and destroyed a number of colonial vessels at anchor (Watson 1992:29; Figure 10). To counter the threat posed by British warships the General Assembly voted to purchase and arm three brigs for the defense of the Cape Fear River. However, these vessels proved inadequate for the task and suggestions were made for either selling them or sending them on trading or privateering expeditions (Watson 1992:29).

The lower Cape Fear remained quiet until 1781 when Major James H. Craig was dispatched by Lord Cornwallis in Charleston to take Wilmington. Craig, with a force of 18 vessels and 400 troops, quickly captured the defenseless town (Sprunt 2005:114). From Wilmington, Craig dispatched parties throughout the countryside to rally local Loyalists and to obtain supplies for Cornwallis's troops, then marching through North Carolina. After being checked by Colonial forces in the battle of Guilford Courthouse the British retreated to Wilmington to recoup and replenish supplies. Later, when Lord Cornwallis moved north to suppress Virginia, Craig remained behind in Wilmington to disrupt Colonial activity in that region. News of Cornwallis's surrender at Yorktown made the British position in Wilmington untenable and on 17 November Major Craig evacuated the city.

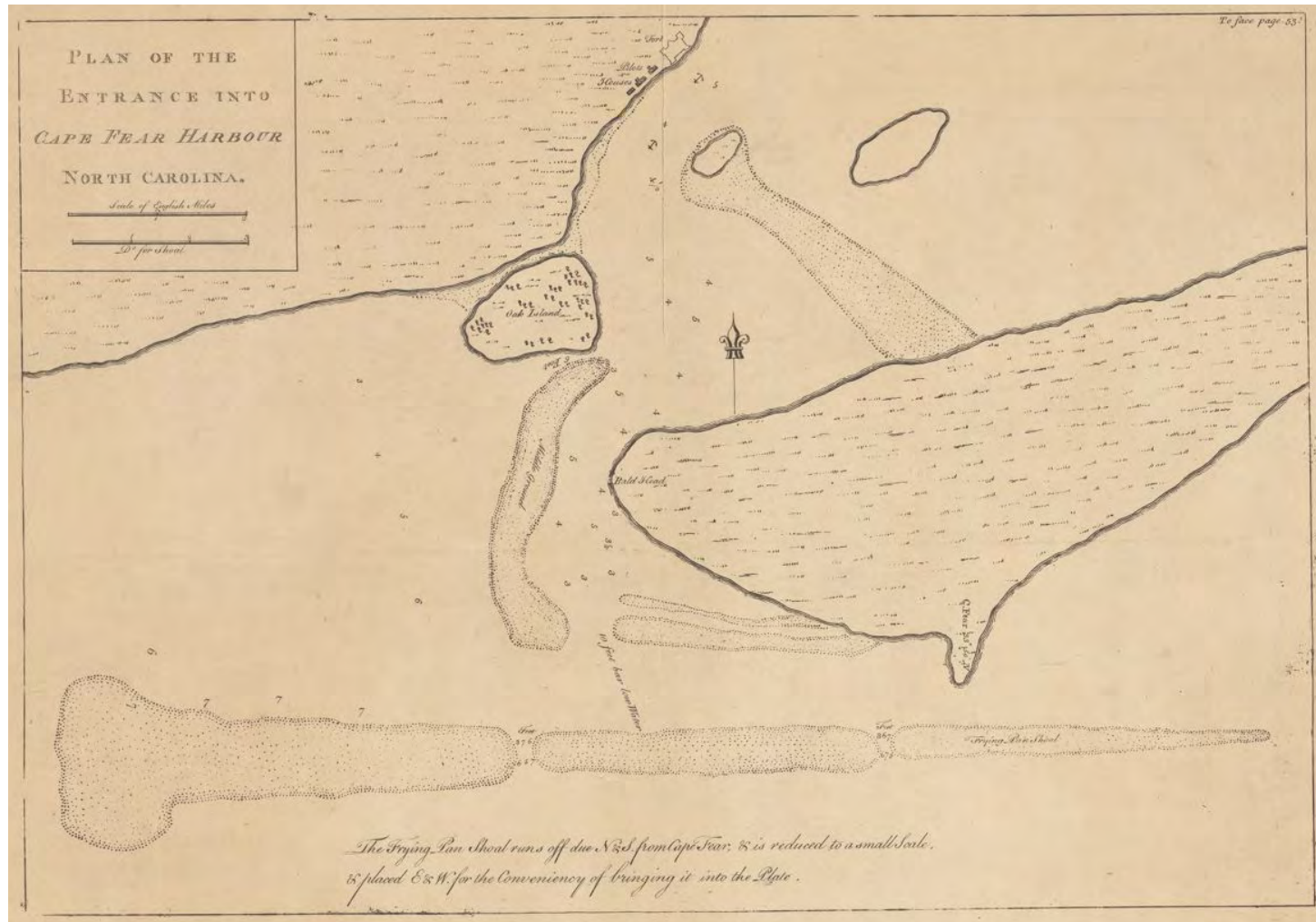


Figure 8. Ca. 1775 British chart identifying the Middle Ground and Frying Pan Shoal (courtesy of the NYPL).



Figure 10. Detail of 1780 *Plan de la rivière du Cap Fear depuis la barre jusques à Brunswick* (courtesy of the LOC).

After the conclusion of the war there was a shift in the maritime development of the Cape Fear region. Almost all the ships that left the Cape Fear now went to Charleston and few to England or the West Indies (Lee 1977:33). Inbound ships now proceeded up to Wilmington. This shift brought about the decline of the town of Brunswick as was indicated by the change in name of the “Port of Brunswick” to the “Port of Wilmington” (Lee 1977:34).

During the last decades of the eighteenth century the area that would become the town of Southport consisted of little more than the remains of Fort Johnston and the homes of local river pilots. The region’s potential, however, was realized by three men from Wilmington, Joshua Potts, John Brown and John Husk, who viewed the area, with its salubrious sea breezes, as an ideal spot for a new town. Though the men’s initial petition was rejected in 1790 the group persevered and on 15 November 1792, the General Assembly issued a charter for the establishment of a town on the bluff overlooking the mouth of the river.

The town was named Smithville, after Benjamin Smith who introduced the bill into the legislature. The town was laid out with lots offered for sale in Wilmington and Fayetteville newspapers. The charter specified that no person could purchase more than six lots in their name and the purchase price of lots was to be 40 shillings per lot (Carson 1992:26). The town plan also reserved space for Fort Johnston which was rebuilt in 1804.

With the growing amount of vessel traffic sailing up to Wilmington there arose a need for improvements in the navigability of the river. As early as 1784, measures were taken to improve the conditions of the lower Cape Fear River (Lee 1977:36). Improvements were needed at the treacherous entrances to the river, at the Bar and upstream at New Inlet. Three major shoals between Wilmington and the sea also caused problems for ships trying to navigate the river. The “upper shoal,” located near the foot of Clarks Island, off the southern tip of Eagles Island, had eight and one-half feet of water. The “middle shoal,” also known as “the Flats,” had nine feet. The “lower shoal,” at the foot of Campbell Island, had nine and one-half feet. The main channel of the river was then located in a narrow passage between Campbell Island, Clarks Island and the west bank (Lee 1978:112).

In addition to the shoals, ships deliberately sunk during the American Revolution as obstructions needed to be removed (Lee 1977:36-37). Around 1819, Hamilton Fulton, a noted English engineer, was hired to make improvements on the Cape Fear River mainly between Wilmington and the ocean where a system of jetties was planned. Work continued for six years until financial limitations halted this project. Some improvements were made on the river up until the start of the Civil War with sporadic financing by the state and local Wilmington businessmen (Lee 1977:37).

Steam vessels first appeared on the Cape Fear River in 1817. The first steamboat to arrive was the side-wheel *Prometheus*, built in Beaufort for a firm in Wilmington that intended to run the vessel from Wilmington to Fayetteville and Southport. The following year the Clarendon Steamboat Company was established at Wilmington. The company held the exclusive right to operate steamboats on the Cape Fear for a period of seven years provided that it kept one boat in service. In addition to the *Prometheus*, the side-wheel *Henrietta*, also made regular runs between Wilmington and Fayetteville (Lee 1977:37-38). By 1822, a second steamship venture,

the Cape Fear Steamboat Company, had begun service on the river. With time the number of steamboats on the river increased significantly (Lee 1977:38: Figure 11). By the 1850s, nearly a hundred vessels of all types were in Wilmington at the same time. Many of the ships were large square-rigged foreign craft, while others were side-wheel steamers. Most, however, were American schooners engaged in the coastal trade (Lee 1978:116).

Development of the Cape Fear region was soon disrupted by the Civil War. After Confederate forces in South Carolina attacked the U.S. garrison at Fort Sumter, President Abraham Lincoln declared a state of open rebellion and called for volunteers to preserve the Union. Lincoln also issued a proclamation on 19 April 1861 establishing a blockade of Confederate ports in South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana and Texas. Eight days later, Lincoln extended the blockade to include ports in Virginia and North Carolina. With North Carolina's withdrawal from the Union, Governor John W. Ellis ordered the occupations of forts Johnston and Caswell.

Union naval forces were inadequate to properly enforce the blockade at the onset of the war. In 1861, U.S. navy registers listed 90 vessels, 50 of which were propelled by sail and were considered obsolete for the task at hand. The remaining 40 were steam, but several of the deep draft vessels proved unsuitable for the shallow southern waters. Eight others were laid up while 22 vessels remained at station off foreign shores and would require at least six months travel to reach the United States (Browning 1980:24). However, within a few months of Lincoln's proclamation, the new Secretary of the Navy, Gideon Welles, took steps to implement an effective blockade off the southern coastline.

The navy department bought or leased nearly any vessel that could be of service. In nine months, U.S. navy agents purchased 136 ships, constructed 52 and commissioned and repaired another 76 (Engle and Lott 1975:180). The Union blockade in turn gave rise to the practice of blockade running. At the beginning of the blockade, practically any vessel was considered suitable for breaking through the Atlantic squadrons to carry cargo in or out of the isolated southern ports. The most successful of the early runners were steamers that had belonged to the Southern Coasting Lines and were idle due to the outbreak of the war. The illicit trade carried on by these ships reaped considerable profit, but failed to compare with the great capital resources brought in during the latter part of the war.

Wilmington provided North Carolina with a deepwater port. By 1860, Wilmington had emerged as a modern shipping center with excellent internal communication. Three railroads ran through the city and daily steamboat service to Charleston and New York, as well as, up the Cape Fear River to Fayetteville. With the capture of New Bern, Roanoke Island and Beaufort, Wilmington was the only North Carolina port left open for the importation and exportation of goods. As long as supplies were imported through the two inlets of the Cape Fear River and transported along the railroad lines, which connected with Lee's army in Virginia, the Confederacy had a lifeline. Wilmington soon became the most vital seaport in the "Southern Cause" (Pleasants 1979:15; Figure 12; Figure 13).

