2018 Isle of Palms Restoration Project
Year 1 Monitoring Report

2019
MONITORING REPORT

Prepared for

City of Isle of Palms
Isle of Palms, South Carolina

COASTAL SCIENCE & ENGINEERING

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2018 Isle of Palms Restoration Project

Year 1 (2019) Monitoring Report

Annual Beach and Inshore Surveys

Prepared for:

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1.0 INTRODUCTION

This monitoring report is submitted to the City of Isle of Palms, SC (IOP) by Coastal Science & Engineering (CSE) as part of an ongoing, beach monitoring effort which began in 2007 as part of the planning for the 2008 Isle of Palms Beach Restoration Project (P/N 2007–02631–2IG) (CSE 2008). This report follows earlier monitoring reports submitted annually to the City as well as additional reports and engineering documents related to shoal management and beach nourishment activities (P/N 2010–1041–2IG; 2016–00803 (CSE 2019). The report details the beach condition as surveyed in June 2019 and compares this condition with selected earlier dates including the pre-2018 project condition. This is the first annual monitoring report following the 2018 nourishment project. Certain portions of this report detail monitoring efforts required by state and federal permit conditions for the 2018 project.

Analyses in this report include detailed beach volume change along the ~7-mile beach which spans from Breach Inlet to Dewees Inlet. It also includes comparisons of earlier beach conditions with the present condition, calculation of annual erosion rates, and measurements of linear shoreline change. Large-scale morphologic changes occurring in Breach Inlet and Dewees Inlet are also discussed along with the anticipated impacts of these shifting shoals on the future beach condition. Ground and aerial photographs are included to provide a visual representation of the beach condition and include identifying areas with dune escarpments, showing dry-beach width, and showing areas with existing or potential damage due to erosion.

This report also discusses general information about storm events occurring in 2019 and their impact on the beach. Observations of dune escarpments, vegetative growth, sand fence installations, and other beach management considerations are discussed.

2018 Nourishment Project Summary

Sponsor: The beach restoration project was funded by the City of Isle of Palms, the State of South Carolina, Wild Dunes Community Association (including individual property owners and regimes), and Wild Dunes Resort. The City of Isle of Palms served as project owner and administrator.

Engineer: Coastal Science & Engineering (CSE, Columbia, SC)

Contractor: Great Lakes Dredge & Dock Co. (Oak Brook, IL)

Permit: SC048C–OCRM USACE P/N 2016–00803

Scope: Placement of 1,676,518 cubic yards (cy) of sand in the following areas.

Reach 1 (4,400 lf)	Sta 236+00–280+00	942,320 cy	214 cy/ft
Reach 2 (4,400 lf)	Sta 280+00–324+00	734,198 cy	167 cy/ft

Const. Cost: $13,545,585.70

Nourishment Schedule

- 13 December 2017 –Mobilization of equipment and pipe
- 16 January 2018 –First pumping near Beach Club Villas
- 24 February 2018 –Completion of Reach 1
- 23 March 2018 –Completion of Reach 2
- 1 April 2018 –All equipment removed from beach and offshore zone – Project Complete

2.0 SETTING

2.1 Project Setting

The Isle of Palms is a ~7-mile-long barrier island located north of Charleston Harbor. It has a southeast facing shoreline bounded by Breach Inlet and Sullivans Island to the south, Dewees Inlet, and Dewees Island to the north (Figure 2.1). The northern end of the island is wider due to periodic sand additions through shoal bypass events (Kana 2002, Traynum and Kaczkowski 2015). These events result in a net accumulation of sand over several decades, which builds the updrift end of the island. The downcoast end of the island is narrower and terminates in a recurve spit at Breach Inlet. These characteristic morphologies are typical of “drumstick” barrier islands (Hayes 1979) and are present along mixed energy coasts where both tides and waves are dominant influences on the shoreline (Figure 2.1).

The eastern end of the island is a dynamic shoreline, influenced by the shoal bypassing of the Dewees Inlet ebb-tidal delta. Figure 2.2 shows aerial images of the east end of the island from the period of 1944–1963. The photos document a large-scale shoal bypass event that impacted the shoreline encompassing the area that is now known as Wild Dunes. The shoal stretched for approximately 2 miles along the eastern end of the island and was so large that a new, ephemeral, barrier beach was established over 1,000 feet (ft) seaward of the previous shoreline. This new beach ridge trapped a water-filled lagoon that was flushed by a small channel and the shoal attached to the beach sometime between 1944 and 1949. From 1949 to 1957, the shoal slowly merged with the beach and by 1963, had completely attached to the upland beach, eliminating the lagoon. The emergence of this large shoal appears to be a result of the merging of several shoals in the delta partially visible in the 1944 image, including two visible shoals at the northeastern tip of the island. It is likely these shoals were at one point a trailing ebb spit, and the sand from this spit merged with a shoal further west to create the large sand body that formed the lagoon. The shoal ultimately added well over 1,000,000 cy of sand to the beach.

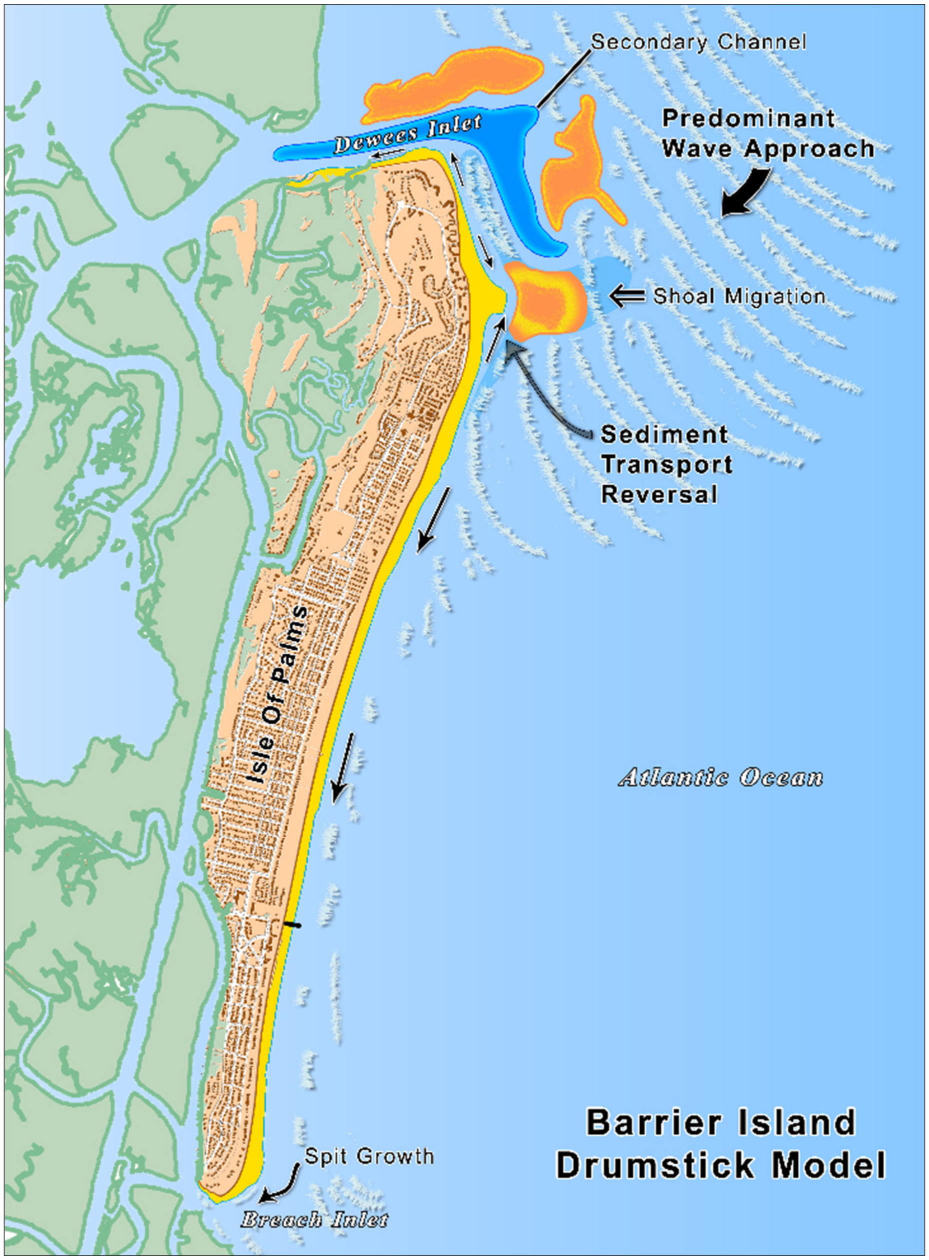

FIGURE 2.1. Schematic of the Isle of Palms showing the wider northeast end characteristic of a "drumstick" barrier island.

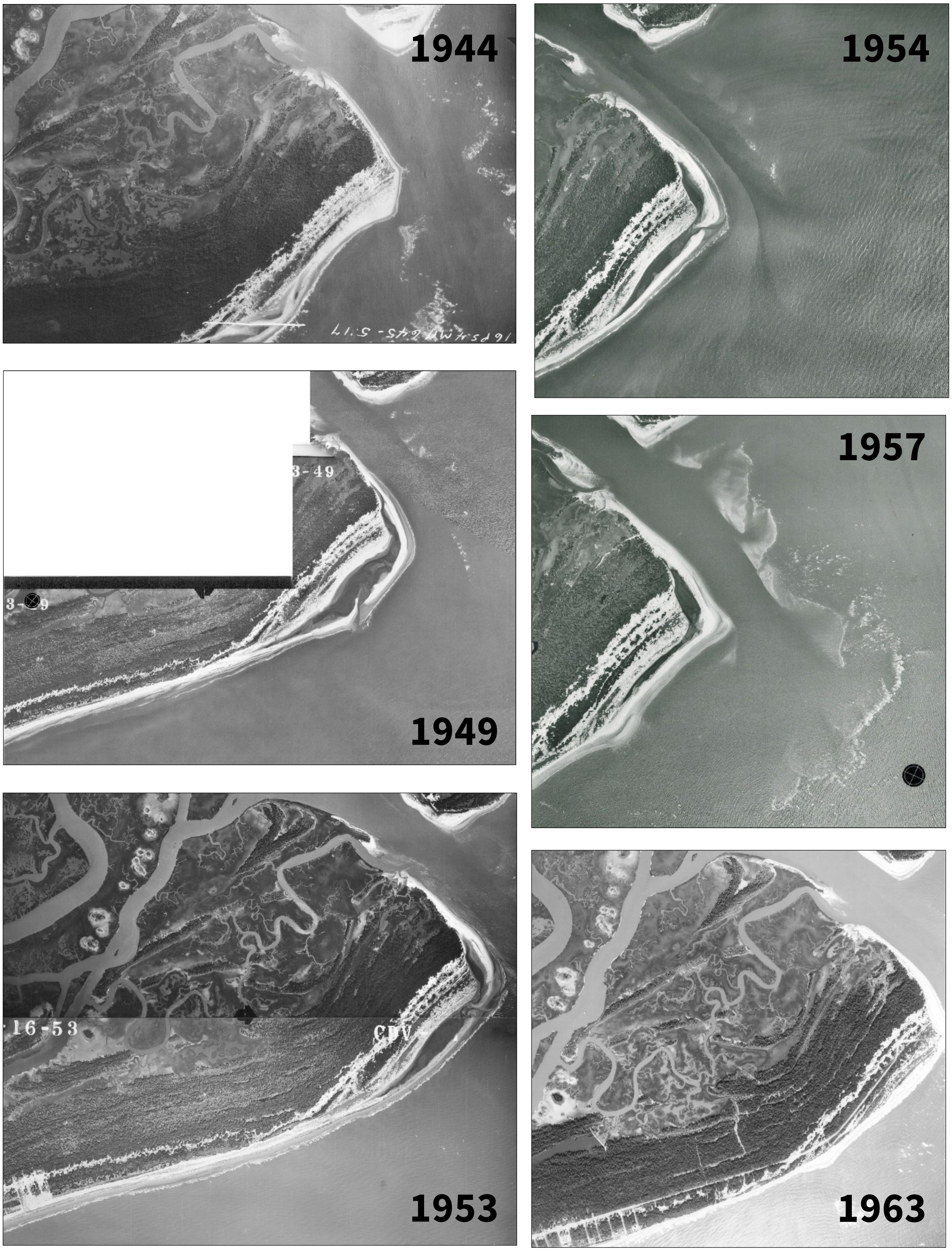

FIGURE 2.2. Historical aerials from CSE 2010 report page 56 (Figure 3.35).

Photo sequence begins (left column from top) in 1944, 1949, and 1953, then continues (right column from top) through 1954, 1957, and 1963. [Note that images are not at the same scale.]

The shoal had the effect of building the shoreline at the northeast end of the island seaward ~500 ft between 1944 and 1963; however, much of the accretion would be subject to future erosion as the shoal sand spread to downcoast areas. In short, the eastern end of the island (east of the present-day Beach Club Villas) was developed on sand that recently accreted to the beach, and not on stable upland area that had existed for decades like the majority of the remainder of the island. Much of the development built in the late 1970s and early 1980s was on areas that were likely wet-sand beach in the 1930s–1940s.

Following the large-scale event mentioned previously, the eastern end of the island continued to experience shoal-bypass events, though all were of substantially smaller in magnitude than the 1940s–1960s event. These events generally attached along the central Wild Dunes area and are more characteristic of shoal-bypass events characterized by Kana (2002), with distinct stages of 1) emergence, 2) migration and attachment, and 3) spreading (Fig 2.3). These events have been responsible for focused erosion along various portions of the Wild Dunes area, including two events in the 1980s, another in the late 1990s, and a large event in the mid-2000s that led to the 2008 beach nourishment project.

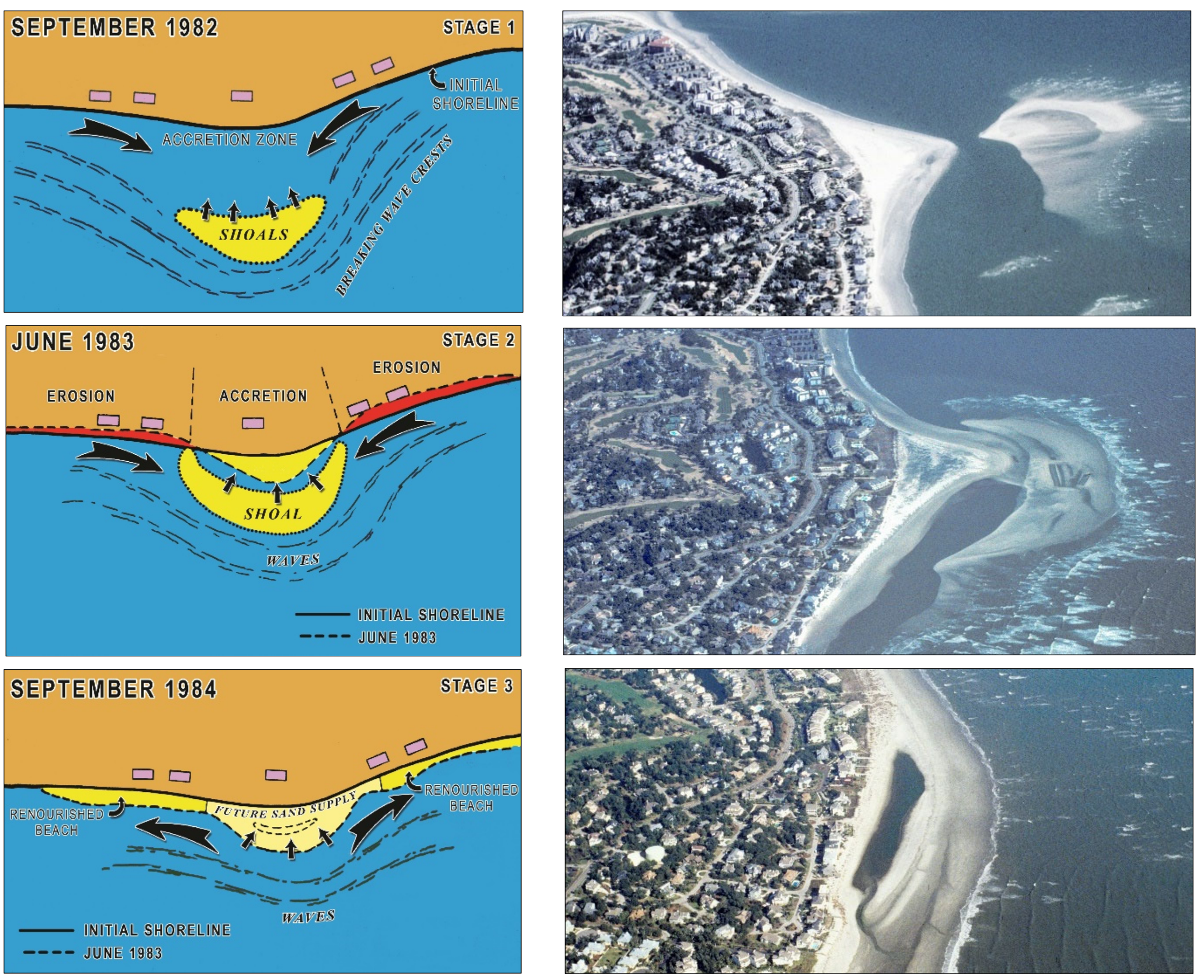

FIGURE 2.3. **[LEFT]** Schematic of the shoal-bypass cycle originally modeled from a bypass event at Isle of Palms. **[RIGHT]** A shoal-bypass event at northeastern Isle of Palms corresponding to the schematic. The upper photo shows a shoal in Stage 1 (1996). The middle image illustrates Stage 2 (1997). The bottom photo shows Stage 3 (1998).

The addition of sand from shoal bypassing at the east end of the island has contributed to relatively steady accretion along the central and western ends, resulting in a wide setback for most properties west of 58th Avenue. In the 1970s, properties along 46th Ave to 53rd Ave had few dunes and had constructed a seawall, and several groins were built by 1984, as shown in Figure 2.4. Since 1984, the beach has accreted rapidly, and all evidence of groins or seawalls have been buried.

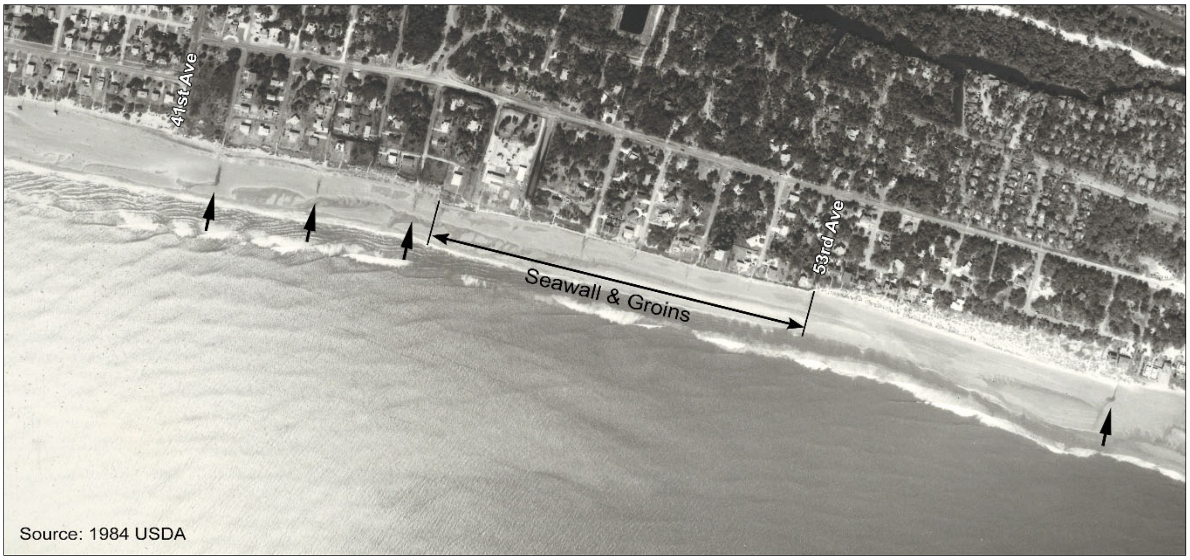

FIGURE 2.4. A seawall and groins were in place in 1984 between 46th Ave to 53rd Ave. Today, due to rapid accretion, these groins and seawalls have been buried.

2.2 Previous Projects

As mentioned in the previous section, erosion mitigation measures at Isle of Palms began by the 1970s with the construction of seawalls and groins in the area between 41st Ave and 53rd Ave. Another groin was visible in 1973 near present-day 58th Avenue. In 1981, a concrete-filled geotextile bag groin was built near the tee of the 17th hole of the Links Course to reduce the erosion threat along the Dewees Inlet shoreline. In 1983, in response to a shoal attachment event, homeowners along Seagrove and Beach Club Villas constructed a rubble mound seawall (Kana, Williams, and Stevens 1985). Sand scraping was also attempted but proved insufficient to preserve a beach under the extreme erosion pressure. In late 1983, the first nourishment project was completed using sand dredged from the new marina. Approximately 350,000 cy of sand was added to the erosional zones adjacent to the shoal as the shoal was beginning stage three of the bypass cycle. This resulted in a dramatic increase in beach width as the nourishment sand added to the accretional shoal sand.

