

**2006 EAST END BEACH RESTORATION PROJECT  
KIAWAH ISLAND SOUTH CAROLINA**

**Survey Report No 7  
February 2014**



***Prepared for:***  
**Town of Kiawah Island**



**2006 EAST END BEACH RESTORATION PROJECT**  
**Kiawah Island – South Carolina**

**SURVEY REPORT NO 7**  
**Annual Beach and Inshore Surveys**

*Prepared for:*



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[CSE 2392 YR7]  
February 2014

**COVER PHOTO:** View looking west along Kiawah spit in January 2014.

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## SYNOPSIS

This report is the seventh in a series of annual monitoring reports following the 2006 east end beach restoration project. It presents results of detailed surveys encompassing the ocean-front of Kiawah Island with particular focus on the area around the Ocean Course and Stono Inlet.

The Town of Kiawah Island sponsored the east end project at a cost of \$3,575,000 for purposes of mitigating encroachment on the Ocean Course and restoring the sand flow to down-coast beaches. The flushing channel was closed and a new channel was opened to the east. About 550,000 cubic yards (cy) of sand were scraped from the new outer beach and were placed along the Ocean Course. [LD Weaver Construction Company was the contractor, and all work was performed by land-based equipment between 8 June and 28 July 2006, a schedule based on recommendations by the US Fish & Wildlife Service.]

In addition to the goal of restoring the flow of sand to downcoast areas of Kiawah Island, the east end project was designed to prolong washover habitat. This was accomplished by removing excess sand in some areas (and transferring it downcoast) before a stable dune line could become established with vegetation. Habitat monitoring showed that washover habitat increased in area by over 50 percent from 2006 to 2011 (CSE 2012).

Kiawah Island remains one of the healthiest beaches in South Carolina (Fig A). The results of shoreline monitoring and tracking the sand supply have provided new insight into the formation of barrier islands and rates of evolution of important habitats. Based on the results herein, the prognosis for the future is favorable for Kiawah's beach.



**FIGURE A.** Kiawah Island remains one of the healthiest beaches in South Carolina (September 2012 aerial).

# TABLE OF CONTENTS

	<b>PAGE</b>
SYNOPSIS.....	i
TABLE OF CONTENTS .....	iii
1.0 INTRODUCTION.....	1
2.0 SETTING AND HISTORY.....	3
2.1 Geologic History of Kiawah Island.....	3
2.2 Previous Shoreline Studies .....	6
Stono Inlet .....	7
2.3 2006 East End Beach Restoration Project .....	11
3.0 METHODOLOGY .....	15
3.1 Survey .....	15
3.2 Volume Calculations .....	17
4.0 RESULTS .....	23
4.1 Project Area Observations .....	23
4.2 Project Area Sand Volumes .....	26
Stono Inlet Reach .....	29
Lagoon Reach .....	34
Ocean Course Reach .....	39
Summary of East-End Changes.....	43
4.3 Downcoast Reaches .....	43
Turtle Point Reach.....	45
West Beach Reach .....	45
Kiawah Spit Reach .....	51
5.0 SUMMARY OF FINDINGS .....	57
REFERENCES & BIBLIOGRAPHY .....	59
ACKNOWLEDGMENTS .....	61

## APPENDIX A) Beach Profiles

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## 1.0 INTRODUCTION

This report is prepared as part of a series of annual beach monitoring reports following the east end restoration project completed in July 2006 (CSE 2005, 2007). The Town of Kiawah Island (SC) is sponsoring annual surveys of the sandy shoreline for purposes of determining the rates of sand movement, accretion, and erosion adjacent to the project area. This seventh report of the series follows over a dozen shoreline erosion reports prepared by Research Planning Institute (RPI) and Coastal Science & Engineering (CSE) for Kiawah Island since the 1980s (eg — Kana et al 1983, CSE 1999). Annual post-project surveys have been conducted in the fall of every year between 2007 and 2013.

The purpose of this report is to describe the current health of Kiawah Island as compared to past conditions. This involves documenting sand volume changes along the entire island (Captain Sams Inlet to Penny's Creek) to identify areas where the beach and dunes may be eroding or accreting. Annual monitoring provides a quantitative account of sand volume changes, which can then be used to infer sediment transport rates along the shoreline and predict future areas of concern before critical situations arise.