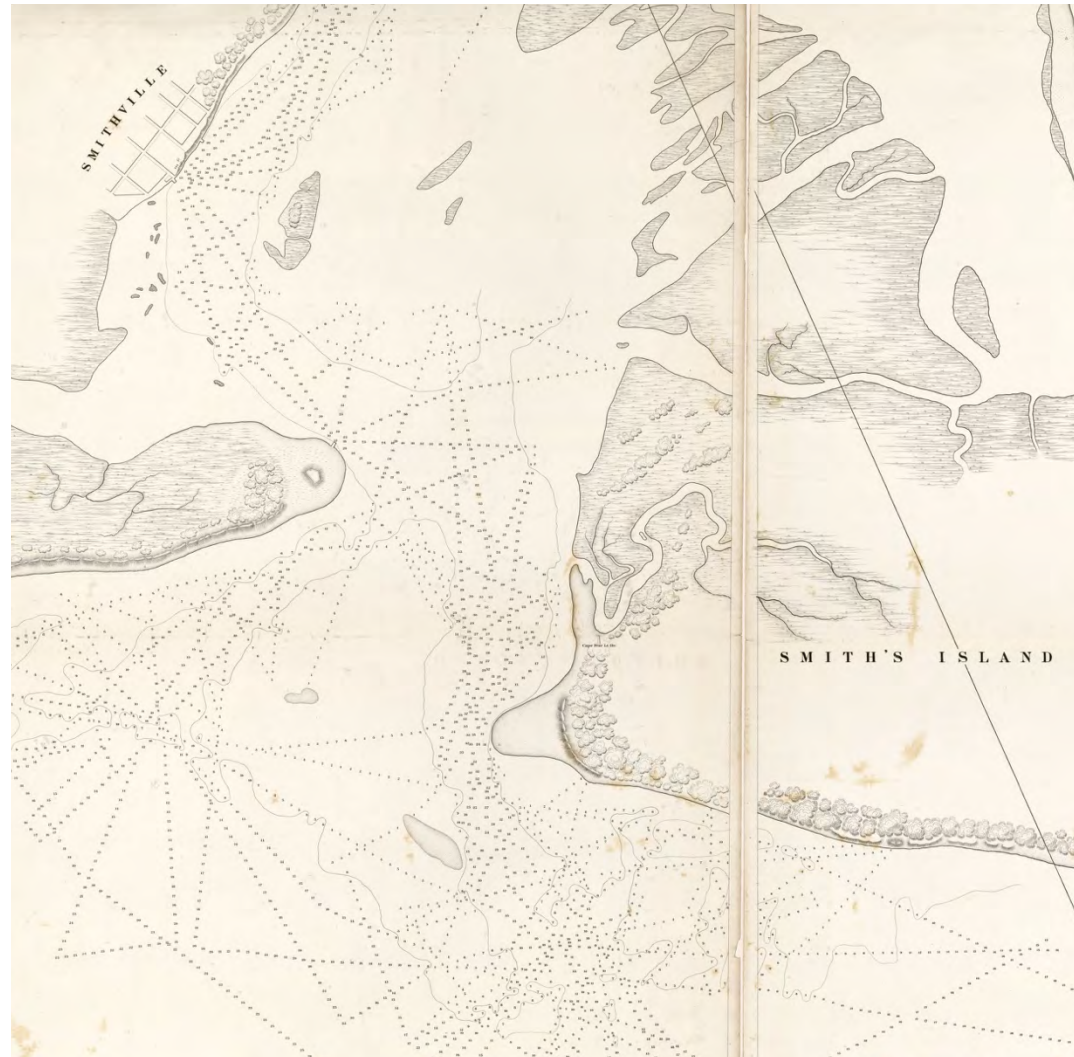


Figure 11. Detail of 1829 chart entitled *The Entrance of Cape Fear River* (courtesy of the LOC).



Figure 12. Detail of 1861 Colton map illustrating Brunswick County and contemporary watercraft (courtesy of the NYPL).



Figure 13. Detail of Confederate chart produced ca. 1862 (courtesy of the LOC).

Wilmington became the key port for “runners” largely because of the area’s topography. Located 28 miles from the mouth of the Cape Fear River, the port had access to the Atlantic through two separate entrances; eastward through New Inlet and southward through the river mouth (Figure 14). Although the two entrances were only six miles apart, Smith’s Island, a strip of sand and shoal, lay in between. Continuing along Cape Fear were the dangerous Frying Pan Shoals, which extended 10 miles further into the Atlantic, making the distance by water between the two entrances a little less than 40 miles (Soley 1883:91).

This geographical configuration proved highly advantageous for blockade runners and the initial blockade of Wilmington proved ineffective. When the *Daylight*, the first and at the time the only Union vessel sent to blockade these waters, arrived, it immediately experienced the difficulties associated with guarding the dual entrances of the Cape Fear River. While pursuing a steamer out of the western bar entrance, the *Daylight* inadvertently allowed several other small vessels to pass out of the New Inlet entrance. Within three months of the *Daylight*’s arrival, 42 vessels either entered or cleared Wilmington (Browning 1980:27).



Figure 14. July 1864 image of the deck of the blockade runner *Lilian* running into Wilmington (courtesy of the NYPL).

During a two-year period (January 1863–November 1864), Confederate naval sources listed numerous vessel stations on the Cape Fear. These vessels were identified as: the ironclad sloop *North Carolina*, the floating battery *Artic*, the steam gunboat *Yadkin*, the steam gunboat *Equator*, the torpedo boat *Squib*, and the ironclad sloop *Raleigh*, and two, long one-gun cutters. In November 1864, Confederate Secretary of the Navy Stephen Mallory also reported to President Jefferson Davis that two new torpedo boats were under construction at Wilmington (U.S. Navy [USN], 1921, ser. II, 2:passim).

The capture of Wilmington proved difficult because both entrances to the Cape Fear were guarded by powerful fortifications and lesser works. Collectively those fortifications became known as the Lower Cape Fear Defense System. The central point of that system was Fort Fisher, located on Confederate Point. That fortification was originally a small earthwork constructed to protect New Inlet. By 1864, Fort Fisher had become the largest seacoast fortification in the Confederacy.

Shaped like an inverted "L," Fort Fisher's land face ran 628 yards and was guarded by 20 of the heaviest seacoast guns. The sea face included a 130-pound Armstrong rifle and a 170-pound Blakely, both from England (Browning 1980:35). Extending from the land face was a string of torpedoes, which could be exploded from inside of the fort (Pleasants 1979:22). Mound Battery, towering to a height of 60 feet with two mounted heavy guns, stood near the end of Confederate Point. Augusta Battery, which stood behind Mound Battery, was located near the river (Pleasants 1979:24).

Fort Holmes, on the other side of New Inlet on Smith's Island, shared the protection of Smith's Inlet in the Cape Fear River with the batteries at Oak Island. Oak Island, located opposite Fort Holmes, held another series of forts and batteries, such as Fort Campbell, Fort Caswell and Battery Shaw (Pleasants 1979:24). Fort Caswell guarded the western bar entrance. Captured by Confederate militia on 14 April 1861, Caswell was renovated into a strong casemated work with new armament consisting of seven 10-inch, four 8-inch Columbiads and one 9-inch Dahlgren gun (Browning 1980:35; Pleasants 1979:24).

Both Fort Caswell and Fort Holmes were responsible for shelling union vessels in the Middle Ground area, including the stranded tug *Violet* which went aground off the Western Bar Channel on the night of 7 August 1864. After his tug struck the shoal Ensign Thomas Stothard requested assistance from the crew of the nearby 866-ton brig USS *Vicksburg* to attempt to re-float the *Violet*. Despite their quick response, the extra manpower and effort proved fruitless as Stothard was ordered to fire the *Violet* after midnight. In response to a court of enquiry [sic] investigation, Captain Stothard submitted an incident report to Captain B.F. Sands of the USS *Fort Jackson* and offered this account:

After all preparations for sending officers, crew, and ship's effects off in boats that he [Lieutenant-Commander Braine of the USS *Vicksburg*] and Acting Volunteer Lieutenant Williams, of the *Emma*, had sent, all of which I did, sending property, a list of which you will find enclosed, also a list of crew, I made preparations for her destruction as follows: I put a lighted slow match to a powder tank in the magazine and closed the door, then filled a large, fine drawer with shavings and straw taken from pillows and mattresses, partially covered it with another, and sprinkled two quarts of spirits of turpentine over all and on the woodwork around it; hung up an oilcloth from the table, one corner hanging in the shavings, which I touched with a lighted match (in the wardroom), after all the boats, but mine in waiting, had left the side, and I followed about 2:00 o'clock a.m. this morning. The explosion of the magazine containing about 200 pounds of powder occurred within half an hour afterwards, and by daylight she was

effectually consumed. One 12-pounder was thrown overboard, one left on the forecastle, spiked with rat-tail file, and the 24-pounder was directly over the magazine aft when it exploded, so that it was thrown into the sea (National Historical Society [NHS] 1987, ser. I, 10:343,344).

Rear-Admiral S.P. Lee recommended that no action be taken to discipline the acting officer of the *Violet*. Lee remarked to Union Secretary of the Navy Gideon Welles, that: “Stothard is a very intelligent and efficient officer, notwithstanding this casualty” (NHS 1987, Ser. I, 10:344). Prior to its destruction, the *Violet* (ex-*Martha*) was described as a fourth-rate, wooden screw steamer measuring 85 feet in length, with a beam of 19 feet. The 166-ton tug housed one, inverted, direct-acting engine with a 30-inch diameter cylinder and one return flue boiler (U.S. Navy 1921, Ser. II, 1:233).

Farther up river from the *Violet* wreck site there were a series of forts and batteries used as secondary defenses for Wilmington and as protection for blockade runners outbound from Smith’s Inlet. Fort Lamb was located on the west side of the Cape Fear River on Reeve’s Point. Above Fort Lamb was Fort Anderson, the most important of the secondary defenses. Partially built from the ruins of Old Brunswick Town, Anderson consisted of a series of trenches and earthworks approximately a mile long. Three smoothbore 24-pounders, three rifled 32-pounders and six smoothbore 32-pounders comprised the Fort’s armaments. By 1864, Fort Anderson had become an inspection station for all craft heading up the Cape Fear River to Wilmington (Pleasants 1979:25). Several secondary forts, including Stokes, Lee, French, Campbell, Strong and Sugarloaf, were situated on the east side of the river (Pleasants 1979:25).

In addition to this impressive array of forts, a naval construction program was initiated in Wilmington to contribute to the defenses of the harbor. The success of the ironclad ram CSS *Virginia* in the March 1862 battles at Hampton Roads demonstrated the superiority of armored warships to naval officers of both the North and South. In late March 1862, Confederate Secretary of the Navy Stephen R. Mallory, sent “instructions relative to gunboats” to Commander William T. Muse, the ranking naval officer at Wilmington. Shortly thereafter, the navy began building two ironclads in the city, the *Raleigh* at James Cassidy’s shipyard at the foot of Church Street, and the *North Carolina* at the Beery shipyard on Eagle Island (Still 1985:5-17, 79-92).

