

Photo Date: 9 May 2018



# Bald Head Island, N.C. Beach Monitoring Program

## Monitoring Report No. 16 (May 2017 to May 2018)

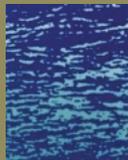
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July 2018



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**BALD HEAD ISLAND, N.C.**  
**Beach Monitoring Program**  
**Report No. 16**  
**(May 2017 – May 2018)**

**EXECUTIVE SUMMARY**

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The most recent Wilmington Harbor Inner Ocean Bar maintenance dredging of Bald Head Shoal Channel Reach 2, and the Smith Island Channel segment is scheduled to be initiated in the summer months of May/June 2018. Approximately 1.15 Mcy of sand excavated during that operation will be placed at Oak Island pursuant to the terms of the Wilmington Harbor Sand Management Plan (WHSMP). The Contractor selected by the Wilmington District, USACOE is Weeks Marine, Inc. The Base Contract cost is \$14.1 M.

Subsequent to federal beach disposal on Oak Island in the summer of 2018, Bald Head Island will be the recipient of the next two *future* beach disposal operations in accordance with the continued implementation of a present day WHSMP. Prior to that time (the next disposal is *estimated* to be spring of 2021) the need to offset annual erosional losses at South Beach on Bald Head Island, as well as to maintain the updrift fillet of the terminal groin constructed in 2015, have necessitated that the Village design and permit a 1 Mcy *interim* beach fill project. The latter will be constructed between November 1, 2018 and April 1, 2019. Bids are tentatively set to be received on 18 July 2018. The project borrow site will be Jay Bird Shoals.

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 have been typically manifest in chronic rates of erosion and a consistent northerly 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 beach fill 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 2018, terminal groin project performance – based upon monitoring – has been both as intended – and as predicted.

To that end, the most recent beach monitoring surveys performed in 2017/18, indicate that the terminal groin's updrift fillet contains approximately 250,000 cy. Without the structure, the significantly improved shoreline at this location resulting from federal beach disposal completed in April 2015 would have normally eroded back to the dune line with the residual sand fillet volume lost to the Cape Fear River channel. Interestingly, federal channel condition surveys performed by the USACOE in the spring prior to the summer of 2018 maintenance project indicated that no maintenance dredging was required this year in Bald Head Reach 1 – the section of channel immediately adjacent to the terminal groin. Until recently, this section of navigation channel had experienced chronic shoaling resulting from littoral material derived from South Beach – and in particular beach fill material episodically placed by the Wilmington District, USACOE since 2000, or by the Village itself.

Between November 2000 and April 2015, Bald Head Island had received about 7.0 Mcy, mol of sand from the initial widening/deepening and four (4) subsequent maintenance dredging operations for the Wilmington Harbor Navigation Project entrance channel. In addition, the Village has placed another 2.1Mcy 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 9.1Mcy since 2000 at those two locations – with South Beach receiving some 75-80% of the total.

Conversely, the *gross* volumetric sediment *loss* over the November 2000 to May 2018 monitoring timeframe is conservatively computed at – 6,781,500 cy, or approximately – 387,500 cy per year – on “average”. This “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,” major storm events (such as Hurricane Matthew), 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 island's littoral system is now adjusting to the quasi-stabilizing effect of the terminal groin in existence only since 2015. Along South Beach per se, there has been historically 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. Currently, within the 22,755 shoreline influenced by sand placed since 2000, some 2,301,300 cy remain in the littoral system (measured above elevation -16 ft. NGVD 29).

From the May 2017 to May 2018 monitoring data, it is clear that sediment losses along the various defined sections of shorefront – this year – are substantially less on average than last year. Most noteworthy was the 2017-2018 South Beach one year loss volume (above -16 ft NGVD) of -270,500 cy compared to the 2016-2017 volumetric loss of -619,000 cy. South Beach in this instance is defined as the shorefront between STA 56+00 and STA 210+00.

Similarly, measured sand losses above the MHWL (i.e. from the beach berm only) for the same two periods were reduced from -161,900 cy (2016-17) to -46,000 cy (2017-18). Conversely, losses or gains above -16 ft. NGVD for West Beach, the Point shorefront northward of terminal groin and the Point shoreline southward of the terminal groin were very self-similar for each of the last two monitoring periods analyzed. The 2016-17 losses were to some degree indicative of a shoreline reconfiguration in response to the completion of the terminal groin in late 2015 as well as the equilibration of the 2015 federal beach disposal project.

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 in November 2008. Since that time, it is observed that East Beach undergoes 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. The most recent May 2018 survey data show a net shoreline accretion of approximately 56,400 cy (above elevation -16 ft NGVD) throughout the 6,000 ft East Beach shoreline lying northward of Cape Fear over the last 12 months. Between November 2008 and May 2018, the total change has been +289,000 cy.

Unfortunately, recent configurations of the Cape Fear spit deemed beneficial to East Beach have resulted in a high rate of erosion and duneline recession along the easternmost section of South Beach – directly seaward of the Shoals Club facility. For example, between 2000 and 2018, the average MHWL erosion rate at this general location has been about -13 ft/yr.

In 2017, the Village was required by Permit to perform the 7<sup>th</sup> year of monitoring for the Jay Bird Shoals borrow site utilized to construct the non-federal 1.85 Mcy beach fill sponsored by the Village in 09/10. The computed change within the monitored survey area (excavated and unexcavated) was a *net* gain of approximately 611,600 cy over the 86 month monitoring period following project construction. As noted above, the Village intends to build a 1 Mcy fill project in 2018/19 again utilizing the Jay Bird Shoal borrow site.

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

Hence, during the last monitoring period, the Village initiated construction of two (2) detached rock breakwaters located north of the marina entrance seaward of the Row Boat Row shoreline. The original project proposed four (4) structures. To receive permission to construct during the months of the “moratorium”, the Village was required to reduce the project scope. Final acceptance of the project occurred in July 2017.

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 existing 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. Another 24,000 cy were placed along a portion of West Beach as beach fill.

In the spring of 2017, the Village submitted permit applications accompanied by indepth 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 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 a long-term source of beach quality material sufficient to meet future South Beach renourishment requirements. It was originally anticipated that the borrow site would be needed for limited sand placement along South Beach in 2018/19 between the terminal groin and Sta. 134+00. That conclusion resulted from the scheduled hiatus in the disposal of channel maintenance sand on Bald Head Island by the Wilmington District, USACOE. Pursuant to the existing tenets of the Wilmington Harbor Sand Management Plan, all beach quality channel maintenance material excavated in the summer of 2018 was to be placed at Oak Island.

In June 2017, the National Marine Fisheries Service (NMFS) issued concerns related to 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 JBS borrow site. Accordingly, in consideration of the NMFS request the Village agreed to withdraw their application and to prioritize the use of the previously authorized borrow site permitted at Jay Bird Shoals (JBS) (including both the partially recovered area dredged in 2009/10 and the remaining undredged portion of the borrow site. For purposes of doing so, the Village was instructed to seek modifications to the existing terminal groin permits which had included proposals for renourishment of the shoreline bordering the terminal groin via the use of alternate sand sources – one of which included Jay Bird Shoals. With the anticipated depletion of the Jay Bird Shoals borrow site resulting from the 2018/19 renourishment project, the Village will need to consider reinitiating the permitting of a long term borrow site located within Frying Pan Shoals.

An important secondary precept of the upcoming (2018/19) beach fill project by the Village is to allow for the replacement of 6 or more sand tube groins which have become damaged over time. During renourishment, the groin field in its entirety will be covered by beach fill. This will allow a second contractor to excavate and replace various sand tube groins “in the dry”. Typically, permits necessitate that all such work must be performed in non-turtle nesting months of the year. Existing permits allow for “maintenance” of the sand tube groins as long as their locations and lengths are not modified.

The Permits for construction of the terminal groin at Bald Head Island stipulate that if the permittee elects to dredge more than 250,000 cy from the Jay Bird Shoals borrow site, limited additional monitoring of the eastern end of Oak Island must be performed. At the scheduled time of the next routine island wide survey at Bald Head Island (*i.e.* November 2018), the Village will initiate the requisite monitoring at Oak Island (Caswell Beach).

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**BALD HEAD ISLAND, N.C.**  
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**1.0 INTRODUCTION**

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**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 historical and recent monitoring surveys performed 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) A summary of Bald Head Island's physical setting including a discussion of the Federal Navigation Channel and the status of the Wilmington Harbor Sand Management Plan.
- (2) An overview of historical erosion control activities on Bald Head Island constructed by the Village.
- (3) A discussion of the two (2) Row Boat Row detached breakwaters constructed in 2017.
- (4) Recent volume and shoreline position changes measured between monitoring surveys of May 2017, November 2017 and May 2018 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 was added to the monitoring program in 2015 and which was recently nourished in 2017.
- (5) Measured changes in the Bald Head Creek borrow site dredged in 2016 as the sand source for the West Beach and Row Boat Row beach fills.
- (6) Monitoring results for the Jay Bird Shoals borrow site surveyed in May 2018.
- (7) A discussion of the upcoming 2018/19 Beach Restoration 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).

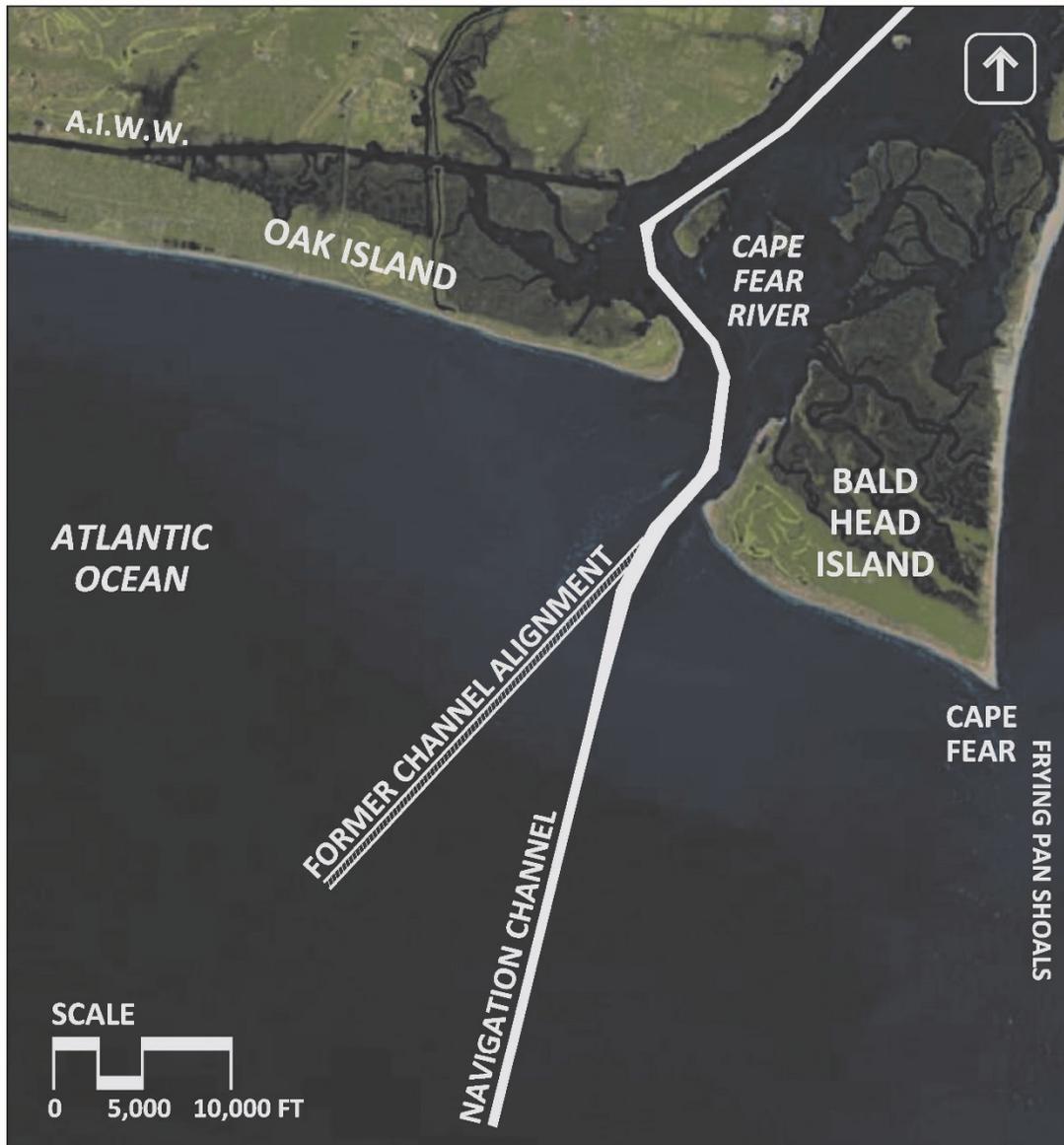
The astronomical tides in the vicinity of Bald Head Island are semi-diurnal and have average mean and spring ranges of approximately 4.3 ft and 5.0 ft, respectively. Tidal datums for Bald Head Island are listed in **Table 1.1** and the predicted astronomical tides during the May 2017 to May 2018 monitoring period are plotted as **Figure 1.2**.

**Table 1.1:** Tidal datums for Bald Head Island, North Carolina<sup>1</sup>.

<b>Datum</b>	<b>Elevation (ft-NGVD29<sup>2</sup>)</b>
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

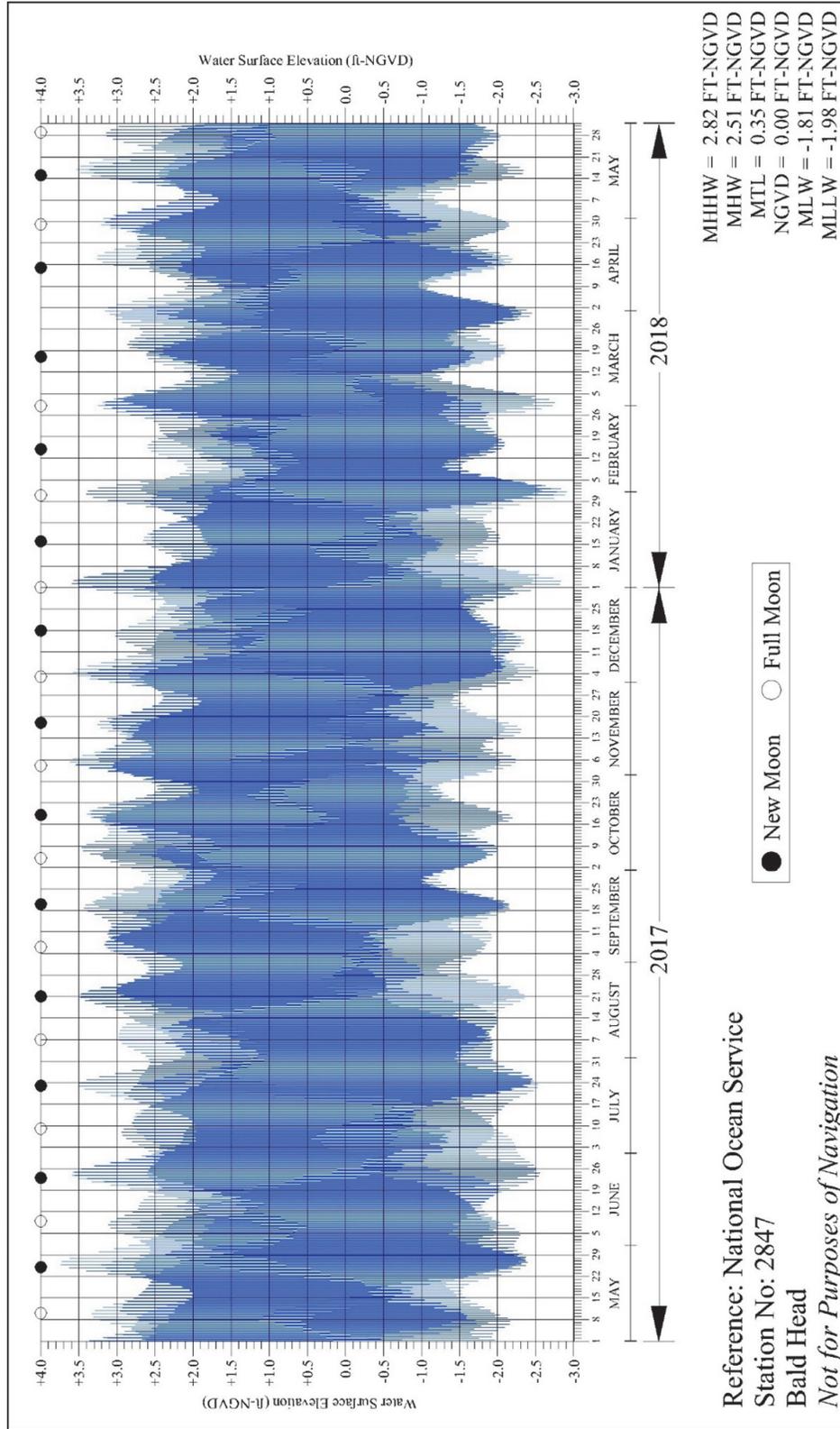
<sup>1</sup> Approximations based upon extrapolation from Southport, N.C.

<sup>2</sup> 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.

# May 2017 through May 2018 Predicted Astronomical Tides Bald Head Island, North Carolina



**Figure 1.2:** May 2017 through May 2018 predicted astronomical tides, Bald Head Island, North Carolina.

### 1.3 Monitoring Period Wave Climate (May 2017 to May 2018)

**Figure 1.3** displays a time series of significant wave heights measured at NOAA Buoy 41108 from May 2017 through May 2018. 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 20+ years except for an approximate five year period between April 1992 and May 1997 and several other periods of lasting a few weeks or less in duration<sup>3</sup>. 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<sup>4</sup> at NOAA Buoy 41108 during the Year 16 monitoring period (May 12, 2017 to May 25, 2018<sup>5</sup>) was 3.43 feet with a maximum wave height of 11.61 ft measured during April 2018 nor'easter. The Year 16 average value is approximately 10 percent higher than the full record average significant wave height of 3.11 feet (March 1988 through May 2018) and 3 percent higher than the Year 15 average wave height (3.33 feet). Note that the Year 15 period included the effects of Hurricanes Hermine and Matthew and while the *average* wave height over the course of Year 15 was slightly lower than Year 16, the maximum wave height experienced that year was significantly higher (18.21 feet, during Matthew) compared to Year 16.

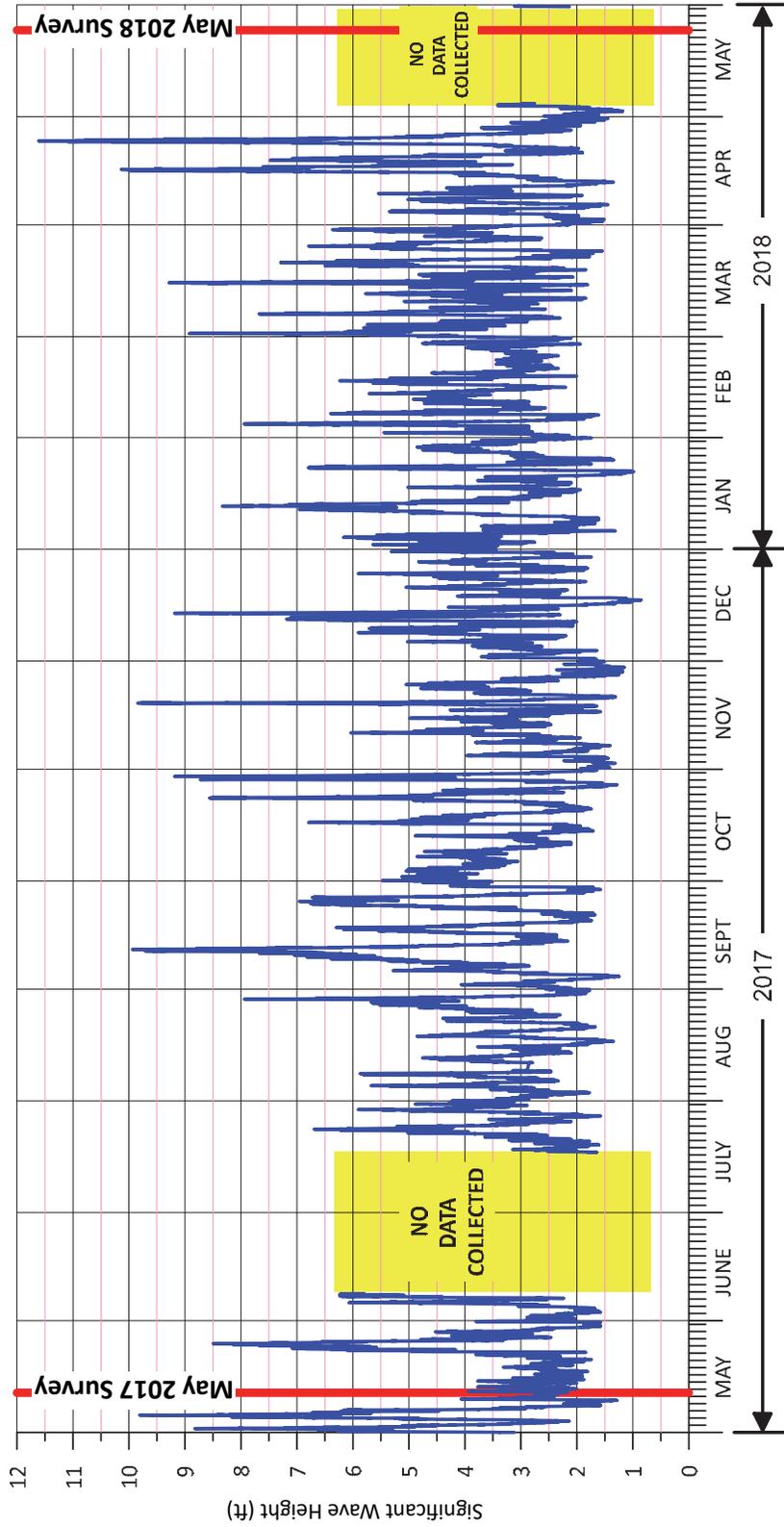
During Year 16 monitoring period, roughly 5.1 percent of the recorded wave heights were above 6 feet, compared to 5.9 percent for the full record average. That is, there were roughly 14 percent fewer wave events recorded above 6 feet during the Year 16 monitoring period than would be expected during a typical similar period of time. Similarly, during the Year 16 monitoring period, the occurrence of waves above 10 feet was slightly lower than the full record average (0.1 percent for Year 16 compared to 0.2 percent for the long-term average). The explanation for the overall more energetic than average wave climate with fewer extreme waves (>8 feet) may be the relatively mild hurricane season coupled with the occurrence of multiple nor'easters during the monitoring period.

