2008 BEACH RESTORATION PROJECT
ISLE OF PALMS SOUTH CAROLINA

Monitoring Report No 4
November 2012

Prepared for:

City of Isle of Palms

2008 Isle of Palms Beach Restoration Project

YEAR 4 MONITORING REPORT

Prepared for:

City of Isle of Palms

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[2386YR1]

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COVER PHOTO: Isle of Palms (SC) front beach area on 10 July 2012.
[Photo by SB Traynum]

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EXECUTIVE SUMMARY

This report presents results of Year 4 beach and inlet monitoring following the 2008 beach restoration project at the Isle of Palms, which was accomplished in May–June 2008 under permit P/N 2007-02631-2IG. Annual surveys are being conducted to track the performance of the project, measure sand volumes remaining, and provide a condition survey of the beach, inlets, and shoals from Dewees Inlet to Breach Inlet.

Year 4 monitoring involved a condition survey in July 2012. These data are compared with pre-project and post-project conditions in the project area (north of 53rd Avenue). Data for remaining areas of the Isle of Palms and Breach Inlet are compared with earlier surveys by CSE and SCDHEC–Office of Ocean & Coastal Resource Management (OCRM). The report includes:

- Shoreline history and summary of the 2008 beach restoration project.
- Important dates of events (Table A).
- Description of the data collection and analysis methods.
- Monitoring results by section of shoreline using seven (7) reaches along the island.
- Nourishment volume remaining within the project limits.
- Identification of local erosion "hot spots."
- Discussion of findings.

The 2008 beach restoration project placed 933,895 cy of sand from offshore in three reaches between 53rd Avenue and Dewees Inlet. As of July 2012 (~4 years after project completion):

- Reach A (53rd Avenue to Beach Club Villas) retained ~10.7 percent of the nourishment volume. Erosion has been mostly restricted to the eastern third of the reach, which presently has less sand than the post-nourishment condition. The western two-thirds of the reach from 53rd Ave to Beachwood East retain 71.3 percent of the nourishment volume.

- Reach B (Mariners Walk Villas to the 18th fairway of Wild Dunes Links Course) retained ~74.3 percent of the nourishment volume.

- Reach C (a 1,000-foot length of Dewees Inlet shoreline adjacent to the 17th hole and 18th tee of the Wild Dunes Links Course) retained ~165.0 percent of the nourishment volume (Fig A).

Collectively, the project reaches retained ~57.1 percent of the nourishment fill as of July 2012. Overall, the island lost 94,800 cy (2.6 cubic yards per foot—cy/ft) of sand between June 2011 and July 2012 (Fig B). This is less than losses over the previous year (~150,000 cy or 4.1 cy/ft). The beach west of 53rd Avenue gained ~120,900 cy, while the beach east of 53rd Avenue lost ~215,700 cy. Erosion was prevalent near Ocean Club, Beach Club Villas, and Breach Inlet.

TABLE A. Important dates of events related to the 2008 beach nourishment project and subsequent monitoring.

Milestone	Date	Comment
Beach Condition Survey	Jul 2007	
Pre-Construction Survey	Mar 2008	
Project Construction	May-Jun 2008	934,000 cubic yards (cy) placed along 10,200 feet (ft) of shoreline
Monitoring Survey	Mar 2009	93 percent of nourishment volume remained within the fill placement area
Monitoring Survey	Sep 2009	81 percent of nourishment volume remained within the fill placement area
Year 1 Monitoring Report	Dec 2009	
Monitoring Survey	Mar 2010	73 percent of nourishment volume remained within the fill placement area
Monitoring Survey	Sep 2010	72 percent of nourishment volume remained within the fill placement area
Permit Application Submitted	Oct 2010	
Year 2 Monitoring Report	Mar 2011	
Monitoring Survey	Jun 2011	66 percent of nourishment volume remained within the fill placement area
Year 3 Monitoring Report	Nov 2011	
Shoal Management Project	Mar-Apr 2012	Redistribution of 87,700 cy at the northeastern end of the island
Monitoring Survey	July 2012	57 percent of nourishment volume remained within the fill placement area
Year 4 Monitoring Report	Nov 2012	

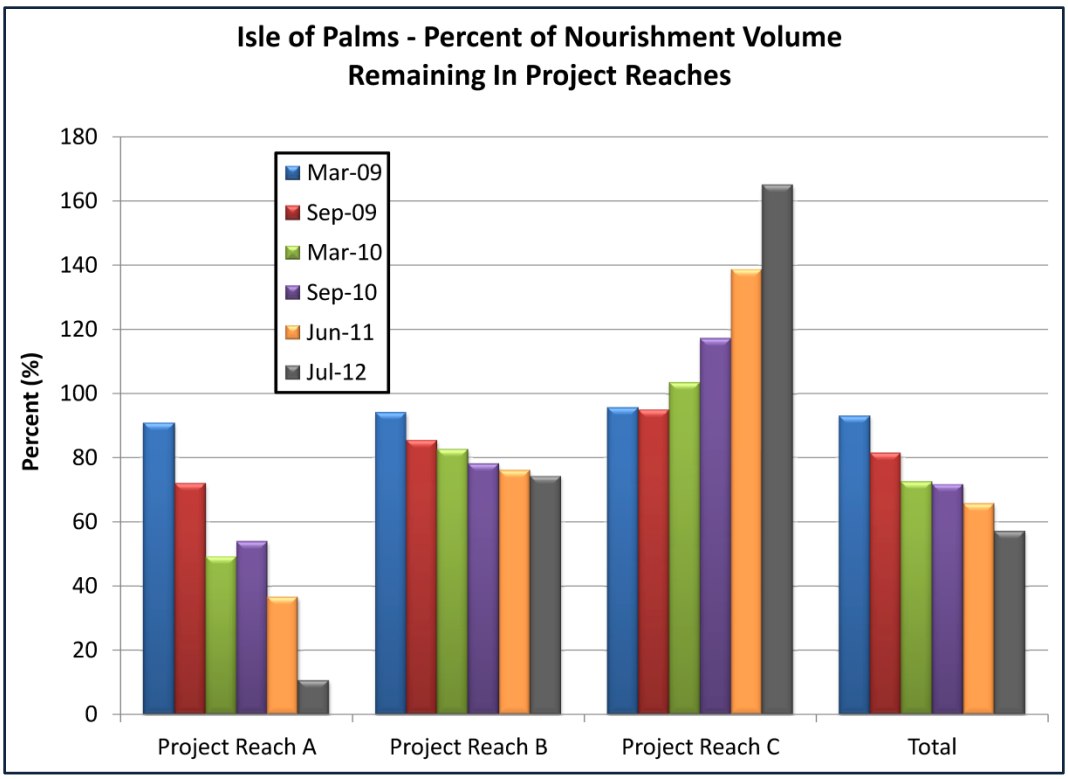

FIGURE A. Percent of nourishment volume remaining in project areas as of July 2012.

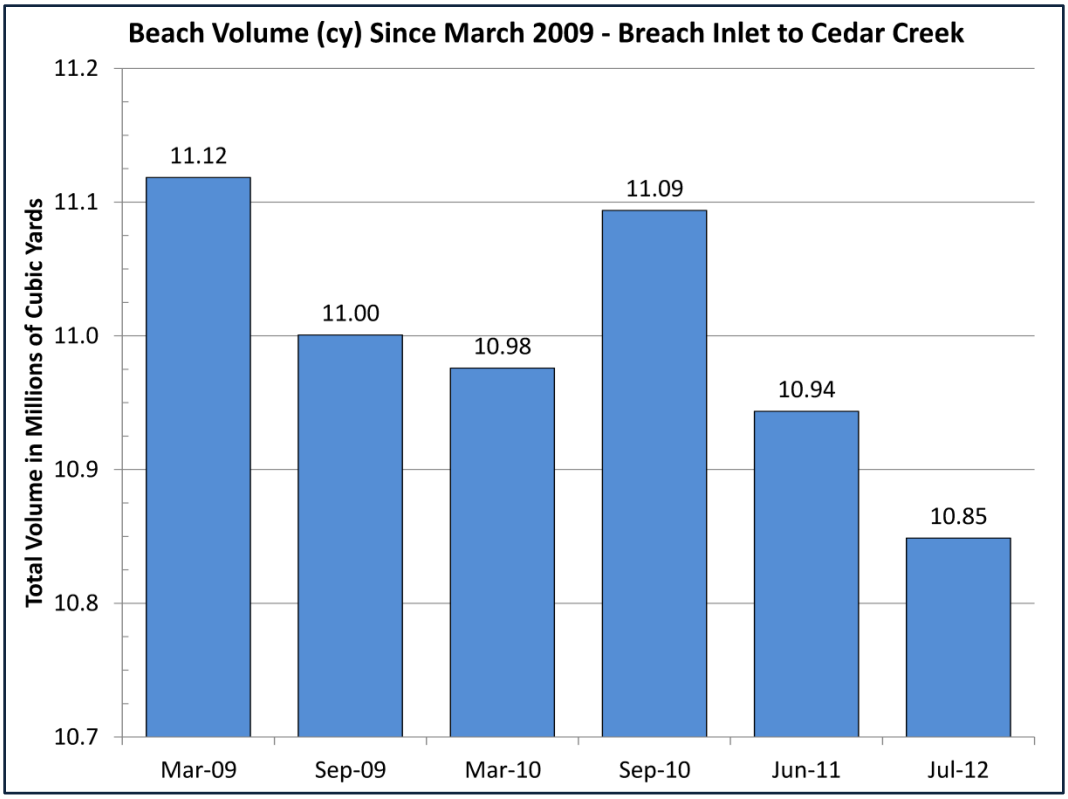

FIGURE B. Total beach volume at Isle of Palms from March 2009 to July 2012. Volume is measured to local closure depth (between −10 ft and −18 ft NAVD).

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1.0 INTRODUCTION

This monitoring report is provided to the City of Isle of Palms by Coastal Science & Engineering (CSE) as part of a three-year agreement for beach monitoring following the 2008 Isle of Palms beach restoration project (P/N 2007-02631-2IG) (CSE 2008). This report details the sixth island-wide data collection after nourishment. It follows submission of the Years 1–3 monitoring reports (CSE 2009, 2010, 2011a,b). Discussions presented herein are based on comparisons of pre-project and post-project data with surveys performed through July 2012.

The analyses presented in this report provide an updated condition of the beach ~48 months after the completion of the restoration project. This report provides beach profile volumes along the length of the Isle of Palms (IOP), including detailed volume changes in the 2008 project areas. Ground and aerial photography are included to identify features such as dunes, escarpments, sand texture and color, as well as to give a visual representation of the beach width for comparison with previous and future surveys.

1.1 Setting

Isle of Palms is an ~7-mile-long, southeast-facing, barrier island located ~8 miles east of Charleston, South Carolina. It is bounded by Dewees Inlet and Dewees Island to the northeast and Breach Inlet and Sullivan's Island to the southwest. A feature typical of the central South Carolina barrier islands is the "drumstick" shape (Hayes 1979) produced by the interaction of waves and tides, and formation of prominent ebb-tidal deltas at the inlets. Seaward shoals of each delta produce wave refraction and variable longshore transport rates. This leads to a wider upcoast (northern) end and a relatively thin downcoast end (Breach Inlet end, Fig 1.1). The wider end of the island is influenced by shoal bypassing, a process whereby sand is periodically released from the inlet delta and moved onshore through wave action. This process occurs at somewhat regular intervals (average interval between events from 1941 to 1997 is 6.6 years, Gaudiano 1998) and contributes to the overall health of the island. However, it also can cause focused erosion in areas adjacent to the shoal attachment zone (Kana et al 1985).

FIGURE 1.1. Isle of Palms is a typical "drumstick" barrier island (after Hayes 1979), where the upcoast end is wider due to sediment accumulation through shoal-bypass events, and the downcoast end usually forms a growing recurve spit. Other examples of drumstick barrier islands along South Carolina are Bull Island, Kiawah Island, and Fripp Island. Zones of sediment transport reversal generally occur in the lee of delta shoals which are situated offshore. Upon shoal attachment to the beach, transport directions in the vicinity of the shoal switch, spreading sand away from the attachment point (see for example — Fig 1.2).

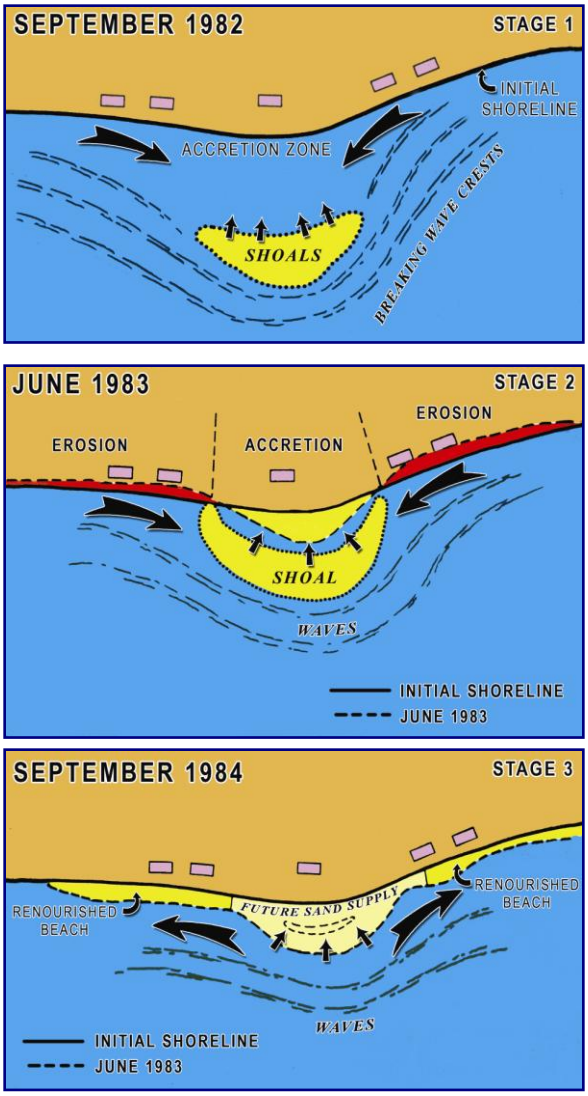

FIGURE 1.2.

[LEFT]
Schematic of the shoal-bypass cycle originally modeled from a bypass event at IOP. During Stages 1 and 2 of the cycle, accretion in the lee of the shoal is accompanied by erosion on either side of the attachment site. (After Kana et al 1985)

[RIGHT]
Shoal-bypass event at the northeastern end of IOP. The upper photo shows a shoal in Stage 1 of the bypass cycle in March 1996. The middle image, taken in 1997, shows that the shoal is beginning to attach to the beach and is in Stage 2 of the bypass cycle. The lower image (from December 1998) shows the shoal completely attached (Stage 3), and sand has spread to previously eroded areas.

The long-term accretion trend at Isle of Palms is a direct result of shoal bypassing at Dewees Inlet. Numerous episodic events have deposited sand on the northeastern end of the island (Gaudiano 1998). The annual average sand gain from shoal-bypass events is ~100,000 cubic yards per year (cy/yr); however, ~120,000–130,000 cy/yr are typically lost to downcoast areas each year, leaving a net sand deficit of ~20,000–30,000 cy/yr at the northeastern end (CSE 2007). A more detailed explanation of the coastal processes and erosion history of Isle of Palms is provided in CSE (2007, 2008, 2009).

The shoal-bypassing event which led to the 2008 project appears to have begun around 2003. By 2004, some areas (eg – Port O'Call) experienced 150 ft of beach recession in one year (ATM 2006). In February 2007, exposed bars extended nearly one-half mile offshore around Beach Club Villas and the Wild Dunes Property Owners beach house (Fig 1.3). The southern part of the attaching shoal was already in Stage 3 with some sand moving south to nourish other parts of IOP; the northern side remained in Stage 2. As Figure 1.3 shows, all properties north of Beach Club Villas had lost their dry-sand beach by then. To protect buildings, property owners placed ~5-gallon-sized sand bags along the scarped dune. These bags were quickly destroyed or washed away, and property owners replaced them with large (1 cy) sand bags in front of buildings for protection. Erosion continued into 2008, eventually claiming half of the signature 18th hole of the Wild Dunes Links Course and leaving no dry beach (even at low tide) in front of several properties.

FIGURE 1.3.

[UPPER]

February 2007 oblique aerial image of the northeastern end of IOP showing the approaching shoal in Stage 2 of the bypass cycle.

Note loss of dry beach and various shore-protection measures from Mariners Walk Villas to the 18th fairway (red-outlined arrows – focused erosion).

[LOWER]

Small, 5-gallon-sized sand bags (left) and large 1 cy-sized sandbags (right) installed by property owners to temporarily offer protection to buildings.

Prior to the 2008 project, little to no beach was present at low tide near the Ocean Club condominiums.

Left image courtesy of Coastal Carolina University Beach Erosion Research and Monitoring Program.

1.2 The 2008 Isle of Palms Beach Restoration Project

The 2008 beach restoration project was designed to add ~850,000 cy of sand to ~10,200 linear feet of beach (Fig 1.4). The fill was to be placed in three reaches. Reaches A and B were located along the oceanfront spanning from ~53rd Avenue to the 18th fairway of the Wild Dunes Links Course, separated by an accretion zone associated with the shoal-bypassing event. Reach C represented a portion of the Dewees Inlet shoreline. Roughly 2,600 linear feet of Reach A bordered publically accessible areas of the City. The remaining fill bordered the Wild Dunes community. Design fill volumes for full sections (excluding tapers) were 75 cy/ft in Reach A, 140 cy/ft to 180 cy/ft for Reach B, and 27 cy/ft in Reach C.

The City of Isle of Palms entered into a contract with Weeks Marine of Covington (LA) for placement of 780,000 cy of sand along 9,200 linear feet of beach. Two change orders increased the total volume to 847,400 cy over 10,200 ft of beach and added a fill section to the Dewees Inlet shoreline. The original bid was for $7,914,100, and the total cost after the change orders was $8,402,090.

The final volume added to the beach calculated from Weeks Marine's surveys was 933,895 cy, which was ~10 percent greater than the design volume of 847,400 cy. The overage of 86,495 cy was not a pay quantity as stated in the contract; therefore, the City was only required to pay for the contract volume of 847,400.

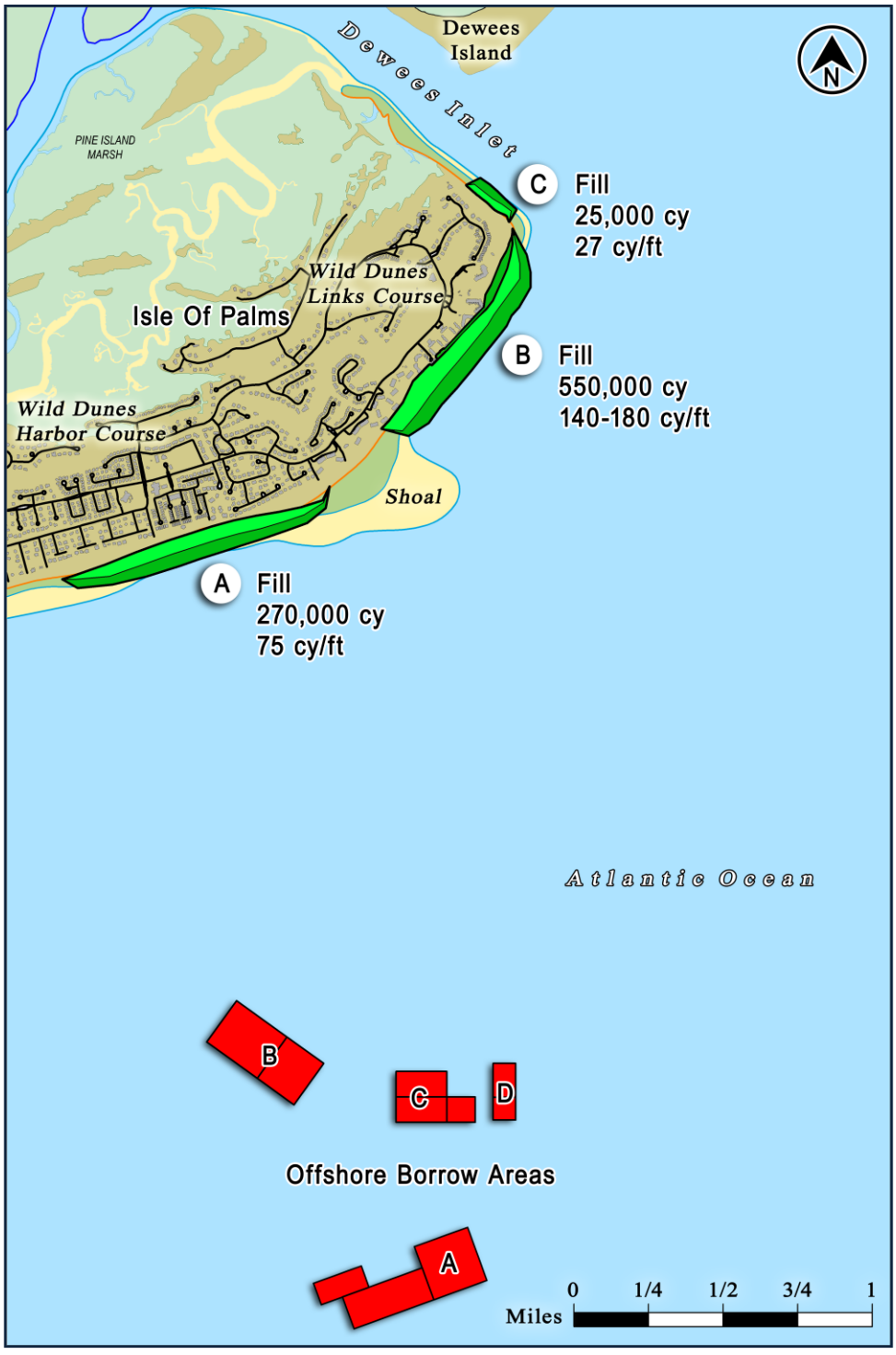

FIGURE 1.4. Project map of the 2008 IOP restoration project. The project was designed to nourish sections of the beach and provide sufficient sand to offset losses associated with long-term erosion as well as an ongoing shoal-bypass event. Borrow areas were located 2-3 miles offshore. Area D was not dredged.

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2.0 METHODS

Monitoring efforts for the present report were performed in July 2012. 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 2.1). 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). The monitoring baseline overlaps the baseline used in the project beginning at 53rd Avenue, which was the location of project station 0+00; that station is now station 222+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 2.2) and was collected with RTK-GPS coupled with an Odom CV100™ precision echo sounder mounted on CSE's shallow-draft vessel, the *RV Congaree River*. Profiles were collected from the most landward accessible point in the dune system to a minimum of 1,500 ft from the baseline. Profiles in the project area 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 in the project area 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 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. [Some sections of this report may refer to volume changes within constructed project reaches and will be clearly indicated.]

FIGURE 2.1 CSE established a monitoring baseline to encompass the length of IOP. The baseline between stations 222+00 and 376+00 corresponds to the baseline used in the 2008 project (project stations 0+00 through 174+00). Red labels indicate locations of OCRM survey monuments. CSE profile sections are oriented perpendicular to the baseline while OCRM profiles are perpendicular to the local beach azimuth. [CSE and OCRM azimuths are only significantly different at Breach Inlet.]

FIGURE 2.2. CSE beach monitoring methods include land-based data collection using Trimble™ RTK GPS from the backshore to low-tide wading depth and over-water work using RTK GPS linked to a precision echosounder aboard CSE's shallow draft boat (RV *Congaree River).*

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

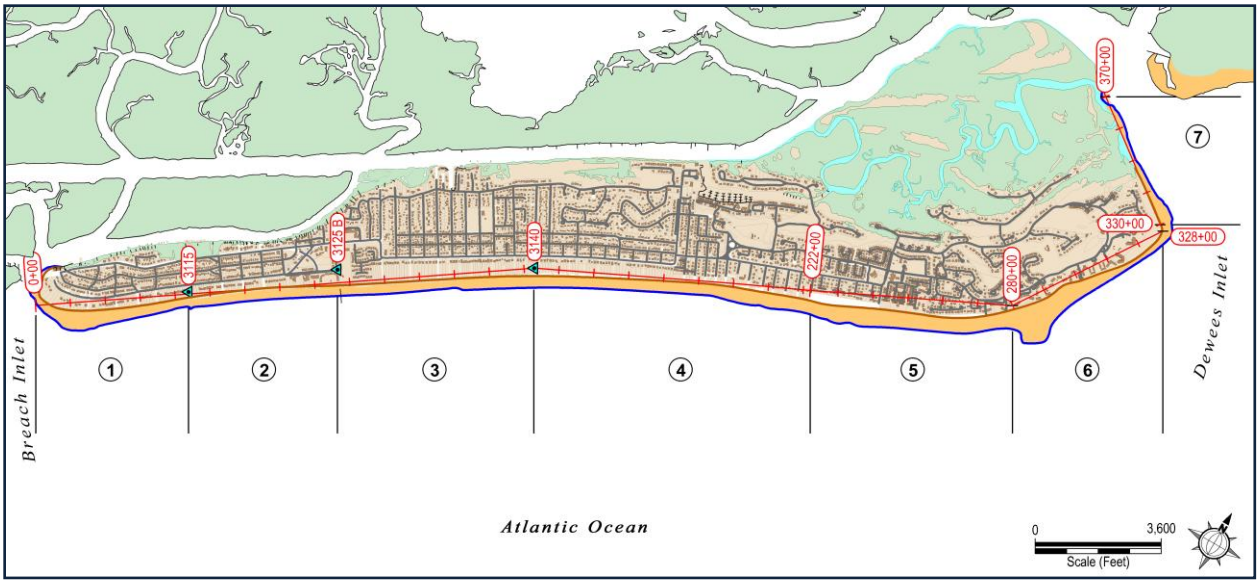

FIGURE 2.3. Location map of the reaches used in post-project monitoring at Isle of Palms. The 2008 beach restoration project occurred in subareas within Reaches 5, 6, and 7.