Both vessels utilized a design based on plans conceived by naval constructor John L. Porter. The plans called for a tightly framed hull, with a slight deadrise and a hard chine. The vessels were to be 174 feet long (150 feet between perpendiculars) with a draft of 13 feet. Amidships, a 105-foot long casemate, angled at thirty-five degrees and covered with 4 inches of iron plate, protected the gun deck. Two boilers provided steam for the vessel’s two horizontal engines, which were geared to a single 10-foot screw. The first ironclad built on this design, the CSS *Richmond*, was completed in Richmond in 1862. Known as the *Richmond* class, this group, consisting of five vessels, was numerically the largest standardized class of ironclads constructed by the Confederacy (Holcombe 1993:63-64).

The two Cape Fear ironclads entered into active service by late 1863/early 1864 (*North Carolina* in December 1863 and the *Raleigh* in April 1864) after numerous delays resulting from material shortages, strikes and epidemics. However, the usefulness of these two vessels to the Confederacy's war effort was limited. *Raleigh* grounded on a shoal near the mouth of New Inlet and was destroyed after a sortie against the blockading squadron on 7 May 1864, less than a month after entering service. The *North Carolina*, on the other hand, was reduced to serving as a floating battery; its deep draft and lack of motive power rendered the vessel ineffective as a ram.

The ironclad was further hampered by the use of unseasoned timber in its construction. Warping and splitting timbers caused the ship to leak incessantly and an infestation by teredo worms further weakened the hull. For most of its career, the ironclad remained at anchor near Smithville, positioned to support the nearby forts in the defense of Wilmington. The *North Carolina* finally sank at its moorings in September 1864. Though useless as an offensive weapon, the *North Carolina* served as a deterrent, preventing the U.S. Navy from entering and seizing the lower Cape Fear until the fall of Fort Fisher in the closing days of the war (Figure 15).



Figure 15. Julian Davidson's "Capture of Fort Fisher" (courtesy of the NYPL).

When hostilities ended in 1865 so did some of the regular river trade. The prewar steamer service between Wilmington, Charleston and Savannah was not resumed, since rail service had been established. Steamship service did, however, resume to the northern cities of Baltimore, Philadelphia and New York (Lee 1977:91). The coastal trade also revived and was conducted mainly by schooners ranging between 150 and 600 tons. Because of the decimation of American shipping during the conflict international commerce was carried in foreign bottoms, usually of British, German or Scandinavian origins (Sprunt 2005:501). Industry had been severely interrupted during the war, but was beginning to make a comeback.

Naval stores and lumber continued to be the principal exports with the addition of some cotton. Exports recorded for the year 1871 amounted to some 95,000 bales of cotton, 100,000 bushels of peanuts, 112,024 barrels of spirits of turpentine, 568,441 barrels of rosin, 37,867 barrels of tar and 17,963 barrels of turpentine (Sprunt 2005:513-514). Without the use of slave labor, the rice industry declined dramatically (Lee 1977:86-87).

By the turn of the century, a decrease in the availability of pine trees resulted in a decline of the naval stores industry. With improvements in cultivation and transportation, cotton became a major industry in Wilmington until its decline in the 1930s. Guano from the West Indies was brought in for the new fertilizer plants. The production of creosote impregnated wood also helped increase shipping in the region (Lee 1977:87-88). During the last quarter of the nineteenth century, efforts were undertaken to develop Smithville into a port city. In 1886, the North and Southern Railroad Company announced plans to extend rail service from Wilmington to Smithville.

Developers, envisioning a port that would rival Charleston and Norfolk, requested that the town's name be changed to Southport to draw attention to the "Port of the South" (Carson 1992:61). In anticipation of the expected development the town's dirt roads were paved in crushed shell and the dredge boat *Woodbury* began deepening and straightening the channel to accommodate increased vessel traffic. However, the proposed rail line did not materialize and Southport remained a small town relying on fishing and tourism for its economic livelihood. The Wilmington, Brunswick and Southport Railroad eventually extended a line to the town in 1911.

Improvements to navigation on the Cape Fear River had deteriorated during the American Civil War. Continual silting reduced the navigable channel. By 1870, federally financed projects were again started to improve the conditions of the river. One such project was the closure of one of the two inlets. New Inlet was closed in 1881 with the belief that the increased force of the concentrated flow would sweep out the channel. The closure was accomplished by placing a rock dam that extended for more than a mile from Federal Point to Zeke's Island. The dam was completed in 1881 and later became known as "the Rocks." Another rock barrier was later built between Zeke's Island and Smith's Island. The channel depth was dredged to accommodate the deeper draft vessels (Lee 1977:91).

Two life-saving stations were established near the mouth of the Cape Fear River during the 1880s. Those stations included the Cape Fear station (b. 1882) at east end of BHI and the Oak Island station (b. 1889) located west of Fort Caswell. Each station was equipped with line-throwing guns and self-righting surfboats (Sprunt 2005:527). Surf men maintained a constant vigil of the sea from the station house and conducted regular nightly beach patrols; additional patrols were conducted in daylight during stormy weather. Both stations remained active until the 1930s when newer Coast Guard facilities were constructed as replacements.

On 20 July 1895, the U.S. Marine Hospital Service appropriated \$25,000 for the construction of a quarantine station at Southport. The new station was to be located on the river on the east side of the channel between the upper end of Battery Island and Price's Creek Lighthouse (Carson 1992:73). The entire station was to be built on a pier 600 feet long and to consist of a

hospital building, a disinfecting house, attendant's quarters and a kitchen. The station opened for service by the middle of 1897 with Dr. J. M. Eager appointed as the station's first quarantine officer. A report for the fiscal year 1907 illustrates the level of activity at the station:

[Eighty six] vessels spoken and passed; 19 steamers and 1 sailing vessels inspected and passed; 2 steamers and 3 sailing vessels disinfected; and 485 crew on steamers, 125 crew on sailing vessels, and 3 passengers on sailing vessels inspected. The vessels disinfected were from Bahia, Portobello, Santos, Rios, and Barbados (Brown 1974).

By 1937 the station had become obsolete and was placed on caretaker status. As the facility was located on water and not a navigation hazard it was left to deteriorate and on 19 August 1951, the abandoned station was destroyed by fire (Brown 1974). The fishing industry provided the financial stamina for the economy on the lower Cape Fear during the early years of the twentieth century.

The principal source of income for Southport was the menhaden fisheries. Most catches were processed into oil which was used in the manufacture of paints, linoleum, tanning solutions, soaps and waterproof fabrics (Carson 1992:96). Leftover scrap was ground up for fertilizer and feed for livestock. The Southport Fish Scrap and Oil Company and the Brunswick Navigation Company established processing plants along the Elizabeth River while additional plants could be found above the town on the Cape Fear River.

World War I initiated a revitalization of the economy with the establishment of the Carolina Shipyard in May 1918. At about the same time, the Liberty Shipyard started producing steel ships as well as experimental concrete ships. The success of the shipyards was short-lived and the economy fluctuated for several years until it fell during the 1930s. Though Wilmington saw moderate success in shipping and shipbuilding after the war, most of the yards had closed by the mid-1920s and competition from Norfolk and Charleston slowly relegated the city to an import distribution center catering mainly to regional trade (Watson 1992:145).

This trade averaged 200,000 or more tons through most of the 1920s, but with the coming of the Great Depression, the amount fell to 94,007 tons by 1932 (Watson 1992:150). Wilmington's economy would not fully recover from the effects of the depression until the end of the decade. Despite this economic uncertainty, foundations were laid for future development. By the beginning of World War II, Wilmington boasted 54 wharves, piers and docks and the opening of the Atlantic Intracoastal Waterway expanded the city's trade with its hinterland and increased its role in the coastal trade (Watson 1992:148-9).

With war in Europe and German submarines prowling the east coast during the early 1940s protection and defense of the coast became a top priority in Washington. The vulnerability of the Cape Fear had been confirmed during World War I and U.S. Navy officials were anxious to be prepared for future enemy intrusions (Gannon 1990:242-243). On 17 November 1941, the U.S. Navy reacquired the 248.8-acre Fort Caswell reservation, sold into private hands in 1929. The old fort grounds were to be used for training, communications and submarine tracking (Carson 1992:126).

The U-boat threat finally reached the Cape Fear region in early 1942. On 16 March, the 11,641-ton tanker *John D. Gill* was torpedoed in the coastal waters off the mouth of the river. As a result of the high number of vessel losses during the early stages of the war, defensive measures were put into place. Coastal communities were systematically blacked out, a more efficient convoy system was devised and additional planes and patrol vessels were put into service along the North Carolina coast (Stick 1952:237-239).

In addition to the menace that Axis submarines and aircraft represented during the conflict, a significant hurricane struck the project area in late summer 1944. On 1 August, the tropical storm made landfall near Southport and the Oak Island coast guard station reported maximum wind speeds of 80 miles per hour. To the north, “substantial damage” occurred in Wilmington and Wrightsville Beach and the combined losses of real estate and crops amounted to two million dollars (Galecki 2005:133-134).

World War II also brought renewed growth to the shipyards and relief to the area (Lee 1977:88-90). The increased jobs and higher wages allowed Wilmington’s economy to increase and become stable. After the war many of the people brought in to build ships chose to stay and make Wilmington their home. In 1945, the State Port Authority was formed, promoting ports in Wilmington and Morehead City and creating new jobs. In 1955, the military established the Sunny Point Army Terminal [Military Ocean Terminal at Sunny Point]. The facility serves as a terminal for shipping military hardware and ammunition to American forces around the globe. The base is a major employer in the area and local service and retail industries serving the military contribute to the economic prosperity of the region.

By 1960, the population of Southport was reported as 2,034 residents. At that time, the town boasted a popular bookmobile, a new water tank, a “lighted” athletic field and a picnic area at the community park. Maritime news included the launch of a “big, new charter boat,” the *Riptide*. Herman Sellers constructed the vessel for Glenn Trunnell of Southport. Other local commercial fishermen commenced discussions on the merits to install an artificial reef near the town. In September 1960, Hurricane *Donna* struck the region and fortunately caused only minimal damage in Brunswick County (Reaves 1999:169,172).

In early February 1970, the Atomic Energy Commission approved construction of a 385 million dollar nuclear power plant to be situated north of Southport. The downtown also experienced a significant economic boost when First-Citizens corporation elected to build a bank in Southport, its first branch in Brunswick County. At the same time, waterfront interests offered services to the public such as the modern 150-seat restaurant Herman’s and the new 450-foot long “fishing and pleasure pier” (Reaves 1999:243).

Today, the region presents a strong economy with a state port facility that is daily frequented by international cargo vessels. The economy is further augmented by the military and commercial fisheries which provide an important source of income to area residents. In addition, Southport and the coastal communities on Oak Island and the resort on BHI are popular tourist destinations. The area’s offshore waters are a sportsman’s paradise catering to recreational boaters and sport fishermen alike.

