Bald Head Island, N.C.

Beach Monitoring Program

Monitoring Report No. 21 (May 2022 to May 2023)

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Village of Bald Head Island

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EXECUTIVE SUMMARY

The most recent Wilmington Harbor Inner Ocean Bar maintenance dredging of Bald Head Shoal Channel Ranges 1 and 2, and the Smith Island Channel range was performed in the months of December 2022 – March 2023. Federal surveys show approximately 1.3 Mcy of sand during that operation were dredged with placement along South Beach pursuant to the terms of the Wilmington Harbor Sand Management Plan (WHSMP). The estimated "final" in-place fill volume measured was somewhat less (by 10-15%). Oak Island will be the recipient of the next tentatively scheduled 2025 beach disposal operation in accordance with the continued implementation of the present day WHSMP. As a result, the Village is planning for a locally constructed project in our about 2025 or 2026. The last sand placement project constructed by the Village was between 13 January 2019 and 22 March 2019. The borrow site for that project was Jay Bird Shoals. The final fill volume (in-place) was 1.1 Mcy which included the addition of a Post-Florence FEMA Claim for documented storm related losses from the *engineered beach* in September 2018 (Olsen 2018). The limits of that fill extended eastward only to Sta. 146+00 on South Beach.

It is anticipated that the next Village sponsored project (in 2025 or 2026) will seek to place approximately 1 Mcy total along two (2) sections of shoreline located at the opposite ends of South Beach. The easternmost segment of approximately .5 Mcy is intended to briefly address the chronic erosion that's been occurring for a number of years in the vicinity of the Shoals Club at Cape Fear. On the western end of South Beach an additional .5 Mcy fill will address the filling of the terminal groin template as well as the section of shoreline extending throughout the limits of the sand tube groinfield. Subsequent to fill placement, it is currently planned to remove and replace sandtube groins which have reached the end of their effective life. The groinfield was last replaced in its entirety in 2019 concurrent with the Village renourishment project. It will need to be readdressed similarly with the next Village project. For purposes of constructing the tentatively upcoming 2025 or 2026 (1 Mcy) Village renourishment project, a pre-existing (but depleted) borrow site at Jay Bird Shoals needs to be expanded to the north.

By about 2013, the results of a comprehensive annual beach monitoring program initiated in 2000 by the Village of Bald Head Island yielded the conclusion that sand placement alone could *not* successfully offset navigation channel impacts to the west end of South Beach which had been typically manifest in chronic rates of erosion and a consistent northerly post-fill recession of the shorefront. Accordingly, the Village was ultimately forced to "change the existing dynamic" by constructing a single terminal groin designed to complement the placement of future beach fills at the persistent South Beach erosional "hot spot". The project was permitted to be constructed in two phases – with Phase 2 being optional. Simplistically,

the structure was designed to serve as a "template" for fill material placed eastward thereof on South Beach. The Phase 1 1,300 ft. long terminal groin (completed in Nov. 2015), was designed however as a "leaky" structure (*i.e.* semi-permeable) so as to provide for some level of continued sand transport to West Beach and portions of the Point (located both westward and northward of the groin stem). Through May 2023, terminal groin project performance – based upon post-construction monitoring – has been both as intended – and as predicted.

Between November 2000 and March 2023, Bald Head Island had received up to 9.9 Mcy, mol of sand from the initial widening/deepening and six (6) subsequent maintenance dredging operations for the Wilmington Harbor Navigation Project entrance channel. Including the 2019 project, the Village has placed another 3.2 Mcy of sand along the West Beach and South Beach shorelines. Accordingly, in the net Bald Head Island has experienced a total *estimated* sand placement volume of approximately 13.1 Mcy since 2000 at those two locations – with South Beach todate receiving 97% or more of the total.

Conversely, the *gross* volumetric sediment *loss* over a November 2000 to May 2023 (post-disposal) monitoring timeframe is conservatively computed at -8,801,300 Mcy, or approximately 391,168 cy per year – on "average". This annualized "loss" addresses the continuous section of Bald Head Island shorefront extending from the marina entrance to the Cape Fear spit. The assignment of an *average annual* long-term rate of sand loss at Bald Head Island however, has *not* necessarily been a meaningful indicator of navigation project impact. Such an average rate is often temporally biased by periods of beach fill equilibration, groinfield "effectiveness due to reconstruction," major storm events (such as Hurricanes Florence, Dorian and Isaias), the occurrence of episodic destabilization dredging events in close proximity to the island, as well as other physiographic phenomena temporally affecting annualized quantities of alongshore sediment transport – from Bald Head Island. In addition, the westernmost segment of the island's littoral system has had to adjust to the quasi-stabilizing effect of the terminal groin at that location in existence only since 2015. Along South Beach per se, there has historically existed a "nodal point" some 7,000 ft. eastward of the terminal groin (approx. STA 116+00). At or close to the nodal point, the directionality of *net littoral transport* on an annual basis changes from West (toward the groin) to East (toward Cape Fear). *Note* – depending on wave climatology, the condition and exposure of the sand tube groinfield, as well as other factors, the effective location of the nodal point can vary slightly along South Beach from year to year. As of May, 2023, within the 22,755 ft of shoreline influenced by sand episodically placed since 2000, up to 4,282,500 cy remain in the littoral system (measured above elevation -16 ft. NGVD 29). This *includes* the most recent beach disposal project completed in early 2023 by the Wilmington District, USACE.

Although not directly impacted by long-term navigation channel improvements and maintenance of the Cape Fear River entrance, the Village Council elected to initiate monitoring of the East Beach shorefront at Bald Head Island beginning in November 2008. Since that time, it is documented that East Beach can undergo strong seasonal variations of beach width and profile volume to a large degree dependent upon storm frequency and intensity, as well as

the ever-changing configuration of the Cape Fear spit. For example, the most recent May 2023 survey data show a net shoreline volumetric gain of approximately +18,400 cy (above elevation -16 ft NGVD). throughout the 6,000 ft East Beach shoreline lying northward of Cape Fear over the last 12 months. In the prior year, it had changed only by about +12,600 cy. Between November 2008 and May 2023, the total change had been +381,100 cy. Most of the volume increase had been caused by post-storm accretion of the Cape Fear spit shoreline fronting Onslow Bay.

Typically, periods of episodic accretional configurations of the Cape Fear spit deemed beneficial to East Beach have corresponded to a high rate of erosion and duneline recession along the easternmost section of South Beach – directly seaward and westward of the Shoals Club facility. For example, between 2000 and 2020, the average MHWL erosion rate at that general location has been over -20 ft/yr – due to sand losses either directly or indirectly associated with the configuration of the Cape Fear spit formation. Although a 2021 federal disposal project placed fill within 2,000 ft. mol. of the Shoals Club and Cape Fear, erosion has continued to the point that the Club was required to install a sandbag revetment seaward of the property in May/June 2022. That revetment requires continuing maintenance due to episodic beach profile lowering at that location and the effects of storms.

In 2022, the Village performed monitoring of the Jay Bird Shoals borrow site utilized to construct the non-federal 1.85 Mcy beach fill sponsored by the Village in 2009/10 and the 1.10 Mcy beach constructed in 2018/19. During the Year 12 monitoring period (May 2022 to May 2023), the fourth year following the 2018/19 project excavation, the entire permitted borrow site gained +16,300 cy (inclusive of the exclusion and buffer zones). As of May 2023, there is theoretically +1,380,000 Mcy of material located within the *permitted borrow site limits* above the permitted cut elevation (-22 ft-NGVD). Most of that material is *not* however practically available for dredging at this time. Hence, an extension of the original JBS borrow site limits will be required to act as a fill source for the next Village beach fill project in 2025 or 2026.

After an extension of the two marina entrance channel jetties in 2015, temporarily reduced shoaling within the navigation channel resulted in a corresponding reduced volume of disposal sand being place along the Row Boat Row shoreline. Although the Village had planned to continue to proactively bypass sand from the south jetty fillet (located at the distal end of West Beach) to the Row Boat Row shorefront, it became clear that the existing four (4) low level timber groins were not capable of providing an acceptable level of shoreline stabilization at that location.

Hence, near the end of the 2017 monitoring period, the Village initiated construction of two (2) shore parallel detached rock breakwaters located north of the marina entrance seaward of the Row Boat Row shoreline. The placement of breakwaters between existing groins northward of the marina entrance was intended to combine the attributes of each of the two types of stabilization structure so as to reduce the rate of sediment transport from the

eroding shoreline caused principally by ferry/barge generated waves. The subject expanded shore stabilization project (detached breakwaters *and* existing groinfield) was designed to have a sand fill prior to construction. The source of the fill was the exiting Bald Head Creek borrow area. A previously permitted Bald Head Creek borrow area was dredged in early 2017 by Marcol Dredging. Some 26,000 cy were placed at Row Boat Row prior to breakwater implementation. Since that time multiple channel maintenance/sand bypass operations have occurred – most with increasing volumes dredged. Typically, dredging is required twice a year on average. This is primarily due to an increasing northerly rate of sediment transport along West Beach caused by a continuing reconfiguration of the Point. As a result, the Village has been forced to perform an increased frequency of bypassing of sand farther northward of the stabilizing influence of the breakwaters. This required a 2020 modification of the permits associated with the limits of allowable beach disposal seaward of Row Boat Row.

In the spring of 2019, the Village resubmitted permit applications accompanied by indepth geotechnical studies and environmental analyses intended to develop a long term (and large scale) supplementary borrow site located within Frying Pan Shoals. The purpose of such a borrow site would be to both ensure compliance with Permit conditions necessitating the maintenance of the updrift fillet associated with the 2015 terminal groin project and to provide an interim source of beach quality material sufficient to meet future South Beach renourishment requirements – when pursuant to the existing tenets of the Wilmington Harbor Sand Management Plan, beach quality channel maintenance material excavated would be placed at Oak Island. In 2021, a pre-project fisheries monitoring plan was submitted for purposes of addressing regulatory agency concerns. In April 2022, the Village acknowledged certain regulatory "concerns" may not be resolved in the near future. Subsequently, the Village authorized work intended to expand the Jay Bird Shoals borrow site for purposes of providing a sand source for the next Village sponsored fill event – when federal beach disposal is contractually redirected to Oak Island. A pre-consultation meeting for the borrow site expansion was performed in July 2023.

An important secondary precept of the spring of 2019 beach fill project constructed by the Village was to allow for the concurrent replacement of the sand tube groinfield which had become damaged over time. During the spring 2023 federal channel maintenance project, the groin field in its entirety was again covered by beach fill.

The original Permits for construction of the terminal groin at Bald Head Island stipulated that if the permittee elected to dredge more than 250,000 cy from the Jay Bird Shoals borrow site after 2015, limited monitoring of the eastern end of Oak Island must be performed. Accordingly, in November 2018, the Village initiated the requisite monitoring at Oak Island (Caswell Beach). The first report of findings for Oak Island followed a November 2019 monitoring survey. A second year monitoring report was issued in December 2020. In early 2021 it was formally agreed by DCM and the USACE that based upon the results of the Year 2 report, the *Village's responsibility for continued monitoring of Oak Island has terminated.*

In 2019, the Port of Wilmington, NC (as project sponsor) commissioned the formulation of a Section 203 Report which proposed a plan to deepen and widen (in places), the Federal navigation project, which extends from the Atlantic Ocean up the Cape Fear River to the Port of Wilmington. The Village of Bald Head Island formally submitted several series of comments to-the-record which addressed deficiencies in the project analyses and which requested clarification to impacts addressed, or unaddressed by the consultant prepared report. In June 2023, the Wilmington District, USACE initiated a Scoping meeting for the Wilmington Harbor 403 Study/EIS.

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1.0 INTRODUCTION

1.1 Overview

This engineering report presents measured physical changes along the South Beach, West Beach, East Beach and Row Boat Row shorelines of Bald Head Island (BHI) based principally upon both historical and updated monitoring surveys performed annually on behalf of the Village of Bald Head Island (Village). It likewise addresses actions taken by the Village or others which have or could affect shoreline conditions. More, specifically, this report addresses:

(1) An overview of Bald Head Island's physical setting including a discussion of the Federal Navigation Channel and the status of the implementation for the Wilmington Harbor Sand Management Plan (WHSMP).

(2) Recent volume and shoreline position changes measured between monitoring surveys of May 2022, November 2022 and May 2023 along the West Beach, "the Point" and South Beach shorelines, as well as *long-term changes* since November 2000. Updates of East Beach and the Cape Fear Spit conditions are likewise provided, as well as near term changes for the Row Boat Row shoreline which receives episodic sand placement associated with routine marina entrance channel sand bypass operations.

(3) A discussion of the most recent Federal Beach Disposal Project constructed along the majority of S. Beach between December 2022 and March 2023 which is now subject to equilibration over the over the next year, mol.

(4) An update on the recent Section 203 Harbor Deepening Project Environmental Permitting initiated by the Wilmington District, USACE and its potential implications to Bald Head Island.

(5) Recent ongoing and new work including a submittal of a permit to expand the Jay Bird Shoals borrow site for purposes of a future Village beach renourishment project.

1.2 Physical Setting

Bald Head Island is located in Brunswick County, North Carolina at approximately 33°51′ N, 78°00′ W (**Figure 1.1**). It is roughly 25 miles south of the City of Wilmington and 32 miles east of the South Carolina/North Carolina state line. It is the southernmost of the coastal barrier islands which form the Smith Island complex at the mouth of the Cape Fear River. The southeastern tip of the island is Cape Fear (also referred to as Cape Fear Point) from which Frying Pan Shoals extend seaward over 20 miles to the southeast.

The island's east and south shorelines, "East Beach" and "South Beach", front the Atlantic shoreline. The west shoreline, or "West Beach", fronts the Cape Fear River. The north side of the island is bounded by the Bald Head Creek estuary, Middle Island and Bluff Island. The Cape Fear River entrance, over one mile in width, separates Bald Head Island from Oak Island (or Caswell Beach).

The astronomical tides in the vicinity of Bald Head Island are semi-diurnal and have average mean and spring ranges of approximately 4.3 ft and 5.0 ft, respectively. Tidal datums for Bald Head Island are listed in **Table 1.1** and the predicted astronomical tides during the May 2022 to May 2023 monitoring period are plotted as **Figure 1.2**.

Table 1.1: Tidal datums for Bald Head Island, North Carolina[1].

Datum	Elevation (ft-NGVD29[2])
Mean Higher High Water (MHHW)	+2.82
Mean High Water (MHW)	+2.51
NAVD 1988	+1.10
Mean Tide Level (MTL)	+0.35
NGVD 1929	0.00
Mean Low Water (MLW)	-1.81
Mean Lower Low Water (MLLW)	-1.98

[1] Approximations based upon extrapolation from Southport, N.C.
[2] NGVD 1929: National Geodetic Vertical Datum of 1929 (1929 Mean Seas Level). Horizontal coordinates are referenced to the North Carolina State Plane Coordinate System, North American Datum of 1983.

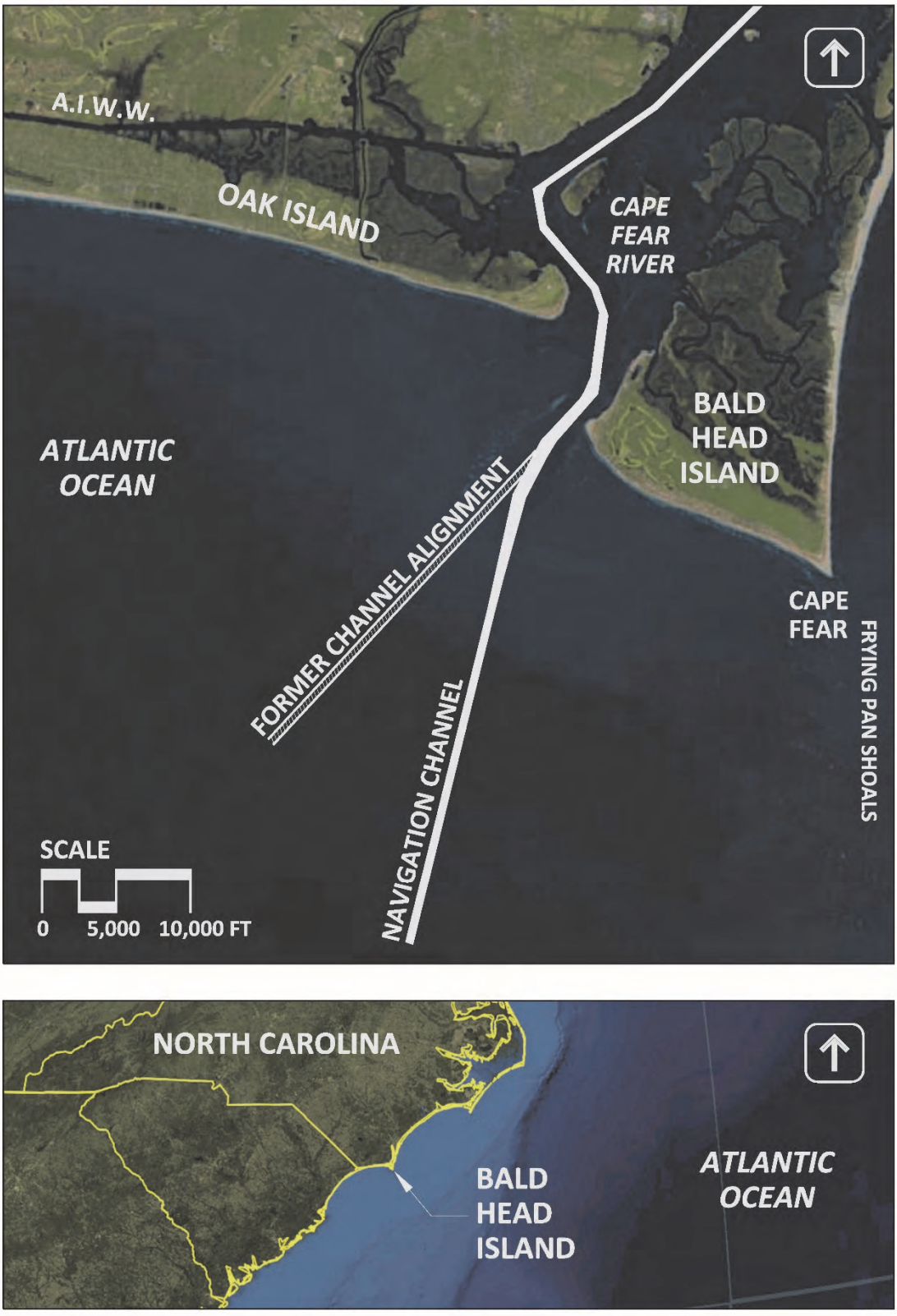


Figure 1.1: Location of Bald Head Island, N.C. and Federal Navigation Channel.

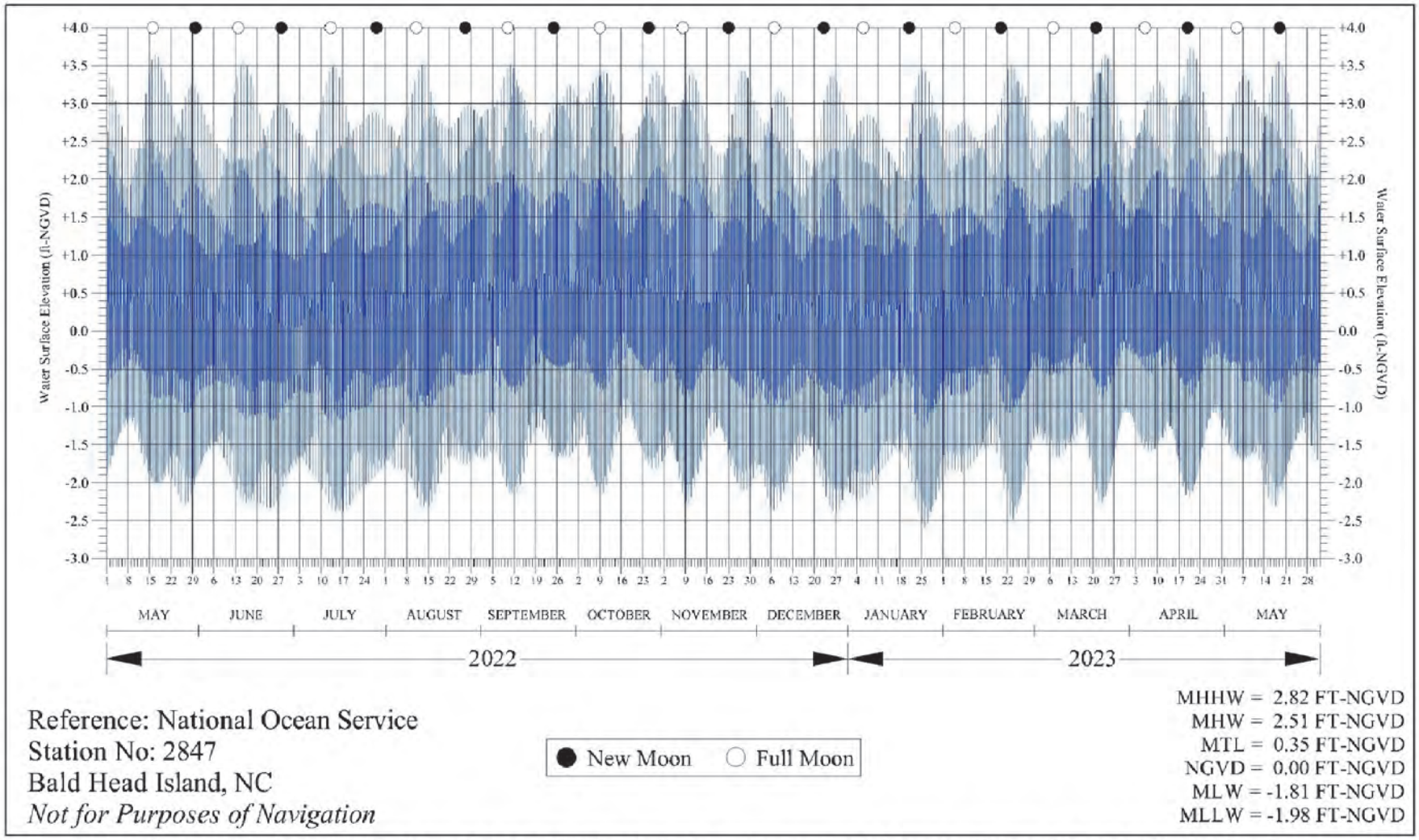


Figure 1.2: May 2022 through May 2023 predicted astronomical tides, Bald Head Island, North Carolina.

1.3 Monitoring Period Wave Climate (May 2022 to May 2023)

Figure 1.3 displays a time series of significant wave heights measured at NOAA Buoy 41108 from May 2022 through May 2023. NOAA Buoy 41108 is located roughly 9 miles south of Bald Head Island in approximately 42 feet of water. The buoy was deployed in March 1988 and has been collecting data nearly continuously for 35+ years except for an approximate five year period between April 1992 and May 1997 and several other periods lasting a few weeks or less in duration[3]. The data collected by the buoy includes significant wave height (average of the highest one-third of all waves in a 20-minute sampling period), wave period, wave direction, wind speed and other standard meteorological data.