To determine changes in beach volume along IOP, 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 2.4 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.

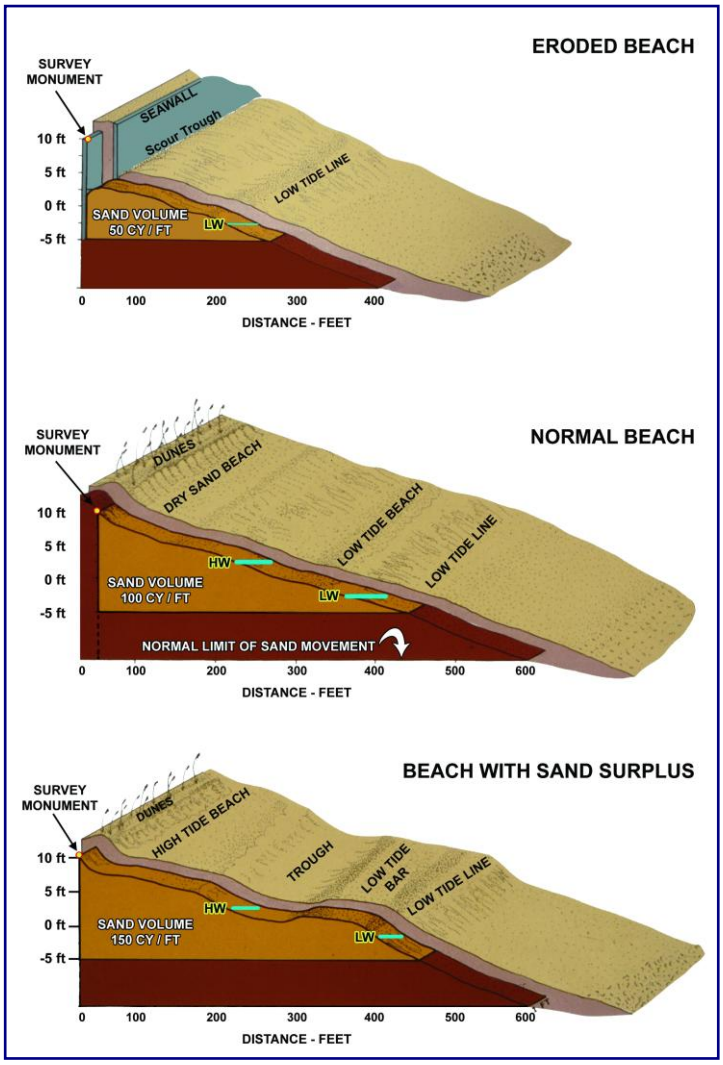

FIGURE 2.4. Calculation of unit-width profile volumes is a means of comparing the condition of one section of beach with another. Profile volumes are the amount of sand contained in a one-foot length of beach between specified elevations. [After Kana 1990]

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 2012 data collections were compared with earlier collections (pre-project and post-project) to determine changes in shoal positions and volumes. Color contour maps were also produced from the DTMs.

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3.0 RESULTS

3.1 Beach Condition in Monitoring Reaches

Results of the 2012 monitoring survey show that the central portion of the island (5th Ave – 54th Ave) was consistently accretional while the east end was variably erosional or accretional. **Overall, the island lost ~95,000 cy (2.6 cy/ft) of sand from June 2011 to July 2012**. The most significant erosion was observed near the Wild Dunes Property Owners Beach House. High erosion rates were also observed in the eastern end of the 2008 project Reach A, and at the western end of the island near Breach Inlet. Volume change data for each monitoring station and reach are given in Figure 3.1, and Tables 3.1 and 3.2.

The following sections describe detailed volume changes within each reach and discuss changes to the inlet deltas.

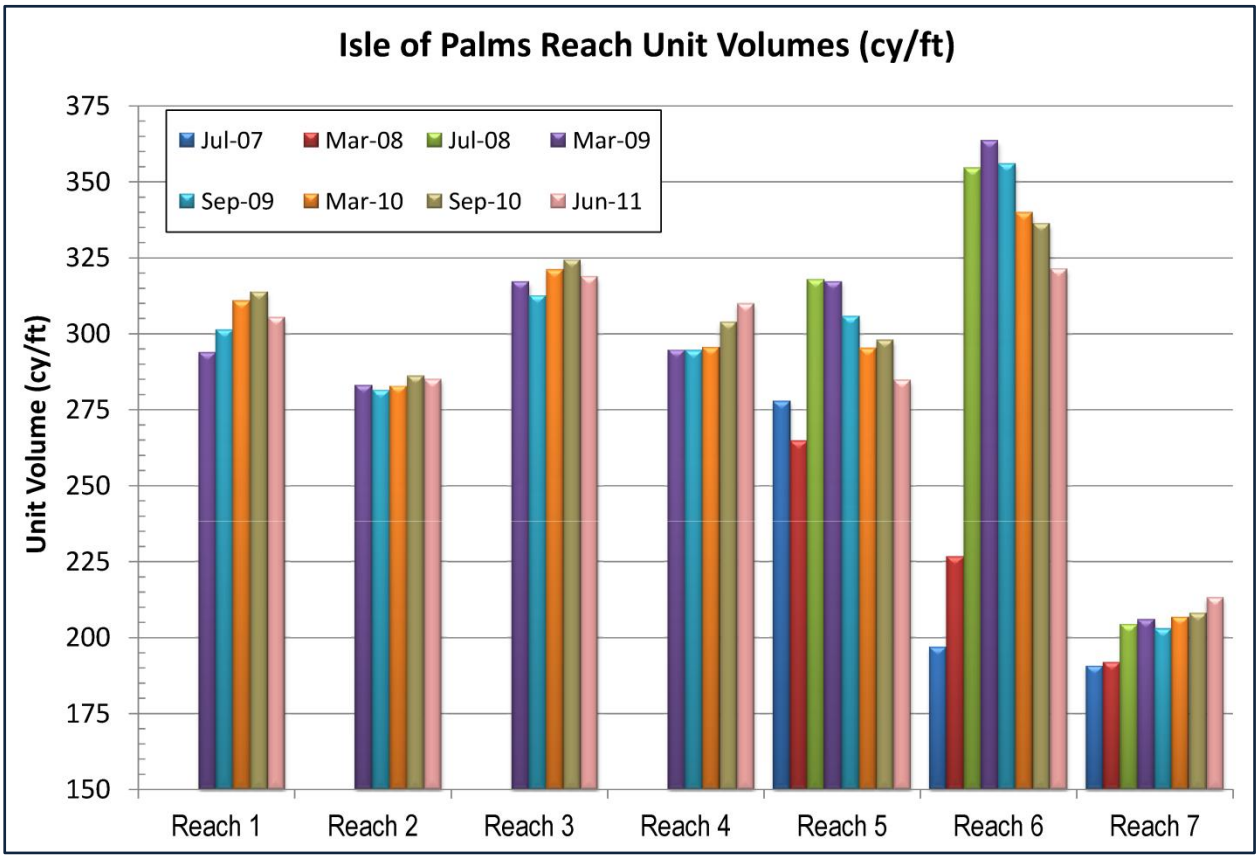


FIGURE 3.1. Average unit-width volumes for each monitoring reach at Isle of Palms. See Figure 2.3 for reach boundaries. Unit volumes were calculated from the primary dune to a profile-specific depth, generally between −9 ft and −13 ft NAVD for the beachfront. Nourishment occurred prior to the July 2008 data collection in Reaches 5, 6, and 7. Design-fill unit volumes for full sections were ~75 cy/ft in Reach 5, ~140-180 cy/ft in Reach 6, and ~27 cy/ft in Reach 7. See Figure 2.1 for beach nourishment locations.

TABLE 3.1. Profile unit-width volumes for each monitoring station at Isle of Palms. Nourishment occurred between stations 224 to 274 and stations 286 to 340 prior to the July 2008 data collection. Volumes are calculated between the approximate crest of the primary dune and the indicated "elevation lens" depth. Nourishment areas are highlighted in blue (project reach A), green, (project reach B), and yellow (project reach C). As additional surveys are completed, calculation limits may change to better encompass volume changes. This results in small differences in reported volumes between the present and earlier reports.

Reach	Line	Elevation Lens (ft NAVD)	Distance to Next (ft)	Unit Volume (cy/ft)							
				Mar-08	Jul-08	Mar-09	Sep-09	Mar-10	Sep-10	Jun-11	Jul-12
Reach 1	3100	-13	0			347.2	347.2	402.7	366.7	-	309.6
	3105	-11	0			523.4	523.4	519.6	530.1	496.4	428.5
	0	-10	400			294.5	221.1	335.0	287.3	301.4	306.1
	4	-10	400			275.8	244.5	281.8	279.4	251.8	232.7
	8	-10	400			271.8	289.1	273.6	277.5	285.9	252.6
	12	-10	400			387.8	424.3	403.7	422.3	388.5	350.2
	16	-10	400			350.0	389.4	367.0	382.6	357.8	300.9
	20	-10	270			271.7	317.3	316.4	317.4	303.1	265.7
	3110	-11	730			295.4	311.6	323.7	323.5	318.3	292.4
	30	-12	1000			275.9	276.9	293.2	300.9	301.8	290.9
	40	-12	390			261.2	261.3	268.3	272.4	270.2	276.1
Reach 2	3115	-12	610			294.4	288.1	299.6	293.0	293.0	308.0
	50	-12	1000			293.2	296.7	297.6	305.3	298.7	307.0
	60	-12	1000			265.6	269.5	274.4	274.7	274.7	286.2
	70	-12	1000			284.1	282.7	272.7	280.1	284.9	297.0
	80	-12	670			276.3	265.7	270.8	274.9	270.5	283.2
Reach 3	3125	-12	330			312.4	308.1	315.8	314.0	312.1	326.3
	90	-13	1000			300.9	292.5	306.4	302.0	303.1	316.4
	100	-13	1000			311.1	304.4	318.1	324.0	315.0	320.8
	110	-13	1000			307.2	306.8	319.1	316.5	309.6	321.6
	120	-13	500			330.4	323.6	325.6	336.6	330.6	349.0
	3135	-12	500			315.4	314.3	304.5	318.6	313.1	322.1
	130	-13	1000			298.9	294.1	302.6	300.9	297.5	299.7
	140	-13	290			371.1	367.3	377.4	383.5	376.6	382.5
Reach 4	3140	-12	710			296.0	292.4	297.5	305.4	299.0	298.0
	150	-13	1000			311.5	299.5	305.2	309.7	311.3	313.0
	160	-13	290			297.8	284.6	275.8	283.1	291.6	305.0
	3145	-12	710			268.2	263.7	243.2	249.2	263.8	284.6
	170	-13	1000			292.5	291.8	290.3	293.4	289.8	317.0
	180	-12	150			277.7	275.7	287.0	293.6	295.4	312.0
	3150	-12	850			289.6	295.3	303.2	315.0	325.0	287.9
	190	-12	1000			280.6	275.9	278.6	293.7	310.8	327.7
	200	-12	200			316.5	307.9	311.9	328.9	337.7	349.7
	202	-12	200		280.5	317.7	325.0	323.1	337.3	341.1	351.3
	204	-12	200		286.8	315.9	333.0	331.6	343.5	344.8	352.8
	206	-12	200		288.7	314.3	336.4	337.7	344.8	346.4	353.4
	208	-11	200		255.9	281.6	294.1	310.6	308.8	311.9	327.0
	210	-11	200		287.8	306.7	328.2	334.2	341.7	346.6	354.9
	212	-11	200		258.0	274.0	298.1	303.9	310.7	316.0	335.2
	214	-11	200		251.7	281.8	305.3	304.3	306.3	321.3	334.9
	216	-11	200		253.4	286.8	302.3	298.9	303.1	317.0	332.4
	218	-11	200		274.5	309.6	312.9	308.9	318.8	332.6	342.8
	220	-11	200		269.5	305.9	309.1	306.1	315.1	327.8	343.5
Reach 5	222	-10	200	252.0	261.0	292.6	295.7	295.6	305.9	322.4	337.3
	224	-10	200	221.5	233.5	269.0	273.0	269.1	271.3	288.3	309.0
	226	-10	200	217.6	225.3	274.0	286.8	276.0	276.8	281.8	300.8
	228	-10	200	222.6	252.1	292.2	299.8	275.3	288.4	285.6	296.4
	230	-10	200	233.0	284.4	306.3	307.4	298.8	304.6	296.5	293.8
	232	-10	200	241.6	284.5	303.9	304.6	301.4	299.6	294.5	284.6
	234	-10	200	245.9	320.5	335.1	327.9	321.9	319.7	317.6	301.7
	236	-10	200	214.2	295.1	317.1	300.6	301.7	297.7	294.7	284.6
	238	-10	200	204.8	294.6	318.1	299.6	303.7	297.9	296.4	279.9
	240	-10	200	184.4	277.6	307.6	285.8	288.9	283.3	285.9	269.5
	242	-10	200	182.6	273.6	304.3	283.8	283.5	282.3	280.0	260.6
	244	-10	200	189.8	283.1	313.0	297.7	289.6	290.0	281.0	267.9
	246	-10	200	181.8	271.0	286.4	271.4	263.5	264.5	262.6	239.8
	248	-10	200	188.7	272.2	280.5	267.2	255.5	258.1	255.9	230.1
	250	-10	200	188.5	282.2	278.3	261.2	253.7	254.2	248.6	220.9
	252	-10	200	197.9	291.9	275.9	265.5	253.3	253.2	245.8	225.0
Reach 5 (continued)	254	-10	200	197.5	298.1	270.3	267.1	247.5	242.3	236.0	222.0
	256	-10	200	212.3	313.2	276.2	273.8	248.0	240.7	233.6	234.1
	258	-10	200	201.7	297.6	256.8	252.6	219.5	214.6	216.7	218.2
	260	-10	200	229.1	305.9	270.5	256.9	215.3	216.8	216.5	224.5
	262	-10	200	283.5	346.2	340.9	297.5	263.5	276.0	251.1	242.2
	264	-10	200	289.4	349.3	340.9	300.6	270.5	267.1	197.5	199.0
	266	-10	200	303.7	374.3	328.9	303.3	242.1	264.1	227.7	204.1
	268	-10	200	292.7	338.1	272.0	266.2	236.3	250.1	232.8	212.4
	270	-10	200	365.0	394.5	314.9	312.5	291.7	309.0	267.2	212.8
	272	-10	200	363.2	377.0	326.0	307.7	287.1	308.2	277.7	221.6
	274	-10	200	341.5	344.6	300.7	289.8	297.7	307.6	293.4	227.6
	276	-10	200	461.8	459.1	427.9	399.1	439.8	433.3	417.3	331.7
	278	-10	400	463.2	415.2	384.9	371.7	450.2	436.7	426.2	297.4
Reach 6	280	-10	200	461.0	436.6	602.3	603.9	535.3	557.5	458.7	336.9
	282	-10	200	501.0	440.4	616.0	634.9	521.9	549.6	411.5	338.5
	284	-10	200	515.3	522.2	627.9	679.5	567.3	583.0	497.7	403.1
	286	-10	200	445.3	471.8	553.2	587.5	500.8	506.8	452.7	374.6
	288	-10	200	333.0	423.8	433.6	453.8	447.5	445.8	442.6	382.5
	290	-10	200	255.4	357.3	387.9	390.9	398.7	391.1	412.7	372.3
	292	-10	200	246.8	355.6	382.7	389.3	400.7	377.8	423.4	403.0
	294	-10	200	235.7	363.0	378.1	380.7	397.9	370.7	395.9	405.5
	296	-10	200	213.5	354.7	359.8	353.7	378.9	352.3	375.0	385.0
	298	-10	200	191.1	354.1	349.5	339.4	360.0	337.2	356.5	366.0
	300	-10	200	173.6	347.5	336.8	323.6	340.8	320.5	339.7	349.9
	302	-10	200	149.8	339.3	329.5	306.7	319.0	305.8	317.6	328.1
	304	-10	200	141.5	333.2	307.5	289.8	293.3	283.0	292.3	310.2
	306	-10	200	171.7	372.6	359.8	312.2	316.7	305.7	310.8	338.8
	308	-10	200	155.4	341.0	301.7	287.0	275.9	260.9	260.9	289.4
	310	-10	200	152.6	312.9	284.6	241.6	236.1	233.9	245.9	239.0
	312	-10	200	111.2	281.0	234.7	215.2	205.2	194.3	192.6	197.5
	314	-10	200	86.9	246.1	198.9	169.0	163.7	170.6	156.0	171.2
	316	-10	200	136.4	309.3	268.6	252.7	245.7	254.3	235.4	223.0
	318	-10	200	128.2	312.0	272.7	256.8	241.4	251.8	229.4	238.9
	320	-10	200	140.9	324.5	284.3	271.8	260.8	264.8	238.8	251.9
	322	-10	200	205.4	368.5	336.5	318.2	297.0	295.5	267.3	249.9
	324	-10	200	212.3	361.7	342.8	331.6	298.6	304.0	270.8	255.0
	326	-10	200	174.1	291.2	314.4	309.9	288.6	290.1	258.3	243.0
	328	-10	100	241.0	285.3	341.4	321.5	299.8	307.5	259.6	263.1
Reach 7	330	-18	200	228.2	262.4	281.7	297.0	329.3	348.6	374.3	374.5
	332	-18	200	286.9	333.6	340.5	344.8	367.4	383.5	389.5	396.8
	334	-18	200	252.6	295.8	324.2	328.5	338.6	349.0	357.5	372.1
	336	-18	200	232.8	284.0	281.2	291.3	298.3	300.7	319.1	330.0
	338	-18	200	214.7	261.2	247.8	240.3	240.1	245.2	252.3	266.0
	340	-18	200	204.6	244.6	223.2	216.1	209.4	212.5	218.4	224.8
	342	-18	200	227.6	246.4	239.2	232.7	226.1	226.1	232.4	246.7
	344	-18	200	201.1	209.5	208.3	205.0	196.9	196.4	198.6	209.7
	346	-18	200	198.4	198.1	201.8	197.7	190.0	189.3	193.5	194.9
	348	-15	200	150.9	147.2	150.7	149.0	141.8	136.2	147.2	144.0
	350	-15	200	170.1	169.7	170.7	167.5	167.2	165.5	165.1	168.0
	352	-15	200	159.8	160.4	155.2	153.3	155.4	157.3	158.9	160.2
	354	-15	200	170.1	171.1	168.1	165.0	167.0	171.8	174.2	176.5
	356	-15	200	186.5	185.6	183.1	177.9	183.7	185.1	189.1	188.6
	358	-15	200	175.3	171.9	173.1	163.8	173.4	174.5	180.0	178.4
	360	-15	200	177.2	172.0	174.4	164.2	179.7	175.7	181.8	177.5
	362	-15	200	173.3	167.4	173.1	164.5	172.4	174.9	174.4	167.6
	364	-15	200	146.2	141.2	137.5	139.7	136.3	145.2	136.3	129.3
	366	-13	200	137.4	131.6	146.1	138.9	135.0	131.2	136.8	135.6
	368	-13	200	168.9	174.2	183.7	178.5	187.0	177.0	174.2	180.1
	370	-13	0				176.0	202.5	178.8	193.5	-

TABLE 3.2. Isle of Palms reach volume analysis from March 2008 through July 2012. Nourishment occurred May-June 2008, prior to the July 2008 data collection. Volumes are calculated for each profile to a profile-specific depth, and then extrapolated to the next profile using the average-end-area method. The March 2008 data collection represents the pre-nourishment condition. As additional surveys are completed, calculation limits may change to better encompass volume changes. This results in small differences in reported volumes between the present and earlier reports.

			Total Volume (cy)								Average unit Volume (cy/ft)							
Reach	Limits	Length (ft)	Mar-08	Jul-08	Mar-09	Sep-09	Mar-10	Sep-10	Jun-11	Jul-12	Mar-08	Jul-08	Mar-09	Sep-09	Mar-10	Sep-10	Jun-11	Jul-12
Reach 1	0-3115	4,390	-	-	1,289,419	1,322,510	1,363,795	1,376,987	1,340,611	1,254,598	-	-	293.7	301.3	310.7	313.7	305.4	285.8
Reach 2	3115-3125	4,280	-	-	1,210,927	1,204,056	1,210,097	1,224,707	1,219,861	1,270,043	-	-	282.9	281.3	282.7	286.1	285.0	296.7
Reach 3	3125-3140	5,620	-	-	1,781,858	1,756,250	1,803,023	1,822,223	1,791,564	1,844,155	-	-	317.1	312.5	320.8	324.2	318.8	328.1
Reach 4	3140-222	7,910	-	-	2,329,739	2,329,332	2,337,148	2,403,086	2,455,964	2,560,074	-	-	294.5	294.5	295.5	303.8	310.5	323.7
Reach 5	222-280	6,000	1,587,593	1,905,827	1,902,750	1,833,722	1,770,696	1,787,429	1,708,389	1,553,302	264.6	317.6	317.1	305.6	295.1	297.9	284.7	258.9
Reach 6	280-328	4,900	1,109,721	1,737,374	1,780,813	1,743,807	1,664,778	1,647,178	1,574,542	1,509,562	226.5	354.6	363.4	355.9	339.8	336.2	321.3	308.1
Reach 7	330-370	4,000	766,568	816,758	822,893	810,992	826,350	832,184	852,642	857,028	191.6	204.2	205.7	202.7	206.6	208.0	213.2	214.3

			Net Change Since Previous								Unit Change Since Previous (cy/ft)							
Reach	Limits	Length (ft)	Mar-08	Jul-08	Mar-09	Sep-09	Mar-10	Sep-10	Jun-11	Jul-12	Mar-08	Jul-08	Mar-09	Sep-09	Mar-10	Sep-10	Jun-11	Jul-12
Reach 1	0-3115	4,390	-	-	-	33,092	41,285	13,192	-36,376	-86,013	-	-	-	7.5	9.4	3.0	-8.3	-19.6
Reach 2	3115-3125	4,280	-	-	-	-6,870	6,041	14,610	-4,846	50,182	-	-	-	-1.6	1.4	3.4	-1.1	11.7
Reach 3	3125-3140	5,620	-	-	-	-25,608	46,773	19,200	-30,659	52,591	-	-	-	-4.6	8.3	3.4	-5.5	9.4
Reach 4	3140-222	7,910	-	-	-	-407	7,815	65,939	52,878	104,110	-	-	-	-0.1	1.0	8.3	6.7	13.2
Reach 5	222-280	6,000	-78,699	318,233	-3,076	-69,028	-63,026	16,732	-79,040	-155,088	-13.1	53.0	-0.5	-11.5	-10.5	2.8	-13.2	-25.8
Reach 6	280-328	4,900	146,076	627,653	43,439	-37,006	-79,029	-17,599	-72,636	-64,981	29.8	128.1	8.9	-7.6	-16.1	-3.6	-14.8	-13.3
Reach 7	330-370	4,000	4,393	50,190	6,135	-11,901	15,358	5,834	20,459	4,385	1.1	12.5	1.5	-3.0	3.8	1.5	5.1	1.1
Total Change Since Previous			71,771	996,076	46,498	-117,729	-24,783	117,908	-150,221	-94,812	1.9	26.8	1.3	-3.2	-0.7	3.2	-4.0	-2.6

			Net Change Since Prenourishment (cy)								Unit Change Since Prenourishment (cy/ft)							
Reach	Limits	Length (ft)	Mar-08	Jul-08	Mar-09	Sep-09	Mar-10	Sep-10	Jun-11	Jul-12	Mar-08	Jul-08	Mar-09	Sep-09	Mar-10	Sep-10	Jun-11	Jul-12
Reach 5	222-280	6,000	-	318,233	315,157	246,129	183,103	199,835	120,796	-34,292	-	53.0	52.5	41.0	30.5	33.3	20.1	-5.7
Reach 6	280-328	4,900	-	627,653	671,092	634,086	555,057	537,458	464,822	399,841	-	128.1	137.0	129.4	113.3	109.7	94.9	81.6
Reach 7	330-370	4,000	-	50,190	56,324	44,424	59,782	65,615	86,074	90,459	-	12.5	14.1	11.1	14.9	16.4	21.5	22.6
5-7 Total Change Since Prenourishment			-	996,076	1,042,574	924,638	797,942	802,909	671,692	456,009	-	66.9	70.0	62.1	53.6	53.9	45.1	30.6

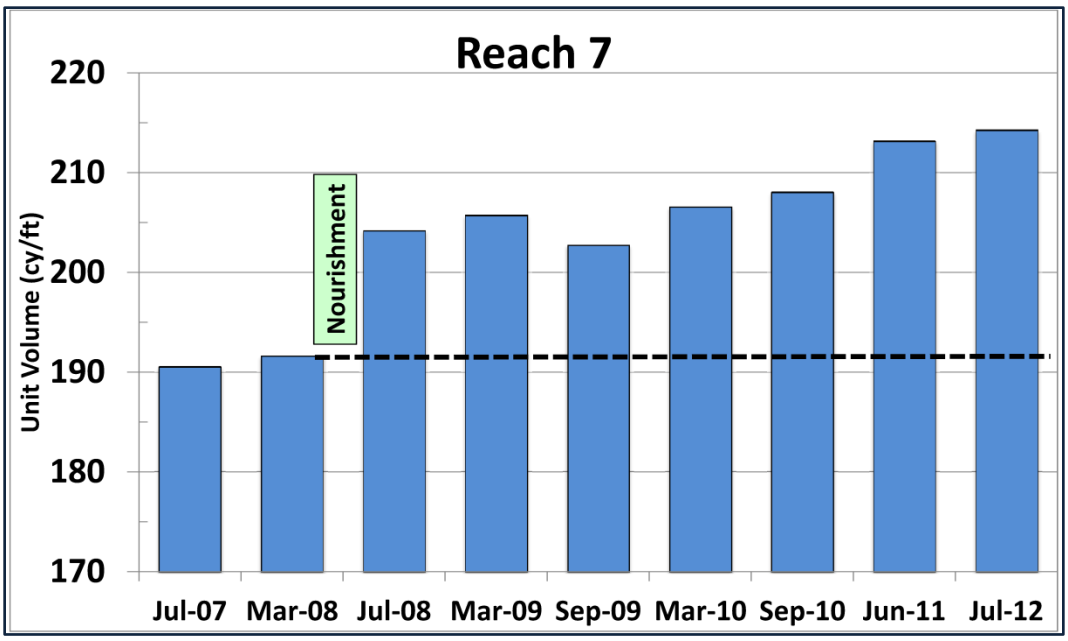
Reach 7 — Dewees Inlet (Volume Changes)

FIGURE 3.2. **[UPPER LEFT]** Reach 7 in December 2007. **[UPPER RIGHT]** June 2008 near the end of the project. **[LOWER]** September 2012. [Upper images by TW Kana] [Lower image by S Traynum]

Dewees Inlet (Fig 3.2, previous page) generally receives less wave energy than the rest of the Isle of Palms due to the sheltering effects of the ebb-tidal delta associated with the inlet. Shorelines along stable inlets usually show less dynamic volume changes than ocean-facing beaches; however, over time, they can experience severe erosion due to several factors. One factor thought to contribute to localized erosion along the Dewees Inlet shoreline is wave focusing through breaks in the inlet delta (Kana and Dinnel 1980). Breaks between the outer shoals on the Dewees Island side of the channel allow larger waves or destabilizing diffracted waves to reach the IOP shoreline and cause localized erosion. A low profile groin was built in 1981 near the 17th tee of the Wild Dunes Links Course to trap sand moving into Dewees Inlet and slow erosion (Kana et al 1985). The monitoring reach (Fig 3.3) extends from the turn in the shoreline near the 18th tee to the end of Cedar Creek spit.