From 1984 to 2007, sand scraping from accretional areas was the only mitigation attempted to combat shoal-induced erosion. CSE is aware of scraping efforts circa 1983, 1987, 1998 (Figure 2.3) which all attempted to move sand to the erosional arcs. From 2004–2007, sandbags were installed along several structures from Shipwatch to Ocean Club in an attempt to prevent additional erosion (Figure 2.5).

FIGURE 2.5. To prevent additional erosion, sandbags were installed along several structures from Shipwatch to Ocean Club from 2004 to 2007.

Erosion reached such a severe condition in 2007 that there was little-to-no beach along portions of the east end of the island, even at low tide (Figure 2.6). The Wild Dunes Community Association contracted with CSE to evaluate the causes of erosion and prepare a feasibility study outlining alternatives for restoration (CSE 2007). CSE recommended nourishing the beach using sand from an offshore borrow area and began the steps to obtain a permit for the work. The City of Isle of Palms then took ownership of the project and served as the applicant for the permits. Permits were obtained (P/N 2007–02631–2IG), and the City contracted with Weeks Marine for a project including nourishment of 847,000 cy of sand over 10,200 lf (linear feet) of beach. The project extended from 200 ft north of 53rd Avenue to the 17th green of the Links Course.

FIGURE 2.6. Isle of Palms in 2007 prior to beach nourishment.

The 2008 project was completed between 15 May and 15 July 2008 (Figure 2.7). As part of the project, Weeks Marine removed all sandbags from the project area, which totaled ~9,400 bags. Homeowners removed an additional 4,680 bags from under buildings. Averaging ~25,000 cy of sand per day, the dredge *RS Weeks* pumped sand from three borrow areas 2–3 miles from the beach. The nourishment was placed in three reaches and included ~270,000 cy between 53rd Ave and Dune Crest Ln (Reach A), 552,400 cy from Mariners Walk to the 18th Fairway (Reach B), and 25,000 cy from the 18th tee to the 17th fairway (Reach C). Figure 2.8 shows the layout of the 2008 project. Figure 2.9 shows a post-project aerial photo (2008) which compares to the project area before renourishment (2007).

FIGURE 2.7. **[ABOVE]** 2008 beach nourishment project (completed on 15 July 2008).

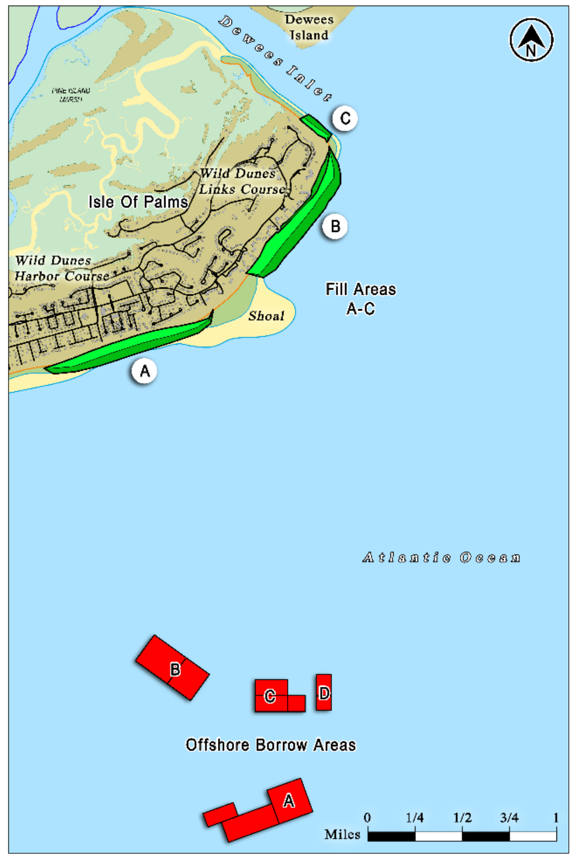

FIGURE 2.8. **[RIGHT]** 2008 nourishment project map.

FIGURE 2.9. **[LEFT]** Isle of Palms in 2008 following beach nourishment. **[RIGHT]** The project area in 2007 prior to nourishment.

Following the 2008 project, CSE monitored the beach at least annually to document beach volume changes and performance of the project. Two shoal-bypass events occurred in 2009 and 2010, and another larger event was beginning to emerge offshore in 2010. In anticipation of the need for potential remediation (and after observation of an erosional hotspot forming near the Ocean Club/Seascape area), the City sought a permit for manipulation of the accretional shoal area to expedite attachment and move sand to the erosional hotspots. A project was completed in 2012 that transferred ~80,000 cy of sand from the central portion of Wild Dunes to the east end near the Ocean Club. A larger project was completed in late 2014 through early 2015 which moved ~280,000 cy from two accretional areas (an attaching shoal centered near Beach Club Villas and from 53rd to 56th Avenue) to the beach fronting Beachwood East (~70,000 cy) and the area fronting Seascape/Ocean Club/18th hole (~210,000 cy). The project sought to transfer as much sand as possible from the shoal to the beach (Figure 2.10).

FIGURE 2.10. January 2015 aerial image of the 2014–2015 shoal management project showing equipment transferring sand from an attaching shoal to the eroded beach.

2.3 2018 Project

From 2015 to 2018, the beach along the eastern end of the island continued to be dynamic in response to a shoal attachment event. Erosional hotpots were present along Beachwood East and near the 18th hole of the Links Course. Overall, the beach condition around 2016 was eroded to the point where the City opted to pursue a permit for a large-scale renourishment project. CSE was retained to provide engineering services necessary to complete a permit application package with associated reports and documents. The project design called for the addition of 1,676,000 cy of sand along the eastern end of the island, with maximum fill densities of over 300 cubic yards per foot (cy/ft). In the largest fill areas, the design fill would add over 600 ft of dry sand beach.

Engineering for the project began with volume analysis to determine the volume of sand required to restore the beach to a desired condition. CSE initially prepared a fill plan based on the beach condition as it existed in 2015 when a recent shoal attachment created a bulge in the shoreline in the center of the project area. Following hurricane impacts in 2015, 2016, and 2017, as well as erosion of the attached shoal, CSE modified the fill template to account for erosion occurring in the center of the project area, as well as substantial accretion at the eastern end. The final fill plan is shown in Table 2.1 and graphically in Figure 2.11. The data reflected show the final design prior to a change order issued during the project that added additional sand to the center of the project area. The fill density averaged 161.5 cy/ft over the length of the project area, with the maximum fill volume of ~325 cy/ft. The nourishment volume decreased along the center of the project area, with a minimum of 50 cy/ft being added.

The berm width ranged in distance based on the fill volume design, reaching as much as 600 ft in the highest density areas. The berm width decreased along the central portion of the project area, as the pre-project beach was wider than adjacent areas. The berm width at either end of the project tapered to the existing dune line (Figs 2.11 and 2.12).

TABLE 2.1. The modified final 2018 fill template designed to account for erosion occurring in the center of the project area, as well as substantial accretion at the eastern end of the island.

Station	Pre-Project Unit Volume (cy/ft)	Fill Vol (cy/ft)	Design Fill Vol (cy/ft)	Post-Project Unit Volume (cy/ft)
230	321.6	**0.0**	321.6	351.6
232	338.9	**0.0**	338.9	379.0
234	298.4	**0.0**	298.4	349.0
236	262.7	**0.0**	262.7	329.7
238	258.3	**26.4**	284.8	358.5
240	272.2	**59.0**	331.2	399.6
242	255.7	**73.9**	329.6	415.9
244	295.9	**170.8**	466.7	499.0
246	283.7	**233.3**	517.0	526.5
248	289.5	**277.7**	567.2	562.6
250	306.2	**296.6**	602.8	587.9
252	283.8	**307.5**	591.2	554.5
254	267.2	**315.2**	582.4	539.7
256	228.9	**320.6**	549.6	524.7
258	251.7	**325.8**	577.6	544.6
260	275.5	**314.6**	590.2	547.9
262	306.5	**298.2**	604.7	563.4
264	333.8	**260.0**	593.8	595.7
266	382.5	**240.0**	622.5	620.5
268	376.4	**210.0**	586.4	543.5
270	359.2	**150.0**	509.2	549.8
272	372.9	**120.0**	492.9	537.1
274	355.6	**90.0**	445.6	515.2
276	442.8	**75.0**	517.8	576.2
278	426.6	**60.0**	486.6	587.3
280	534.3	**60.0**	594.3	771.4
282	436.3	**60.0**	496.3	652.7
284	450.9	**50.0**	500.9	746.0
286	520.6	**50.0**	570.6	760.5
288	456.4	**50.0**	506.4	705.7
290	444.9	**60.0**	504.9	657.8
292	479.3	**60.0**	539.3	672.8
294	526.0	**80.0**	606.0	686.2
296	511.1	**110.0**	621.1	655.5
298	498.4	**130.0**	628.4	634.5
300	487.0	**160.0**	647.0	630.9
302	472.4	**190.0**	662.4	622.6
304	436.9	**225.0**	661.9	597.7
306	442.7	**250.0**	692.7	614.1
308	392.2	**250.0**	642.2	571.3
310	376.4	**250.0**	626.4	560.2
312	361.0	**225.0**	586.0	546.5
314	320.2	**180.0**	500.2	488.9
316	415.6	**140.0**	555.6	560.5
318	427.6	**90.0**	517.6	529.7
320	449.0	**30.0**	479.0	526.7
322	449.8	**20.0**	469.8	495.5
324	418.4	**0.0**	418.4	450.9
326	415.0	**0.0**	415.0	434.3
328	420.0	**0.0**	420.0	451.0

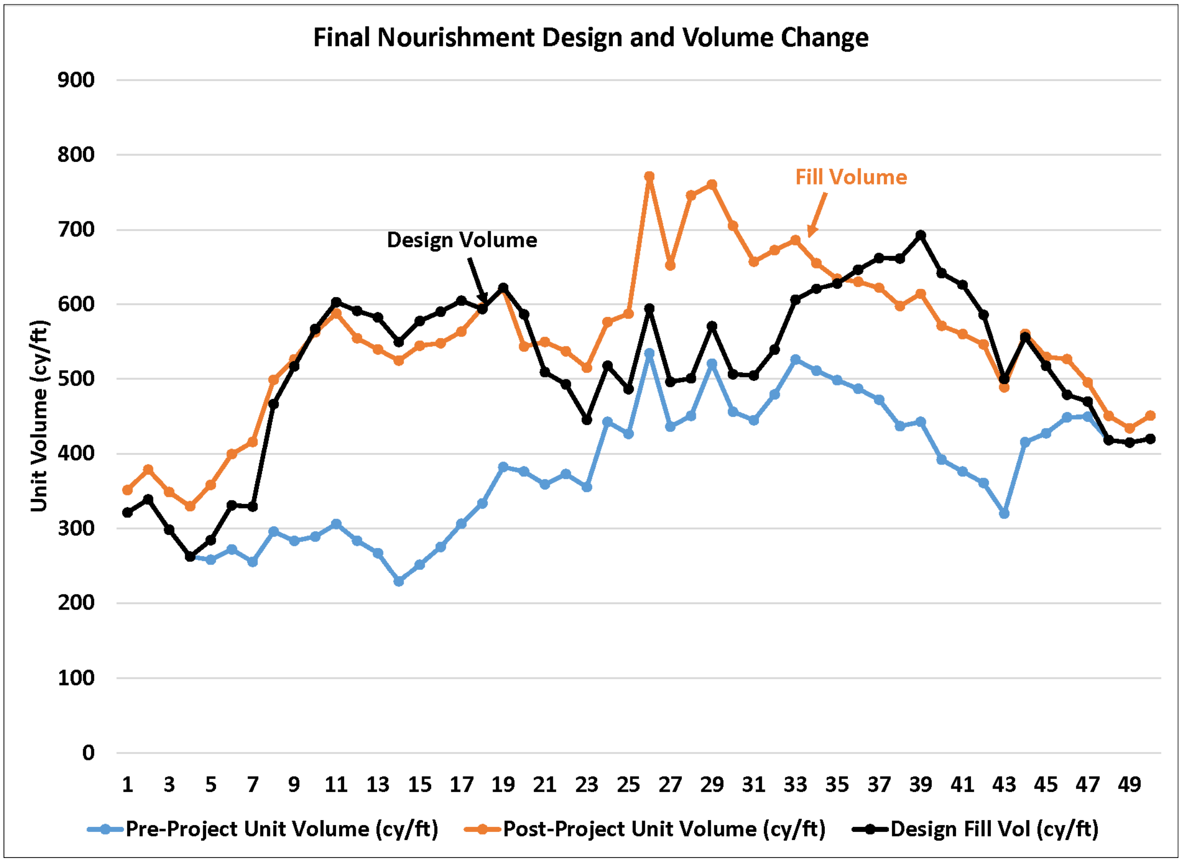

FIGURE 2.11. A graphic representation of the 2018 final fill template (shown in TABLE 2.2).

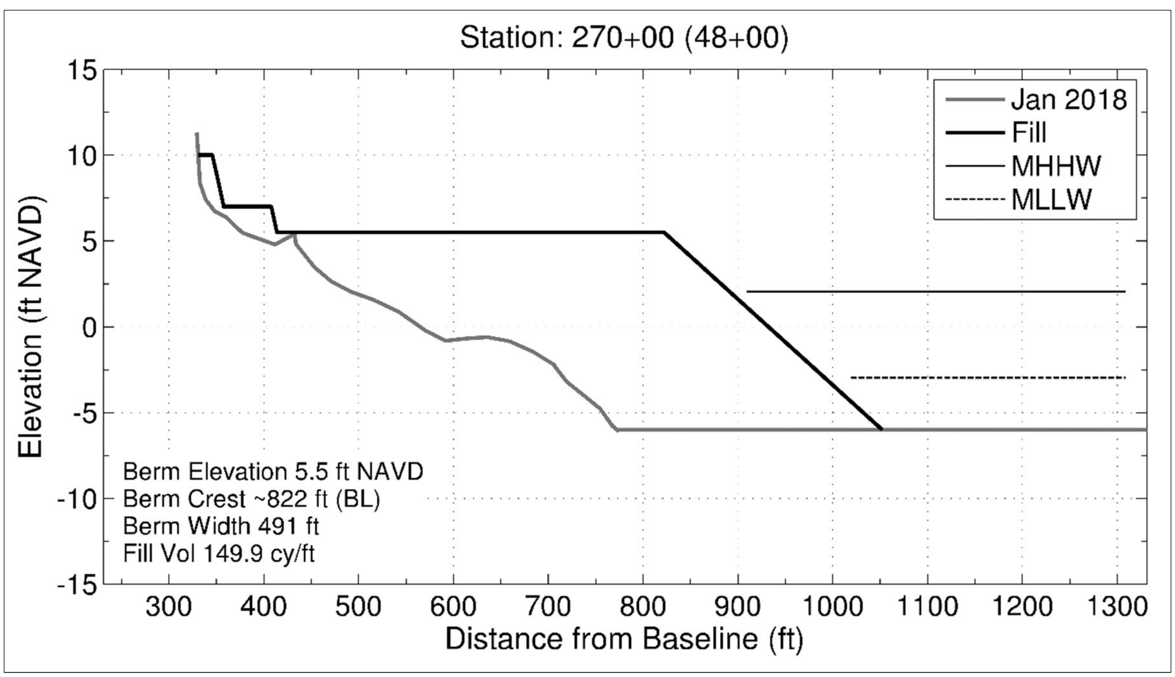

FIGURE 2.12. The design 2018 fill profile which plans for a dune, storm berm, fill berm, and sloping section.

The project was completed between 16 January and 23 March 2018. Table 2.2 shows the design and actual fill volumes determined by TI Coastal. The “Design Volume” column represents the volume of sand above the before dredge (BD) condition and below the design template. Note that this volume is less than the final contract amount due to accretion occurring between the pre-project design surveys and TI Coastal’s BD survey. The “Fill Volume” column represents the total amount of sand placed on the beach. The rows highlighted in yellow represent the area repumped following the Hurricane *Irma* change order. In total, 1,725,942 cy of sand was added to the project area. Of that total, 974,374 cy were pumped west of Station 280+00 (Property Owners Beach House), and 751,568 cy were placed east of Station 280+00. The 49,424 cy of sand placed above the pay quantity of 1,676,518 cy was not a pay quantity.

TABLE 2.2. Design and actual fill volumes determined by TI Coastal.

Station	Design Volume (cy)	Fill Volume (cy)	Station	Design Volume (cy)	Fill Volume (cy)
236+00	0		289+00	11,105	11,132
237+00	804	884	290+00	11,049	11,207
238+00	2,205	3,896	291+00	11,063	11,254
239+00	3,170	5,926	292+00	11,125	11,402
240+00	4,061	8,310	293+00	11,333	11,170
241+00	6,061	11,356	294+00	11,347	10,909
242+00	9,107	13,518	295+00	11,327	11,444
243+00	12,503	15,683	296+00	11,308	11,948
244+00	16,387	18,628	297+00	11,631	11,995
245+00	19,920	21,625	298+00	12,201	12,333
246+00	22,899	24,474	299+00	12,236	12,523
247+00	25,585	27,183	300+00	12,241	13,075
248+00	27,455	28,754	301+00	12,913	13,281
249+00	28,789	28,239	302+00	13,948	14,104
250+00	30,167	31,479	303+00	15,069	15,477
251+00	31,181	32,451	304+00	16,027	16,373
252+00	31,470	33,976	305+00	16,586	16,906
253+00	31,426	32,359	306+00	17,129	17,478
254+00	32,042	32,369	307+00	17,448	18,473
255+00	32,443	30,318	308+00	17,536	18,527
256+00	33,719	34,416	309+00	17,610	18,244
257+00	34,963	35,931	310+00	17,555	18,307
258+00	33,841	34,875	311+00	17,757	18,698
259+00	32,952	33,558	312+00	17,687	18,582
260+00	32,567	32,868	313+00	17,120	17,922
261+00	31,827	32,428	314+00	16,452	16,991
262+00	30,985	32,027	315+00	15,600	16,329
263+00	29,682	30,800	316+00	13,887	14,910
264+00	27,782	28,388	317+00	11,634	12,404
265+00	26,261	26,810	318+00	9,514	10,179
266+00	25,145	25,880	319+00	7,189	8,952
267+00	23,634	24,314	320+00	5,076	8,638
268+00	22,321	22,946	321+00	3,256	7,093
269+00	21,015	22,001	322+00	1,831	4,643
270+00	18,789	19,955	323+00	1,030	2,780
271+00	16,199	17,330	324+00	631	1,609
272+00	13,753	14,883	279+00	0	0
273+00	11,886	12,419	279+80	1,782	1,812
274+00	10,815	11,146	279+90.404	12,904	14,394
275+00	10,220	10,461	280+00	14,782	16,133
276+00	10,142	10,235	281+00	12,116	12,366
277+00	10,368	10,381	282+00	12,265	12,707
278+00	10,533	10,394	283+00	12,658	13,602
279+00	10,860	10,903	284+00	12,539	13,338
279+80	8,977	9,312	285+00	12,243	12,875
279+90.404	8,459	9,138	286+00	12,229	12,552
280+00	8,460	9,147	287+00	12,153	12,283
281+00	11,040	11,720	288+00	11,948	12,239
282+00	11,006	11,551	289+00	12,056	12,328
283+00	11,091	11,565	290+00	12,171	12,270
284+00	11,120	11,190	291+00	11,992	11,919
285+00	10,931	10,094	292+00	10,418	10,852
286+00	10,903	10,901	293+00	6,838	8,118
287+00	11,171	11,319	294+00	3,503	4,813
288+00	11,218	11,336	**Total**	**1,635,358**	**1,725,942**

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3.0 METHODS

Monitoring efforts for the present report were performed in June 2019. Changes in the volume of sand in the active beach zone were evaluated by obtaining topographic and bathymetric data along shore-perpendicular transects at established locations along the beach (herein referred to as the baseline) (Fig 3.1). The present baseline spans from the center of the Breach Inlet Bridge (Station 0+00) and continues to Cedar Creek spit at the northeastern end of the island (Station 376+00). Stationing relates to the distance along the shore with the number before the "+" symbol representing 100 feet (ft). Therefore, Station 36+00 is 3,600 ft from Station 0+00. The baseline is generally set landward of the present active beach to allow for future erosion/accretion.

Topographic data were collected via RTK-GPS (Trimble™ R8 GNSS), which provides position and elevation measurements at centimeter accuracy. Beach profiles were obtained by collecting data at low tide along the dunes, berm, and active beach to low-tide wading depth. Overwater work was then performed at high tide to overlap the land-based work (Fig 3.2) and was collected with RTK-GPS coupled with an Odom CV100™ precision echosounder mounted on CSE's survey vessel, the *RV Southern Echo*.