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<sup>3</sup> During the Year 16 monitoring period, data was not collected at the buoy between June 8, 2017 and July 17, 2017 as well as May 4, 2018 and May 31, 2018

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

<sup>5</sup> The May 2017 beach profile survey was completed May 12, 2017 and the May 2018 beach profile survey completed on April 25, 2018.



**Figure 1.3:** Significant wave heights recorded by NOAA Buoy 41108 during the 2016-17 monitoring period (Wilmington Harbor, NC).

#### **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 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.

## 1.5 Historical Erosion Control Activities (1991 to 2018)

### 1.5.1 Channel Maintenance Beach Disposal and Beach Restorations

Beach fill placement activities constructed at Bald Head Island since 1991 are summarized in **Table 1.2**. 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/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

\* Disposal pursuant to the WHSMP

### 1.5.2 Erosion Control Structures (1996 to 2018) - Synopsis

Erosion control structures constructed at Bald Head Island since 1996 are summarized in **Table 1.3**. A detailed discussion of the 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.

<b>Year</b>	<b>Location</b>	<b>Description</b>
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 Section 1.5.3 of this report.

### 1.5.3 Row-Boat-Row Shoreline Detached Breakwater Project

The two marina entrance channel jetties located to the south of the Row-Boat-Row shorefront were originally constructed by Bald Head Island, Ltd. (developer), at lengths which over time failed to effectively control shoaling due to northerly directed littoral transport along West Beach. In 2015, the Village of Bald Head Island formally assumed various marina entrance channel and shorefront maintenance responsibilities from the development company. In consideration of the undesirable frequency and cost of channel dredging operations, the Village both permitted (CAMA 208-86) and constructed rock jetty extensions at the ends of the two pre-existing marina entrance channel structures. The purpose of the extended jetties was to reduce chronic channel shoaling, as well as potential temporary closures associated with extreme storm events. The Village sponsored jetty extension project was completed in early 2015.

Historically, high frequency maintenance dredging by Bald Head Island, Ltd. of the marina navigation channel had been required in order to provide reasonably reliable ferry and barge access between the mainland and the island. To complement this activity, “advance dredging” of the West Beach shorefront immediately southward of the south jetty was likewise performed on a routine basis in an attempt to create a “sink” intended to intercept sand before it shoaled the channel. All sand dredged was placed on (i.e. or bypassed northward to) the Row-Boat-Row shorefront. This resulted in a relatively stable beach and dune system at that location through 2014.

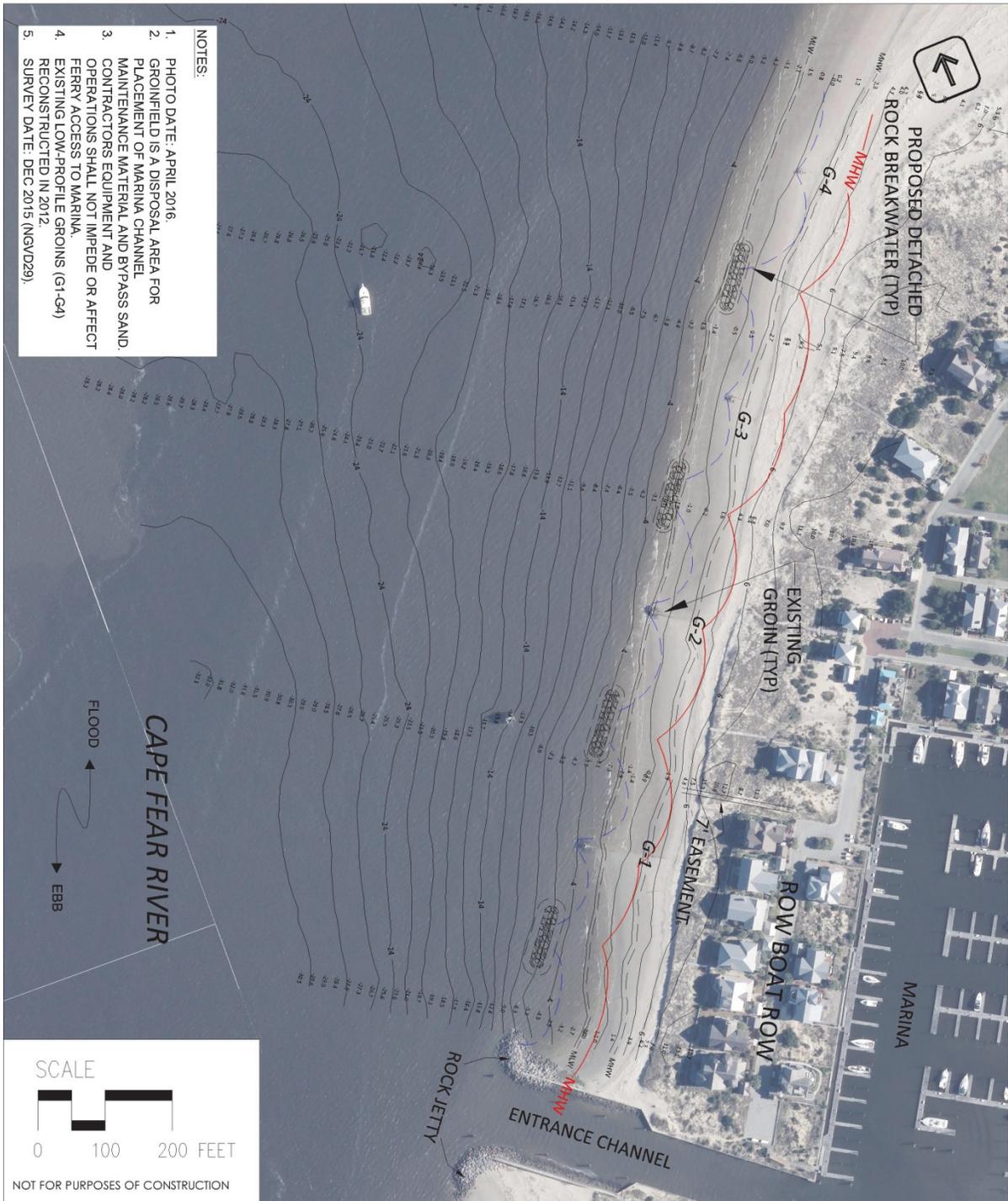
Although the Village had been planning to strategically “bypass” some unspecified quantity of sand from West Beach once or twice a year, it was clear that the existing low profile Row-Boat-Row groinfield was not capable of providing an acceptable level of shoreline stabilization at that location – given a greatly reduced frequency of sand disposal operations. In order to seek a reasonable balance between sand bypass activities and the protection of upland development, as well as to reduce the continuing post-jetty loss of beach and dune resources, additional stabilization measures or remedial actions, were determined to be required seaward of the Row-Boat-Row shorefront.

Hence, breakwaters capable of reducing (or intercepting) vessel generated wave impacts at that location were proposed. The plan was to construct four (4) detached low-profile rock breakwaters – each approximately 90 ft. in length along its crest (114 ft. overall including end slopes). Each detached breakwater was to be constructed between two existing groin structures and sited *below the MHWL* in approximately 2 to 5 ft of water (MLW datum) (see **Figure 1.4**).

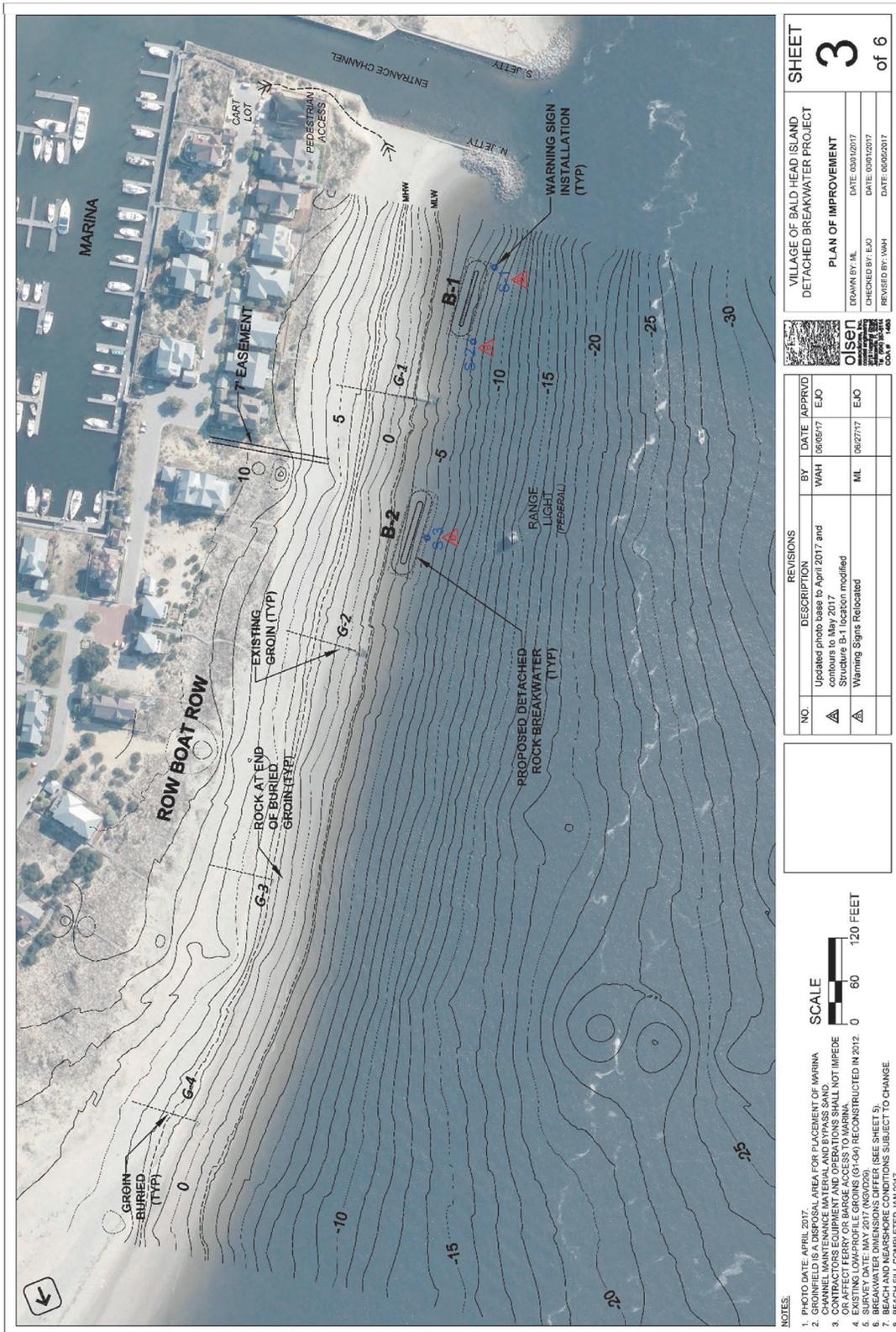
The placement of breakwaters north of the marina entrance was intended to combine the attributes of each of the two types of stabilization structure so as to reduce the rate of

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 placement. The source of the fill was the existing Bald Head Creek borrow area.

A delay in the issuance of the breakwater permits necessitated that the beach fill be constructed first. As noted in **Section 1.5**, roughly 26,000 cy of clean sand fill was placed in early 2017 by Marcol Dredging. Similarly, in order to construct the breakwater project in the fair weather months of 2017 – coincident with a State moratorium of such work – the Village agreed to reduce the project scope to initially place two breakwaters, in lieu of the four (4) originally proposed structures (see **Figure 1.5**). In early 2017, the project was awarded to the firm Intracoastal Marine. Final acceptance of their work occurred in July 2017.



**Figure 1.4:** Original proposed plan for Row-Boat-Row shoreline detached breakwater project.



**SHEET 3 of 6**

VILLAGE OF BALD HEAD ISLAND  
DETACHED BREAKWATER PROJECT

PLAN OF IMPROVEMENT

DRAWN BY: ML DATE: 03/01/2017  
CHECKED BY: EJO DATE: 03/01/2017  
REVISED BY: WAH DATE: 06/26/2017



NO.	REVISIONS	DESCRIPTION	BY	DATE	APPROVED
1	Updated photo base to April 2017 and contours to May 2017	Structure B-1 location modified	WAH	06/05/17	EJO
2	Warning Signs Relocated		ML	06/27/17	EJO

--	--	--	--	--	--

**SCALE**

0 60 120 FEET

- NOTES:**
1. PHOTO DATE: APRIL 2017.
  2. GROINFIELD IS A DISPOSAL AREA FOR PLACEMENT OF MARINA CHANNEL MAINTENANCE MATERIAL AND BYPASS SAND.
  3. EXISTING GROIN (G-1) IS TO BE RECONSTRUCTED IN 2012 OR AFFECT FERRY OR BARGE ACCESS TO MARINA.
  4. EXISTING LOW-PROFILE GROINS (G1-G4) RECONSTRUCTED IN 2012.
  5. SURVEY DATE: MAY 2017. (INGVD29)
  6. BEACH AND NEARSHORE CONDITIONS SUBJECT TO CHANGE. (SEE SHEET 5)
  7. BEACH FILL COMPLETED JAN 2017.

Figure 1.5: Modified plan for Row-Boat-Row shoreline detached breakwater project.

## **2.0 PHYSICAL MONITORING PROGRAM**

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### **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 program onshore and offshore profiles are measured annually at seventy-six (76) stations spaced approximately 400 ft apart along the roughly 31,400 ft of Bald Head Island’s shoreline. **Table 2.2** summarizes the monitoring surveys conducted to date as part of the monitoring program. The primary focus of this monitoring report (No. 16) is beach profile and shoreline changes occurring over the latest set of surveys (May 2017 to November 2017 to May 2018).

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 shoreline. In Chapter 3, 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 2018) 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. Finally, 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.

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

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



**Figure 2.1:**  
Island-wide beach monitoring baseline.

**Table 2.2: Bald Head Island monitoring surveys collected as of May 2018.**

<b>Survey Date</b>	<b>Surveyor</b>	<b>Comments</b>
1999 Nov.	Brunswick Surveying., Inc.	16 months pre-construction (2001 disposal)
2000 Nov.	Brunswick Surveying., Inc.	4 months pre-construction (2001 disposal)
2001 Aug.	Brunswick Surveying., Inc.	1 month post-construction (2001 disposal)
2002 July	Brunswick Surveying., Inc.	12 months post-construction (2001 disposal)
2002 Dec.	Brunswick Surveying., Inc.	17 months post-construction (2001 disposal)
2003 May	Brunswick Surveying., Inc.	22 months post-construction (2001 disposal)
2003 Oct.	McKim & Creed	27 months post-construction (2001 disposal)
2004 Apr.	McKim & Creed	33 months post-construction (2001 disposal)
2004 Oct.	McKim & Creed	39 months post-construction (2001 disposal)
2005 Apr.	McKim & Creed	3 months post-construction (2004/05 disposal)
2005 Nov.	McKim & Creed	10 months post-construction (2004/05 disposal)
2006 Apr	McKim & Creed	15 months post-construction (2004/05 disposal)
2006 Nov.	McKim & Creed	22 months post-construction (2004/05 disposal)
2007 June	McKim & Creed	2 months post-construction (2007 disposal)
2007 Nov.	McKim & Creed	7 months post-construction (2007 disposal)
2008 May	McKim & Creed	13 months post-construction (2007 disposal)
2008 Nov.	McKim & Creed	19 months post-construction (2007 disposal)
2009 May	McKim & Creed	25 months post-construction (2007 disposal)
2009 Sept.	Gahagan & Bryant	Survey required by dredge Contractor.
2010 May	McKim & Creed	2 months post-renourishment (09/10)
2010 Sept.	McKim & Creed	6 months post-renourishment (09/10)
2011 May	McKim & Creed	14 months post-renourishment (09/10)
2011 Sept.	McKim & Creed	18 months post-renourishment (09/10)
2012 May	McKim & Creed	26 months post-renourishment (09/10)
2012 Nov.	McKim & Creed	32 months post-renourishment (09/10)
2013 May	McKim & Creed	38 months post-renourishment (09/10)
2013 Nov.	McKim & Creed	44 months post-renourishment (09/10)
2014 May	McKim & Creed	50 months post-renourishment (09/10)
2014 Nov.	McKim & Creed	56 months post-renourishment (09/10)
2015 April	McKim & Creed	1 month post-construction (2015 Disposal)
2015 Nov.	McKim & Creed	8 months post-construction (2015 Disposal)
2016 April	McKim & Creed	13 months post-construction (2015 Disposal)
2016 Oct.	McKim & Creed	19 months post-construction (2015 Disposal)
2017 May	McKim & Creed	26 months post-construction (2015 Disposal)
2018 Nov.	McKim & Creed	32 months post-construction (2015 Disposal)
2018 May	McKim & Creed	38 months post-construction (2015 Disposal)

**MHWL SUVEYS** 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 will be monitored at 6 months and thereafter annually for the next 3 years. The purpose of the monitoring will be 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 will be 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 will be performed by the firm LMG. The Marcol March 2017 AD Survey will be considered as the baseline condition.

## **2.3 Jay Bird Shoal Borrow Site Surveys**

Permits for the beach renourishment project constructed by the Village in 2009/2010 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 last scheduled borrow site survey was performed in May 2018 for purposes of formulating beach renourishment construction documents. The area surveyed is 400-acres ± which includes a buffer area outside the “permitted” limits of work. The actual work area in 2009/10 utilized only about 2/3 of the permitted area (and associated total dredge volume). As a result, somewhere between 1 and 2 Mcy of beach compatible material continue to exist within the undisturbed portion of the previously permitted and developed borrow area. Part of that area is restricted from excavation due to potential cultural resources.

**Table 2.3:** Jay Bird Shoal borrow site surveys collected as of May 2018.

<b>Borrow Site Survey Date</b>	<b>Comment</b>
October 2009	Before Dredge (BD) Survey
March 2010	After Dredge (AD) Survey
May 2011	14 Months Post-Dredge
May 2012	26 Months Post-Dredge
May 2013	38 Months Post-Dredge
April 2015	61 Months Post-Dredge
May 2017	86 Months Post-Dredge
November 2017	92 Months Post-Dredge
May 2018	98 Months Post-Dredge

#### **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 Independent Mapping Consultants, Inc.<sup>6</sup> **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 (April 2017, November 2017 and April 2018) are presented in **Appendices B, C and D**, respectively.

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<sup>6</sup> Independent Mapping Consultants, Inc.; 3909 Wrightsville Ave. Suite 200; Wilmington, NC 28403.

**Table 2.4:** Bald Head Island monitoring aerial photography collected as of May 2018.

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	1 month 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 (2009/10)
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.)