Reach 7 has consistently accreted since 2007 (Fig 3.4, upper) with the accretion being mostly restricted to the area seaward of the groin near the 17th tee (Fig 3.4, lower). The shoreline between the groin and Cedar Creek has been mostly stable since 2008. From June 2011 to July 2012, stations 330–348 have shown a net gain of ~15,600 cy, which is an average gain of 8.8 cy/ft. Since July 2008, these stations have gained an average of 31.1 cy/ft, yielding a total volume gain since nourishment of 44,500 cy. The inland beach (northwest of the groin) shows a net loss of ~4,000 cy since nourishment. Moderate erosion was observed at stations 360–364 over the past year, ranging from 4.3 cy/ft to 7.0 cy/ft.

FIGURE 3.3. Station map of the Dewees Inlet area (Reach 7). Reach 7 spans from station 330+00 near the 18th tee to station 368+00 near Cedar Creek spit. The approximate limits of nourishment Reach C are identified by the orange-highlighted bar. The 1981 low profile groin is positioned near station 348+00. [July 2011 aerial image by Independent Mapping Consultants Inc]



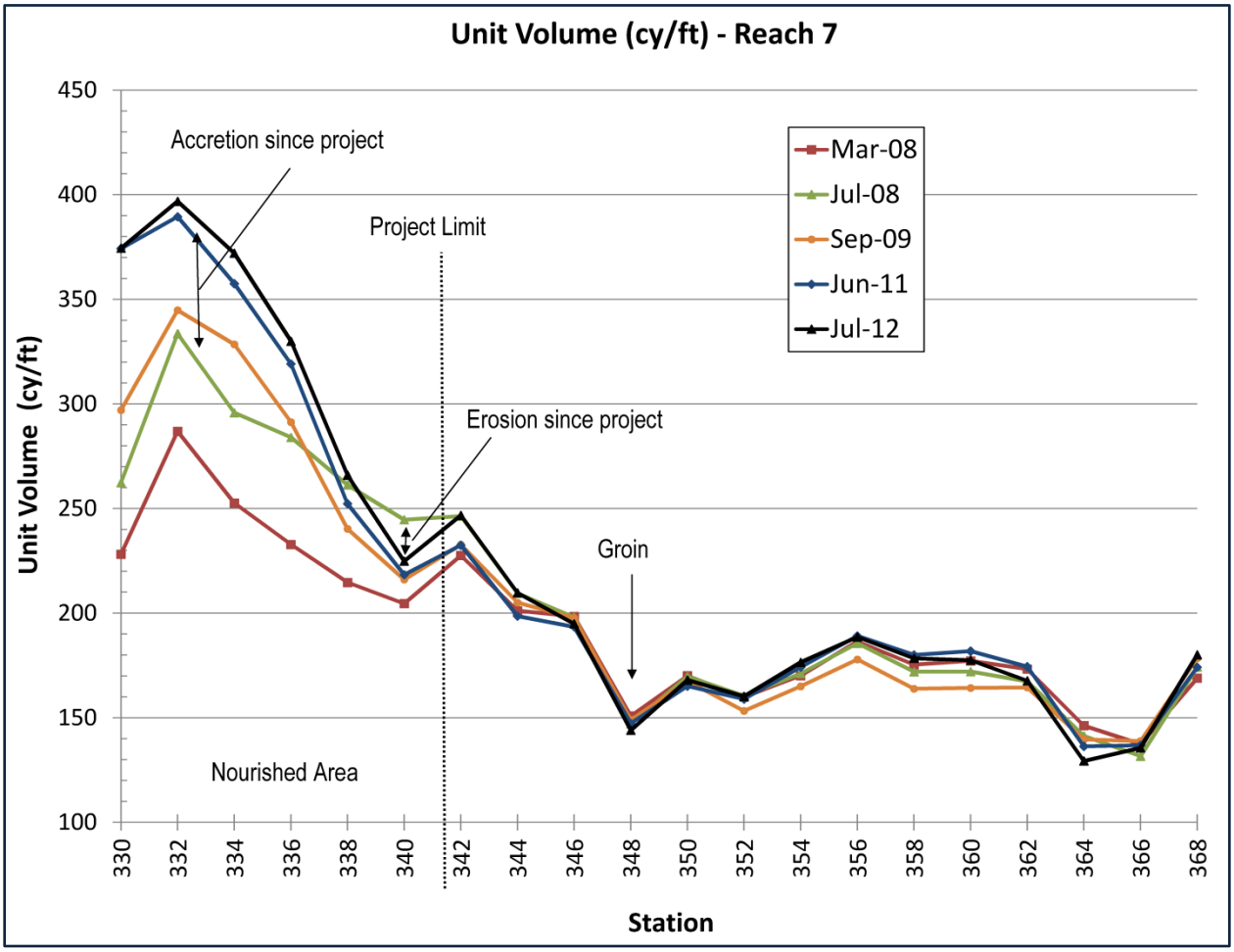
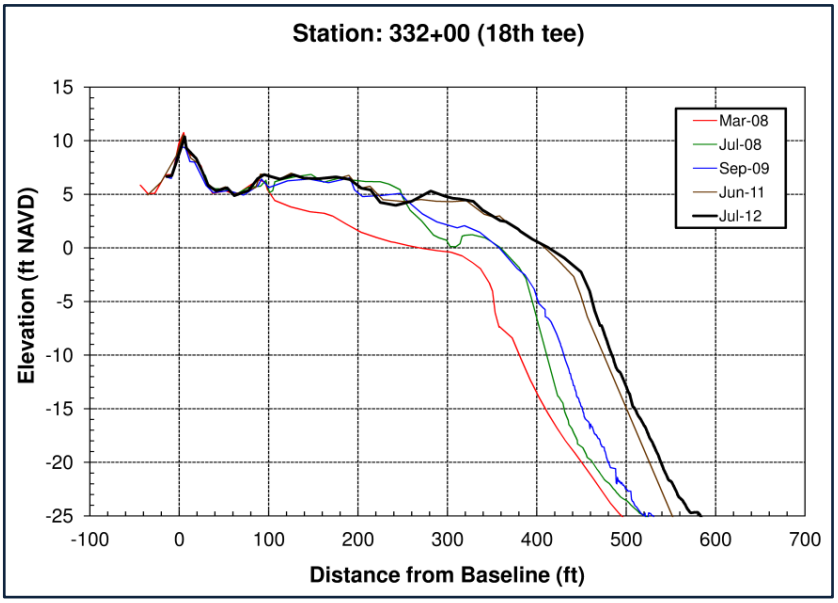


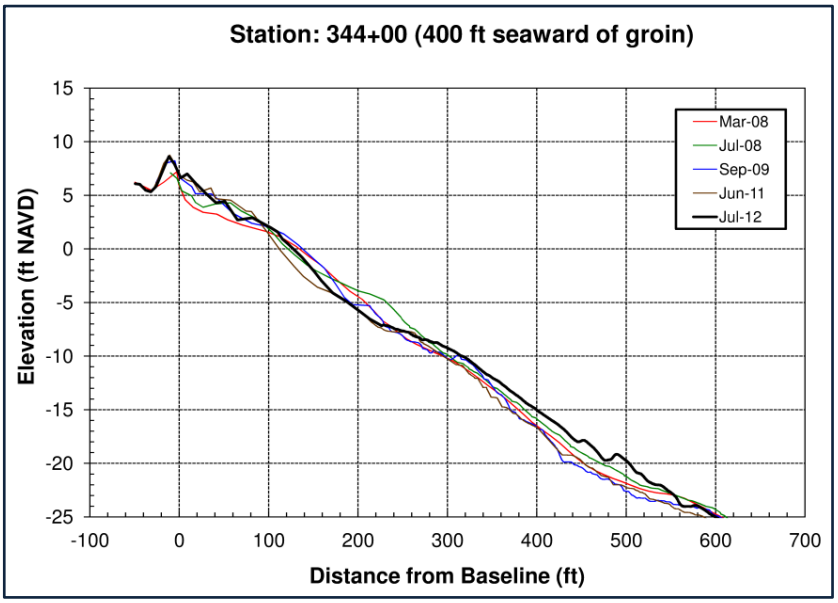
FIGURE 3.4. **[UPPER]** Cumulative unit volumes for Reach 7 from 2007 to 2012. **[LOWER]** Unit volumes for stations in Dewees Inlet. Profiles in the southwestern portion of the reach (17th green – 18th tee) have accreted following the project, while the remaining stations have been stable or have eroded. The difference between 2012 (black line) and post-nourishment (green line) shows the volume change since nourishment.

Profiles from select stations in Reach 7 are shown in Figure 3.5. Station 332 is just seaward of the beach access at the 17th green. The 0 ft NAVD contour (approximate mean sea level) has moved over 100 ft seaward since the 2008 nourishment project. The station has accreted between every monitoring survey since 2008. Station 344 is ~400 ft seaward of the groin and has shown variable periods of erosion and accretion. The dune has built higher and wider since March 2008, while the active beach has remained stable. Station 362 is near the end of Cedar Creek spit. The spit has been extending landward (northwest) over the past ~15 years as sand from the front beach is pushed inland along the inlet shoreline. Profiles and aerial imagery show the spit has transitioned from bare sand flats to a vegetated dune area with a dry beach. Since May 2008, the profiles show ~4 ft of vertical dune growth, though a loss of ~70 ft of beach width at the 0 ft NAVD contour.

Ground photos of Reach 7 show that vegetation has spread and matured along the 2008 fill area (Fig 3.6). The escarpment which ran along the 17th green prior to nourishment has healed and is now well set back from the water. A substantial amount of wrack (dead marsh grass) has accumulated along the shoreline in this reach. The wrack facilitates dune growth and is a benefit to beach organisms. USFWS generally discourages removal of wrack from the beach.

[Note: These results are based on profile volumes between the foredune and −13 ft to −18 ft NAVD. They do not include changes along the Dewees Inlet channel margin between −18 ft and −38 ft, the approximate inlet depth along the reach.]





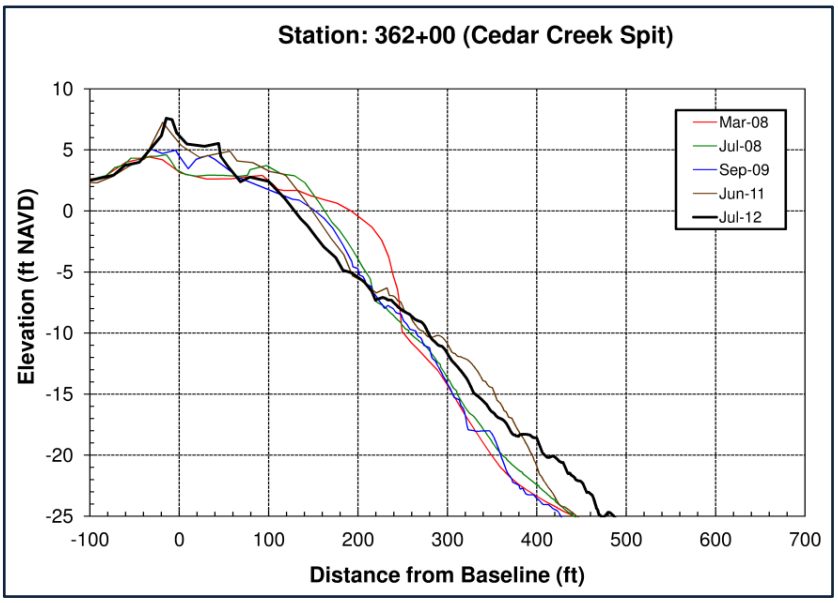


FIGURE 3.5.

Profiles for selected stations in Reach 7.

The seaward end of the reach has accreted (station 332), while the central and inland portions of the reach have remained fairly stable (stations 344 and 362).

FIGURE 3.6. **[UPPER]** View inland of Reach 7 from the 17th tee. **[MIDDLE]** View seaward of Reach 7 from the 17th tee. **[LOWER]** View seaward of the nourished area of Reach 7. Vegetation has become well established seaward of the sand fencing. The pre-project dune line (red dotted line) is the dense vegetation ~25 ft to the right of the fencing in the image. [July 2012 –Photos by S Traynum]

Reach 6 — Wild Dunes Property Owners Beach House to Dewees Inlet

FIGURE 3.7. Reach 6 in December 2007 (upper left), June 2008 near the end of the project (upper right), September 2009 (lower left) and September 2012 (center right).

[Upper images by TW Kana; lower left image by C Jones; center right image by S Traynum]

Reach 6 (Fig 3.7, previous page) extends from the Wild Dunes Property Owners Beach House ~4,900 ft northeast to the 18th fairway, where the beach turns into Dewees Inlet (station 280+00 to station 328+00, Fig 3.8). Shoal-bypassing events have highly impacted this area since the island's formation. Depending on the location and timing of the bypass events, the shoreline can change hundreds of feet over a period of several months (Kana et al 1985, Gaudiano 1998). As was the case in 2007-2008, the shoreline may encroach on development in this reach when shoal-bypass events are prolonged.

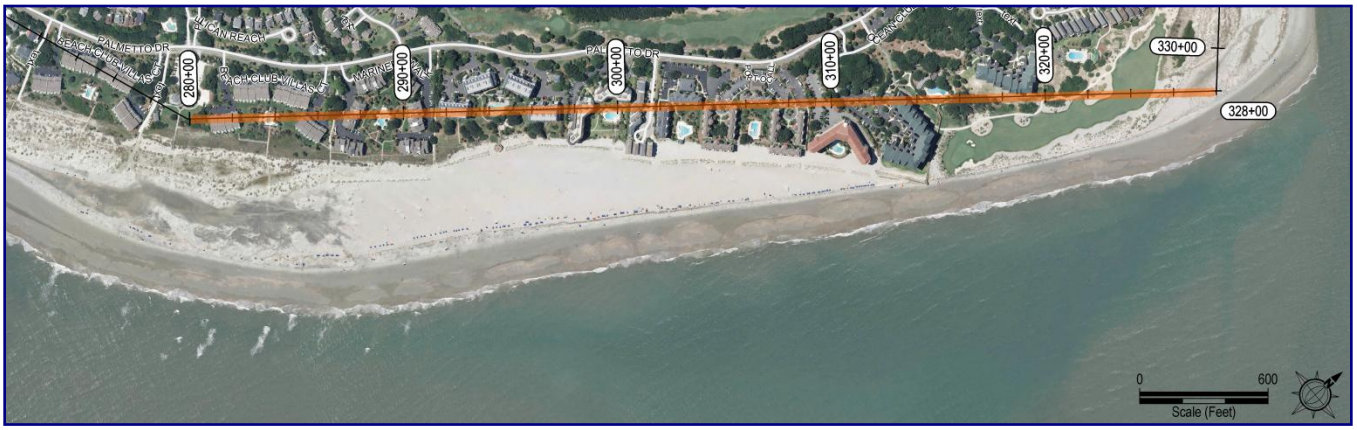


FIGURE 3.8. Reach 6 spans from the Wild Dunes Property Owners Beach House (station 280+00) to the 18th fairway of the Wild Dunes Links Course (station 328+00). The approximate limits of nourishment Reach B are identified by the orange-highlighted bar. [July 2011 aerial image by Independent Mapping Consultants Inc]

Previous studies have suggested that the background, long-term erosion for the northeastern end of IOP is between 15,000 cy/yr and 30,000 cy/yr even though the estimated average volume of sand added by each shoal-bypass event is ~500,000 cy (CSE 2007). This means that, while large fluctuations in the shoreline and severe local erosion may occur, the long-term erosion rate for the area is relatively low. Sand simply migrates from one area of the beach to another and is either transported back to Dewees Inlet or downcoast to IOP, eventually being replaced by offshore sand through another shoal-bypassing event.

Prior to nourishment in June 2008, most of Reach 6 was severely eroded with profile volumes seaward of development well below an ideal condition. Property owners had piled sand bags against buildings for protection, and little or no dry beach was present (see Fig 1.3). The condition was beginning to improve just before the nourishment as the shoal attaching at the western end of the reach was in Stage 3 of the bypass cycle. Sand was moving from the shoal toward Dewees Inlet, but not quickly enough to restore the beach along most properties north of the Wild Dunes Property Owners Beach House.

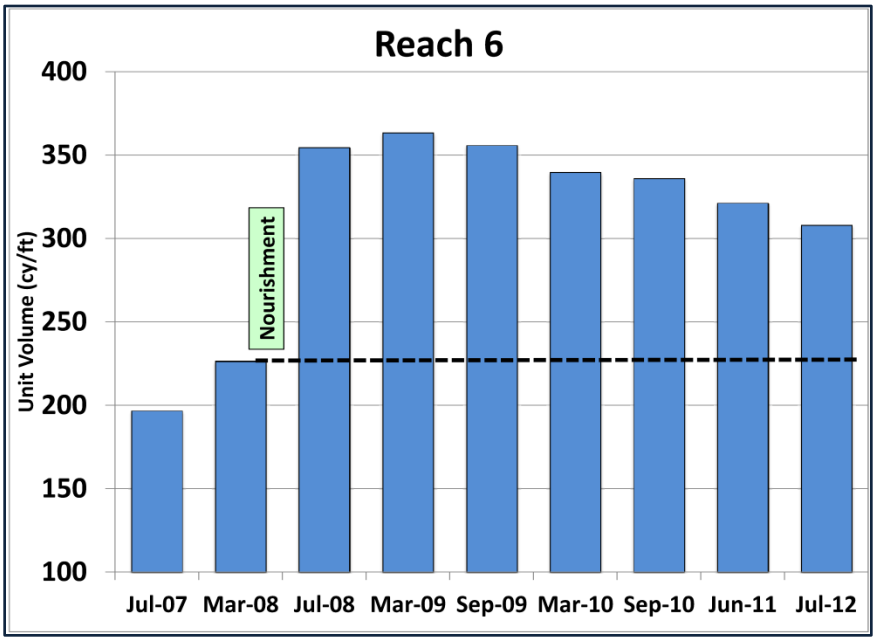
Additional sand was needed to supplement the natural sand transport condition. Between March and July 2008, ~628,000 cy of sand were added to the reach through nourishment and natural spreading of sand from the shoal (the design volume for this reach was 550,000 cy). Average profile unit volumes increased from 226 cy/ft to 355 cy/ft (calculated to −10 ft NAVD) (Fig 3.9, upper).

The western end of Reach 6 (and eastern portion of Reach 5) has experienced large fluctuations in beach width in recent years in response to attaching and spreading shoals (Fig 3.9, lower). Shortly after the 2008 project, a small shoal emerged near the Wild Dunes Property Owners Beach House and Beach Club II and attached to the beach in 2009. A second shoal, centered a few hundred feet north of the previous shoal, formed and attached in 2010. The addition of new sand from these two shoals led to gains of over 100 cy/ft in the attachment area (stations 280–288) (Fig 3.10). Since September 2009, this area has rapidly eroded as the excess sand spread to adjacent areas. Through 2011, the shoal attachment area had the largest volume of sand per linear foot of beach of any area on the island. Continued erosion from 2011 to 2012 has resulted in the beach here having less volume than the area just north, in front of Mariners Walk and Shipwatch (which has been gaining sand recently). The area around Beach Club Villas I is likely to continue to erode over the next year due to onshore migration of the current shoal-bypass event.

The beach from station 290 through station 300 (Mariners Walk to Summer Dunes Lane) has shown net accretion since 2008 (averaging ~25 cy/ft), maintaining a significant dry-sand berm between the dune and water (see Fig 3.10). It is expected that vegetation will continue to spread and lead to additional dune development over the next few years (Fig 3.11). These stations are in the lee of the current shoal-bypass event and are expected to accrete as sand from adjacent areas accumulates in the shelter of the shoal.

The beach east of Summer Dunes eroded significantly in the first year following nourishment (July 2008–September 2009). Erosion has continued since September 2009, but at a much lower pace. Despite removal of sand during the 2012 redistribution project, station 294 (Summer House) to station 308 (east Port O'Call) gained sand over the past year, averaging +15.5 cy/ft. Stations 312–314 (Seascape/Ocean Club) along with stations 318 and 320 (18th Hole) also show volume gain over the past year as a result of the 2012 shoal management project (see Fig 3.10). The area in front of the 18th fairway (stations 322–326) eroded an average of 15 cy/ft over the last year.

Overall, Reach 6 lost ~65,000 cy (13.3 cy/ft) over the past year. This is similar to losses during the previous year. The reach still shows ~400,000 cy (81.6 cy/ft) more sand than the pre-nourishment condition.