Improvement History of the Entrance Channel to the Cape Fear River

In 1870, the U.S. Army Corps of Engineers (USACE) initiated a project to improve navigation on the Cape Fear River. An examination of the river conducted by a commission appointed by the War Department suggested that priorities at that time should be given to closing off the channel between Smith's and Zeke's Islands (USACE 1870:70). In 1874, the closing off of New Inlet had increased the flow of water in the main navigation channel and scouring effects were noted to be deepening the channel over Bald Head Bar (USACE 1874:88-89). The officer in charge of operations also stated that a suction dredge was employed at Bald Head Bar to assist in the scouring process.

Furthermore, the officer's report also noted that there were two channels into the river: a western channel with two bars (an outer with 14 feet at low water and an inner or "rip" with 10 feet at low water) and the Bald Head channel (USACE 1874:69). It was suggested that since the Bald Head channel was the natural channel all efforts should be directed towards maintaining a 12-foot level of water over it and that the western channel be disregarded.

During 1889, the project was modified to provide for a 20-foot depth, at low water, from Wilmington to the Ocean. Surveys conducted during the fiscal year ending 30 June 1890 reported that the depth of water over bar had reached 16 feet (USACE 1890:131). The wreck of a Civil War gunboat was uncovered during dredging activities on the bar in 1891. The boiler from the wreck reduced water depths in the channel to 13.5 feet providing a serious impediment to navigation (*The Messenger [TM]* 16 May 1891).

Examinations of the wreck indicated that it was a wooden-hull vessel approximately 110 tons and 100 to 110 feet long (USACE 1893 Appendix L:1451). Portions of the flue and boiler were removed by the government in 1890. On 20 May 1893, Messrs. Johnston and Townsend were awarded a contract to remove the rest of the wreck structure (USACE 1893 Appendix L:1451). The wreck site was dynamited and remaining sections of boiler recovered for disposal. Inspection of the wreck area by First Lieut. E. W. V. Lucas, E. D. Thompson and Robert Merritt revealed no trace of the hull and soundings in the vicinity indicated a depth of water of 22 feet (*TM* 7 July 1893; USACE 1893 Appendix L:1451).

The River and Harbor Act of 2 March 1907 provided for additional dredging for completing the channel to the mandated 20-foot depth level. In addition, the act also authorized for improvements in excess of 20 feet as appropriations permitted (USACE 1912:459). The project was modified again in the River and Harbor Act of 25 July 1912. Those modifications called for a channel of 26 feet deep at low water with widths of 300 feet in the river, increasing to 400 feet across the bar and in curves in the river (USACE 1912:459-460). The controlling depths of the channel were increased to 30 feet in the River and Harbor Act of 2 March 1919. In 1922, the USACE discontinued the then current entrance channel and authorized for a new one over the bar with the same dimensions as the previous one (USACE 1922:682-683). The new channel was to run in a southwesterly direction from Bald Head Point. These improvements were noted as being completed in 1932.

In the River and Harbor Act of 2 March 1945, the controlling dimensions for the navigation channels on the Cape Fear River were increased further. Water depths from the outer end of the bar to Wilmington were increased to 32 feet and all channels were now to maintain a width of 400 feet throughout (USACE 1945:632-631). The project was estimated to be 65 per cent complete by the end of the fiscal year. In 1950, the controlling depths over the ocean bar were increased to 35 feet (USACE 1950:653-654).

Additional modifications to the navigation channels were authorized in the River and Harbor Act of 23 October 1962. Among the provisions of that Act was the deepening and widening of the entrance channel to 40 feet deep and 500 feet wide (USACE 1962:360-361). The channel was to maintain those dimensions as far as Southport were they were reduced to 38 feet deep and 400 feet wide up to Wilmington. The project was reported as being completed in 1973 (USACE 1979:6-9).

Survey Data Analysis

The remote-sensing survey of the JBS borrow site extension included a 200-foot perimeter buffer on all sides except the southwest. That side corresponded to the buffer included on the previously surveyed area (Figure 16). The borrow site and buffer areas were investigated on northwest to southeast survey lines laid out on 50-foot centers (Figure 17).

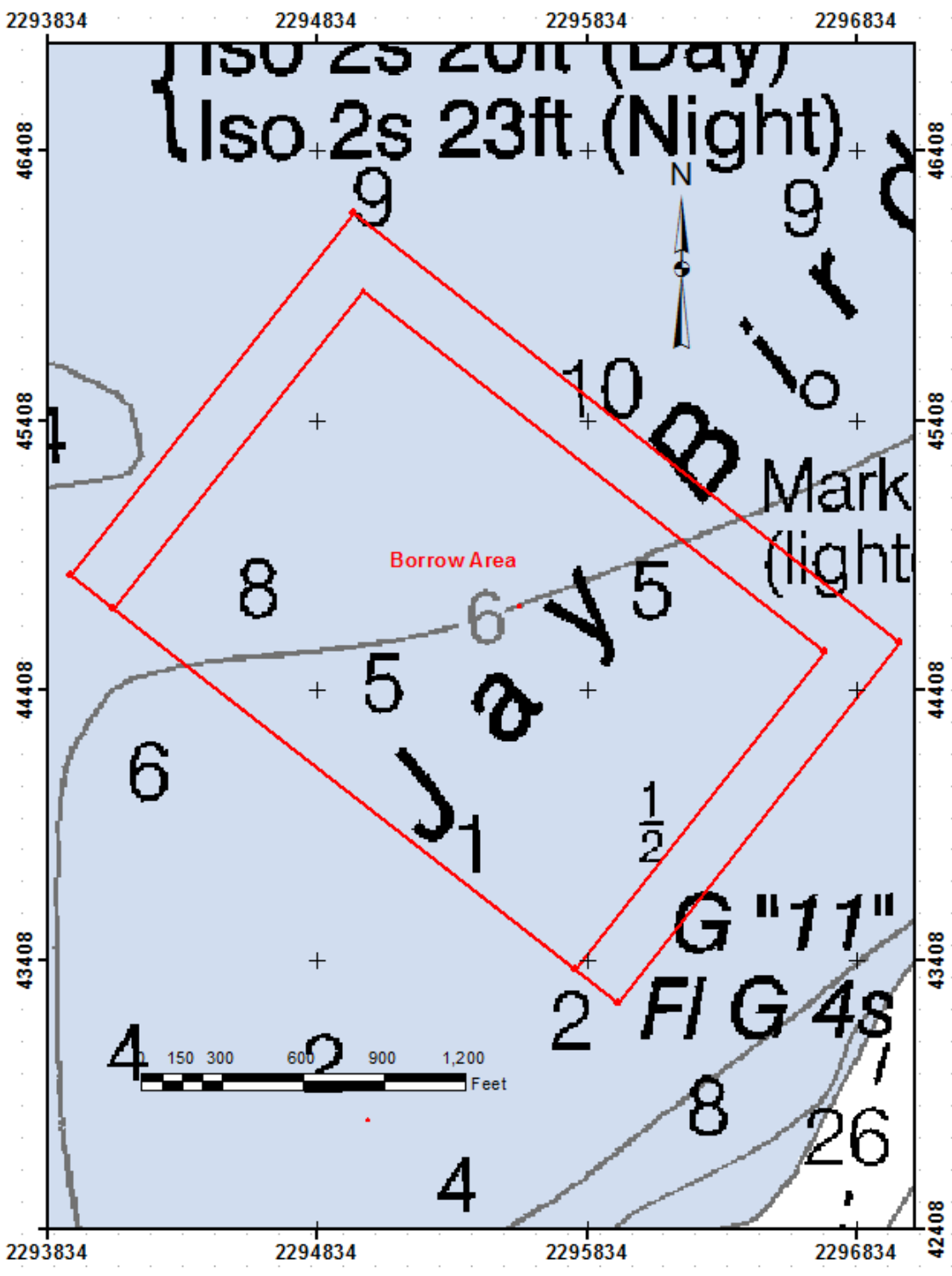


Figure 16. The JBS borrow area and 200-foot buffer.

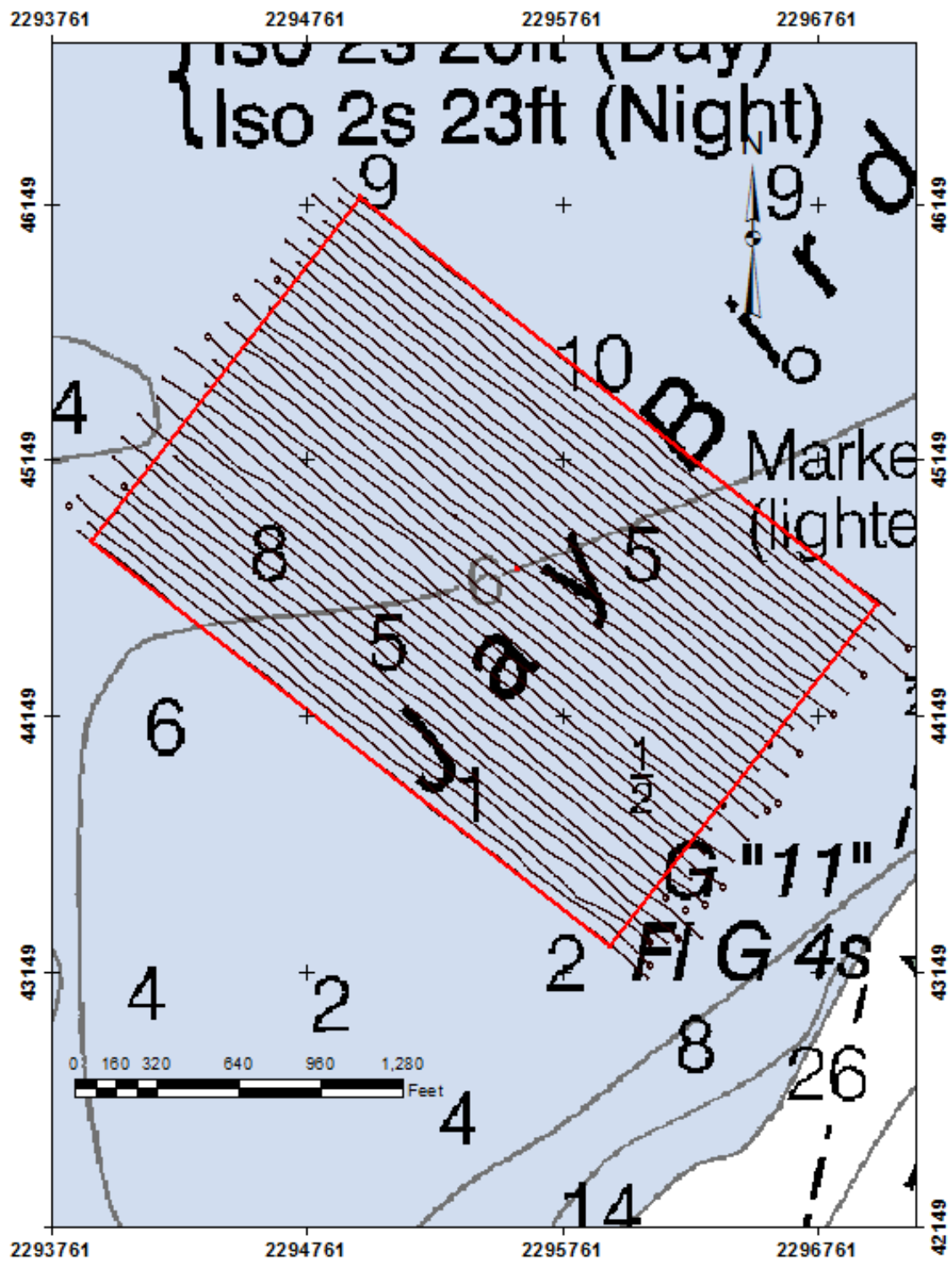


Figure 17. As-run JBS data collection survey lines.