The average significant wave height[4] at NOAA Buoy 41108 during the Year 22 monitoring period (May 26, 2022 to May 11, 2023[5]) was 3.27 feet with a maximum wave height of 17.68 ft measured on September 30, 2022 during the passage of Hurricane Ian (see **Figure 1.4**). The Year 22 average value is approximately 2 percent higher than the full record average significant wave height of 3.22 feet (March 1988 through May 2022) and 4 percent higher than the Year 21 average wave height (3.10 feet).

During the Year 22 monitoring period, roughly 5.3 percent of the recorded wave heights were above 6 feet, compared to 5.6 percent for the full record average. That is, there were roughly 5 percent fewer wave events recorded above 6 feet during the Year 22 monitoring period than would be expected during a typical similar period of time. During Year 22 monitoring period, the occurrence of waves above 10 feet was also slightly lower than the full record average (0.20 percent for Year 22 compared to 0.25 percent for the long-term average).

[3] During the Year 22 monitoring period, data was not collected at the buoy between September 30 and November 22, 2022 following the passage of Hurricane Ian.

[4] These measurements reflect the significant wave height, or the average of the highest 1/3rd of waves passing the buoy during a 20 minute sampling period.

[5] The May 2022 beach profile survey was completed May 26, 2022, the November 2022 survey on November 29, 2022 and the May 2023 survey completed on May 21, 2023.

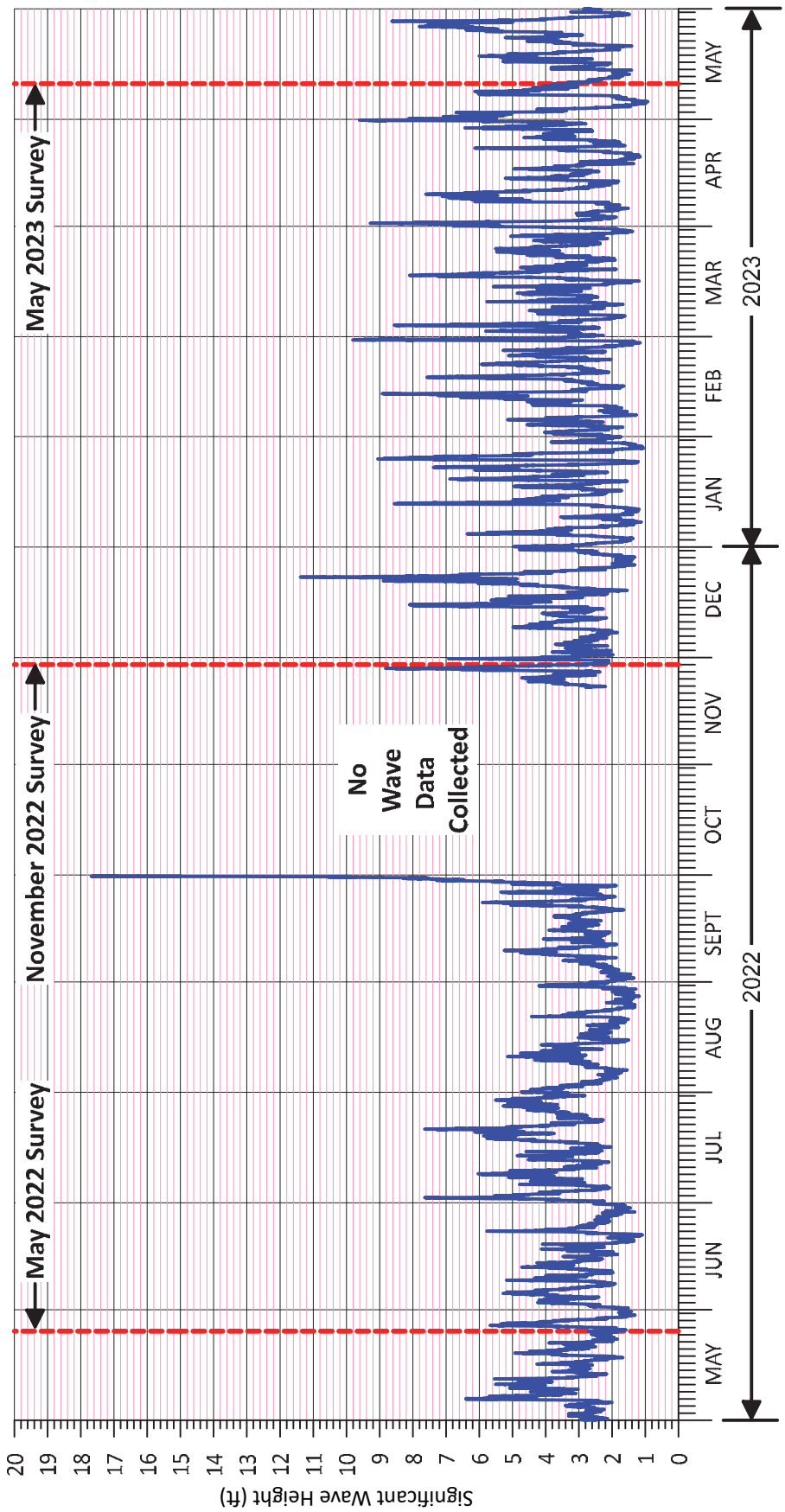


Figure 1.6: Significant wave heights recorded by NOAA Buoy 41108 during the 2022-23 monitoring period (Wilmington Harbor, NC).

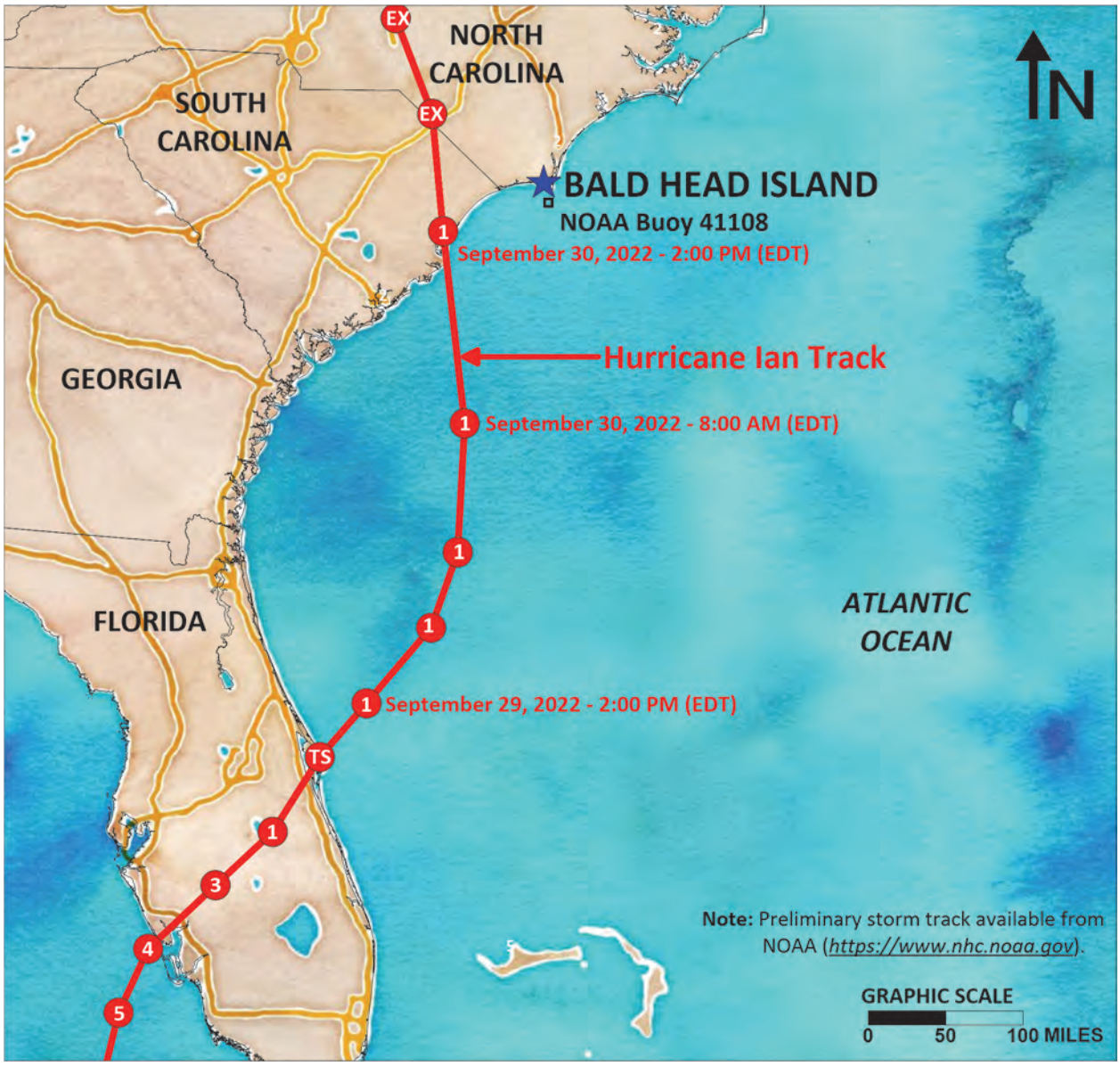


Figure 1.4: Hurricane Ian (2022) track as the storm approached the coast of the United States. Track retrieved from the National Hurricane Center (NHC 2022).

1.4 Wilmington Harbor Federal Navigation Channel and Sand Management Plan

A detailed discussion of the history of the navigation channel and the Wilmington Harbor Sand Management Plan (WHSMP) is provided in Monitoring Report No. 15 (Olsen 2017).

The Wilmington Harbor Federal Navigation Project extends up the Cape Fear River from a point seven statute miles seaward of the Bald Head Island Marina, upstream 30.4 miles to a location just north of the City of Wilmington, N.C. The Wilmington District, U.S. Army Corps of Engineers (USACE) is responsible for maintaining the project at its congressionally authorized depths and widths.

The Wilmington Harbor Sand Management Plan (USACOE 2000) was formulated as a specific action element of the deepening project for Wilmington Harbor. For the most part, the Plan was in direct response to the stated concerns of the Village of Bald Head Island regarding the historical harbor maintenance impacts and potential new impacts of the deepening project to both the regional sediment budget and Bald Head Island. The Plan's stated purpose was to reverse the practice of placing beach quality sand in the off-shore disposal area by calling for placement of this sand onto adjacent beaches. Over a theoretical six-year biennial maintenance cycle, the initial Wilmington Harbor Sand Management Plan (WHSMP) stipulated that approximately 1.0 Mcy of sand was to be placed on the beaches of Bald Head Island in years two and four (*after* initial construction) and on Oak Island/Caswell Beach during year six. The six-year disposal cycle was proposed for the life of the project but, accordingly to its terms, could be altered based upon documentation of impacts to adjacent beaches, changes in conditions and other relevant factors. The first six-year (3 maintenance event) cycle was completed in April 2009. In early 2011, the Wilmington District issued a draft report-of-findings both summarizing approximately 10-years of monitoring and readdressing the tenets of the original (2000) Sand Management Plan based upon their interpretation of monitoring results, related analyses and other salient factors or considerations. Subsequently the District solicited public comments from the two (2) principal stakeholders – the Village of Bald Head Island and Caswell Beach.

It has been OAI's continuing opinion that the division of sand between the two (2) abutting shorefronts of Oak Island and Bald Head Island should be based upon the cumulative quantities of sediment *lost* from each shoreline over the prior dredging cycle(s) as documented by survey, as well as identifiable impacts which exceed the November 2000 (pre-project) benchmark survey. Alternatively, it should be based upon the ratio of documented littoral transport rates for each island toward the Cape Fear River. Pursuant to the existing Plan however, the most recent disposal operation at South Beach occurred in the winter/spring months of 2022/2023. A subsequent tentatively scheduled disposal event will address the eastern end of Oak Island (estimated for 2025) at Caswell Beach.

1.5 Historical Erosion Control Activities (1991 to 2023)

1.5.1 Channel Maintenance Beach Disposal and Beach Restorations – Chronology

Beach fill placement activities constructed at Bald Head Island since 1991 are summarized in **Table 1.2**. Not including disposal operations after 2018/19, a detailed discussion of the history of channel maintenance beach disposal and beach restoration activities is provided in Monitoring Report No. 15 (Olsen 2017).

Table 1.2: Beach disposal or sand placement activities at Bald Head Island since 1991.

Year	Volume	Sponsor	Location
1991	0.35 ± Mcy	VBHI	(Sta. 24+00 to 138+00)
1996	0.65 ± Mcy	VBHI	(Sta. 24+00 to 142+00)
1997	0.45 ± Mcy	VBHI	(Sta. 24+00 to 128+00)
2001	1.849 ± Mcy	USACE*	South Beach (Sta. 41+60 to 205+50)
2005	1.217 ± Mcy	USACE*	South Beach (Sta. 46+00 to 126+00)
2006	47,800 cy	VBHI	West Beach (Sta. 16+00 to 34+00)
2007	0.9785 ± Mcy	USACE*	South Beach (Sta. 46+00 to 174+00)
2009/10	1.850 ± Mcy	VBHI	West Beach (Sta. 8+00 to 32+00) South Beach (Sta. 40+00 to 190+00)
2012	137,990 cy	FEMA/VBHI	West Beach & Western South Beach
2013	1.566 ± Mcy	USACE*	South Beach (Sta. 44+00 to 150+00)
	92,500 cy		West Beach (Sta. 8+00 to 27+00)
2015	1.33 ± Mcy	USACE*	South Beach (Sta. 41+50 to 154+00)
2016/17	50,000 cy	VBHI	West Beach and Row Boat Row
2018/19	1.1 Mcy	VBHI	South Beach (Sta. 49+00 to Sta. 146+00)
2021	1.61 Mcy	USACE	South Beach (Sta. 60+00 to Sta. 212+00)
2023	1.3 Mcy	USACE	South Beach (Sta. 60+00 to Sta. 165+00)

* Disposal pursuant to the WHSMP. Dredge volume estimate (pre-losses).

1.5.2 Erosion Control Structures (1996 to 2023) - Chronology

Erosion control structures constructed at Bald Head Island since 1996 are summarized in **Table 1.3**. A detailed discussion of the (pre-2021) history of erosion control structures is provided in Monitoring Report No. 15 (Olsen 2017).

Table 1.3: History of erosion control structures at Bald Head Island since 1994.

Year	Location	Description
1994	Western South Beach	Sand bag revetment located along 645 feet of the back-beach berm
1996 (March)	Western South Beach	Sixteen (16) soft groins (geotube-type structures) were constructed of geotextile material and sand fill
2003/2004	Western South Beach	Rehabilitation of 1994 constructed sand bag revetment. Revetment lengthened by approximately 200 feet and base width increased to 40 ft and crest elevation raised to +12 ft-NGVD).
2005 (January to March)	Western South Beach	Replacement of 1996 constructed sand tube groin field. Minor changes in groin location were made in an effort to improve performance. Similarly, experimental "tapered" tubes were deployed in an attempt to better accommodate beach profile recession over time.
2009	Western South Beach	Complete rehabilitation of the sand tube groin field. Some adjustment of groin lengths, and the westward relocation of groin no. 16 were made in an attempt to refine the project design.
2011	Western South Beach	300 ft sand bag revetment was constructed on the downdrift (western side) of the last sand tube groin in order to protect several endangered residential structures.
2013	Western South Beach	In the spring of 2013, the westernmost five (5) sand tube groins were replaced in their entirety. This work was co-funded by FEMA as part of a post-Irene damage mitigation effort. The project P.W. was BHGJS04 in accordance with FEMA declaration 4019 DR NC.
2015	Western South Beach	In the spring of 2015, construction was initiated on a single 1,300 ft. long rock terminal groin designed to complement future placement of beach fill at South Beach. At that time, the westernmost three (3) geotube groins were removed in their entirety. A detailed description of the project is provided in Monitoring Report No. 15 (Olsen 2017).
2015	Bald Head Marina	The two marina entrance channel structures seaward of Row-Boat-Row originally constructed by Bald Head Island, Ltd., were modified through the addition of rock extensions.
2017	Row Boat Row	Two (2) detached breakwaters were constructed just north of the Marina Entrance. Construction details are provided in Monitoring Report No. 16 (Olsen, 2018).
2019	Western South Beach	All remaining 13 sand tube groins were removed and replaced coincident with the 2019 beach fill.
2022	Eastern South Beach	A major sand tube revetment was constructed seaward of the Shoals Club property.

2.0 PHYSICAL MONITORING PROGRAM

2.1 Monitoring Baseline & Beach Profiles

MONITORING BASELINE The present day Bald Head Island monitoring baseline extends roughly 31,400 ft from the northern end of Row Boat Row (Sta. -014+72), southward along West Beach, around "the Point", then eastward along South Beach to Cape Fear and finally northward along East Beach (Sta, 284+00). The individual profile stationing and coordinates are listed in **Table 2.1** and graphically depicted in **Figure 2.1**.

BEACH PROFILES In order to document and assess any potential adverse effects of the Wilmington Harbor Navigation Channel Navigation project to Bald Head Island, the Village Council initiated a comprehensive beach monitoring program which commenced in 1999. As part of the present-day program onshore and offshore profiles are measured annually at seventy-nine (79) stations spaced approximately 400 ft apart along the roughly 31,400 ft of Bald Head Island's shorefront. Since October 2003 profiles have been surveyed at 6 month intervals (i.e. fall and spring). The primary focus of this monitoring report (No. 21) is beach profile and shoreline changes occurring over the latest set of surveys (May 2022 to November 2022 to May 2023).

Typically, survey transects extend across the upland berm or from the dune line seaward a distance of up to 3,000 ft. Depending upon the location of the survey profile, this distance corresponds to offshore waters depths of at least -40 ft relative to NGVD within the Cape Fear River Channel and -16 ft-NGVD along the Atlantic Ocean shorefront. In **Chapter 5.0**, these surveys are intra-compared in order to determine trends in the condition of the beaches of Bald Head Island. Plots of selected historical comparative beach profile data (through May 2023) are provided in **Appendix A**.

Prior to October 2003, fifty-five (55) stations were surveyed as part of the monitoring program. Five (5) additional intermediate stations were added at the Point, commencing with the October 2003 survey. These profile stations were added to more accurately capture the extreme changes that occur at the Point. Seven (7) profiles were added along East Beach (EB-01 to EB-07) beginning with the November 2008 survey. Beginning with the November 2015 survey five (5) profiles were added along Row Boat Row and four (4) were added at the Point, as part of the terminal groin monitoring requirement. Finally, in November 2016, three (3) additional profiles were added along West Beach.

Table 2.1: Bald Head Island baseline stationing and beach monitoring profile locations.

Station (Monument)	Station Location Easting (FT-NAD83)	Station Location Northing (FT-NAD83)	Grid Azi. (Deg.)	Station	Station Location Easting (FT-NAD83)	Station Location Northing (FT-NAD83)	Grid Azi. (Deg.)
Row Boat Row				084+16 (B-22)	2,303,032.1	40,924.5	219
-014+72 (RB-01)	2,304,277.9	49,117.4	302	088+23 (B-23)	2,303,372.1	40,705.0	214
-012+00 (RB-02)	2,304,068.6	48,776.5	302	092+15 (B-24)	2,303,714.1	40,513.9	209
-008+00 (RB-03)	2,303,937.2	48,538.1	302	097+10 (B-25)	2,304,146.1	40,272.5	206
-004+00 (RB-04)	2,303,728.0	48,197.2	302	102+08 (B-26)	2,304,592.1	40,057.6	204
-003+00 (RB-05)	2,303,518.7	47,856.3	302	106+00 (B-27)	2,304,960.4	39,915.3	201
West Beach				110+00 (B-28)	2,305,333.5	39,771.1	201
000+00 (B-01)	2,303,309.3	47,515.5	302	114+00 (B-29)	2,305,708.5	39,626.3	202
004+00 (B-02)	2,303,100.4	47,174.4	301	118+00 (B-30)	2,306,080.6	39,482.5	202
008+00 (B-03)	2,302,891.5	46,833.3	301	122+00 (B-31)	2,306,451.7	39,339.2	201
010+00 (I-03)	2,302,788.1	46,662.0	301	126+00 (B-32)	2,306,824.0	39,195.3	200
012+00 (B-04)	2,302,682.5	46,492.2	301	130+00 (B-33)	2,307,196.5	39,051.4	200
014+00 (I-04)	2,302,578.8	46,321.1	301	134+00 (B-34)	2,307,569.6	38,907.3	200
016+00 (B-05)	2,302,473.6	46,151.1	301	138+00 (B-35)	2,307,943.9	38,767.8	200
018+00 (I-05)	2,302,369.5	45,980.3	301	142+00 (B-36)	2,308,320.5	38,633.0	200
020+00 (B-06)	2,302,264.7	45,810.0	301	146+00 (B-37)	2,308,697.1	38,498.2	200
024+00 (B-07)	2,302,055.2	45,468.8	302	150+00 (B-38)	2,309,073.8	38,363.4	200
"the Point"				154+00 (B-39)	2,309,452.4	38,228.0	201
028+00 (B-08)	2,301,845.1	45,126.6	303	158+00 (B-40)	2,309,818.8	38,074.6	202
032+00 (B-09)	2,301,566.1	44,843.7	301	162+00 (B-41)	2,310,179.1	37,895.6	203
034+00 (I-09)	2,301,394.4	44,742.0	301	166+00 (B-42)	2,310,539.0	37,716.9	204
036+00 (B-10)	2,301,220.2	44,647.1	299	170+00 (B-43)	2,310,903.5	37,552.0	204
038+00 (I-10)	2,301,043.1	44,550.6	296	174+00 (B-44)	2,311,267.9	37,387.2	204
039+60 (B-11)	2,300,902.6	44,473.9	291	178+00 (B-45)	2,311,632.4	37,222.3	204
041+50 (I-11)	2,300,765.0	44,365.0	287	182+00 (B-46)	2,311,996.9	37,057.4	204
043+47 (B-12)	2,300,757.5	44,167.6	284	186+00 (B-47)	2,312,361.3	36,892.6	204
044+25 (I-12)	2,300,754.6	44,090.2	276	190+00 (B-48)	2,312,725.8	36,727.8	204
045+07 (B-13)	2,300,751.4	44,007.0	268	194+00 (B-49)	2,313,090.2	36,562.9	204
046+00 (I-13)	2,300,784.9	43,920.7	260	198+00 (B-50)	2,313,454.7	36,398.1	204
046+89 (B-14)	2,300,813.7	43,836.0	251	202+00 (B-51)	2,313,819.2	36,233.2	204
049+00 (H-13)	2,300,881.5	43,636.5	247	206+00 (B-52)	2,314,183.6	36,068.4	204
050+50 (I-14)	2,300,913.5	43,541.9	247	210+00 (B-53)	2,314,548.1	35,903.5	204
051+00 (J-14)	2,300,945.8	43,447.1	247	214+00 (B-54)	2,314,912.5	35,738.7	204
052+64 (B-15)	2,300,998.3	43,292.1	243	218+00 (B-55)	2,315,277.0	35,573.8	204
054+00 (I-15)	2,301,042.2	43,163.0	243	**East Beach**			
South Beach				224+80 (EB-01)	2,315,748.8	36,063.3	90
056+56 (B-16)	2,301,148.7	42,933.8	233	234+80 (EB-02)	2,315,748.8	37,063.3	90
060+51 (B-17)	2,301,399.6	42,628.3	230	244+80 (EB-03)	2,315,748.8	38,063.3	90
065+50 (B-18)	2,301,716.0	42,243.2	229	254+80 (EB-04)	2,315,748.8	39,063.3	90
069+46 (B-19)	2,301,967.6	41,937.0	227	264+80 (EB-05)	2,315,748.8	40,063.3	90
073+39 (B-20)	2,302,246.1	41,660.5	223	274+80 (EB-06)	2,315,748.8	41,063.3	90
076+37 (B-21)	2,302,609.2	41,320.5	222	284+80 (EB-07)	2,315,748.8	42,063.3	90