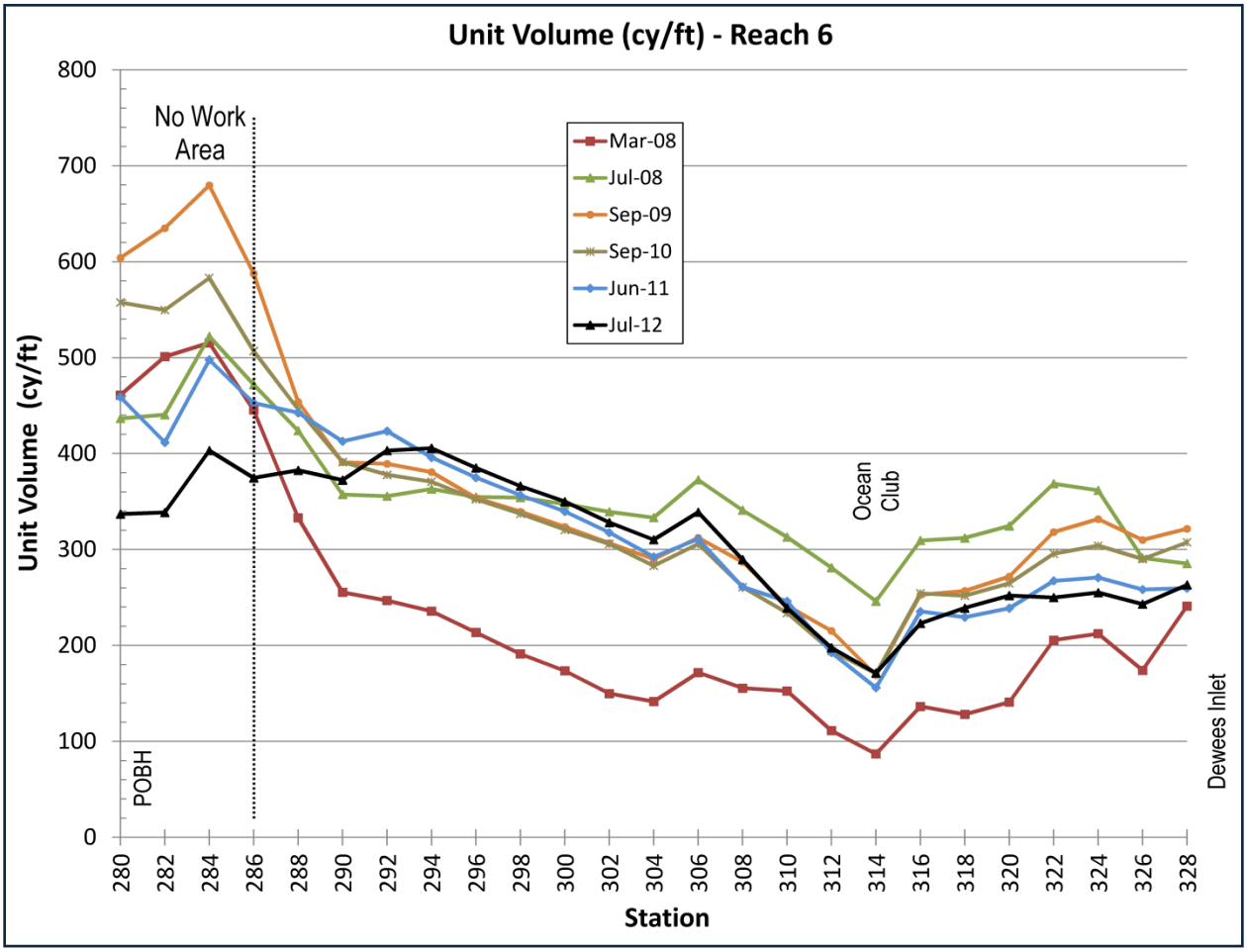
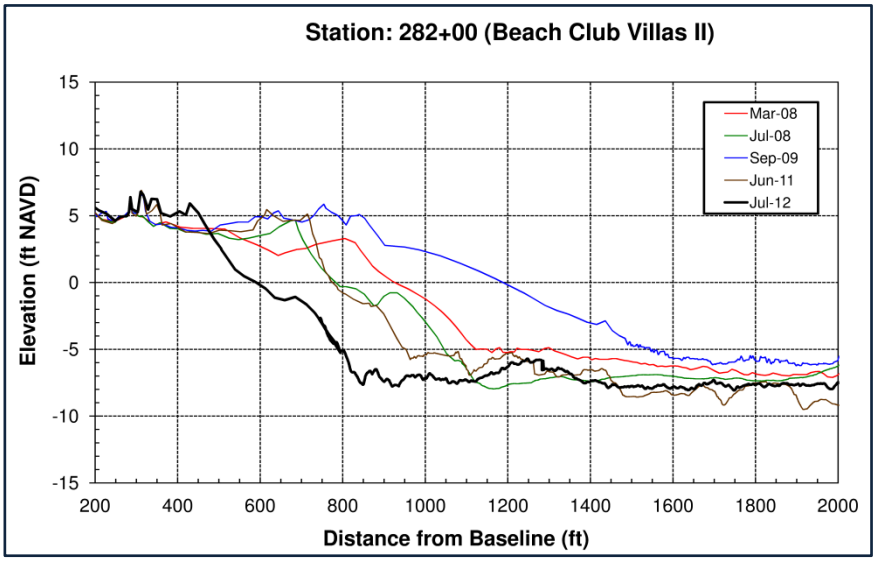
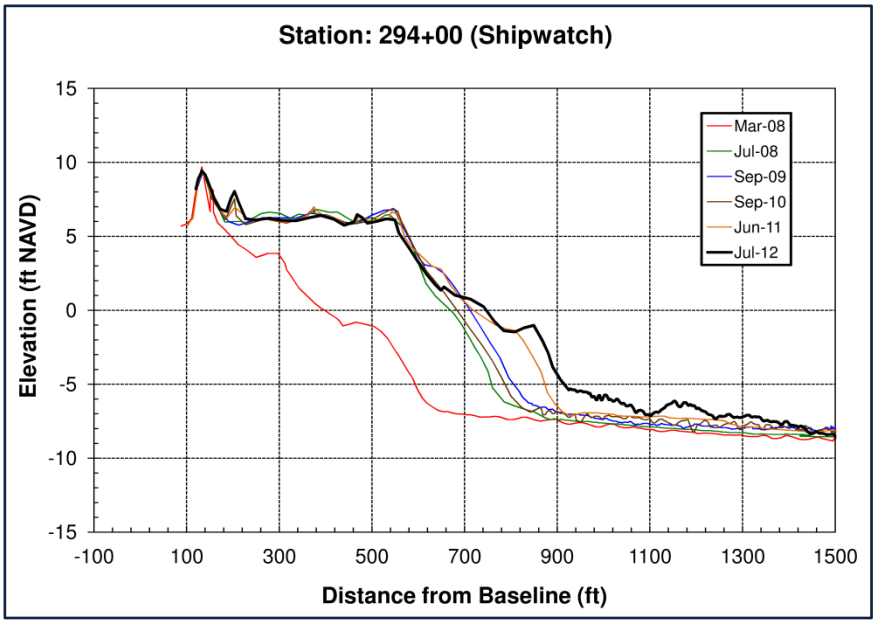


FIGURE 3.9. **[UPPER]** Bar graph showing beach unit volumes calculated to −10 ft NAVD in Reach 6. Overall, this reach has over 100 cy/ft more sand in July 2012 than in July 2007 (prior to shoal attachment and nourishment. **[LOWER]** Profile unit-width volumes for stations in Reach 6. Erosion has dominated the ends of the reach. The beach was much more stable from 2009 to 2012.





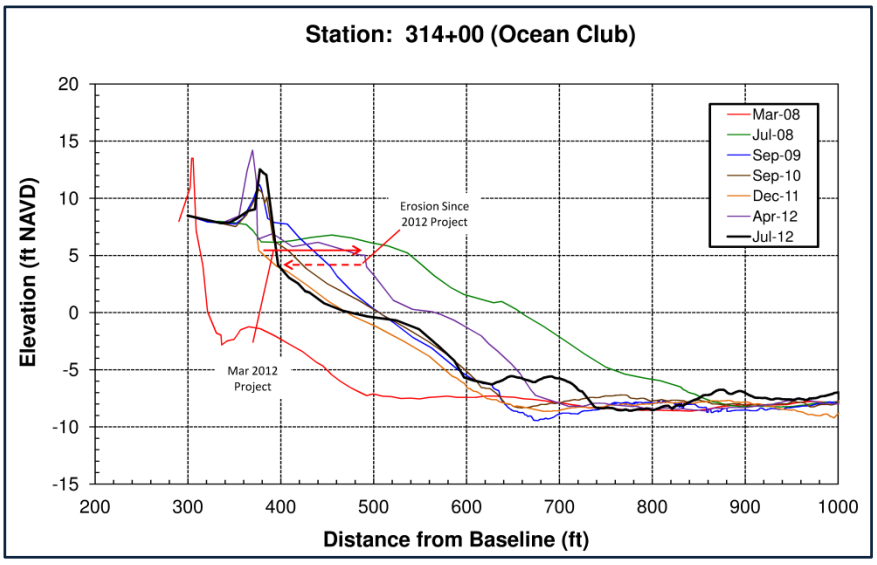


FIGURE 3.10.

Profiles for selected stations in Reach 6.

Station 282+00 has rapidly eroded since 2009.

Station 294+00 (Shipwatch) has accreted since nourishment.

Station 314+00 eroded rapidly the first year after the 2008 project and continues to be an erosion hotspot.

The 2012 shoal management project widened the beach to a maximum of 100 ft (December 2011 to April 2012 change); however, the fill eroded rapidly leaving the beach near the pre-project condition by July 2012.

FIGURE 3.11.

[1ST] View north in December 2007 near Summer Dunes Lane prior to the nourishment project.

[2ND] View east in July 2012 from Ocean Club (station 314+00).

[3RD] View west in July 2012 from Ocean Club.

[4TH] Station 294+00 (Shipwatch) in July 2012.

[Photos by S Traynum]

Reach 5 — 53rd Avenue to Wild Dunes Property Owners Beach House

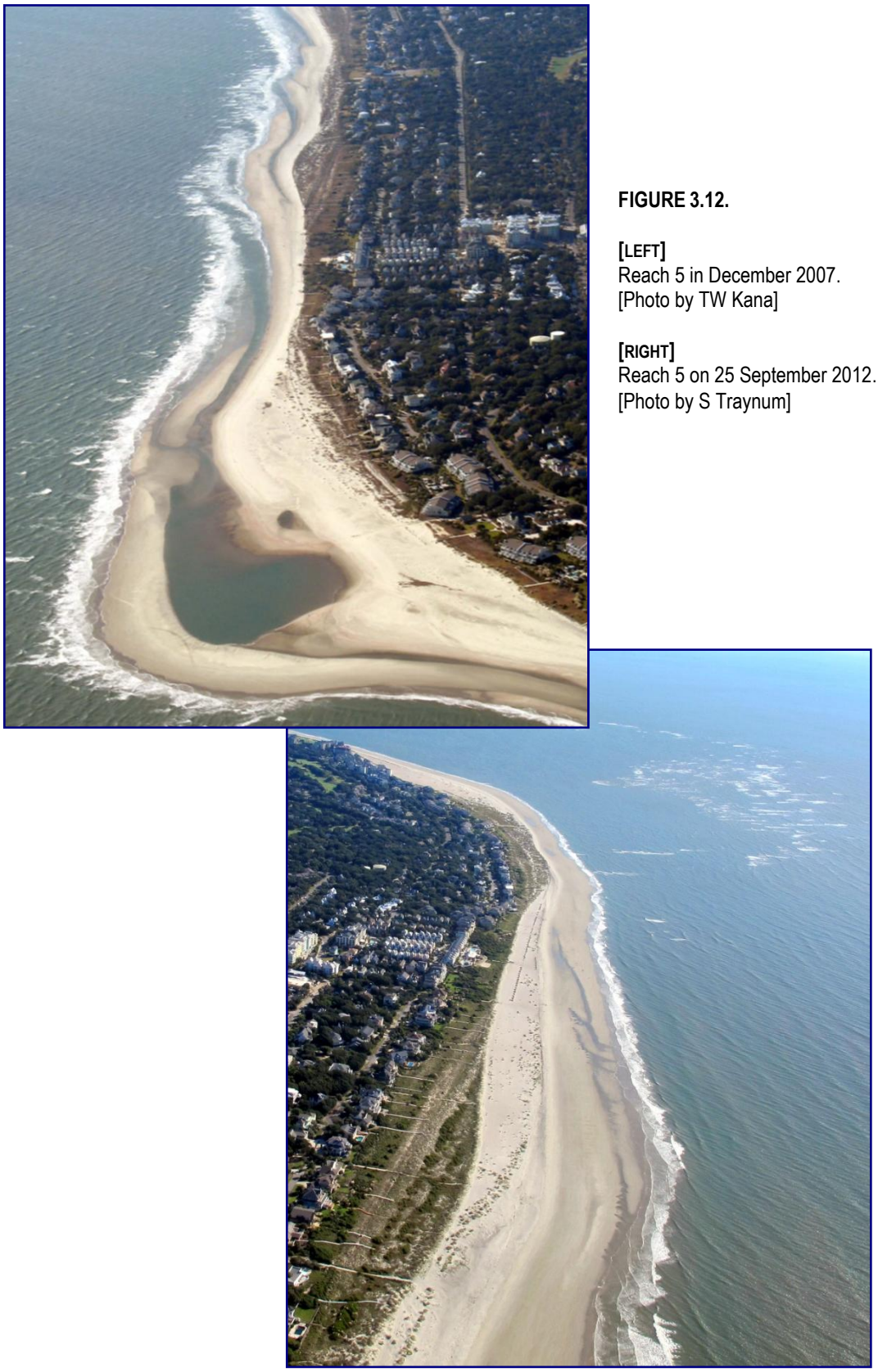


FIGURE 3.12.

[LEFT]
Reach 5 in December 2007.
[Photo by TW Kana]

[RIGHT]
Reach 5 on 25 September 2012.
[Photo by S Traynum]

Reach 5 (Fig 3.12, previous page) spans ~6,000 ft between 53rd Avenue and the Wild Dunes Property Owners Beach House and encompasses project Reach A (Fig 3.13, stations 222+00 thru 280+00). Like Reach 6, this area is greatly influenced by shoal-bypass events, especially at the northern end of the reach where the majority of shoals attach to the beach.

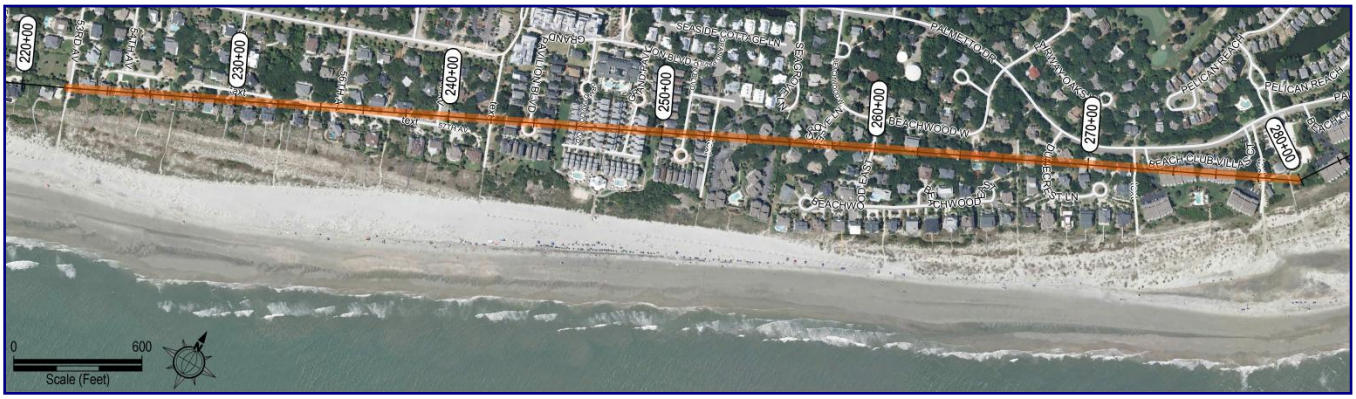


FIGURE 3.13. Reach 5 spans from 53rd Avenue (station 222+00) to the Wild Dunes POBH (station 280+00). The approximate limits of nourishment Reach A are identified by the orange-highlighted bar. [March 2009 aerial image by Independent Mapping Consultants Inc]

Prior to the 2008 nourishment, an erosional arc had formed in the area of the Wild Dunes Grand Pavilion (station ~248+00) (Fig 3.14). Erosional arcs are typical in areas adjacent to shoal attachment sites because of wave refraction and sediment transport reversals, which drive sand from these areas into the lee of the shoal during Stages 1 and 2 of the shoal-bypass cycle. Immediately prior to nourishment, the "2007" shoal had completely attached (Stage 3) at the northern end of the reach, and sand was beginning to spread into the eroded areas.

Reach 5 gained ~318,000 cy (128.1 cy/ft) of sand between March and July 2008; this included nourishment and natural accretion from the shoal attachment (Fig 3.15, upper). The design volume was 270,000 cy, and CSE estimates ~340,000 cy of sand were added to the project area between March and July 2008. [Note the project reach limits differ from the monitoring reach, producing the difference in accretion numbers.] Design fill unit volumes were ~75 cy/ft throughout area A, decreasing in the taper sections. Dry beach width increased up to ~225 ft in this reach. The northern portion of Reach 5 was highly erosional prior to the nourishment project, losing up to 45 cy/ft between July 2007 and March 2008 (Fig 3.15, lower). The rest of the reach was more stable, gaining sand at most stations.

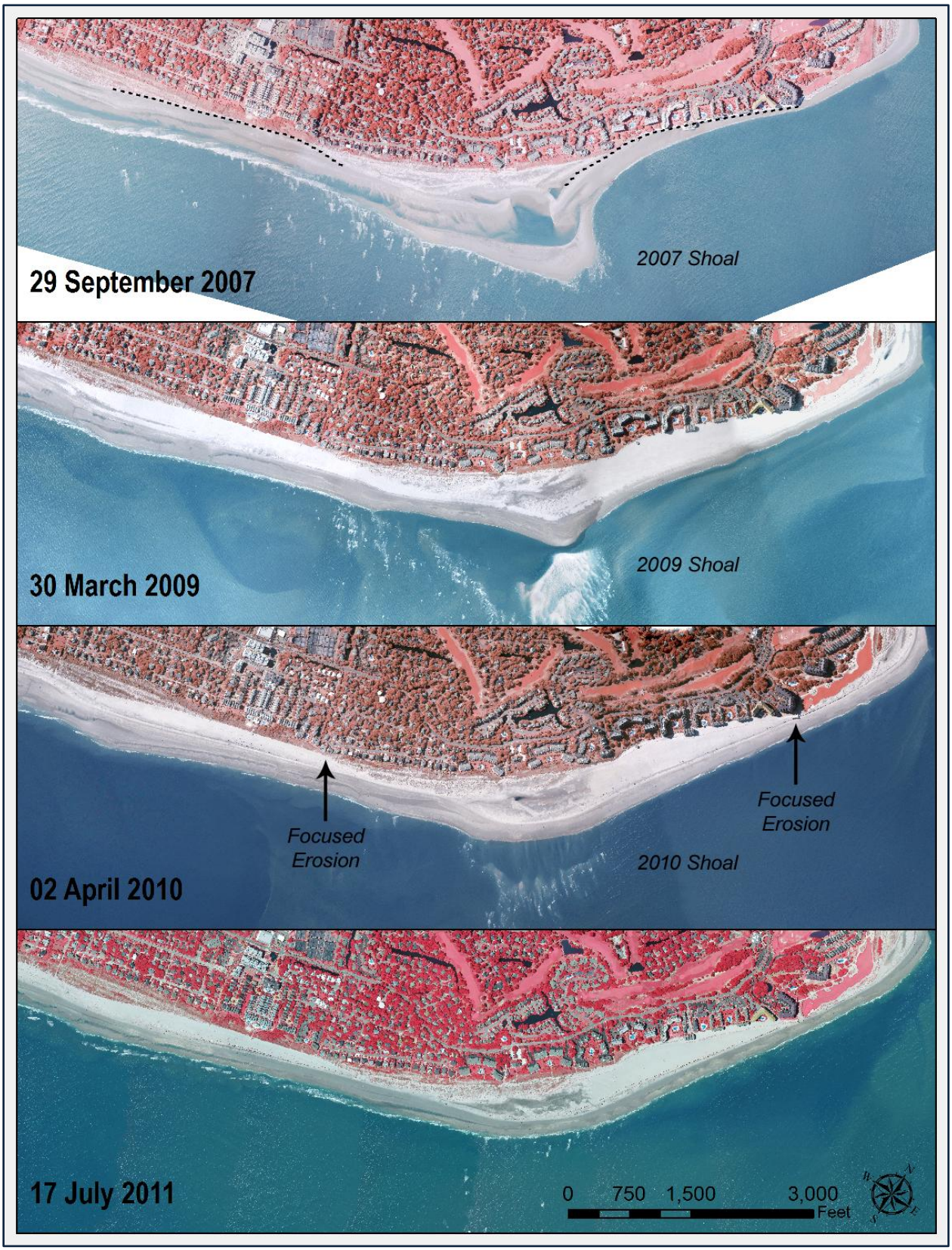
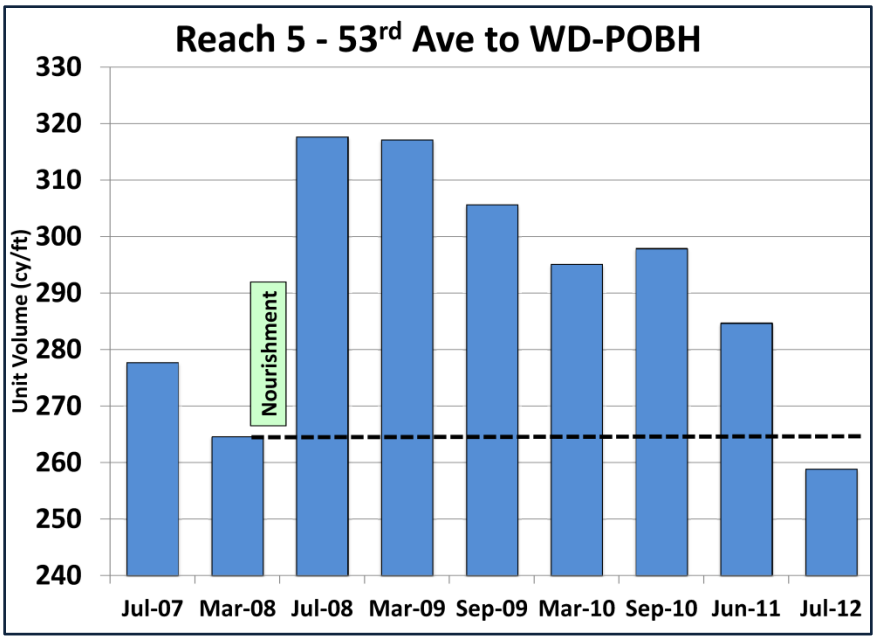


FIGURE 3.14. Reach 5 and Reach 6 in September 2007 (first), March 2009 (second), April 2010 (third), and July 2011 (fourth). Note the erosional arcs in the 2007 image adjacent to the Wild Dunes Grand Pavilion. The "2009" shoal is visible in the second image, and the "2010" shoal in the third image.



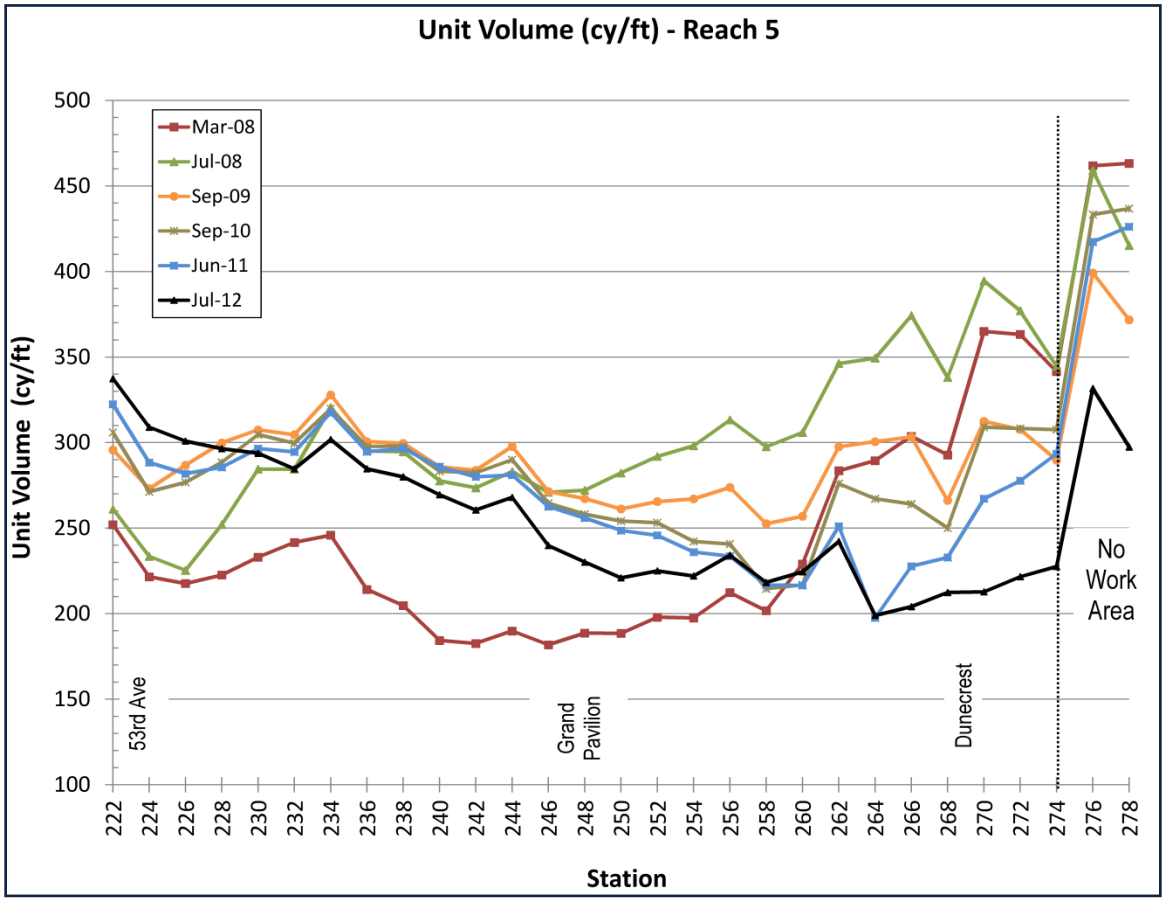


FIGURE 3.15. **[UPPER]** Bar graph showing beach unit volumes calculated to −10 ft NAVD in Reach 5. While the 2012 average sand volume is less than the pre-nourishment condition, stations 222–258 (3,600 ft of a total of 6,000 ft of Reach 5) still hold ~210,600 cy (58.5 cy/ft) more sand than the pre-nourishment condition. **[LOWER]** Profile unit-width volumes for stations in Reach 5. Erosion has dominated the northern part of the reach (stations 250–278) and is associated with excess sand resulting from shoal attachment events in 2006, 2009, and 2010.

Erosion prior to the project was due to spreading of the "2007" shoal, which attached to the beach in 2007 at the northern end of the reach. The bulge of sand created an unnatural shape in the shoreline until wave action worked this area into a straighter shoreline between 2007 and 2008. Since project completion in June 2008, Reach 5 has shown erosion in the eastern portion of the reach and accretion in the western part of the reach (Fig 3.15, lower). Erosion has been most prevalent near Beachwood East and Dunecrest Lane. The beach fronting the Wild Dunes Grand Pavilion has been more stable, while the western ~1,000 ft of beach have accreted.

Reach 5 showed distinct areas of erosion and accretion over the past year. The most significant change was at the eastern end of the reach from station 266 to station 278 (Dunecrest and Beach Club Villas I); this area lost between 20 cy/ft and 130 cy/ft (Fig 3.16). The high erosion rates are attributed to continued spreading of the 2007 salient, which existed prior to the 2008 project. Sand borrowing during the 2012 shoal management project also contributed to the high erosion observed. The beach near Dunecrest Lane currently has the lowest unit volumes along Reach 5.

The beach near Beachwood East (stations 256–264) remained stable over the past year. The area had eroded fairly rapidly from 2008 to 2010. Further west, the beach between 55th Avenue and Beachwood East (stations 232–254) was more erosional than previous years (Fig 3.17). These stations lost an average of 17.7 cy/ft, which is about 20 percent of the nourishment volume in this area. Erosion of stations 232–254 contributed to accretion along the western end of the reach and the downcoast areas.