Profiles were collected from the most landward accessible point in the dune system to a minimum of 1,500 ft from the baseline. Profiles along the northeast end of the island extended up to 6,000 ft offshore to encompass the shoals associated with Dewees Inlet. Alongshore spacing of the profiles ranged from 200 ft to 1,000 ft with the more closely spaced profiles north of 53rd Avenue and along Breach Inlet. Comparative profiles from CSE's monitoring efforts are shown in Appendix A. The complexity of areas impacted by inlets requires more detailed analysis (closer profile spacing) to fully incorporate volume changes associated with shoal-bypassing events and inlet migration.

To better understand regional sand volume changes, seven reaches were defined along the Isle of Palms. By combining several profiles into a reach, it is easier to identify overall sediment gains and losses over large portions of the beach. In the project area, the reaches differ from reaches used during construction so as to encompass areas where no work was performed.

FIGURE 3.1. Baseline map of Isle of Palms showing the reference line used to establish monitoring profiles. Stationing increases to the north from Breach Inlet.

FIGURE 3.2. Surveying beach profiles involves collection of land-based data at low-tide and hydrographic data collection overlapping the land-based work.

The reaches used for monitoring purposes are shown in Figure 2.3 and are defined as follows:

Reach 1	0+00 to OCRM 3115	Breach Inlet to 6th Avenue
Reach 2	OCRM 3115 to OCRM 3125	6th Avenue to Sea Cabins Pier
Reach 3	OCRM 3125 to OCRM 3140	Sea Cabins Pier to 31st Avenue
Reach 4	OCRM 3140 to 222+00	31st Avenue to 53rd Avenue
Reach 5	222+00 to 280+00	53rd Avenue to Wild Dunes Property Owners Beach House
Reach 6	280+00 to 328+00	Wild Dunes Property Owners Beach House to Dewees Inlet
Reach 7	330+00 to 370+00	Dewees Inlet Shoreline

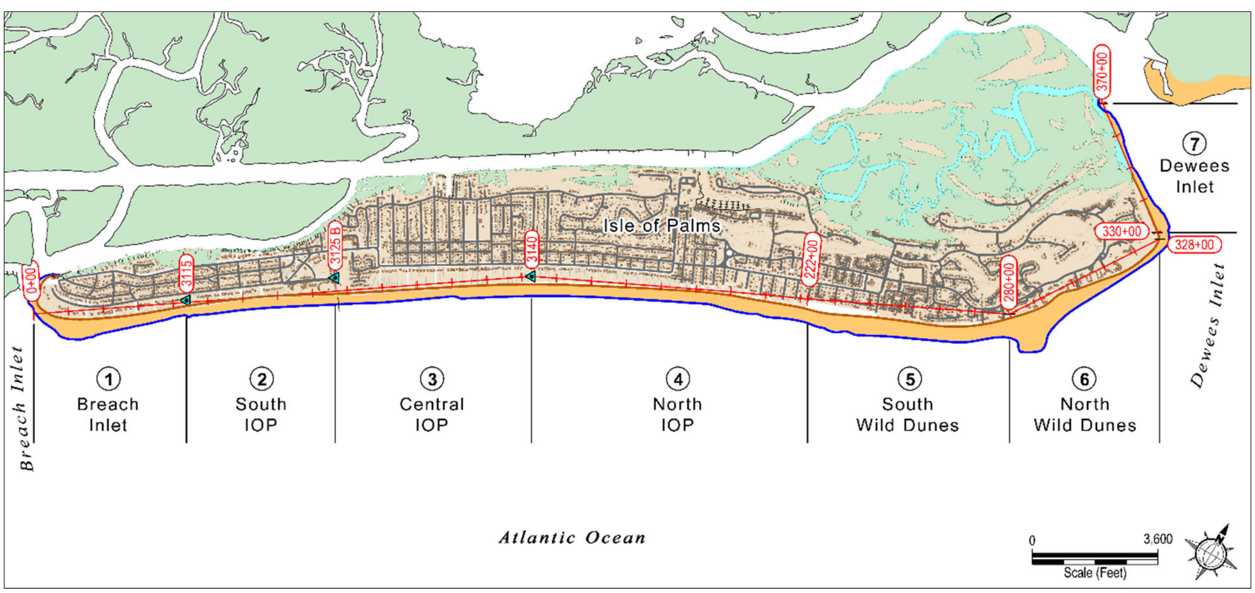

FIGURE 3.3. Reach limits used in the present monitoring report.

To determine changes in beach volume along Isle of Palms, beach profile data were entered into CSE's in-house custom software, Beach Profile Analysis System (BPAS), which converts 2D profile data in x–y (distance–elevation) format to 3D volumes. The software provides a quantitative and objective way of determining ideal minimum beach profiles and how the sand volume per unit length of shoreline compares with the desired condition. It also provides an accurate method of comparing historical profiles—as the volume method measures sand volumes in the active beach zone rather than extrapolating volumes based on single-contour shoreline position (ie – from aerial photography). Unit-volume calculations can distinguish the quantity of sediment in the dunes, on the dry beach, in the intertidal zone to wading depth, and in the remaining area offshore to the approximate limit of profile change (closure depth).

Figure 3.4 depicts the profile volume concept. The reference boundaries are site-specific, but ideally, encompass the entire zone over which sand moves each year. Sand volume was calculated between the primary dune and between −10 ft and −18 ft NAVD. The lower calculation limit was site-specific, as profiles in the center of the island and along Dewees Inlet generally have deeper closure depths than areas in the unstable inlet/shoal zones. Comparative volumes and volume changes were computed using standard procedures (average-end-area method, in which the average of the area under the profiles computed at the ends of each cell is multiplied by the length of the cell to determine the cell's sand volume). Certain adjustments were made to account for changes in the baseline direction and for volumes at the turn in the baseline at Dewees Inlet.

Note that for the present report, several adjustments were made to the calculation limits for profiles showing significant erosion in recent years. The erosion has resulted in the active beach moving landward into areas that were not previously included in volume measures. Profile volumes for all previous surveys were recomputed using these new limits to provide accurate comparisons. This results in report volumes for a given year being slightly different than volumes reported in earlier reports.

Sand volumes for offshore areas were calculated from digital terrain models (DTMs) produced from MATLAB® and AutoCAD® Civil 3D®. DTMs are digital 3D representations of the topography and bathymetry of an area and are useful for calculating changes in contour positions and calculating sediment volumes. Position data were entered into software as x–y–z coordinates and were processed to provide cross-section profiles and volumes. DTMs from the 2015 data collections were compared with earlier collections to determine changes in shoal positions and volumes. Color contour maps were also produced from the DTMs.

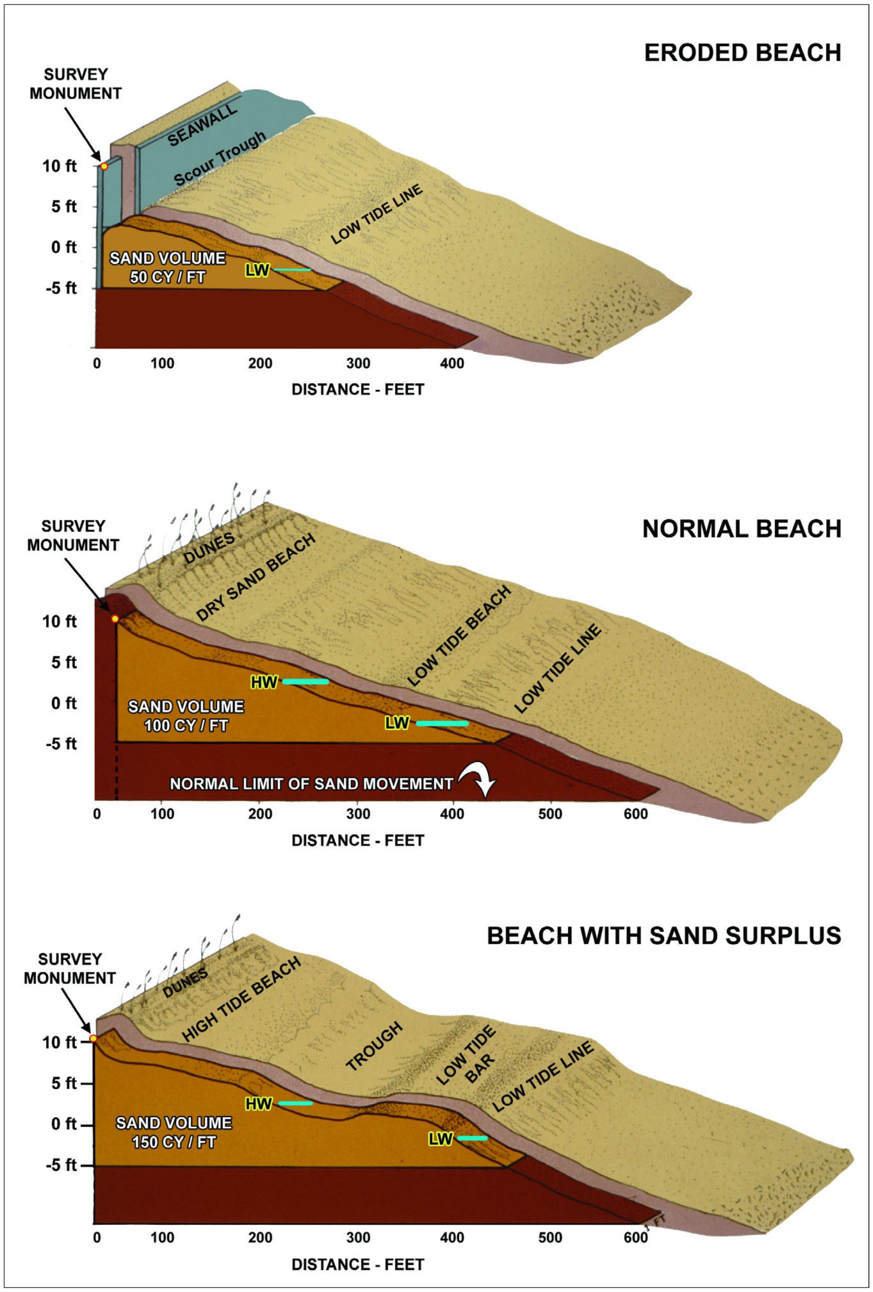

FIGURE 3.4. Illustration of the profile volume concept.

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4.0 RESULTS

Results of the beach monitoring effort presented in the following sections will focus on changes occurring since the 2018 project, but will also address the condition relative to earlier periods, such as the pre-2008 project condition. CSE attempts to simplify the discussion of beach changes by focusing on larger reaches or areas rather than change occurring at a single profile; however, individual profiles are useful in visualizing how the shape of the beach changes over time, how shoals migrate onshore, and how the beach condition exists in front of specific properties or features. Volume change will first be reported for the entire island and will identify overall trends occurring between 2018 and 2019. The next sections will focus on changes occurring in Dewees and Breach Inlets followed by localized changes in Reaches 1–7.

4.1 Island-wide Changes

The Isle of Palm's beach lost 234,583 cy of sand between April 2018 and June 2019. Figure 4.1 shows a map of the island with the distribution of volume change as colored lines. In the figure, warmer colors indicate erosion, while cooler colors show areas that gained sand. The image shows that there were erosional hotspots along the eastern end of the island and along the area from 3rd Ave to 12th Ave. Another erosional hotspot was present between 32nd and 38th Ave. Accretion was measured along most of the central portion of the island, especially just west of the 2018 project area and at the northeast corner of the island. Figure 4.2 provides a graph of the beach volume change for each profile line. Overall, the island holds 1,280,000 cy more sand than the 2017 pre-nourishment condition, and 1,165,000 cy more sand than in 2009 (Figure 4.3). Details of beach volume change for each reach of the island are discussed in the following sections.

Tables 4.1 and 4.2 provide beach volume data for selected dates since 2008 for each project reach and each monitoring profile. Table 4.1 shows the beach volume change over the past year ranged from losses of 22–25 cy/ft per year in reaches 5 and 6 to gains of 8 cy/ft per year in reach 4 (just downcoast of the project area). Table 4.2 provides unit volumes for each line, with the 2018 project area highlighted.

FIGURE 4.1. Line map showing erosion and accretion patterns over Isle of Palms from 2018–2019.

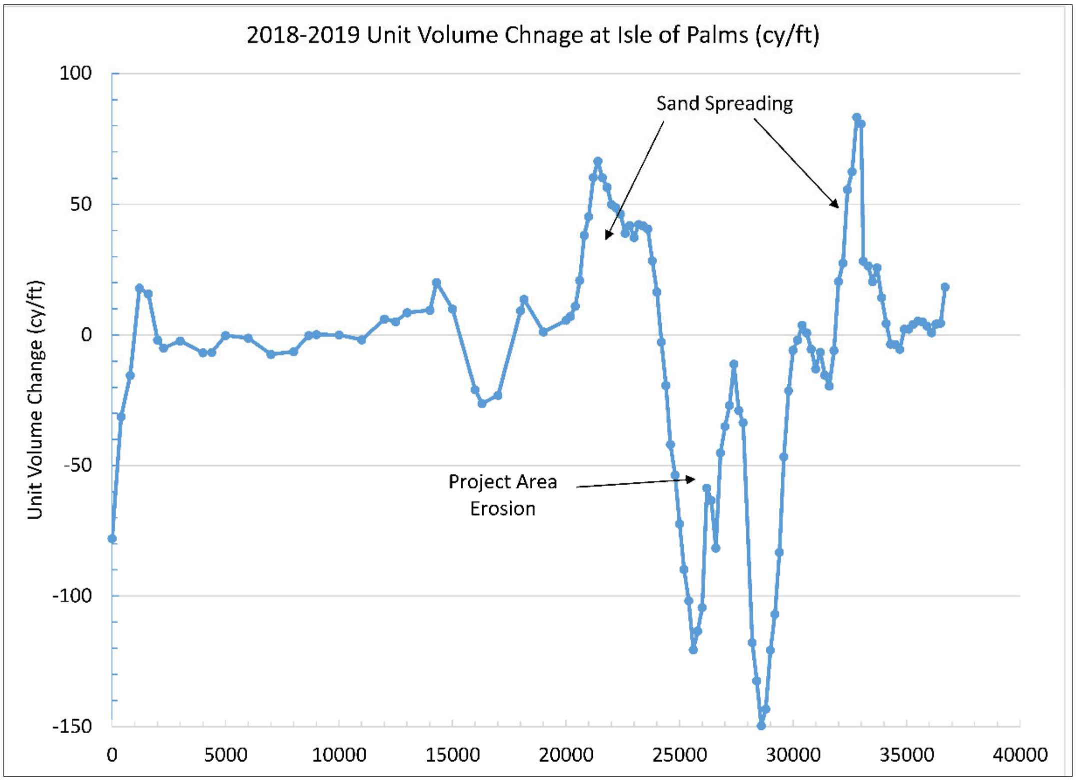


FIGURE 4.2. Beach unit volume change from 2018 to 2019 for each monitoring line at Isle of Palms. The X axis represents distance from Breach Inlet in feet. This graph highlights the erosion occurring in the project area and accumulation of spreading sand adjacent to the project area.

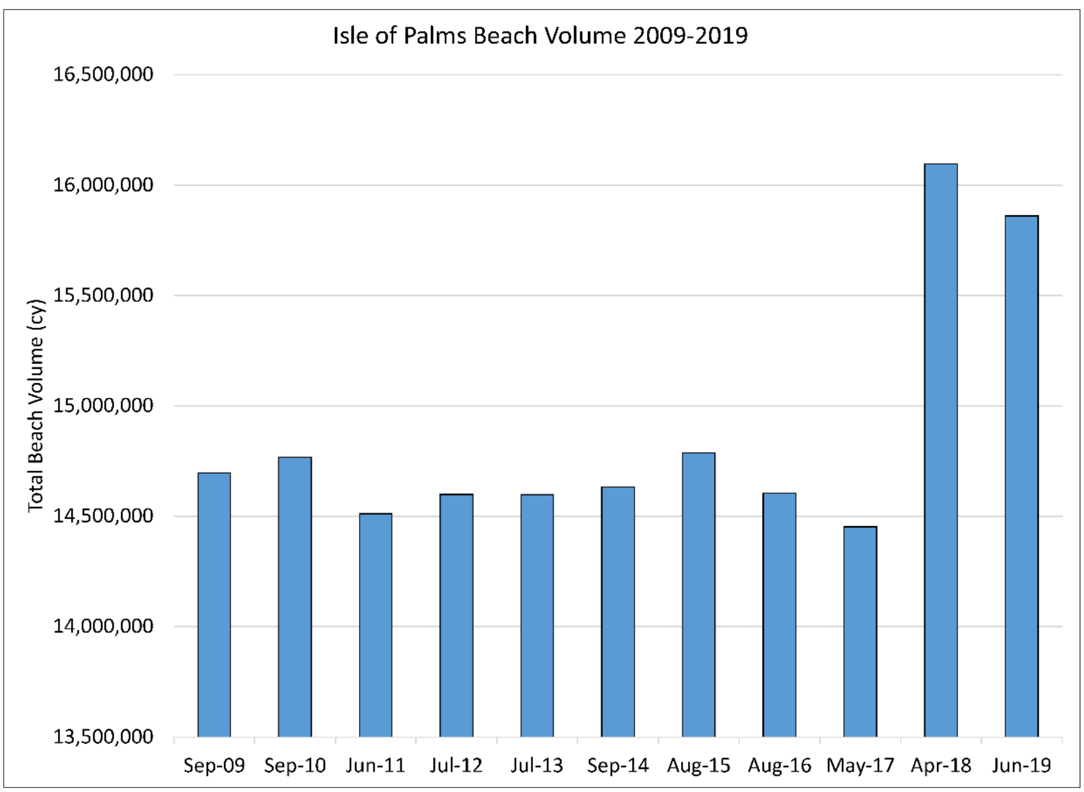


FIGURE 4.3. Total beach volume at Isle of Palms from 2009 to 2019. Effects of the 2018 project are seen in the rapid increase in the April 2018 condition.

TABLE 4.1. Beach volume data for selected dates since 2008 for each project reach and each monitoring profile. Beach volume change over the past year ranged from losses of 22-25 cy/ft per year in reaches 5 and 6 to gains of 8 cy/ft per year in reach 4 (just downcoast of the project area).

Area	Length (ft)	Total Volume (cy)													
		Jul-07	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19
Reach 1	4,390				1,940,588	1,993,636	1,942,143	1,881,244	1,816,322	1,881,462	1,872,947	1,775,416	1,757,549	1,791,525	1,759,618
Reach 2	4,280				1,459,694	1,482,997	1,415,263	1,531,348	1,552,061	1,528,779	1,494,240	1,517,129	1,493,822	1,502,877	1,486,790
Reach 3	5,620				1,810,569	1,876,440	1,828,257	1,896,808	1,967,693	1,970,583	2,007,460	2,016,198	2,012,752	2,019,758	2,040,749
Reach 4	7,910				2,596,737	2,631,739	2,651,113	2,803,737	2,921,254	2,934,335	3,002,074	2,980,044	2,987,522	3,032,547	3,106,339
Reach 5	6,000	2,629,327	2,549,937	2,861,693	2,786,313	2,745,765	2,661,727	2,512,657	2,406,324	2,362,329	2,293,119	2,129,726	2,063,023	2,972,774	2,796,544
Reach 6	4,900	1,683,637	1,693,074	2,315,187	2,323,458	2,239,921	2,182,964	2,119,653	2,053,612	2,048,008	2,206,134	2,267,962	2,249,140	2,919,450	2,796,471
Reach 7	4,000	1,686,112	1,734,455	1,747,799	1,779,401	1,796,965	1,829,702	1,852,674	1,879,955	1,906,471	1,911,566	1,918,296	1,887,345	1,857,506	1,875,343
Total Island Volume	37,100					14,767,463	14,511,169	14,598,121	14,597,222	14,631,967	14,787,541	14,604,770	14,451,155	16,096,437	15,861,854
		Unit Volume (cy/ft)													
		Jul-07	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19
Reach 1	4,390				442.0	454.1	442.4	428.5	413.7	428.6	426.6	404.4	400.4	408.1	400.8
Reach 2	4,280				341.1	346.5	330.7	357.8	362.6	357.2	349.1	354.5	349.0	351.1	347.4
Reach 3	5,620				322.2	333.9	325.3	337.5	350.1	350.6	357.2	358.8	358.1	359.4	363.1
Reach 4	7,910				328.3	332.7	335.2	354.5	369.3	371.0	379.5	376.7	377.7	383.4	392.7
Reach 5	6,000	438.2	425.0	476.9	464.4	457.6	443.6	418.8	401.1	393.7	382.2	355.0	343.8	495.5	466.1
Reach 6	4,900	343.6	345.5	472.5	474.2	457.1	445.5	432.6	419.1	418.0	450.2	462.8	459.0	595.8	570.7
Reach 7	4,000	421.5	433.6	436.9	444.9	449.2	457.4	463.2	470.0	476.6	477.9	479.6	471.8	464.4	468.8
Reaches 1-7	37,100				396.1	398.0	391.1	393.5	393.5	394.4	398.6	393.7	389.5	433.9	427.5
		Profile Volume Change Since Last Survey (cy)													
			Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19
Reach 1	4,390					53,048	-51,492	-60,899	-64,922	65,140	-8,515	-97,531	-17,867	33,975	-31,907
Reach 2	4,280					23,303	-67,734	116,085	20,713	-23,282	-34,539	22,888	-23,306	9,054	-16,086
Reach 3	5,620					65,871	-48,183	68,550	70,886	2,889	36,877	8,738	-3,446	7,007	20,990
Reach 4	7,910					35,002	19,374	152,624	117,518	13,081	67,739	-22,030	7,478	45,025	73,792
Reach 5	6,000		-79,389	311,755	-75,379	-40,548	-84,038	-149,070	-106,333	-43,996	-69,210	-163,393	-66,703	909,751	-176,230
Reach 6	4,900		9,437	622,113	8,271	-83,537	-56,958	-63,310	-66,042	-5,604	158,126	61,828	-18,821	670,309	-122,978
Reach 7	4,000		48,343	13,344	31,602	17,565	32,736	22,972	27,282	26,516	5,095	6,729	-30,950	-29,839	17,837
Total Volume Change	37,100		-69,952	933,868	-67,108	-124,085	-140,996	-212,380	-172,374	-49,600	88,917	-101,565	-85,524	1,580,061	-299,209
Annual Volume Change	37,100		-104,641	2,793,950	-57,364	-124,085	-189,204	-195,755	-172,374	-42,398	97,169	-101,288	-114,346	1,721,558	-256,364
Island Change	37,100					70,703	-256,294	86,951	-898	34,744	155,574	-182,770	-153,616	1,645,283	-234,583
		Annualized Unit Volume Change Since Last Survey (cy/ft)													
			Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19
Reach 1	4,390					12.1	-15.7	-12.8	-14.8	12.7	-2.1	-22.2	-5.4	8.4	-6.2
Reach 2	4,280					5.4	-21.2	25.0	4.8	-4.6	-8.8	5.3	-7.3	2.3	-3.2
Reach 3	5,620					11.7	-11.5	11.2	12.6	0.4	7.2	1.6	-0.8	1.4	3.2
Reach 4	7,910					4.4	3.3	17.8	14.9	1.4	9.4	-2.8	1.3	6.2	8.0
Reach 5	6,000		-19.8	155.5	-10.7	-6.8	-18.8	-22.9	-17.7	-6.3	-12.6	-27.2	-14.9	165.2	-25.2
Reach 6	4,900		2.9	379.8	1.4	-17.0	-15.6	-11.9	-13.5	-1.0	35.3	12.6	-5.1	149.0	-21.5
Reach 7	4,000		18.1	10.0	6.8	4.4	11.0	5.3	6.8	5.7	1.4	1.7	-10.3	-8.1	3.8
Reaches 1-7	37,100					1.9	-9.3	2.2	0.0	0.8	4.6	-4.9	-5.5	48.3	-5.4

TABLE 4.2. Beach volume data for selected dates since 2008 for each project reach and each monitoring profile. Unit volumes for each line are provided below, with the 2018 project area highlighted.