The scope of work for the annual monitoring effort includes:

- Ground surveys of the dunes, beach, and inshore zone.
- Oblique aerial photography
- Data analysis and production of a technical report describing beach volume changes.

The next section presents a brief description of Kiawah Island and its historical shoreline changes. A summary of the methods used during surveying and data analyses follows in Section 3. Section 4 includes the results of the survey. Section 5 presents a discussion of CSE's present findings and recommendations.

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## 2.0 SETTING AND HISTORY

Kiawah Island continues to be one of the healthiest barrier islands in South Carolina. The addition of sand generated from Stono Inlet has led to stable dunes spanning the beachfront with only minor localized erosion in specific hot spots as sand migrates downcoast from Stono Inlet. The addition of sand through the process of inlet bypassing and the foresight of the island's developers to properly study the processes controlling the morphology of the island (Hayes et al 1975, Hayes 1977) make Kiawah Island an excellent example of beachfront development and a premier community along the South Carolina coast (Fig 2.1).



FIGURE 2.1. View east from Beachwalker Park in January 2014.

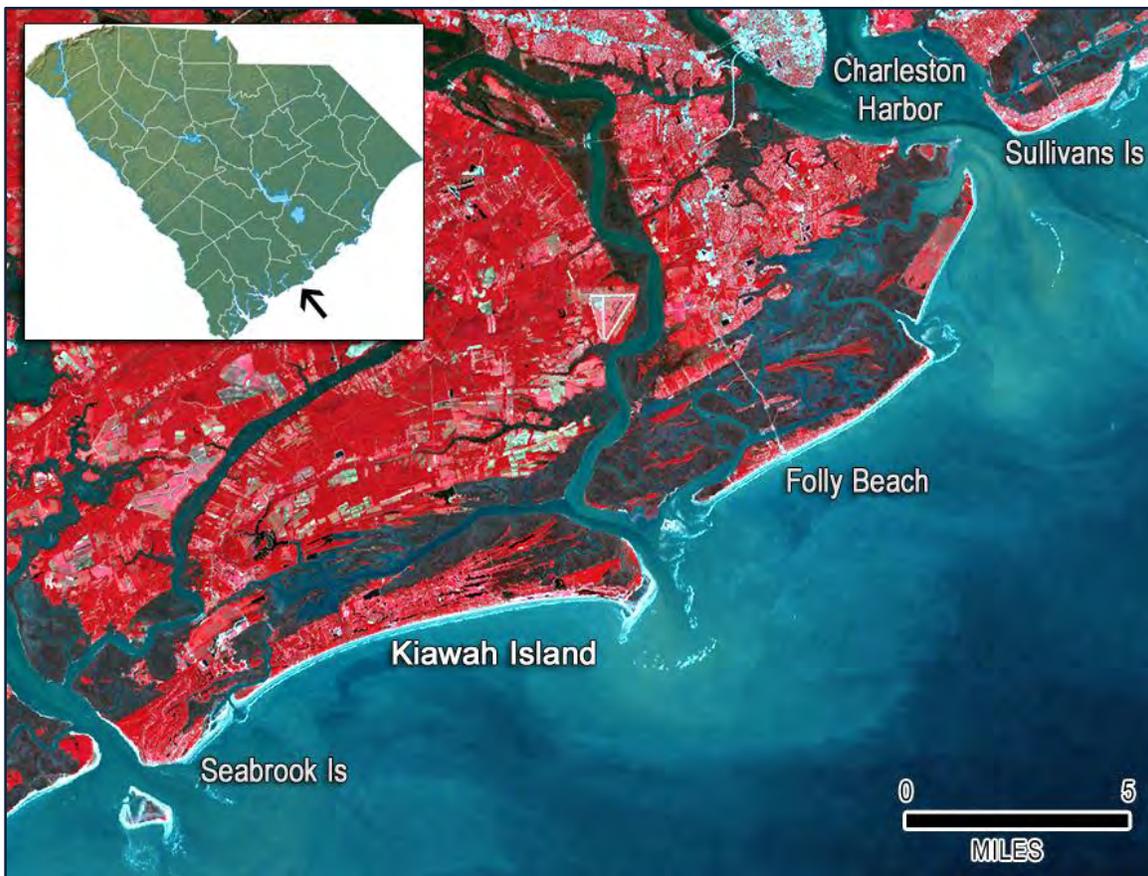
### 2.1 Geologic History of Kiawah Island