Contouring and analysis of the JBS magnetometer data identified a total of 26 magnetic anomalies (Figure 18; Appendix B). Nine of those were located within the 200-foot perimeter buffer area. A cluster of four anomalies within the borrow area have collective signature characteristics that could represent historic vessel remains. Those four anomalies are buffered and recommended for avoidance or additional investigation. That avoidance buffer is a 300-foot-diameter circle (Figure 19) centered on coordinates presented in Table 2.

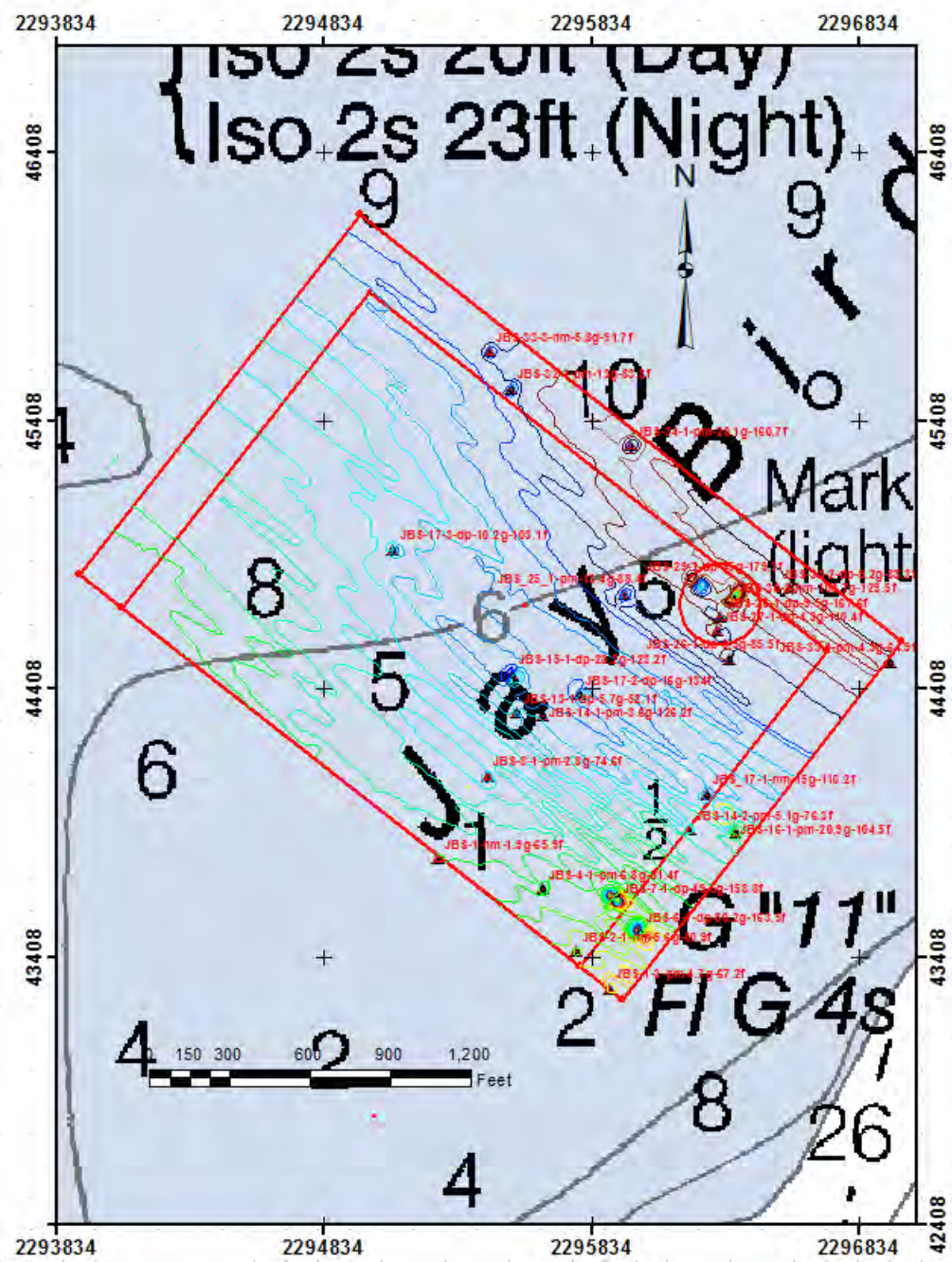


Figure 18. Survey area magnetic contours, anomalies, and avoidance buffer.

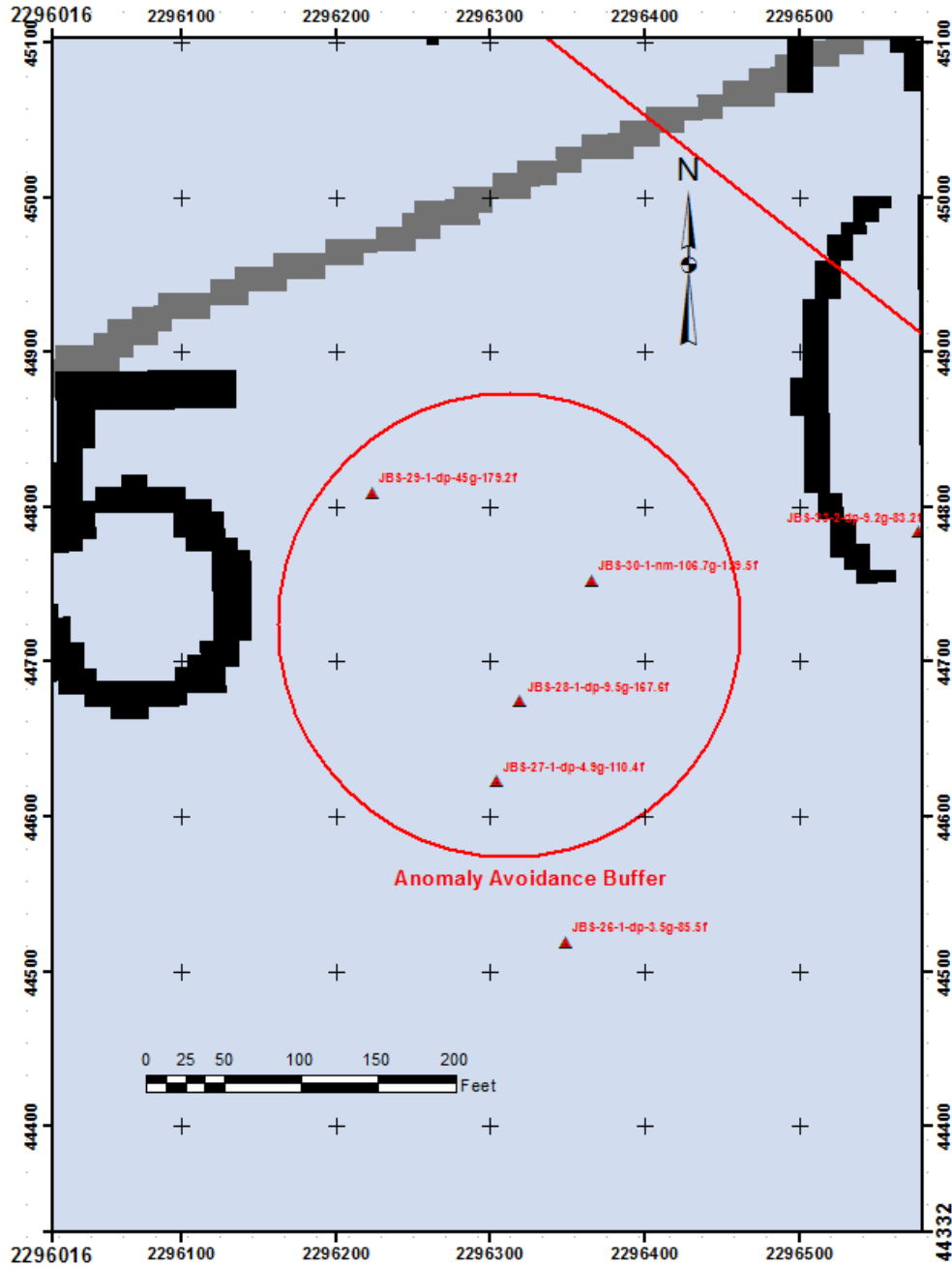


Figure 19. Recommended magnetic anomaly avoidance buffer.

Avoidance Buffer	X Coordinate	Y Coordinate
Center	2296306.5	44731.4

Table 2. Magnetic anomaly avoidance buffer coordinates.

JBS has a high potential for submerged historically significant shipwrecks that include the “Sir John Yeamans flyboat”. That vessel wrecked on JBS in 1665 and could well be one of the oldest known wrecks in North Carolina waters. No additional investigation of those buffered anomalies is recommended in conjunction with the proposed dredging unless the buffer could be impacted or anomaly identification is desirable. The remaining 22 anomalies within and outside the borrow area appear to have been generated by modern debris such as fish and crab traps, pipes, small diameter rods, cable, wire rope, chain, small boat anchors and possibly ordnance associated with fortifications on BHI and Oak Island.

Analysis of the JBS sidescan sonar data identified only one bottom surface target (Figure 20). The signature for that acoustic target represents a linear object on the bottom surface (Figure 21). No magnetic anomaly is associated with the acoustic target. It likely represents a piling or navigation reference day board.