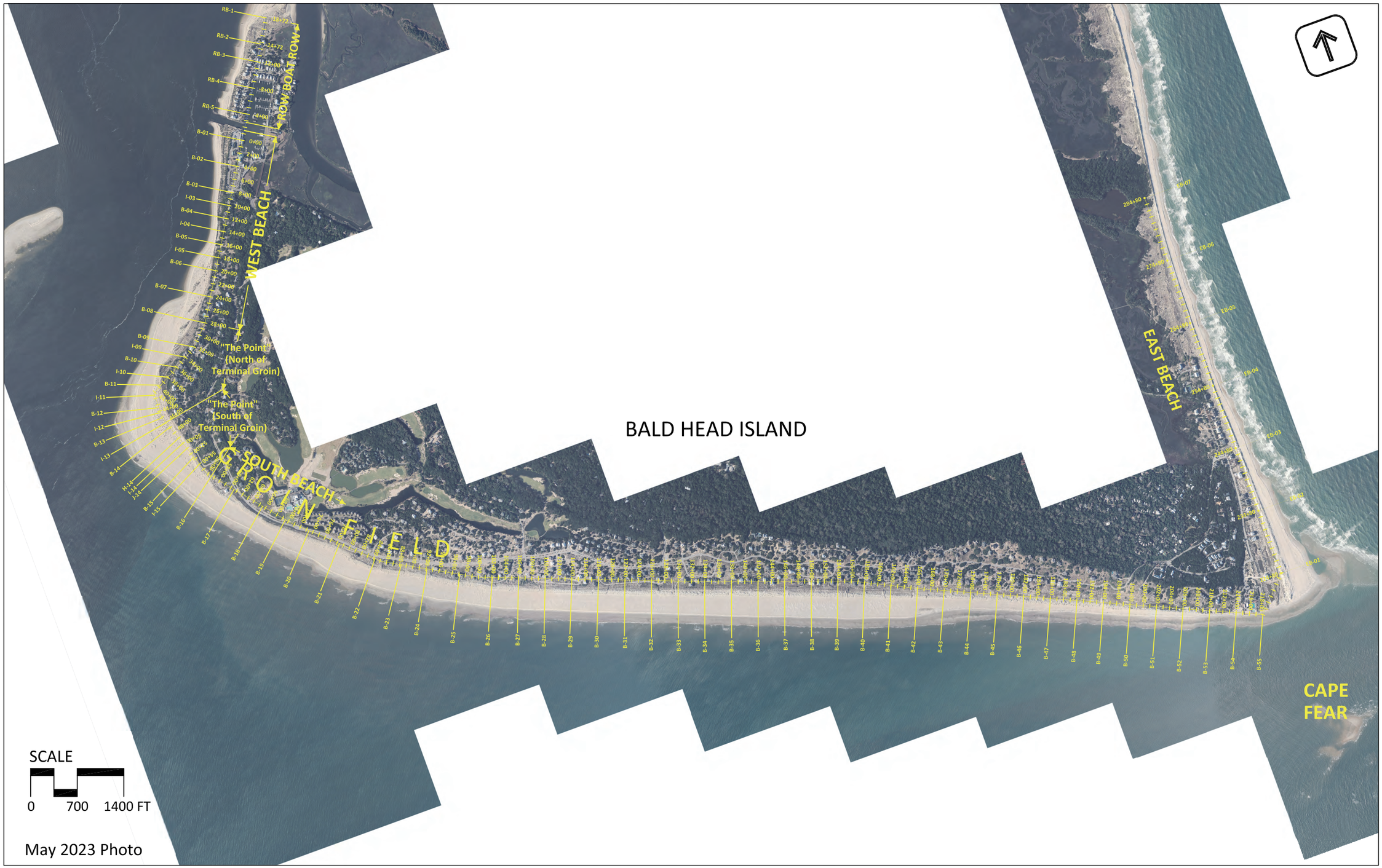


Figure 2.1:
Island-wide beach monitoring baseline.

MHWL SURVEYS As part of the permit required monitoring for the terminal groin project completed in late 2015, post-construction MHWL surveys were initiated in November 2015. Each survey was specified to begin at the Marina entrance (Sta. 0+00) and extend to St. 75+00, about 3,000 ft eastward of the terminal groin head. On an annual basis, surveys are to be intercompared to assess both updrift fillet conditions and the location of the downdrift shoreline fronting the Cape Fear River.

2.2 Bald Head Creek Borrow Site Surveys

The Bald Head Creek borrow site and adjacent areas utilized for the 2017 Shore Stabilization Project constructed by Marcol Dredging were monitored at 6 months and thereafter annually for the following 3 years. **Table 2.2** summarizes selected surveys collected to date. *No survey was required or conducted during the current monitoring year.* The purpose of the monitoring is to document hydrographic changes throughout the borrow site and in particular areas which were "over-dredged" by the Contractor. Of specific interest to State and Federal regulatory agencies has been the rate of recovery and the composition of the material that infills the area(s) excavated by hydraulic dredge below that addressed by permit. In addition to annual surveys, limited grab samples and sediment analysis are performed by the firm LMG. The Marcol March 2017 AD Survey is considered as the "baseline condition". As of May 2019, physical monitoring was deemed complete. Subsequent monitoring has not occurred.

Table 2.2: Selected Bald Head Creek borrow site surveys collected as of May 2023.

Borrow Site Survey Date	Comment
March 2012	After Dredge (AD) Survey (11/12 Project)
January 2013	10 Months Post-Dredge (11/12 Project)
December 2013	21 Months Post-Dredge (11/12 Project)
April 2015	37 Months Post-Dredge (11/12 Project)
April 2016	49 Months Post-Dredge (11/12 Project)
November 2016	Before Dredge (BD) Survey (16/17 Project)
March 2017	After Dredge (AD) Survey (16/17 Project)
November 2017	7 Months Post-Dredge (11/12 Project)
May 2018	14 Months Post-Dredge (11/12 Project)
May 2019(1)	26 Months Post-Dredge (11/12 Project)

(1) Last monitoring survey required.

2.3 Jay Bird Shoal Borrow Site Surveys

Permits for the last beach renourishment project constructed by the Village in 2019 necessitate the resurveying of the Jay Bird Shoal borrow site as part of the annual island-wide monitoring program. **Table 2.3** summarizes the borrow site surveys conducted to date. Specifically, borrow site surveys are required both pre- and post-excavation, as well as at 12-, 24- and 36-months and biennially thereafter. The area typically surveyed is 400-acres ± which includes a buffer area outside the original "permitted" limits of work.

Table 2.3: Jay Bird Shoal borrow site surveys collected as of May 2023.

Borrow Site Survey Date	Comment
October 2009	Before Dredge (BD) Survey (09/10 Project)
March 2010	After Dredge (AD) Survey (09/10 Project)
May 2011	14 Months Post-Dredge (09/10 Project)
May 2012	26 Months Post-Dredge (09/10 Project)
May 2013	38 Months Post-Dredge (09/10 Project)
April 2015	61 Months Post-Dredge (09/10 Project)
May 2017	86 Months Post-Dredge (09/10 Project)
November 2017	92 Months Post-Dredge (09/10 Project)
May 2018	98 Months Post-Dredge (09/10 Project)
September 2018	98 Months Post-Dredge (09/10 Project)
December 2018	Before Dredge (BD) Survey (19 Project)
March 2019	After Dredge (AD) Survey (19 Project)
May 2020	14 Months Post Project (19 Project)
May 2021	26 Months Post Project (19 Project)
May 2022	38 Months Post Project (19 Project)
May 2023	50 Months Post Project (19 Project)

2.4 Orthorectified Aerial Photography

In addition to the beach profile surveys, digital color aerial photography of the island's shoreline has been acquired at a minimum, annually by Greenman-Pedersen, Inc.[6] **Table 2.4** summarizes the aerial photography collected to date as part of the monitoring program. Reproductions of the three most recent aerial photography sets (May 2022, November 2022 and May 2023) are presented in **Appendices B, C** and **D**, respectively.

[6] Greenman-Pederson, Inc.; 3909 Wrightsville Ave. Suite 200; Wilmington, NC 28403.

Table 2.4: Bald Head Island monitoring aerial photography collected as of May 2023.

Photo Date			Comment
Year	Month	Day	
2001	September	NA	2 months post-construction (2001 disposal)
2002	November	14	16 months post-construction (2001 disposal)
2003	April	NA	21 months post-construction (2001 disposal)
2004	January	NA	30 months post-construction (2001 disposal)
2004	May	NA	34 months post-construction (2001 disposal)
2004	October	NA	39 months post-construction (2001 disposal)
2005	May	NA	4 months post-construction (2004/05 disposal)
2005	November	NA	10 months post-construction (2004/05 disposal)
2006	April	NA	15 months post-construction (2004/05 disposal)
2006	October	NA	21 months post-construction (2004/05 disposal)
2007	May	20	1month post-construction (2007 disposal)
2008	May	13	13 months post-construction (2007 disposal)
2009	January	14	21 months post-construction (2007 disposal)
2009	May	31	25 months post-construction (2007 disposal)
2009	August	26	3 months pre-renourishment (09/10)
2010	April	NA	1 month post-renourishment (09/10)
2011	April	NA	13 months post-nourishment (09/10)
2012	May	NA	26 months post-nourishment (09/10)
2012	December	14	33 months post-nourishment (09/10)
2013	May	14	38 months post-nourishment (09/10)
2013	November	14	44 months post-nourishment (09/10)
2014	May	23	50 months post-nourishment (09/10)
2014	November	03	56 months post-nourishment (09/10)
2015	March	29	Post-construction (2015 Disposal)
2015	August	9	5 months post-construction (2015 Disposal)
2015	November	29	Post-terminal groin construction
2016	April	3	4 months post-construction (T.G.)
2016	October	13	Post-Hurricane Matthew
2017	April	14	5 months Post-Hurricane Matthew
2017	November	27	24 months post-construction (T.G.)
2018	April	19	29 months post-construction (T.G.)
2018	October	14	Post-Hurricane Florence
2019	April	10	1 month post-renourishment (18/19)
2019	Nov	13	8 months post-renourishment (18/19)
2020	May	15	13 months post-renourishment (18/19)
2020	Nov	19	20 months post-renourishment (18/19)
2021	May	1	25 months post-renourishment (18/19)
2021	Nov	17	31 months post-renourishment (18/19)
2022	May	20	37 months post-renourishment (18/19)
2022	October	5	43 months post-renourishment (18/19)
2023	May	10	49 months post-renourishment (18/19)

3.0 MONITORING (SURVEY) RESULTS

3.1 Methodology

For purposes of analysis and discussion, the Bald Head Island monitoring baseline is qualitatively broken into seven (7) shoreline segments, or zones of interest, with significantly varying physiographic characteristics as follows:

- Station -018+72 to -003+00 "Row Boat Row"
- Station -001+60 to 028+00 "West Beach"
- Station 028+00 to 046+00 "The Point" – North of Terminal Groin
- Station 046+00 to 056+56 "The Point" – South of Terminal Groin
- Station 056+56 to 214+00 "South Beach"[7]
- Station 214+00 to 224+80 "Cape Fear Point"[8]
- Station 224+80 to 284+80 "East Beach"

These zones differ slightly from the shoreline segments used monitoring reports prior to 2015 (OAI 2015). More specifically, "the Point" is now divided into two areas rather than one, based upon the location of the recently completed terminal groin. The update is intended to more accurately capture the influence of that structure on the physical processes along the Bald Head Island shoreline. Additionally, the "Row Boat Row" reach was added to the monitoring analysis with the initial monitoring surveys along this reach completed in November 2015.

Alongshore volume changes were calculated using an average end-area method, where the cross-sectional areas are determined by comparing beach profiles at each beach monitoring station above several different vertical datums. This approach allows evaluation of beach changes at different elevations along the project in addition to the total profile.

Average shoreline position changes were spatially weighted based upon the distance between stations due to the non-uniform alongshore spacing of survey monuments.

[7] East of Sta. 214+00, the remaining 400 ft of surveyed Atlantic oceanfront shoreline becomes part of Cape Fear Point and is not included in the South Beach analysis due to its highly dynamic nature.

[8] The general condition of the Cape Fear spit is qualitatively monitored primarily through controlled aerial photography. This depositional feature is routinely subject to episodic periods of accretion and erosion resulting from eventual detachment via tidal channel breakthrough during storms. It is likewise influenced by beach fill activities and sediment added to the littoral system of South Beach as well as storm waves originating from the east or southeast.

3.2 Year 22: Monitoring Program (May 2022 – November 2022 – May 2023)

The May 2022 to May 2023 monitoring period represents the twenty second year of measured shoreline change following completion of the initial 2001 Federal +1.849 Mcy beach disposal at Bald Head Island. For compliance purposes, the May 2023 survey represents the 4th year following completion of the +1.1 Mcy beach fill constructed by the Village of Bald Head Island in the winter of 2018/2019 at South Beach. This survey period also serves to document the first full year following the April 2021 completion of a 1.61 Mcy Federal beach disposal project at S. Beach as well as the initial period of equilibration of an estimated 1.1 Mcy Federal Beach disposal project constructed in early 2023. Note – the contract dredge volume was 1.3 Mcy.

Volume changes between condition surveys were computed using the average end-area method above the mean high water line (MHWL; +2.51 ft-NGVD) and the assumed typical depth of closure (-16.0 ft-NGVD). **Tables 3.1** through **3.3** list the computed changes along the Bald Head Island shoreline for the May 2022 – November 2022 – May 2023 survey intervals. **Figures 3.1, 3.2** and **3.3** depict the cumulative and local volume changes for the same intervals. Changes in shoreline position at each station were computed at the MHWL and the seaward edge of berm (+6 ft-NGVD contour). The results are summarized in **Tables 3.4** and **3.5** and graphically depicted in **Figures 3.4** and **3.5** (relative to their *November 2000* pre-disposal locations).

3.3 West Beach, "The Point" and South Beach: Discussion

3.3.1 Survey Period: May 2022 to November 2022

This survey period represents the second monitoring period following completion of the +1.1 Mcy 2018/19 beach fill as well as the first few months following a Village project completion in March 2019 and federal beach disposal completed in March 2023.

As depicted in **Figure 3.1** and **Table 3.1**, the island-wide *net* shoreline volume change trend for this period was erosional with -172,000 cy (-8.2 cy/ft) of loss, mol. over the 6 month span above -16 ft-NGVD. Similarly, above the MHWL, the shoreline lost –96,800 cy

In the net, West Beach was relatively slightly erosional during this period losing –3,300 cy above the MHWL and -4,900 cy between the MHWL and the -16 ft-NGVD contour. Overall West Beach lost roughly -8,200 cy above the -16 ft contour. The largest loss occurred closest to the Point northernmost 400 ft.

The entire 3,690 ft of "the Point" shoreline (Sta. 28+00 to 56+56) was net erosional during this monitoring period, losing -3,200 cy above -16 ft-NGVD. For purposes of evaluating the impacts of the terminal groin completed in November 2015, "the Point" shoreline is

subdivided into two reaches with Sta. 46+00, the approximate location of the terminal groin, as the dividing station. North of the terminal groin (Sta. 28+00 to 46+00), the shoreline gained +3,400 cy above the MHWL and +36,900 above the -16 ft. NGVD contour. South of the terminal groin (Sta. 46+00 to 56+56), the shoreline eroded above the MHWL (on average) and lost -40,100 cy above the -16 ft-NGVD contour adjacent to the channel.

South Beach was net erosional during the period, losing roughly -67,800 cy above the MHWL and -160,000 cy above -16 ft-NGVD. All but 1 (*i.e.*37 of 38) of the monitoring stations were net erosional above -16 ft-NGVD.

3.3.2 Survey Period: November 2022 to May 2023 (Two Months Post-Federal Beach Fill)

As depicted in **Figure 3.2** and **Table 3.2,** the island-wide *net* volume change was a large-scale gain of approximately -1,113,200 cy above -16 ft-NGVD. Gaines throughout the overall fill volume placed were as expected due to the federal disposal project completed in March 23. Hence, the berm and MHWL prograded seaward along about two-thirds of the South Beach shoreline.

In the net, West Beach was relatively stable during this period with only a small loss of -300 cy above the MHWL. Overall West Beach gained 14,000 cy above the -16 ft contour.

Along "the Point" shoreline north of the terminal groin, the beach accreted by +11,400 cy above the MHWL and gained +61,800 cy above the -16 ft-NGVD contour. Along "the Point" shoreline south of the terminal groin, the beach gained 21,900 cy above the MHWL and gained +86,000 cy above -16 ft-NGVD -- all due to beach fill placed by the USACOE.

South Beach was net accretional during the period due to the recent completion of the 2023 federal beach fill, gaining 950,000 cy above the -16 ft-NGVD. Similarly, above the MHWL, the shoreline gained 317,600 cy.

3.3.3 Year 22 Monitoring Results: May 2022 to May 2023 –Post Federal Beach Disposal (Excluding East Beach & Row Boat Row)

During Year 22 in its entirety, the monitored portion of the island experienced a net gain of -941,200 above the -16 ft contour (see **Table 3.3and Figure 3.3**). All of this gain occurred during the second six months of the monitoring period (Nov 2022 to May 2023), directly following the federal beach disposal project at South Beach (completed in March 2023). Above the MHWL, the island gained 253,800 cy.

Along West Beach, the shoreline lost approximately -3,600 cy above the MHWL but gained 5,800 cy above -16 ft-NGVD.

The entire Point shoreline (north and south of the terminal groin), experienced a net gain of roughly +25,000 cy above the MHWL and +145,000 cy above -16 ft-NGVD. This inlet shoreline accretion was principally a result of beach fill placed by the Corps being transported over and through the terminal groin structure – and being deposited as an inlet-facing spit. Such material serves (by design) to function as a feeder beach to the West Beach shoreline lying northward thereof.

In the net, the South Beach shorefront gained +231,800 cy above the MHWL and +790,000 cy above -16 ft-NGVD. During this period, the recently improved fill berm and MHWL westward of Sta. 150 + 00 advanced seaward due to the federal disposal project. Eastward there of, the shoreline experienced net recession.

Table 3.1: Bald Head Island shoreline volume change (May 2022 to November 2022).

	Start Station	End Station	Reach (FT)	Volume Change Above +2.51 (FT)	Volume Change Above -16 (FT)
West Beach	Jetty	000+00	160	-300	-700
	000+00	004+00	400	0	+500
	004+00	008+00	400	+400	+1,400
	008+00	010+00	200	0	-100
	010+00	012+00	200	-200	-500
	012+00	014+00	200	-100	-700
	014+00	016+00	200	0	-700
	016+00	018+00	200	+100	+100
	018+00	020+00	200	0	+300
	020+00	024+00	400	-1,600	-4,900
	024+00	028+00	400	-1,600	-2,900
		Subtotal	**2,960**	**-3,300**	**-8,200**
Point (North of Groin)	028+00	032+00	395	+1,700	+12,900
	032+00	034+00	200	+1,700	+8,500
	034+00	036+00	210	+1,000	+2,300
	036+00	038+00	230	+300	+800
	038+00	039+60	230	+400	+7,400
	039+60	041+50	220	-400	+8,900
	041+50	043+47	220	-1,100	+1,000
	043+47	044+25	190	-800	-2,900
	044+25	045+07	190	0	-1,300
	045+07	046+00	200	+600	-700
		Subtotal	**2,285**	**+3,400**	**+36,900**
Point (South of Groin)	046+00	046+89	200	-600	-2,900
	046+89	049+00	250	-3,500	-8,500
	049+00	050+50	100	-1,300	-3,600
	050+50	051+00	100	-1,000	-3,600
	051+00	052+64	240	-2,200	-8,000
	052+64	054+00	135	-600	-3,300
	054+00	056+56	380	-1,900	-10,200
		Subtotal	**1,405**	**-11,100**	**-40,100**
South Beach	056+56	060+51	423	-3,000	-9,800
	060+51	065+50	510	-2,300	-7,700
	065+50	069+46	423	-1,100	-6,900
	069+46	073+39	442	-2,200	-7,200
	073+39	076+37	516	-4,000	-7,100
	076+37	084+16	611	-4,600	-10,600
	084+16	088+23	471	-3,600	-11,100
	088+23	092+15	455	-4,100	-10,200
	092+15	097+10	536	-3,200	-6,700
	097+10	102+08	525	-2,300	-5,100
	102+08	106+00	436	-1,700	-3,100
	106+00	110+00	400	-1,600	-600
	110+00	114+00	388	-2,400	-800
	114+00	118+00	407	-2,400	-700
	118+00	122+00	413	-2,400	+1,000
	122+00	126+00	405	-3,100	+1,400
	126+00	130+00	405	-3,300	+100
	130+00	134+00	398	-3,500	-1,900
	134+00	138+00	401	-3,700	-2,000
	138+00	142+00	400	-2,900	-1,800
	142+00	146+00	400	-1,300	-2,200
	146+00	150+00	399	-1,100	-400
	150+00	154+00	385	-900	+600
	154+00	158+00	383	-900	-2,300
	158+00	162+00	386	-3,500	-7,200
	162+00	166+00	393	-2,200	-5,600
	166+00	170+00	394	-100	-4,200
	170+00	174+00	400	-300	-8,500
	174+00	178+00	400	-200	-5,000
	178+00	182+00	400	-1,100	-3,100
	182+00	186+00	400	-1,700	-5,900
	186+00	190+00	400	-1,800	-4,300
	190+00	194+00	400	-2,300	-4,400
	194+00	198+00	400	-2,700	-7,200
	198+00	202+00	400	-2,700	-8,700
	202+00	206+00	400	-2,100	-8,600
	206+00	210+00	400	-2,100	-2,600
	210+00	214+00	400	-1,400	+9,800
		Subtotal	**16,105**	**-85,800**	**-160,600**
		Bald Head Total	**22,755**	**-96,800**	**-172,000**

Note: Elevations are referenced to NGVD 1929.