### 3.0 MONITORING (SURVEY) RESULTS

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#### 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”<sup>7</sup>
- Station 214+00 to 224+80 “Cape Fear Point”<sup>8</sup>
- Station 224+80 to 284+80 "East Beach"

These zones differ slightly from the shoreline segments used in the prior monitoring reports (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.

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<sup>7</sup> 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.

<sup>8</sup> 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 17: Monitoring Program (May 2017 – November 2017– May 2018)**

The May 2017 to May 2018 monitoring period represents the seventeenth 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 2018 survey represents the nominal 8 year post-renourishment shoreline conditions for the +1.84 Mcy project constructed by the Village of Bald Head Island in the winter of 2009/2010.

The period also represents the third year following completion of the 1.33 Mcy 2015 Federal beach disposal, the fifth year following a 2013 disposal event of 1.66 Mcy. This period also represents the thirteenth year of measured shoreline change following the 2005/06 beach disposal, the twelfth year following the placement of +47,800 cy of beach fill along the West Beach shoreline (by the Village) and the eleventh year following the 2007 Federal 978,000 cy beach disposal placed along the South Beach shoreline (Sta. 46+00 to 174+00).

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 2017 – November 2017 – May 2018 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).

**Table 3.1: Bald Head Island shoreline volume change (May 2017 to November 2017).**

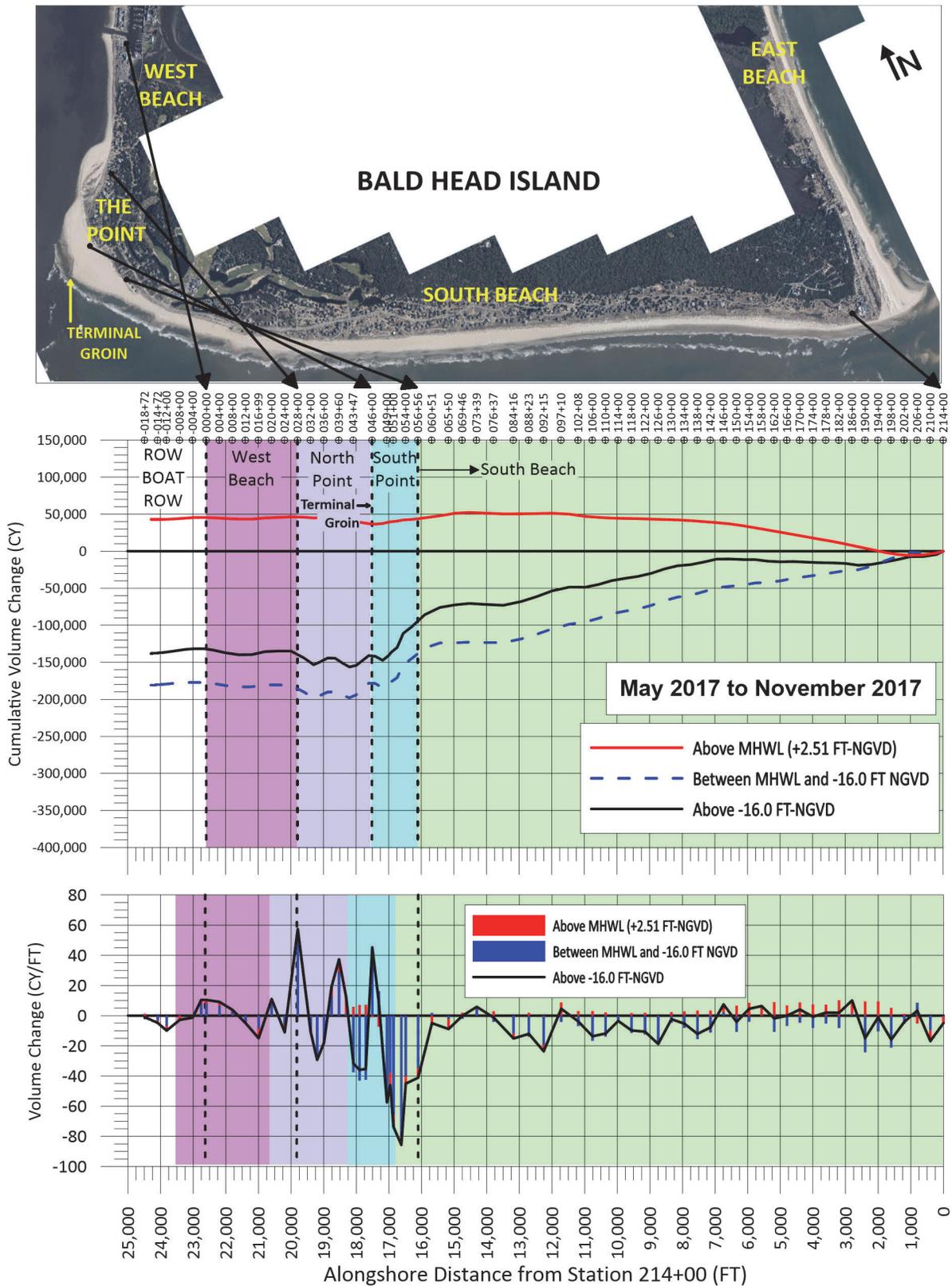
	Start Station	End Station	Reach (FT)	Volume Change		Start Station	End Station	Reach (FT)	Volume Change	
				Above +2.51 (FT)	Above -16 (FT)				Above +2.51 (FT)	Above -16 (FT)
West Beach	Jetty	000+00	160	+400	+1,700	056+56	060+51	423	-2,800	-9,800
	000+00	004+00	400	+1,000	+3,900	060+51	065+50	510	-3,400	-3,500
	004+00	008+00	400	+800	+2,600	065+50	069+46	423	-1,000	-1,900
	008+00	012+00	400	0	-200	069+46	073+39	442	+800	+1,300
	012+00	016+00	400	-1,500	-4,000	073+39	076+37	516	+1,100	+1,200
	016+00	020+00	400	-800	-800	076+37	084+16	611	-100	-5,000
	020+00	024+00	400	-600	0	084+16	088+23	471	-300	-6,400
	024+00	028+00	400	+300	+9,300	088+23	092+15	455	-500	-8,100
	<b>Subtotal</b>	<b>2,960</b>	<b>-400</b>	<b>+12,500</b>	092+15	097+10	536	+1,200	-5,100	
Point (North of Groin)	028+00	032+00	395	+1,100	+9,200	097+10	102+08	525	+3,100	+200
	032+00	034+00	200	-400	-4,000	102+08	106+00	436	+1,300	-3,800
	034+00	036+00	210	-600	-5,000	106+00	110+00	400	+1,000	-5,100
	036+00	038+00	230	+500	+100	110+00	114+00	388	+400	-3,000
	038+00	039+60	230	+1,700	+6,500	114+00	118+00	407	+300	-2,700
	039+60	041+50	220	+2,100	+5,400	118+00	122+00	413	+700	-4,200
	041+50	043+47	220	+1,800	-2,200	122+00	126+00	405	+500	-5,900
	043+47	044+25	190	+1,200	-6,400	126+00	130+00	405	+500	-4,300
	044+25	045+07	190	+1,400	-6,800	130+00	134+00	398	+1,000	-1,500
	045+07	046+00	200	+600	+1,000	134+00	138+00	401	+1,300	-3,500
	<b>Subtotal</b>	<b>2,285</b>	<b>9,400</b>	<b>-2,200</b>	138+00	142+00	400	+1,400	-4,000	
Point (South of Groin)	046+00	046+89	200	-800	+5,400	142+00	146+00	400	+1,700	-100
	046+89	049+00	250	-1,800	-6,100	146+00	150+00	399	+2,400	+700
	049+00	050+50	100	-700	-5,200	150+00	154+00	385	+2,900	+100
	050+50	051+00	100	-800	-6,000	154+00	158+00	383	+2,900	+2,100
	051+00	052+64	240	-1,500	-19,100	158+00	162+00	386	+3,000	+900
	052+64	054+00	135	-700	-8,800	162+00	166+00	393	+3,100	-400
	054+00	056+56	380	-2,200	-16,400	166+00	170+00	394	+3,100	+800
	<b>Subtotal</b>	<b>1,405</b>	<b>-8,500</b>	<b>-56,200</b>	170+00	174+00	400	+3,200	+700	
<b>Note:</b> Elevations are referenced to NGVD 1929.						174+00	178+00	400	+3,000	+300
						178+00	182+00	400	+3,500	+800
						182+00	186+00	400	+3,800	+2,400
						186+00	190+00	400	+3,700	-1,000
						190+00	194+00	400	+3,800	-3,200
						194+00	198+00	400	+2,900	-3,400
						198+00	202+00	400	+1,300	-4,000
						202+00	206+00	400	-800	-200
						206+00	210+00	400	-2,500	-2,700
						210+00	214+00	400	-2,400	-4,400
						<b>Subtotal</b>	<b>16,105</b>	<b>+45,100</b>	<b>-85,700</b>	
						<b>Bald Head Total</b>	<b>22,755</b>	<b>+45,600</b>	<b>-131,600</b>	

**Table 3.2: Bald Head Island shoreline volume change (November 2017 to May 2018).**

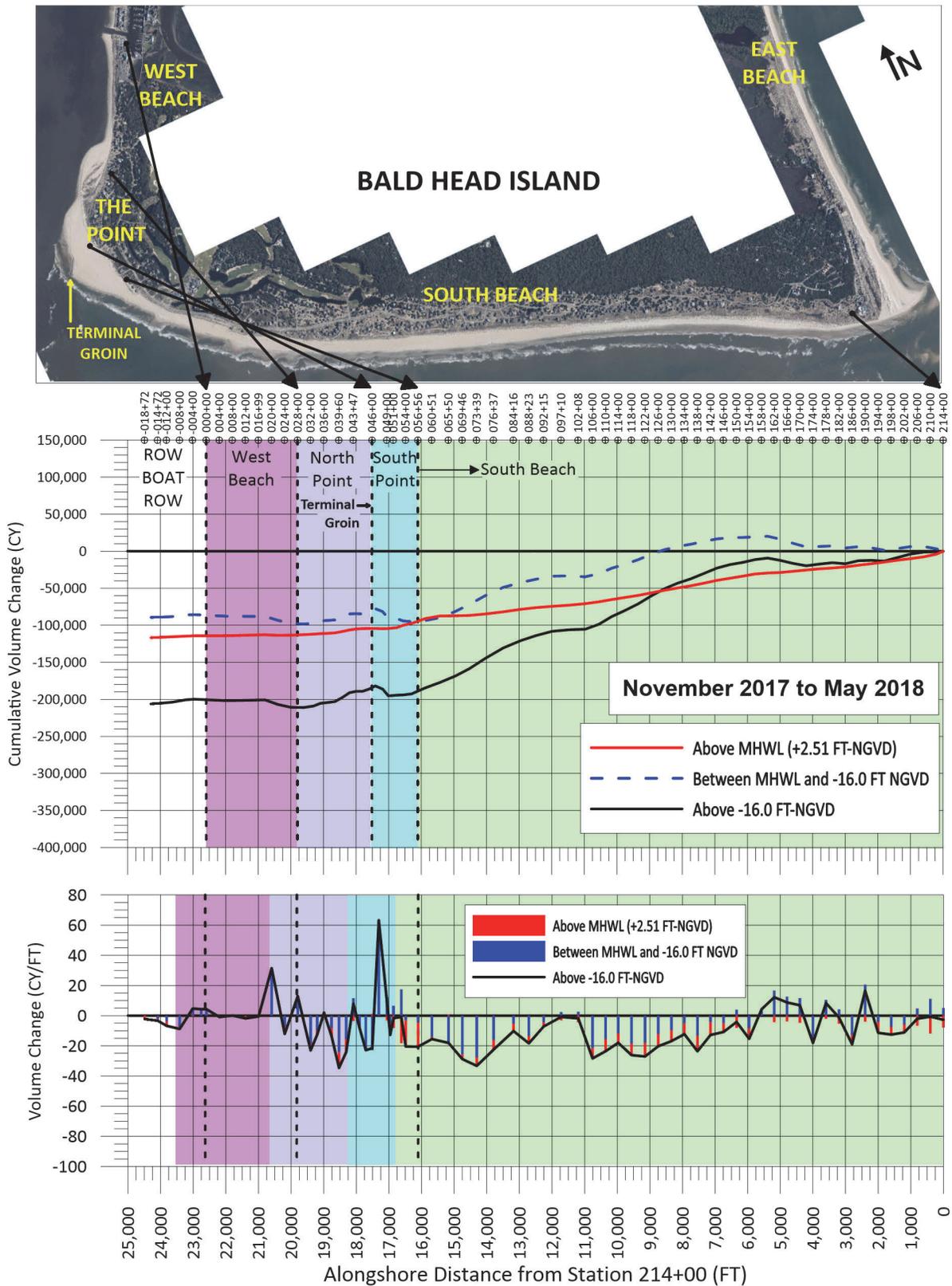
	Start Station	End Station	Reach (FT)	Volume Change		Start Station	End Station	Reach (FT)	Volume Change	
				Above +2.51 (FT)	Above -16 (FT)				Above +2.51 (FT)	Above -16 (FT)
West Beach	Jetty	000+00	160	0	+700	056+56	060+51	423	-3,700	-7,600
	000+00	004+00	400	-200	+700	060+51	065+50	510	-200	-8,600
	004+00	008+00	400	-300	-200	065+50	069+46	423	-500	-9,900
	008+00	012+00	400	-500	-300	069+46	073+39	442	-1,900	-13,700
	012+00	016+00	400	-400	-500	073+39	076+37	516	-3,000	-14,400
	016+00	020+00	400	+800	+6,200	076+37	084+16	611	-3,400	-10,000
	020+00	024+00	400	-200	+3,900	084+16	088+23	471	-2,300	-6,700
	024+00	028+00	400	-800	+200	088+23	092+15	455	-1,700	-5,800
	<b>Subtotal</b>	<b>2,960</b>	<b>-1,600</b>	<b>+10,700</b>	092+15	097+10	536	-1,600	-2,100	
Point (North of Groin)	028+00	032+00	395	-600	-2,000	097+10	102+08	525	-2,000	-700
	032+00	034+00	200	-700	-3,600	102+08	106+00	436	-2,500	-6,600
	034+00	036+00	210	-400	-1,100	106+00	110+00	400	-3,000	-10,400
	036+00	038+00	230	-700	-1,300	110+00	114+00	388	-2,800	-8,100
	038+00	039+60	230	-1,800	-5,500	114+00	118+00	407	-2,800	-9,000
	039+60	041+50	220	-2,100	-6,500	118+00	122+00	413	-3,500	-11,000
	041+50	043+47	220	-1,300	-1,800	122+00	126+00	405	-3,500	-9,600
	043+47	044+25	190	-500	0	126+00	130+00	405	-3,100	-7,500
	044+25	045+07	190	-200	-2,900	130+00	134+00	398	-2,900	-5,800
	045+07	046+00	200	0	-4,400	134+00	138+00	401	-3,500	-7,200
	<b>Subtotal</b>	<b>2,285</b>	<b>-8,300</b>	<b>-29,100</b>	138+00	142+00	400	-3,800	-7,300	
Point (South of Groin)	046+00	046+89	200	+300	+4,200	142+00	146+00	400	-2,900	-4,700
	046+89	049+00	250	-100	+9,100	146+00	150+00	399	-2,800	-3,000
	049+00	050+50	100	-600	-200	150+00	154+00	385	-3,000	-3,800
	050+50	051+00	100	-800	-700	154+00	158+00	383	-1,300	-2,100
	051+00	052+64	240	-3,200	-300	158+00	162+00	386	-700	+3,200
	052+64	054+00	135	-2,400	-1,400	162+00	166+00	393	-1,600	+4,100
	054+00	056+56	380	-6,400	-7,800	166+00	170+00	394	-1,700	+3,100
	<b>Subtotal</b>	<b>1,405</b>	<b>-13,200</b>	<b>+2,900</b>	170+00	174+00	400	-1,600	-2,200	
<b>Note:</b> Elevations are referenced to NGVD 1929.						174+00	178+00	400	-1,100	-1,900
						178+00	182+00	400	-1,500	1,400
						182+00	186+00	400	-2,300	-4,100
						186+00	190+00	400	-2,000	-500
						190+00	194+00	400	-2,300	1,000
						194+00	198+00	400	-2,500	-4,800
						198+00	202+00	400	-2,100	-4,700
						202+00	206+00	400	-2,400	-2,600
						206+00	210+00	400	-3,700	-500
						210+00	214+00	400	-3,900	-700
						<b>Subtotal</b>	<b>16,105</b>	<b>-91,100</b>	<b>-184,800</b>	
						<b>Bald Head Total</b>	<b>22,755</b>	<b>-114,200</b>	<b>-200,300</b>	

**Table 3.3: Bald Head Island shoreline volume change (May 2017 to May 2018).**

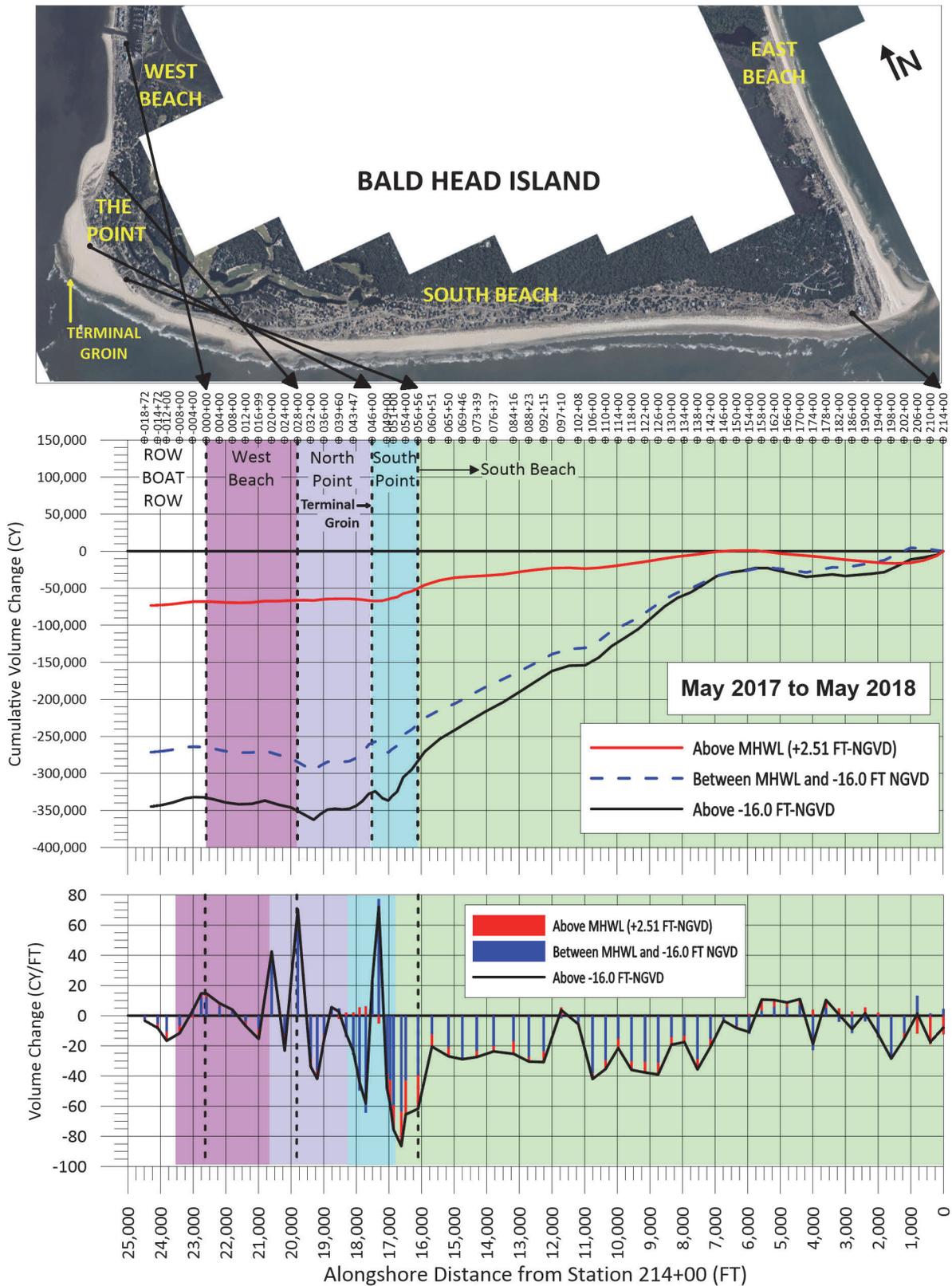
	Start Station	End Station	Reach (FT)	Volume Change		Start Station	End Station	Reach (FT)	Volume Change		
				Above +2.51 (FT)	Above -16 (FT)				Above +2.51 (FT)	Above -16 (FT)	
West Beach	Jetty	000+00	160	+400	+2,400	056+56	060+51	423	-6,500	-17,400	South Beach
	000+00	004+00	400	+800	+4,600	060+51	065+50	510	-3,600	-12,100	
	004+00	008+00	400	+500	+2,400	065+50	069+46	423	-1,500	-11,800	
	008+00	012+00	400	-500	-500	069+46	073+39	442	-1,100	-12,400	
	012+00	016+00	400	-1,900	-4,500	073+39	076+37	516	-1,900	-13,200	
	016+00	020+00	400	0	+5,400	076+37	084+16	611	-3,500	-15,000	
	020+00	024+00	400	-800	+3,900	084+16	088+23	471	-2,600	-13,100	
	024+00	028+00	400	-500	+9,500	088+23	092+15	455	-2,200	-13,900	
	<b>Subtotal</b>	<b>2,960</b>	<b>-2,000</b>	<b>+23,200</b>	092+15	097+10	536	-400	-7,200		
Point (North of Groin)	028+00	032+00	395	+500	+7,200	097+10	102+08	525	+1,100	-500	
	032+00	034+00	200	-1,100	-7,600	102+08	106+00	436	-1,200	-10,400	
	034+00	036+00	210	-1,000	-6,100	106+00	110+00	400	-2,000	-15,500	
	036+00	038+00	230	-200	-1,200	110+00	114+00	388	-2,400	-11,100	
	038+00	039+60	230	-100	+1,000	114+00	118+00	407	-2,500	-11,700	
	039+60	041+50	220	0	-1,100	118+00	122+00	413	-2,800	-15,200	
	041+50	043+47	220	+500	-4,000	122+00	126+00	405	-3,000	-15,500	
	043+47	044+25	190	+700	-6,400	126+00	130+00	405	-2,600	-11,800	
	044+25	045+07	190	+1,200	-9,700	130+00	134+00	398	-1,900	-7,300	
	045+07	046+00	200	+600	-3,400	134+00	138+00	401	-2,200	-10,700	
	<b>Subtotal</b>	<b>2,285</b>	<b>+1,100</b>	<b>-31,300</b>	138+00	142+00	400	-2,400	-11,300		
Point (South of Groin)	046+00	046+89	200	-500	+9,600	142+00	146+00	400	-1,200	-4,800	
	046+89	049+00	250	-1,900	+3,000	146+00	150+00	399	-400	-2,300	
	049+00	050+50	100	-1,300	-5,400	150+00	154+00	385	-100	-3,700	
	050+50	051+00	100	-1,600	-6,700	154+00	158+00	383	+1,600	0	
	051+00	052+64	240	-4,700	-19,400	158+00	162+00	386	+2,300	+4,100	
	052+64	054+00	135	-3,100	-10,200	162+00	166+00	393	+1,500	+3,700	
	054+00	056+56	380	-8,600	-24,200	166+00	170+00	394	+1,400	+3,900	
	<b>Subtotal</b>	<b>1,405</b>	<b>-21,700</b>	<b>-53,300</b>	170+00	174+00	400	+1,600	-1,500		
<b>Note:</b> Elevations are referenced to NGVD 1929.											
						174+00	178+00	400	+1,900	-1,600	
						178+00	182+00	400	+2,000	+2,200	
						182+00	186+00	400	+1,500	-1,700	
						186+00	190+00	400	+1,700	-1,500	
						190+00	194+00	400	+1,500	-2,200	
						194+00	198+00	400	+400	-8,200	
						198+00	202+00	400	-800	-8,700	
						202+00	206+00	400	-3,200	-2,800	
						206+00	210+00	400	-6,200	-3,200	
						210+00	214+00	400	-6,300	-5,100	
						<b>Subtotal</b>	<b>16,105</b>	<b>-46,000</b>	<b>-270,500</b>		
						<b>Bald Head Total</b>	<b>22,755</b>	<b>-68,600</b>	<b>-331,900</b>		