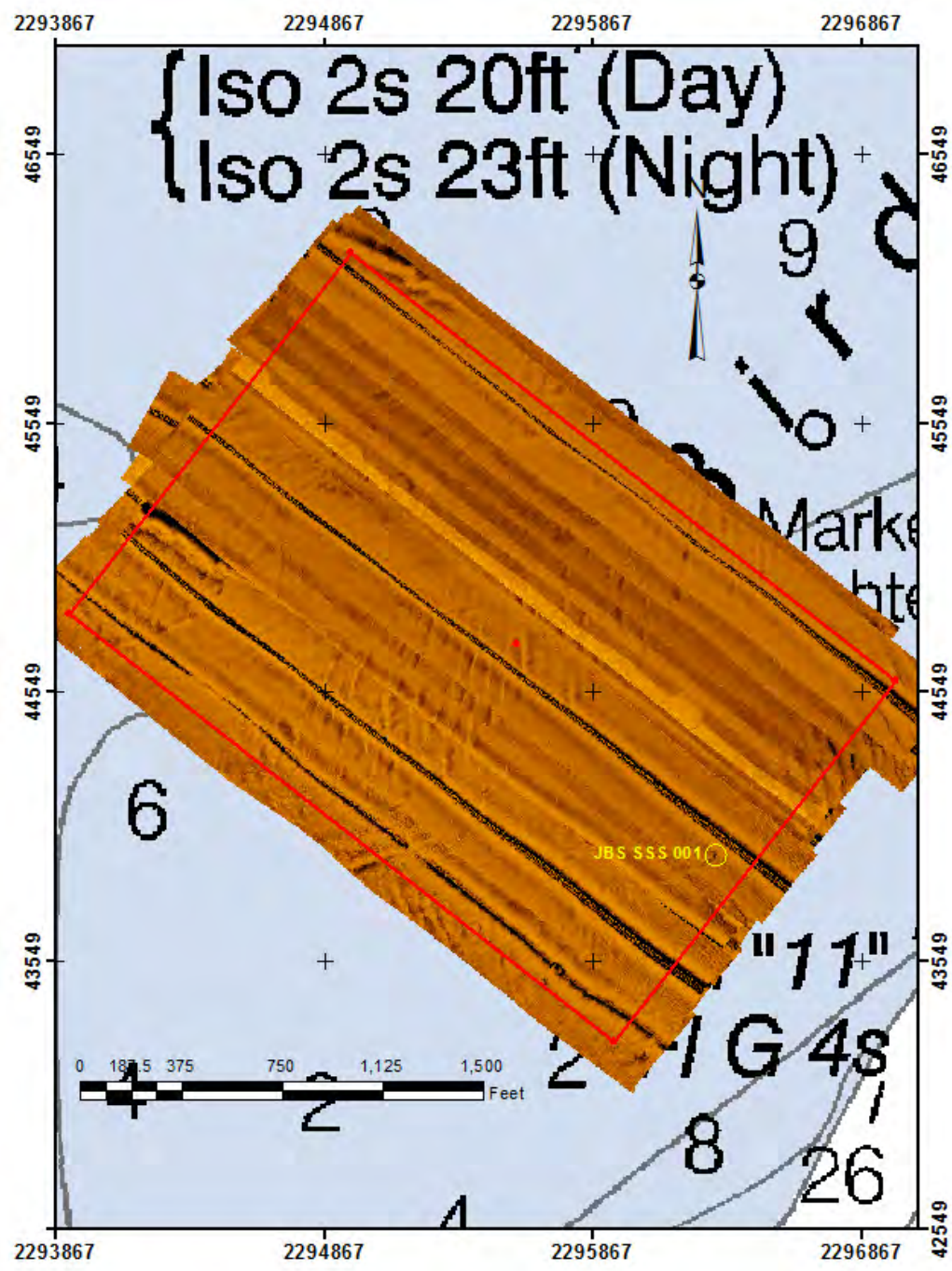


Figure 20. Sidescan sonar coverage mosaic and Target JBS SSS 001 location.

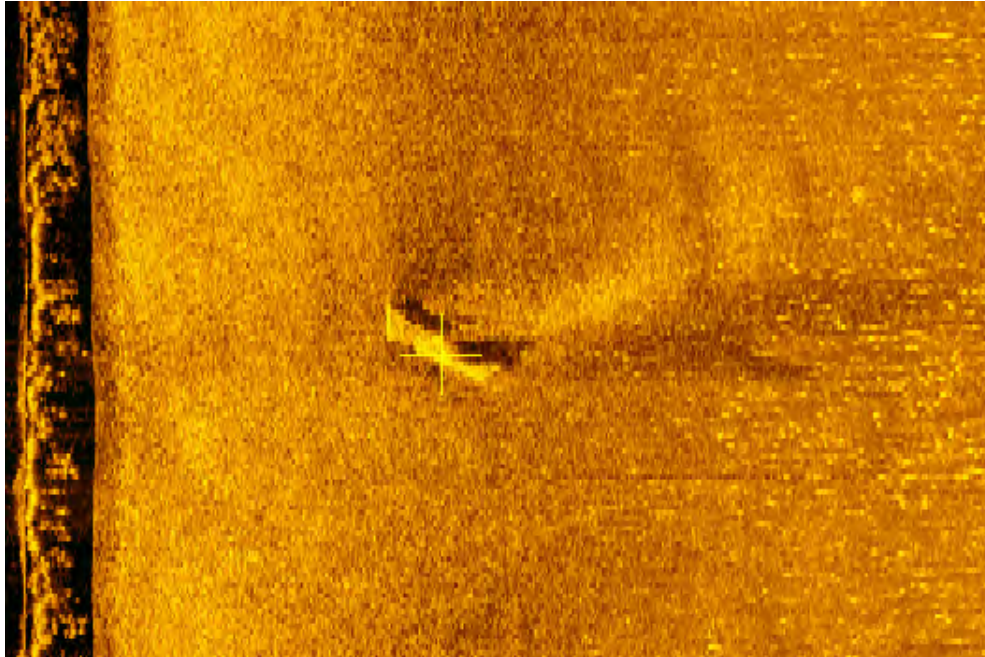


Figure 21. Sonar image of Target JBS SSS 001.

Analysis of the sub-bottom profiler data identified no geological features or targets associated with any of the magnetic anomalies. Due to shallow water and wave generated disturbance in the survey area, the EdgeTech 214 sub-bottom profiler provided less than ideal sediment profiles in the survey area (Figure 22). Although some of the seismic survey lines crossed over magnetic anomalies, no correlation with material generating magnetic signatures could be established.

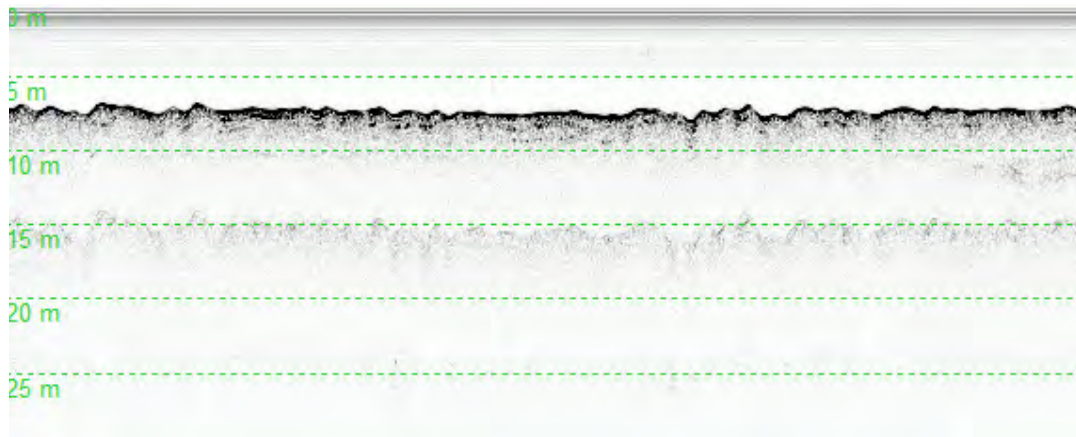


Figure 22. Example of sub-bottom profiler data where water depth near the channel was sufficient to produce reasonable definition.

Previous Remote-Sensing Survey Investigations

Report Title: *A Remote Sensing Survey and Anomaly Assessment Investigation On Jay Bird Shoal off Smith Island Channel, Cape Fear River, Brunswick County, North Carolina*

Submittal Date: 2007

Corporate Author: Tidewater Atlantic Research, Inc., Washington, North Carolina

Principal Investigator: Gordon P. Watts, Jr.

Client: Olsen Associates, Inc., Jacksonville, Florida

Report Title: *Anomaly Reassessment Investigation [Addendum Report for A Remote Sensing Survey and Anomaly Assessment Investigation On Jay Bird Shoal off Smith Island Channel, Cape Fear River, Brunswick County, North Carolina submitted 2007]*

Submittal Date: 30 November 2017

Corporate Author: Tidewater Atlantic Research, Inc., Washington, North Carolina

Principal Investigator: Gordon P. Watts, Jr.

Client: Olsen Associates, Inc., Jacksonville, Florida

Report Title: *Phase II Remote-Sensing Archaeological Survey of the Western Extremity of Jay Bird Shoals Near the Mouth of the Cape Fear River, Brunswick County, North Carolina*

Submittal Date: 27 September 2019

Corporate Author: Tidewater Atlantic Research, Inc., Washington, North Carolina

Principal Investigator: Gordon P. Watts, Jr.

Client: Geodynamics LLC, Newport, North Carolina

Conclusions and Recommendations

A survey of historical and archaeological literature and extensive background research confirmed evidence of sustained maritime activity associated with the Cape Fear River. That activity began in the seventeenth century and continues in the present day. Twenty-seven vessels have been documented as lost in the Smith Island vicinity. Seven have been documented as lost on the “Middle Ground” now identified as JBS. An additional nine vessels have been recorded as being lost on the bar or at the mouth of the Cape Fear River and may lie in the vicinity of the proposed borrow site.

One of the earliest and most significant historically documented shipwrecks in North Carolina waters is the flyboat of Sir John Yeamans which was lost on the “middle ground” in October 1665. The Union armed-tug *Violet* was lost on the “western bar channel shoal” in August 1864. An 1884 U.S. Coast and Geodetic chart of the entrance to the Cape Fear (Figure 23) documented the possible location of *Violet*. Although USACE records indicated that elements of the steam machinery associated with a Civil War era shipwreck were removed from the channel adjacent to the shoal, archaeological evidence from other subject period shipwrecks “cleared” as obstructions has confirmed that considerable amounts of vessel structures were frequently left at sites. Among those examples are the USS *Southfield* (Roanoke River NC), the CSS *Fredericksburg* (James River VA), CSS *Chattahoochee* (Chattahoochee River GA), and tug *Lavender* (off Egmont Key FL).