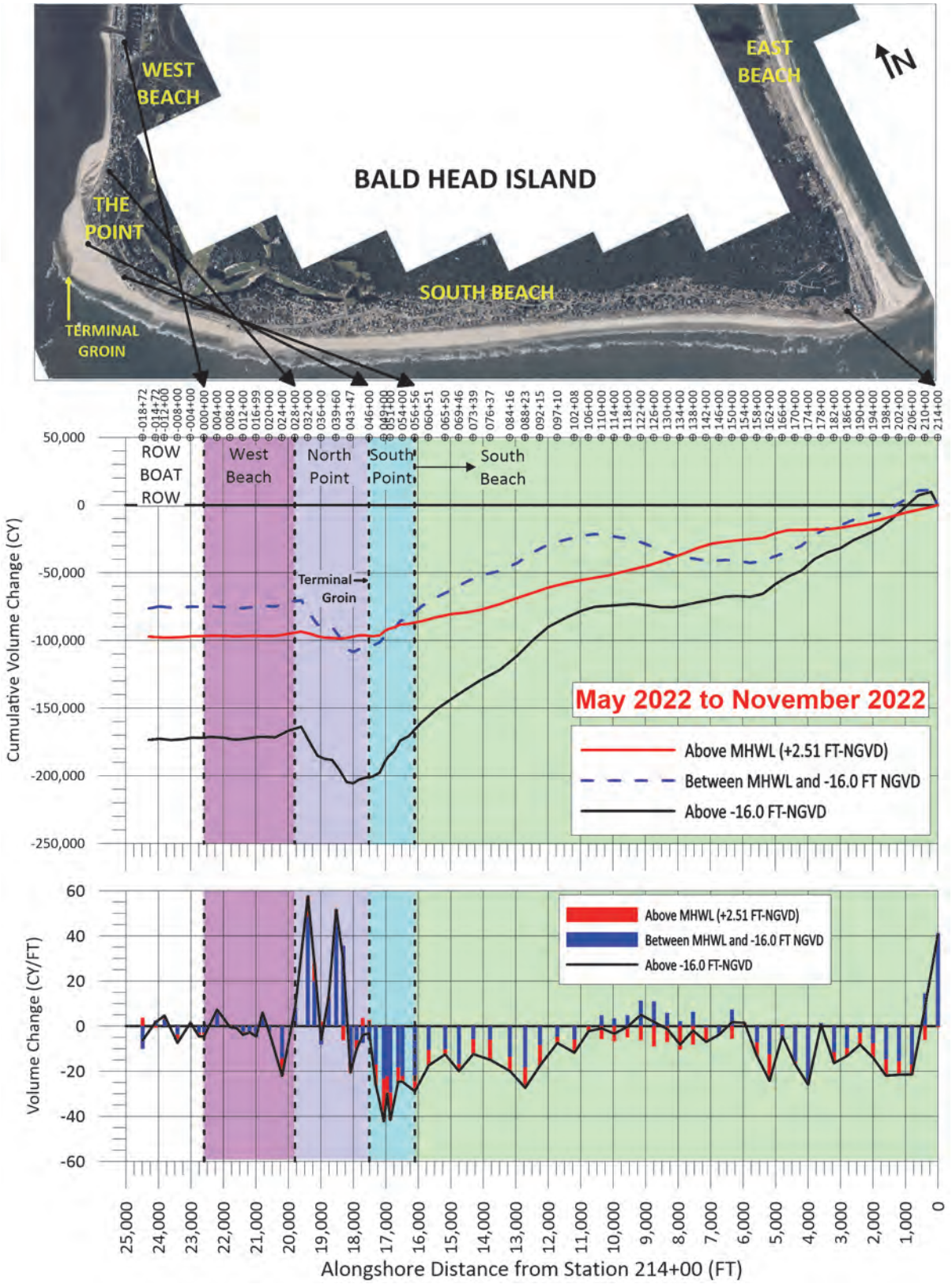


Figure 3.1: Volume change along the Bald Head Island shoreline between May 2022 and November 2022.

Table 3.2: Bald Head Island shoreline volume change (November 2022 to May 2023).

	Start Station	End Station	Reach (FT)	Volume Change Above +2.51 (FT)	Volume Change Above -16 (FT)
West Beach	Jetty	000+00	160	-500	-600
	000+00	004+00	400	-400	+700
	004+00	008+00	400	0	+1,600
	008+00	010+00	200	-100	+200
	010+00	012+00	200	0	+300
	012+00	014+00	200	0	+400
	014+00	016+00	200	+100	+700
	016+00	018+00	200	+200	+500
	018+00	020+00	200	-100	-1,000
	020+00	024+00	400	-1,300	-5,200
	024+00	028+00	400	+1,800	+16,400
		Subtotal	**2,960**	**-300**	**+14,000**
Point (North of Groin)	028+00	032+00	395	+1,800	+14,600
	032+00	034+00	200	-1,200	-5,400
	034+00	036+00	210	-900	-4,100
	036+00	038+00	230	0	-100
	038+00	039+60	230	+600	+900
	039+60	041+50	220	+1,700	+2,500
	041+50	043+47	220	+2,300	+10,800
	043+47	044+25	190	+2,200	+18,000
	044+25	045+07	190	+2,500	+15,800
	045+07	046+00	200	+2,400	+8,800
		Subtotal	**2,285**	**+11,400**	**+61,800**
Point (South of Groin)	046+00	046+89	200	+2,600	+8,300
	046+89	049+00	250	+3,200	+9,900
	049+00	050+50	100	+700	+3,300
	050+50	051+00	100	+900	+4,100
	051+00	052+64	240	+3,300	+14,200
	052+64	054+00	135	+2,000	+9,600
	054+00	056+56	380	+9,200	+37,400
		Subtotal	**1,405**	**+21,900**	**+86,800**
South Beach	056+56	060+51	423	+14,400	+54,700
	060+51	065+50	510	+16,200	+66,600
	065+50	069+46	423	+11,300	+50,700
	069+46	073+39	442	+10,200	+45,300
	073+39	076+37	516	+13,500	+44,200
	076+37	084+16	611	+16,400	+50,500
	084+16	088+23	471	+9,800	+36,600
	088+23	092+15	455	+9,800	+35,100
	092+15	097+10	536	+10,700	+41,900
	097+10	102+08	525	+11,200	+42,000
	102+08	106+00	436	+11,200	+38,300
	106+00	110+00	400	+10,800	+34,900
	110+00	114+00	388	+10,900	+33,100
	114+00	118+00	407	+11,300	+34,000
	118+00	122+00	413	+11,100	+30,600
	122+00	126+00	405	+10,400	+27,500
	126+00	130+00	405	+11,400	+30,200
	130+00	134+00	398	+12,800	+32,300
	134+00	138+00	401	+14,200	+32,800
	138+00	142+00	400	+14,400	+33,300
	142+00	146+00	400	+13,700	+35,000
	146+00	150+00	399	+15,000	+38,400
	150+00	154+00	385	+14,900	+36,400
	154+00	158+00	383	+15,600	+34,500
	158+00	162+00	386	+18,500	+37,000
	162+00	166+00	393	+12,500	+29,300
	166+00	170+00	394	+1,700	+12,900
	170+00	174+00	400	-2,200	+5,100
	174+00	178+00	400	-2,600	-3,900
	178+00	182+00	400	-2,300	-9,000
	182+00	186+00	400	-1,800	-5,000
	186+00	190+00	400	-900	-3,400
	190+00	194+00	400	-1,200	-3,800
	194+00	198+00	400	-1,300	-2,900
	198+00	202+00	400	-300	-4,600
	202+00	206+00	400	-400	-5,600
	206+00	210+00	400	-1,800	-12,000
	210+00	214+00	400	-1,500	-22,400
		Subtotal	**16,105**	**+317,600**	**+950,600**
		Bald Head Total	**22,755**	**+350,600**	**+1,113,200**

Note: Elevations are referenced to NGVD 1929.

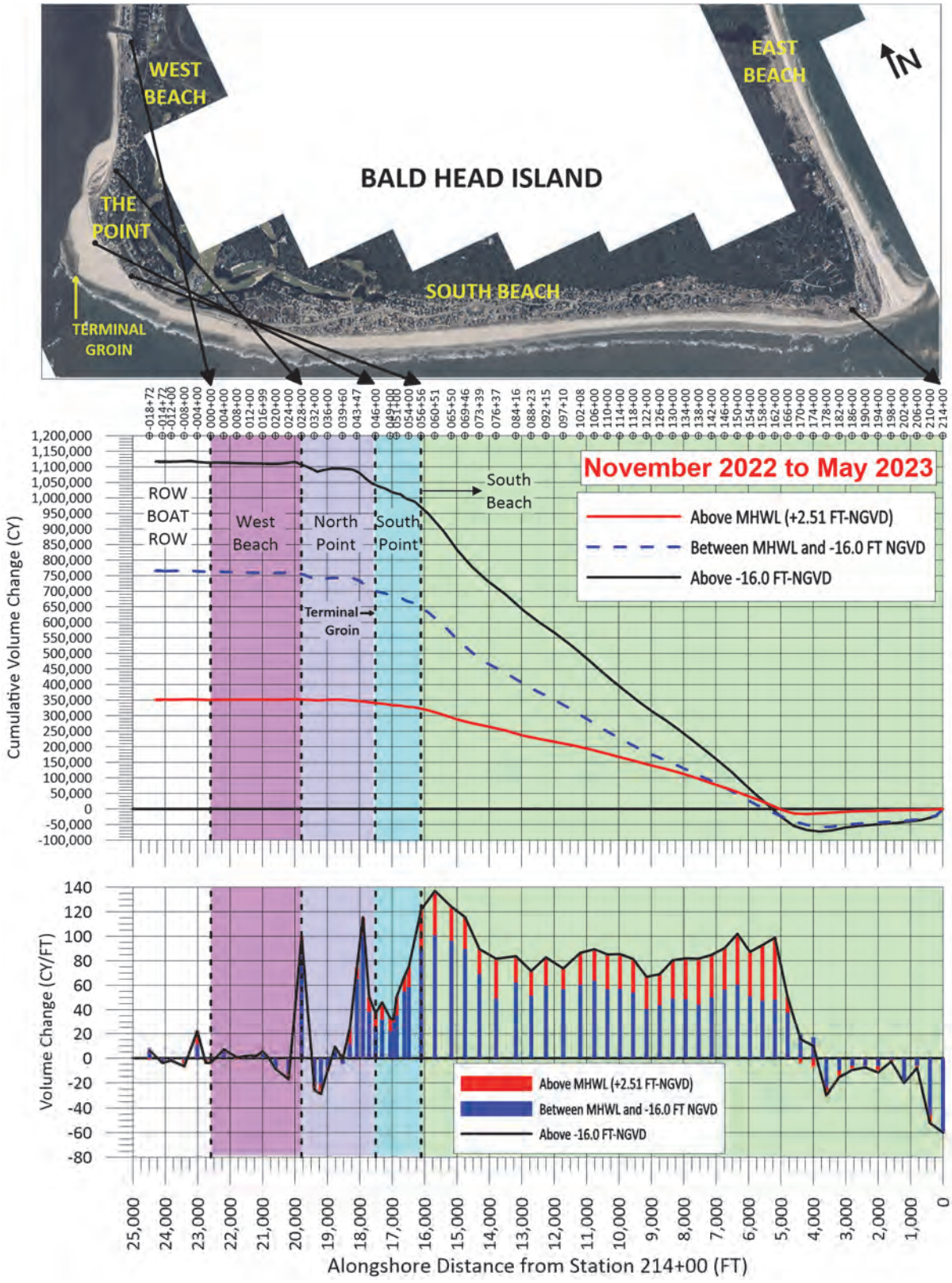


Figure 3.2: Volume change along the Bald Head Island shoreline between November 2022 and May 2023.

Table 3.3: Bald Head Island shoreline volume change (May 2022 to May 2023).

	Start Station	End Station	Reach (FT)	Volume Change Above +2.51 (FT)	Volume Change Above -16 (FT)
West Beach	Jetty	000+00	160	-800	-1,300
	000+00	004+00	400	-400	+1,200
	004+00	008+00	400	+400	+3,000
	008+00	010+00	200	-100	+100
	010+00	012+00	200	-200	-100
	012+00	014+00	200	-100	-300
	014+00	016+00	200	+100	0
	016+00	018+00	200	+300	+600
	018+00	020+00	200	-100	-700
	020+00	024+00	400	-2,900	-10,100
	024+00	028+00	400	+200	+13,500
		Subtotal	**2,960**	**-3,600**	**+5,800**
Point (North of Groin)	028+00	032+00	395	+3,500	+27,500
	032+00	034+00	200	+500	+3,100
	034+00	036+00	210	+100	-1,800
	036+00	038+00	230	+300	+700
	038+00	039+60	230	+1,000	+8,300
	039+60	041+50	220	+1,300	+11,400
	041+50	043+47	220	+1,200	+11,800
	043+47	044+25	190	+1,400	+15,100
	044+25	045+07	190	+2,500	+14,500
	045+07	046+00	200	+3,000	+8,100
		Subtotal	**2,285**	**+14,800**	**+98,700**
Point (South of Groin)	046+00	046+89	200	+2,000	+5,400
	046+89	049+00	250	-300	+1,400
	049+00	050+50	100	-600	-300
	050+50	051+00	100	-100	+500
	051+00	052+64	240	+1,100	+6,200
	052+64	054+00	135	+1,400	+6,300
	054+00	056+56	380	+7,300	+27,200
		Subtotal	**1,405**	**+10,800**	**+46,700**
South Beach	056+56	060+51	423	+11,400	+44,900
	060+51	065+50	510	+13,900	+58,900
	065+50	069+46	423	+10,200	+43,800
	069+46	073+39	442	+8,000	+38,200
	073+39	076+37	516	+9,500	+37,100
	076+37	084+16	611	+11,800	+39,900
	084+16	088+23	471	+6,200	+25,500
	088+23	092+15	455	+5,700	+24,900
	092+15	097+10	536	+7,500	+35,200
	097+10	102+08	525	+8,900	+36,900
	102+08	106+00	436	+9,500	+35,200
	106+00	110+00	400	+9,200	+34,300
	110+00	114+00	388	+8,500	+32,300
	114+00	118+00	407	+8,900	+33,300
	118+00	122+00	413	+8,700	+31,600
	122+00	126+00	405	+7,300	+28,900
	126+00	130+00	405	+8,100	+30,300
	130+00	134+00	398	+9,300	+30,400
	134+00	138+00	401	+10,500	+30,800
	138+00	142+00	400	+11,500	+31,500
	142+00	146+00	400	+12,400	+32,800
	146+00	150+00	399	+13,900	+38,000
	150+00	154+00	385	+14,000	+37,000
	154+00	158+00	383	+14,700	+32,200
	158+00	162+00	386	+15,000	+29,800
	162+00	166+00	393	+10,300	+23,700
	166+00	170+00	394	+1,600	+8,700
	170+00	174+00	400	-2,500	-3,400
	174+00	178+00	400	-2,800	-8,900
	178+00	182+00	400	-3,400	-12,100
	182+00	186+00	400	-3,500	-10,900
	186+00	190+00	400	-2,700	-7,700
	190+00	194+00	400	-3,500	-8,200
	194+00	198+00	400	-4,000	-10,100
	198+00	202+00	400	-3,000	-13,300
	202+00	206+00	400	-2,500	-14,200
	206+00	210+00	400	-3,900	-14,600
	210+00	214+00	400	-2,900	-12,600
		Subtotal	**16,105**	**+231,800**	**+790,000**
		Bald Head Total	**22,755**	**+253,800**	**+941,200**

Note: Elevations are referenced to NGVD 1929.

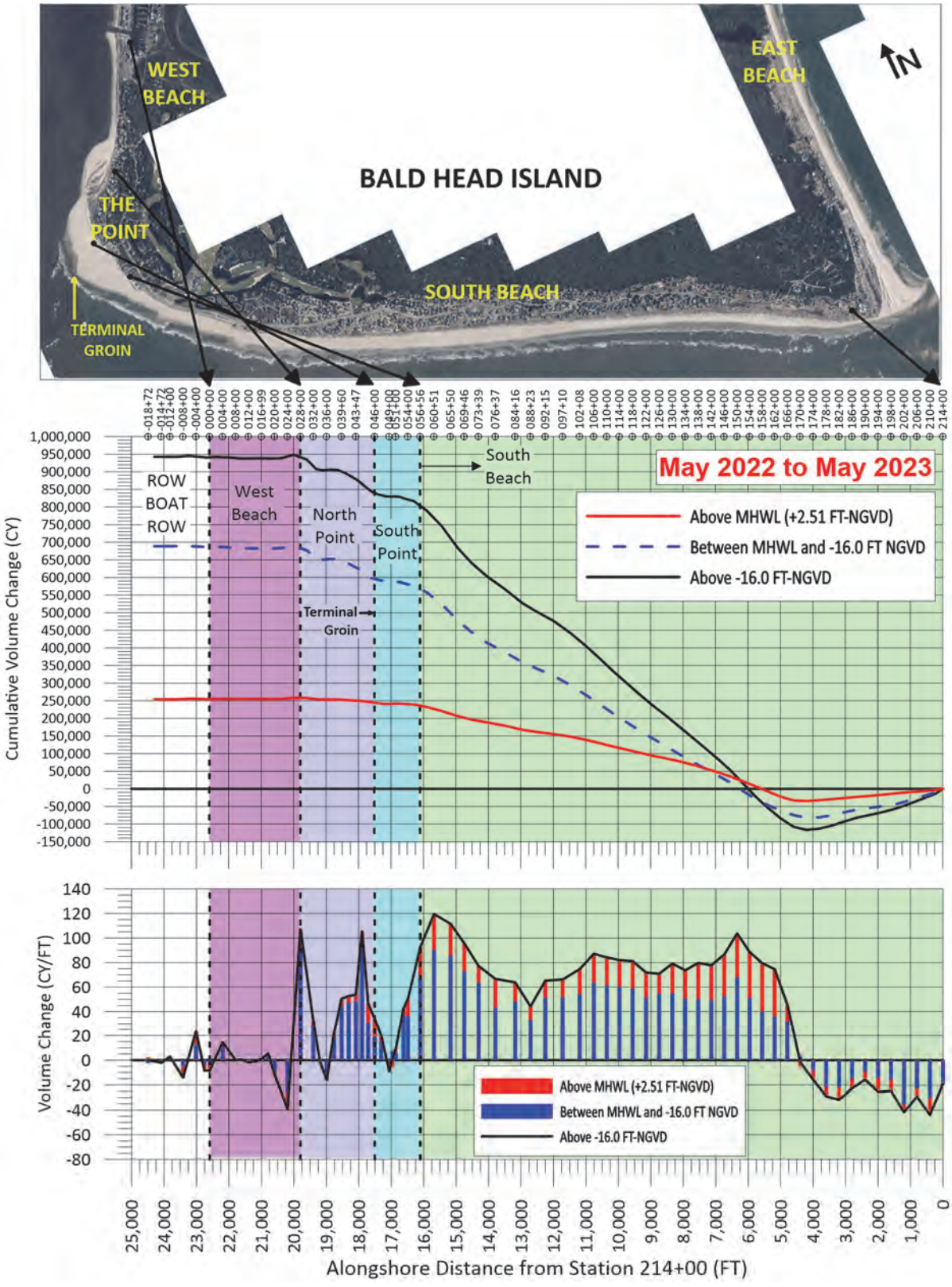


Figure 3.3: Volume change along the Bald Head Island shoreline between May 2022 and May 2023 (Year 22).

Table 3.4: Location of the **BERM** (+6.0 ft-NGVD) relative to the November 2000 (pre-2001 fill) location for selected monitoring surveys.

	Station	Location Relative to Nov. 2000		
		May 2022	Nov. 2022	May 2023
West Beach	000+00	+88.8	+102.6	+67.5
	004+00	+5.2	+2.1	+10.3
	008+00	-12.2	-9.6	-12.0
	010+00	No November 2000 profile		
	012+00	+20.0	+16.9	+12.7
	014+00	No November 2000 profile		
	016+00	+24.5	+28.5	+31.3
	018+00	No November 2000 profile		
	020+00	+226.9	+185.0	+193.2
	024+00	+308.2	+250.4	+205.8
	028+00	+162.1	+144.5	+144.3
Point (North of Groin)	032+00	+28.1	+300.6	+346.5
	034+00	No November 2000 profile		
	036+00	+247.7	+205.4	+160.5
	038+00	No November 2000 profile		
	039+60	+109.2	+149.9	+120.8
	041+50	No November 2000 profile		
	043+47	+152.4	+62.5	+98.6
	044+25	No November 2000 profile		
	045+07	+104.0	+122.7	+151.9
	046+00	No November 2000 profile		
Point (South of Groin)	046+89	+288.6	+274.6	+269.0
	049+00	No November 2000 profile		
	050+50	No November 2000 profile		
	051+00	No November 2000 profile		
	052+64	+234.1	+224.5	+257.5
	054+00	No November 2000 profile		
	056+56	+144.7	+116.7	+227.1

Positive values indicate shoreline advance relative to the pre-construction location. Negative values indicate shoreline erosion and are highlighted in red.

	Station	Location Relative to Nov. 2000		
		May 2022	Nov. 2022	May 2023
South Beach	060+51	+46.5	+18.6	+156.7
	065+50	+64.0	+66.0	+166.7
	069+46	+126.4	+109.4	+212.8
	073+39	+188.4	+152.8	+226.6
	076+37	+233.3	+170.2	+291.3
	084+16	+250.7	+217.9	+302.8
	088+23	+293.8	+214.7	+298.4
	092+15	+255.9	+193.6	+272.0
	097+10	+198.3	+156.4	+238.1
	102+08	+202.4	+151.1	+250.5
	106+00	+205.2	+163.6	+286.1
	110+00	+225.8	+168.0	+295.4
	114+00	+233.8	+192.9	+306.3
	118+00	+259.8	+210.0	+321.5
	122+00	+305.0	+247.1	+360.1
	126+00	+320.9	+262.0	+362.9
	130+00	+330.7	+281.0	+391.3
	134+00	+347.6	+281.4	+406.1
	138+00	+356.1	+317.9	+429.2
	142+00	+353.8	+307.4	+428.4
	146+00	+338.5	+298.4	+424.8
	150+00	+333.6	+291.1	+430.7
	154+00	+292.4	+283.1	+433.3
	158+00	+289.7	+275.8	+422.4
	162+00	+239.7	+258.6	+410.7
	166+00	+300.1	+286.1	+383.4
	170+00	+281.4	+279.0	+250.0
	174+00	+254.9	+252.9	+208.2
	178+00	+254.3	+244.3	+215.3
	182+00	+248.6	+236.8	+199.5
	186+00	+195.5	+181.8	+160.5
	190+00	+164.9	+155.5	+141.5
	194+00	+132.1	+119.9	+100.2
	198+00	+64.5	+49.5	+44.3
	202+00	+13.3	-5.7	+7.6
	206+00	-100.4	-91.8	-96.9
	210+00	-184.7	-201.3	-222.2
	214+00	-321.5	-353/3	-371.5

Table 3.5: Location of the **MHWL** (+2.51 ft-NGVD) relative to the November 2000 (pre-2001 fill) location for selected monitoring surveys.

	Station	Location Relative to Nov. 2000		
		May 2022	Nov. 2022	May 2023
West Beach	000+00	+103.3	+92.2	+52.5
	004+00	-1.3	+1.3	+8.2
	008+00	-4.7	-7.4	-12.4
	010+00	No November 2000 profile		
	012+00	-17.7	-30.3	-27.0
	014+00	No November 2000 profile		
	016+00	+25.9	+10.1	+17.9
	018+00	No November 2000 profile		
	020+00	+237.4	+218.2	+188.2
	024+00	+285.9	+234.9	+187.6
	028+00	+69.4	+102.9	+319.0
Point (North of Groin)	032+00	+264.6	+339.2	+264.1
	034+00	No November 2000 profile		
	036+00	+190.2	+141.8	+105.3
	038+00	No November 2000 profile		
	039+60	+78.4	+100.3	+89.5
	041+50	No November 2000 profile		
	043+47	+87.8	-11.3	+22.3
	044+25	No November 2000 profile		
	045+07	+80.0	+153.9	+190.9
	046+00	No November 2000 profile		
Point (South of Groin)	046+89	+289.4	+284.9	+322.4
	049+00	No November 2000 profile		
	050+50	No November 2000 profile		
	051+00	No November 2000 profile		
	052+64	+216.6	+203.9	+261.4
	054+00	No November 2000 profile		
	056+56	+121.2	+108.8	+237.7

Positive values indicate shoreline advance relative to the pre-construction location. Negative values indicate shoreline erosion and are highlighted in red.