Kiawah Island has been studied in detail since 1974, when Professor Miles O. Hayes and colleagues at the University of South Carolina initiated field measurements and review of the geologic history of the island. Using Kiawah Island as a model, Hayes coined the term “drumstick” barrier island, which today commonly describes barrier islands of the South Carolina coast and other “mixed-energy settings” (Fig 2.2) (Hayes 1977, 1994; Hayes & Michel 2008). The oldest part of the island, adjacent to the Kiawah River, was found to be about 4,000 years old. The island’s eastern end has prograded several thousand feet seaward since the mid 1800s, leading to the creation of parallel dune ridges, each representing the shoreline at the time it was created.



**FIGURE 2.2.** Barrier island drumstick model (after Hayes 1977) using Isle of Palms as an example. The upcoast end is wider due to additions of sand from shoal-bypass events in the inlet. Net transport to the south builds a spit at the downcoast end of the island.

The island is roughly 10 miles long, bounded by Stono Inlet to the east and Captain Sams Inlet to the west (Fig 2.3). The eastern end episodically gains sand by way of shoal-bypassing events (Williams & Kana 1986, Gaudiano 1998), and the sand eventually spreads to down-coast parts of the island until reaching Captain Sams Inlet, where it accumulates and forms Kiawah spit. These shoal-bypassing cycles are responsible for the continued growth of Kiawah Island, but can also cause temporary erosion, which will be discussed later. The geologic history of Kiawah and the processes controlling sand movement along the island are discussed in more detail in CSE (1999).



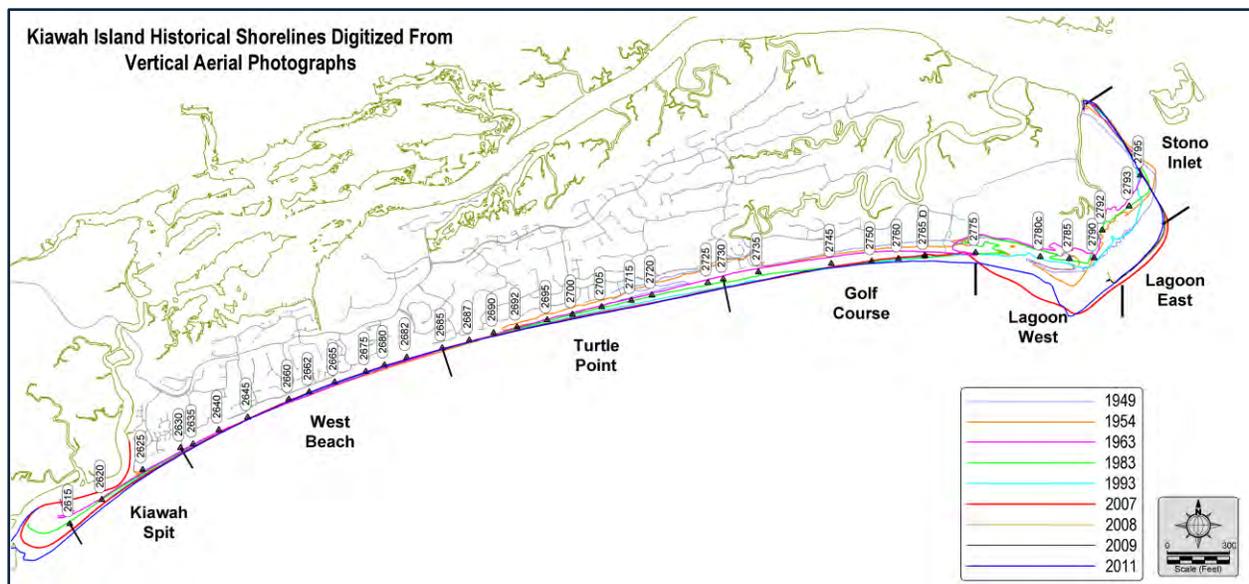
**FIGURE 2.3.** South Carolina coastline from Seabrook Island to Charleston Harbor. [Image courtesy Research Planning Inc and SCDNR]

## 2.2 Previous Shoreline Studies

The first shoreline assessment of Kiawah Island was performed by Hayes and his students in the early 1970s (Hayes et al 1975). Based on the geomorphology of the island, Hayes identified five zones along the beach and recommended two middle zones (West Beach and Turtle Point) as being suitable for development landward of the second dune ridge (Fig 2.4). The early development of the island was based on the findings of these studies, and it became one of the first localities in the State to implement rigorous setback lines.