**Figure 3.1:** Volume change along the Bald Head Island shoreline between May 2017 and November 2017.



**Figure 3.2:** Volume change along the Bald Head Island shoreline between November 2017 and May 2018.



**Figure 3.3:** Volume change along the Bald Head Island shoreline between May 2017 and May 2018 (Year 16).

**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				Station	Location Relative to Nov. 2000		
		May 2017	Nov. 2017	May 2018			May 2017	Nov. 2017	May 2018
West Beach	000+00	+96.2	+121.4	+108.5	South Beach	060+51	+42.7	+5.3	+3.0
	004+00	+8.5	+28.1	+18.3		065+50	+50.5	+16.4	+18.8
	008+00	+9.8	+11.8	+9.6		069+46	+91.2	+104.7	+78.5
	012+00	+60.1	+55.7	+45.0		073+39	+159.8	+163.6	+125.3
	016+00	+58.7	+27.7	+26.6		076+37	+132.9	+148.8	+122.9
	020+00	+57.5	+93.1	+55.2		084+16	+165.1	+149.6	+117.3
	024+00	+372.2	+352.0	+342.8		088+23	+154.5	+173.7	+140.6
028+00	+258.1	+220.1	+396.1	092+15		+166.6	+148.4	+128.4	
Point (North of Groin)	032+00	+325.7	+296.1	+255.4		097+10	+93.8	+136.6	+107.6
	034+00	No November 2000 profile				102+08	+74.4	+96.8	+64.7
	036+00	+132.0	+101.4	102.4		106+00	+80.6	+108.4	+69.8
	038+00	No November 2000 profile				110+00	+111.7	+145.3	+86.4
	039+60	+7.6	+26.1	-20.2		114+00	+132.7	+147.6	+104.7
	041+50	No November 2000 profile				118+00	+163.9	+179.2	+128.2
	043+47	-81.9	-32.6	-76.7		122+00	+201.9	+209.7	+151.2
	044+25	No November 2000 profile				126+00	+220.2	+233.6	+188.2
	045+07	-46.0	+22.1	+1.8		130+00	+214.4	+236.0	+191.1
046+00	No November 2000 profile			134+00		+227.4	+251.7	+204.7	
Point (South of Groin)	046+89	+252.2	+250.3	+253.7		138+00	+225.9	+255.5	+189.5
	049+00	No November 2000 profile				142+00	+222.6	+247.6	+204.7
	050+50	No November 2000 profile				146+00	+202.4	+240.7	+178.1
	051+00	No November 2000 profile				150+00	+175.3	+218.0	+174.6
	052+64	+264.9	+225.2	+163.0		154+00	+160.2	+210.8	+171.5
	054+00	No November 2000 profile				158+00	+139.7	+191.6	+162.8
	056+56	+121.8	+79.5	+32.8		162+00	+133.5	+179.1	+151.0
Positive values indicate shoreline advance relative to the pre-construction location. Negative values indicate shoreline erosion and are highlighted in red.						166+00	+142.2	+181.9	+158.0
						170+00	+130.5	+179.7	+146.1
						174+00	+106.2	+161.3	+125.5
					178+00	+121.3	+173.4	+134.7	
					182+00	+125.4	+192.8	+143.3	
					186+00	+117.7	+182.1	+125.9	
					190+00	+116.3	+172.9	+129.3	
					194+00	+119.9	+177.3	+121.2	
					198+00	+105.9	+142.5	+101.0	
					202+00	+104.2	+112.7	+84.9	
					206+00	+23.4	+12.4	-14.6	
					210+00	-35.7	-57.6	-90.5	
214+00	-152.9	-149.5	-198.8						

**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				Station	Location Relative to Nov. 2000		
		May 2017	Nov. 2017	May 2018			May 2017	Nov. 2017	May 2018
West Beach	000+00	+89.4	+108.7	+105.6	South Beach	060+51	+32.9	-6.2	-11.0
	004+00	+7.4	+27.7	+19.8		065+50	+34.4	+19.1	+7.7
	008+00	+8.3	+18.9	+14.6		069+46	+85.0	+83.6	+74.7
	012+00	+15.3	+4.9	+1.1		073+39	+170.2	+160.1	+120.6
	016+00	+35.6	+1.1	+5.4		076+37	+154.2	+150.9	+130.5
	020+00	+88.9	+99.5	+151.2		084+16	+165.3	+145.9	+110.7
	024+00	+367.2	+349.0	+339.2		088+23	+170.0	+174.6	+155.1
	028+00	+148.8	+294.6	+316.1		092+15	+182.9	+141.3	+138.0
Point (North of Groin)	032+00	+253.4	+213.6	+175.3		097+10	+108.9	+131.8	+108.5
	034+00	No November 2000 profile				102+08	+89.2	+93.8	+68.7
	036+00	+68.9	+33.7	+50.6		106+00	+124.3	+110.3	+85.4
	038+00	No November 2000 profile				110+00	+147.5	+131.3	+80.8
	039+60	-59.3	+13.6	-69.8		114+00	+188.0	+148.9	+110.7
	041+50	No November 2000 profile				118+00	+183.3	+179.0	+137.6
	043+47	-179.7	-133.6	-151.3		122+00	+213.2	+210.0	+167.9
	044+25	No November 2000 profile				126+00	+236.1	+228.9	+185.0
	045+07	-50.5	+9.6	+42.1		130+00	+230.8	+239.9	+188.5
	046+00	No November 2000 profile				134+00	+242.2	+254.2	+204.7
Point (South of Groin)	046+89	+289.5	+267.4	+275.1		138+00	+233.0	+240.7	+191.1
	049+00	No November 2000 profile				142+00	+224.7	+240.2	+193.2
	050+50	No November 2000 profile				146+00	+207.5	+224.6	+173.2
	051+00	No November 2000 profile				150+00	+195.3	+201.3	+164.6
	052+64	+254.7	+204.2	+148.1		154+00	+172.6	+192.9	+165.3
	054+00	No November 2000 profile				158+00	+170.0	+178.3	+159.2
	056+56	+105.6	+60.3	+13.7		162+00	+145.3	+162.1	+140.9
						166+00	+146.1	+159.2	+138.5
				170+00		+121.4	+158.5	+131.6	
				174+00		+113.3	+146.9	+128.5	
				178+00	+137.2	+177.6	+164.7		
				182+00	+137.3	+170.1	+150.6		
				186+00	+130.9	+164.0	+130.7		
				190+00	+124.6	+147.4	+131.7		
				194+00	+120.3	+141.8	+117.2		
				198+00	+122.0	+124.3	+96.1		
				202+00	+98.2	+82.3	+64.6		
				206+00	+5.0	-16.3	-39.8		
				210+00	-64.3	-90.1	-122.8		
				214+00	-165.4	-169.7	-213.0		

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

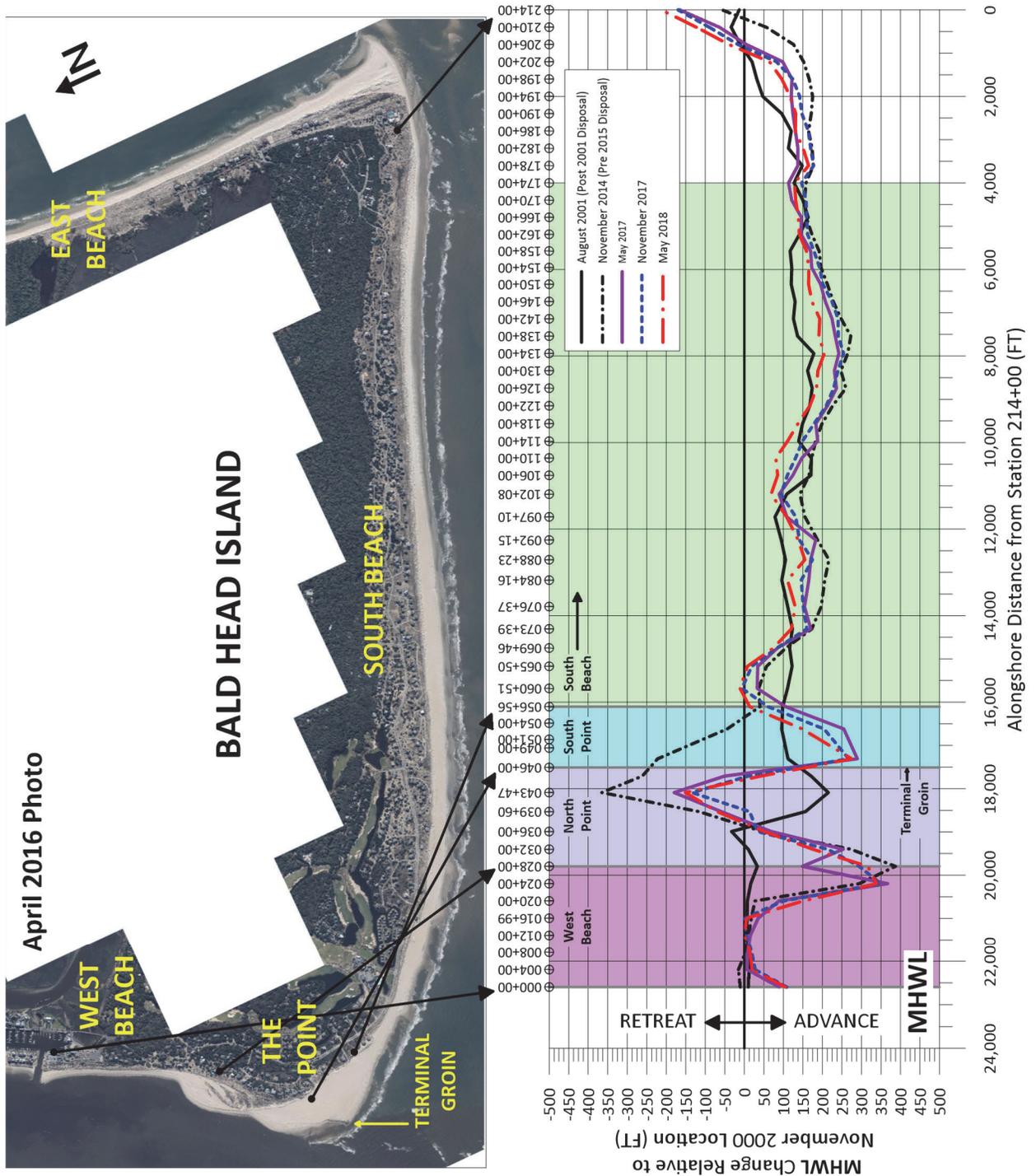


Figure 3.4: Location of the MHWL (+2.51 ft-NGVD) relative to the Nov. 2000 (pre-2001 fill) location.

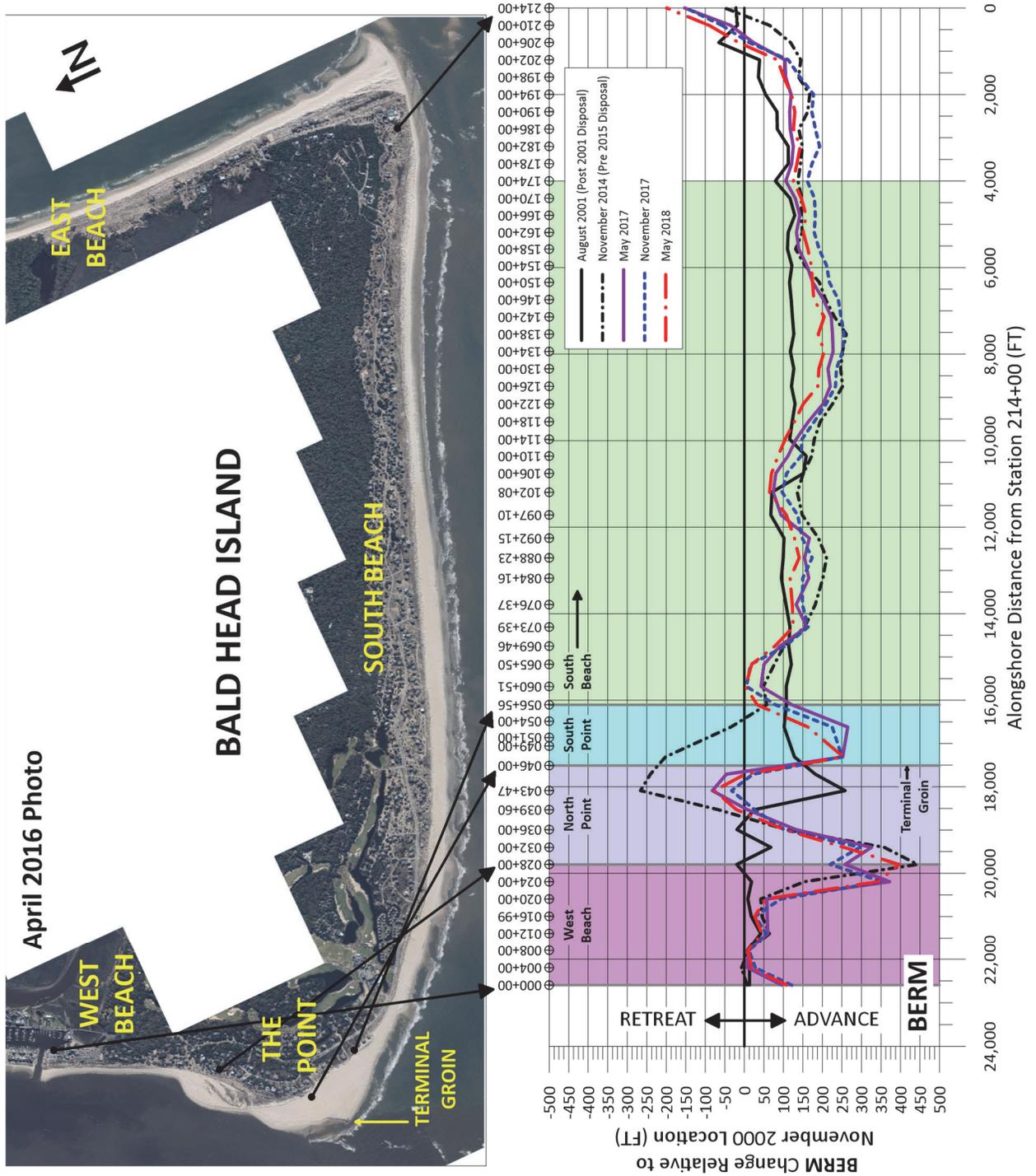


Figure 3.5: Location of the BERM (+6.00 ft-NGVD) relative to the Nov. 2000 (pre-2001 fill) location.

### 3.3 West Beach, “The Point” and South Beach: Discussion

#### 3.3.1 Survey Period: May 2017 to November 2017

This six (6) month survey period represents the 7 to 13 months post-hurricane Matthew recovery period. The November 2017 survey was conducted approximately two years following completion of the terminal groin construction and 2.5 years following a +1.3 Mcy 2015 federal disposal project at South Beach.

As depicted in **Figure 3.1**, the island-wide *net* shoreline volume change trend for this period was erosional with -131,600 cy (-5.8 cy/ft) of loss, mol. over the 6 month span above -20 ft-NGVD. However, above the MHWL, the shoreline gained +45,600 cy. Consistent with the volume gains above the MHWL, the berm and MHWL advanced by spatially weighted averages<sup>9</sup> of roughly +14 ft and +3 ft, respectively, along the approximate 22,755 ft of shoreline (West Beach, “the Point”, and South Beach). However, subreaches of the monitored shoreline experienced varied changes over this monitoring period.

In the net, West Beach was relatively stable during this period with a loss of -400 cy above the MHWL and a gain of +12,900 cy between the MHWL and the -16 ft-NGVD contour. Overall West Beach gained roughly +12,500 cy above the -16 ft contour. Most of the gains occurred along the northernmost 960 ft of West Beach, adjacent to the recently extended marina jetties. Along this reach (Sta 000+00 to 008+00), the beach gained +8,200 cy above -16 ft. Along the remaining 2,000 ft of West Beach, the shoreline gained a net +4,300 cy. During this period, the berm and MHWL advanced by weighted averages of +1 and +9 ft, respectively.

The entire 3,690 ft of “the Point” shoreline (Sta. 28+00 to 56+56) was net erosional during this monitoring period, losing -58,400 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 +9,400 cy above the MHWL and lost -2,200 cy above -16 ft-NGVD. Along this reach, the berm advanced by roughly +5 ft on average and the MHWL by +32 ft. South of the terminal groin (Sta. 46+00 to 56+56), the shoreline lost -8,500 cy above the MHWL and -56,200 cy above the -16 ft-NGVD contour. Similarly, the berm and MHWL retreated by averages of -31 ft and -39 ft, respectively.

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<sup>9</sup> Due to the irregular spacing of the profile stations, the average shoreline changes are weighted based upon the distance between stations and calculated using an average end method.