	Station	Location Relative to Nov. 2000		
		May 2022	Nov. 2022	May 2023
South Beach	060+51	+32.0	+33.1	+161.7
	065+50	+50.6	+60.5	+168.8
	069+46	+111.5	+110.9	+200.7
	073+39	+183.3	+163.5	+248.4
	076+37	+234.2	+183.8	+300.6
	084+16	+256.1	+240.5	+298.4
	088+23	+290.7	+243.3	+308.2
	092+15	+247.0	+193.5	+277.5
	097+10	+191.6	+180.7	+237.7
	102+08	+193.8	+168.6	+254.3
	106+00	+207.5	+188.1	+279.7
	110+00	+212.4	+180.9	+279.9
	114+00	+226.1	+200.4	+294.5
	118+00	+258.0	+226.9	+314.6
	122+00	+288.1	+253.5	+341.5
	126+00	+313.8	+270.9	+360.5
	130+00	+319.1	+291.9	+370.9
	134+00	+341.2	+299.1	+391.6
	138+00	+341.9	+323.2	+404.2
	142+00	+342.2	+323.3	+408.3
	146+00	+319.5	+308.6	+403.4
	150+00	+325.9	+310.4	+410.8
	154+00	+309.1	+304.4	+409.0
	158+00	+310.7	+297.0	+406.1
	162+00	+304.4	+285.2	+387.3
	166+00	+306.7	+297.2	+369.5
	170+00	+296.4	+279.9	+281.0
	174+00	+275.3	+260.4	+211.0
	178+00	+285.9	+266/4	+219.2
	182+00	+273.6	+243.5	+200.2
	186+00	+224.8	+196.6	+155.9
	190+00	+192.6	+149.4	+128,3
	194+00	+158.1	+120.6	+94.5
	198+00	+126.7	+69.9	+52.4
	202+00	+87.0	+14.3	-6.6
	206+00	-70.7	-104.5	-119.3
	210+00	-197.0	-202.5	-249.4
	214+00	-329.6	-323.8	-359.9

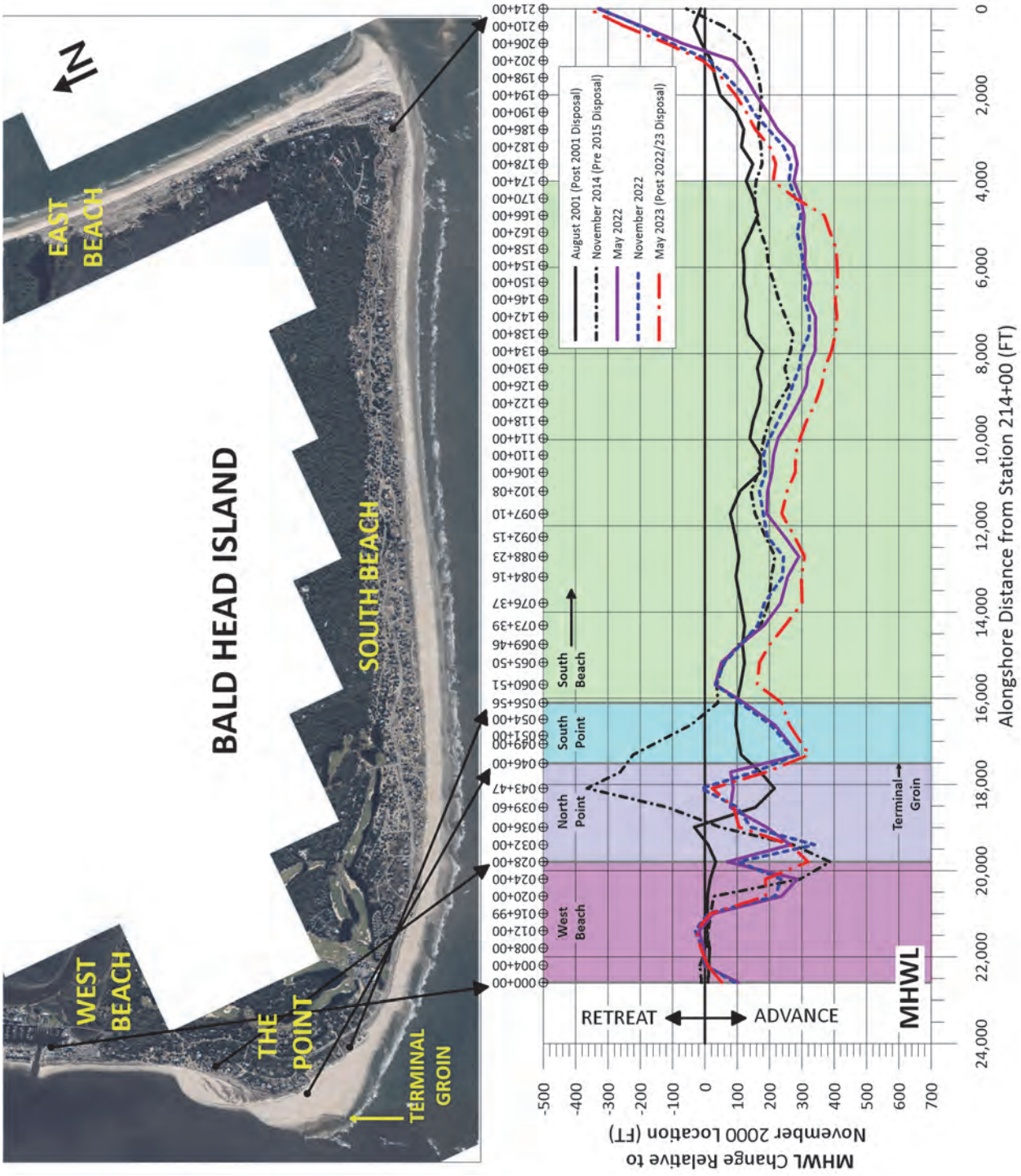


Figure 3.4: Location of the MHWL (+2.51 ft-NGVD) relative to the November 2000 (pre-2001 fill) location.

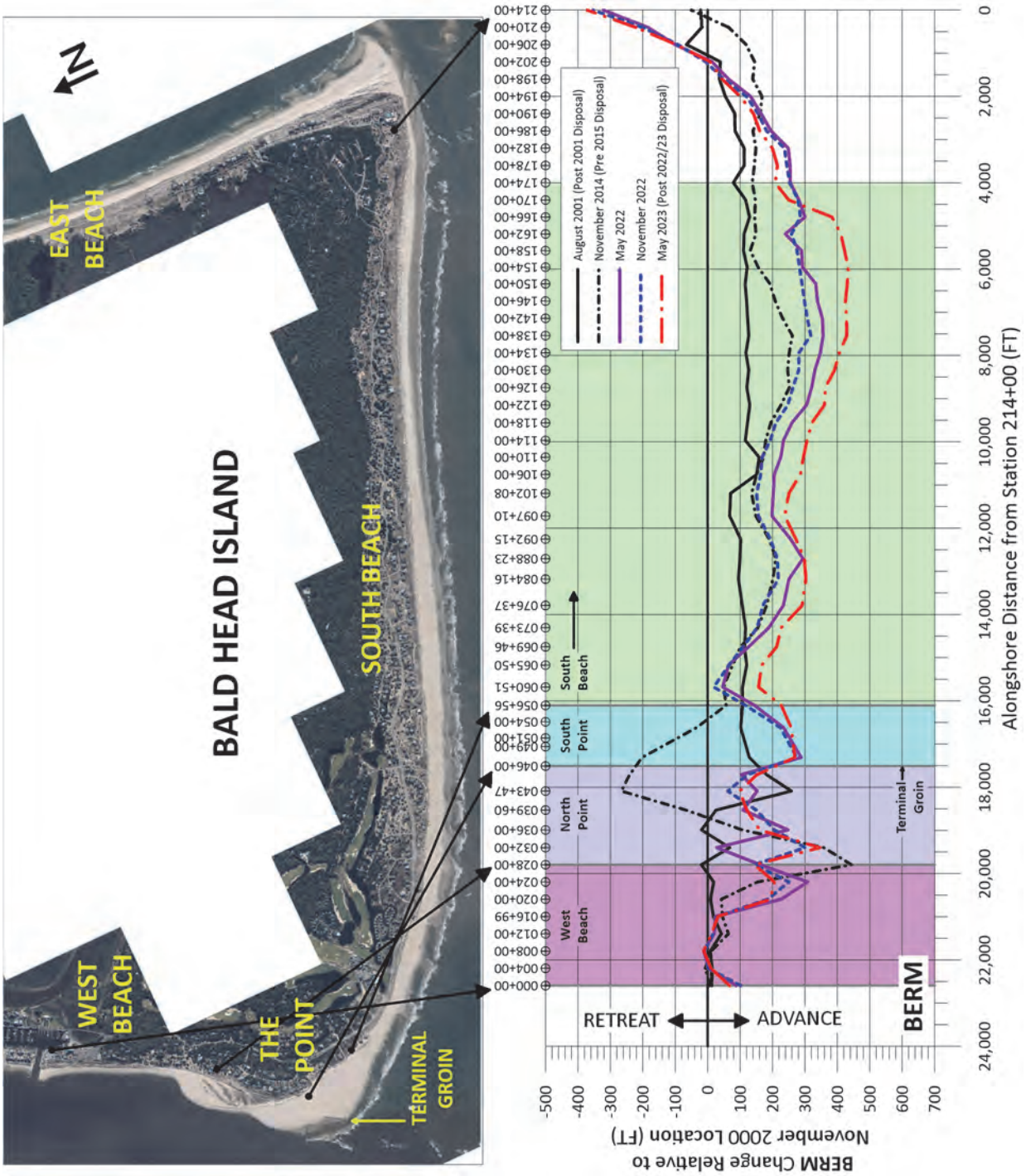


Figure 3.5: Location of the BERM (+6.00 ft-NGVD) relative to the November 2000 (pre-2001 fill) location.

3.3.4 Long-Term Beach Changes: November 2000 to May 2023 (Post-Federal Disposal)

For purposes of tracking gross sand placement performance, **Figure 3.6** plots a time history of cumulative volume change relative to November 2000 conditions. **Figure 3.7** presents net volumetric change (alongshore above -16 ft NGVD) for the maximum period of comparison to date (*i.e.* November 2000 and May 2023). In both Figures the effects of direct South Beach sand placement over time are included. As with other similar analyses over the last decade, East Beach, Cape Fear and Row Boat Row are *excluded* from this analysis.

The classic "saw-tooth" effects of episodic sand placement (and subsequent sand losses over time), as reflected in **Figure 3.6**, are indicative of the periodic infusion of sand along South Beach at Bald Head Island associated with the placement of sand during initial construction of the channel deepening project, six (6) subsequent beach disposal operations pursuant to the WHSMP, the proactive beach renourishment project constructed by the Village in 2009/10 and to a smaller degree the emergency fill of 2012. The Village 1.85 Mcy fill was constructed with the knowledge gained through monitoring that certain irreparable large-scale impacts to Bald Head Island would predictably occur as a direct result of the proposed diversion of channel maintenance material in 2009 to Oak Island. *Note – a similar diversion of Federal maintenance sand occurred in the summer of 2018.* As a result of the 2018 federal sand disposal at Oak Island, the Village constructed a 1.1 Mcy interim beach fill at South Beach in the fall/winter of 2018/19. The most recent federal beach disposal project was completed in March 2023 along South Beach on Bald Head Island. Over the following 2 months, mol the fill berm had just begun to equilibrate. Similarly, a portion of that sand placed can be found as an accretional spit located immediately westward of the terminal groin. The episodic formation of that depositional feature was intended "by design" in order to maintain a sand supply to West Beach – subsequent to terminal groin construction.

Table 3.6 presents a chronology of sediment volumes (measured in-place) for the three (3) segments of shoreline noted between the benchmark survey of November 2000 and present (*i.e.* May 2023). Currently, within the **approximate** 22,755 ft of shoreline considered, there is a net gain of +4,282,500 cy. However, after removing the effects of the gross volume of sand artificially placed along the Bald Head Island shoreline since the 2000 deepening project, the net change in Island-wide volume (exclusive of East Beach and the Cape Fear Point) is a measured sediment *loss* of -8,801,300 cy. It is important to note that the chronology of sand volumes presented by this **Table** reflects the *actual volumes* of sand *measured in-place* by survey and therefore is not related to projections based upon *estimated* volumes dredged from the channel or borrow site, *estimated* sand volumes placed, contractual "net pay" volumes, etc.

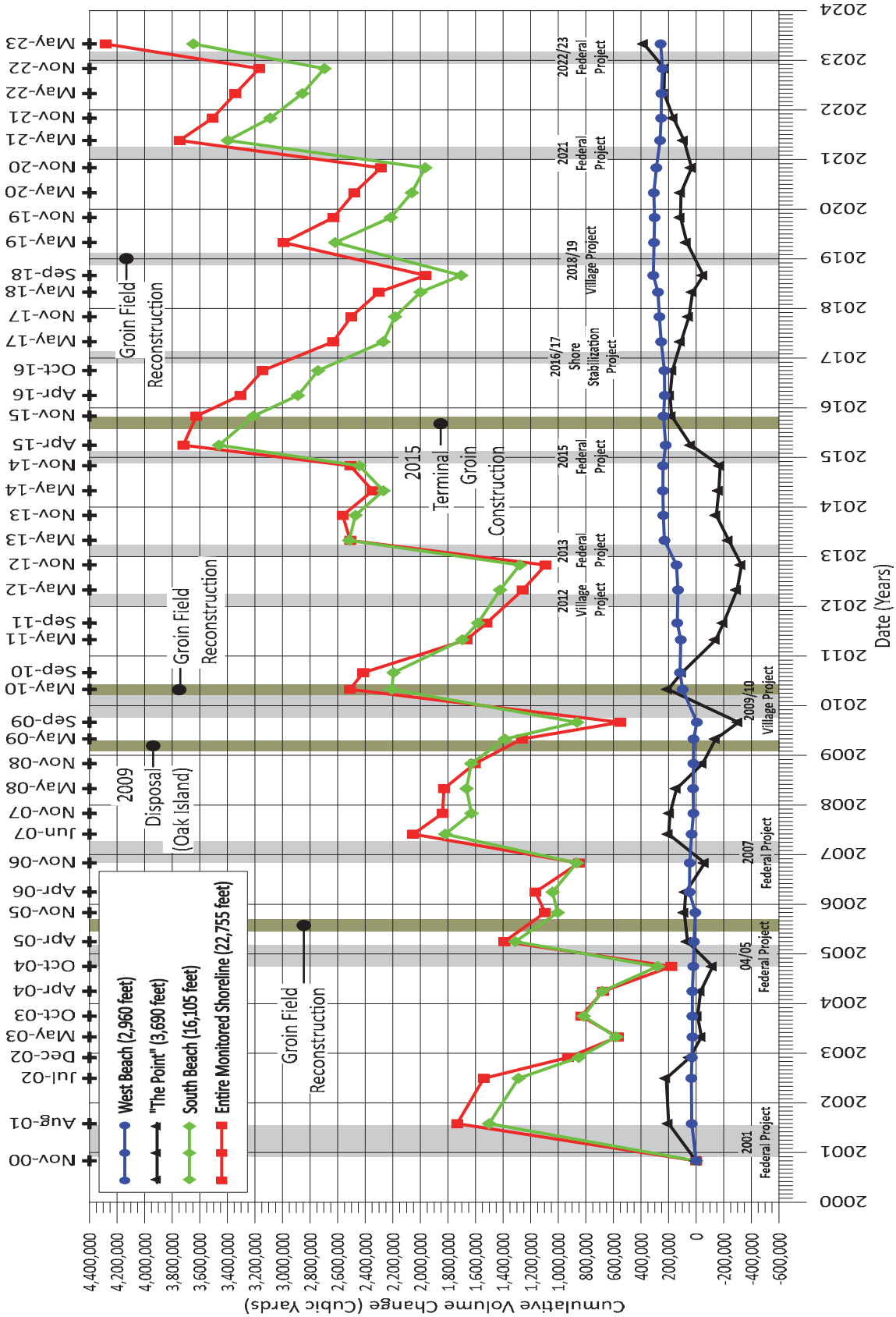


Figure 3.6: Cumulative volume change (above -16 ft-NGVD) relative to November 2000 conditions.

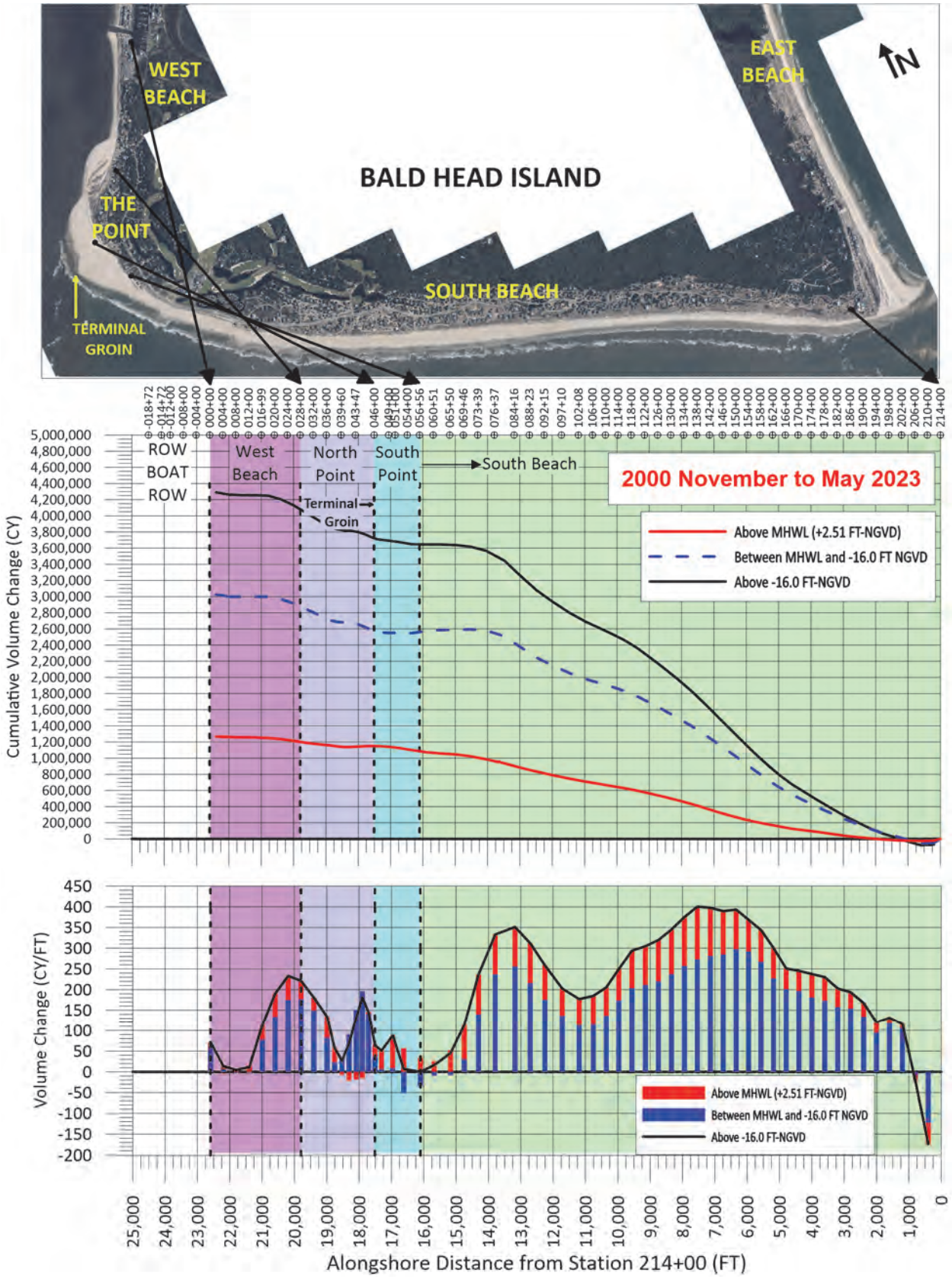


Figure 3.7: Volume change along the Bald Head Island shoreline between November 2000 and May 2023.

Table 3.6: Bald Head Island historic net volume change above -16 ft-NGVD (presumed closure depth).