From 1981 to 1987, regular monitoring efforts were conducted by Research Planning Institute Inc (RPI) and CSE (cf – Sexton et al 1981, Williams & Kana 1987). In July 1988, the Beach Management Act (BMA) of South Carolina was enacted, and by 1989, management of the State’s beach monitoring programs was taken over by the State, ending CSE’s involvement. In 1994, CSE was again contracted by the Town of Kiawah Island and conducted monitoring through 1999.

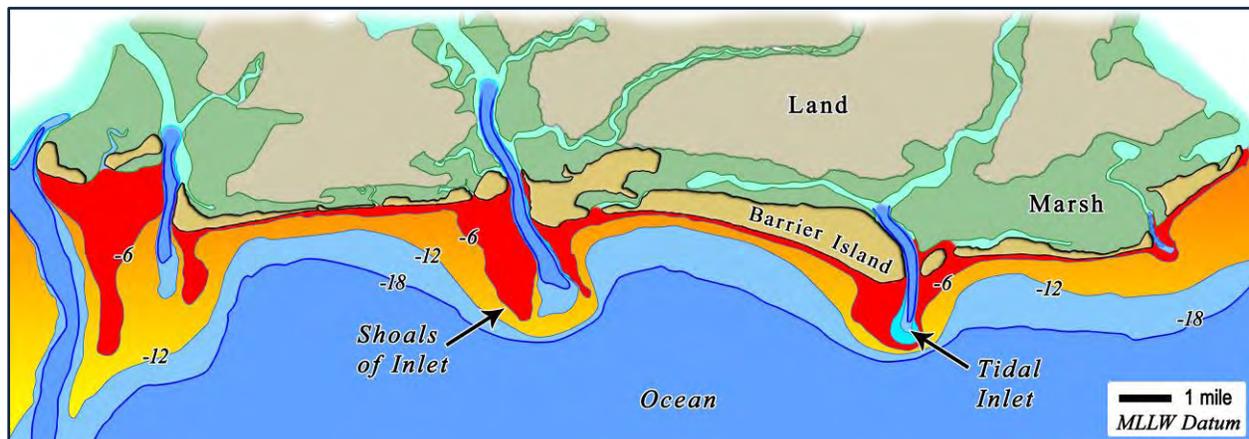
From 1981 through 1999, Kiawah Island either gained sand or remained stable. Specific areas showed sporadic erosion; however, the magnitude of sand loss was generally small. The West Beach area (encompassing Windswept Villas, Mariners Watch Villas, Eugenia Avenue, West Beach Village, and Kiawah Inn) remained stable, losing only 0.21 cubic yards per foot per year (cy/ft/yr) from 1983 until 1999 (with episodic accretion and erosion events). All other reaches showed gains in sand between 1983 and 1999. Details of volume changes from 1983 to 1999 are given in CSE (1999).



**FIGURE 2.4.** Historical shorelines (seaward vegetation lines). West Beach has been slightly erosional whereas all other reaches have been accretional since 1949. [Updated from CSE 1995]

## Stono Inlet

Sand from Stono Inlet is the major littoral source for Kiawah Island (Kana et al 1981). Inlet ebb-tidal deltas often contain as much or more sand than the adjacent barrier islands along the southern two-thirds of the South Carolina coast (Sexton & Hayes 1996). In this mixed-energy environment (Hayes 1994), waves and tidal currents both have a significant impact on shaping the morphology of the inshore zone (Fig 2.5). Sand is moved seaward by strong ebb-tidal currents at the inlets. Waves then push deposited sand landward in the form of shoals. This produces characteristic features common to much of the central and southern South Carolina coast—such as lobate deltas extending miles offshore, marginal flood channels (small channels near the beach flanking the main channel and dominated by flood currents), and migrating shoals (cf – Figs 2.2 and 2.3).