South Beach was net erosional during the period, losing roughly -131,600 cy above the MHWL and -184,800 cy above -16 ft-NGVD. Approximately 74% of the monitoring stations (28 of 38) were net erosional above -16 ft-NGVD. However, above the MHWL South Beach gained +45,100 cy. Consistent with the volume gains above the MHWL, the berm and MHWL advanced by spatially weighted averages of roughly +22 ft and +1 ft, respectively.

### **3.3.2 Survey Period: November 2017 to May 2018**

This seven (7) month survey period represents the 86 to 93 months post-construction monitoring period for the 2009/10 Village sponsored renourishment. As depicted in **Figure 3.2**, the island-wide *net* volume change was a loss of approximately -200,300 cy (-8.8 cy/ft) above -16 ft-NGVD. Consistent with the overall volume losses, the berm and MHWL retreated by spatially weighted averages of roughly -29 ft and -24 ft, respectively, along the approximate 22,755 ft of shoreline (West Beach, “the Point”, and South Beach).

In the net, West Beach was relatively stable during this period with a loss of -1,600 cy above the MHWL and a gain of +12,300 cy between the MHWL and the -16 ft-NGVD contour. Overall West Beach gained roughly +10,700 cy above the -16 ft contour. During this period, the berm and MHWL advanced by weighted averages of +1 and +5 ft, respectively.

Along “the Point” shoreline north of the terminal groin, the beach lost -8,300 cy above the MHWL and -29,100 cy above the -16 ft-NGVD contour. During this period, the berm retreated by an average of -8 ft and the MHWL by -20 ft. Along “the Point” shoreline south of the terminal groin, the beach gained +2,900 cy above -20 ft-NGVD. However, above the MHWL, the beach lost -13,200 cy. This loss along the upper portions of the profile is reflected in the measured changes of the berm and MHWL. During this period, the berm retreated by an average of -34 ft and the MHWL by -29 ft.

South Beach was net erosional during the period, losing roughly -91,100 cy above the MHWL and -184,800 cy above -16 ft-NGVD. Approximately 84% of the monitoring stations (32 of 38) were net erosional. Consistent with the volume losses, the berm and MHWL advanced by spatially weighted averages of roughly -37 ft and -29 ft, respectively

### **3.3.3 Year 17 Monitoring Results: May 2017 to May 2018 (Excluding East Beach & Row Boat Row)**

During Year 17 in its entirety, the island experienced a net loss of -331,900 cy (-14.6 cy/ft) above the -16 ft contour. Above the MHWL, the island lost -68,600 cy (-3.0 cy/ft). However, all of these net losses occurred along South Beach and “the Point”, as West Beach experienced net accretion.

Along West Beach, the shoreline lost approximately -2,000 cy above the MHWL and gained +23,200 cy above -16 ft-NGVD. During this period, the berm advanced by an average of +2 ft and the MHWL advanced by +14 ft.

The entire Point shoreline (north and south of the terminal groin), experienced a net loss of roughly -84,600 cy above -16 ft-NGVD during the latest monitoring year. However, most of this loss occurred below the MHWL. Above the MHWL, this reach lost -20,600 cy. During this period, the berm retreated by an average of -26 ft and the MHWL by -19 ft.

The South Beach shorefront, which received the majority of the 2015 disposal sand lost approximately -46,000 cy above the MHWL and -270,500 cy above -16 ft-NGVD. All but 8 of the 38 monitoring stations along South Beach experienced net erosion above -16 ft during Year 17. During this period, the berm and MHWL receded by averages of -15 ft and -19 ft, respectively.

### 3.3.4 Long-Term Beach Changes: November 2000 to May 2018

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 2018). In both figures the effects of direct 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, 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, three (3) 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 sand will occur in the summer of 2018.* As a result of the 2018 disposal at Oak Island, the Village intends to construct a 1 Mcy interim beach fill at South Beach in the fall/winter of 2018/19.

**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 2018). Currently, within the **approximate** 22,755 ft of shoreline considered, there is a net gain of +2,301,300 cy. However, after removing the effects of the 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 -6,781,500 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 in the channel or borrow site, *estimated* sand volumes placed, contractual “net pay” volumes, etc.

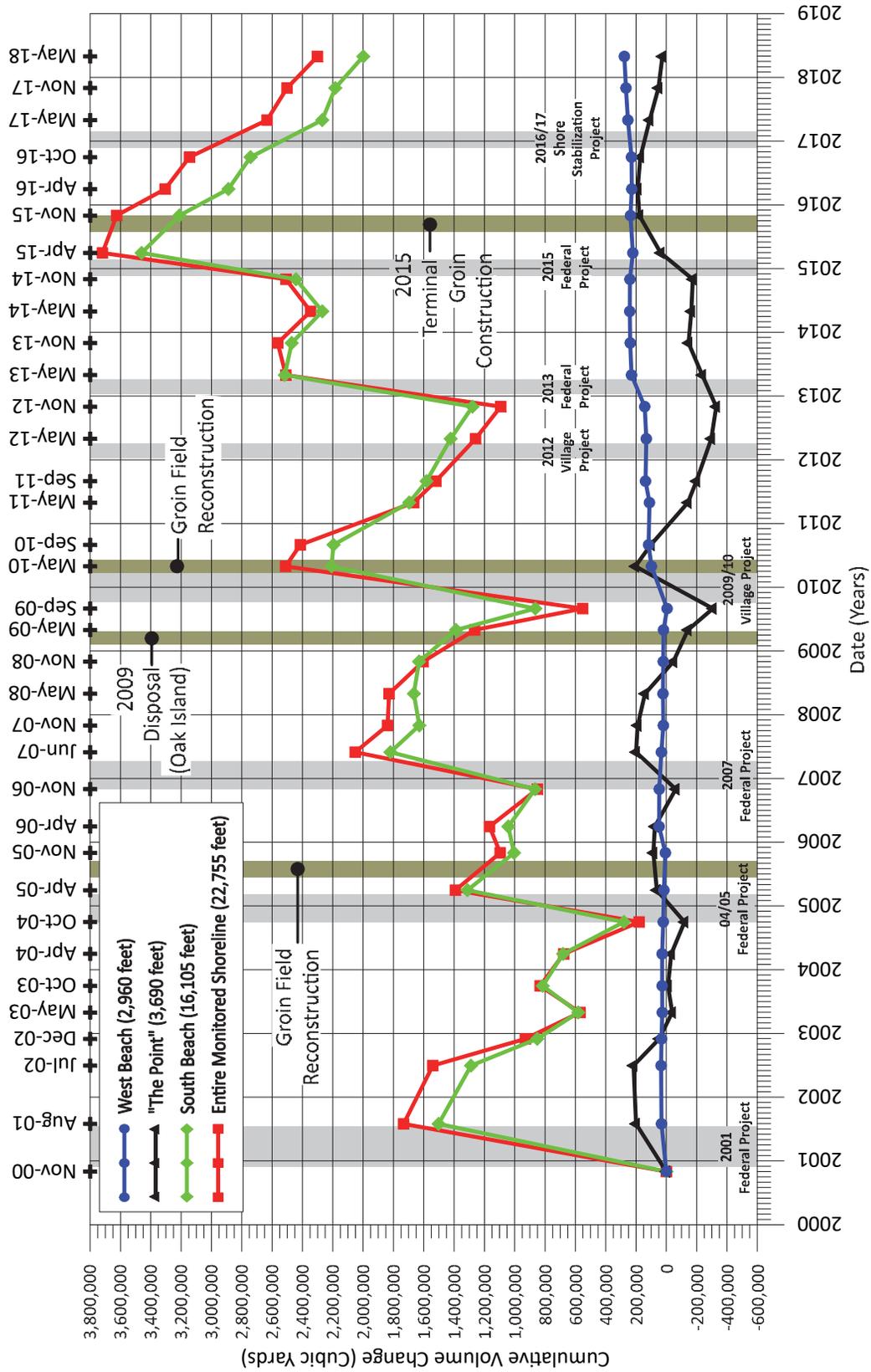


Figure 3.6: Cumulative volume change (above -16 ft-NGVD) relative to November 2000 conditions.

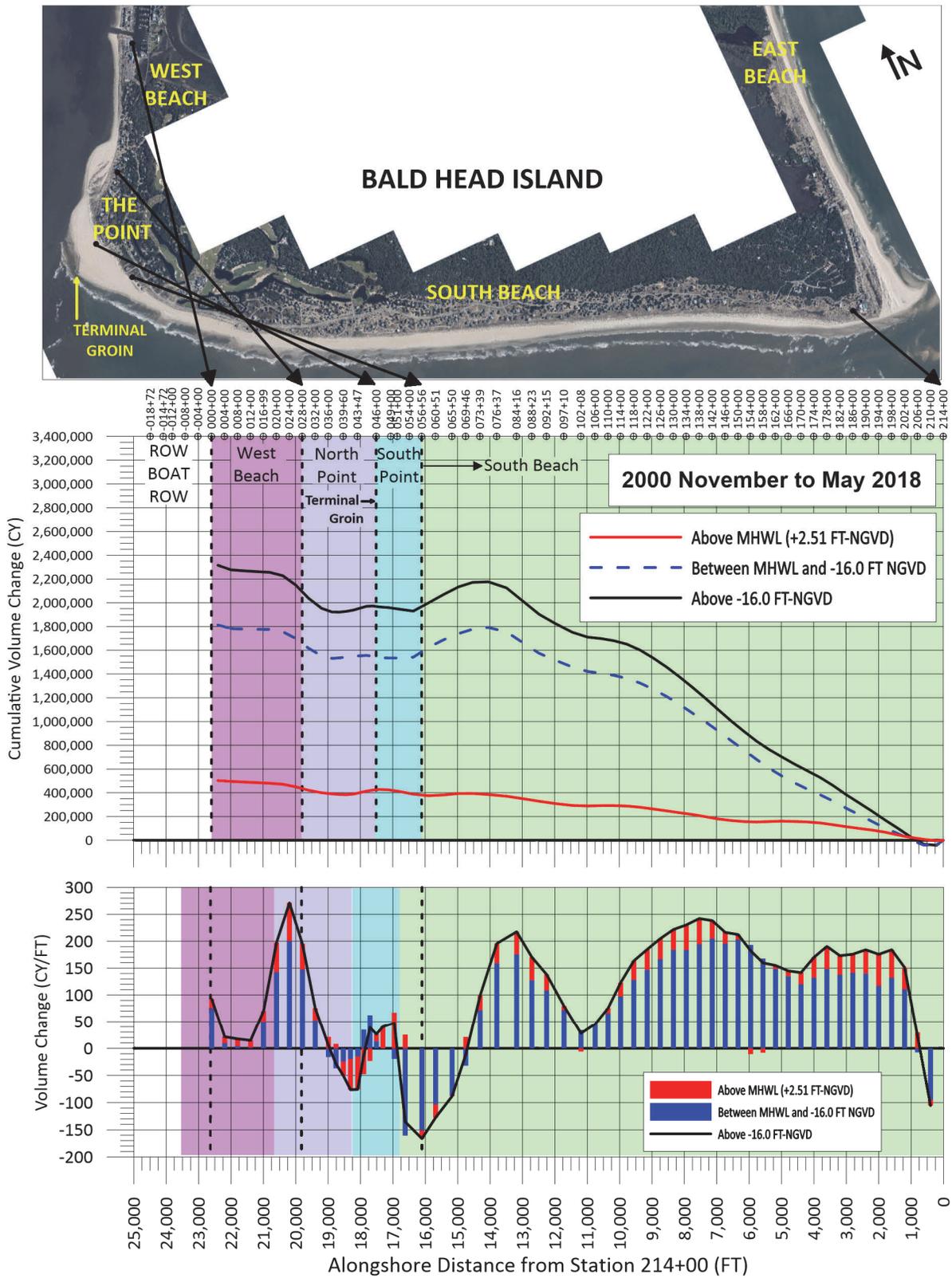


Figure 3.7: Volume change along the Bald Head Island shoreline between November 2000 and May 2018.

**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
Construction <sup>10</sup>	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 (2004/05 Project) <sup>11</sup>	Apr. 2004	Apr. 2005	12	-11,800	+94,700	+631,200	+714,100
Year 5 (2006 WB Project) <sup>12</sup>	Apr. 2005	Apr. 2006	12	+32,000	+13,300	-270,200	-224,900
Year 6 (2007 Project) <sup>13</sup>	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 (2009/10 Project) <sup>14</sup>	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 (2012 Beach Fill) <sup>15</sup>	May 2011	May 2012	12	+20,800	-154,600	-273,300	-407,100
Year 12 (2013 Disposal) Project <sup>16</sup>	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 (2015 Disposal) Project <sup>17</sup>	May 2014	April 2015	11	-20,400	+201,800	+1,191,800	+1,373,200
Year 15	April 2015	April 2016	12	+7,200	+151,800	-572,500	-413,500
Year 16 <sup>18</sup>	April 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
Pre-2000 Construction to Year 17	Nov. 2000	May 2018	210	+276,900	+25,600	+1,998,800	+2,301,300
Pre-2000 Construction to Year 17 (Fill Removed)	Nov. 2000	May 2018	210	NA	NA	NA	-6,781,500

<sup>10</sup> 2001 Initial Disposal (1,849,500± CY)

<sup>11</sup> 2005 Beach Disposal (1,217,000± CY)

<sup>12</sup> 2006 West Beach Fill (47,800± CY)

<sup>13</sup> 2007 Beach Disposal (978,500± CY)

<sup>14</sup> 2009/10 Beach Fill (1,850,000± CY)

<sup>15</sup> 2012 Beach Fill (138,000 ± CY)

<sup>16</sup> 2013 Beach Disposal Fill (1,658,000 ± CY)

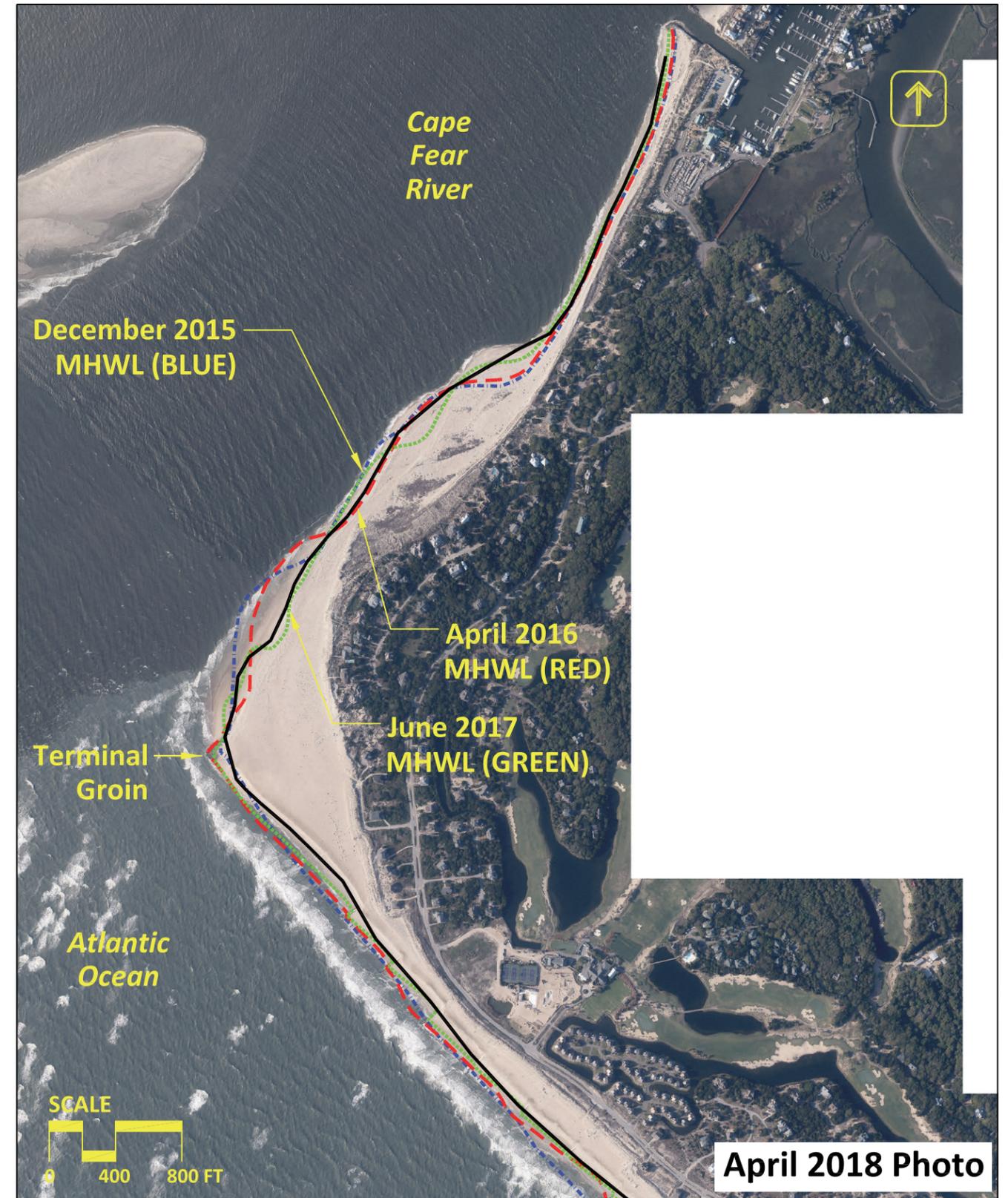
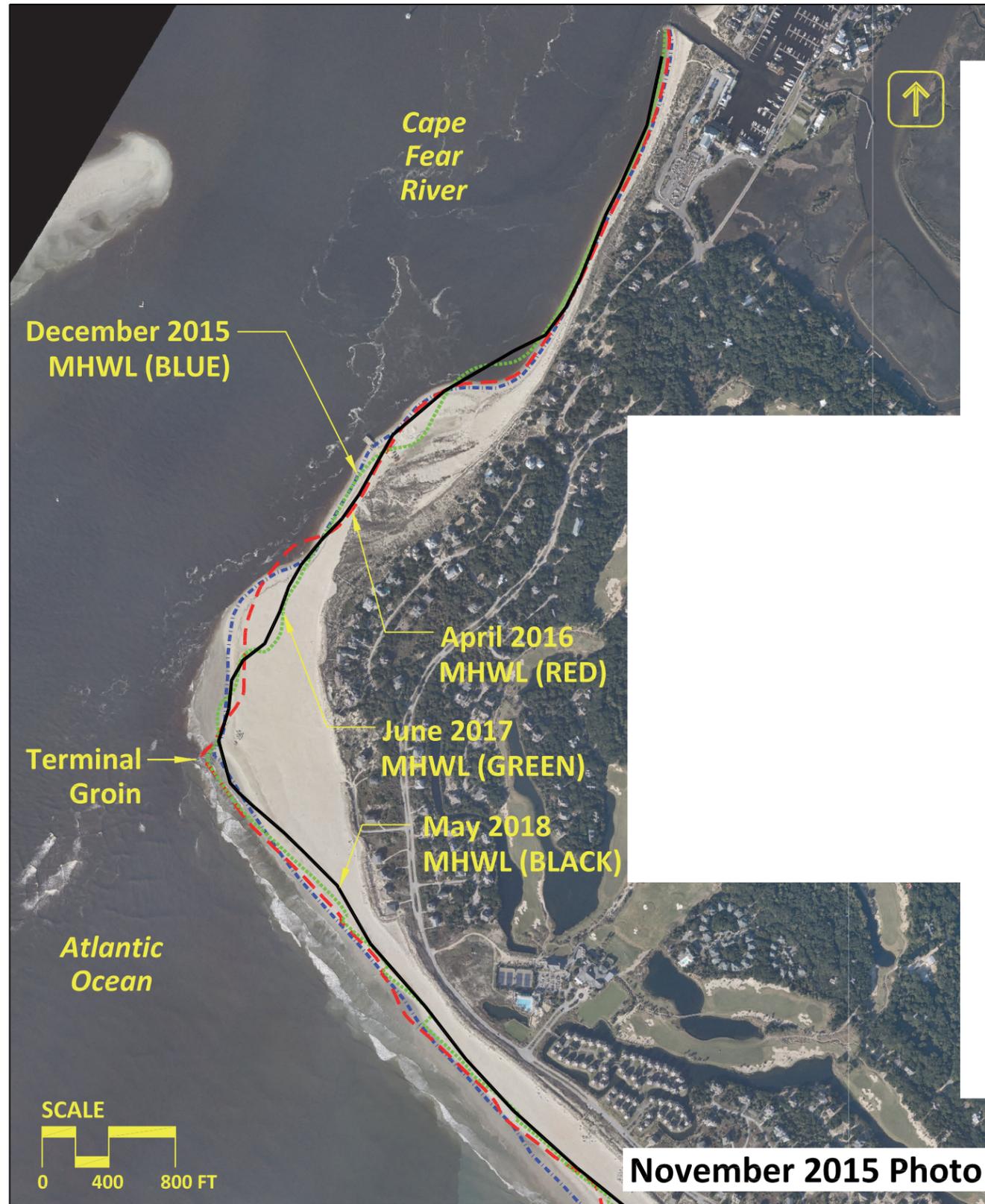
<sup>17</sup> 2015 Beach Disposal Fill (1,320,000 ± CY)

<sup>18</sup> 2016/17 Beach Disposal (24,000± 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 387,500 cy per year. 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 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.