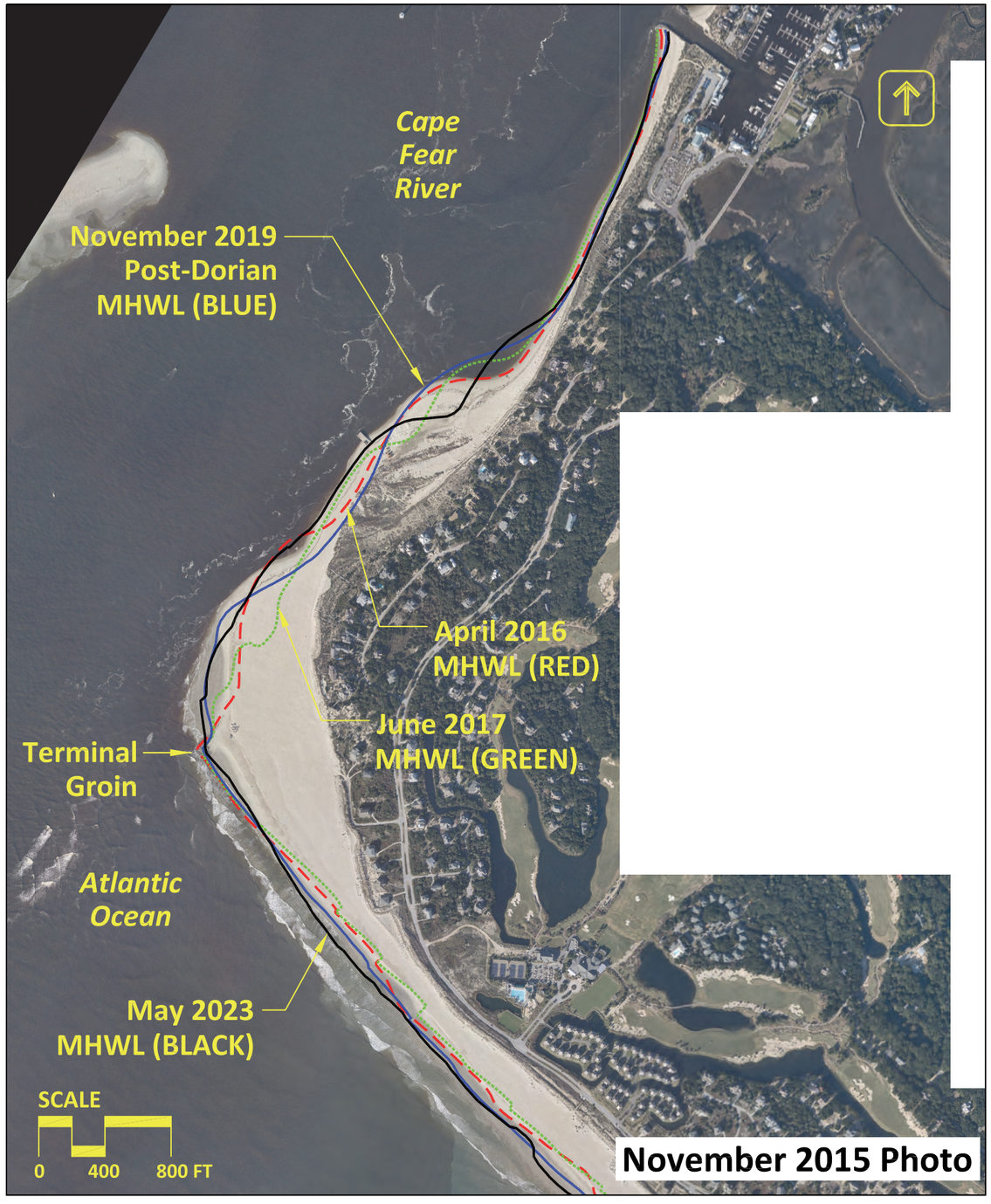
Period	Start Date	End Date	Span (Months)	Volume Change Above -16 ft-NGVD (CY)			
				West Beach	The Point	South Beach	Total
Year 0 (Const.)[1]	Nov. 2000	Aug. 2001	9	+31,900	+199,500	+1,501,800	+1,733,200
Year 1	Aug. 2001	Jul. 2002	11	+2,900	+17,400	-213,300	-193,000
Year 2	Jul. 2002	May 2003	10	-8,000	-255,500	-707,400	-970,900
Year 3	May 2003	Apr. 2004	11	+1,000	+6,500	+99,900	+107,400
Year 4 (Project)[2]	Apr. 2004	Apr. 2005	12	-11,800	+94,700	+631,200	+714,100
Year 5 (Project)[3]	Apr. 2005	Apr. 2006	12	+32,000	+13,300	-270,200	-224,900
Year 6 (Project)[4]	Apr. 2006	Jun. 2007	14	-15,400	+123,500	+778,100	+886,200
Year 7	Jun. 2007	May 2008	11	-10,300	-58,200	-154,600	-223,100
Year 8	May 2008	May 2009	12	-3,400	-282,800	-278,200	-564,400
Year 9 (Project)[5]	May 2009	May 2010	12	+79,300	+346,000	+821,300	+1,246,600
Year 10	May 2010	May 2011	12	+13,200	-346,100	-512,700	-845,600
Year 11 (Fill)[6]	May 2011	May 2012	12	+20,800	-154,600	-273,300	-407,100
Year 12 (Disposal)[7]	May 2012	May 2013	12	+97,600	+59,800	+1,093,900	+1,251,300
Year 13	May 2013	May 2014	12	+11,600	+72,100	-247,500	-163,800
Year 14 (Disposal)[8]	May 2014	Apr. 2015	11	-20,400	+201,800	+1,191,800	+1,373,200
Year 15	Apr. 2015	Apr. 2016	12	+7,200	+151,800	-572,500	-413,500
Year 16	Apr. 2016	May 2017	13	+25,500	-79,000	-619,000	-672,500
Year 17	May 2017	May 2018	12	+23,200	-84,600	-270,500	-331,900
Year 18 (Fill)[10]	May 2018	May 2019	12	+29,000	+42,200	+619,500	+690,700
Year 19	May 2019	May 2020	12	+1,200	+42,200	-555,900	-512,500
Year 20 (Disposal)[11]	May 2020	May 2021	12	-45,300	-21,600	+1,334,400	+1,267,500
Year 21	May 2021	May 2022	12	-9,400	+144,500	-540,800	-405,700
Year 22 (Disposal)[12]	May 2022	May 2023	12	+5,800	+145,400	+790,000	+941,200
Year 0 to Year 22	Nov. 2000	May 2023	270	+258,200	+378,300	+3,646,000	+4,282,500
Year 0 to Year 22 (12,883,800 CY of Fill Removed)	Nov. 2000	May 2023	270	NA	NA	NA	-8,601,300

[1] 2001 Initial Disposal (1,849,500± CY); [2] 2005 Beach Disposal (1,217,000± CY); [3] 2006 West Beach Fill (47,800± CY)
[4] 2007 Beach Disposal (978,500± CY); [5] 2009/10 Beach Fill (1,850,000± CY); [6] 2012 Beach Fill (138,000± CY)
[7] 2013 Beach Disposal Fill (1,658,000± CY); [8] 2015 Beach Disposal (1,320,000± CY);
[9] 2016/17 Beach Disposal (24,000± CY); [10] 2018/19 Beach Fill (1,100,000± CY); [11] 2021 Beach Disposal (1,601,000± CY)
[12] 2022/23 Beach Disposal (1,100,000± CY)

The estimated *average* annual loss of sand from the monitored section of Bald Head Island shorefront (excluding East Beach and Row Boat Row) since November 2000, is approximately -391,169 cy per year including the impacts of numerous major storm events. The assignment of an "average" annual long-term rate of sand loss at Bald Head Island however, is *not* necessarily a meaningful indicator of navigation project impact. Such an "average rate" is temporally biased by periods of beach fill placement and equilibration, groin field effectiveness, the occurrence of episodic destabilizing dredging events in close proximity to the island, as well as other physiographic phenomena temporally affecting annualized quantities of alongshore sediment transport – from Bald Head Island – to the navigation channel, -- including meteorological effects – such has Hurricanes Florence, Dorian and Isaias.

3.3.5 MHWL Shoreline Position

As part of the permit required monitoring for the terminal groin project completed in late 2015, the MHWL was surveyed in December 2015 (post-construction), April 2016 (5 months post-construction), June 2017 (19 months post-construction), May 2018 (30 months post-construction), September 2018 (post-Florence), May 2019 (post-fill), November 2019 (post-Dorian), May 2020, May 2021, May 2022, and May 2023. Various selected surveys are plotted in **Figure 3.8**. The purpose of the surveys is to be able to intercompare and assess both updrift fillet conditions and the location of the downdrift shoreline immediately fronting the Cape Fear River. Through May 2023, terminal groin project performance – based upon monitoring – has been both as intended and as predicted.



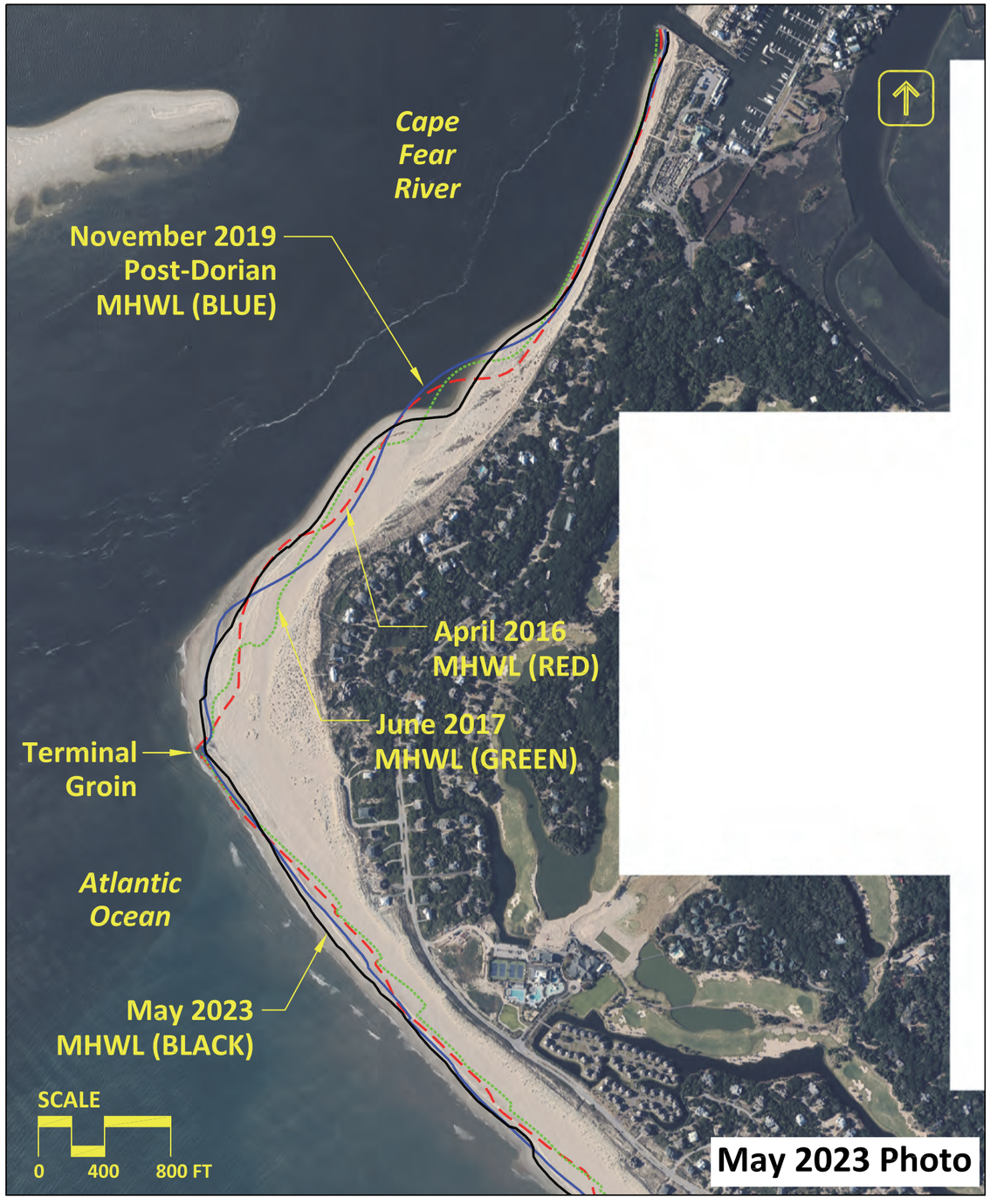


Figure 3.8:
MHWL positions in the vicinity of the terminal groin Bald Head Island, NC

3.3.6 Chronology of the Point

Since the construction of the Wilmington Harbor Channel Deepening Project – in about 2001, the spatial configuration of the spit feature (known as the "Point") located at the juncture of South Beach and the entrance channel, has been a focal point of the Village's monitoring program. Accordingly, the chronology of the Point's condition and evolution over time is indicative of the dynamic interaction between the ever increasing rate of sand transport westward along South Beach and the man-altered inlet hydrodynamics, as well as episodic dredging operations which result in sand removal from the island's littoral system. In its simplest sense, the Point has historically been to a large degree, a visual indictor of the processes involved and a potential "bellwether" as to direct and indirect impacts associated with the Navigation Project – irrespective of proactive or remedial actions specified within the Wilmington Harbor Sand Management Plan. The latter take the form of alongshore sand placement events intended to mitigate adverse impacts associated with both project construction in 2000 and episodic channel maintenance required to ensure navigability.

Appendix E includes a high resolution visual chronology of the Point from 1998 to May 2023. Demarcated on each photo panel are the approximate September 2001 (blue line) and May 2023 (red line) apparent vegetation lines. Also placed on each photo are two reference marks (green dots). The variation in spit configuration from the before navigation improvement project photos (1998 and 1999) throughout the last approximate twenty-one years for pre- and post-fill timeframes can be easily visualized. Similarly, the advance and recession of the Point, as well as its consistent *net northerly migration* are self-evident. An additional perspective can be gained by an assessment of the locations of the pre-project and present day "vegetation lines" over the 1998 through 2021 timeframe. As had been concluded throughout the numerous years of comprehensive beach monitoring funded by the Village of Bald Head Island – improved conditions along the westernmost segment of South Beach and the Point were documented to last only about 2 years after each federal disposal event – *prior* to terminal groin construction in 2015.

Both long term monitoring, as well as numerical modeling of the Cape Fear River Entrance by Olsen Associates, Inc. (Olsen 2013a), and the abutting Bald Head Island shoreline, indicated that additional structural measures were warranted. As the westernmost segment of South Beach shoreline had "rolled back," the annualized rate of littoral transport at that location had correspondingly increased. Hence, in 2012 the Village initiated the permitting for a 1,300 ft terminal structure intended to both reorient the effective updrift shoreline alignment (so as to reduce annual sediment losses) and to allow for the reconstruction of a protective beach where one now could not be reliably established through sand placement alone. That project was constructed during the summer of 2015. Subsequently, monitoring reports now document a "new dynamic" predicted to result from the implementation of the terminal groin structure. Analytical predictions of shoreline change to both the updrift and downdrift shorelines abutting

the structure – via DELFT 3D modeling – were discussed in a detailed report formulated for purposes of both design and permitting of the terminal groin (Olsen 2013a). Additional monitoring data required by Permit are intended to assist in the quantification of the terminal groin effects on littoral processes and resultant shoreline reconfiguration. These include additional transects in the vicinity of the structure as well as an approximate MHWL delineation performed by survey every 6-months.

For the May 2022 to May 2023 monitoring period, the inlet facing shoreline adjacent to the terminal groin continues to realign (as predicted) and adjust to a new equilibrium condition. An intertidal spit formation continues to form on the inlet side of the structure as a result of sediment transported from South Beach through or across the structure. Updrift thereof, portions of the historical Point continue to migrate northward as they did prior to terminal groin construction. This is best represented by the surveyed MHWL locations depicted in **Figure 3.8**. The configuration of the sand fillet updrift of the terminal groin continues to be influenced by the sand tube groin field as fill berms recede and the formerly buried groins become "activated". The most recent Jan – March 2023 federal beach disposal project placed approximately 1.1 Mcy along South Beach. The mobilization of a portion of that fill westward directly affected the volume of material directed toward, over and through the terminal structure at the Point. Resultant increased rates of sand deposition on the western side of the structure were therefore measured between May 2022 and May 2023.

3.4 East Beach Shoreline Conditions

In November 2008, East Beach was added to the island-wide beach monitoring program[9]. Profiles along the East Beach shoreline are collected at seven (7) monitoring stations starting just north of Cape Fear and extending approximately 6,000 feet northward along the Onslow Bay facing shoreline (see **Figure 2.1**). Plots of these profiles are provided at the end of **Appendix A** (**Figures A-70** to **A-76**). **Tables 3.7** and **3.8** summarize the shoreline and volume changes measured during the May 2022 to November 2022 to May 2023 monitoring periods. **Figure 3.9** presents drone imager of East Beach flown in July 2023. **Figure 3.10** depicts the May 2022, October 2022 and May 2023 aerial photographs along southern East Beach.

During the May 2022 to November 2022 period, the East Beach shoreline lost approximately -37,300 cy above the MHWL and -9,700 cy below the MHWL for a net loss above -16 ft-NGVD of -47,000 cy. During this same period the backshore berm (at elevation +6 ft-NGVD) receded by an average of -19.5 ft and the MHWL receded by an average of -11.2 ft.

During the November 2022 to May 2023 winter period, the East Beach shoreline gained approximately +35,300 cy above the MHWL and +30,100 cy below the MHWL for a net gain above -16 ft-NGVD of +65,400 cy. During this same period the berm advanced by an average of +27.4 ft while the MHWL advanced by an average of +18.3 ft.

Table 3.9 summarizes the volume changes measured over the entire period of survey record (November 2008 – May 2023). Over the 175-month period, the East Beach shoreline gained approximately +72,800 cy above the MHWL and +381,100 cy above the -16 ft-NGVD contour.

Figure 3.9: Northward looking view of East Beach from Cape Fear. (July 2023 Photo).

[9] Profiles were not acquired at East Beach in the fall of 2009

Table 3.7: East Beach shoreline and volume changes between May 2022 and November 2022.

Station	Reach (FT)	Volume Change (CY) Above MHWL (+2.51 FT)	Above -16 FT		Shoreline Change (FT) Berm (+6 FT)	MHWL (+2.51 FT)
224+80					-73.4	-97.0
	1,000	-1,400	-30,300			
234+80					+45.1	+62.0
	1,000	+1,200	+14,600			
244+80					-19.8	+5.2
	1,000	-9,200	-4,300			
254+80					-19.4	+2.3
	1,000	-11,000	-8,900			
264+80					-21.2	-18.6
	1,000	-9,400	-13,000			
274+80					-30.5	-19.2
	1,000	-7,500	-5,100			
284+80					-17.0	-13.5
Total	**6,000**	**-37,300**	**-47,000**		**-19.5** (AVG)	**-11.2** (AVG)

Table 3.8: East Beach shoreline and volume changes between November 2022 and May 2023.

Station	Reach (FT)	Volume Change Above MHWL (+2.51 FT)	Above -16 FT		Shoreline Change (FT) Berm (+6 FT)	MHWL (+2.51 FT)
224+80					+38.6	+97.6
	1,000	+9,100	+53,300			
234+80					+18.6	-24.1
	1,000	+5,400	+4,700			
244+80					+43.7	+13.0
	1,000	+6,100	+2,900			
254+80					+4.4	-8.0
	1,000	+4,700	-3,100			
264+80					+16.5	+9.0
	1,000	+5,400	+1,800			
274+80					+49.8	+25.9
	1,000	+4,600	+5,800			
284+80					+20.2	+14.5
Total	**6,000**	**+35,300**	**+65,400**		**+27.4** (AVG)	**+18.3** (AVG)

Table 3.9: Volume changes along East Beach (Sta. 224+80 to 284+80).

Survey Period	Volume Change Above Datum (CY)		
	Above MHWL (+2.51 ft-NGVD)	Below MHWL to -16 ft-NGVD	Total Change Above -16 ft-NGVD
November 2008 to May 2009	+700	-65,600	-64,900
May 2009 to May 2010	-23,300	-8,600	-31,900
May 2010 to May 2011	+10,600	+18,000	+28,600
May 2011 to May 2012	+5,700	+87,700	+93,400
May 2012 to May 2013	+20,000	-41,600	-21,600
May 2013 to May 2014	+17,700	+105,200	+122,900
May 2014 to April 2015	-900	+44,100	+43,200
April 2015 to April 2016	+20,800	-400	+20,400
April 2016 to May 2017	+4,500	+38,200	+42,700
May 2017 to May 2018	+31,400	+25,000	+56,400
May 2018 to May 2019	+9,600	+140,300	+149,900
May 2019 to May 2020	-12,500	-76,100	-88,600
May 2020 to May 2021	-7,800	+7,400	-400
May 2021 to May 2022	-1,700	+14,300	+12,600
May 2022 to May 2023	-2,000	+20,400	+18,400
November 2008 to May 2023	**+72,800**	**+308,300**	**+381,100**

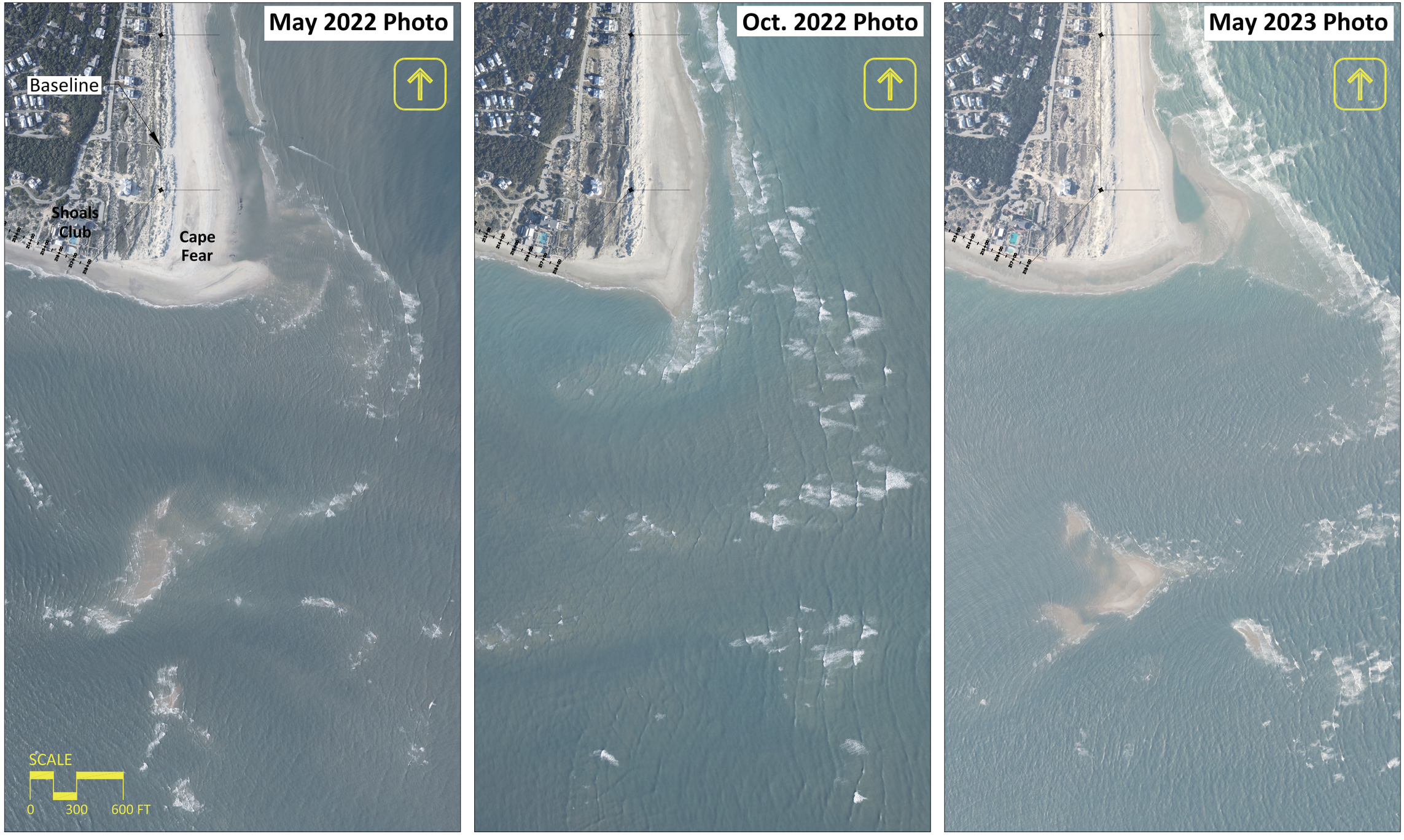


Figure 3.10:
Cape Fear aerial photography
Bald Head Island, NC

As demonstrated by the survey and photographic data (**Figure 3.10**), it can be reasonably assumed that the condition of East Beach at any one time is, has been and will continue to be not only seasonal but highly influenced by the configuration of the depositional spit and shoals associated with the "Cape Fear Point". Of further interest are the variations in spit size and orientation over the 12 years (2008-2023) which are depicted by **Figure 3.12**. In its simplest sense, the Cape Fear spit is a highly dynamic feature which is influenced by sand supply originating from both the west (along South Beach) and the north (along East Beach). The Point is also highly susceptible to storm waves originating from *both* the west (Atlantic Ocean) and the east (Onslow Bay) and resultant tidal channels which episodically break through and subsequently influence localized patterns of sand deposition (or erosion).