Reach	Line	Distance to Next (ft)	Mar-08	Jul-08	Sep-10	Jul-12	Sep-14	Aug-16	Apr-18	Jun-19	Reach	Line	Distance to Next (ft)	Mar-08	Jul-08	Sep-10	Jul-12	Sep-14	Aug-16	Apr-18	Jun-19
Reach 1	3100	0			429.9	374.7	418.4	386.7	442.7		Reach 5 (continued)	254	200	346.4	447.1	390.2	372.1	326.8	237.4	539.7	437.8
	3105	0			782.4	636.3	747.4	673.1	675.7			256	200	351.5	450.2	373.2	381.1	291.4	239.3	524.7	404.2
	0	400			278.7	290.5	254.8	212.9	266.3	188.3		258	200	390.9	484.6	399.7	421.4	321.9	264.1	544.6	431.3
	4	400			458.6	412.0	393.2	386.7	425.1	393.6		260	200	432.0	502.2	414.9	415.9	308.6	264.9	547.9	443.5
	8	400			449.6	423.2	436.9	415.9	424.9	409.5		262	200	464.2	529.3	457.9	417.1	293.5	294.5	563.4	504.8
	12	400			610.8	543.2	582.7	515.6	514.8	532.7		264	200	525.0	575.4	504.4	444.6	349.6	329.9	595.7	532.2
	16	400			567.0	485.1	541.3	475.2	480.4	496.1		266	200	538.0	599.6	521.8	459.8	377.5	353.0	620.5	538.8
	20	270			492.0	437.0	458.8	410.8	418.6	416.7		268	200	521.0	566.2	478.2	438.2	366.3	339.9	543.5	498.2
	3110	730			454.4	422.9	418.7	400.8	398.8	393.8		270	200	550.5	582.7	501.4	400.2	412.7	383.8	550.1	514.9
	30	1000			425.9	422.8	408.9	401.2	388.5	386.3		272	200	555.0	569.4	503.4	416.0	416.2	416.3	537.1	510.1
	40	390			390.1	401.1	375.9	374.0	367.1	360.4		274	200	518.1	526.2	490.7	402.0	398.1	408.9	509.0	497.9
Reach 2	3115	610			369.2	386.8	363.4	361.5	355.6	349.0		276	200	622.6	619.9	594.1	492.4	527.9	494.7	576.2	547.2
	50	1000			379.7	382.2	360.1	365.2	357.1	357.0		278	400	642.3	593.3	616.4	475.2	524.2	506.8	585.4	551.8
	60	1000			347.7	360.2	353.7	353.4	343.4	342.2	Reach 6	280	200	706.1	676.2	794.7	578.3	665.6	701.1	766.3	648.6
	70	1000			340.9	358.9	364.9	357.7	358.7	351.3		282	200	631.7	568.1	683.5	480.2	556.7	580.1	652.7	520.2
	80	670			310.0	318.7	336.0	328.0	330.1	323.7		284	200	676.3	671.0	737.7	575.3	672.3	705.1	757.8	608.2
Reach 3	3125	330			350.1	359.6	384.7	381.9	385.9	385.8		286	200	651.2	666.9	709.0	590.8	700.8	711.7	760.5	617.3
	90	1000			316.1	330.5	350.8	345.1	345.8	346.0		288	200	487.2	577.8	599.8	536.5	608.0	635.0	705.7	585.0
	100	1000			344.3	339.6	363.7	371.5	362.7	362.8		290	200	382.0	486.4	524.9	498.9	573.6	595.3	657.8	550.8
	110	1000			316.5	321.6	332.3	341.9	338.6	336.8		292	200	377.4	486.6	511.3	538.4	608.3	625.3	672.8	589.4
	120	500			346.4	358.9	358.5	376.7	375.3	381.4		294	200	385.8	514.9	527.6	571.9	585.9	659.8	686.2	639.5
	3135	500			355.8	360.9	364.6	381.6	389.0	394.1		296	200	356.5	496.5	495.8	539.7	518.2	615.0	655.5	634.1
	130	1000			329.3	328.4	335.5	350.8	356.9	365.4		298	200	320.0	483.9	467.6	490.9	446.3	562.2	634.5	628.7
	140	290			330.6	328.5	346.1	344.8	354.5	364.0		300	200	308.2	483.5	457.4	491.4	433.8	524.1	630.9	629.0
Reach 4	3140	710			342.7	335.8	357.4	355.3	362.3	382.5		302	200	279.5	474.9	436.7	463.0	405.7	468.6	622.6	626.4
	150	1000			309.7	313.0	337.9	347.8	350.6	360.5		304	200	259.8	451.5	399.8	429.3	355.4	383.9	597.7	598.5
	160	290			283.1	305.0	328.2	349.6	377.0	356.1		306	200	270.1	460.1	400.2	421.7	364.6	377.2	614.1	608.7
	3145	710			285.0	321.9	345.3	362.6	399.3	373.0		308	200	246.1	428.0	346.3	366.0	287.4	313.7	571.3	558.4
	170	1000			293.4	317.0	339.3	364.5	388.0	364.8		310	200	252.2	412.0	333.4	336.9	247.0	286.5	560.2	553.7
	180	150			336.2	354.6	375.4	391.3	395.6	404.9		312	200	232.0	398.1	310.3	322.9	235.8	259.1	546.5	531.1
	3150	850			274.4	317.7	393.6	401.3	406.2	419.8		314	200	192.1	349.8	274.0	279.6	208.0	220.2	488.9	469.4
	190	1000			336.5	370.6	366.8	371.6	372.3	373.5		316	200	261.7	432.8	371.6	348.4	286.4	313.6	560.5	554.6
	200	200			362.5	383.1	388.9	382.4	375.8	381.5		318	200	246.7	428.2	358.9	355.4	275.1	327.8	529.7	550.2
	202	200		320.6	377.3	391.4	396.9	393.4	386.4	393.6		320	200	261.3	440.4	375.6	361.3	297.4	365.1	526.7	554.2
	204	200		339.9	396.1	405.7	410.8	415.7	400.3	411.3		322	200	267.0	435.2	379.2	334.4	297.3	370.7	495.5	551.2
	206	200		327.6	383.6	392.3	400.6	389.5	389.1	409.9		324	200	246.4	407.1	370.1	316.7	291.6	360.1	450.9	513.4
	208	200		328.8	381.7	400.8	406.1	404.9	386.5	424.6		326	200	248.7	365.9	369.7	325.7	323.2	368.0	434.3	517.5
	210	200		354.1	407.9	421.1	438.8	426.3	413.6	458.9		328	100	303.2	354.4	388.6	344.2	344.3	389.7	451.0	531.6
	212	200		333.8	386.7	411.1	411.7	400.6	385.2	445.4	Reach 7	330	200	180.0	209.7	281.7	302.3	280.4	275.5	250.3	278.6
	214	200		326.9	381.8	410.3	391.2	387.2	388.6	455.1		332	200	507.1	560.5	619.8	650.7	685.0	706.9	630.3	656.8
	216	200		327.4	377.2	406.5	394.4	387.0	391.5	451.7		334	200	473.1	528.3	573.4	611.3	652.3	660.1	605.6	626.0
	218	200		349.3	393.6	417.6	419.3	407.8	409.2	465.7		336	200	459.8	519.2	524.7	567.2	612.2	612.4	584.2	609.9
	220	200		342.5	388.1	416.4	430.0	405.0	412.5	462.4		338	200	444.2	500.0	467.4	504.7	551.0	569.9	546.9	561.2
Reach 5	222	200	302.4	310.3	352.6	382.3	388.2	358.2	366.0	414.6		340	200	438.0	495.3	441.8	472.8	514.8	525.1	509.3	513.6
	224	200	323.2	335.2	373.5	411.2	409.6	377.4	382.1	428.3		342	200	481.5	505.0	470.4	506.3	530.0	537.8	521.2	517.8
	226	200	303.2	310.8	362.8	386.4	383.6	339.8	342.3	381.3		344	200	444.6	456.2	431.6	459.1	479.0	479.0	462.9	459.3
	228	200	328.1	357.6	383.2	396.4	392.6	348.9	343.0	384.9		346	200	437.6	438.2	421.3	440.1	454.6	460.4	443.1	437.6
	230	200	370.4	422.4	414.5	399.9	406.1	356.4	354.8	392.1		348	200	380.9	378.1	364.8	376.9	384.5	399.4	388.8	391.1
	232	200	400.4	436.9	452.3	445.8	427.0	379.2	379.0	421.3		350	200	429.8	430.5	424.2	432.6	446.1	457.6	453.3	455.6
	234	200	342.6	417.1	416.4	398.4	378.7	329.4	348.6	390.4		352	200	422.4	423.1	417.6	421.9	437.4	441.7	444.9	449.0
	236	200	307.8	388.7	391.4	378.3	345.9	301.1	329.7	370.2		354	200	436.8	438.7	437.0	445.0	453.9	454.1	450.9	456.2
	238	200	299.2	389.0	392.4	374.4	343.8	300.9	358.5	386.9		356	200	447.7	447.2	444.1	453.3	454.9	445.1	443.0	448.1
	240	200	306.6	400.9	407.0	392.5	355.4	313.3	399.6	416.0		358	200	413.8	411.0	412.2	422.4	402.8	393.7	384.2	387.7
	242	200	292.4	385.7	394.8	372.4	336.6	297.9	415.9	413.2		360	200	405.8	402.9	402.3	413.2	380.7	365.7	360.5	361.5
	244	200	339.5	433.3	441.5	419.2	383.5	341.0	499.0	479.7		362	200	394.5	392.3	400.4	402.3	360.4	348.9	340.4	344.5
	246	200	355.9	444.8	439.1	413.0	386.1	335.3	526.5	484.5		364	200	352.4	352.7	362.2	337.8	311.6	299.3	296.3	300.8
	248	200	387.0	469.0	451.5	421.9	420.6	340.4	562.6	508.9		366	200	413.5	410.9	402.6	405.0	408.5	401.7	379.3	397.7
	250	200	391.8	484.0	465.2	420.7	436.8	339.3	587.9	515.6		368	200	538.8	544.3	534.6	538.0	566.5	574.4	584.1	557.1
	252	200	365.7	458.7	418.2	389.7	369.1	281.1	554.5	464.7		370	0	520.1		583.1	503.3	611.5	641.2	666.6	611.7

4.2 Project Area Reaches

The 2018 nourishment project placed sand along the majority of Reaches 5 and 6 at the eastern end of the island. Reach 7 is included in this section as a portion of it was nourished in the 2008 project. The entire length of the beach along these reaches is affected by morphological changes occurring in Dewees Inlet as discussed in earlier sections.

4.2.1 Reach 7

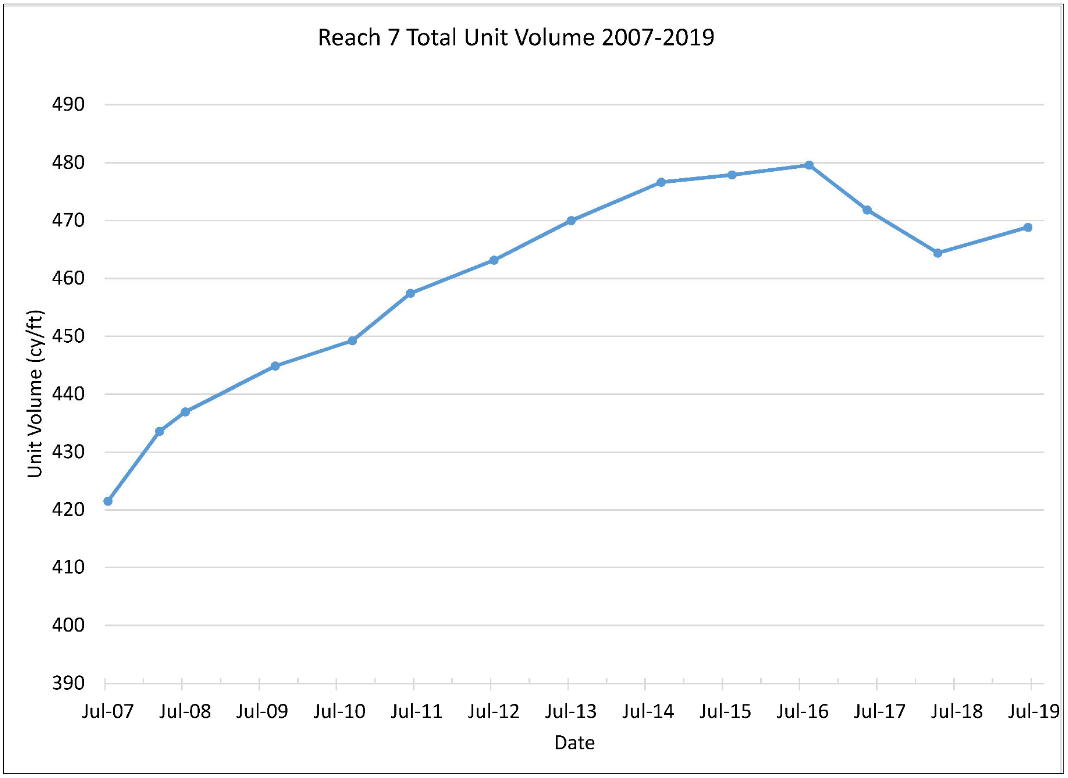
Reach 7 encompasses the length of beach between lines 330 and 370 that span the shoreline fronting the Dewees Inlet channel (Figure 4.4). The inlet shoals shelter large waves from impacting this portion of beach which results in the profile generally showing a narrow dry sand berm and a steep beach face. The steep beach face reduces the total profile volume needed for a stable profile compared to front-beach areas. In 2008, a significant erosional escarpment existed along most of the reach seaward of the 17th tee box (Figure 4.5). The seaward end of the reach was included in the 2008 nourishment project and remained fairly stable in the following years. The healthy condition in 2018 did not require nourishment as part of the last project.

FIGURE 4.4. Baseline stationing along Reach 7 encompassing the length of beach between lines 330 and 370.

Reach 7 was accretional from 2018 to 2019, gaining 17,837 cy (4.5 cy/ft) of sand. The seaward end of the reach was highly accretional, with profiles gaining up to 28 cy/ft of sand due to spreading from the front beach. Only three profiles located just north of the groin at the 17th tee measured erosion. Figure 4.6 shows the beach volume trends for the reach since 2007, with the upper figure showing the total reach volume and the lower figure showing the volume history for each monitoring line. Figure 4.7 provides beach profiles and representative photos of the reach in 2019. Profiles from the seaward end of the reach (ie – Station 332) show substantial growth of the dry sand berm from 2018 to 2019, with the area gaining approximately 50 ft in width and increasing in elevation. Stations further inland were much more stable as shown in the profiles from Station 344. Ground photos from Station 344 show a wide area of unvegetated dry sand, indicative of recent accretion. Photos from further inland also show a very healthy dry sand beach with a vegetated dune well landward of the typical high tide line.

Overall, Reach 7 has gained 189,230 cy of sand since 2007, which is an average annual increase of 15,870 cy per year (4.0 cy/ft per year). CSE expects continued accretion of the reach as additional sand spreads from Reach 6 along the front beach.

FIGURE 4.5. In 2008, a significant erosional escarpment was documented along most of Reach 7 seaward of the 17th tee box of the Links Course.



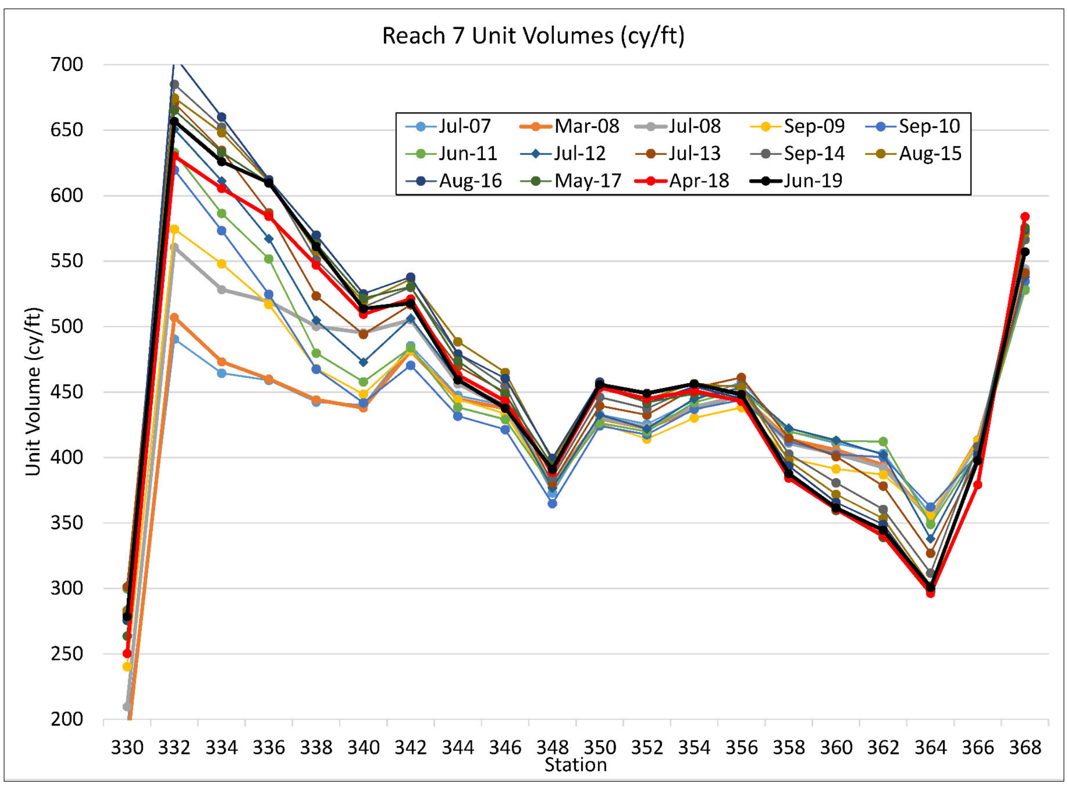
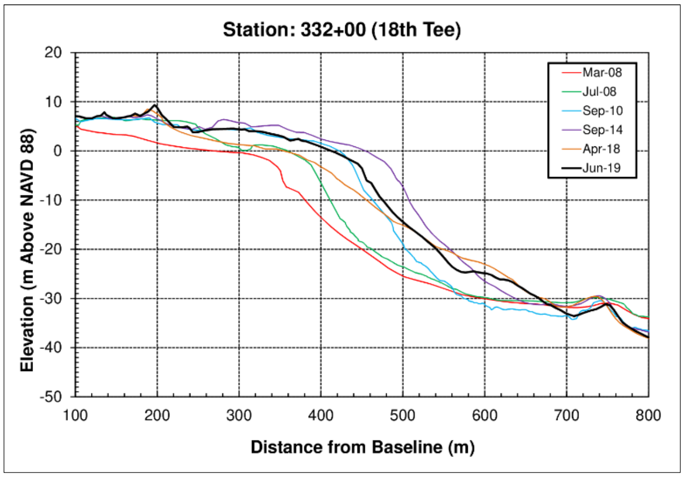


FIGURE 4.6. **[UPPER]** Total beach volume in Reach 7 since 2007. **[LOWER]** Profile unit volumes for each monitoring line in Reach 7.