Overall, Reach 5 lost ~155,000 cy (25.8 cy/ft) of sand from June 2011 to July 2012, although the majority of the erosion (~110,000 cy from station 270 to station 278) was focused at the eastern end of the reach. Compared to the pre-nourishment condition of March 2008, the beach shows a net loss of ~34,000 cy. This volume loss is somewhat misleading because all of the loss is restricted to the eastern end of the reach (east of station 260). Stations 222–258 still show a net gain of ~210,600 cy compared to the pre-nourishment condition (Fig 3.18).

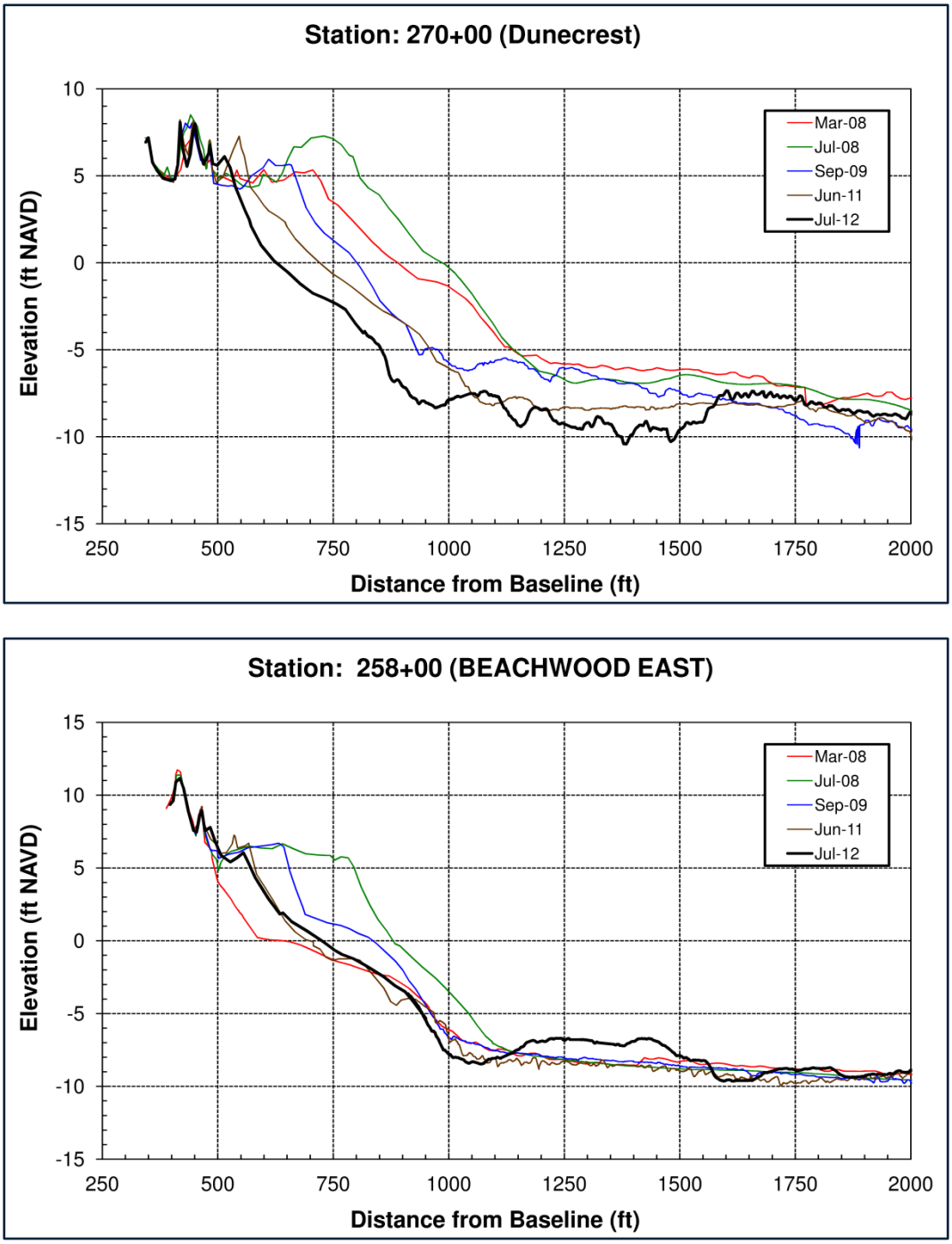
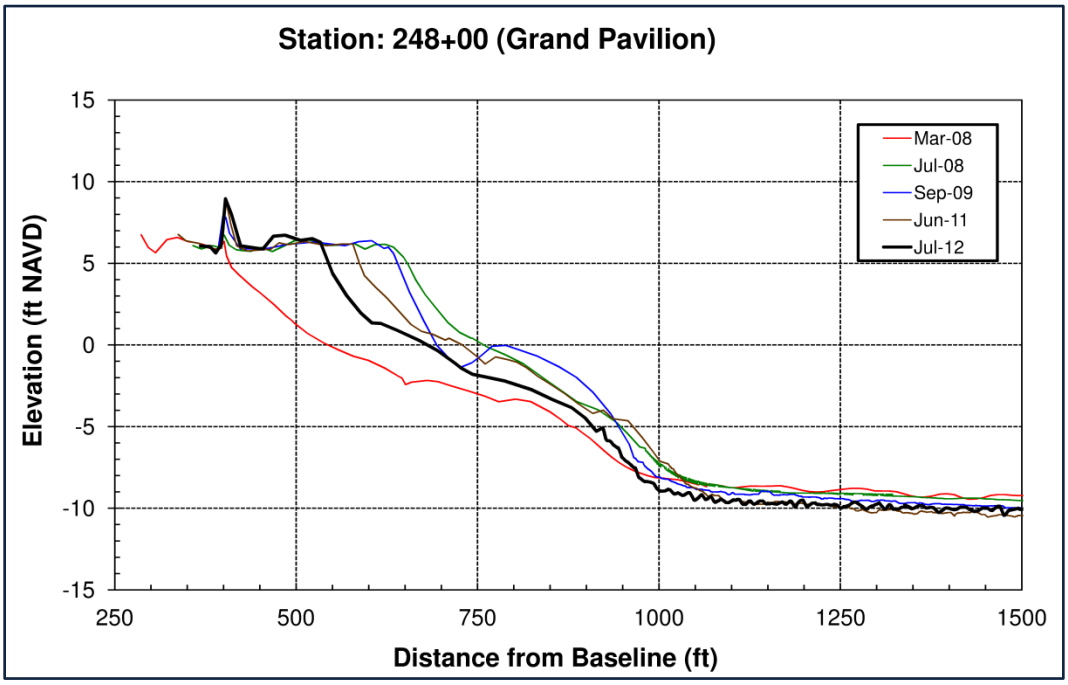


FIGURE 3.16. Profiles from station 270+00 (upper) and 258+00 (lower) in Reach 5. Generally, the eastern portion of the reach has been highly erosional since 2008, while the central portion has eroded slowly and the western portion has accreted.



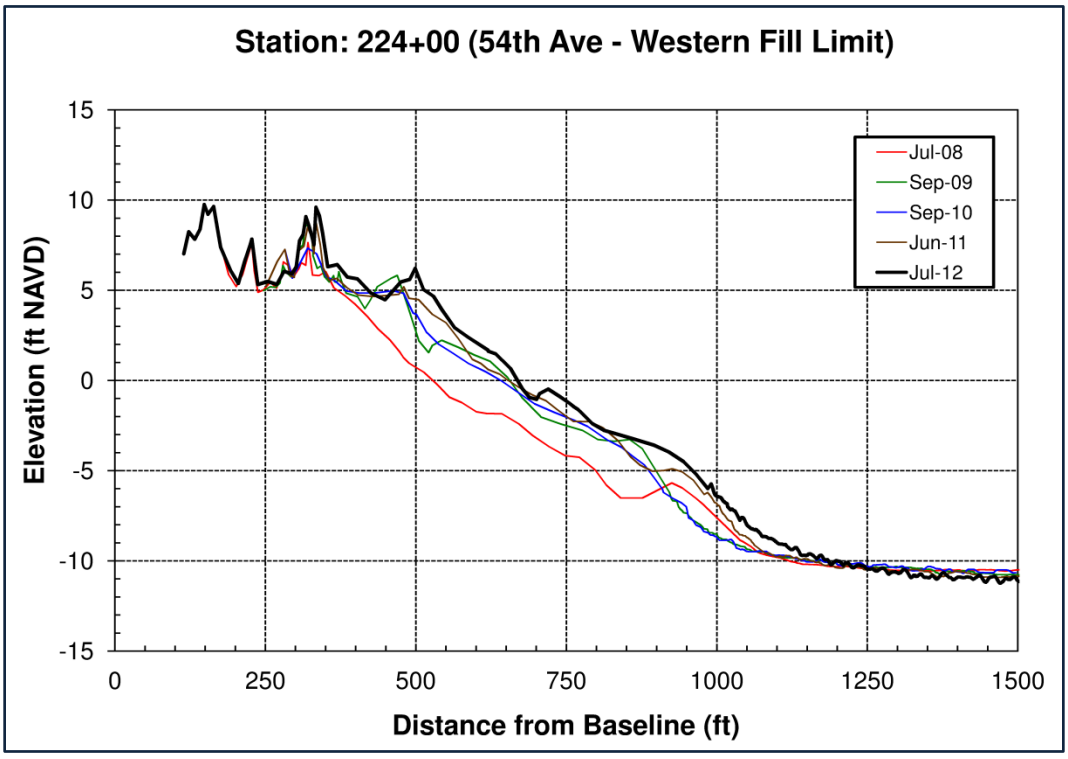


FIGURE 3.17. Profiles from station 248+00 (upper) and 224+00 (lower) in Reach 5. Generally, the eastern portion of the reach has been highly erosional since 2008, while the central portion has eroded slowly and the western portion has accreted.

FIGURE 3.18.
Ground photos along various areas of Reach 5 in July 2012.

[1st RIGHT] Dunecrest Lane (~station 270+00) looking west.

[2nd LEFT] West end of Beachwood East (~station 256+00).

[3rd RIGHT] Looking west from station 248+00 near the Wild Dunes Grand Pavilion.

[4th LEFT] Looking east from station 222+00 (53rd Avenue). This station is just downcoast of the 2008 nourishment area and has grown significantly since 2008.

Summary of Volume Changes in Reaches 5–7 (53rd Avenue to Cedar Creek)

The variable erosion/accretion observations along the eastern end of the Isle of Palms (Reaches 5–7) were detailed in the previous sections. The influence of Dewees Inlet leads to rapid shoreline fluctuations that are difficult to predict; however, the City's monitoring effort has generated a reliable and comprehensive data set which allows for advanced planning and better predictions of future changes. Beach volume changes over the past year reflect distinct processes which are all tied to various stages of shoal-bypassing events, specifically:

1) The area from Beachwood East to Beach Club Villas II continues to lose sand that attached in 2007, 2009, and 2010 during discrete bypass events.

2) Areas west of the Wild Dunes Grand Pavilion receive sand lost from upcoast (east) and continue to accrete.

3) An erosion hot spot, centered near the 18th hole, is likely a result of wave focusing through the channel break in the Dewees Inlet delta.

4) Sand continues to accumulate at the northeastern point of the island, forming a "trailing ebb spit" (see photo) from sand lost from the project areas.

While a portion of Reaches 5–7 (stations 260–286 and some areas of Reach 7) currently contains less volume than the pre-nourishment condition, the majority of the nourishment area remains in much better condition than before restoration. Overall, Reaches 5–7 retain ~456,000 cy (30.6 cy/ft) more sand than the March 2008 condition (Fig 3.19); this number includes areas not nourished. Over the same time period, Reaches 5–7 have lost 540,000 cy or 54 percent of the volume gained (March to July 2008 changed).

1980 aerial image of a trailing ebb spit at the northeast end of Isle of Palms [Photo by TW Kana]

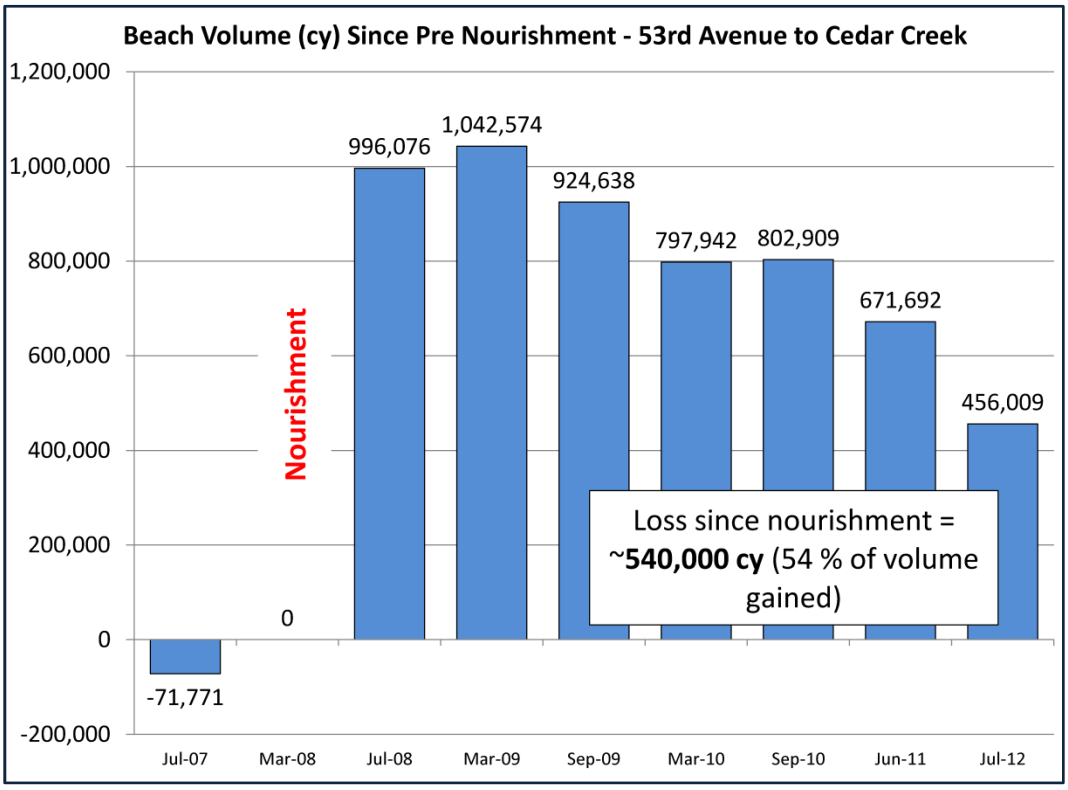


FIGURE 3.19. Beach volume relative to March 2008 (pre-nourishment). The values shown include all areas (both nourished and non-nourished) and do not account for sand accumulated at the turn in the baseline at the northeastern point, which is estimated to have gained over 50,000 cy since March 2008.

Downcoast Reaches 2–4 (6th Avenue to 53rd Avenue)

Reaches 2–4 represent the central portion of the island and have historically been stable to accretional over the past century. The reaches are considered to be outside of the direct influence of Dewees and Breach Inlets and are classified as "S" for standard erosion zones by SCDHEC–OCRM. Erosion/accretion signatures along "S" zones tend to be predictable over the long term. Short-term changes in sand volume are generally smaller in magnitude than in areas close to inlets (SCSGC 2001).

Reaches 2–4 represent 17,810 ft of shoreline between 6th and 53rd Avenues (Fig 3.20). CSE established profile stations at 1,000-ft spacing and reoccupied monuments established by SCDHEC–OCRM, which have been surveyed generally every year since the early 1990s. CSE profiles were obtained in March and September of 2009 and 2010, in June 2011, and in July 2012. Unit volume changes for Reaches 1–4 are shown in Figure 3.21.

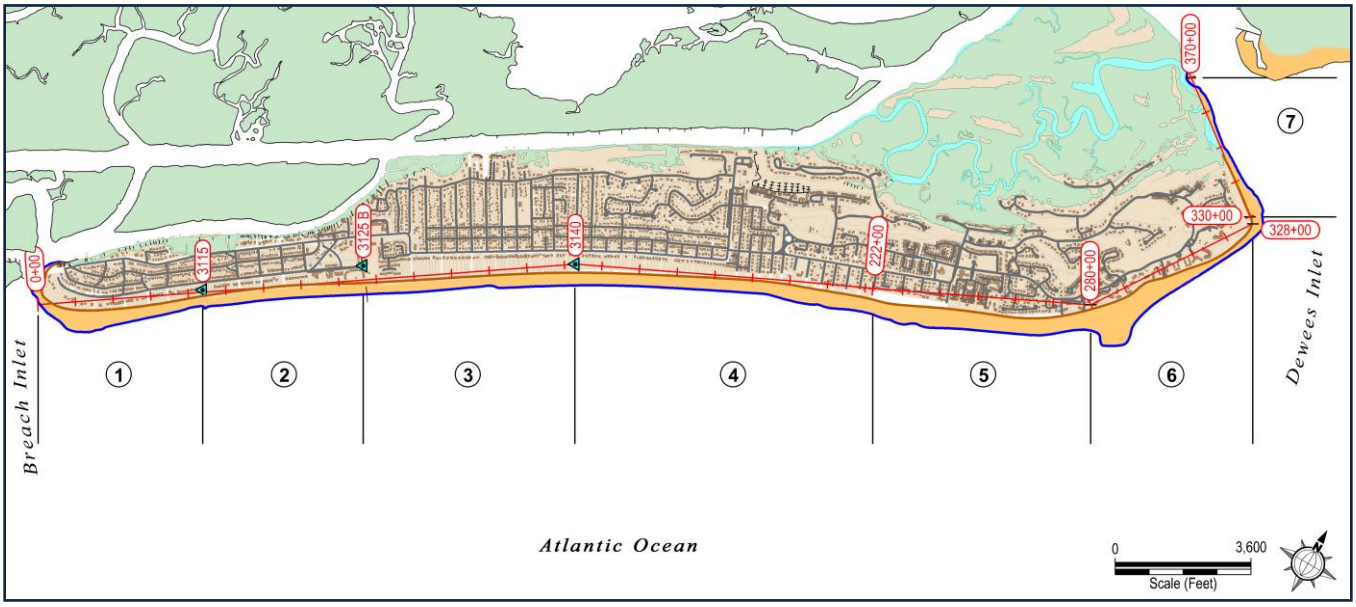


FIGURE 3.20. Monitoring reach boundaries.

From March 2009 to September 2009, Reaches 2–4 lost ~33,000 cy (1.8 cy/ft) of sand over the ~18,000 ft of shoreline represented. Since then, these reaches have shown net accretion, gaining the most sand over the past year (207,800 cy or 11.6 cy/ft). The changes since March 2009 totals 351,750 cy (19.8 cy/ft), which is an annual accretion rate of 5.9 cy/ft per year. Over the past year, station 3140 (31st Avenue) was the only profile that lost sand (−1.1 cy/ft), while all other stations gained sand—up to 27.2 cy/ft.

Details for each reach are given in the following sections.

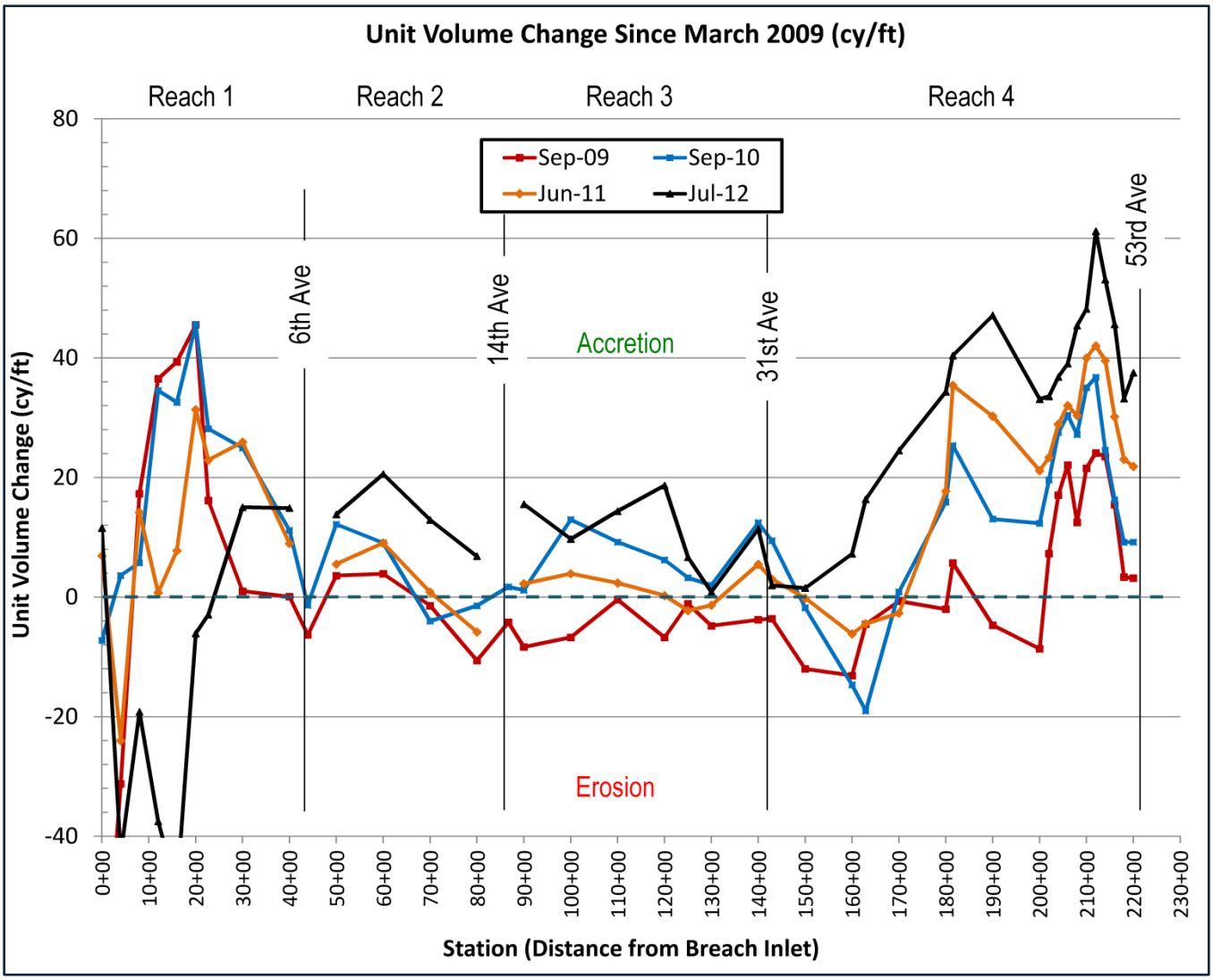


FIGURE 3.21. Profile unit-width volume change (cy/ft) between March 2009 and later dates for Reaches 1–4. CSE established and surveyed profiles spaced 1,000 ft apart within the Isle of Palms reaches and reoccupied monuments surveyed annually by SCDHEC-OCRM. Historically, these reaches have been accretional; however, between March and September 2009, most stations outside of the influence of the inlet or project were erosional. Since September 2009, most stations have shown accretion and are currently healthier than the March 2009 condition (ie – where the black line is greater than zero). The higher rates and westward sequence of accretion along Reach 4 illustrate the downcoast spread of nourishment sand from Reach 5. [Volumes are relative to the March 2009 condition.]

Reach 4 — 31st Avenue to 53rd Avenue

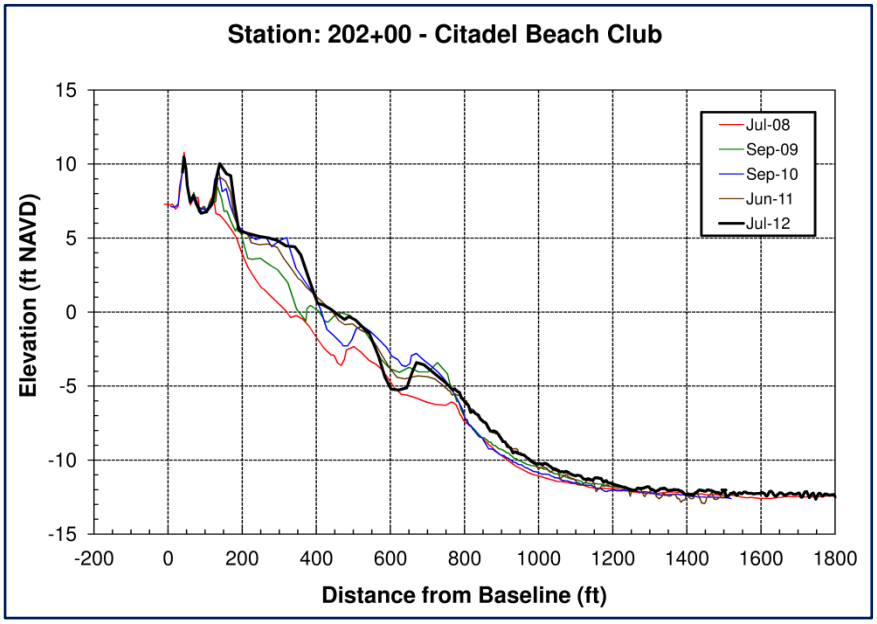
Reach 4 spans 7,910 ft between 31st Avenue and 53rd Avenue (stations OCRM 3140 to CSE 222+00) (Fig 3.22). Being immediately downdrift of the 2008 nourishment project, it should, therefore, benefit from losses of nourishment sand from the project area. Reach 4 was stable from March to September 2009 and has accreted between each monitoring event since then (see Table 3.2). From June 2011 to July 2012, the reach gained 104,100 cy (13.2 cy/ft) of sand.