### **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) and May 2018 (30 months post-construction). The four surveys completed to date 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 fronting the Cape Fear River. Through May 2018, 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 indicator 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 April 2018. Demarcated on each photo panel are the approximate September 2001 (blue line) and April 2018 (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 eighteen 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 2018 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 has “rolled back,” the annualized rate of littoral transport at that location has 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 “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 2017 to May 2018 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 forms 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**. It has been noted previously that the majority of the terminal groin was constructed “in the dry” – with only the distal head of the structure evident at completion in late 2015. Since that time, portions of the federal disposal located berm westward of the new structure have receded as a new equilibrium condition evolves.

Eastward of the structure, the updrift sand fillet retained by the groin is relatively stable – or mildly recessive. As predicted, the need for episodic sediment placement extending eastward of the groin some 9,300 ft to approximately Sta. 134+00 is scheduled to be constructed in the winter of 2018/19. The source of fill will be Jay Bird Shoals. The proposed fill volume is 1 Mcy.

### 3.4 East Beach Shoreline Conditions

In November 2008, East Beach was added to the island-wide beach monitoring program<sup>19</sup>. 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 2017 to November 2017 to May 2018 monitoring periods.

During the May 2017 to November 2017 summer period, the East Beach shoreline was accretional, gaining +18,600 cy (3.1 cy/ft) above the MHWL and +121,100 cy (+28.1 cy/ft) above -16 ft-NGVD. During this same period the backshore berm (at elevation +6 ft-NGVD) retreated by a spatially weighted average<sup>20</sup> of -32.0 ft while the MHWL advanced by an average of +28.8 ft. However, the advance at the MHWL average advances are *heavily influenced* by the large advancement at the southernmost two stations, STA 224+80 and 234+80, located immediately north of Cape Fear. At these stations, the MHWL advanced by an average of 59.8 ft. This advancement is evident in **Figure 3.9** which depicts the April 2017, November 2017 and April 2018 aerial photographs along East Beach.

During the November 2017 to May 2018 winter period, the East Beach shoreline gained approximately +12,800 cy (2.1 cy/ft) above the MHWL but lost -77,500 cy (-12.9 cy/ft) below the MHWL for a net total change above -16 ft-NGVD of -64,700 cy (-10.8 cy/ft). During this same period the berm advanced by a spatially weighted average of +14.8 ft while the berm receded by an average of -7.5.

**Table 3.10** summarizes shoreline and volume changes measured over the entire period of survey record (November 2008 – May 2018). Over the 115-month period, the East Beach shoreline gained approximately +289,200 cy above the -16 ft-NGVD contour and +87,200 cy above the MHWL. Likewise, the backshore berm and MHWL advanced by weighted averages of +19.9 ft and +78.1 ft, respectively over this period. However, most of these shoreline gains occurred immediately adjacent to Cape Fear (Sta. 224+80 to 254+80).

As demonstrated by the survey and photographic data (**Figure 3.9**), it can be reasonably assumed that the condition of East Beach at any one time is, has been and will continue to be 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 last decade (2008-2018) which are depicted by **Figure 3.10**. In its

<sup>19</sup> Profiles were not acquired at East Beach in the fall of 2009

<sup>20</sup> Due to the irregular spacing of the profile stations, the average shoreline changes are weighted based upon the distance between stations and calculated using an average end method.

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 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 location of the Cape Fear spit has been beneficial to East Beach properties, it has caused significant shoreline and dune recession seaward of the South Beach Shoals Club facility. 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. May 2017 shoreline conditions are visually shown by **Figure B-9** (Appendix B – May 2018 Aerial Photography – page B-10). Since November 2000, the MHWL at profile B-54 has receded by -213 ft, or about -12 ft/yr. At B-55, over the same period of time, the MHWL has receded -329 ft, or about -19 ft/yr. More recently however, between November 2014 and May 2018, the MHWL at B-55 had receded by about -127 ft which equates to a rate of -36 ft/yr.

**Table 3.7:** East Beach shoreline and volume changes between May 2017 and November 2017.

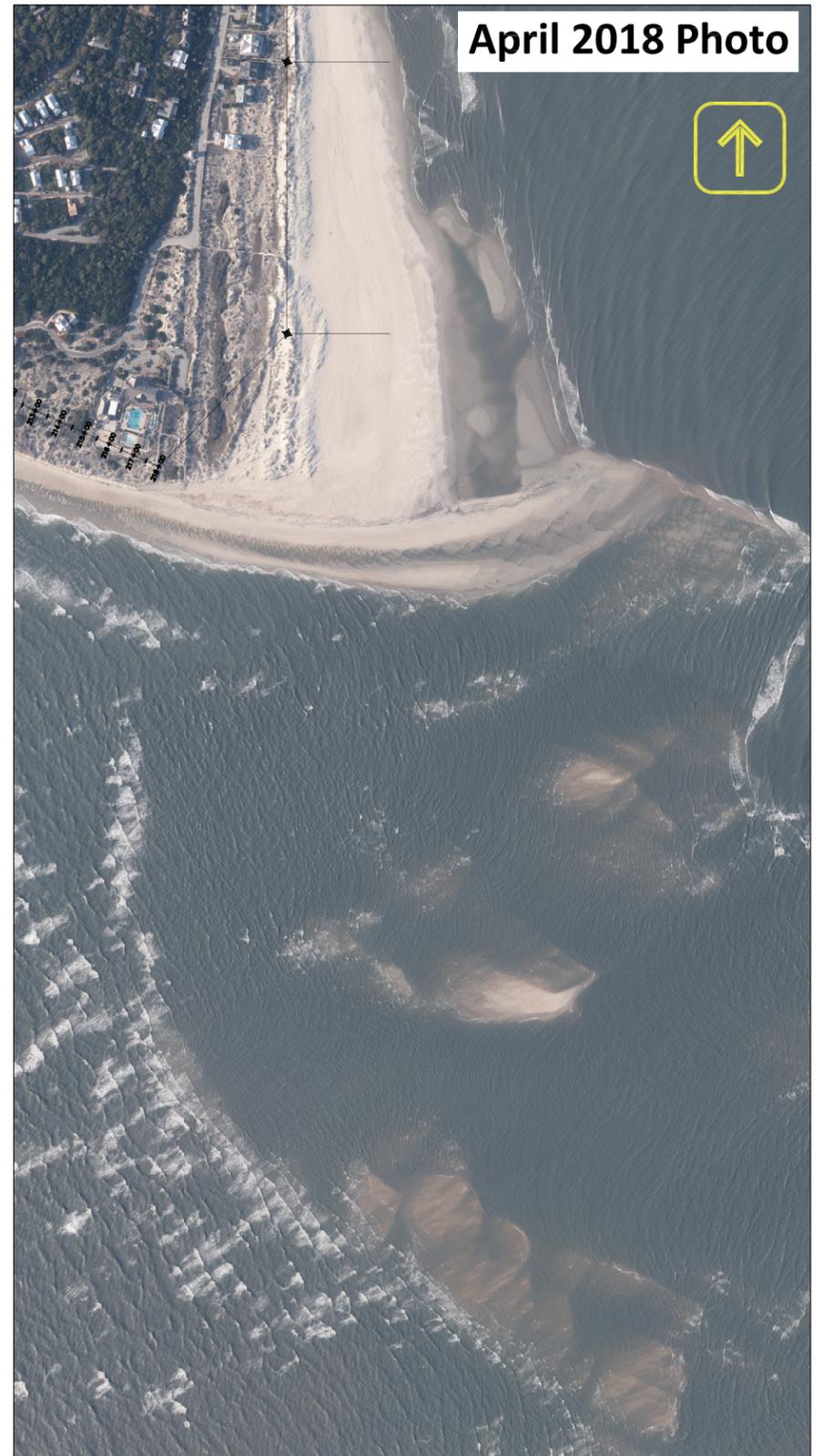
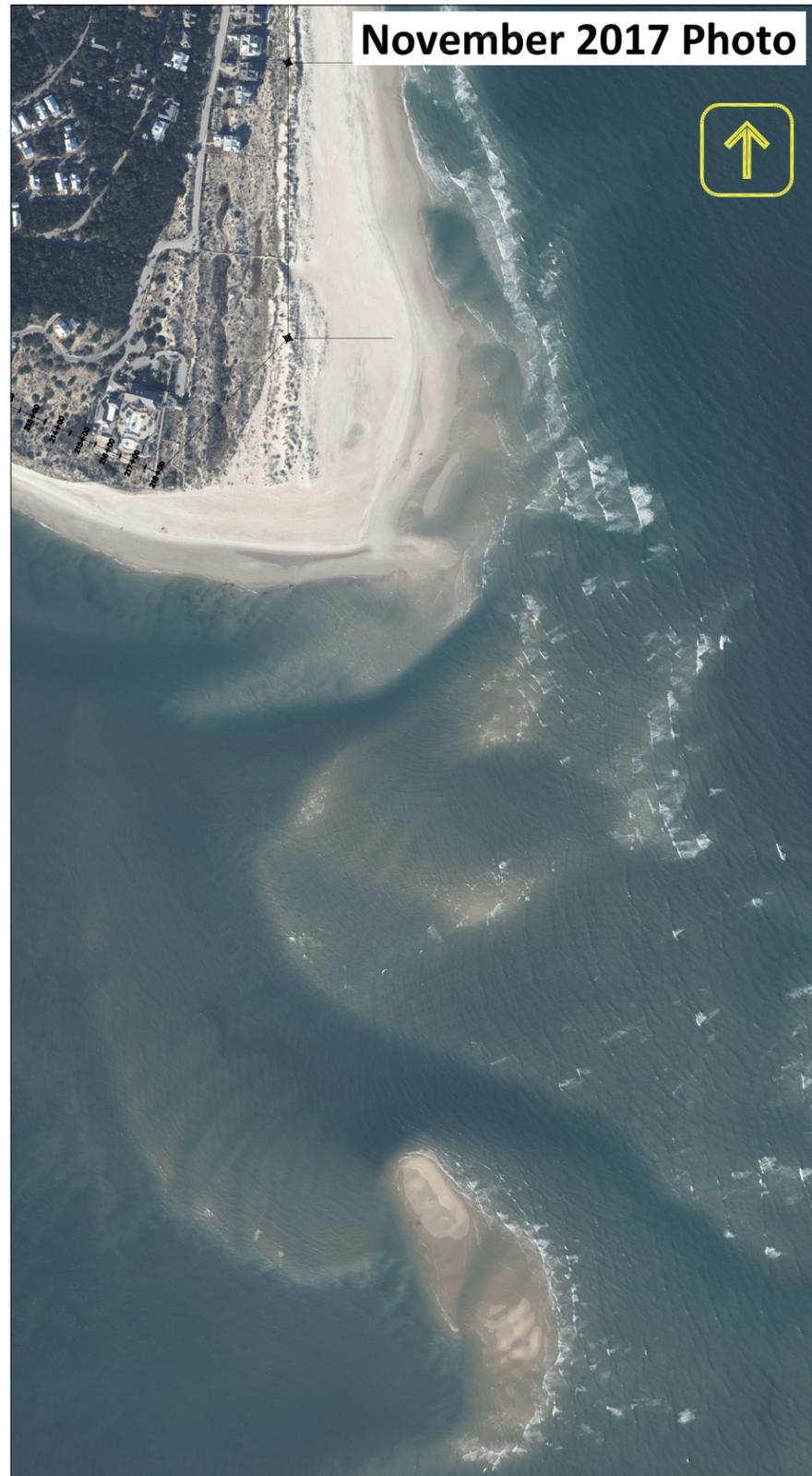
Station	Reach (FT)	Volume Change (CY)		Shoreline Change (FT)	
		Above MHWL (+2.51 FT)	Above -16 FT	Berm (+6 FT)	MHWL (+2.51 FT)
224+80				-193.4	+68.9
	1,000	+7,200	+40,000		
234+80				-3.6	+50.7
	1,000	+3,200	+45,600		
244+80				-4.6	+27.1
	1,000	+3,600	+33,300		
254+80				+3.4	+22.1
	1,000	+4,300	+16,500		
264+80				0.0	+29.1
	1,000	+1,000	-3,100		
274+80				-21.9	-14.7
	1,000	-700	-11,200		
284+80				-3.8	+18.6
<b>Total</b>	<b>6,000</b>	<b>+18,600</b>	<b>+121,100</b>	<b>-32.0</b>	<b>+28.8</b>

**Table 3.8:** East Beach shoreline and volume changes between November 2017 and May 2018.

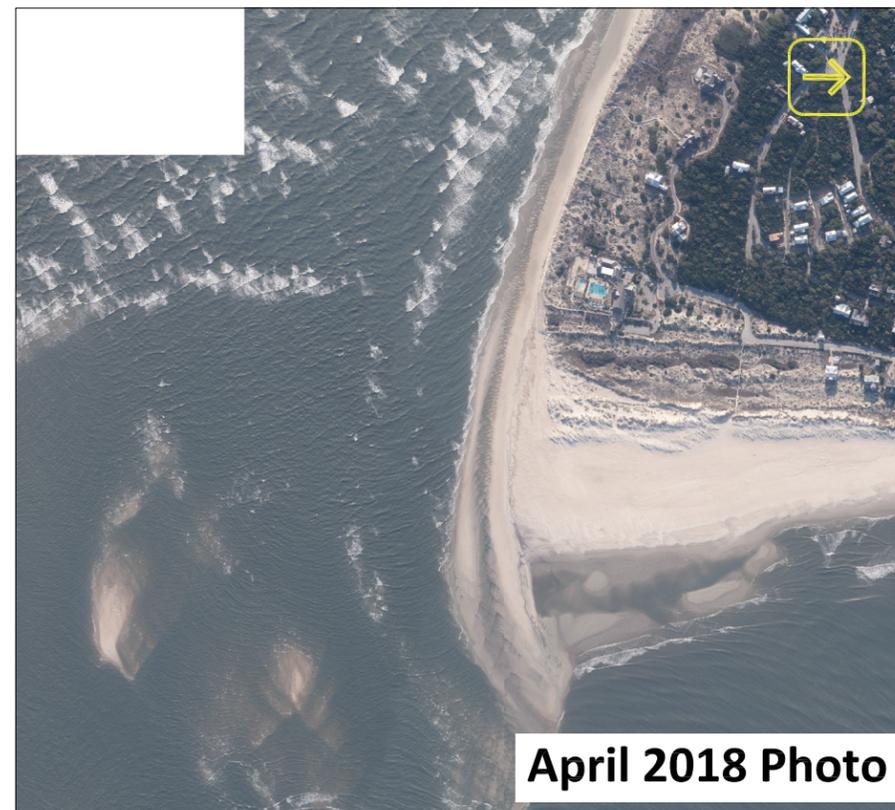
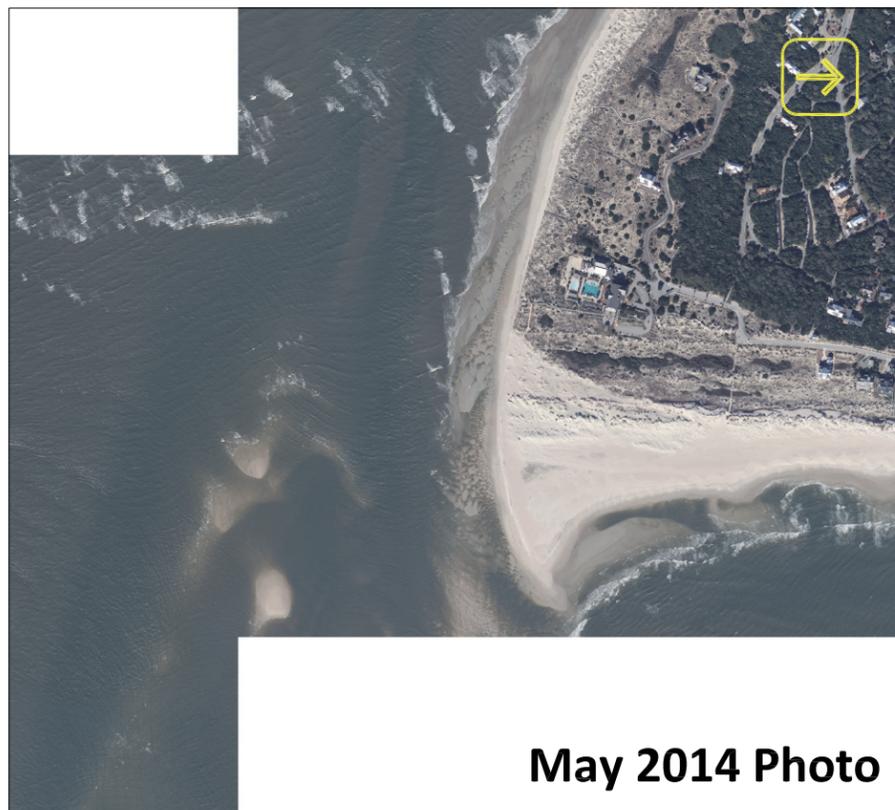
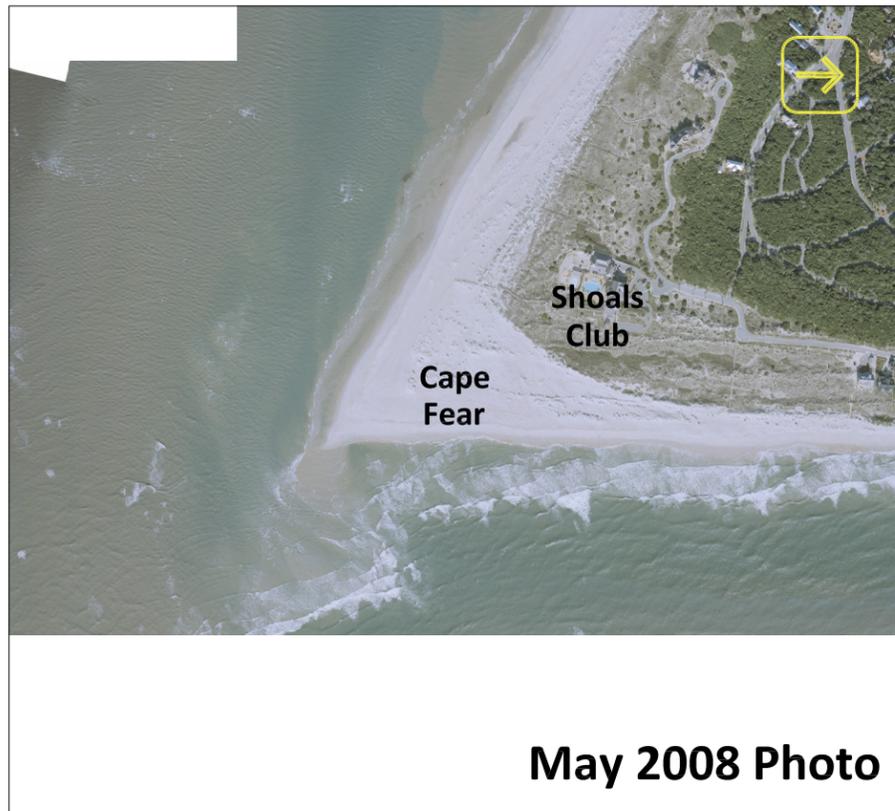
Station	Reach (FT)	Volume Change		Shoreline Change (FT)	
		Above MHWL (+2.51 FT)	Above -16 FT	Berm (+6 FT)	MHWL (+2.51 FT)
224+80				-2.2	-41.3
	1,000	+5,200	-14,500		
234+80				+52.1	+17.5
	1,000	+6,300	+7,400		
244+80				+11.9	-0.4
	1,000	+700	-5,000		
254+80				-1.2	-5.1
	1,000	0	-17,500		
264+80				+11.6	-5.9
	1,000	+100	-17,200		
274+80				+10.2	-14.7
	1,000	+500	-17,900		
284+80				+21.5	-2.3
<b>Total</b>	<b>6,000</b>	<b>+12,800</b>	<b>-64,700</b>	<b>+14.8</b>	<b>-7.5</b>

**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 November 2015	+14,000	-52,100	-38,100
November 2015 to April 2016	+6,800	+51,700	+58,500
April 2016 to October 2016	-8,100	+55,400	+47,300
October 2016 to May 2017	+12,600	-17,200	-4,600
May 2017 to November 2017	+18,600	+102,500	+121,100
November 2017 to May 2018	+12,800	-77,500	-64,700
<b>November 2008 to May 2018</b>	<b>+87,200</b>	<b>+202,000</b>	<b>+289,200</b>



**Figure 3.9:**  
Cape Fear aerial photography  
Bald Head Island, NC



**Figure 3.10:**  
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 3.1**). 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 2017 to November 2017 to May 2018 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 begun to equilibrate into a series of discrete crenulate features between tombolos which extend from the center of each breakwater in a landward direction.