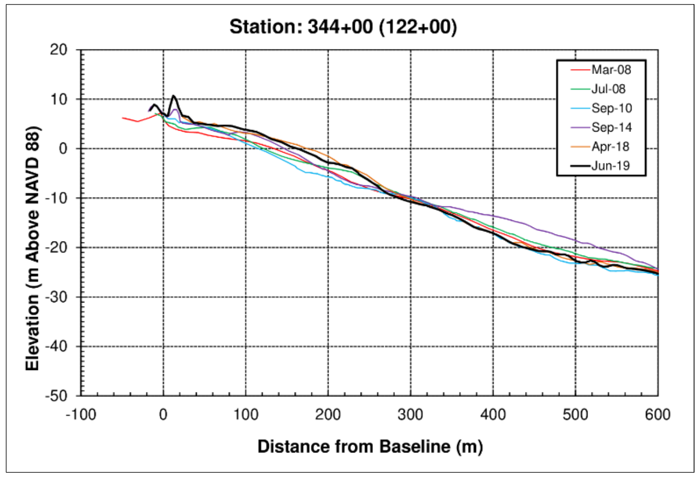


FIGURE 4.7.
Beach profiles and ground photos from Reach 7. Photos are from stations 334 (left) looking seaward, 346 looking seaward (bottom left), and 346 looking landward (bottom right).

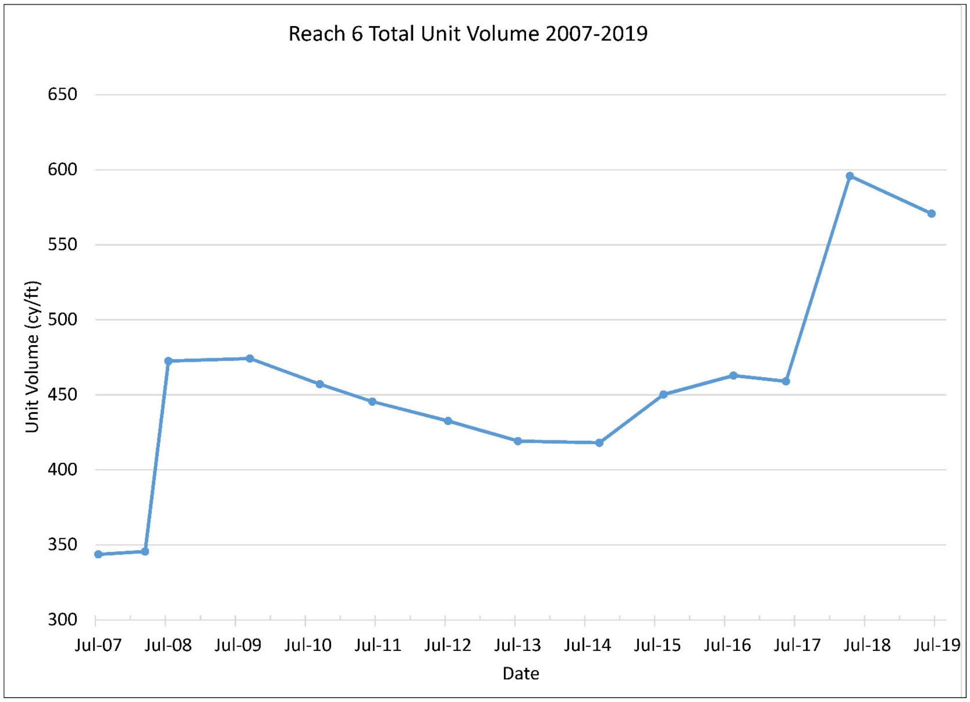
4.2.2 Reach 6

Reach 6 encompasses ~4,900 linear feet of beach between the Wild Dunes Property Owners Beach House (Station 280) and the 18th Hole of the Links Course (Station 328+00) (Figure 4.8). Along with Reach 5, shoal-bypass events have directly impacted this length of beach since the island's formation. Depending on the location of bypass events, the shoreline can change hundreds of feet over a period of several months (Kana et al 1985, Gaudiano 1998). The waterline has periodically encroached on properties since this area was developed.

FIGURE 4.8. Baseline stationing along Reach 6 encompassing ~4,900 lf of beach between Wild Dunes Property Owners Beach House and the 18th Hole of the Links Course.

Details of beach volume changes occurring in the reach from 2007 to 2015 are detailed in the 2015 annual beach monitoring report (CSE 2016). In summary, following nourishment in 2008, this reach experienced several periods of varying erosion and accretion, often with one part of the reach gaining sand while the other losing sand. The area along the eastern end of the reach near Beach Club Villas was highly erosional following the 2008 project, requiring additions of sand via shoal-management projects in 2012 and late 2014. The western end of the reach fluctuated in volume based on attaching shoals; however, it always maintained a sufficient width to protect property. By 2018, the eastern end of the reach was accreting from a prior shoal attachment while the western end was eroding. The erosion pattern prior to nourishment necessitated an adjustment to the fill design, with less sand being placed at the east of the reach and additional sand being placed at the west end. The reach gained ~670,000 cy of sand via nourishment in 2018.

From April 2018 to June 2019, Reach 6 lost 123,000 cy (25.1 cy/ft). The volume change pattern showed a distinct trend of significant erosion along the west end of the reach, general stability at the center of the reach, and accretion along the eastern end (Figure 4.9). Erosion was severe at the western end of the reach, with the area fronting Beach Club Villas (~Station 284) losing nearly 150 cy/ft. This was nearly all of the nourishment quantity in that area. Erosion quickly tapered off to the east, with Station 298 only losing 6 cy/ft. The rapid erosion of the western end is most likely a continuation of the higher erosion trend observed prior to the project in this area, which was due to the spreading of a large shoal bypass event that attached in 2015 (Figure 4.10). Pre-project losses were nearly 100 cy/ft in the 8-month period prior to the project near Beach Club Villas. A large portion of the sand lost from the west end of the reach was deposited at the eastern end, which caused areas to gain up to 80 cy/ft. Additional sand was likely deposited east of Line 328 beyond the limits of the cross-shore survey lines. This sand will be accounted for in the comprehensive 3D model of the Dewees Inlet delta presented in later sections.



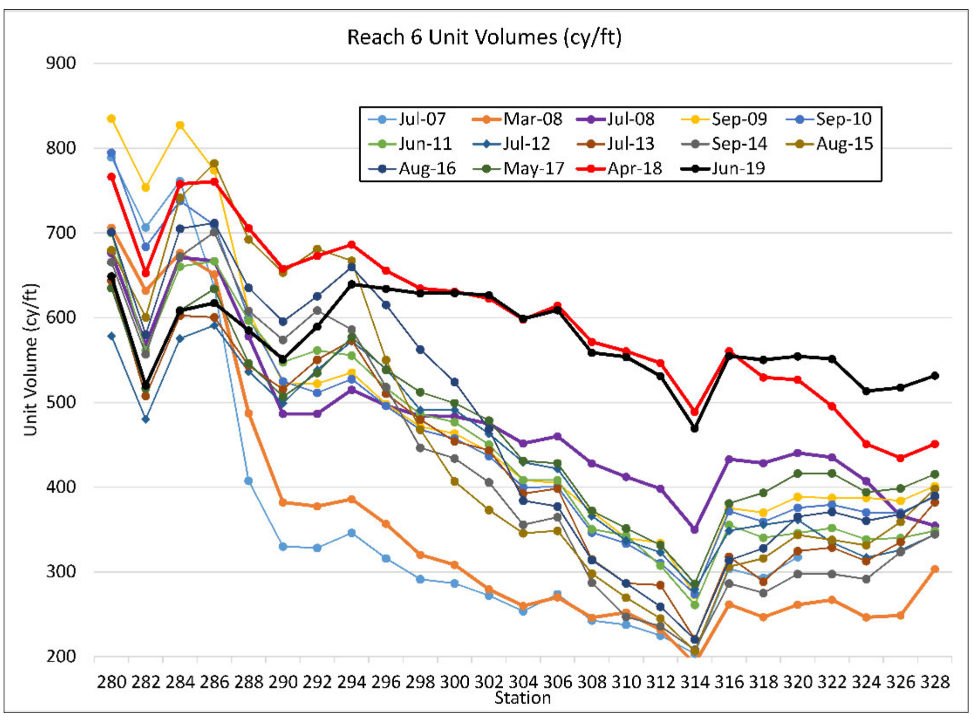


FIGURE 4.9. **[UPPER]** Total beach volume in Reach 6 since 2007. **[LOWER]** Profile unit volumes for each monitoring line in Reach 6.

Hurricane *Dorian* impacted the area in September 2019. Figure 4.11 shows aerial photos of the reach following the storm. There was significant overwash of the berm, however, there was no significant damage to the dune and only minor damage to some sand fencing. The dry sand berm dissipated wave energy prior to the waves hitting the dune and created escarpments. Figure 4.12 shows ground photos of the reach prior to the storm.

All stations east of line 296 (Shipwatch) show a greater sand volume in June 2019 than at any other time since monitoring began in 2007. Overall, the reach holds 1,112,800 cy more sand than the 2007 condition. Nourishment projects in 2008 and 2018 have resulted in an average annual accretion rate of 19.0 cy/ft per year along Reach 6. While the volume totals are very positive, the reach is subject to localized areas of very dynamic volume changes and needs to be monitored closely.

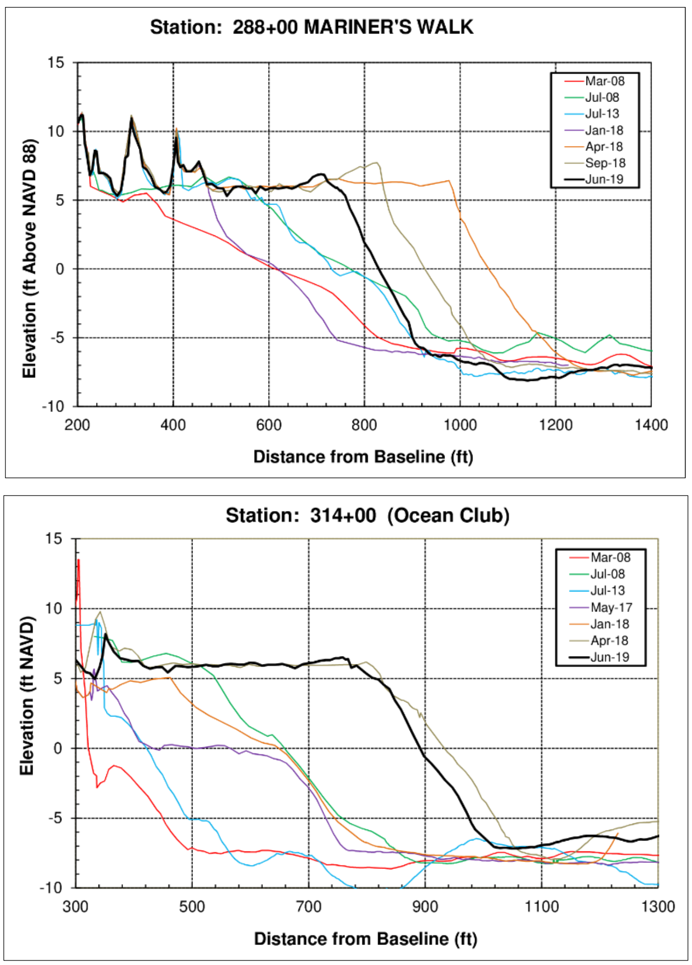


FIGURE 4.10. Reach 6 profiles. The rapid erosion in this area is suspected to be a continuation of the higher erosion trend observed prior to the 2018 project.

FIGURE 4.11. Aerial photos of Reach 6 following Hurricane *Dorian* in September 2019 which document significant overwash of the berm.

FIGURE 4.12. Ground photos of Reach 6 prior to Hurricane *Dorian*.

4.2.3 Reach 5

Reach 5 spans ~5,800 lf of beach between 53rd Avenue and the Wild Dunes Property Owners Beach House (stations 222–280 – Figure 4.13). Similar to Reach 6, this area of the beach is highly influenced by shoal-bypass events, especially along the central and eastern portion of the reach. The 2008 nourishment project added ~318,000 cy of sand to the reach; however, by 2015, the area fronting Beachwood East and Dunecrest Lane was highly erosional. The erosion was so severe that homeowners installed sandbags and/or experimental wave dissipation systems to attempt to reduce additional erosion. There was some recovery of the eastern end of the reach just prior to the 2018 nourishment; however, the erosional arc had migrated west to include the area fronting the Wild Dunes Grand Pavilion and the western end of Beachwood. Overall, reach 5 was the most erosional area of Isle of Palms from 2008 to 2018.

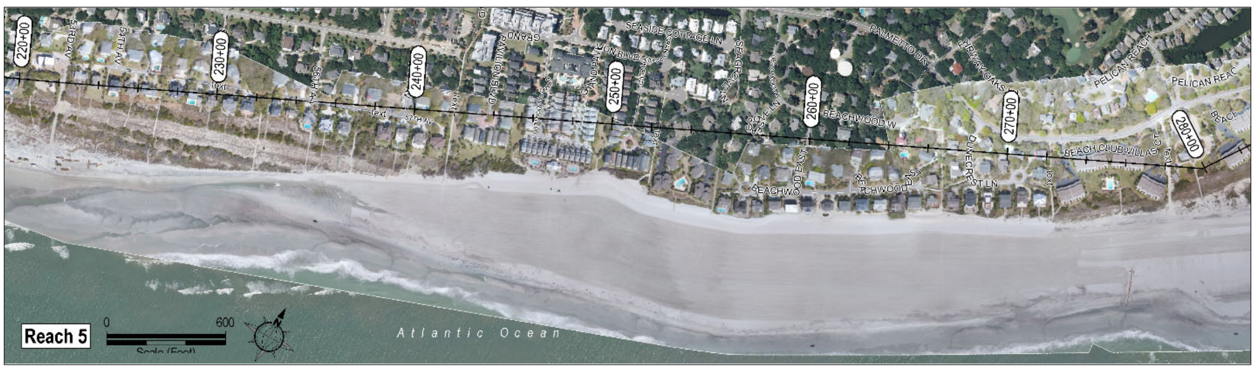
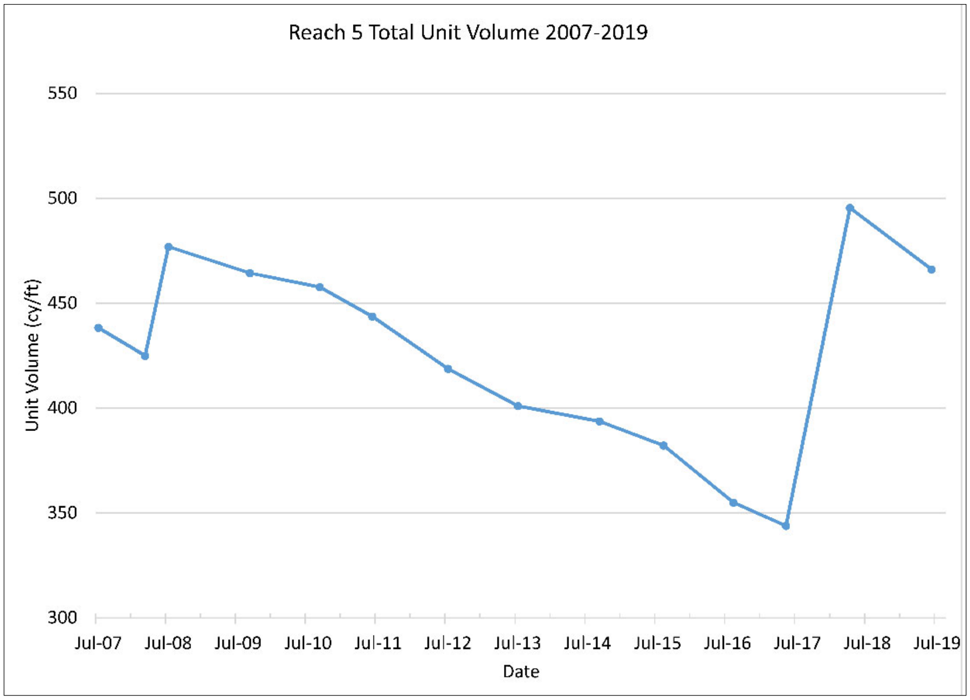


FIGURE 4.13. Baseline stationing along Reach 5 which spans ~5,800 lf of beach between 53rd Avenue and Wild Dunes Property Owners Beach House.

Reach 5 gained 909,000 cy of sand (151 cy/ft) from 2017 to 2018 (including nourishment and background changes – Figure 4.14). This was nearly three times the volume added during the 2008 project. Beach width increased by over 500 ft in some locations, and like Reach 6, a dune was constructed as part of the nourishment design. Dune vegetation and sand fencing were installed by the City to promote natural dune building.

The reach lost 176,000 cy (29.4 cy/ft) of sand between April 2018 and June 2019. Losses over the past year were greatest along the central portion of the reach, from stations 246–268 (Grand Pavilion to Beachwood East). Figure 4.14 (lower) shows the profile volume record for Reach 5 since 2007. The difference between the red and black lines represents the 2018–2019 change. The position of the 2019 (black) line relative to the other dates provides an indication of how the present condition compares to earlier conditions. Generally, the 2019 condition is near the healthiest condition observed since 2007 along most of the reach, with the exception being at the very eastern end of the reach. The 2019 condition shows at least 100 cy/ft more sand than the most eroded condition along the majority of the reach, and over 200 cy/ft greater along the central portion of the reach.



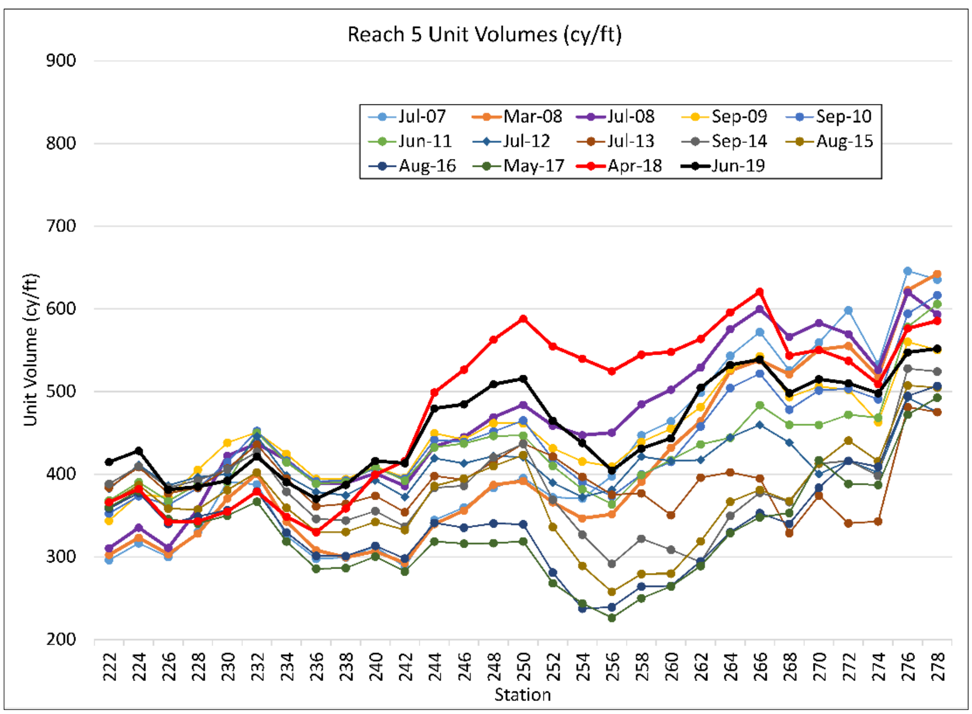


FIGURE 4.14. **[UPPER]** Total beach volume in Reach 5 since 2007. **[LOWER]** Profile unit volumes for each monitoring line in Reach 5.

Beach volume change within the reach ranged from a loss of 100–120 cy/ft along Seagrove and the western end of Beachwood East to gains of over 40 cy/ft west of 56th Ave. Most of the area gaining sand was south of the fill area and is gaining sand that is spreading from the fill area. With any large-scale nourishment project, sand typically erodes from the ends of the project and feeds downcoast areas. These end-losses result from waves focusing on the protruding corners of the beach fill. Profiles from within the reach (Figure 4.15) show the berm fronting Grand Pavilion and Beachwood East remains ~400 ft wider than the pre-project condition, despite ~100 ft of recession over the past year. Profiles from Station 226, located south of the nourishment area, show a rapid buildup of a sand berm ~200 ft wide from April to September 2018, and further growth of the berm through 2019. There remains a low swale on the landward side of the berm, seaward of the pre-project dune line (Figure 4.16).