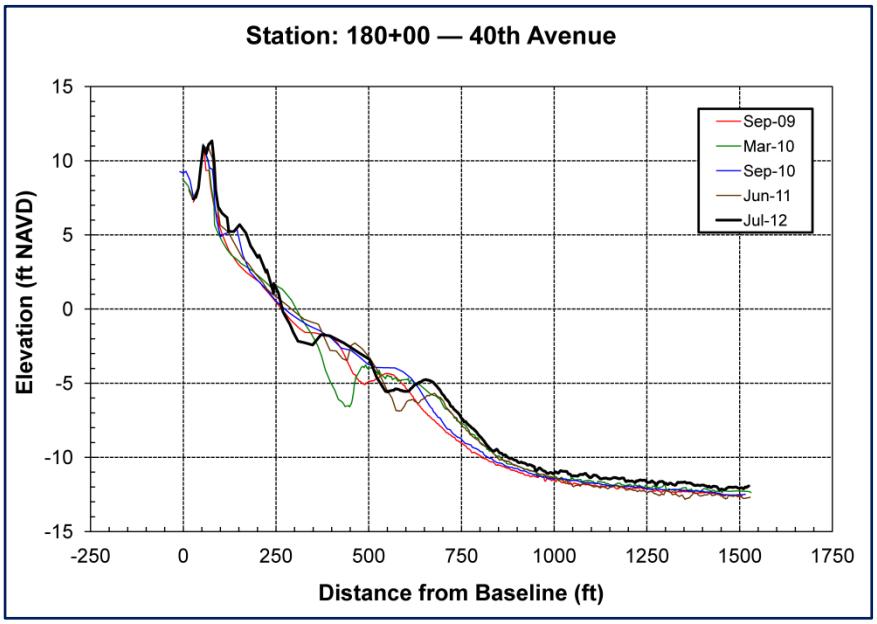
FIGURE 3.22. Reach 4 spans from stations OCRM 3140 (31st Avenue) to CSE 222+00 (53rd Avenue) — noted by the orange-highlighted bar.

The beach between 31st Avenue and 33rd Avenue remained mostly stable while the remainder of the reach was consistently accretional. The beach between 38th Avenue and 53rd Avenue shows more accretion since March 2009 than any other downcoast area. These stations have gained at least 20 cy/ft since 2009 and average a gain of 40.9 cy/ft (Fig 3.23). Since March 2009, Reach 4 has gained ~230,300 cy (29.1 cy/ft), which is an annual accretion rate of 8.6 cy/ft per year.

CSE expects additional nourishment (and shoal) sand to shift into Reach 4 from Reach 5; however, at some point in the near future, the current shoal-bypass event will temporarily modify this transport. Instead of spreading downcoast (southwest), some quantity of sand in Reach 5 will migrate to the shoreline in the lee of the attaching shoal, which will reduce the sand transport to downcoast areas. Overall, the beach in Reach 4 is healthy and is capable of withstanding temporary interruptions of sand supply during shoal-bypass events.

Historical accretion along this reach (combined with sufficient setbacks for development) has led to a substantial dune system between most structures and the beach. As long as there is slow steady accretion, the foredune will continue to build wider and higher, offering more storm protection to property behind the dunes (Fig 3.24).





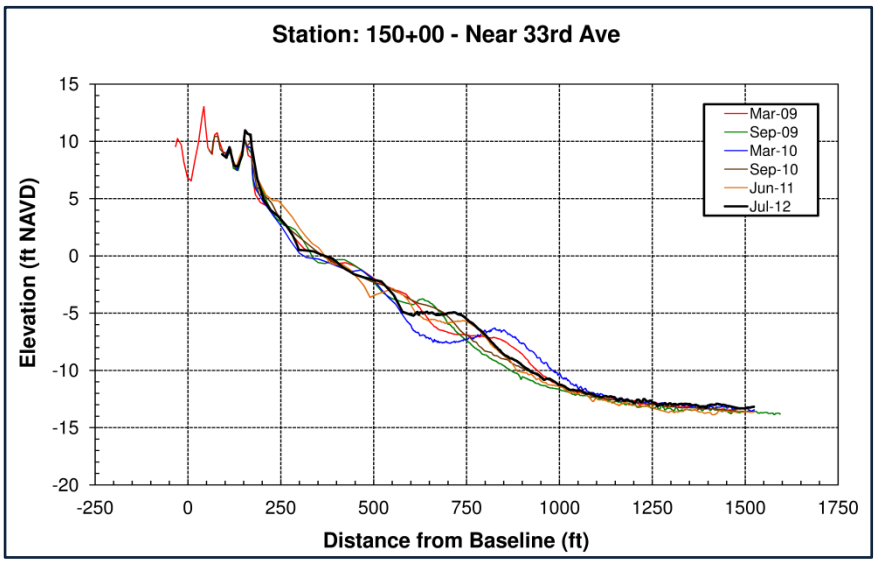


FIGURE 3.23.

Profiles from Reach 4 stations 202+00 (47th Avenue), 180+00 (40th Avenue), and 150+00 (33rd Avenue). Respectively, these stations gained 33.6 cy/ft, 34.3 cy/ft, and 1.5 cy/ft between June 2011 and July 2012.

A volume of sand is spreading down-coast from the nourishment area, visible as higher unit volumes (relative to March 2009) being observed further downcoast (southwest) each year.

FIGURE 3.24. July 2012 photos from Reach 4. **[TOP]** Near 53rd Avenue. **[CENTER LEFT]** Near 48th Avenue. **[CENTER RIGHT]** Near 40th Avenue. **[BOTTOM]** Near 33rd Avenue. [Photos by S Traynum]

Reach 3 — The Sea Cabins Pier to 31st Avenue

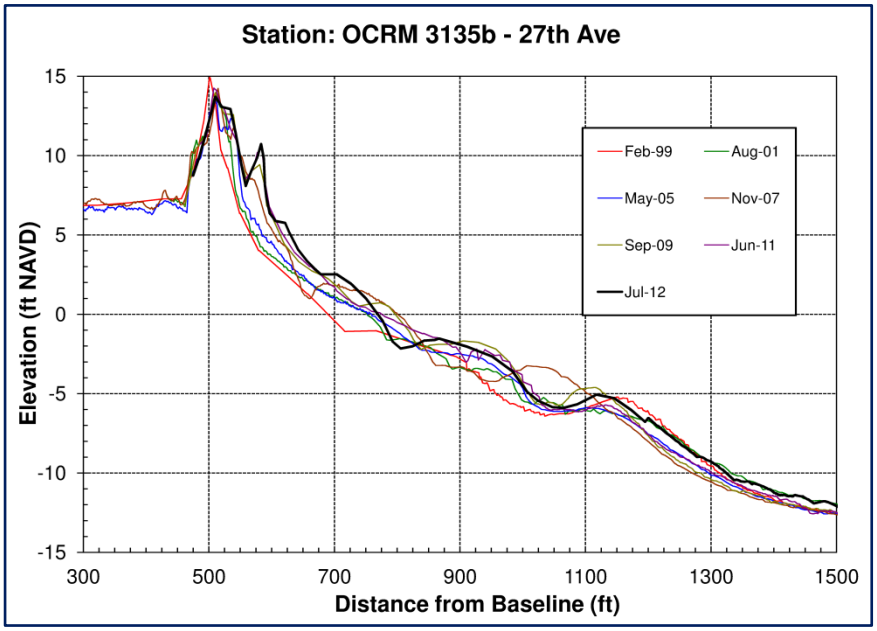
Reach 3 spans the oceanfront between the Sea Cabins Pier and 31st Avenue (OCRM monuments 3125 to 3140, Fig 3.25). As previously mentioned, the long-term trend in this area is stable to accretional. Profiles from OCRM station 3135 (near 27th Avenue) show the beach in this area has gained ~40 ft in width at the +5-ft NAVD contour (Fig 3.26) over the past ten years. A similar trend is evident at OCRM station 3125 (14th Avenue) with dune growth and beach widening over the past ten years.

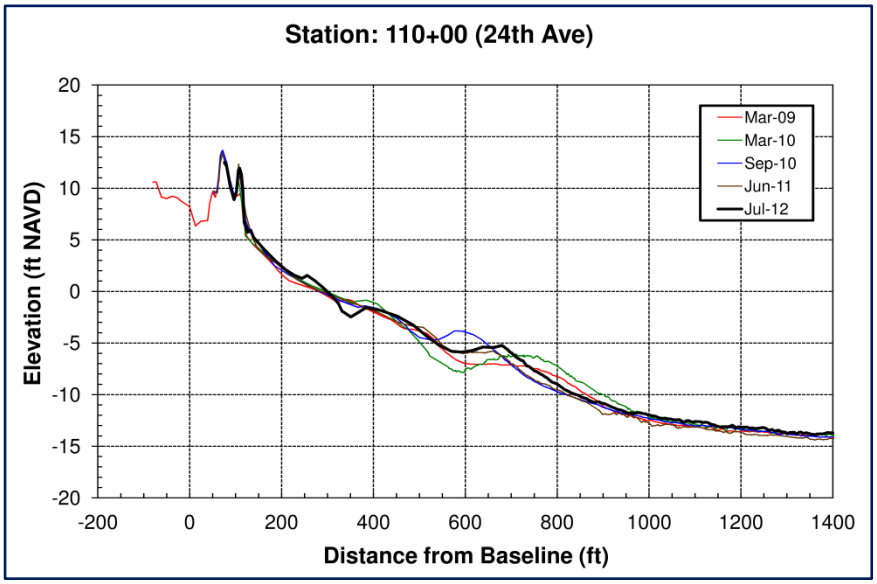
FIGURE 3.25. Reach 3 spans from station OCRM 3125 (pier) to station OCRM 3140 (31st Avenue) — noted by the orange-highlighted bar.

Of the five intervals between monitoring surveys, Reach 3 has shown net erosion twice and accretion over three periods, including over the past year (see Table 3.2). This is characteristic of a stable to mildly accretional beach as variations in weather conditions and sediment supply lead to minor fluctuations in yearly volume change. Over the long term, the trend is accretion.

Reach 3 gained ~52,500 cy (9.4 cy/ft) from June 2011 to July 2012 (see Fig 3.1). Since March 2009, it has gained ~62,300 cy, which is an annual accretion rate of 3.3 cy/ft per year. Individual stations gained between 2.2 and 18.4 cy/ft over the past year (eg – Fig 3.21). All stations in Reach 3 contain more sand than the March 2009 condition.

Accretion was most significant near the Sea Cabins Pier and between 24th and 26th Avenues. Photos show that a dry beach is present, though somewhat narrow (Fig 3.27). During moderate storm events (such as Hurricane *Irene* in August 2011), high water levels and wave runup can erode the dry beach and lead to minor scarping of the dune. Calmer conditions allow the dune to heal over time and the dry beach to reform. The resulting dune is somewhat truncated on the seaward side compared to areas with greater rates of accretion and wider dry beaches (such as around 53rd Avenue). Figure 3.28 shows the beach condition on 25 September 2012.





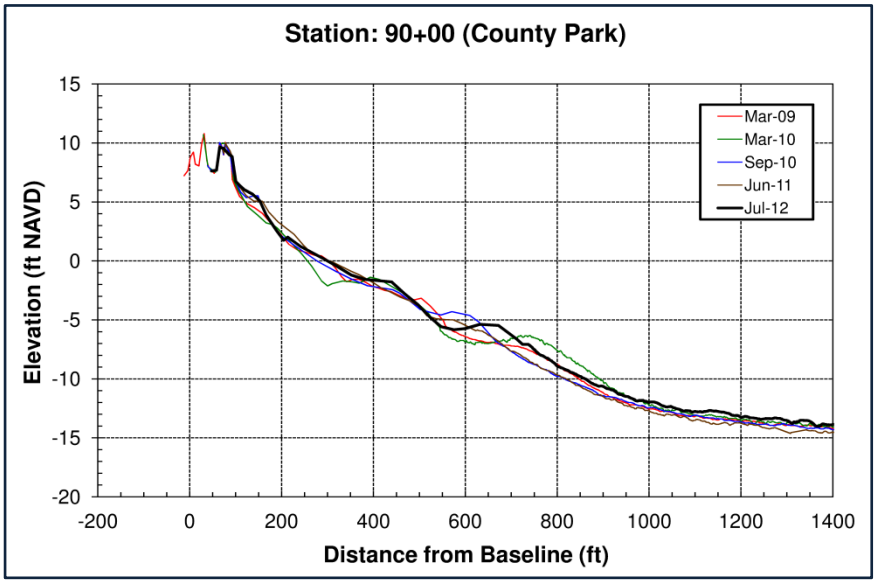


FIGURE 3.26.

Profiles from OCRM station 3135 (27th Avenue) (upper), station 110+00 (24th Avenue) (middle), and station 90+00 (County Park) (lower).

Sustained accretion has led to over 100 ft of beach growth over the past decade along Reach 3.

[Profiles prior to March 2009 courtesy SCDHEC-OCRM.]

FIGURE 3.27. Ground photos of Reach 3 at 29th Avenue (upper left), 25th Avenue (upper right), 21st Avenue (center), and the County Park (lower). [Photos by S Traynum]

FIGURE 3.28. Aerial view of central and southern Isle of Palms on 25 September 2012. Properties in Reach 3 and Reach 4 are set back a few hundred feet from the beach. The seaward edge of the wax myrtles (dark green vegetation) marks an earlier foredune/shoreline position. [Photo by SB Traynum]

Reach 2 — 6th Avenue to the Sea Cabins Pier

Reach 2 spans 4,280 ft between 6th Avenue and the Sea Cabins Pier (OCRM monuments 3115–3125) (Fig 3.29). Reach 2 shows an erosion-accretion pattern similar to Reach 3 with net accretion since 2009 although the magnitude of volume change is generally smaller in Reach 2. The reach eroded from March to September 2009 (−1.6 cy/ft), then accreted from September 2009 to March 2010 (1.4 cy/ft) and again to September 2010 (3.4 cy/ft). Erosion was observed from September 2010 to June 2011 (−1.1 cy/ft). Over the past year, the reach gained ~50,000 cy (11.7 cy/ft) of sand. Individual stations gained from 8.3 cy/ft to 15.0 cy/ft (eg – Fig 3.21). Since March 2009, the reach has gained ~59,000 cy (annual rate of 4.1 cy/ft per year). Like Reach 3, most of this accretion since 2009 is attributed to gains over the past year.

FIGURE 3.29. Reach 2 spans from OCRM 3115 (6th Avenue) to OCRM 3125 (Sea Cabins Pier) — noted by the orange-highlighted bar.

Reach 2 is the location of the "Front Beach" commercial area and is the most widely used portion of the beach. Profiles show accretion of the dry-sand beach (elevation of +5 to +6 ft NAVD) since 2009 (Fig 3.30). Ground photos (Fig 3.31) confirm a moderately wide dry beach capable of supporting volleyball nets and recreational area as well as withstanding minor storms and large tides. Like Reach 3, moderate storms can create conditions which erode the dry beach and cause minor dune scarping. Remnants of a scarp were present near 6th Avenue in July 2012 (Fig 3.31).

All properties maintain a substantial setback (greater than 100 ft) from the dry beach and, given the historical accretion, are not likely to be impacted by typical erosional events (minor storms, seasonal cycles, etc).

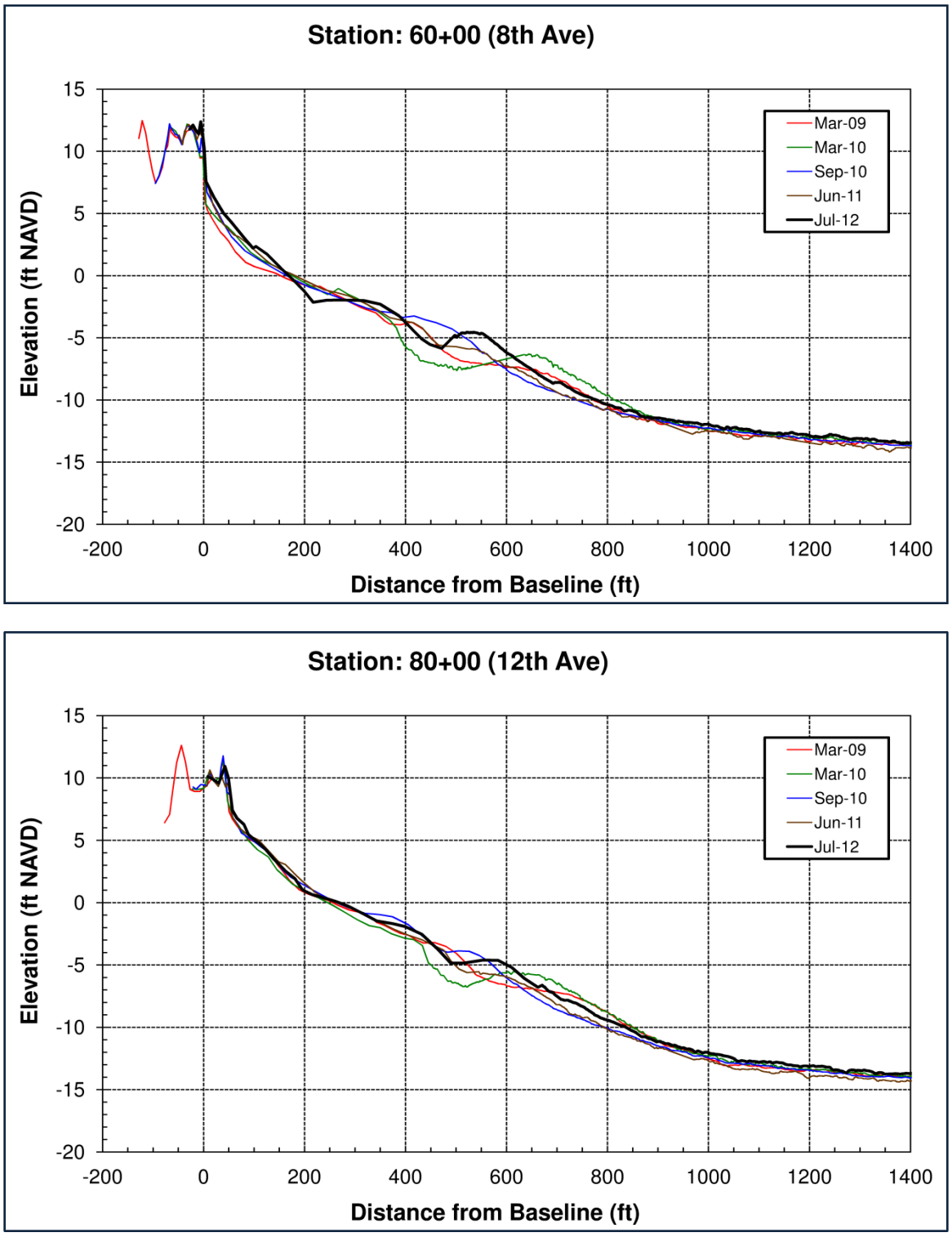


FIGURE 3.30. Profiles from station 60+00 (8th Avenue, upper) and station 80+00 (12th Avenue, lower). Reach 2 has gained ~50,000 cy (11.7 cy/ft) over the past year.

FIGURE 3.31. Reach 2 photos in July 2012, looking west from the Sea Cabins Pier (upper), east from 9th Avenue (center), and west from 6th Avenue (lower), where a healthy dune escarpment is visible.

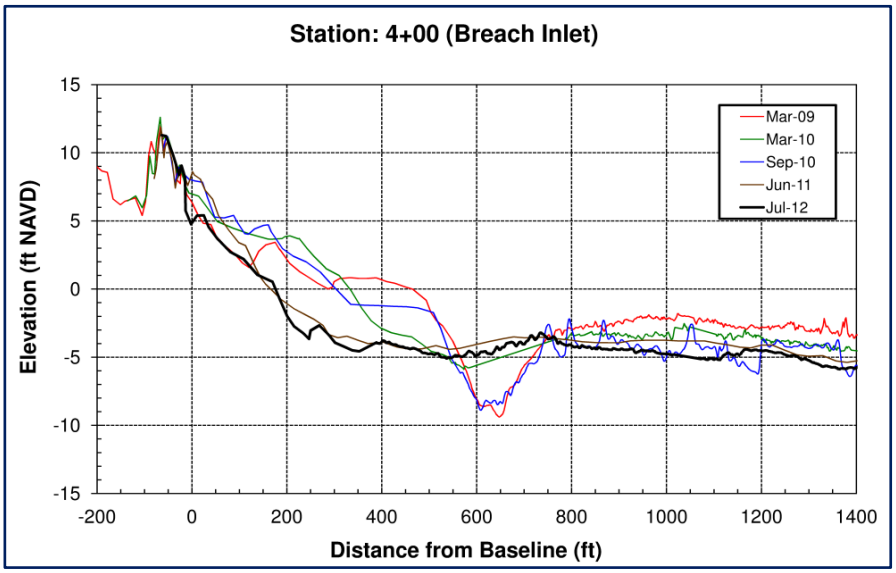
Reach 1 — Breach Inlet

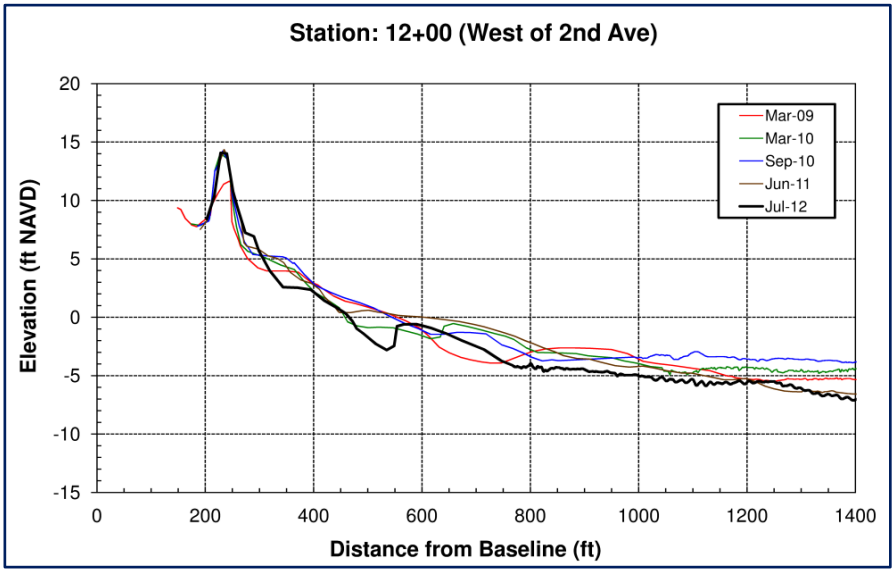
Reach 1, between Breach Inlet and 6th Avenue (Fig 3.32), is classified as an unstabilized inlet erosion zone due to the dynamic nature of the shoals associated with the inlet delta. While labeled as unstable, the long-term trend for this reach is accretional with an estimated growth of ~8.9 ft/yr (linear beach width). The historical accretion trend in this reach is due to a plentiful sand supply from upcoast and sand trapping by the Breach Inlet ebb-tidal delta.

FIGURE 3.32. Reach 1 spans between Breach Inlet and 6th Avenue — noted by the orange-highlighted bar.

Sand supply originates from shoal-bypass events at Dewees Inlet and longshore sand transport from north to south over the length of IOP. Excess sand is deposited along the southern spit of the island (Reach 1) 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 IOP reaches.

Reach 1 was accretional from March 2009 to September 2010, gaining a total of ~87,500 cy of sand. Since then, the reach has lost ~122,400 cy of sand. Over the past year, the reach lost 86,000 cy (19.6 cy/ft) (eg – Fig 3.1) Erosion dominated the reach, with all stations except 0+00 and 40+00 eroding more than 10 cy/ft (up to 56.9 cy/ft) (eg – Fig 3.21). Stations 0+00 and 40+00 gained 4.6 and 5.9 cy/ft (respectively). Overall, the reach shows a net loss of 34,800 cy (7.9 cy/ft) since March 2009. Despite the recent erosion, the dunes at all stations continue to grow higher and seaward. Observations in July 2012 showed only a small area with an active escarpment (near station 8+00). Erosion was confined to the beach below +5 ft NAVD (normal high tide swash line) (Fig 3.33).





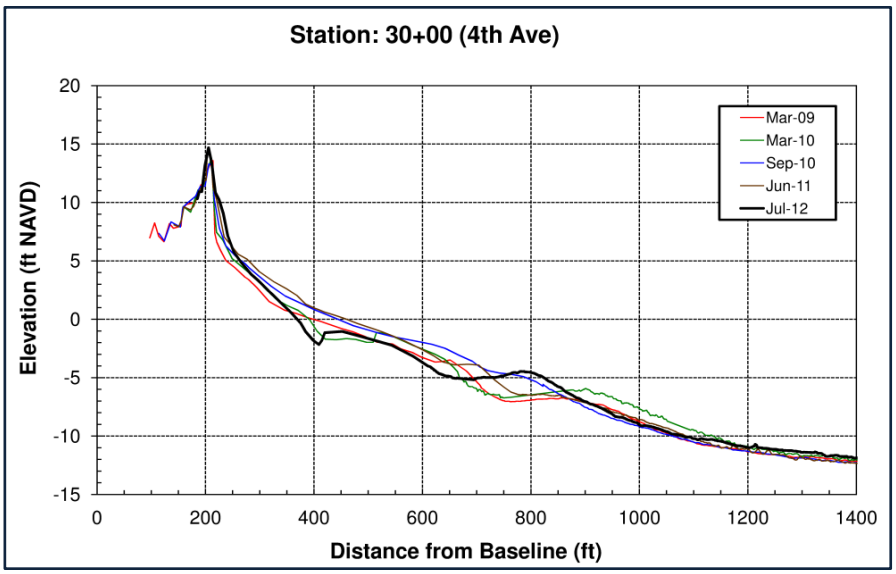


FIGURE 3.33.

Profiles from stations 4+00 and 12+00 near Breach Inlet and station 30+00 near 2nd Avenue.

A marginal flood channel migrated landward between March and September 2009 (at stations 4+00 and 8+00), but had returned to its March 2009 position as of September 2010.