During the monitoring year (May 2017 to May 2018), the shoreline showed losses of roughly -5,300 cy (-3.4 cy/ft) above the MHWL and -12,500 cy (-8.0 cy/ft) above -16 ft-NGVD. Few conclusions can be drawn at this time since the shoreline is in the process of equilibrating to the structures. In addition, small episodic channel maintenance and sand bypass events occur with the disposal material being placed behind and between the structures (see **Figure 3.11**).



**Figure 3.11:** Northward looking view of the Row-Boat-Row shoreline detached breakwaters. (May 2018 Photo).

**Table 3.10:** Row Boat Row shoreline and volume changes between May 2017 and November 2017.

Station	Reach (FT)	Volume Change (CY)		Shoreline Change (FT)	
		Above MHWL (+2.51 FT)	Above -16 FT	Berm (+6 FT)	MHWL (+2.51 FT)
-018+72				+57.9	+14.4
	400	0	-1,200		
-014+72				-13.0	-12.2
	272	-600	-2,000		
-012+00				-18.8	-27.1
	400	-1,200	-2,500		
-008+00				-22.9	-21.1
	400	-800	-800		
-004+00				-14.9	-8.5
	100	-100	-100		
Marina					
<b>Total</b>	<b>1,572</b>	<b>-2,700</b>	<b>-6,600</b>	<b>-8.1 (AVG)</b>	<b>-13.6 (AVG)</b>

**Table 3.11:** Row Boat Row shoreline and volume changes between November 2017 and May 2018.

Station	Reach (FT)	Volume Change (CY)		Shoreline Change (FT)	
		Above MHWL (+2.51 FT)	Above -16 FT	Berm (+6 FT)	MHWL (+2.51 FT)
-018+72				+4.6	-13.7
	400	-700	-1,100		
-014+72				-27.9	-14.1
	272	-600	-1,400		
-012+00				-26.1	-18.7
	400	-900	-3,100		
-008+00				-12.5	-16.9
	400	-400	-800		
-004+00				-5.4	+1.3
	100	0	+500		
Marina					
<b>Total</b>	<b>1,572</b>	<b>-2,600</b>	<b>-5,900</b>	<b>-15.2 (AVG)</b>	<b>-12.8 (AVG)</b>

## 4.0 BORROW SITE MONITORING (SURVEY) RESULTS

### 4.1 Borrow Site Evaluation – Bald Head Creek

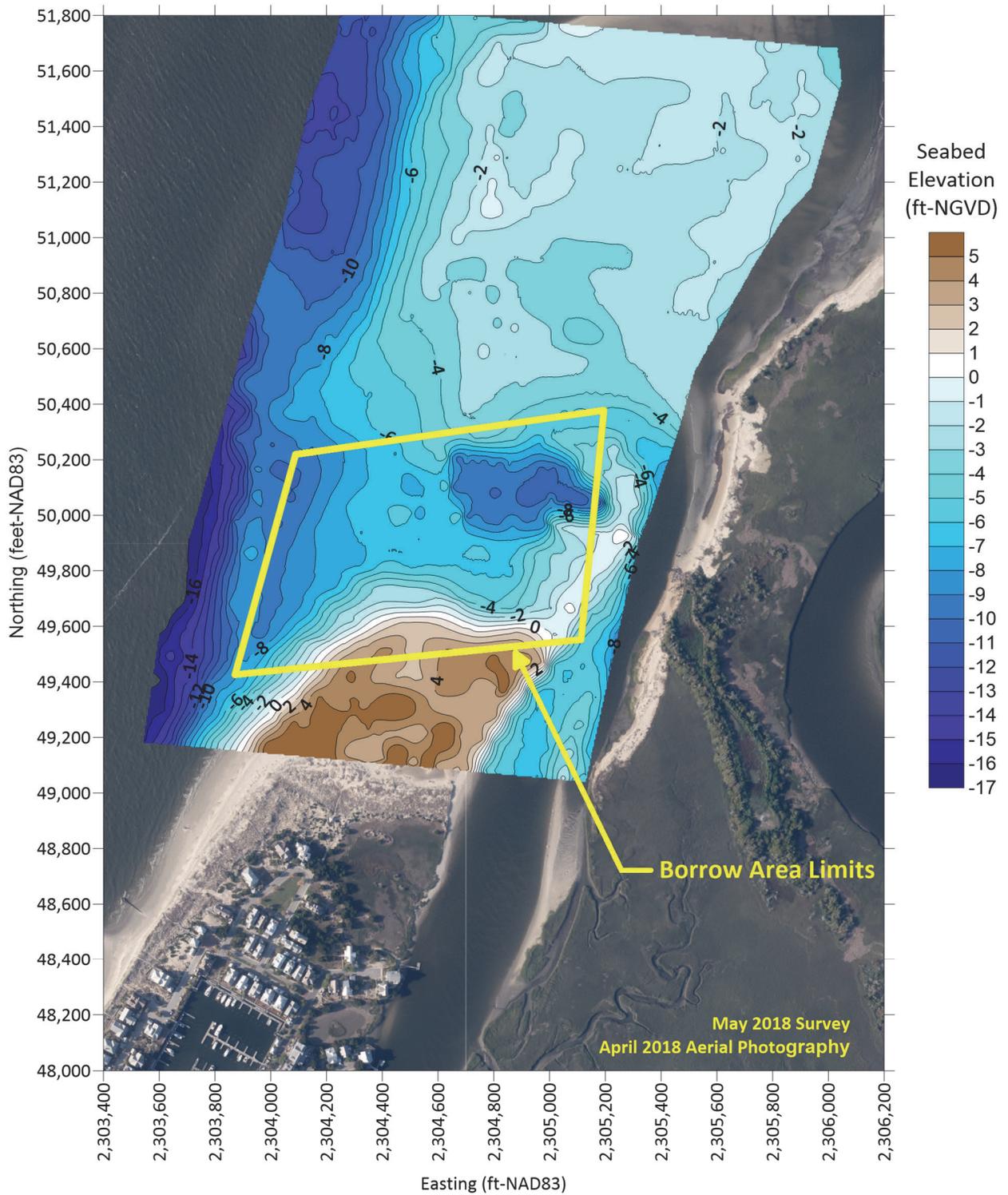
A small-scale beach restoration project utilizing sand from the Bald Head Creek borrow site was constructed between December 2016 and March 2017 along the West Beach and Row Boat Row shorefronts. Approximately 48,700 cy were dredged from the northeastern corner of the permitted borrow site. This same borrow site was utilized for the 2012 Post-Irene small scale mitigation project and continues to be resurveyed annually. Approximately 138,000 cy of sand were dredged from the borrow site between January and February 2012.

**Figure 4.1** presents the seabed conditions within the vicinity of the borrow site as of the most recent monitoring survey (May 2018). **Figure 4.2** presents the relative seabed elevation change over the past monitoring year (March 2017 to May 2018) and **Figure 4.3** presents the seabed elevation change since project completion (March 2012 to May 2018).

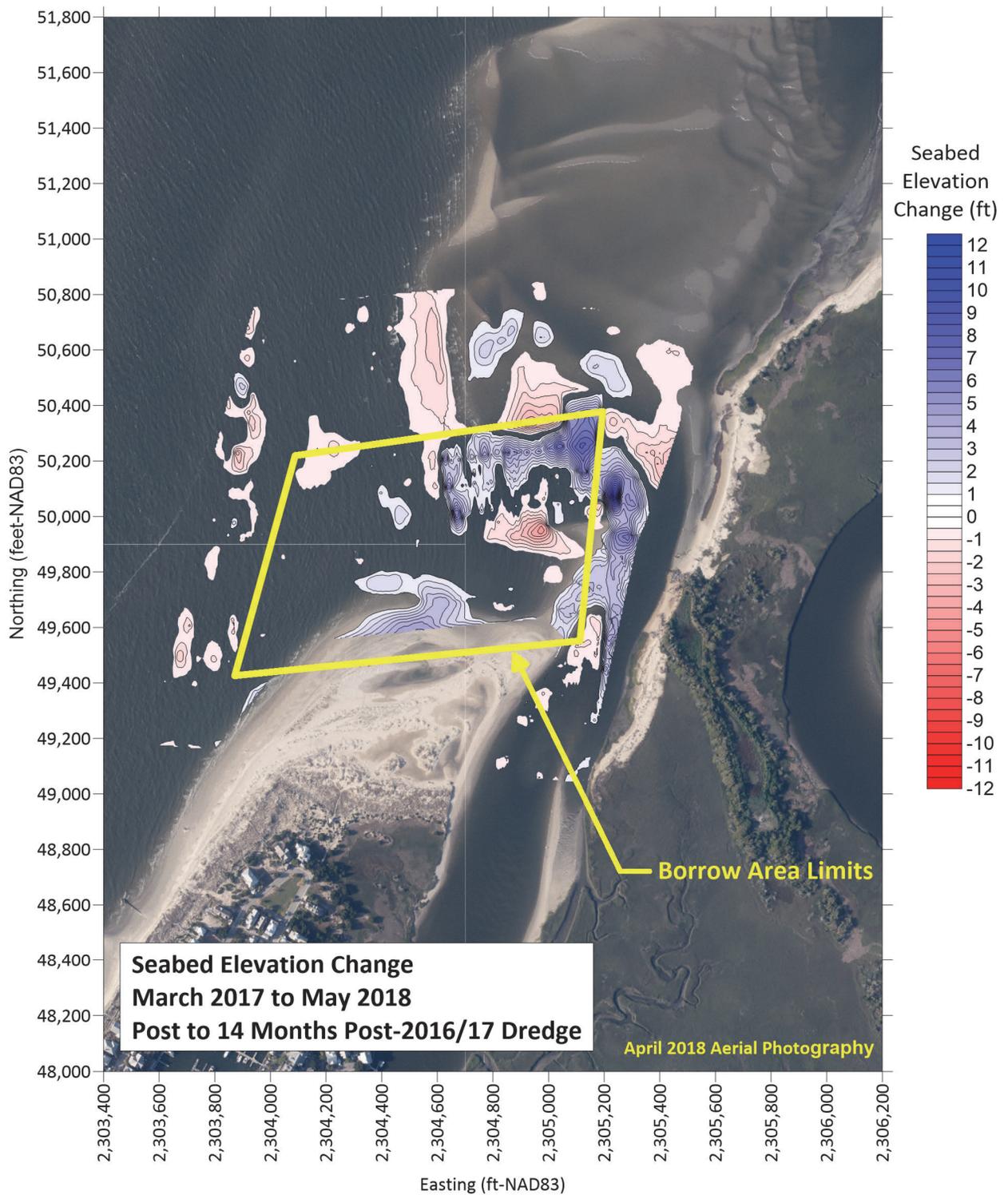
The most recent monitoring year (March 2017 to May 2018) represents the first year following completion of 2016/17 dredging of the borrow site. During this period, the borrow site gained +21,100 cy within the entire permitted limits (both excavated and unexcavated) Within the approximate 2016 excavation limits, the borrow site gained +12,400 cy or roughly 25 percent of the dredged volume (-48,700 cy). In the 6 years since the completion of the initial dredging project (March 2012 to May 2018), the area within the limits of the permitted borrow site has gained +45,600 cy.

**Table 4.1:** Bald Head Creek borrow site volume changes (within permitted limits).

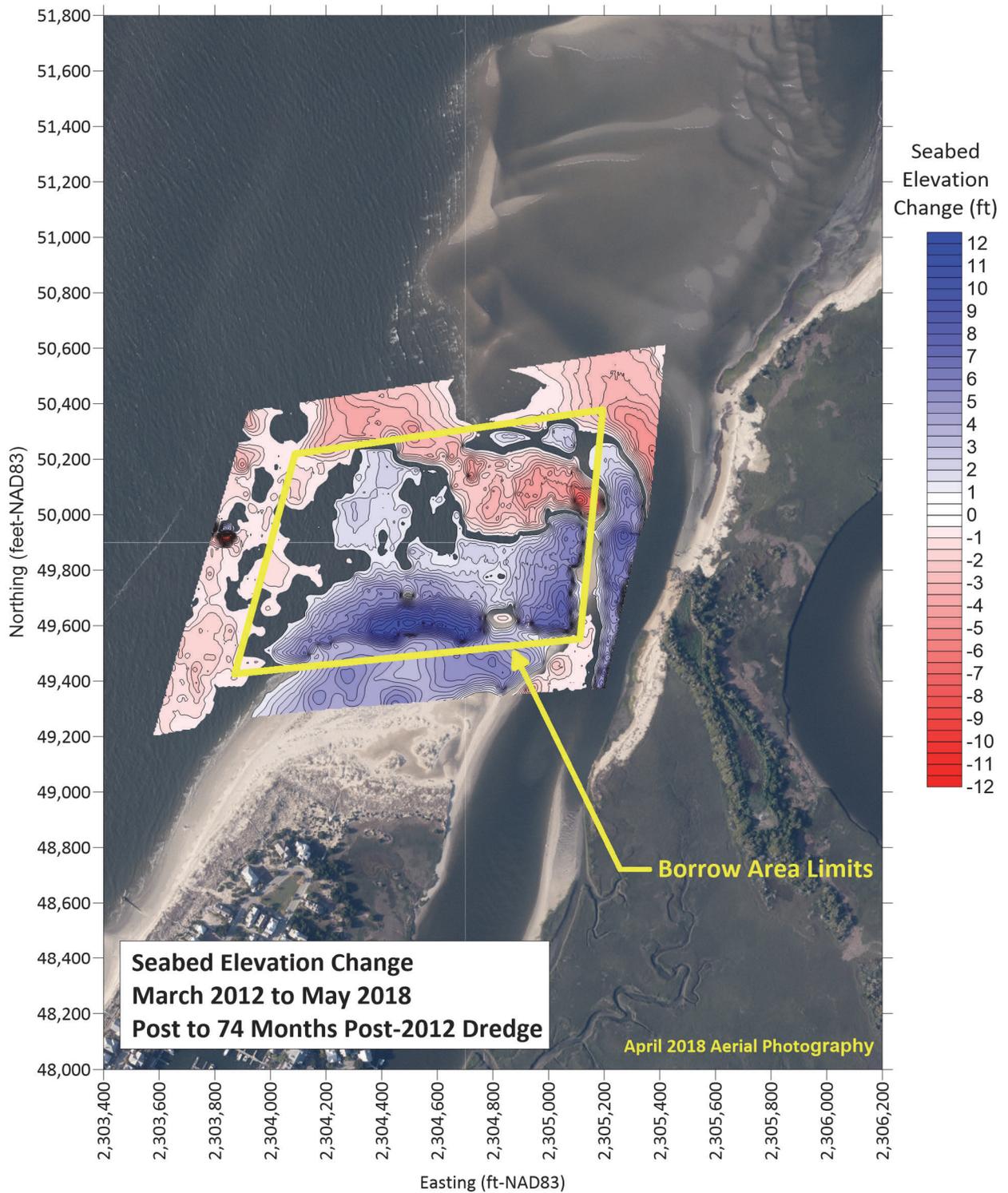
Survey Period	Duration	Volume Change (CY)		
		Gross	Gross	Net Change
March 2012 to January 2013 (AD to Year 1)	10 months	+22,400	-10,600	<b>+11,800</b>
January 2013 to December 2013 (Year 1 to Year 2)	11 months	+21,800	-1,800	<b>+20,000</b>
December 2013 to April 2015 (Year 2 to Year 3)	16 months	+34,700	-1,200	<b>+33,500</b>
April 2015 to April 2016 (Year 3 to Year 4)	12 months	+15,600	-10,900	<b>+4,700</b>
April 2016 to November 2016 (Year 4 to Year 4.5)	7 months	+9,700	-2,000	<b>+7,700</b>
November 2016 to March 2017 (2016/17 Construction Period)	4 months	+1,800	-55,000	<b>-53,200</b>
March 2017 to May 2018 (Year 5 to Year 6)	14 months	+30,500	-9,400	<b>+21,100</b>
<b>Since Construction (March 2012 to May 2018)</b>	<b>74 months</b>	<b>+136,500</b>	<b>-90,900</b>	<b>+45,600</b>



**Figure 4.1:** Existing Bald Head Creek borrow site conditions (May 2018 survey).



**Figure 4.2:** Bald Head Creek borrow site seabed elevation changes post-2016/17 project (March 2017 to May 2018).



**Figure 4.3:** Bald Head Creek borrow site seabed elevation changes post-2012 project (March 2012) to May 2018.

## 4.2 Borrow Site Evaluation – Jay Bird Shoals

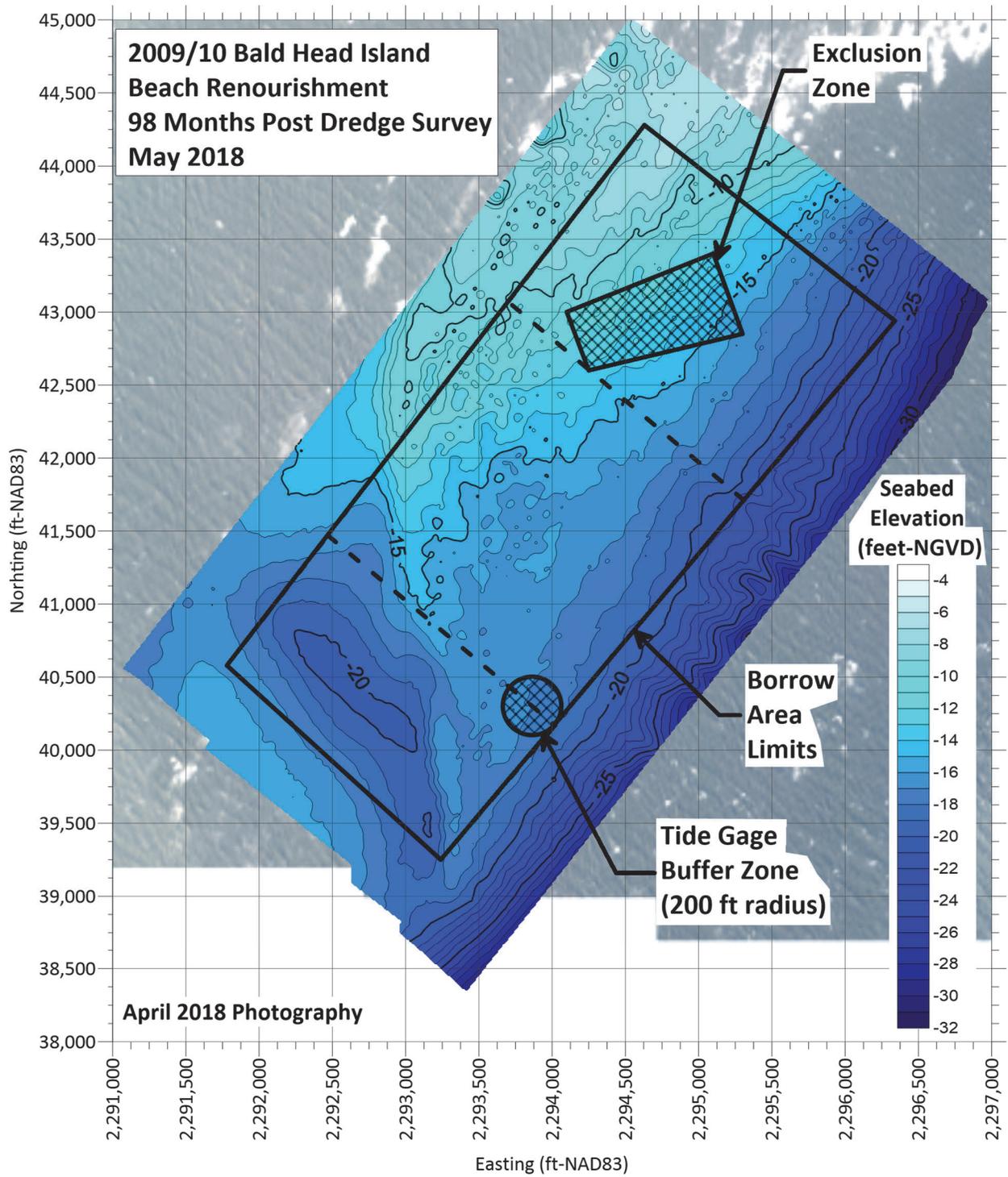
Pursuant to permit requirements, the Jay Bird Shoal borrow site was surveyed in May 2018. **Table 4.2** summarizes the volume changes within the *excavated* borrow site limits<sup>21</sup> between the monitoring surveys conducted to date. **Figure 4.4** depicts the most recent 8-year post 2009/10 project (98 months) borrow site condition as surveyed in May 2018. **Figure 4.5** depicts the changes between the May 2017 and May 2018 surveys (Year 8). **Figure 4.6** depicts the changes during the 98 months since project construction (March 2010 to May 2018).