CSE expects the rapid changes observed since the 2018 project to reduce in scale over the next few years as the initial adjustment phase of the nourishment fill tapers off. Profiles show that much of the volume change measured since the post-project survey (April 2018) occurred by September 2018. The September 2018 survey was obtained by CSE as part of a research partnership with DELFT University (Netherlands) for five graduate students studying coastal engineering. Shoreline change was much less severe between September 2018 and June 2019.

4.2.4 Summary of East End Changes

Overall, the 2018 project area reaches (5 and 6) lost ~300,000 cy of sand from April 2018 to June 2019. This represents ~18% of the nourishment pay quantity. While this value is higher than desired, much of the losses can be accounted for in gains in adjacent areas. Further, the rate of changes appears to be decreasing based on interim surveys obtained in September 2018. Figure 4.17 provides the beach volume history of the eastern end of the island since 2007, with dates following nourishment indicated. The overall erosional trend is evident between nourishment projects, which restore the necessary sand volume to maintain the health of the island. Sand lost from these reaches either moves south to provide a sediment supply for the rest of Isle of Palms, or it recycles to Dewees Inlet, where it will eventually form a shoal that attaches to the beach.

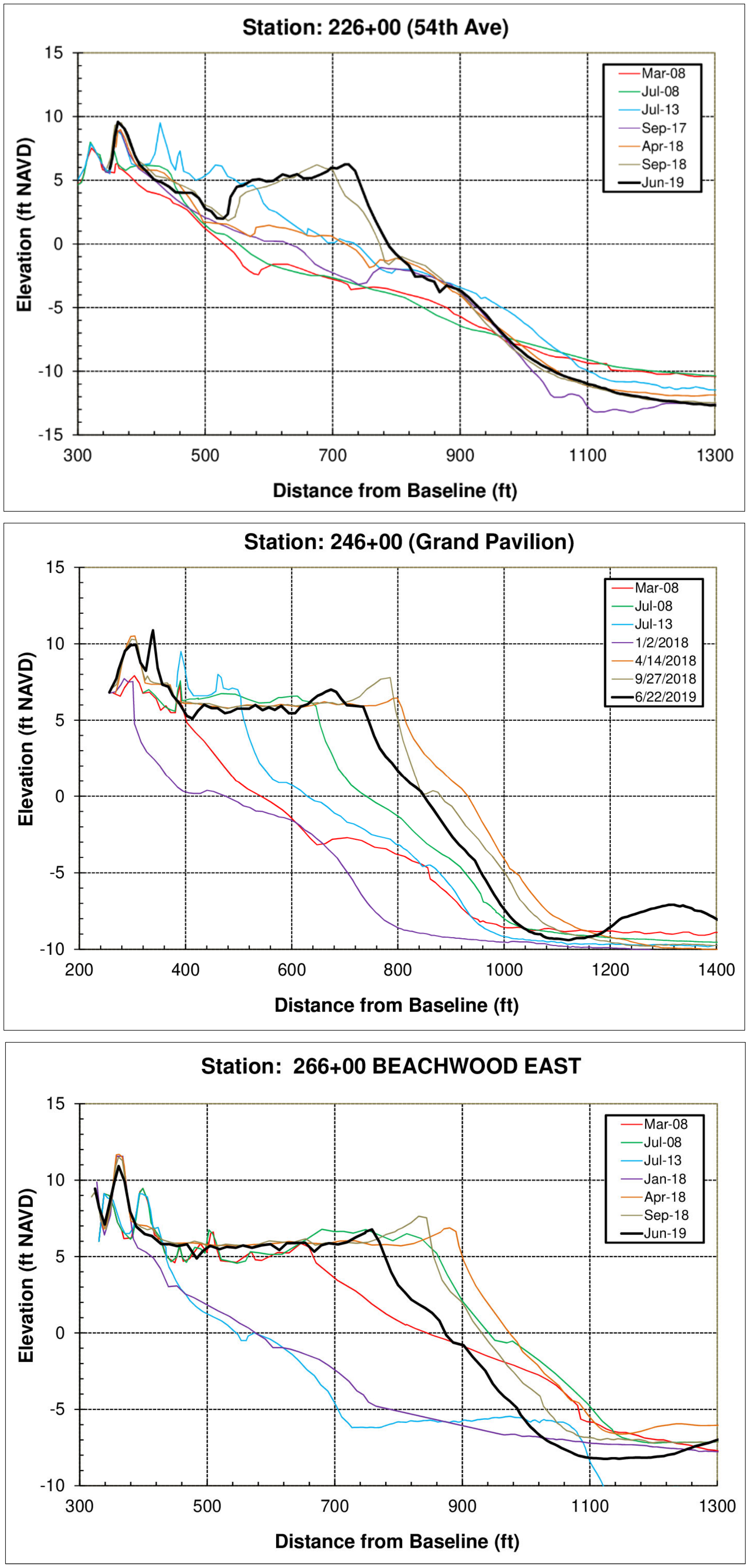


FIGURE 4.15. Reach 5 profiles. The data shown indicates that the berm fronting Grand Pavilion and Beachwood East remains ~400 ft wider than pre-project condition.

FIGURE 4.16. Ground photos of Reach 6. There remains a low swale on the landward side of the berm, seaward of the pre-project dune line.

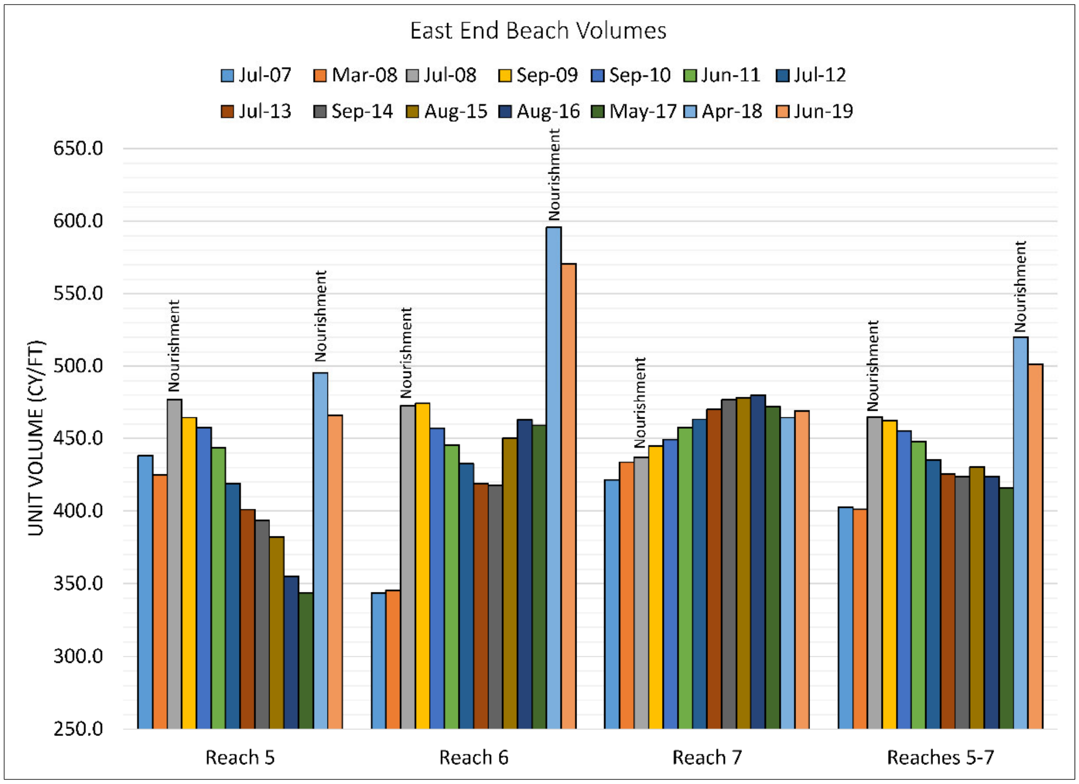


FIGURE 4.17. The beach volume history of the eastern end of the island since 2007, with dates following nourishment indicated

4.2.5 Reach 4

Reach 4 includes the length of beach between 31st and 53rd Avenues (stations OCRM 3140 to CSE 222+00 – Fig 4.18 and Fig 4.19). This reach is ~7,910 ft long and immediately downdrift of the 2008 and 2018 project area. It is also outside of the direct influence of Dewees Inlet and maintains a more typical and consistent beach profile shape. By being positioned downdrift of the nourishment area, it receives nourishment sand spreading from the placement area as well as spreading shoal sand. The reach has gained sand every year since 2009 except 2016.

FIGURE 4.18. Baseline stationing along Reach 4 spanning the length of beach between 31st Ave and 53rd Ave.

The accretional trend of the reach is fueled by sand moving from the east end of the island, with that sand originating from shoal bypass events or from nourishment. Between April 2018 and June 2019, CSE observed a significant influx of sand along the northern half of the reach. Profiles along the northern 2,000 lf of beach gained up to 66 cy/ft of sand. This accretion resulted in a large ridge and runnel system along the wet sand beach and a shift of the dry sand berm over 200 ft seaward (Figure 4.20). The central portion of the reach was more stable, while stations 160–170 (35th–38th Ave) eroded over 20 cy/ft. The erosion was limited to the wet sand beach and was likely the result of an ephemeral intertidal bar welding and spreading downcoast (Figure 4.21).

FIGURE 4.19. By being positioned downdrift of the nourishment area, Reach 4 receives nourishment sand spreading from the placement area as well as spreading shoal sand. This reach has gained sand every year since 2009 except 2016.

Overall the reach gained 73,800 cy (8.0 cy/ft) of sand over the past year. The beach volume in Reach 4 has increased by over 500,000 cy since 2009, which is an average annual accretion rate of 6.6 cy/ft per year. The dune width has increased by at least 50 ft along the reach, not including the wider dry sand berm seaward of the dune. This level of accretion is of similar magnitude to many beach nourishment projects conducted along coastal communities in South Carolina and is equivalent to an $8-10-million-dollar nourishment investment. The dune has grown ~3 ft in elevation and offers substantially more storm protection than the 2009 condition. CSE anticipates additional accretion over the next few years as more sand spreads from the 2018 project area.

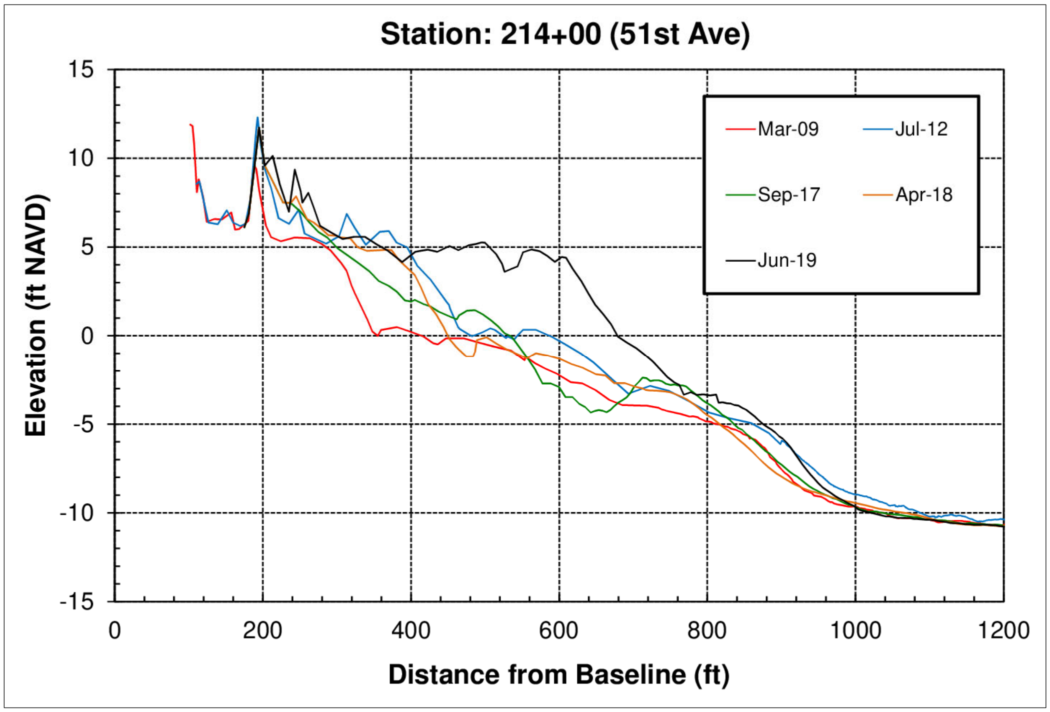


FIGURE 4.20. Profiles along the northern 2,000 lf of beach gained up to 66 cy/ft of sand. This accretion resulted in a large ridge and runnel system along the wet sand beach and a shift of the dry sand berm over 200 ft seaward.

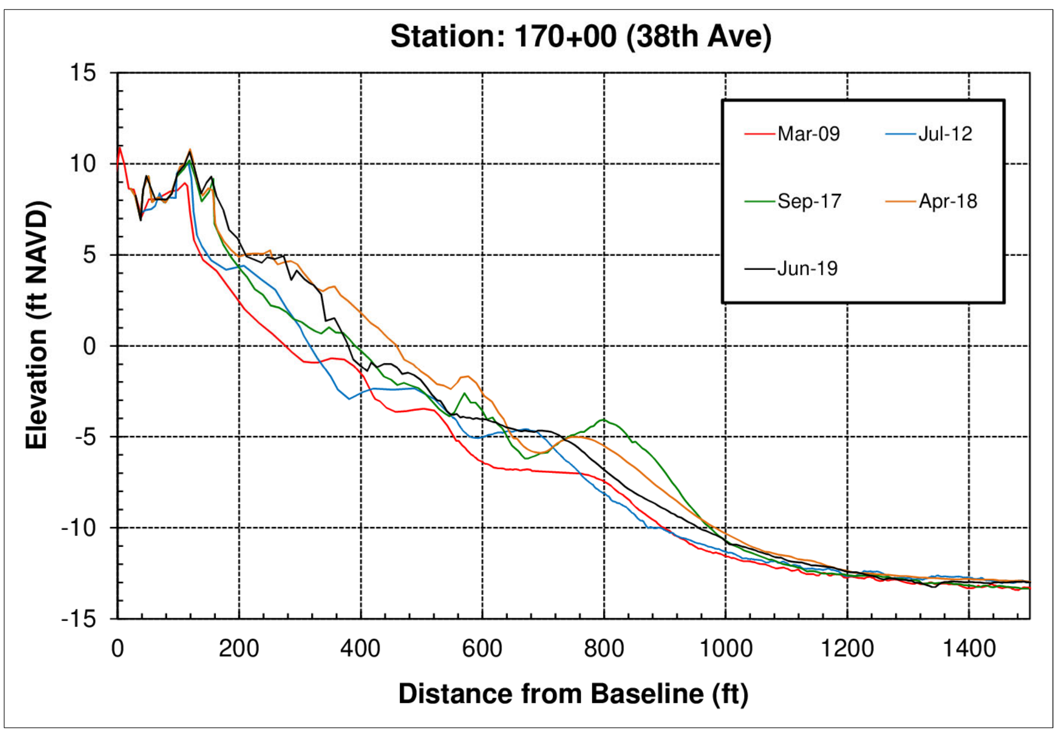


FIGURE 4.21. Stations 160–170 (35th–38th Ave) eroded over 20 cy/ft in 2019. The erosion was limited to the wet sand beach and was likely the result of an ephemeral intertidal bar welding and spreading downcoast.

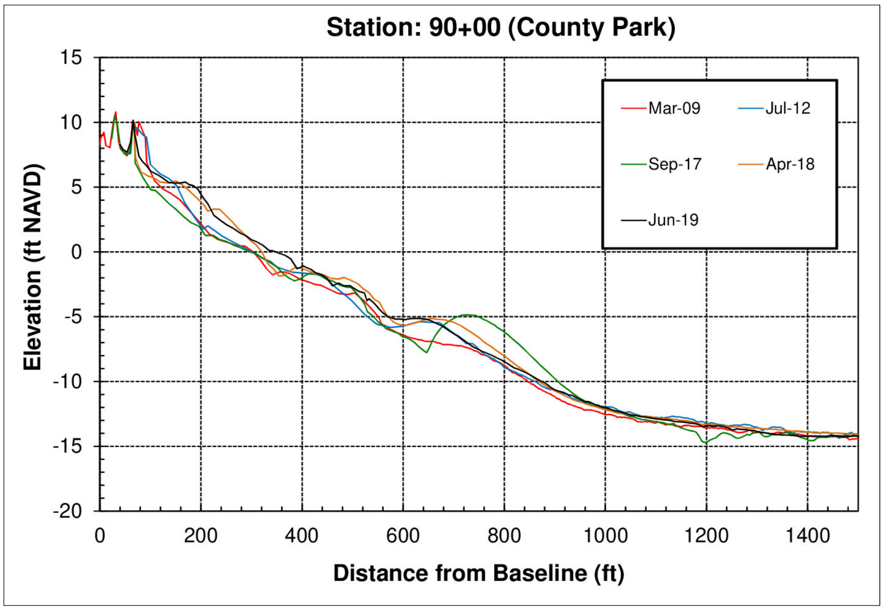
4.2.6 Reach 3

Reach 3 extends from the Sea Cabins Pier to 31st Avenue (OCRM monuments 3125 to 3140 – Fig 4.22 and Fig 4.23). Like Reach 4, the long-term trend in this area is stable to accretional. Dwellings in the reach are well set back from the beach, generally between 400 ft and 500 ft except at the western end where Sand Dune Lane and the county park are set back ~150 ft. The reach has shown periods of erosion and accretion since CSE began island-wide monitoring in 2009. This is typical for stable to moderately accretional beaches as variations in wave conditions from year to year and temporary changes in sediment supply lead to minor fluctuations in yearly volume change. Over the long term, the trend is accretion.

FIGURE 4.22. Baseline stationing along Reach 3 spanning the length of beach from the Sea Cabins Pier to 31st Ave.

FIGURE 4.23. The long-term trend for Reach 3 is stable to accretional. Dwellings in the reach are generally set back from the beach between 400 ft and 500 ft.

From April 2018 to June 2019, the reach gained nearly 21,000 cy (3.2 cy/ft) of sand. Most of the gains were confined to the eastern end of the reach, from stations 120 to 150 (26th – 31st Ave), where each station gained between 5.1 and 9.5 cy/ft. The remainder of the reach west of 26th Ave was essentially stable, ranging from –1.8 cy/ft to +0.2 cy/ft unit volume change. Profile plots from the reach (Figure 4.24) show that the base of the dune increased in width over the past year along most of the reach; however, it is still eroded compared to the pre-*Matthew* condition along the western end of the reach (ie – Station 90). All stations in the reach hold 30–43 cy/ft more sand than the 2009 condition despite hurricane impacts over the past few years.



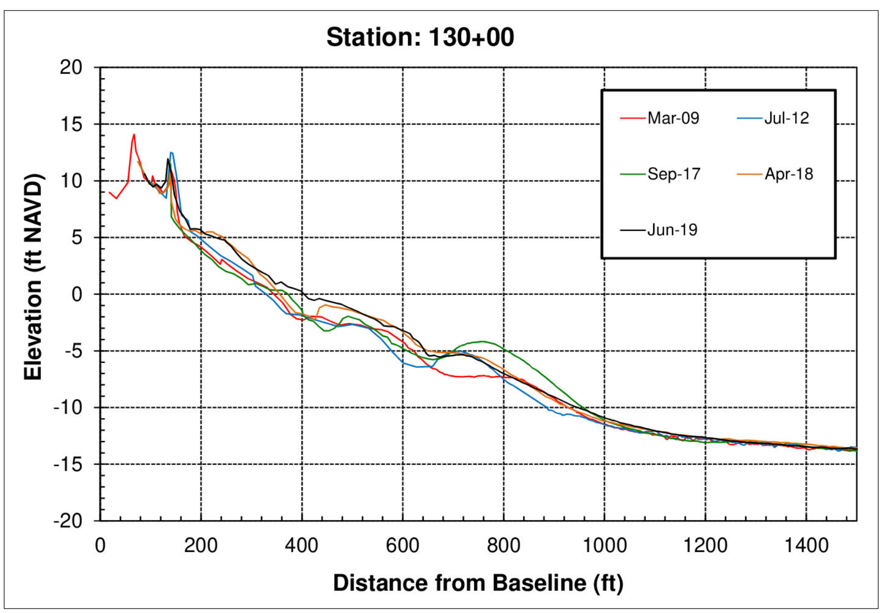


FIGURE 4.24. According to these profile plots the base of the dune has increased in width over the past year along most of the reach; however, it is still eroded compared to the pre-*Matthew* condition along the western end of the reach.