A defined channel was not present in 2011 or 2012. Passage of Hurricane *Sandy* in October 2012 led to significant dune erosion along Reach 1.

While Reach 1 is the recipient of sand from upcoast areas, it is also closely linked to changes in Breach Inlet. The most significant change in Breach Inlet from June 2011 to July 2012 is the buildup of the offshore delta of the inlet. The IOP side of the delta grew westward, into the inlet channel (labeled A in Fig 3.34) and also extend southwest (labeled B) along the outer portion of the delta. After infilling in 2011, a marginal flood channel (labeled C) is reforming just off the beach at the western tip of the island. The formation and growth of the marginal flood channel contributed to sand losses in the underwater profiles of stations 0+00 through 8+00. As visible in Figure 3.35, the channel shoal is more compact in 2012 than in 2011, and the boundary between the channel and shoal is more defined.

These changes follow a channel avulsion event that occurred from 2009 to 2011. During this time, the old main channel of Breach Inlet was deflected to the west, and a secondary channel merged through the eastern shoal of the delta. This new channel became dominant and carried most of the flow through the inlet. The sand between the old main channel and the new channel migrated onto Sullivan's Island, attaching in 2011 (labeled S in Fig 3.35). The secondary channel became the new main channel and has been migrating west since its formation.

This event is analogous to the event presently occurring at the northeastern end of IOP, though the scale is smaller. Much like the event at Dewees Inlet (discussed in Section 3.3), the new main channel is already migrating to the southwest. As it migrates, it will facilitate shoal attachment on Sullivan's Island. It also could lead to erosion of the IOP beach as it creates a sediment "sink" (a place where sediment accumulates) in the ebb-tidal delta. Sand from IOP will fill the void left by the migrating channel. Historically, sufficient sediment has reached the inlet to keep pace with losses to the channel while maintaining a healthy beach on the IOP side of Breach Inlet.

Hurricane *Sandy* passed offshore of Isle of Palms in late October 2012. High surf from the hurricane caused significant dune erosion along the Breach Inlet reach. Ground photos from July and November 2012 show the beach condition before and after *Sandy* (Fig 3.36).

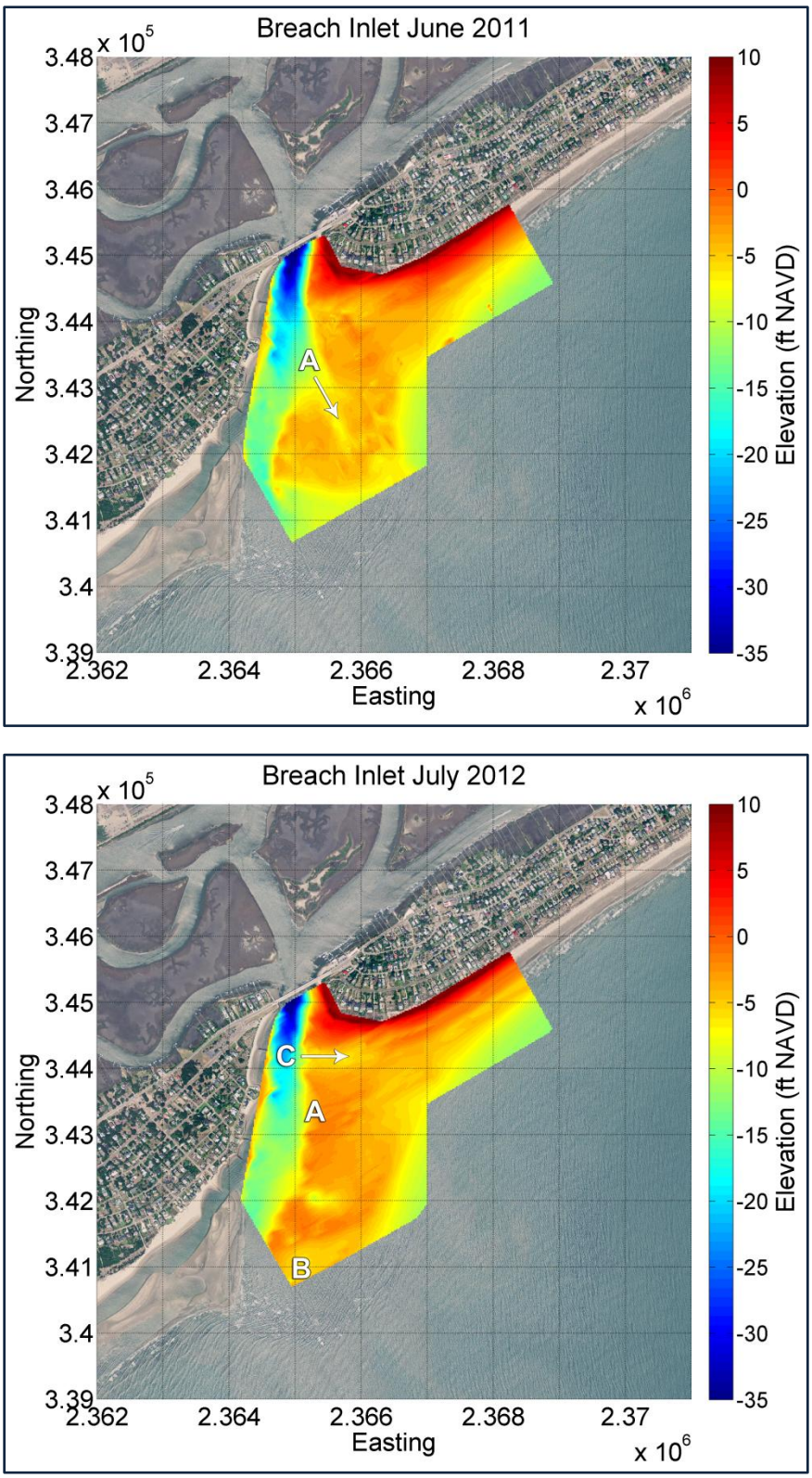


FIGURE 3.34. Color DTMs of Breach Inlet and neighboring IOP shoreline in June 2011 (upper) and July 2012 (l0wer). Note the buildup of sand on the western side of the delta shoal (A), westward migration of the main channel (B), and development of a marginal flood channel (C) between 2011 and 2012.

FIGURE 3.35. Aerial images of Breach Inlet in April 2011 (upper) and September 2012 (lower). Note the buildup of the exposed shoal at A, seaward expansion at B, development of a marginal flood channel at C. A recent channel avulsion event is reaching its final stage, where the old channel (labeled) is completely infilled with sand (S) which was originally on the IOP side of the inlet. [Photos by TW Kana and SB Traynum]

FIGURE 3.36.

[1st & 2nd LEFT] 4th Avenue (10 July 2012).

[1st & 2nd RIGHT] 4th Avenue (5 November 2012) – After passage of Hurricane *Sandy*, severe dune erosion was observed between Breach Inlet and 6th Avenue.

[3rd LEFT] View west from beach access 2 (10 July 2012).

[3rd RIGHT] Beach access 2 (29 October 2012) – Hurricane *Sandy* caused over 50 ft of dune erosion and damaged walk-overs in this area. [Photo by D Kynoski]

[4th LEFT] A high scarp was present near Breach Inlet in July 2012.

3.2 Shoal Management Project Conditions

As part of the monitoring effort for the City, CSE evaluated beach volumes in the borrow and fill areas for the 2012 shoal management project. Details of the project are given in the project final report (CSE 2012) and will not be repeated here. Volumes reported in this section only include sand that remains within the project boundaries (stations 276–298 for the borrow area and stations 306–320 for the fill area); the volumes do not consider sand that may have spread into adjacent areas. Total unit volumes for the borrow and fill areas are plotted in Figure 3.37 (to −10 ft NAVD). The trend in the borrow area is increasing volume from 2008 to September 2009 as sand from shoal-bypass events came ashore. Beach volume has declined in the borrow area since September 2009. The erosion rate increased from 65 cy/ft per year between June and December 2011 to 84.4 cy/ft per year from December 2011 to April 2012. The higher rate includes removal of ~87,700 cy (~45 cy/ft) during March and April for the project. Between April and July 2012, the erosion rate decreased to 17.9 cy/ft per year, likely a result of sheltering in the lee of the offshore shoal. Presently, the borrow area contains a similar volume of sand as it did in March 2008.

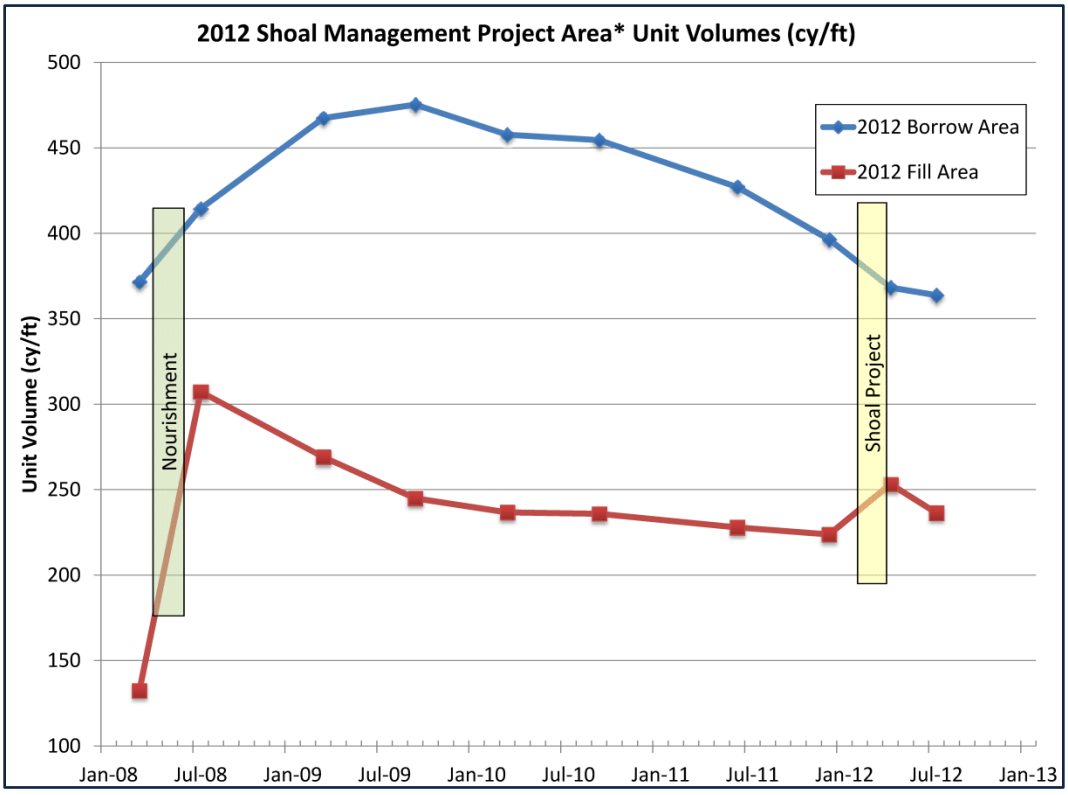


FIGURE 3.37. Unit volumes for the 2012 shoal management project borrow area (*blue, stations 276–298) and fill area (*red, stations 306–320). Presently, the borrow area contains a similar volume of sand is it did in March 2008. The fill area lost sand rapidly after placement and appears to have reached its pre-2012 project condition following passage of Hurricane *Sandy* in October 2012.

The fill area (red line) showed a unit volume of 132.4 cy/ft in March 2008. The 2008 nourishment increased this volume to 307.2 cy/ft in July 2008. Erosion was rapid over the first year after nourishment, and the volume decreased to 244.9 cy/ft by September 2009. Erosion continued at a slower rate through December 2011, when the unit volume reached 223.7 cy/ft. The 2012 shoal management project increased the volume by ~30 cy/ft. Between April and July 2012, the fill area lost 16.8 cy/ft (56 percent of the in-place fill). Overall, the beach within the fill limits lost ~23,500 cy between April 2012 and July 2012. However, as of July 2012, it retained ~17,600 cy more sand than the December 2011 condition.

As of this writing (November 2012), it appears that all of the dry-sand area created by the fill was lost during passage of Hurricane *Sandy* around 27 October 2012 (Fig 3.38). Without comprehensive survey data, it is unclear whether most of the sand that eroded from the upper beach shifted offshore (and will likely return to the upper beach in calmer weather) or whether it shifted alongshore. Photos taken after *Sandy* show the dune escarpment well landward of the pre-project (March 2012) position.

FIGURE 3.38. The boardwalk at the Ocean Club complex following passage of Hurricane *Sandy* in October 2012. Since this photo was taken, a small volume of sand from upland sources has been placed by property owners to rebuild the dune.

3.3 Dewees Inlet and Delta

CSE has monitored the morphology of Dewees Inlet since 2007. Since then, a major channel avulsion event has been occurring. Details of the morphological changes occurring from 2007 to 2011 are given in earlier reports to the City (CSE 2010, 2011a,b). The present report focuses on current conditions of the ebb-tidal delta and what impact it is having on the beach. Morphologic changes are visualized in digital terrain models (DTMs) (Fig 3.39). Section profiles from selected stations are shown in Figure 3.40.

Between June 2011 and July 2012, the shoal (labeled S on Fig 3.39, lower) offshore of the beach between the Wild Dunes Grand Pavilion and Summer Dunes Lane became more defined and moved landward. The most visible change was landward migration of the portion of the shoal offshore of Mariners Walk and Shipwatch. This portion of the shoal is sand that was seaward of the Dewees Inlet main channel in 2007, which has now merged with sand remaining from the "2007" delta lobe (which is also moving landward – marked L in Fig 3.39).

Other changes immediately visible from comparative DTMs are:

- Increasing elevation and landward movement of the "2007" delta lobe (labeled L). This is visible as the breakers offshore of the Wild Dunes Property Owners Beach House in the September 2012 aerial image shown in Figure 3.41.
- Infilling of the "2007" main channel.
- Southern migration of the present main channel (labeled C in Fig 3.39).
- Offshore expansion of the new delta lobe (where the channel exits the delta).
- Buildup of a channel margin linear bar (labeled B in Fig 3.39) adjacent to the Dewees Inlet channel near the northeastern corner of the island.

The changes listed above are continuations of changes observed over the past several years. It is worthwhile to note that the formation and growth of the channel margin linear bar over the past two years is a potential positive for future sediment supply to the eastern end of the island. The buildup of sand can act as a groin and trap sand moving east along the ocean front. However, the initial buildup of this feature is associated with sand lost from the beach. The bar is likely to expand and may eventually merge with the incoming shoal, trapping a lagoon between the outer sand bar and the present shoreline. It is not yet certain if this will occur or what the direct impact of the channel margin linear bar will be. CSE will continue to track the feature in future monitoring events.

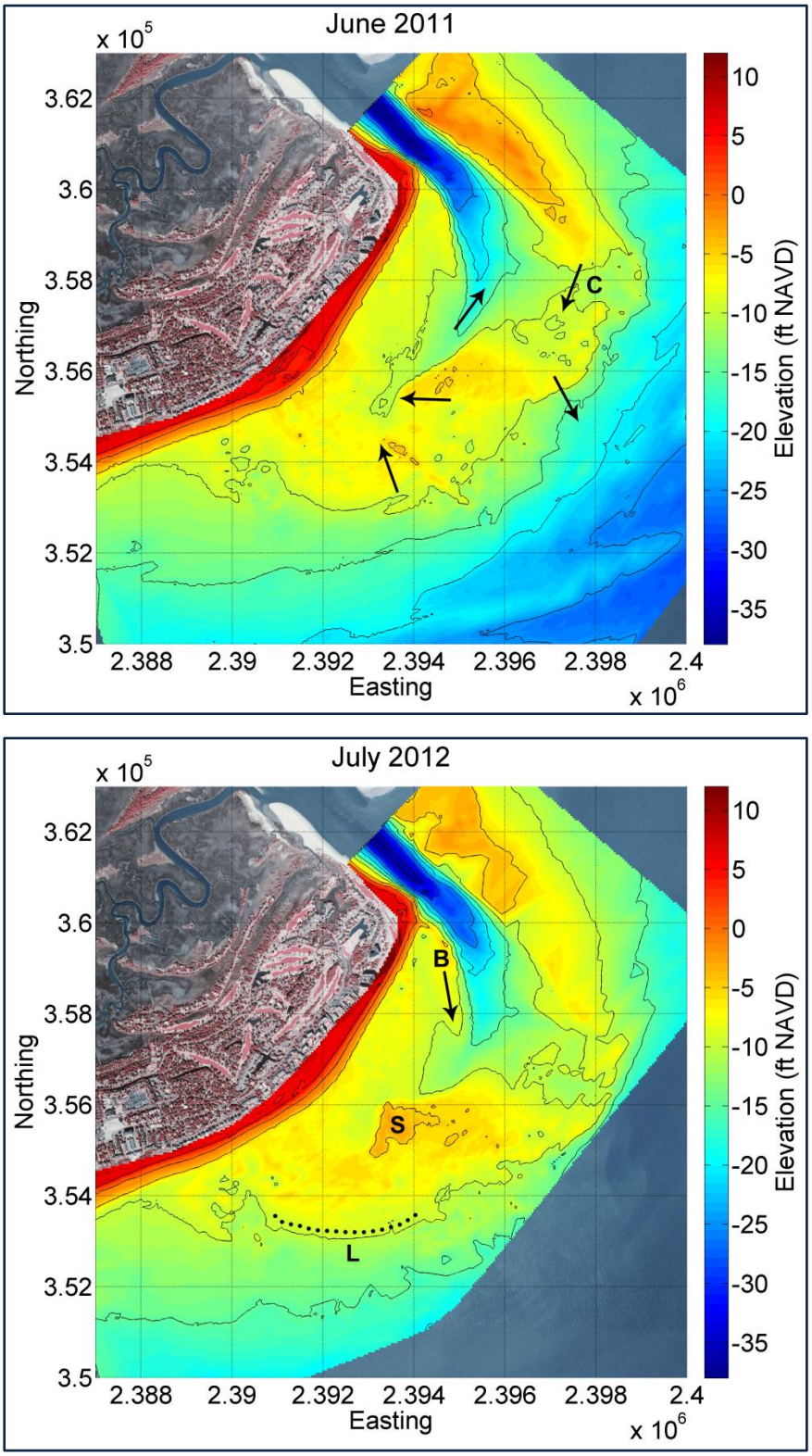
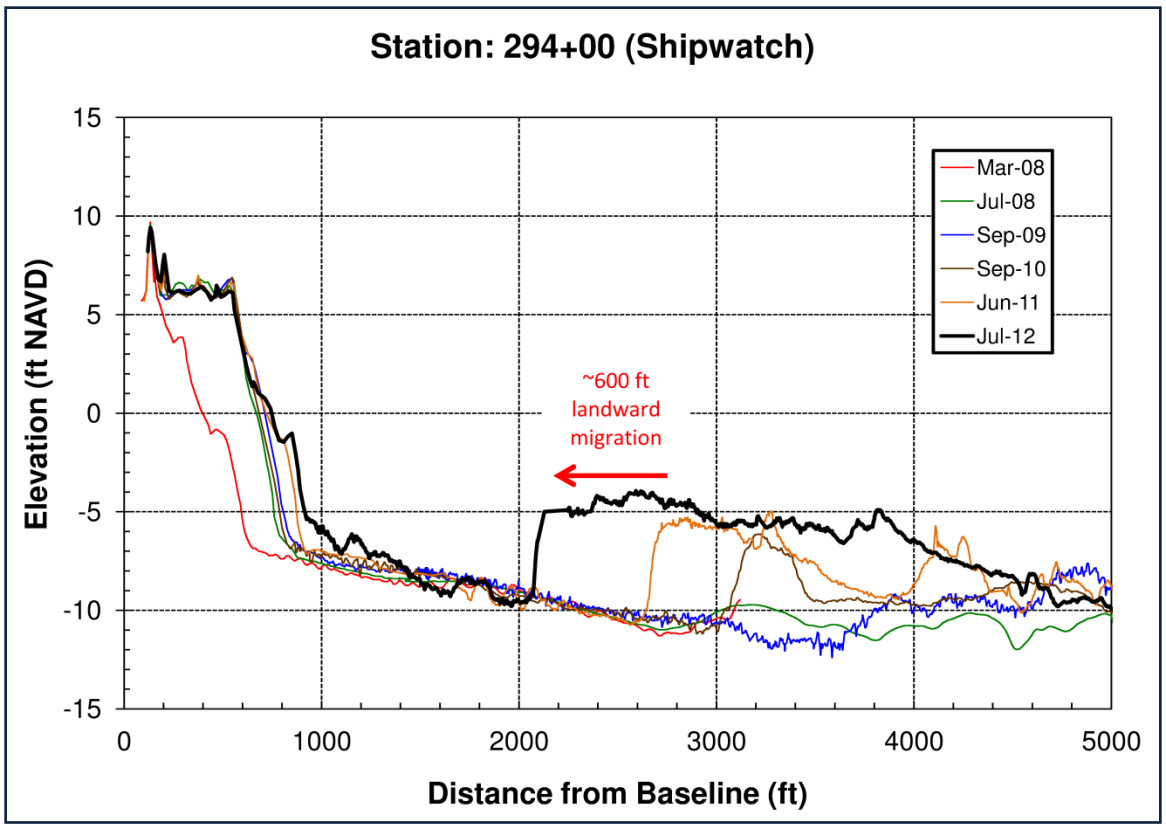


FIGURE 3.39. Color DTMs from the June 2011 (upper) and July 2012 (lower) surveys of the Dewees Inlet ebb-tidal delta. The general directions of sand/channel movement are shown by the arrows. [Labels are described in the text.]



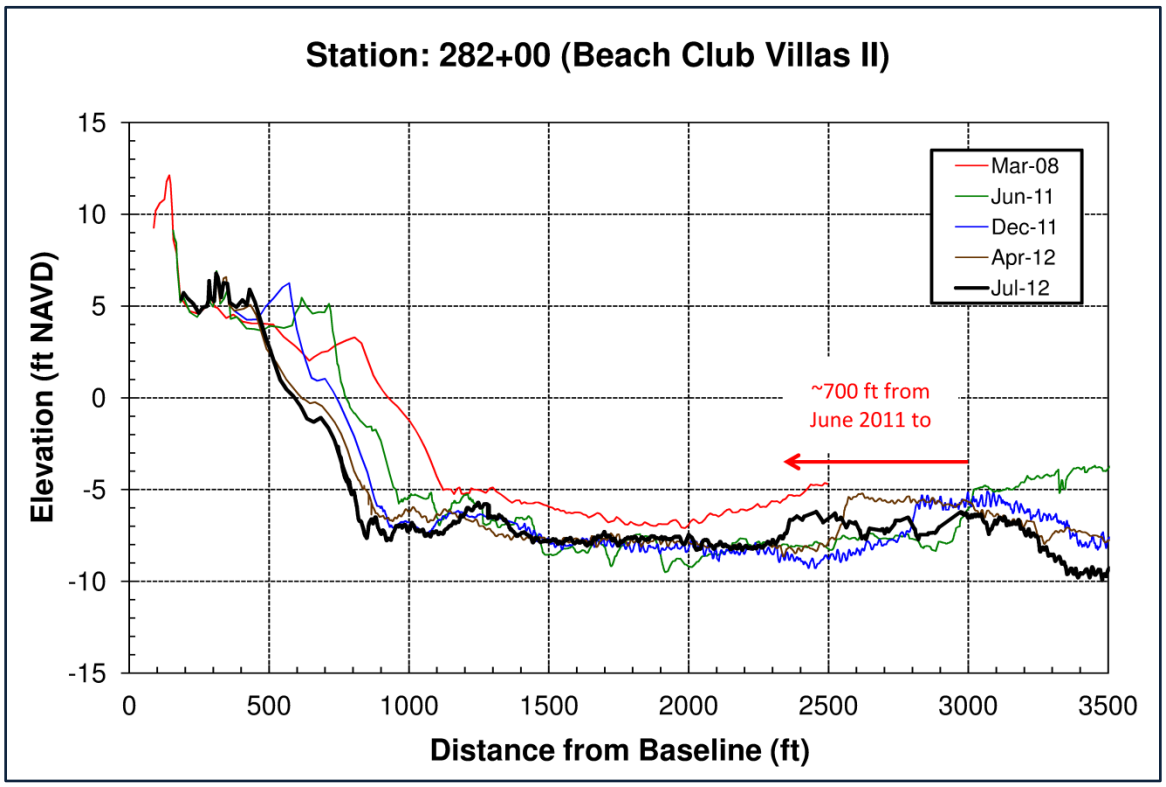


FIGURE 3.40. Profiles from station 294+00 (Shipwatch, upper) and station 282+00 (Beach Club Villas II, lower) extending to the Dewees Inlet delta. At both stations, the leading edge of the shoal migrated over 600 ft landward between June 2011 and July 2012.

FIGURE 3.41. Aerial image of the migrating shoal offshore of northeast Isle of Palms. The general direction of sand movement is shown by the arrows. [Photo taken 25 September 2012 by SB Traynum]

The leading edge of the shoal offshore of Shipwatch moved ~600 ft landward between June 2011 and July 2012 (see Fig 3.40). This resulted in roughly 1,200 ft separating the shoal from the beach. The shoal also increased in elevation over the past year; as it moves closer to shore and increases in elevation, it is more often impacted by waves and will migrate faster. At the same time, the leeward beach accretes and moves seaward which results in a more rapid merging of the beach and shoal as it moves closer to the beach.

The underwater portions of the beach (below 0 ft NAVD) at station 294 grew 50 ft seaward from June 2011 to July 2012, despite removal of sand during the 2012 shoal management project. This is clear evidence of the beach responding to the shoal. CSE expects this accretion pattern to magnify over the next year. CSE also expects erosion of adjacent areas to occur, characteristic of shoal-bypass events. The beach to the east of Shipwatch (Seascape/Ocean Club) is more susceptible to erosion due to a lack of sheltering from offshore shoals. It is positioned landward of the inlet channel (break in the outer delta) and is thus exposed to larger waves which focus on the area.