During the Year 8 monitoring period (May 2017 to May 2018), the borrow site gained approximately +50,100 CY within the entire *excavated* area. In the eight years since project completion (March 2010 to May 2018), the *excavated* area gained roughly +661,700 CY or approximately 36 percent of the estimated dredge volume (-1,835,700 CY). Overall, within the *permitted* limits (both excavated and unexcavated), the borrow site gained +260,000 CY during this same period. The Jay Bird Shoal borrow site is next scheduled to be surveyed in May 2019 after the next renourishment project.

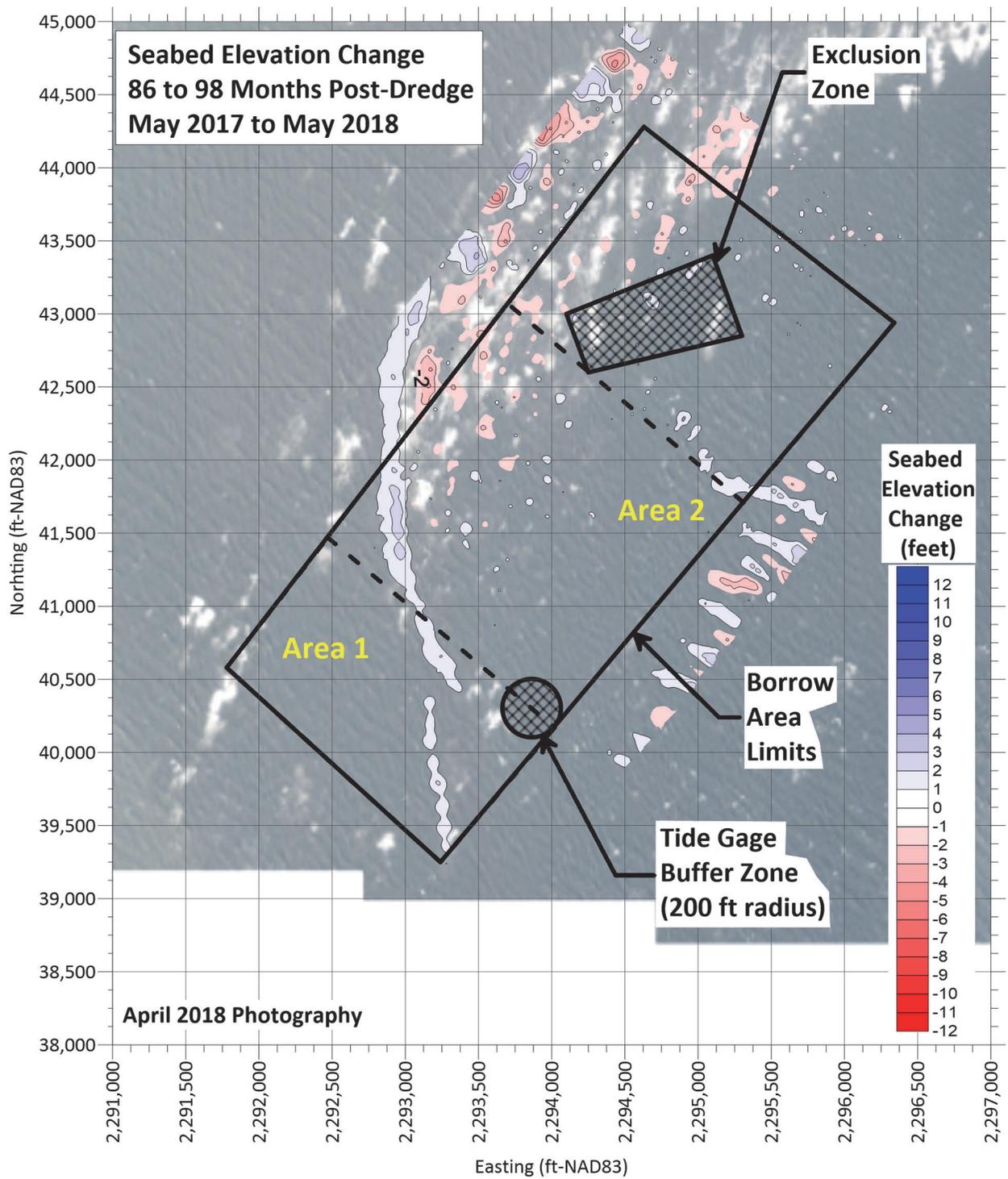
**Table 4.2:** Jay Bird Shoals borrow site volume changes (*EXCAVATED limits*).

Survey Period	Duration	Volume Change (CY)		
		Gross Gain	Gross Loss	Net Change
October 2009 to March 2010 (Construction)	5 months	+6,000	-1,791,400	-1,785,400
March 2010 to May 2011 (Year 1 Post-Construction)	14 months	+259,400	-36,800	+222,600
May 2011 to May 2012 (Year 2 Post-Construction)	12 months	+84,700	-39,000	+45,700
May 2012 to May 2013 (Year 3 Post-Construction)	12 months	+155,300	-13,300	+142,000
May 2013 to April 2015 (Years 4 & 5 Post-Construction)	23 months	+249,700	-54,700	+195,000
April 2015 to May 2017 (Years 6 & 7 Post-Construction)	25 months	+141,800	-135,500	+6,300
May 2017 to November 2017	6 months	+50,400	-14,900	+35,500
November 2017 to May 2017	6 months	+39,100	-24,500	+14,600
<b>Since Construction (March 2010 to May 2018)</b>	<b>98 months</b>	<b>+986,400</b>	<b>-318,700</b>	<b>+661,700</b>

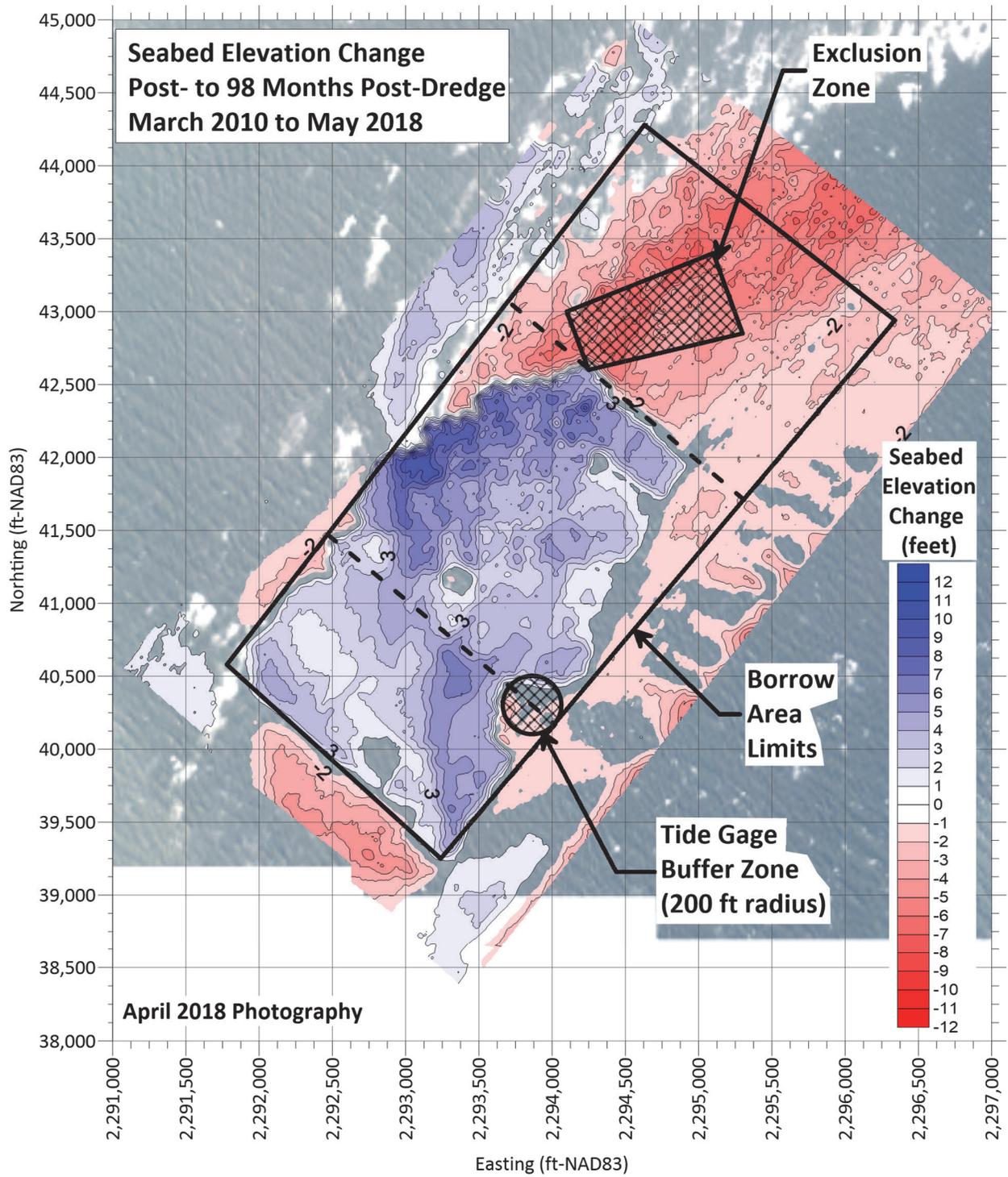
<sup>21</sup> Excavation occurred with Areas 1 & 2 (minus the exclusion zones) depicted in **Figure 4.5**.



**Figure 4.4:** 98 months post-dredge (May 2018) Jay Bird Shoal borrow site conditions.



**Figure 4.5:** Jay Bird Shoals seabed elevation changes 86 to 98 months post-dredge (May 2017 to May 2018).



**Figure 4.6:** Jay Bird Shoals seabed elevation changes since project completion (March 2010 to May 2018).

## **5.0 ONGOING PLANNED OR PROPOSED ACTIVITIES**

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### **5.1 2018/19 Beach Renourishment Project**

The Village has received permits for the construction of a 1 Mey *interim* beach fill project at South Beach between the months of November 2018 and March 2019. The project borrow site is Jay Bird Shoals. Project bids will be received by the Village in mid-July 2018.

Globally, the purpose of the 2018/19 renourishment project is three-fold: 1.) to ensure that the updrift fillet of the terminal groin structure is full as required by State Statute, and in order to meet the project design intent for the “leaky” structure – which seeks to protect the downdrift shoreline of West Beach; 2.) to completely fill the existing sand tube groinfield such that a number of the groins which are now becoming subject to failure due to wear at their seaward tips can be replaced after the fill and 3.) to maintain a feeder beach intended to benefit the eastern half of South Beach through the placement of beach compatible sand eastward of a nodal point which exists at that location.

### **5.2 Sand Tube Groinfield Repair**

As noted above, a secondary precept of the beach fill project is to allow for the replacement of 6 or more sand tube groins which have become damaged over time. During renourishment, the groin field in its entirety will be covered by beach fill. This will allow a second contractor to excavate and replace any damaged tube “in the dry”. Typically, permits necessitate that all such work must be performed in non-turtle nesting months of the year. Existing permits allow for maintenance of the sand tube groins as long as their locations and lengths are not modified.

### **5.3 Development of 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 would be to ensure compliance with Permit conditions necessitating the maintenance of the updrift fillet associated with the 2015 terminal groin project. It was originally anticipated that the borrow site would be needed for limited sand placement along South Beach in 2018/19 between the terminal groin and Sta. 134+00. That conclusion resulted from the scheduled hiatus in the disposal of channel maintenance sand on Bald Head Island by the Wilmington District, USACOE. Pursuant to the exiting tenets of the Wilmington Sand Management Plan, all beach quality channel maintenance material excavated in the summer of 2018 would be placed at Oak Island.

In June 2017, the National Marine Fisheries Service (NMFS) issued concerns related to 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 the partially recovered area dredged in 2009/10 and the remaining undredged portion of the borrow site). For purposes of doing so, the Village was instructed to seek modifications to the existing terminal groin permits which had included proposals for renourishment of the shoreline bordering the terminal groin via the use of alternate sand sources – one of which included Jay Bird Shoals. With the virtual depletion the Jay Bird Shoals borrow site, necessitated by the 2018/19 renourishment project, the Village will reinitiate the permitting of a long-term borrow site located within Frying Pan Shoals.

## 6.0 SUMMARY AND CONCLUSIONS

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The most recent Wilmington Harbor Inner Ocean Bar maintenance dredging of Bald Head Shoal Channel Reach 2, and the Smith Island Channel segment is scheduled to be initiated in the summer months of May/June 2018. Approximately 1.15 Mcy of sand excavated during that operation will be placed at Oak Island pursuant to the terms of the Wilmington Harbor Sand Management Plan (WHSMP). The Contractor selected by the Wilmington District, USACOE is Weeks Marine, Inc. The Base Contract cost is \$14.1 M.

Subsequent to federal beach disposal on Oak Island in the summer of 2018, Bald Head Island will be the recipient of the next two *future* beach disposal operations in accordance with the continued implementation of a present day WHSMP. Prior to that time (the next disposal is *estimated* to be spring of 2021) the need to offset annual erosional losses at South Beach on Bald Head Island, as well as to maintain the updrift fillet of the terminal groin constructed in 2015, have necessitated that the Village design and permit a 1 Mcy *interim* beach fill project. The latter will be constructed between November 1, 2018 and April 1, 2019. Bids are tentatively set to be received on 18 July 2018. The project borrow site will be Jay Bird Shoals.

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 have been typically manifest in chronic rates of erosion and a consistent northerly 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 beach fill 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 2018, terminal groin project performance – based upon monitoring – has been both as intended – and as predicted.

To that end, the most recent beach monitoring surveys performed in 2017/18, indicate that the terminal groin’s updrift fillet contains approximately 250,000 cy. Without the structure, the significantly improved shoreline at this location resulting from federal beach disposal completed in April 2015 would have normally eroded back to the dune line with the residual sand fillet volume lost to the Cape Fear River channel. Interestingly, federal channel

condition surveys performed by the USACOE in the spring prior to the summer of 2018 maintenance project indicated that no maintenance dredging was required this year in Bald Head Reach 1 – the section of channel immediately adjacent to the terminal groin. Until recently, this section of navigation channel had experienced chronic shoaling resulting from littoral material derived from South Beach – and in particular beach fill material episodically placed by the Wilmington District, USACOE since 2000, or by the Village itself.

Between November 2000 and April 2015, Bald Head Island had received about 7.0 Mcy, mol of sand from the initial widening/deepening and four (4) subsequent maintenance dredging operations for the Wilmington Harbor Navigation Project entrance channel. In addition, the Village has placed another 2.1Mcy 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 9.1Mcy since 2000 at those two locations – with South Beach receiving some 75-80% of the total.

Conversely, the *gross* volumetric sediment *loss* over the November 2000 to May 2018 monitoring timeframe is conservatively computed at – 6,781,500 cy, or approximately – 387,500 cy per year – on “average”. This “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,” major storm events (such as Hurricane Matthew), 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 island’s littoral system is now adjusting to the quasi-stabilizing effect of the terminal groin in existence only since 2015. Along South Beach per se, there has been historically 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. Currently, within the 22,755 shoreline influenced by sand placed since 2000, some 2,301,300 cy remain in the littoral system (measured above elevation -16 ft. NGVD 29).

From the May 2017 to May 2018 monitoring data, it is clear that sediment losses along the various defined sections of shorefront – this year – are substantially less on average than last year. Most noteworthy was the 2017-2018 South Beach one year loss volume

(above -16 ft NGVD) of -270,500 cy compared to the 2016-2017 volumetric loss of -619,000 cy. South Beach in this instance is defined as the shorefront between STA 56+00 and STA 210+00.

Similarly, measured sand losses above the MHWL (i.e. from the beach berm only) for the same two periods were reduced from -161,900 cy (2016-17) to -46,000 cy (2017-18). Conversely, losses or gains above -16 ft. NGVD for West Beach, the Point shorefront northward of terminal groin and the Point shoreline southward of the terminal groin were very self-similar for each of the last two monitoring periods analyzed. The 2016-17 losses were to some degree indicative of a shoreline reconfiguration in response to the completion of the terminal groin in late 2015 as well as the equilibration of the 2015 federal beach disposal project.

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 in November 2008. Since that time, it is observed that East Beach undergoes 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. The most recent May 2018 survey data show a net shoreline accretion of approximately 56,400 cy (above elevation -16 ft NGVD) throughout the 6,000 ft East Beach shoreline lying northward of Cape Fear over the last 12 months. Between November 2008 and May 2018, the total change has been +289,000 cy.

Unfortunately, recent configurations of the Cape Fear spit deemed beneficial to East Beach have resulted in a high rate of erosion and duneline recession along the easternmost section of South Beach – directly seaward of the Shoals Club facility. For example, between 2000 and 2018, the average MHWL erosion rate at this general location has been about -13 ft/yr.

In 2017, the Village was required by Permit to perform the 7<sup>th</sup> year of monitoring for the Jay Bird Shoals borrow site utilized to construct the non-federal 1.85 Mcy beach fill sponsored by the Village in 09/10. The computed change within the monitored survey area (excavated and unexcavated) was a *net* gain of approximately 611,600 cy over the 86 month monitoring period following project construction. As noted above, the Village intends to build a 1 Mcy fill project in 2018/19 again utilizing the Jay Bird Shoal borrow site.

After the extension of the two marina entrance channel jetties in 2015, reduced shoaling within the navigation channel resulted in a corresponding reduced volume of disposal sand being placed along the Row Boat Row shoreline. Although the Village had

planned to continue to proactively bypass sand from the south jetty fillet (at the distal end of West Beach) to the Row Boat Row shoreline, it became clear that the existing four (4) low level groins would not be capable of providing an acceptable level of shoreline stabilization at that location – with a significant reduction in episodic sand placement.

Hence, during the last monitoring period, the Village initiated construction of two (2) detached rock breakwaters located north of the marina entrance seaward of the Row Boat Row shoreline. The original project proposed four (4) structures. To receive permission to construct during the months of the “moratorium”, the Village was required to reduce the project scope. Final acceptance of the project occurred in July 2017.

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. Another 24,000 cy were placed along a portion of West Beach as beach fill.

In the spring of 2017, the Village submitted permit applications accompanied by indepth 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 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 a long-term source of beach quality material sufficient to meet future South Beach renourishment requirements. It was originally anticipated that the borrow site would be needed for limited sand placement along South Beach in 2018/19 between the terminal groin and Sta. 134+00. That conclusion resulted from the scheduled hiatus in the disposal of channel maintenance sand on Bald Head Island by the Wilmington District, USACOE. Pursuant to the existing tenets of the Wilmington Harbor Sand Management Plan, all beach quality channel maintenance material excavated in the summer of 2018 was to be placed at Oak Island.

In June 2017, the National Marine Fisheries Service (NMFS) issued concerns related to 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 JBS borrow site. Accordingly, in consideration of the NMFS request the Village agreed to withdraw their application and to prioritize the use of the previously authorized borrow site permitted at Jay Bird Shoals (JBS) (including both the partially recovered area dredged in 2009/10 and the remaining undredged portion of the borrow site. For purposes of doing so, the Village was instructed to seek modifications to the existing terminal groin permits which had included proposals for renourishment of the shoreline bordering the terminal groin via the use of alternate sand sources – one of which included Jay Bird Shoals. With the anticipated depletion of the Jay Bird Shoals borrow site resulting from the 2018/19 renourishment project, the Village will need to consider reinitiating the permitting of a long term borrow site located within Frying Pan Shoals.

An important secondary precept of the upcoming (2018/19) beach fill project by the Village is to allow for the replacement of 6 or more sand tube groins which have become damaged over time. During renourishment, the groin field in its entirety will be covered by beach fill. This will allow a second contractor to excavate and replace various sand tube groins “in the dry”. Typically, permits necessitate that all such work must be performed in non-turtle nesting months of the year. Existing permits allow for “maintenance” of the sand tube groins as long as their locations and lengths are not modified.

The Permits for construction of the terminal groin at Bald Head Island stipulate that if the permittee elects to dredge more than 250,000 cy from the Jay Bird Shoals borrow site, limited additional monitoring of the eastern end of Oak Island must be performed. At the scheduled time of the next routine island wide survey at Bald Head Island (*i.e.* November 2018), the Village will initiate the requisite monitoring at Oak Island (Caswell Beach).

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