Overall the reach holds 230,000 cy (41 cy/ft) more sand than the 2009 condition, which is equivalent to an average annual accretion of 4.2 cy/ft per year. Figure 4.25 shows the accretional trend over the past decade. Photos of the reach in June 2019 show a recovering dune system with a significant dry sand beach seaward of the growing dune (Fig 4.24). A site visit in early 2020 shows the dune is continuing to grow and vegetate, and the wide dry beach seaward of the dune is protecting it from eroding during spring tides or minor storms.

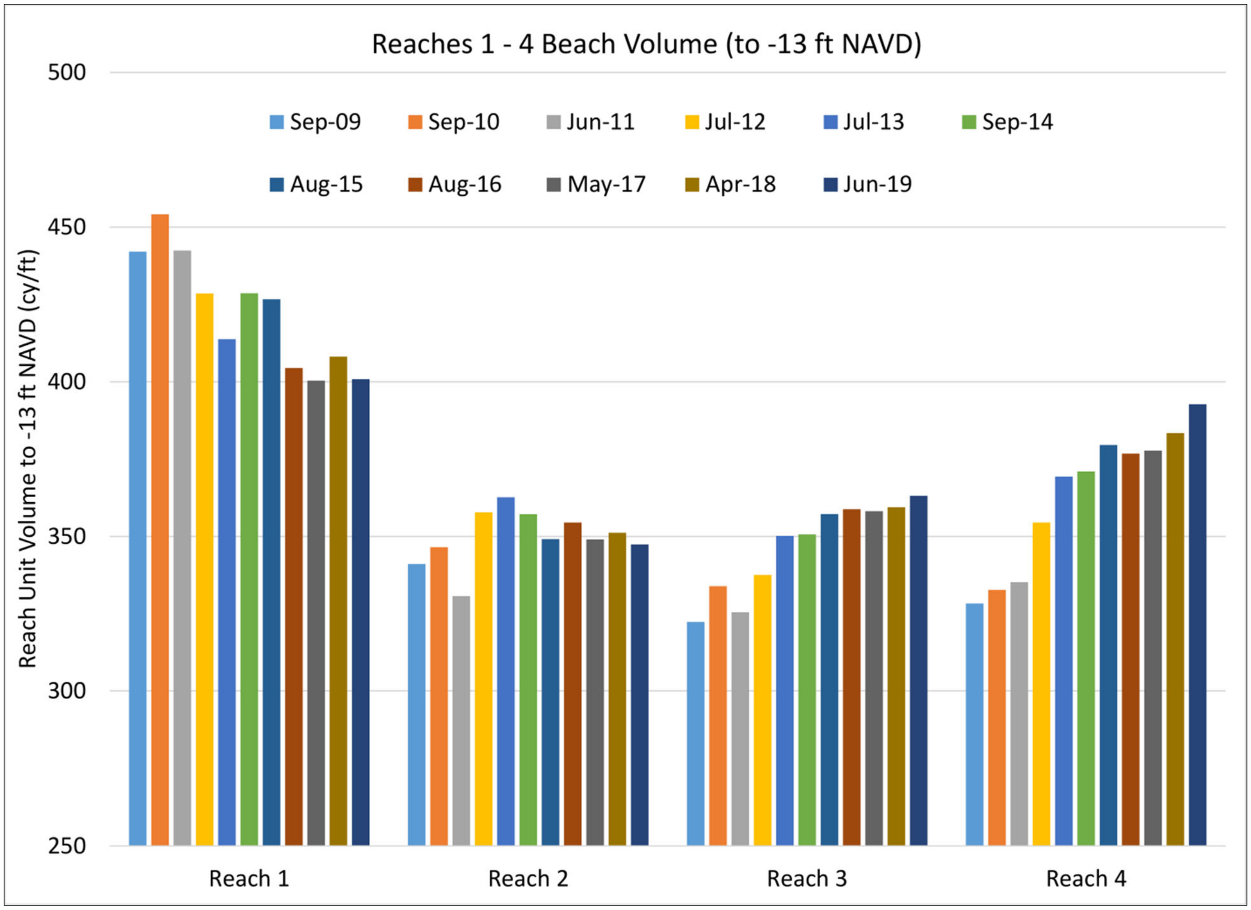


FIGURE 4.25. This graphic illustrates the accretional trend of Reaches 3 and 4 over the past decade.

4.2.7 Reach 2

Reach 2 spans 4,280 ft between 6th Avenue and the Sea Cabins Pier (OCRM monuments 3115–2125 – Fig 4.26 and Fig 4.27). It includes the Front Beach commercial area at the eastern end of the reach. Reach 2 shows an erosion/accretion pattern similar to Reach 3 with intermittent periods of accretion and erosion, and a long-term trend of accretion. Since monitoring began in 2009, Reach 2 has been the most stable reach, typically showing lower magnitudes of volume change compared to the other reaches.

FIGURE 4.26. Baseline stationing along Reach 2 spanning between 6th Avenue and the Sea Cabins Pier.

Volume trends for Reach 2 shown in Figure 4.25 highlight the varying trend in accretion and erosion over the past decade. Over the ten monitoring intervals since 2009, five have measured erosion, and five have measured accretion. The magnitude of volume change has ranged from +25 cy/ft per year to –21.2 cy/ft per year. The reach has alternated periods of accretion and erosion each year since 2014. This trend suggests that of any area along Isle of Palms, Reach 2 is most sensitive to yearly changes in weather patterns impacting temporary sediment supply.

Over the past year, the reach lost 16,000 cy (3.2 cy/ft) of sand. Every station in the reach eroded, ranging from losses of –0.2 cy/ft to –7.4 cy/ft. There was minor dune erosion along most of the reach over the past year; however, the dune remains healthier than the 2017 condition. Compared to the 2009 condition, the eastern half of the reach has accreted while the western half has eroded. Photos show the healthier condition of the eastern end of the reach (south of the pier) compared to the western end (Fig 4.27). One positive finding of the 2019 survey is that the dune constructed following Hurricane *Irma* remains mostly in place, and is beginning to show natural vegetative growth along the crest and slope of the dune. This dune was scraped from the intertidal beach following the storm to accelerate the natural beach recovery cycle.

FIGURE 4.27. Compared to the 2009 condition, the eastern half of the reach has accreted while the western half has eroded. **[UPPER]** The healthier condition of the eastern end of the reach (south of the pier). **[LOWER]** Western end which is undergoing a higher rate of erosion.

An aerial photo (Fig 4.28) of the reach shows a crescent-shaped beach extending south of the pier, with a pronounced landward offset of the shoreline south of the pier. It is unclear whether the crescent shoreline is a result of sediment trapping from the pier or if it is a result of natural morphologic features associated with Breach Inlet. The shoreline morphology coupled with the lower accretion rate observed in this area should be closely monitored, as building setbacks along this area are generally lower than Reaches 3–4.

FIGURE 4.28. Aerial view of Reach 2. Since monitoring began in 2009, Reach 2 has been the most stable reach, typically showing lower magnitudes of volume change compared to the other reaches along Isle of Palms.

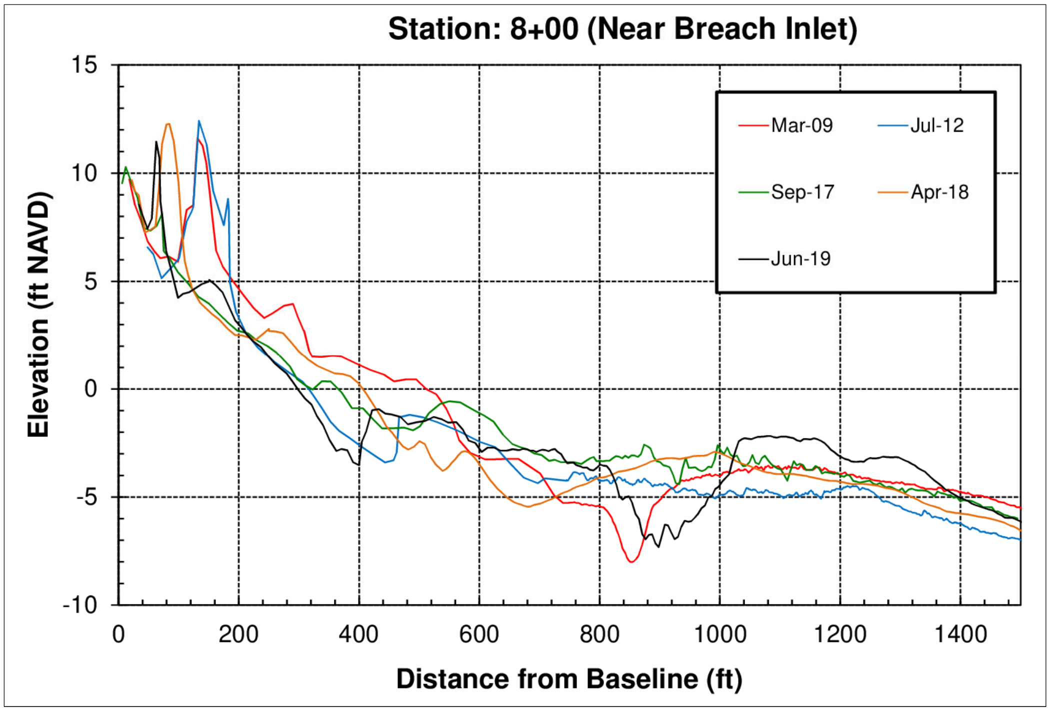
4.2.8 Reach 1 – Breach Inlet

Reach 1 encompasses the beach between Breach Inlet and 6th Avenue (Fig 4.29), and is classified as an unstabilized inlet erosion zone due to the dynamic nature of the shoals associated with the inlet delta. The long-term trend in the reach is accretion, evidenced by a new row of houses being built seaward of the original "beachfront" row in the 1980s. Sand supply originates from shoal-bypass events at Dewees Inlet and longshore sand transport from north to south over the length of the Isle of Palms. Excess sand is deposited along the southern spit of the island and in the Breach Inlet ebb-tidal delta. Shoals of Breach Inlet form a protuberance in the shoreline, which backs sand up along the oceanfront much like a terminal groin traps sand. Changes in this area are related to bars from the inlet delta migrating onto the beach or marginal flood channels moving landward or seaward. Such natural processes lead to rapid changes in the beach volume compared to the central Isle of Palms reaches.

FIGURE 4.29. Baseline stationing along Reach 1 which encompasses the beach between Breach Inlet and 6th Avenue.

Similar to Reach 2, Reach 1 has shown variable periods of erosion and accretion, with the long term trend showing erosion since 2009. Ove the past year, the majority of the profiles measured erosion, with the exception of stations 12 and 16. Erosion was most severe at stations 0–8, which are located along the western-most end of the island at Breach Inlet. Profiles from this area show additional dune erosion over the past year, adding to losses observed since 2012. Further east within the reach, there was also dune erosion; however, to a lesser extent than further east. Overall, the reach lost ~32,000 cy (7.3 cy/ft) of sand from 2018 to 2019. Since 2009, the reach has lost approximately 180,000 cy of sand. While the erosion value is higher than historical trends, the majority of volume loss has been restricted to the portion of the profile below the high tide line (Figure 4.30), meaning that the dunes have been more stable than the erosion rate would suggest. Changes in the lower portion of the profile are likely related to morphological changes in the Breach Inlet delta and are less likely a result of lower sediment inputs from upcoast.

Figure 4.31 shows that in December 2019, most of the dune constructed following Hurricane *Irma* remained in place north of 2nd Ave, but was mostly eroded west of Station 20+00. West of Station 20+00, there are a few properties where erosion threatened to encroach onto landscaped lawns or swimming pools. The houses are still set back from the waterline providing some protection from storm events; however, no additional significant flood protection exists due to the lack of elevated dunes. CSE observed some recovery of the area in 2020 and noted growth of the dunes and a new dry sand beach in place. The Breach Inlet reach has been dynamic since 2009 and needs to be closely monitored moving forward. CSE recommends the City pursue discussions with the US Army Corps of Engineers (USACE) to attempt to place material along this area as a beneficial use of dredged material when the Intracoastal Waterway is dredged in the future.



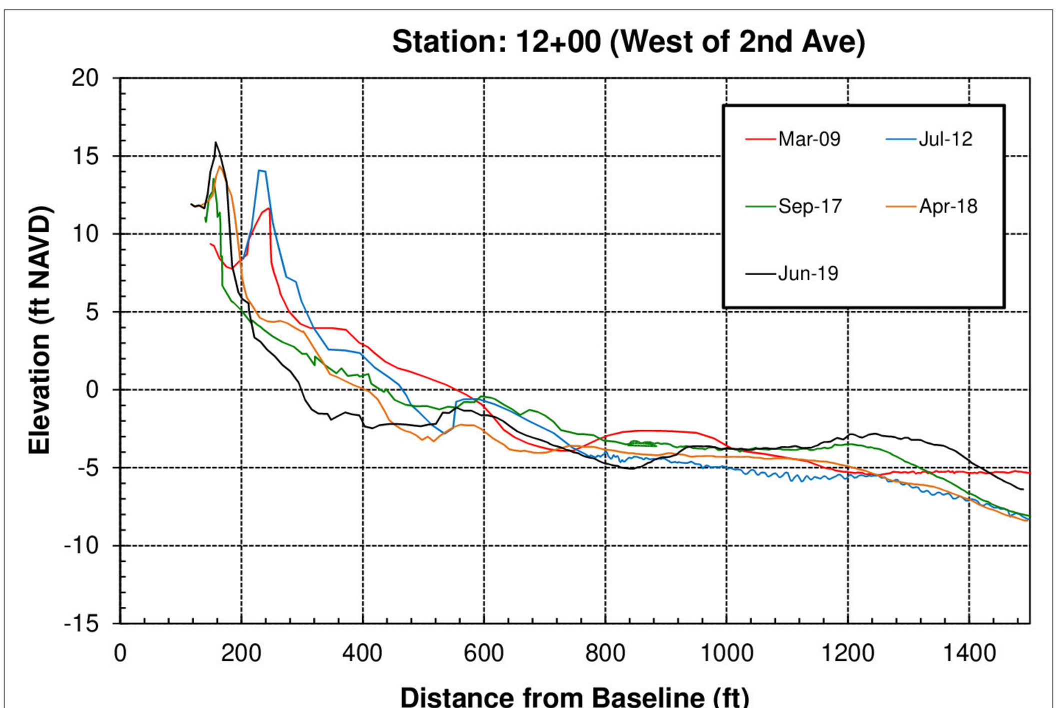


FIGURE 4.30. Profile plots for Reach 1 indicate that while the erosion value is higher than historical trends, the majority of volume loss has been restricted to the portion of the profile below the high tide line. This means that the dunes have been more stable than the erosion rate would suggest.

FIGURE 4.31. Aerial photos taken in December 2019 show that most of the dune constructed following Hurricane *Irma* remained in place north of 2nd Ave, but was mostly eroded west of Station 20+00.

CSE obtained bathymetric data spanning the majority of the Breach Inlet channel and created a digital terrain model of the data, shown in Figure 4.32. The model shows a well-defined main channel abutting Sullivan's Island. Typically, there are one or more spillover lobes or secondary channels that breach the northern shoal of the inlet; however, none were readily visible in the 2019 model. When the channel is well defined and the northern shoal is unbroken, it is likely that more sand will be drawn away from the Isle of Palms beach near the inlet due to a weakening of the trapping effect of the delta. Once a secondary channel forms, it will help trap sand closer towards Isle of Palms and may help restore some of the dry sand beach along the shoreline. The shifting channel morphology is a frequent occurrence at Breach Inlet and has contributed to the dynamic sediment gains and losses at both Isle of Palms and Sullivan's Island. CSE will continue to monitor both the configuration of the inlet to better infer the relationship between beach health and channel/delta morphology.

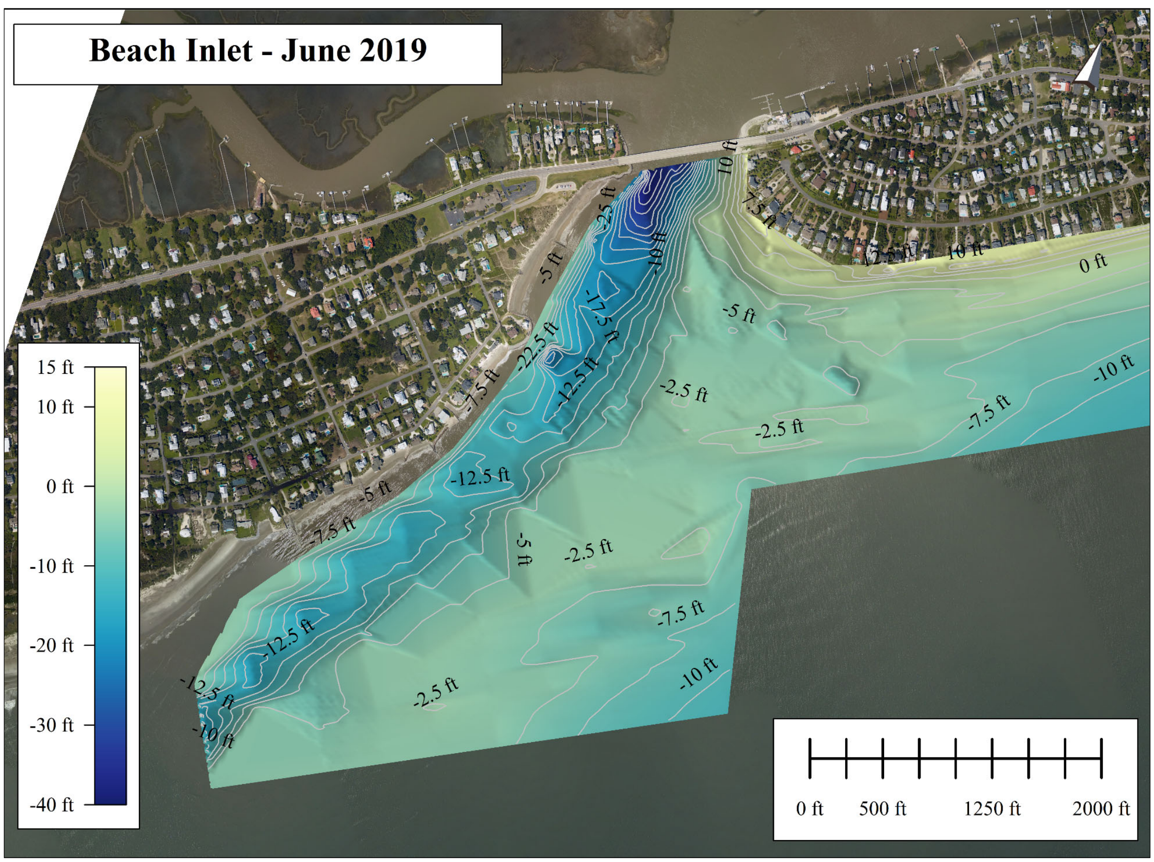


FIGURE 4.32. A digital terrain model spanning the majority of the Breach Inlet channel. The model shows a well-defined main channel abutting Sullivan's Island. When the channel is well defined and the northern shoal is unbroken, it is likely that more sand will be drawn away from the Isle of Palms beach near the inlet due to a weakening of the trapping effect of the delta.

5.0 BORROW AREAS

Per conditions of the permit for the 2018 nourishment project, the City is required to obtain bathymetric surveys of the borrow areas to monitor rates of infilling. CSE collected bathymetric data at 100 ft spacing over all dredged areas within permitted borrow areas E and F in June 2019. Data were used to generate digital terrain models of the borrow areas and compared to pre- and post-project surveys. Figure 5.1 shows the models for both borrow areas used in the project for each survey. The effects of the 2018 nourishment are clearly visible as the blue shaded colors in the elevation models. The 2018 post-project model shows a rough surface of the seafloor which was generated by the arcing motion of the cutterhead during dredging. By 2019, the contours reveal a less rugged bathymetry as sediment shifted from high spots and infilled lower areas. Generally, the boundaries of the dredged areas showed erosion of the top of the slope and accretion along the foot of the slope.

Figure 5.2 shows cross-sections of the borrow area bathymetry. At borrow area E, the sections show ~2 ft of infilling along the north/south section line, except at the southern (seaward) end of the area. Some erosion of the upper boundaries of the side slopes is also evident, with up to one foot of loss along the landward slope. The west-to-east section shows limited infilling of the small area dredged along the western half of the borrow area, and ~2 ft of infilling along the eastern half of the area. Of note is a small mound that was not dredged along the eastern end of the area showed flattening, as would be expected.

Less infilling was observed in Area F, as the sections lines from 2018 and 2019 generally average a similar depth. The north/south section view shows the landward and seaward edges of the dredged area showed significant shifting of sand from the upper slope to the lower portion of the slope.

Table 5.1 shows the sediment volume within the dredged areas for the pre-, post-, and 1-year-post dredge surveys. These areas include the actual dredge footprint and areas immediately adjacent to the dredge areas. This means that some of the volume gains within the dredged areas will be negated by slumping of the adjacent areas. Borrow areas E and F showed a net loss of 1,919,200 cy of sand between 2017 and 2018, which included the nourishment project. This quantity is similar to the measured in place volume, but also includes any nourishment losses occurring during the project. Nourishment losses include fine-grained material that spread beyond the project limits before settling out of suspension.