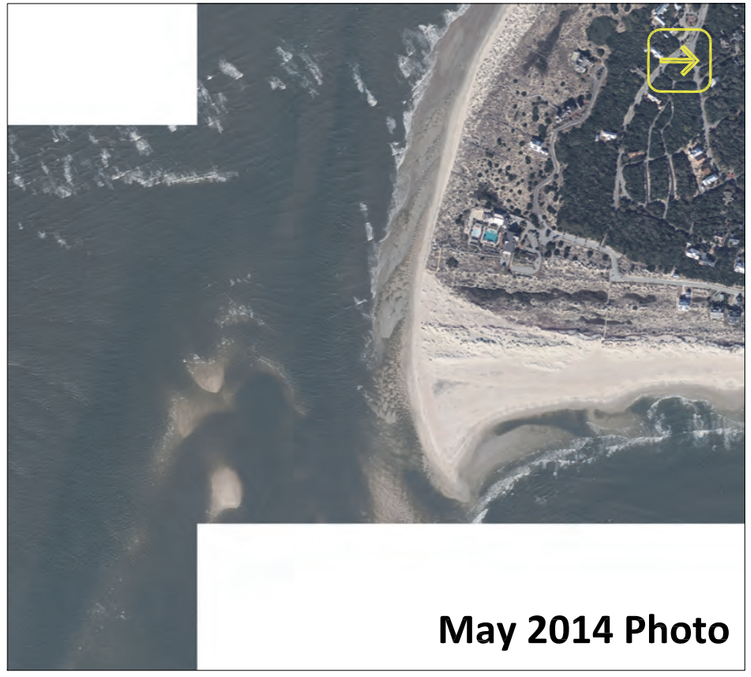
Although the near-term locations of the Cape Fear spit have been beneficial to East Beach properties lying northward thereof, it has typically caused significant shoreline and dune recession seaward of the South Beach Shoals Club facility (see **Figure 3.11**). That section of shorefront is monitored via beach profiles B-54 and B-55 (Sta. 214+00 and 218+00). The Shoals Club lies approximately mid-way between these two survey stations. **Figure A-71** and **A-72** (**Appendix A**) depict some level of fill being placed by the Corps April 2021 disposal project. As shown by survey profiles for May 2022 to May 2023, however, virtually all of the fill material had been lost and that the location of the MHWL had receded even more landward than its pre-disposal project location. As a result, in the spring of 2022 the Shoals Club was required to construct a sand bag revetment along the existing scarp line seaward of the Club facility in order to preclude future losses of land an infrastructure. It is opined that the federal fill project failed to provide net benefit to this affected area due to the nature of very fine sand placed – which derives from material dredged from Bald Head Reach 2 of the navigation project channel.

Figure 3.11: View of the South Beach Shoals Club facility. (July 2023 Photo).

May 2008 Photo

April 2010 Photo

April 2011 Photo



May 2014 Photo

April 2017 Photo

May 2023 Photo

Figure 3.12:
Cape Fear aerial photography
Bald Head Island, NC

3.5 Row Boat Row Shoreline Conditions

In November 2015, the "Row Boat Row" shoreline was added to the island-wide beach monitoring program. Survey data are collected at five (5) monitoring stations starting just north of the marina entrance and extending approximately 1,500 feet northward along the Cape Fear River facing shoreline (see **Figure 2.1**). Plots of these profiles are provided at the beginning of **Appendix A** (**Figures A-1** to **A-5**). **Tables 3.10** and **3.11** summarize the shoreline and volume changes measured during the May 2022 to November 2022 to May 2023 monitoring period (12 months).

In early 2017, after completion of a 26,000 cy beach fill placed by Marcol Dredging along the Row Boat Row shoreline, two detached rock breakwaters were constructed by Intra Coastal Marine Construction. Final acceptance of the project occurred in July 2017. Subsequently, the shorefront within the influence of the two shore parallel structures has equilibrated into a series of discrete crenulate features between tombolos which extend from the center of each breakwater in a landward direction (**Figure 3.13**).

During the monitoring year (May 2022 to May 2023), the shoreline showed a net loss of roughly –100 cy above the MHWL and a net gain of +1,700 cy above -16 ft-NGVD.

Figure 3.13: Southward looking view of the Row-Boat-Row shoreline detached breakwaters (July 2023 photo).

Table 3.10: Row Boat Row shoreline and volume changes between May 2022 and November 2022.

Station	Reach (FT)	Volume Change (CY) Above MHWL (+2.51 FT)	Above -16 FT		Shoreline Change (FT) Berm (+6 FT)	MHWL (+2.51 FT)
-018+72					-0.4	+9.3
	400	+600	-900			
-014+72					+14.0	+14.8
	272	+100	+900			
-012+00					+21.5	+16.3
	400	-400	-600			
-008+00					-21.3	-14.9
	400	-700	-1,200			
-004+00					-3.0	+2.4
	100	0	+200			
Marina						
Total	**1,572**	**-400**	**-1,600**		**+2.1 (AVG)**	**+5.6 (AVG)**

Table 3.11: Row Boat Row shoreline and volume changes between November 2022 and May 2023.

Station	Reach (FT)	Volume Change (CY) Above MHWL (+2.51 FT)	Above -16 FT		Shoreline Change (FT) Berm (+6 FT)	MHWL (+2.51 FT)
-018+72					-1.6	-3.9
	400	-300	+500			
-014+72					-21.5	-18.4
	272	-200	-800			
-012+00					-17.9	-18.9
	400	-1,300	-1,700			
-008+00					-25.1	-19.4
	400	+1,100	+3,100			
-004+00					+54.5	+51.1
	100	+1,000	+2,200			
Marina						
Total	**1,572**	**+300**	**+3,300**		**-2.3 (AVG)**	**-1.7 (AVG)**

Note – Volumes of sand associates with multiple sand bypass operations since 2017 have not been accounted for in these tables.

4.0 JAY BIRD SHOALS BORROW SITE MONITORING (SURVEY) RESULTS

Pursuant to permit requirements for the 2009/10 project, the Jay Bird Shoal borrow site has been surveyed for purposes of monitoring its recovery. Approximately 1.8 Mcy of material was excavated during the 2009/10 project and 1.1 Mcy during the 2018/19 project.

Figure 4.1 depicts the most recent borrow site (May 2023) seabed elevations. This plot represents conditions approximately 4 years post-2018/19 project and 13 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 3 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[10] (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 4.2 depicts the seabed elevation change during the Year 4 monitoring period (May 2022 to May 2023). **Figure 4.3** depicts the seabed elevation changes during the 13 years (158 months) since 09/10 project construction to the most recent survey (March 2010 to May 2023).

Table 4.1 summarizes the volume changes within the permitted borrow site limits between the monitoring surveys conducted since constriction of the 2009/10 project. During the Year 13 monitoring period (May 2022 to May 2023), the fourth year following the 2018/19 project excavation, the entire permitted borrow site gained +16,300 cy (inclusive of the exclusion and buffer zones). Within just the latest excavated areas (Areas 2 & 3), the borrow site gained +17,400 cy. Within just these areas, the average seabed elevation increased from -18.5 ft-NGVD to -18.4 ft-NGVD over this period.

Table 4.2 summarizes the volume of material theoretically remaining above the permitted cut elevation (-22 ft-NGVD) by survey date and sub-area. These volumes are exclusive of the exclusion and buffer zones shown in **Figure 4.1**. As of May 2023, there are approximately +1,380,000 cy of material theoretically available within the permitted borrow site limits above -22 ft-NGVD. A portion of this is undredged. Another portion is depositional. None of it is suitable in depth for purposes of excavation by an ocean certified dredge.

[10] By permit, no work was allowed within 150 feet and 100 feet of two potential shipwreck sites located within the Jay Bird Shoals borrow site.

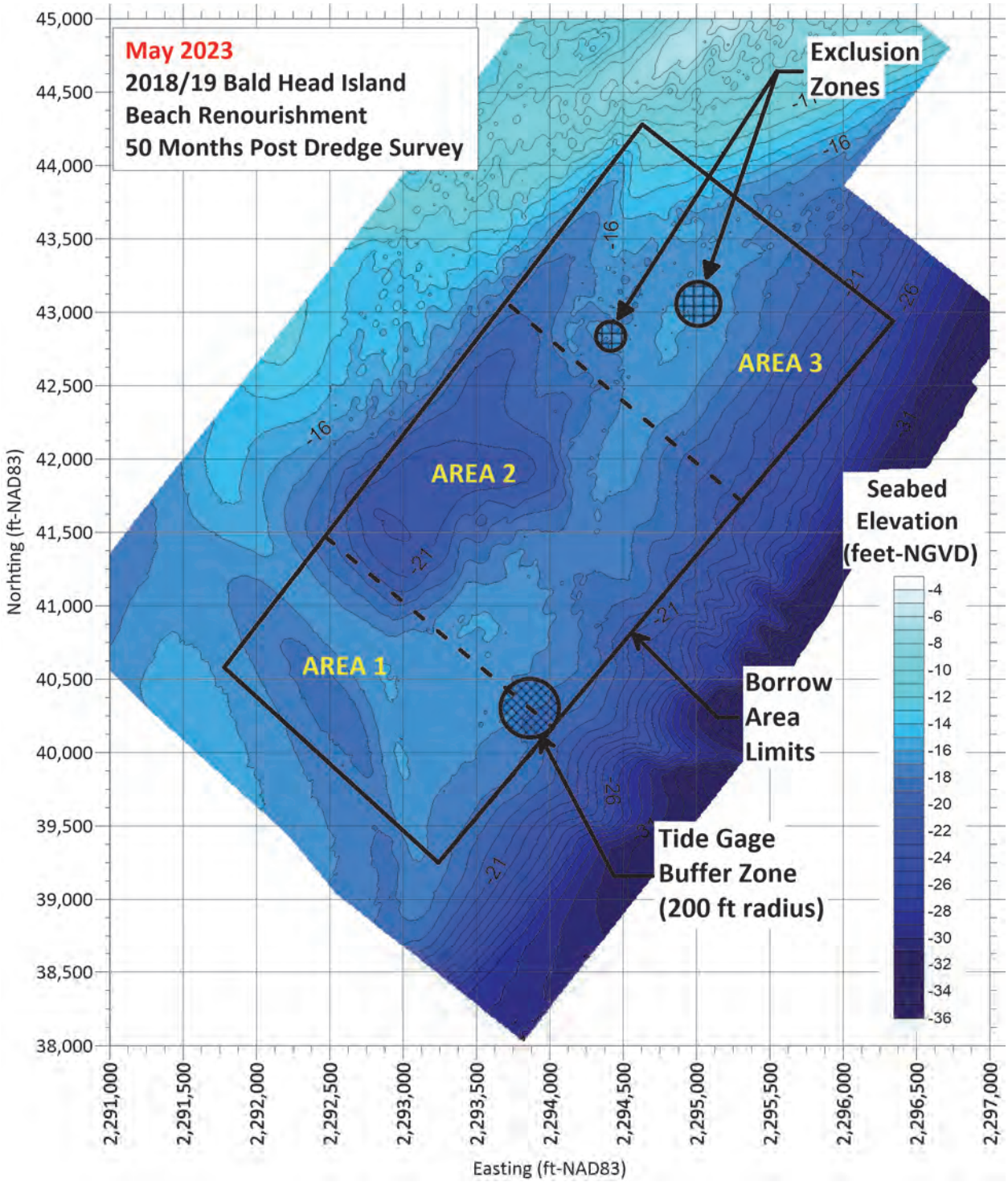


Figure 4.1: Jay Bird Shoals borrow site conditions in May 2023 (50 months post-dredge 2018/19 project).

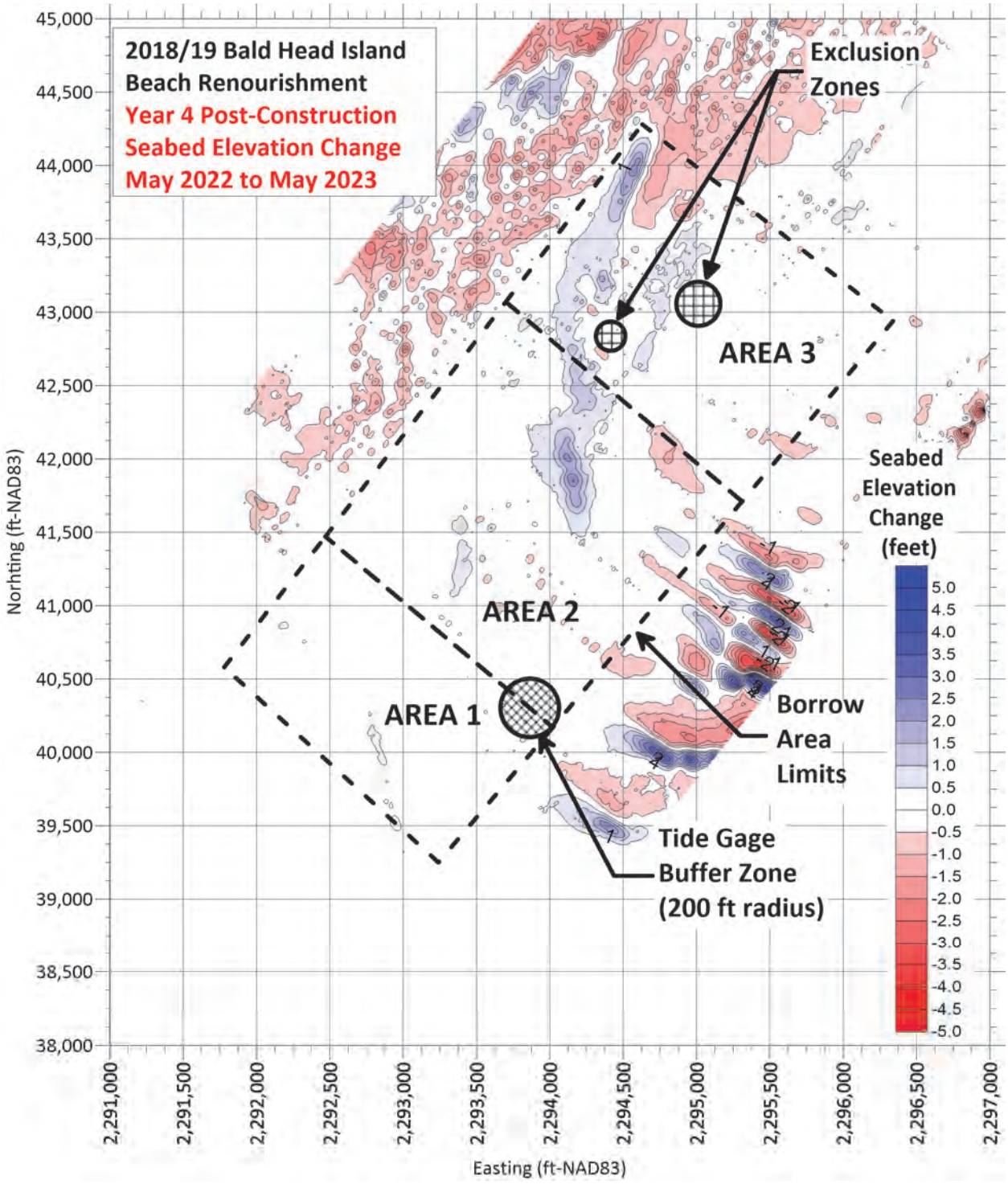


Figure 4.2: Jay Bird Shoals seabed elevation changes during the Year 4 Post-Construction for the 2018/19 project (May 2022 to May 2023).

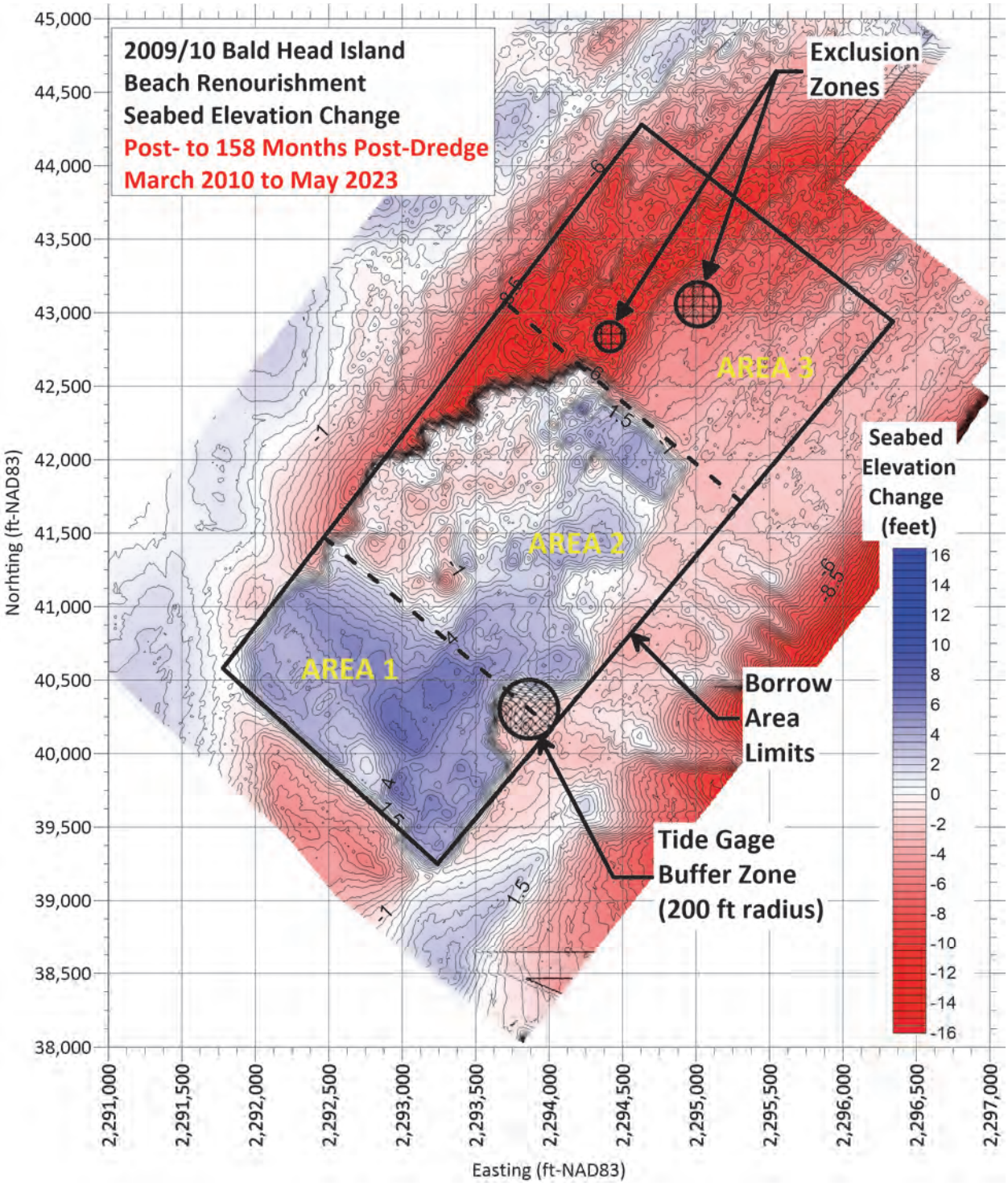


Figure 4.3: Jay Bird Shoals seabed elevation changes since the initial 2009/10 project completion (March 2010 to May 2023).

Table 4.1: Jay Bird Shoals borrow site volume changes *(PERMITTED LIMITS)*.

Survey Period	Duration	Volume Change (CY)		
		Gross Gain	Gross Loss	Net Change
October 2009 to March 2010 (Construction)	5 months	+52,700	-1,888,400	-1,835,700
March 2010 to May 2011 (Year 1 Post-Construction)	14 months	+307,200	-104,800	+202,400
May 2011 to May 2012 (Year 2 Post-Construction)	12 months	+112,700	-107,200	+5,500
May 2012 to May 2013 (Year 3 Post-Construction)	12 months	+178,700	-77,600	+101,100
May 2013 to April 2015 (Years 4 & 5 Post-Construction)	23 months	+286,000	-217,100	+68,900
April 2015 to May 2017 (Years 6 & 7 Post-Construction)	25 months	+144,900	-328,500	-183,600
May 2017 to May 2018 (Year 8 Post-Construction)	12 months	+136,800	-71,400	+64,400
May 2018 to September 2018	4 months	+24,400	-246,300	-221,900
September 2018 to December 2018	3 months	+188,700	-5,400	+183,300
December 2018 to March 2019 (BD/AD 18/19 Project)	3 months	+63,700	-1,229,300	-1,165,600
March 2019 to May 2020 (Year 1 Post-2018/19)	14 months	+239,200	-105,600	+133,600
May 2020 to May 2021 (Year 2 Post-2018/19)	12 months	+199,000	-121,800	+77,300
May 2021 to May 2022 (Year 3 Post-2018/19)	12 months	+150,300	-11,800	+138,500
May 2022 to May 2023 (Year 4 Post-2018/19)	12 months	+56,000	-39,700	+16,300
Since 2009/10 Construction (March 2010 to May 2023)	160 months	**+2,087,600**	**-2,666,500**	**-579,800**
Since 2018/19 Construction (March 2019 to May 2023)	50 months	**+644,500**	**-278,900**	**+365,700**

Table 4.2: Jay Bird Shoals borrow site theoretical volume available above -22 ft-NGVD.

Survey	Volume above -22 ft-NGVD (CY)			
	Area 1	Area 2	Area 3	Total
October 2009 (Pre-2009/10 Excavation)	812,200	1,593,100	1,330,000	**3,735,300**
March 2010 (Post-2009/10 Excavation)	89,100	540,900	1,291,600	**1,921,600**
May 2011 (1 Year Post-2009/10)	157,900	685,600	1,275,500	**2,119,000**
May 2012 (2 Years Post-2009/10)	154,900	734,400	1,237,900	**2,127,200**
May 2013 (3 Years Post-2009/10)	186,300	844,000	1,200,200	**2,230,500**
April 2015 (5 Years Post-2009/10)	232,300	992,800	1,081,500	**2,306,600**
May 2017 (7 Years Post-2009/10)	289,300	942,100	898,800	**2,130,200**
November 2017 (7.5 Years Post-2009/10)	297,400	969,600	923,000	**2,190,000**
May 2018 (8 Years Post-2009/10)	315,200	966,400	912,800	**2,194,400**
September 2018 (8.5 Years Post-2009/10)	318,600	862,600	800,000	**1,981,200**
December 2018 (Pre-2018/19 Excavation)	355,000	945,200	858,900	**2,159,100**
March 2019 (Post-2018/19 Excavation)	398,700	332,900	286,200	**1,017,800**
May 2020 (1 Year Post-2018/19)	383,000	356,600	410,900	**1,150,500**
May 2021 (2 Year Post-2018/19)	387,700	379,000	464,000	**1,230,700**
May 2022 (3 Year Post-2018/19)	407,400	447,700	508,000	**1,363,100**
May 2023 (4 Year Post-2018/19)	406,500	464,200	509,300	**1,380,000**

5.0 ONGOING PLANNED OR PROPOSED ACTIVITIES

5.1 Jay Bird Shoals Borrow Site Expansion Area

The Village of Bald Head Island is currently pursuing a modification to CAMA 91-14 and USACE No. SAW-2012-00040 to expand a portion of the previously developed Jay Bird Shoals borrow site. The intended project volume required is estimated at approximately 1 Mcy. Details of the proposed expansion area including geotechnical and cultural resource analyses are available in the Jay Bird Shoals Borrow Site Expansion Analysis (Olsen 2022). **Figure 4.4** depicts the location of the proposed expansion area located to the northwest of the original permitted site. As of the May 2023 survey, there are approximately +1,468,100 cy of material theoretically available within the proposed expansion area above -22 ft-NGVD.