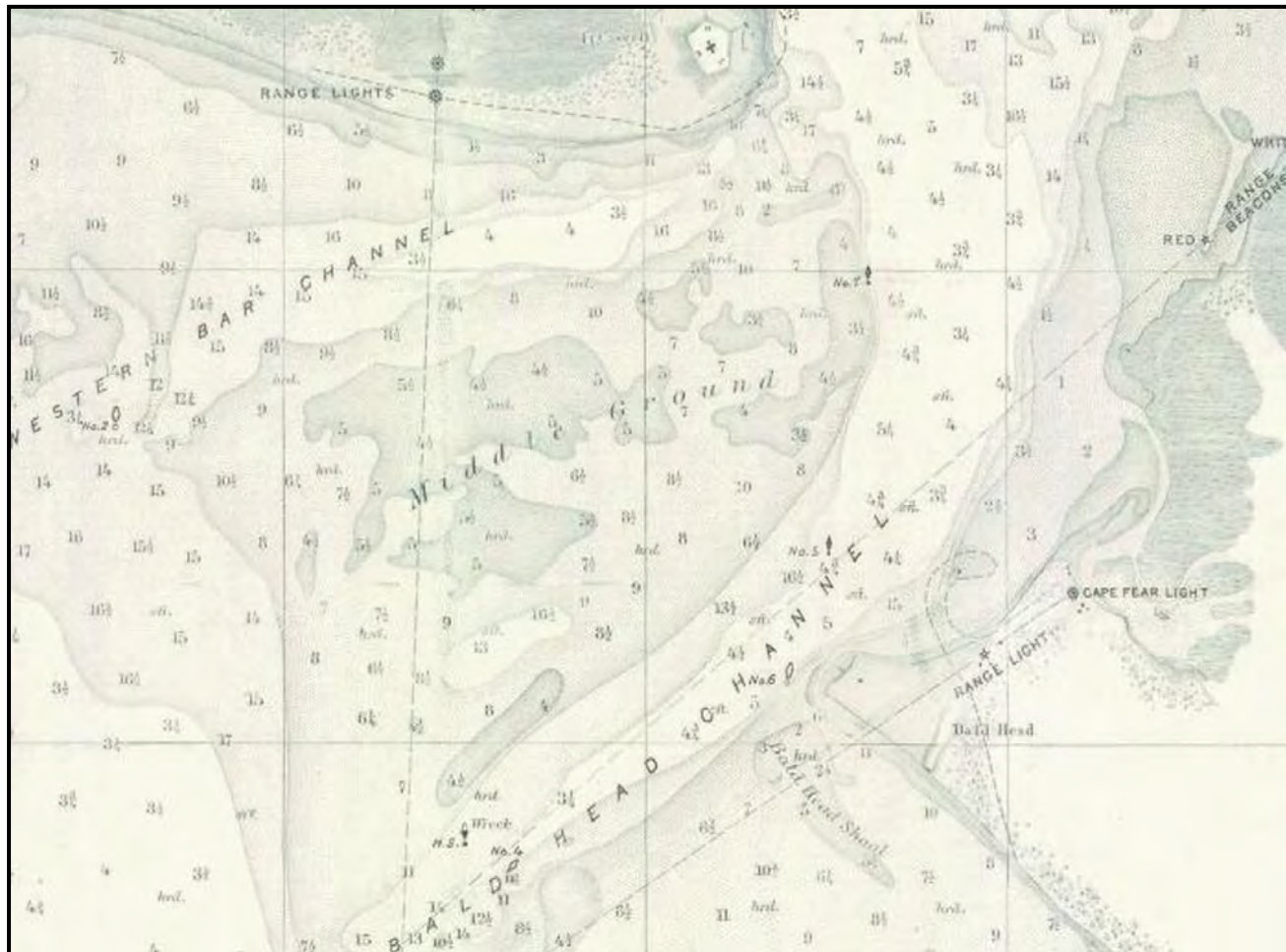


Figure 23. Detail of 1884 U.S. Coast & Geodetic Survey chart of the Cape Fear River Entrance.

While there is documentary evidence of historic shipwrecks in the project vicinity, the one-charted wreck in the survey area was not previously located. Several lines previously surveyed in 2007 (Tidewater Atlantic Research 2007) ran across the wreck symbol that appears on the current Cape Fear River NOAA Chart 11537-1 (Figure 24). No magnetic anomalies or acoustic targets were identified on any of the lines. Additional lines run through the wreck symbol roughly perpendicular to the planned lines also failed to produce any indication of a wreck at (or near) the site.

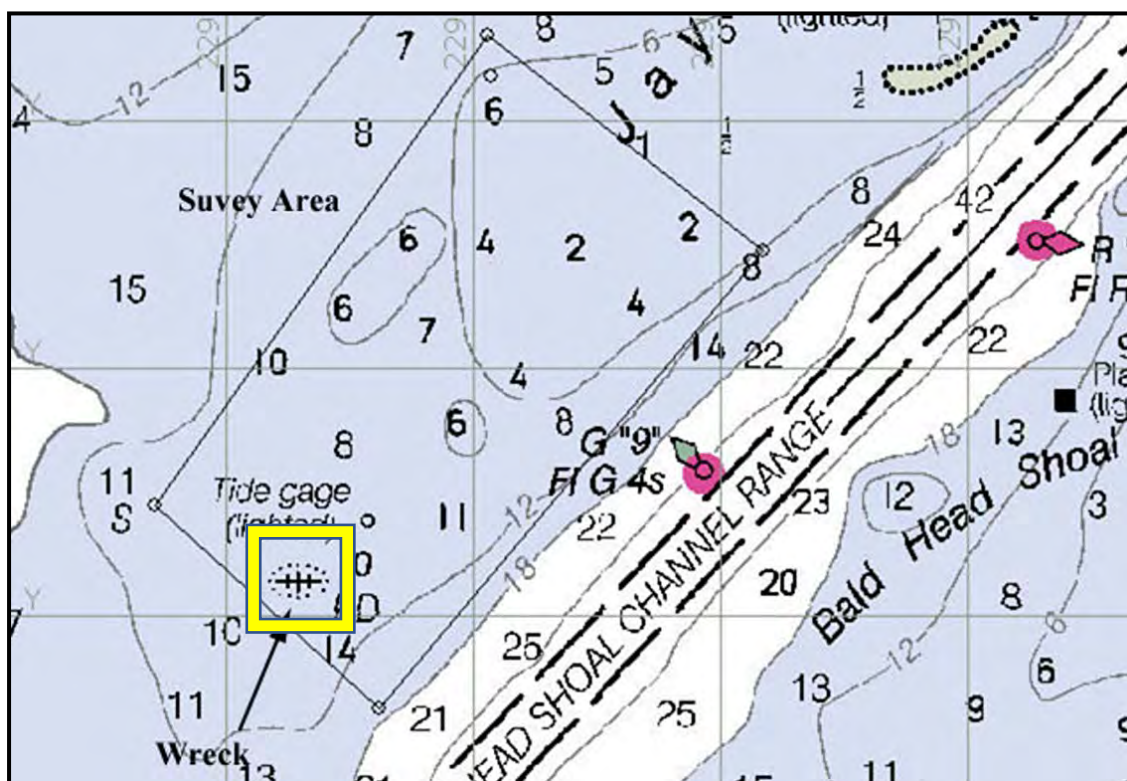


Figure 24. Detail of NOAA Chart 11537-1 showing mapped wreck in 2007 survey area.

Twenty-six magnetic anomalies were identified in the current JBS survey data. Analysis of those data identified a cluster of four anomalies that have collective signature characteristics that could represent historic vessel remains. Those four anomalies are recommended for avoidance or additional investigation. Nine of the remaining 22 anomalies are located in the 200-foot perimeter buffer. One magnetic anomaly is located outside the current survey area.

The 12 unbuffered anomalies inside the borrow area are not considered to be potentially significant. Those anomalies appear to have been generated by modern debris such as fish and crab traps, pipes, small diameter rods, cable, wire rope, chain, small boat anchors and possibly ordnance associated with fortifications on BHI and Oak Island. None of the magnetic anomalies have an associated acoustic signature.

Analysis of the sidescan sonar data identified only one target. The signature for that acoustic target represents a linear object on the bottom surface. No magnetic anomaly is associated with the target. It likely represents a piling or navigation reference such as a dayboard. Analysis of the sub-bottom profiler data was not ideal due to shallow water in the majority of the area surveyed. No geological features or targets were identified in those data.

Unexpected Discovery Protocol

In the event that any project activities expose potential prehistoric or historic cultural material not identified during the remote-sensing survey, the dredge company under contract should *immediately* shift operations away from the site (or sites) and notify the respective Point of Contact for VBHI, OAI, the NCHPO (Raleigh), the NCDNCR (Raleigh), and the UAB (Kure Beach). Notification should address the exact location, where possible, the nature of material exposed by project activities and options for *immediate* archaeological inspection and assessment of the site (or sites).

References Cited and Consulted

Berman, Bruce D.

1972 *Encyclopedia of American Shipwrecks*. Mariners Press, Boston.

Brown, Landis G.

1974 Cape Fear Quarantine Station: Origin and Disease Barrier. *Brunswick County Historical Society Newsletter* 14(2).

Browning, Robert M., Jr.

1980 The Blockade of Wilmington, North Carolina: 1861-1865. Unpublished M.A. thesis, Department of History, East Carolina University, Greenville.

Carson, Susan S.

1992 *Joshua's Dream: The Story of Old Southport, A Town with Two Names*. Southport Historical Society, Southport, North Carolina.

Duffus, Kevin P.

2017 *The Story of Cape Fear and Bald Head Island*. Southport Historical Society, Southport, NC.

Engle, Eloise, and Arnold S. Lott

1975 *America's Maritime Heritage*. Naval Institute Press, Annapolis.

Galecki, Bryan

2005 *Rum Runners, U-Boats, & Hurricanes: The Complete History of the Coast Guard Cutters Bedloe and Jackson*. Pine Belt Publishing, Wilmington, N.C.

Gannon, Michael

1991 *Operation Drumbeat: The Dramatic True Story of Germany's First U-Boat Attacks Along the American Coast in World War II*. Reprint of the 1990 edition. HarperPerennial, New York.

Holcombe, Robert

1993 The Evolution of Confederate Ironclad Design. Unpublished M. A. thesis, Department of History, East Carolina University, Greenville, North Carolina.

Lee, Lawrence

1965 *The Lower Cape Fear in Colonial Days*. University of North Carolina Press, Chapel Hill.

1977 *New Hanover County: A Brief History*. Division of Archives and History, North Carolina Department of Cultural Resources, Raleigh.

1978 *The History of Brunswick County North Carolina*. Board of County Commissioners, Brunswick County, North Carolina.

Lockhead, John L. (Compiler)

1954 *Disasters to American Vessels, Sail and Steam, 1841-1846*. Compiled from the New York Shipping and Commercial List, Mariners Museum, Newport News, VA.

Lonsdale, Adrian L., and H. R. Kaplan (compilers-editors)

1964 *A Guide to Sunken Ships in American Waters*. Compass Publications, Arlington, VA.

Lytle, William M. and Forrest R. Holdcamper (compiler-editor)

1975 *Merchant Steam Vessels of the United States 1790-1868 "The Lytle-Holdcamper List."* Edited by C. Bradford Mitchell. The Steamship Historical Society of America, Staten Island, NY.

Marx, Robert F.

1983 *Shipwrecks in the Americas*. Bonanza Books, New York, NY.

National Historical Society

1987 *Official Records of the Union and Confederate Navies in the War of the Rebellion*. Ser. 1, vol. 12. Historical Times, Harrisburg, PA.