The shoreline west of the shoal attachment is sheltered by the remnant of the 2007 delta lobe. Station 288 through station 304 all show volume gain in the lower beach from June 2011 through July 2012 and are expected to continue to accrete over the next year. This area may be a likely borrow source should another shoal project be needed and conditions meet appropriate thresholds to enact a project.

3.4 Project Area Volume Changes

The following section provides volume change results within the limits of the 2008 nourishment project boundaries. It provides a measure of how much sand is left within the initial alongshore fill limits. While these results are useful for measuring project performance, it should be noted that sand gained or lost from these areas may be accounted for in adjacent areas as noted in Section 3.1.

Within the fill limits of the *Dewees Inlet* project area (nourishment Reach C, Fig 3.42), the beach continued to gain sand. **Overall, the project reach gained ~11,300 cy (11.3 cy/ft) since June 2011, leaving it with 165 percent of the nourishment volume remaining** (Fig 3.43). As of July 2012, Reach C contained ~70,550 cy more sand than the pre-nourishment condition. Accretion between station 330+00 and station 338+00 (area of the 18th tee and fairway) is likely due to losses in Reach 6. The volume change trends along the 18th fairway of the Wild Dunes Links Course, which wraps around the northeastern point of the island, provide an indicator of net sand transport from the oceanfront to the inlet shoreline in this area, consistent with the findings of Kana and Dinnel (1980).

The length of beach within the project boundary Reach B (between Shipwatch and the 18th fairway) presently retains 110.3 cy/ft more sand than the pre-nourishment condition (compared to 148.4 cy/ft immediately following nourishment). **As of July 2012, 74.3 percent of the nourishment volume remains in project Reach B.** Overall project Reach B lost ~11,500 cy (2.7 cy/ft) of sand since June 2011.

Similar to the previous year, Project Reach A was the most erosional project reach, losing ~87,000 cy since June 2011. The project area presently retains an average of 6.9 cy/ft more sand than the pre-nourishment condition compared to 64.6 cy/ft more sand immediately post-nourishment. In March 2009, 90.8 percent of the nourishment volume remained in the project area. This reduced to 72.0 percent in September 2009, 53.9 percent in September 2010, 36.7 percent in June 2011, **and 10.7 percent of the nourishment volume remaining in July 2012**.

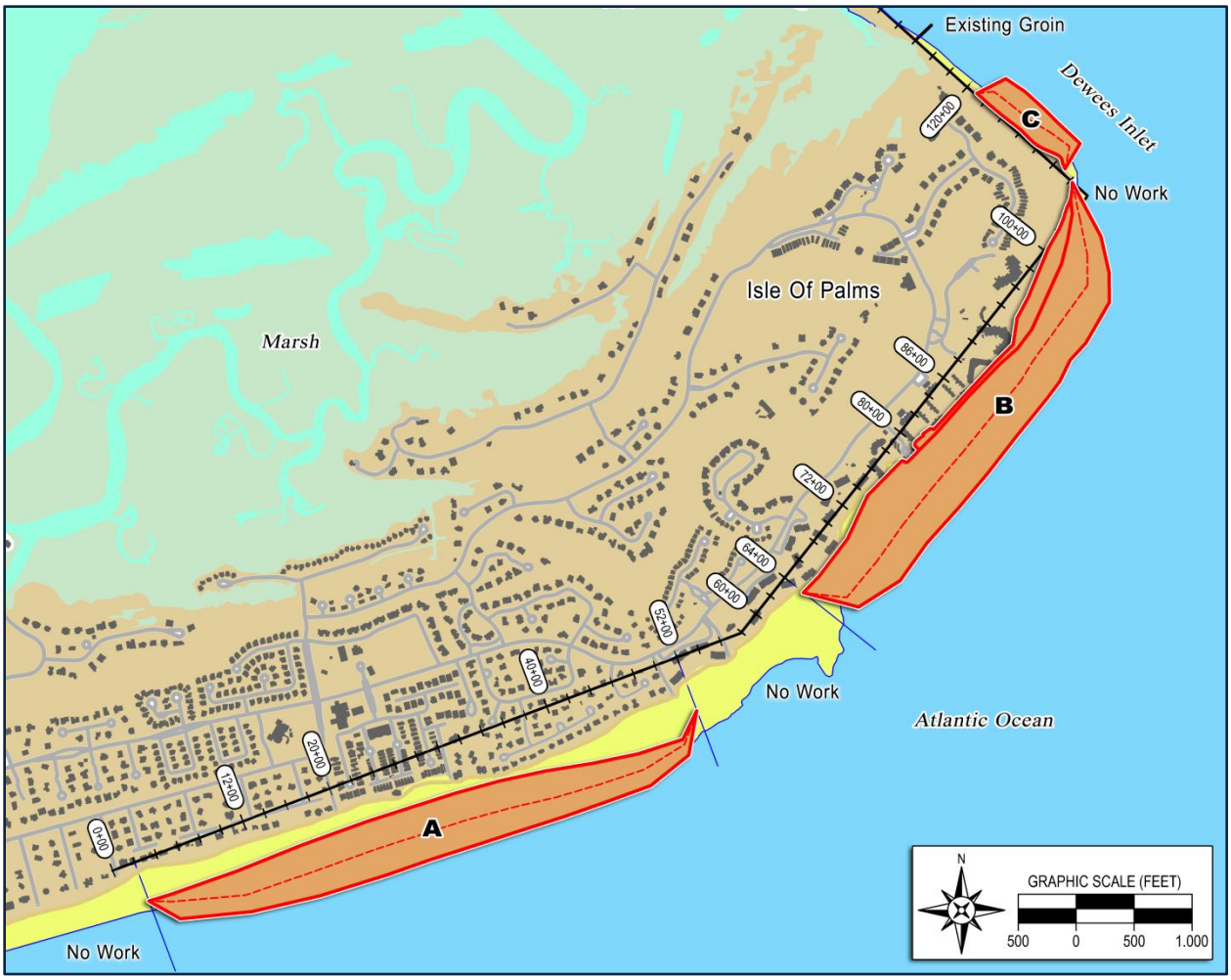
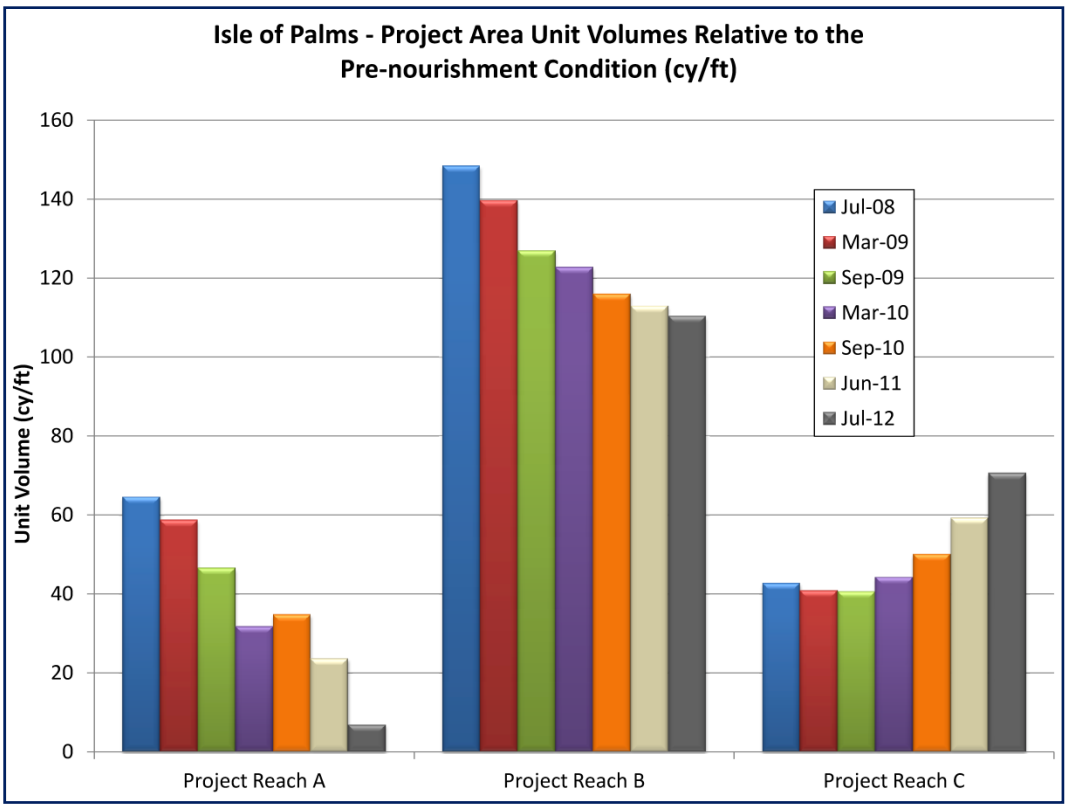


FIGURE 3.42. Reaches for the 2008 nourishment project. The graphic shows the project baseline with 0+00 located at 53rd Avenue (monitoring station 222+00).



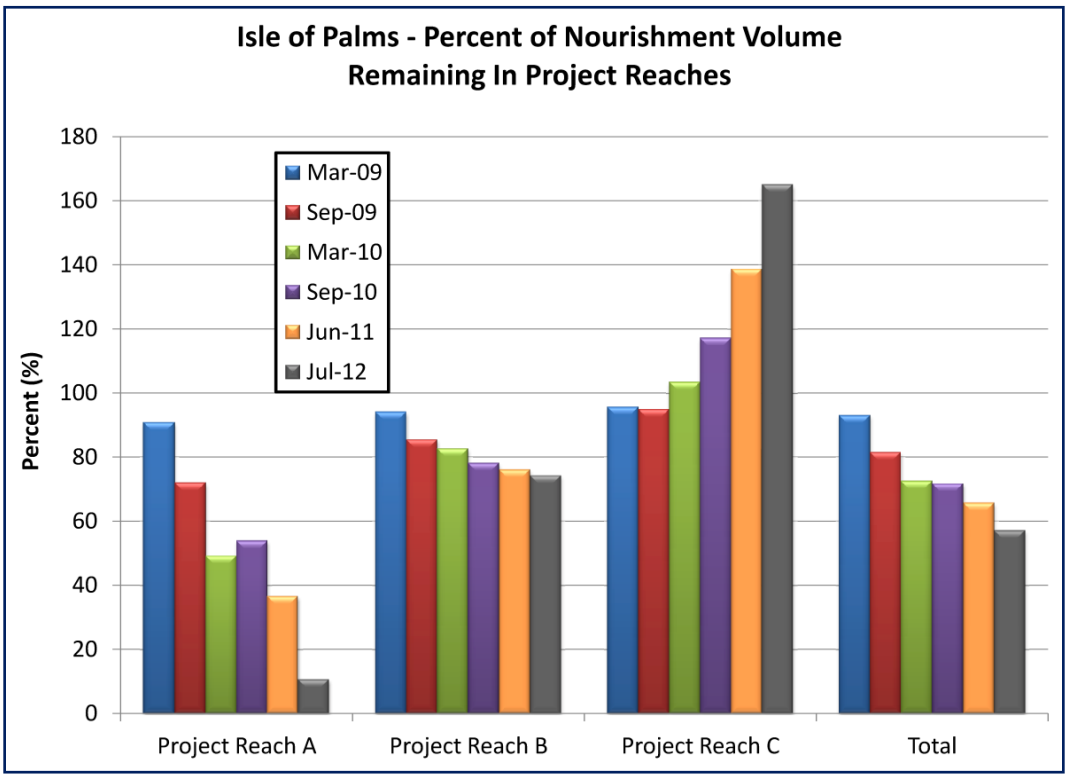


FIGURE 3.43. **[UPPER]** Project area unit volumes relative to the pre-nourishment (March 2008) condition, which is zero on these graphs. [Note that the project area limits differ from monitoring reach limits.] **[LOWER]** Percent of nourishment volume remaining in each project area.

The low retainage is due to significant erosion in the eastern end of the reach (see for example, Reach 5 unit volumes from Section 3.2). To highlight this, CSE compared the percent remaining from station 224 (near 53rd Avenue and the western limit of Reach A) to station 260 (near the central portion of Beachwood East), and from station 260 to station 276 (Beach Club Villas I at the east end of the reach). The 3,600 linear feet of beach (~70 percent of the length of Reach A) from station 224 to station 260 retains 71.3 of the nourishment fill placed within those stations. The 1,600 linear feet of beach (~30 percent of the length of Reach A) from station 260 to station 276 has lost 244.2 percent of the nourishment volume placed in that area.

CSE believes erosion of the reach is due to losses to downcoast areas as well as continued straightening of the shoreline following recent shoal-bypass events. The nourishment fill density was also smaller in the eastern end of the reach, meaning smaller volume changes can lead to higher percentages.

3.5 Sand Fencing/Dune Growth

Installation of sand fencing was included in the project design in areas lacking existing dunes or vegetation. Installed in "v-shaped" sections spaced ~10 ft apart (Fig 3.44), fencing was placed in May 2009 between Beach Club Villas and Ocean Club as well as along the Dewees Inlet shoreline. Dune vegetation was also installed in a 15-ft-wide swath surrounding the fencing. Sand fencing aids in dune building by accumulating wind-blown sand. Vegetation also acts to block wind and accumulate sand. While vegetation would naturally spread to the nourished areas, which would then begin to build dunes, installation of the fencing and vegetation speeds the process. A desirable goal is to build a dune line along the back beach as high and wide as possible to provide storm protection to buildings. A secondary benefit is creation of habitat for beach organisms.

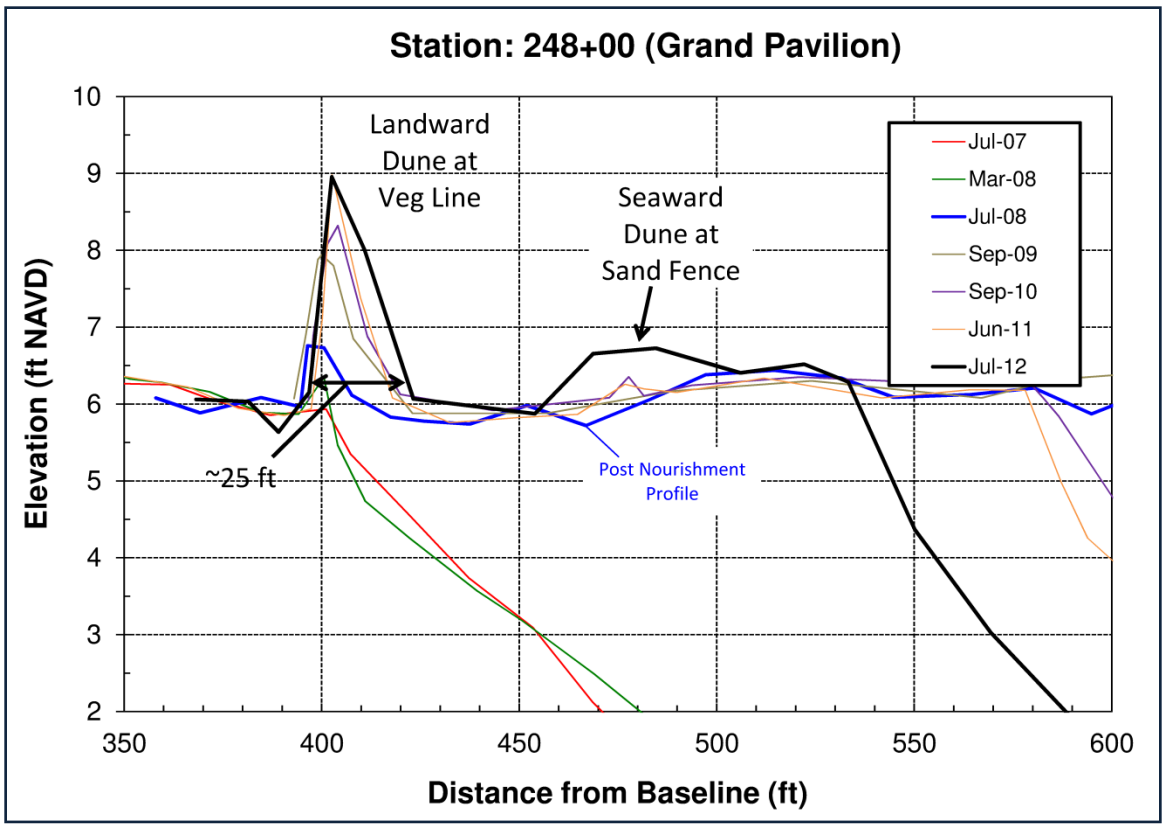
FIGURE 3.44. **[LEFT]** Sand fencing in Reach 5 in July 2012. There is less dune growth in this area than in Reach 6. **[RIGHT]** Sand fencing and vegetation in Reach 6 near Port O'Call in July 2012. [Photos by SB Traynum]

As of July 2012, the sand fencing had accumulated 4–5 ft of sand in many areas. The fencing is expected to continue to trap sand as long as the areas are fronted by an area of dry-sand beach and are not regularly impacted by overwash. It is very likely that natural vegetation and dune growth will occur in nourishment areas seaward of the fencing, where a large platform of dry berm is situated between the fencing and the normal high-tide limit.

In areas of the island already possessing dunes and/or vegetation (nourished and unnourished areas), natural dune building was evident in many of the profiles. Of particular interest is the area in front of the Wild Dunes Grand Pavilion, which has lower and narrower dunes than most other areas of the island. Profile 248+00 shows the landward dune along the vegetation line grew ~5 ft wider between June 2011 and July 2012 and maintained its elevation. The dune at that location has grown 3 ft higher since March 2008—the pre-nourishment condition (Fig 3.45). Dune growth has been slower at the sand fence (~25 ft seaward of the 2009 shoreline), although a 1-ft-high foredune is present at the fence.

It is preferable for natural dune building to occur at the most landward portion of the dry beach. This results in formation of a larger dune in a more stable part of the beach. CSE recommends evaluating future placement of fencing prior to installation to encourage maximum dune growth at stable locations.

Significant dune growth is present along project Reach B between Mariners Walk and Seascape (Fig 3.45). At these locations, sand fencing has been effective in trapping sand, and planted vegetation is maturing well. At Port O'Call, the dune has built over 5 ft in elevation since installation of fence in 2009 and is over 50 ft wide at the base. This growth represents a unit volume of ~4 cy/ft in the dune above the post-nourishment profile.



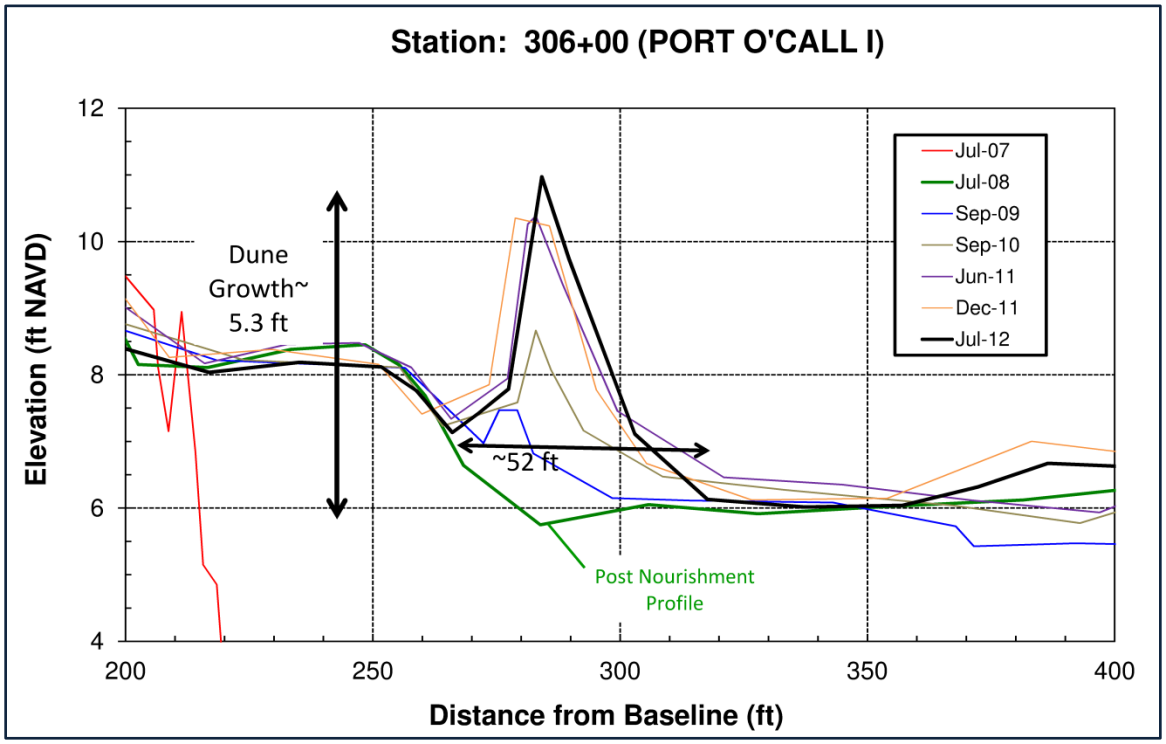


FIGURE 3.45. Evidence of dune growth at station 248+00 (adjacent to the Wild Dunes Grand Pavilion) following nourishment (May-June 2008). Elevation of the dune has increased ~3 ft naturally since the pre-project condition. Dune growth has been more rapid at station 306+00 (near Port O'Call). A wider dry beach here facilitates wind-blown sand transport, leading to higher dunes. Note vertical exaggeration is ~1 on 12.

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4.0 DISCUSSION AND RECOMMENDATIONS

CSE has collected detailed morphological data at Isle of Palms over the past five years (2007-2012). Over that time, significant changes have occurred in Dewees Inlet which have impacted the shoreline and will continue to drive beach volume changes at the northeast end for several years. Specifically, a channel avulsion event (shift of the channel to a more northerly position) has been occurring, which has released several million cubic yards of sand from the inlet delta. This sand is positioned just offshore and is moving slowly toward the beach. Changes in the beach condition along the central and north ends of the island since the 2008 nourishment are a result of several processes, including:

- Erosion of the areas near Beach Club Villas where the 2007 shoal attachment created an unstable shoreline salient. This area now has beach volumes comparable to adjacent areas.

- The ongoing channel avulsion event, which has opened a new flushing channel for Dewees Inlet and closed off the "2007" main channel. As a result, the volume of sand that existed between the old and new channel has migrated southwest and has merged with the old delta lobe. This is forming a new, distinct, shoal-bypass event which is in the beginning of Stage 2 of the bypass cycle (where it begins to affect the leeward beach).

- Focused erosion of the area near Ocean Club and the 18th hole of the Links Course resulting from (1) wave focusing through the inlet channel and (2) northerly sediment transport following the 2008 project.

- Significant accretion of the area downcoast of the 2008 project (between 35th and 53rd Avenues) as nourishment sand and shoal sand shift south.

- Accretion of the central and southwestern portions of the island due to abundance sediment from upcoast.

The July 2012 survey confirms that, overall, the island lost ~94,800 cy (or 2.6 cy/ft) of sand averaged over the entire island. This includes a loss of ~215,700 cy northeast of 53rd Avenue and a gain of 120,000 cy south of 53rd Avenue. Reach 5 (53rd Avenue to Beach Club Villas) was the most erosional reach, losing 25.9 cy/ft from June 2011 to July 2012. Reach 6 (Beach Club Villas to the 18th hole) was also fairly erosional, losing 13.3 cy/ft. Reaches 2, 3, 4, and 7 all gained sand, while the shoreline near Breach Inlet (Reach 1) lost 19.5 cy/ft.

The outer shoal at Dewees Inlet has merged with the remnant delta (2007) and continues to approach the shore. As of July 2012, the leading edge of the shoal was ~1,200 ft from the beach. CSE expects the shoreline response to magnify over the next year as the shoal moves closer to the beach. Accretion is expected near Mariner's Walk and Shipwatch (in the lee of the shoal), while erosion is likely to intensify to the east of the attachment site (Port O'Call, Seascape, and Ocean Club).

Like Dewees Inlet, Breach Inlet is undergoing a channel avulsion event. The event at Breach Inlet is nearing completion (the old channel is almost complete infilled and the shoal sand is attached to the beach), though the new channel has created a sediment sink for sand leaving Isle of Palms. Sediment is lost from Isle of Palms and filling the sediment sink, rather than building the eastern end of the shoal (which helps retain sand along the Breach Inlet shoreline). While houses are sufficiently set back from the ocean (thanks to decades of accretion in the area), several dune walkovers extend onto the beach and are susceptible to damage.

The results herein focus on changes from June 2011 to July 2012. Hurricane *Sandy* passed the South Carolina coast in late October 2012, creating high surf and moderate storm surge. In many areas, the storm conditions led to dune erosion and overtopping of the normal dry-sand beach. The most significant erosion was near Breach Inlet, where dunes eroded over 50 ft in places, causing damage to several dune walkovers. Erosion also breached the remaining dune fronting the green and fairway of the 18th hole of the Links Course.

The current availability of sand for another shoal management project is not sufficient to justify using the last permitted sand scraping under the City's Shoal Management Project permit. The permit allows for two events to occur, each of which may move up to 250,000 cy of sand. The first event was completed in March–April of 2012. CSE expects more sand will be available to borrow during the winter of 2013–2014 or 2014–2015, and the beach condition will warrant implementing a project. If the City were able to obtain a modification to the existing permit to allow for an additional event, a project may be justified (likely with a volume under 100,000 cy) for winter 2012–2013. CSE will work with the City to discuss options and implement mediation measures, if necessary.

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