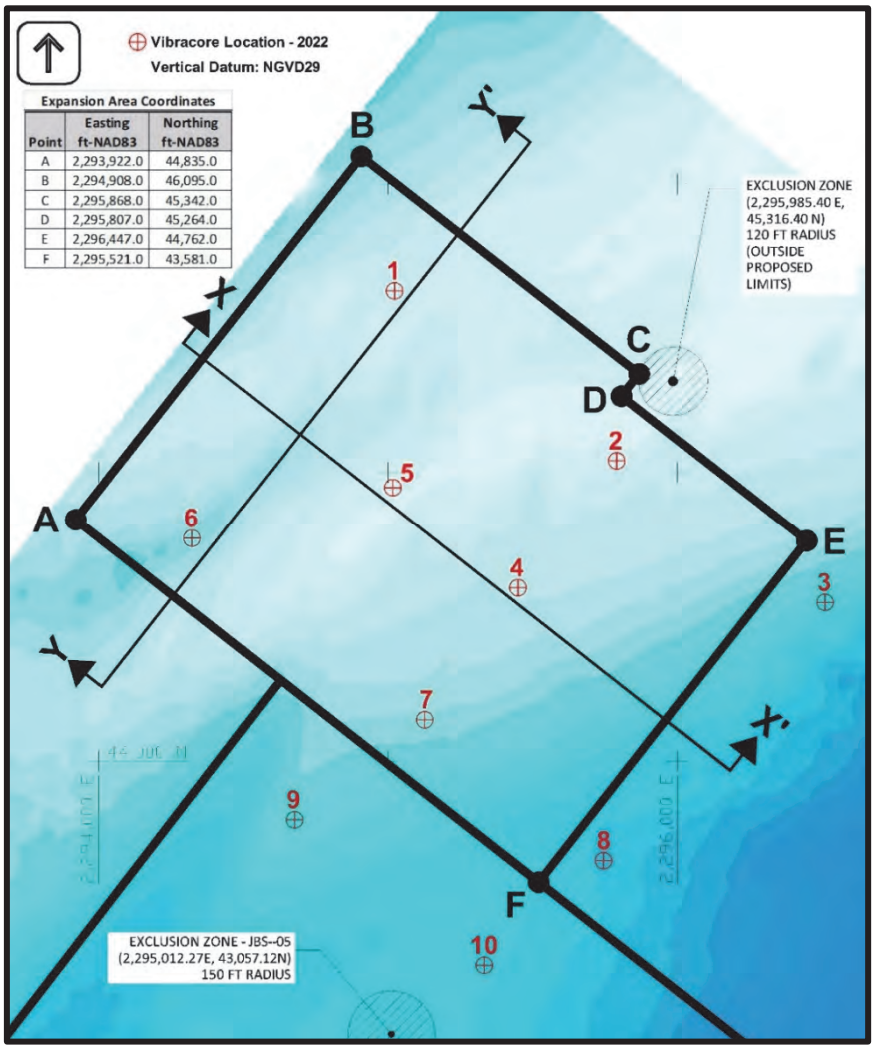


Figure 5.1: Jay Bird Shoals proposed expansion area.

5.2 Withdrawal of a Permit for a Frying Pan Shoals Borrow Site

In early 2017, the Village submitted permit applications with associated in-depth geotechnical studies and environmental analyses necessary to develop a long-term (and large scale) borrow site located within Frying Pan Shoals. The purpose of such a borrow site was to ensure compliance with Permit conditions necessitating the maintenance of the updrift fillet associated with the 2015 terminal groin project and to allow for large-scale beach renourishment of South Beach. Historically, sand placement from an alternate site has been required due to the scheduled hiatus in the disposal of channel maintenance sand on Bald Head Island by the Wilmington District, USACOE. To that end, pursuant to the existing tenets of the Wilmington Sand Management Plan, all beach quality channel maintenance material to be excavated in the spring of 2025 is to be placed at Oak Island. This action will necessitate a borrow site for excavation and fill placement by the Village during a 4 to 5 year hiatus.

In June 2017, the National Marine Fisheries Service (NMFS) issued concerns related to permits associated with the near-term use of the Frying Pan Shoals (FPS) borrow site *without first exploring and exhausting other viable sand source alternatives.* Realistically, the only alternate borrow area available for near-term sand placement at Bald Head Island (BHI) was sand remaining in the previously permitted Jay Bird Shoals (JBS) borrow site. Accordingly, in consideration of the NMFS request, the Village agreed to withdraw their application and prioritize the use of the previously authorized borrow site permitted at JBS (including both a partially "recovered" area dredged in 2009/10 and the remaining undredged portion of the borrow site). With the virtual depletion the Jay Bird Shoals borrow site, resulting from the 2018/19 renourishment project, the Village has reinitiated the permitting of a long-term borrow site located within Frying Pan Shoals in 2019. At the request of the Wilmington District, USACOE, Regulatory Branch, the permit request has been submitted as a modification of the 2015 Terminal Groin permit. By early 2022, the permit application continued to be in the RAI stage with fisheries "concerns" being a major hurdle to permit issuance. In April 2022, the Village acknowledged that the ongoing fisheries issue would not be readily resolved without seeking a Variance from the CRC. To that end, regulatory agencies recommended the prioritization of the use of Jay Bird Shoals over the use of Frying Pan Shoals for the next Village renourishment project. Accordingly, the Village authorized the necessary studies required to seek a Permit to expand the Jay Bird Shoals borrow site for purposes of providing sand for the next Village sponsored beach fill project.

5.3 Wilmington Harbor Navigation Project

In early 2023, the Wilmington District, USACE performed a routine navigation channel maintenance operation for the Smith Island Range as well as Bald Head Reaches 1 and 2. All beach compatible material excavated was placed on South Beach, Bald Head Island. The contract volume dredged was about 1.3 Mcy, mol. An estimate of the in-place volume at Bald Head Island was about 1.1 Mcy, mol. At the time of disposal, the sand tube groin field was again buried in its entirety below the beach disposal project berm. The District will schedule the next channel maintenance project disposal to be placed along Oak Island.

5.4 Wilmington Harbor Deepening Project

In 2019, the Port of Wilmington, NC both sponsored and formulated a Section 203 Report which proposes a plan to deepen and widen (in places), the Federal navigation project, which extends from the Atlantic Ocean up the Cape Fear River to the Port of Wilmington. The Village of Bald Head Island has formally submitted comments to the record which address deficiencies in the project analyses and which request clarification to impacts addressed or unaddressed by the consultant prepared report. No responses or additional information were received by the Village over the last 12 month period. In 2023, the Wilmington, USACE District has initiated the various environmental studies, E.I.S., and permitting. During the NEPA process the Village will again submit comments to that regard.

6.0 SUMMARY AND CONCLUSIONS

The most recent Wilmington Harbor Inner Ocean Bar maintenance dredging of Bald Head Shoal Channel Ranges 1 and 2, and the Smith Island Channel range was performed in the months of December 2022 – March 2023. Federal surveys show approximately 1.3 Mcy of sand during that operation were dredged with placement along South Beach pursuant to the terms of the Wilmington Harbor Sand Management Plan (WHSMP). The estimated "final" in-place fill volume measured was somewhat less (by 10-15%). Oak Island will be the recipient of the next tentatively scheduled 2025 beach disposal operation in accordance with the continued implementation of the present day WHSMP. As a result, the Village is planning for a locally constructed project in our about 2025 or 2026. The last sand placement project constructed by the Village was between 13 January 2019 and 22 March 2019. The borrow site for that project was Jay Bird Shoals. The final fill volume (in-place) was 1.1 Mcy which included the addition of a Post-Florence FEMA Claim for documented storm related losses from the *engineered beach* in September 2018 (Olsen 2018). The limits of that fill extended eastward only to Sta. 146+00 on South Beach.

It is anticipated that the next Village sponsored project (in 2025 or 2026) will seek to place approximately 1 Mcy total along two (2) sections of shoreline located at the opposite ends of South Beach. The easternmost segment of approximately .5 Mcy is intended to briefly address the chronic erosion that's been occurring for a number of years in the vicinity of the Shoals Club at Cape Fear. On the western end of South Beach an additional .5 Mcy fill will address the filling of the terminal groin template as well as the section of shoreline extending throughout the limits of the sand tube groinfield. Subsequent to fill placement, it is currently planned to remove and replace sandtube groins which have reached the end of their effective life. The groinfield was last replaced in its entirety in 2019 concurrent with the Village renourishment project. It will need to be readdressed similarly with the next Village project. For purposes of constructing the tentatively upcoming 2025 or 2026 (1 Mcy) Village renourishment project, a pre-existing (but depleted) borrow site at Jay Bird Shoals needs to be expanded to the north.

By about 2013, the results of a comprehensive annual beach monitoring program initiated in 2000 by the Village of Bald Head Island yielded the conclusion that sand placement alone could *not* successfully offset navigation channel impacts to the west end of South Beach which had been typically manifest in chronic rates of erosion and a consistent northerly post-fill recession of the shorefront. Accordingly, the Village was ultimately forced to "change the existing dynamic" by constructing a single terminal groin designed to complement the placement of future beach fills at the persistent South Beach erosional "hot spot". The project was permitted to be constructed in two phases – with Phase 2 being optional. Simplistically, the structure was designed to serve as a "template" for fill material placed eastward thereof on South Beach. The Phase 1 1,300 ft. long terminal groin (completed in Nov. 2015), was designed

however as a "leaky" structure (*i.e.* semi-permeable) so as to provide for some level of continued sand transport to West Beach and portions of the Point (located both westward and northward of the groin stem). Through May 2023, terminal groin project performance – based upon post-construction monitoring – has been both as intended – and as predicted.

Between November 2000 and March 2023, Bald Head Island had received up to 9.9 Mcy, mol of sand from the initial widening/deepening and six (6) subsequent maintenance dredging operations for the Wilmington Harbor Navigation Project entrance channel. Including the 2019 project, the Village has placed another 3.2 Mcy of sand along the West Beach and South Beach shorelines. Accordingly, in the net Bald Head Island has experienced a total *estimated* sand placement volume of approximately 13.1 Mcy since 2000 at those two locations – with South Beach todate receiving 97% or more of the total.

Conversely, the *gross* volumetric sediment *loss* over a November 2000 to May 2023 (post-disposal) monitoring timeframe is conservatively computed at -8,801,300 Mcy, or approximately 391,168 cy per year – on "average". This annualized "loss" addresses the continuous section of Bald Head Island shorefront extending from the marina entrance to the Cape Fear spit. The assignment of an *average annual* long-term rate of sand loss at Bald Head Island however, has *not* necessarily been a meaningful indicator of navigation project impact. Such an average rate is often temporally biased by periods of beach fill equilibration, groinfield "effectiveness due to reconstruction," major storm events (such as Hurricanes Florence, Dorian and Isaias), the occurrence of episodic destabilization dredging events in close proximity to the island, as well as other physiographic phenomena temporally affecting annualized quantities of alongshore sediment transport – from Bald Head Island. In addition, the westernmost segment of the island's littoral system has had to adjust to the quasi-stabilizing effect of the terminal groin at that location in existence only since 2015. Along South Beach per se, there has historically existed a "nodal point" some 7,000 ft. eastward of the terminal groin (approx. STA 116+00). At or close to the nodal point, the directionality of *net littoral transport* on an annual basis changes from West (toward the groin) to East (toward Cape Fear). *Note* – depending on wave climatology, the condition and exposure of the sand tube groinfield, as well as other factors, the effective location of the nodal point can vary slightly along South Beach from year to year. As of May, 2023, within the 22,755 ft of shoreline influenced by sand episodically placed since 2000, up to 4,282,500 cy remain in the littoral system (measured above elevation -16 ft. NGVD 29). This *includes* the most recent beach disposal project completed in early 2023 by the Wilmington District, USACE.

Although not directly impacted by long-term navigation channel improvements and maintenance of the Cape Fear River entrance, the Village Council elected to initiate monitoring of the East Beach shorefront at Bald Head Island beginning in November 2008. Since that time, it is documented that East Beach can undergo strong seasonal variations of beach width and

profile volume to a large degree dependent upon storm frequency and intensity, as well as the ever-changing configuration of the Cape Fear spit. For example, the most recent May 2023 survey data show a net shoreline volumetric gain of approximately +18,400 cy (above elevation -16 ft NGVD). throughout the 6,000 ft East Beach shoreline lying northward of Cape Fear over the last 12 months. In the prior year, it had changed only by about +12,600 cy. Between November 2008 and May 2023, the total change had been +381,100 cy. Most of the volume increase had been caused by post-storm accretion of the Cape Fear spit shoreline fronting Onslow Bay.

Typically, periods of episodic accretional configurations of the Cape Fear spit deemed beneficial to East Beach have corresponded to a high rate of erosion and duneline recession along the easternmost section of South Beach – directly seaward and westward of the Shoals Club facility. For example, between 2000 and 2020, the average MHWL erosion rate at that general location has been over -20 ft/yr – due to sand losses either directly or indirectly associated with the configuration of the Cape Fear spit formation. Although a 2021 federal disposal project placed fill within 2,000 ft. mol. of the Shoals Club and Cape Fear, erosion has continued to the point that the Club was required to install a sandbag revetment seaward of the property in May/June 2022. That revetment requires continuing maintenance due to episodic beach profile lowering at that location and the effects of storms.

In 2022, the Village performed monitoring of the Jay Bird Shoals borrow site utilized to construct the non-federal 1.85 Mcy beach fill sponsored by the Village in 2009/10 and the 1.10 Mcy beach constructed in 2018/19. During the Year 12 monitoring period (May 2022 to May 2023), the fourth year following the 2018/19 project excavation, the entire permitted borrow site gained +16,300 cy (inclusive of the exclusion and buffer zones). As of May 2023, there is theoretically +1,380,000 Mcy of material located within the *permitted borrow site limits* above the permitted cut elevation (-22 ft-NGVD). Most of that material is *not* however practically available for dredging at this time. Hence, an extension of the original JBS borrow site limits will be required to act as a fill source for the next Village beach fill project in 2025 or 2026.

After an extension of the two marina entrance channel jetties in 2015, temporarily reduced shoaling within the navigation channel resulted in a corresponding reduced volume of disposal sand being place along the Row Boat Row shoreline. Although the Village had planned to continue to proactively bypass sand from the south jetty fillet (located at the distal end of West Beach) to the Row Boat Row shorefront, it became clear that the existing four (4) low level timber groins were not capable of providing an acceptable level of shoreline stabilization at that location.

Hence, near the end of the 2017 monitoring period, the Village initiated construction of two (2) shore parallel detached rock breakwaters located north of the marina entrance seaward of the Row Boat Row shoreline. The placement of breakwaters between existing groins northward of the marina entrance was intended to combine the attributes of each of the two types of stabilization structure so as to reduce the rate of sediment transport from the eroding shoreline caused principally by ferry/barge generated waves. The subject expanded shore stabilization project (detached breakwaters *and* existing groinfield) was designed to have a sand fill prior to construction. The source of the fill was the exiting Bald Head Creek borrow area. A previously permitted Bald Head Creek borrow area was dredged in early 2017 by Marcol Dredging. Some 26,000 cy were placed at Row Boat Row prior to breakwater implementation. Since that time multiple channel maintenance/sand bypass operations have occurred – most with increasing volumes dredged. Typically, dredging is required twice a year on average. This is primarily due to an increasing northerly rate of sediment transport along West Beach caused by a continuing reconfiguration of the Point. As a result, the Village has been forced to perform an increased frequency of bypassing of sand farther northward of the stabilizing influence of the breakwaters. This required a 2020 modification of the permits associated with the limits of allowable beach disposal seaward of Row Boat Row.

In the spring of 2019, the Village resubmitted permit applications accompanied by indepth geotechnical studies and environmental analyses intended to develop a long term (and large scale) supplementary borrow site located within Frying Pan Shoals. The purpose of such a borrow site would be to both ensure compliance with Permit conditions necessitating the maintenance of the updrift fillet associated with the 2015 terminal groin project and to provide an interim source of beach quality material sufficient to meet future South Beach renourishment requirements – when pursuant to the existing tenets of the Wilmington Harbor Sand Management Plan, beach quality channel maintenance material excavated would be placed at Oak Island. In 2021, a pre-project fisheries monitoring plan was submitted for purposes of addressing regulatory agency concerns. In April 2022, the Village acknowledged certain regulatory "concerns" may not be resolved in the near future. Subsequently, the Village authorized work intended to expand the Jay Bird Shoals borrow site for purposes of providing a sand source for the next Village sponsored fill event – when federal beach disposal is contractually redirected to Oak Island. A pre-consultation meeting for the borrow site expansion was performed in July 2023.

An important secondary precept of the spring of 2019 beach fill project constructed by the Village was to allow for the concurrent replacement of the sand tube groinfield which had become damaged over time. During the spring 2023 federal channel maintenance project, the groin field in its entirety was again covered by beach fill.

The original Permits for construction of the terminal groin at Bald Head Island stipulated that if the permittee elected to dredge more than 250,000 cy from the Jay Bird Shoals borrow site after 2015, limited monitoring of the eastern end of Oak Island must be performed. Accordingly, in November 2018, the Village initiated the requisite monitoring at Oak Island (Caswell Beach). The first report of findings for Oak Island followed a November 2019 monitoring survey. A second year monitoring report was issued in December 2020. In early 2021 it was formally agreed by DCM and the USACOE that based upon the results of the Year 2 report, the *Village's responsibility for continued monitoring of Oak Island has terminated*.

In 2019, the Port of Wilmington, NC (as project sponsor) commissioned the formulation of a Section 203 Report which proposed a plan to deepen and widen (in places), the Federal navigation project, which extends from the Atlantic Ocean up the Cape Fear River to the Port of Wilmington. The Village of Bald Head Island formally submitted several series of comments to-the-record which addressed deficiencies in the project analyses and which requested clarification to impacts addressed, or unaddressed by the consultant prepared report. In June 2023, the Wilmington District, USACOE initiated a Scoping meeting for the Wilmington Harbor 403 Study/EIS.

7.0 REFERENCES

Olsen Associates, Inc. (2003). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 1 (Nov. 1999 – May 2003)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 66 pp plus app. (June 2003).

Olsen Associates, Inc. (2004). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 2 (May 2003 – April 2004)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 51 pp plus app. (August 2004).

Olsen Associates, Inc. (2005). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 3 (May 2004 – April 2005)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 38 pp plus app. (December 2005).

Olsen Associates, Inc. (2006). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 4 (April 2005 – May 2006)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 40 pp plus app. (July 2006).

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

Olsen Associates, Inc. (2007b). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 5 (June 2006 – May 2007)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 37 pp plus app. (December 2007).

Olsen Associates, Inc. (2008). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 6 (June 2007 – May 2008)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 40 pp plus app. (August 2008).

Olsen Associates, Inc. (2009). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 7 (June 2008 – May 2009)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 49 pp plus app. (August 2009).

Olsen Associates, Inc. (2010). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 8 (June 2009 – May 2010)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 64 pp plus app. (August 2010).

Olsen Associates, Inc. (2011). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 9 (May 2010 – May 2011)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 69 pp plus app. (August 2011).

Olsen Associates, Inc. (2012). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 10 (May 2011 – May 2012)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 70 pp plus app. (July 2012).

Olsen Associates, Inc. (2013a). "*Shoreline Stabilization Analysis*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 338 pp. (July 2013).

Olsen Associates, Inc. (2013b). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 11 (May 2012 – May 2013)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 63 pp plus app. (August 2013).

Olsen Associates, Inc. (2014). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 12 (May 2013 – May 2014)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 63 pp plus app. (August 2014).

Olsen Associates, Inc. (2015). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 13 (May 2014 – May 2015)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 65 pp plus app. (June 2015).

Olsen Associates, Inc. (2016). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 14 (April 2015 – April 2016)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 80 pp plus app. (June 2016).

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

Olsen Associates, Inc. (2017). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 15 (April 2016 – May 2017)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 80 pp plus app. (June 2016).

Olsen Associates, Inc. (2018a). "*Bald Head Island, N.C. Beach Monitoring Program Report No. 16 (May 2017 – May 2018)*", Report prepared for Village of Bald Head Island. Olsen Associates, Inc. 2618 Herschel St., Jacksonville, FL 32204. 69 pp plus app. (July 2018).

Olsen Associates, Inc. (2018b). "Documentation for the Village of Bald Head Island, N.C., Engineered Beach Project", Olsen Associates, Inc., 2618 Herschel St., Jacksonville, FL 32204. 18 pp plus app. (September 2018).

Olsen Associates, Inc. (2019). "Village of Bald Head Island; 2018-2019 Beach Renourishment Project: Post-Construction Report", Olsen Associates, Inc., 2618 Herschel St., Jacksonville, FL 32204. 36 pp plus app. (April 2019).

Olsen Associates, Inc. (2019,b). "Bald Head Island, N.C.; Beach Monitoring Program Report No. 17 (May 2018 to May 2019)", Report Prepared for Village of Bald Head Island. Olsen Associates, Inc., 2618 Herschel St., Jacksonville, FL 32204. 81 pp plus app. (July 2019).

Olsen Associates, Inc. (2019,c). "Terminal Groin Project – Inlet Management Plan – Oak Island Monitoring (November 2018 to November 2019)", Report Prepared for Village of Bald Head Island. Olsen Associates, Inc., 2618 Herschel St., Jacksonville, FL 32204. 18 pp plus app. (December 2019).

Olsen Associates, Inc. (2020,c). "Village of Bald Head Island; Beach Monitoring Program, Report No. 18 (May 2019 to May 2020)", Report Prepared for Village of Bald Head Island. Olsen Associates, Inc., 2618 Herschel St., Jacksonville, FL 32204. 65 pp plus app. (July 2020).

Olsen Associates, Inc. (2022,a). "Village of Bald Head Island; Beach Monitoring Program, Report No. 20 (May 2021 to May 2022)", Report Prepared for Village of Bald Head Island. Olsen Associates, Inc., 2618 Herschel St., Jacksonville, FL 32204. 66 pp plus app. (July 2022).

Olsen Associates, Inc. (2022,b). "Village of Bald Head Island; Jay Bird Shoals Borrow Site Expansion Investigation", Report Prepared for Village of Bald Head Island. Olsen Associates, Inc., 2618 Herschel St., Jacksonville, FL 32204. 22 pp plus app. (October 2022).

Tidewater Atlantic Research, Inc. (2017). "A Remote Sensory Survey and Anomaly Assessment Investigation 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. 22 pp plus app (30 November 2017).

USACOE (2000). "*Environmental Assessment – Wilmington Harbor, N.C.*", U.S. Army Corps of Engineers, Wilmington District. (February 2000).

USACOE, (2011a). Draft – "*Physical Monitoring, Wilmington Harbor Navigation Project, Report 8: October 2009 – September 2010*", U.S. Army Corps of Engineers, Wilmington District, January, 2011.

USACOE (2011b). "*Draft – Reevaluation Report, Sand Management Plan, Wilmington Harbor Navigation Project*", U.S. Army Corps of Engineers, Wilmington District. (January 2011).