Borrow Area E gained 130,300 cy of sand from 2018 to 2019, which is ~10 percent of the volume removed during nourishment. Area F showed a further loss of sand, losing 23,000 cy from 2018–2019. Measured losses are due to erosion of the upper slopes of the borrow area boundary and potentially some landward movement of sediment from the measurement area. Also, for an area the size of the borrow area, a volume of 23,000 cy represents a vertical elevation change of only two inches, which is within the accuracy limitations of survey equipment in this setting. Future surveys will allow for long-term trends to be more accurately determined if relative volume changes are low magnitude. Overall, the net volume change in the borrow areas was 107,290 cy, which is 5.5% of the dredged volume. Of note is that sufficient beach compatible sand infilled the 2008 borrow areas to allow for a portion of one of the dredge areas to be reused for the 2018 project (the central-southern portion of Area E). Over time, the offshore zone may prove to be a renewable borrow source for future projects.

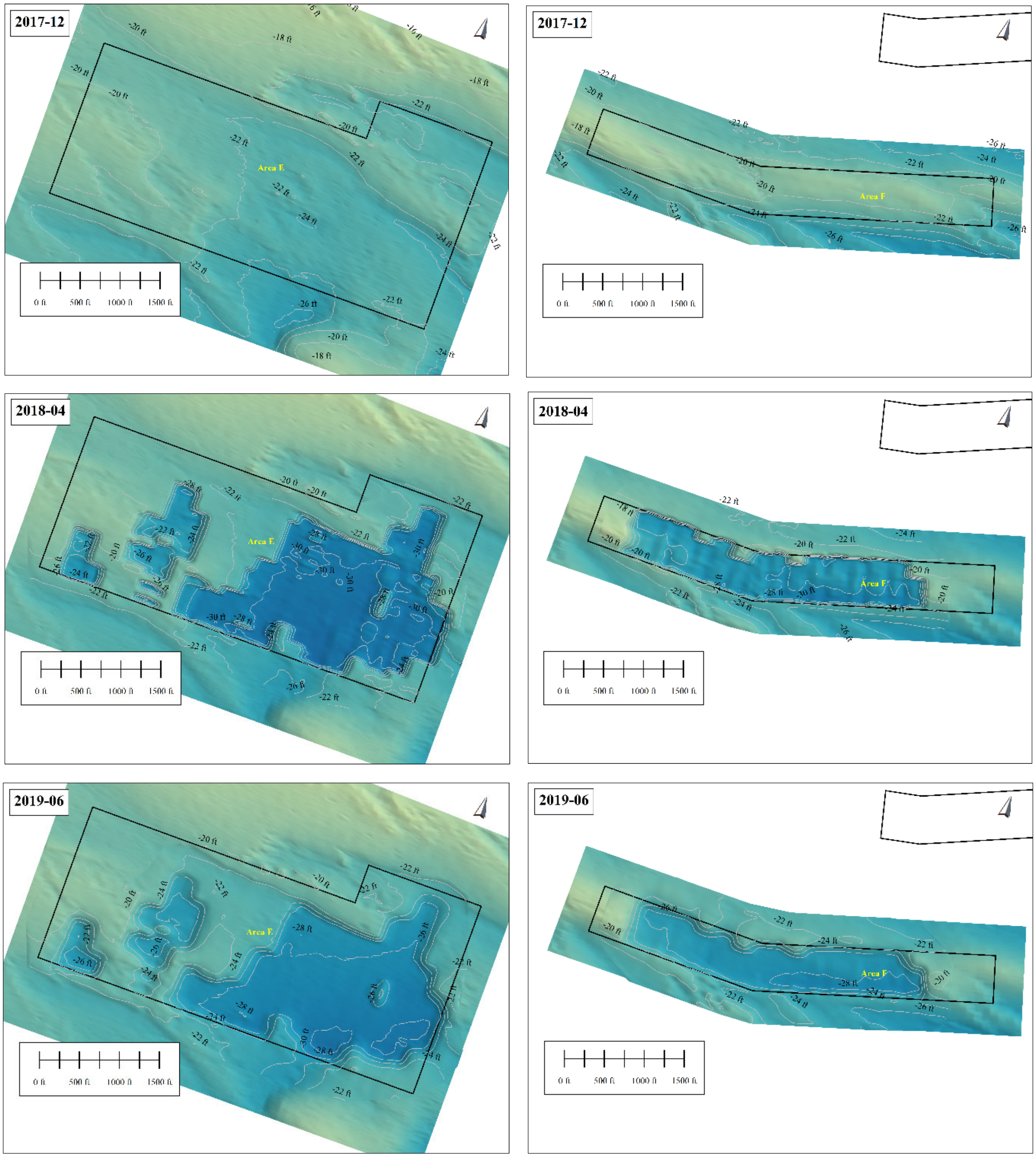


FIGURE 5.1. Terrain models for both borrow areas used in the project for each survey.

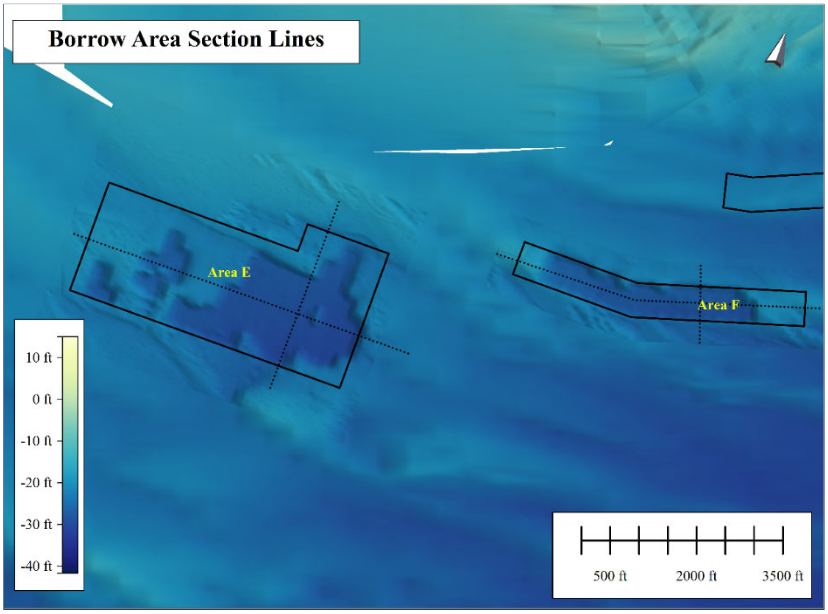


FIGURE 5.2.
Cross sections of the borrow area bathymetry for Borrow Area E and Borrow Area F.

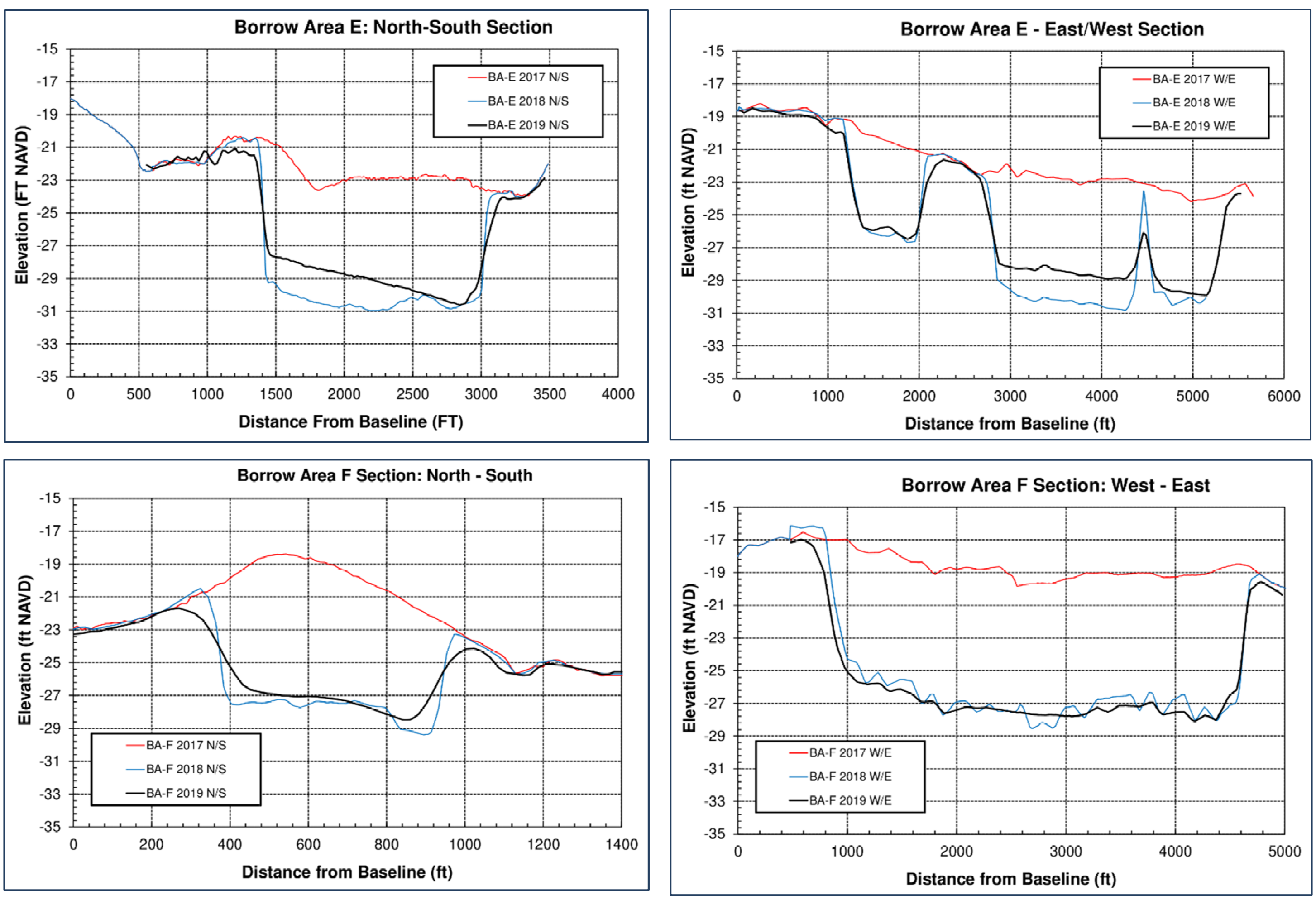


TABLE 5.1. Sediment volume within the dredged areas for the pre-, post-, and 1-year-post dredge surveys. These areas include the actual dredge footprint and areas immediately adjacent to the dredge areas.

Borrow Area Volume (cy)			
Total Volume to −40 ft NAVD			
	May-17	Apr-18	Jun-19
Area E	5,851,575	4,522,218	4,652,568
Area F	2,482,250	1,892,402	1,869,341
Total	8,333,824	6,414,620	6,521,909
Volume Relative to BD condition			
	May-17	Apr-18	Jun-19
Area E	0	−1,329,357	−1,199,007
Area F	0	−589,848	−612,908
Total	0	−1,919,205	−1,811,915
Volume Change Year to Year			
	May-17	Apr-18	Jun-19
Area E	0	−1,329,357	130,350
Area F	0	−589,848	−23,060
Total	0	−1,919,205	107,290

6.0 DEWEES INLET CHANGES

The City of Isle of Palms has sponsored comprehensive surveys of the Dewees Inlet delta since 2007. Previous monitoring reports have detailed morphological changes occurring each year; however, the general observation is that a large-scale channel avulsion (relocation) event occurred between 2007 and 2010. During this period, the main channel of the inlet was closed by a migrating shoal on the seaward lobe of the delta and a new channel opened through the delta further to the northeast. Once the new channel was fully formed in 2010, it began migrating to the southwest, returning to near the 2007 position by 2017. The series of models reveals the cyclic evolution of the delta where shoals migrate from the seaward lobe of the delta towards the beach. A portion of the sand stays on the beach to feed downcoast areas and the remainder is recycled back into the inlet. **CSE computed the total sand volume in the delta in 2008 and 2019, finding that there is a net increase of ~775,000 cy of sand during that time.**

Figure 6.1 shows selected models of the Dewees Inlet delta since 2007. While the main channel is presently in a location similar to the 2007 condition, there are substantial differences in the delta that are a benefit to the long-term health of Isle of Palms. Most notably is the existence of a significant sand body connected to the northeast end of the island called a "trailing ebb spit." This feature grew following the 2008 project as nourishment sand shifted to the north end of the island and began to recirculate within the inlet. Much of the sand was deposited into this trailing ebb spit on the landward side of the channel body. This sand acts to break wave energy before it reaches the beach, which reduces the rate of sediment transport on the beach. It also shields the beach from waves focusing on gaps in the offshore delta. These effects should help stabilize the eastern end of the Wild Dunes area (Reach 6) over the next several years.

Over the past two years, the trailing ebb spit has elongated to the southwest and is close to connecting to the shoal platform seaward of Beach Club Villas. The connection creates a continuous shallow shoal extending along the nearshore zone from Beach Club Villas all the way to Dewees Inlet. There is a strong possibility that the shoal configuration will develop into a continuous emergent shoal similar to an event occurring in the 1940s–1950s within the next several years. Sand could also migrate towards the beach at a lower elevation, slowly working onshore via low ridge and runnel systems.

There is not an emergent shoal presently migrating towards the beach; however, sand continues to coalesce below the low-tide line and appears to be migrating towards the beach. CSE expects this sand to become emergent (visible at low tide) within the next two years and potentially merge with the trailing ebb spit as mentioned previously. The extent of any merging of the shoals will determine the impact to the shoreline as they approach. In general, larger shoals tend to take longer to migrate and merge with the shore, so any associated erosion or accretion patterns will likely have a higher magnitude and longer duration if the shoals merge into one large, emergent shoal.

The terminus of the main channel appears to be undergoing another major relocation process, as the existing channel throat at the southern end of the delta is being constricted by a significant shoal. At the same time, there is a deepening and widening of an area along the northern end of the delta, seaward of the deep channel between Isle of Palms and Dewees Island. Of note is that a secondary channel exit which was present in 2018 along the central lobe was not as evident in 2019, suggesting that the northern pathway will become the dominant channel over the next few years.

The present configuration of the delta shoals suggests that there will be substantial shoal bypassing events occurring within the next 2–5 years that will bring several hundreds of thousands of cubic yards of sand to the beach. While the net volume increase will be a positive result; shoal-induced erosion of localized areas may be significant and needs to be monitored closely. As mentioned previously, the two large-scale nourishment projects have increased the total volume of sand within the beach and delta system at the northeast end of the island by over 2,000,000 cubic yards. The volume will help to buffer development from impacts of the shoal events and hopefully allow the processes to occur without the need for mitigation via sand transfers.

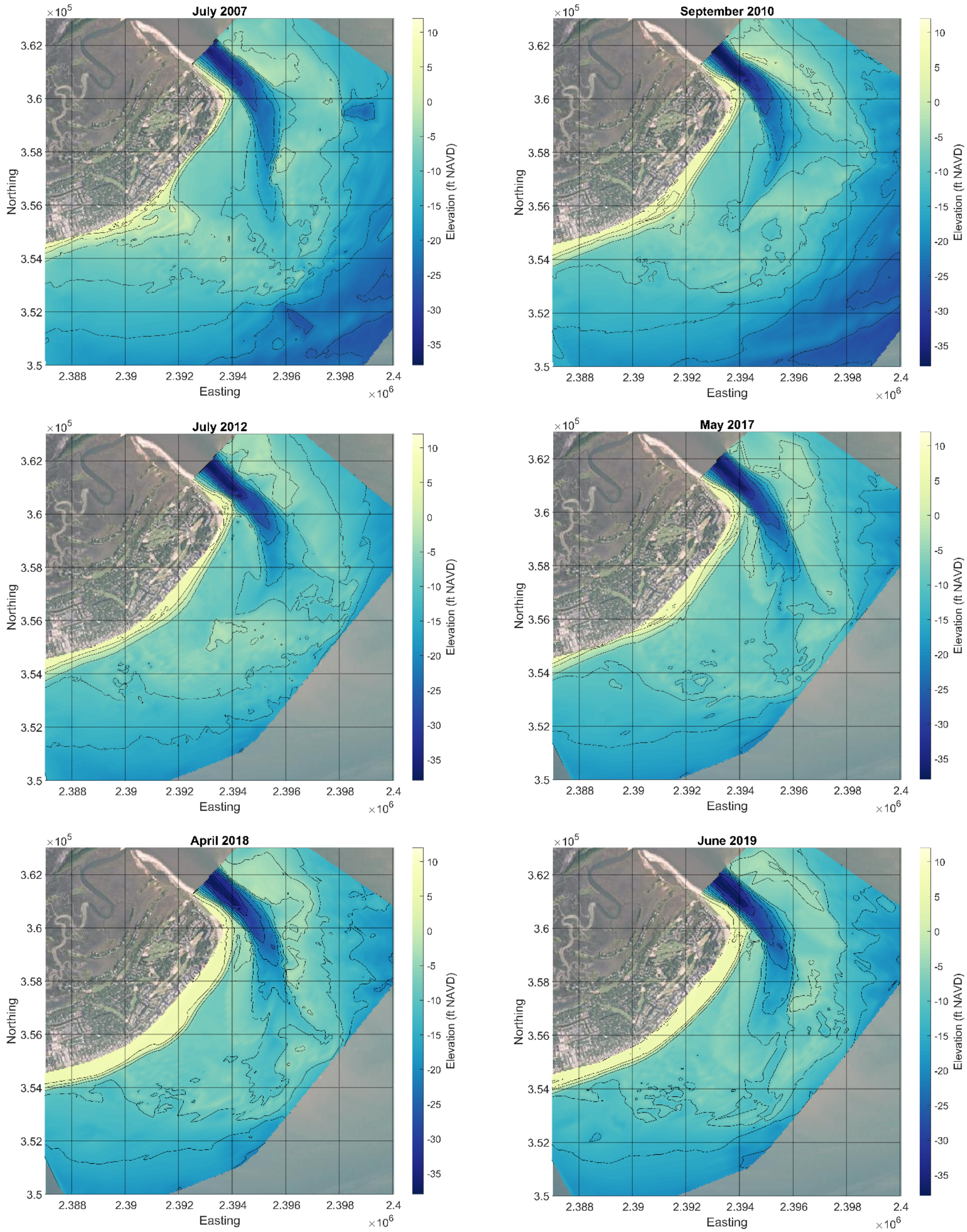


FIGURE 6.1. Selected models of the Dewees Inlet delta since 2007. Although the main channel is currently in a location similar to the 2007 condition, there are substantial differences in the delta — most notably is the existence of a significant sand body connected to the northeast end of the island called a "trailing ebb spit."

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7.0 SUMMARY & RECOMMENDATIONS

This report provides a detailed description of beach condition changes occurring at Isle of Palms beach from 2018 to 2019. Overall, the island lost 234,583 cy of sand from April 2018 to June 2019, which is equivalent to a unit volume loss of 5.4 cy/ft over that time period. Erosion was most severe along the center of the 2018 project area, including losses of up to 120 cy/ft in the most eroded areas. The 2018 project area lost ~300,000 cy, with much of the lost sand spreading to adjacent areas or recycling into the Dewees Inlet delta. The project area still holds over 1.3 million cy more sand than the pre-nourishment condition. Erosion was also observed along most of the beach south of the pier, while the beach between the pier and Wild Dunes gained sand. The evolution of the beach since completion of the 2018 project follows the expected pattern of erosion that generally occurs after large-scale nourishments, with sand eroding from the ends of the project and shifting to downcoast areas.

The erosion along the center of the project area was likely magnified by the continued erosion of a shoal that had attached to the beach prior to the project. Within the delta, a new channel avulsion event appears to be occurring, with the channel shifting to the north. The old channel is being closed by a shoal shifting from the seaward lobe of the delta. A large emergent shoal will likely form in the next 1–2 years from sand on the shoal platform extending seaward of Beach Club Villas coupled with sand from the growing trailing-ebb-spit at the northeast corner of the island. Once formed, the shoal will migrate towards the beach. Any impacts of the shoal on erosion or accretion patterns will depend on the location, size, and duration of the shoal attachment process. CSE anticipates that the northeastern end of the project site will be fairly protected from typical shoal-induced erosion due to the existence of the trailing-ebb-spit, while the western end near Beachwood East and the Grand Pavilion may continue to be an erosional hotspot until attachment.

CSE recommends the City pursue discussions with the USACE to determine the feasibility of placing sand from the next federal dredging effort of the Intracoastal Waterway along the Isle of Palms beach near Breach Inlet. Partnering with the USACE may provide benefits to both the USACE and IOP through the beneficial use of dredged material. This effort will likely require the City to secure permits and/or complete engineering studies to support any additional effort the USACE requires beyond their existing work plan or permits; however, there may be the opportunity to place sand along the beach at a net lower cost.

The next monitoring effort for Isle of Palms is scheduled for the summer of 2020 and will include an update on the condition of the beach and evolution of the 2018 nourishment project. It will also update the status of the shoal migration and anticipated bypass event outlined in this report. Copies of this report and associated data will be sent to regulatory agencies to satisfy permit compliance requirements.

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