Old Baldy Foundation

n.d. Wreck Logs: 5 November 1883-18 January 1906. Life Saving Station No. Cape Fear, District No. Six. Transcribed by Kim H. Gottshall. Old Baldy Museum, Bald Head Island, NC. [Hard copy on file at Tidewater Atlantic Research, Washington, NC; cannot be distributed or copied]

Pleasants, James A.

1979 *A Brief History of the Lower Cape During the Civil War*. Ms. on file, Tidewater Atlantic Research, Washington, NC.

Potter, Greg L.

1993 *Report of Findings: The Yeamans' Expedition Flyboat*. Submitted to the Underwater Archaeology Unit, Division of Archives and History, North Carolina Department of Cultural Resources, Fort Fisher.

Powell, William.

1989 *North Carolina Through Four Centuries*. University of North Carolina Press, Chapel Hill.

Reaves, Bill

1999 *Southport (Smithville), A Chronology (1941-1970)*. Southport Historical Society, Southport, NC.

Shomette, Donald G.

1973 *Shipwrecks of the Civil War, The Encyclopedia of Union and Confederate Naval Losses*. Donic Ltd., Washington, DC.

Soley, James Russell

1883 *The Navy in the Civil War: The Blockade and the Cruisers*. Charles Scribner's, London, England.

Sprunt, James

2005 *Chronicles of the Cape Fear River*. Second Edition. Dram Tree Books, Wilmington, NC.

Still, Jr. William N.

1985 *Iron Afloat: The Story of the Confederate Armorclads*. University of South Carolina Press, Columbia.

The Messenger [Wilmington NC]

1891 *The Messenger*, 16 May 1891, 7 July 1892.

Tidewater Atlantic Research (TAR)

2007 *A Remote Sensing Survey and Anomaly Assessment Investigation On Jay Bird Shoal off Smith Island Channel, Cape Fear River, Brunswick County, North Carolina*. Report submitted to Olsen Associates, Inc., Jacksonville, FL, submitted by Tidewater Atlantic Research, Washington, NC.

2017 *Anomaly Reassessment Investigation*. Addendum Report for *A Remote Sensing Survey and Anomaly Assessment Investigation On Jay Bird Shoal off Smith Island Channel, Cape Fear River, Brunswick County, North Carolina*. Report submitted to Olsen Associates, Inc., Jacksonville, FL, submitted by Tidewater Atlantic Research, Washington, NC.

2019 *Phase II Remote-Sensing Archaeological Survey of the Western Extremity of Jay Bird Shoals Near the Mouth of the Cape Fear River, Brunswick County, North Carolina*. Report submitted to Geodynamics LLC, Newport, NC, submitted by Tidewater Atlantic Research, Washington, NC.

U. S. Army Corps of Engineers (USACE)

1870-1979 *Annual Reports of the Chief of Engineers*, U.S. Department of the Army, Washington, DC.

Watson, Alan D.

1992 *Wilmington: Port of North Carolina*. University of South Carolina Press, Columbia.

Appendix A: Known Shipwreck Losses in the Vicinity of JBS

Vessel	Type	Use	Date of Loss	Location	Disposition
Spanish Vessel			1526	Mouth of the Cape Fear River	
<i>Sir John</i>	Fly Boat		OCT 1665	Middle Ground	
Unknown			FEB 1767	Cape Fear River Bar	
<i>Enterprise</i>			15 FEB 1768	Mouth of the Cape Fear River	
<i>Clementine</i>			MAR 1775	Middle Ground	Salvaged(?)
Unknown			FEB 1784	Mouth of the Cape Fear River	
<i>Neptune</i>	Brig		26 JAN 1789	Middle Ground	
<i>Sabine</i>		Privateer	11 SEP 1814		
<i>Florie</i>		Blockade Runner	OCT 1864	Inside Bar	
<i>Georgiana McCaw</i>		Blockade Runner	2 JUN 1864	SW of Baldhead Light	
<i>Violet</i>		U.S.S. Gunboat	7 AUG 1864	Western Bar	Possibly cleared by USACE
<i>Frying Pan Shoals Lightship</i>		Light Ship	20 DEC 1861	North of Fort Caswell	Sunk by U.S.S. <i>Mount Vernon</i>
<i>Ellen</i>	Schooner	Blockade Runner	26 JUN 1862	Burned while ashore at Bald Head Channel	Taken in tow by U.S.S. <i>Victoria</i> . Sunk in 15 minutes.
<i>Emily</i>	Schooner	Blockade Runner	26 JUN 1862	Burned under the guns of Fort Caswell	
<i>Lizzie</i>	Sloop	Blockade Runner	1 AUG 1862	Captured and burned by USS <i>Penobscot</i> off Bald Head.	
<i>Ella</i>	Steamer	Blockade Runner	3 DEC 1864	Run ashore on Bald Head Beach.	Partially Salvaged
<i>Agnes Emily Frye</i>	Steamer	Blockade Runner	27 DEC 1864	Lost 2 miles south of Fort Caswell off Old Inlet	
<i>Pine</i>	Sloop		MAY 1868	Cape Fear Bar	
<i>Alex Sprunt</i>		Lighter	FEB 1872		
<i>Felicitus</i>	Bark (Ger.)		JUL 1874	Main Bar	Salvaged
<i>Maria Needham</i>	Bark (Br.)		14 JAN 1874	Middle Ground	Salvaged
<i>Vapor</i>	Schooner		5 NOV 1895	Cape Fear Bar	
<i>San Antonio</i>	Bark (Br.)		13 JAN 1890		Salvaged
<i>Ogir</i>	Bark (Nor.)		10 NOV 1894	Middle Ground	Salvaged
<i>Clarence H</i>	Schooner		9 DEC 1902	South of Cape Fear Bar	
<i>Col. Thos. F. Austin</i>	Schooner		24 FEB 1916	Middle Ground	
Unknown	Bark		13 JUN 1930	Middle Ground	
<i>Magnolia</i>	Sailboat	Pleasure	30 OCT 1993	“on Jay Bird Shoal”	
<i>Apnoia</i>	Tanker	Commercial	20 DEC 1999	“west of Buoy #7 at Jay Bird Shoal”	Refloated

Appendix B: JBS Magnetic Anomaly Table

Appendix B: Magnetic Anomaly Table

Name	X Coordinate	Y Coordinate	Survey Line #	Anomaly #	Signature	Gammas	Duration	Assessment	Significance
JBS-1-nm-1.9g-65.9f	2295264.6	43772	1	1	Negative Monopolar	1.9g	65.9f	In Perimeter Buffer	Not Potentially Significant
JBS-1-2-pm-4.7g-67.2f	2295906.1	43288.8	1	2	Positive Monopolar	4.7g	67.2f	In Perimeter Buffer	Not Potentially Significant
JBS-2-1-nm-5.6g-60.9f	2295779.3	43428.1	2	1	Negative Monopolar	5.6g	60.9f	Small Ferrous Object	Not Potentially Significant
JBS-4-1-pm-6.8g-81.4f	2295654.3	43659.4	4	1	Positive Monopolar	6.8g	81.4f	Small Ferrous Object	Not Potentially Significant
JBS-6-1-dp-80.2g-163.5f	2296018.3	43501.5	6	1	Dipolar	80.2g	163.5f	In Perimeter Buffer	Not Potentially Significant
JBS-7-1-dp-49.5g-158.8f	2295929.8	43644.6	7	1	Dipolar	49.5g	158.8f	Moderate Ferrous Object	Not Potentially Significant
JBS-8-1-pm-2.8g-74.6f	2295447.3	44081.1	8	1	Positive Monopolar	2.8g	74.6f	Small Ferrous Object	Not Potentially Significant
JBS-13-1-dp-5.7g-52.1f	2295557.1	44318.5	13	1	Dipolar	5.7g	52.1f	Small Ferrous Object	Not Potentially Significant
JBS-14-1-pm-3.6g-126.2f	2295652.6	44309.4	14	1	Positive Monopolar	3.6g	126.2f	Small Ferrous Object	Not Potentially Significant
JBS-14-2-pm-5.1g-76.3f	2296201.4	43882.4	14	2	Positive Monopolar	5.1g	76.3f	In Perimeter Buffer	Not Potentially Significant
JBS-15-1-dp-28.2g-123.2f	2295539.1	44461.3	15	1	Dipolar	28.2g	123.2f	Moderate Ferrous Object	Not Potentially Significant
JBS-16-1-pm-20.9g-104.5f	2296372.4	43873.9	16	1	Positive Monopolar	20.9g	104.5f	In Perimeter Buffer	Not Potentially Significant
JBS_17-1-nm-15g-110.2f	2296267.2	44013.7	17	1	Negative Monopolar	15g	110.2f	Small Ferrous Object	Not Potentially Significant
JBS-17-2-dp-16g-134f	2295790.9	44385.5	17	2	Dipolar	16g	134f	Moderate Ferrous Object	Not Potentially Significant
JBS-17-3-dp-10.2g-103.1f	2295093.1	44927	17	3	Dipolar	10.2g	103.1f	Small Ferrous Object	Not Potentially Significant
JBS_25_1-pm-13.4g-88.4f	2295957.8	44762.7	25	1	Positive Monopolar	13.4g	88.4f	Small Ferrous Object	Not Potentially Significant
JBS-26-1-dp-3.5g-85.5f	2296349.5	44518.9	26	1	Dipolar	3.5g	85.5f	Small Ferrous Object	Not Potentially Significant
JBS-27-1-dp-4.9g-110.4f	2296304.3	44622.9	27	1	Dipolar	4.9g	110.4f	Avoidance Buffered	Potentially Significant
JBS-28-1-dp-9.5g-167.6f	2296320	44674.7	28	1	Dipolar	9.5g	167.6f	Avoidance Buffered	Potentially Significant
JBS-29-1-dp-45g-179.2f	2296224.5	44809.3	29	1	Dipolar	45g	179.2f	Avoidance Buffered	Potentially Significant
JBS-30-1-nm-106.7g-129.5f	2296366	44752.5	30	1	Negative Monopolar	106.7g	129.5f	Avoidance Buffered	Potentially Significant
JBS-32-1-pm-13g-83.8f	2295535.7	45528	32	1	Positive Monopolar	13g	83.8f	In Perimeter Buffer	Not Potentially Significant
JBS-33-1-pm-4.3g-64.9f	2296951.9	44508.4	33	1	Positive Monopolar	4.3g	64.9f	Out of Survey Area	Not Potentially Significant
JBS-33-2-dp-9.2g-83.2f	2296578.6	44784	33	2	Dipolar	9.2g	83.2f	In Perimeter Buffer	Not Potentially Significant
JBS-33-3-nm-5.8g-91.7f	2295453.2	45667.4	33	3	Negative Monopolar	5.8g	91.7f	In Perimeter Buffer	Not Potentially Significant
JBS-34-1-pm-20.1g-160.7f	2295985.4	45316.4	34	1	Positive Monopolar	20.1g	160.7f	In Perimeter Buffer	Not Potentially Significant