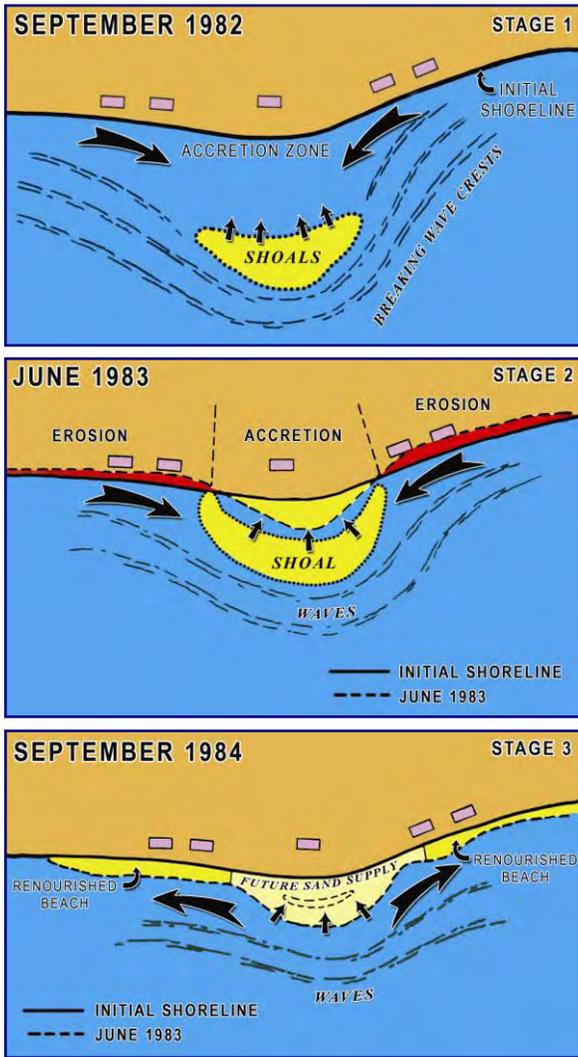


**FIGURE 2.5.** Nearshore bathymetry for a typical section of the central and southern South Carolina coast. Ebb-tidal deltas contain large amounts of sand, which alter the local bathymetry. This in turn directs wave energy and sediment transport patterns along the adjacent beaches. [From *Coastal Erosion and Solutions — A Primer* (Kana 2011) — CSE]

Periodically, sand stored in the ebb-tidal delta of Stono Inlet is released when the inlet channel shifts position. Shoals on the downcoast (west) side of the channel are freed from the delta and pushed shoreward by wave action. During this process, the beach in the lee of the shoal builds because of decreased wave energy (Fig 2.6). Adjacent to the areas of accretion, erosional arcs are formed by changes in the wave patterns due to refraction around the offshore shoal. This process continues until waves have pushed the shoal to the point of attachment along the beach.

Once attached, the shoal is considered to be in Stage 3 of the shoal-bypass cycle (Kana et al 1985, Williams & Kana 1986). Waves continue to push the shoal landward and upward while spreading sand laterally along the beach. Shoal spreading (Stage 3) provides natural nourishment with sand moving downcoast via longshore currents.

**THE THREE STAGES OF SHOAL BYPASSING**



**FIGURE 2.6**

**[LEFT]**  
Schematic of the shoal-bypass cycle originally modeled from a bypass event at Isle of Palms (SC). 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 bypassing at the east end of Kiawah Island.

Stage 1 in 1977 (upper). Stage 2 in January 1979 (upper middle) (courtesy of Research Planning Institute Inc). Stage 3 in 1983 (lower middle). Stage 1 in 1986 (lower). Note the similarity between the 1977 shoal and the 1986 shoal, but the additional sand accumulated on Kiawah in 1986. [After Kana et al 1999]

The time between release of the shoal by the inlet, and attachment and spreading depends on the size of the inlet and its ebb tidal delta. Large inlets, such as Stono Inlet, tend to initiate shoal-bypassing events every 7–8 years with individual shoal volumes often exceeding 0.5 million cubic yards (Gaudio & Kana 2001).

Kiawah Island has recently experienced two impressively large shoal-bypassing events. The first formed offshore in 1994 and had completely attached to the eastern end of Kiawah by 1997. The second began attaching to Kiawah along its eastern flank in 1998. The western flank of the second shoal overlapped the eastern Kiawah shoreline as it built and migrated west and north between 1998 and 2004 (Fig 2.7). These two events were the largest ever documented on the South Carolina coast (CSE 2005). They contained such a large quantity of sand that wave action was not able to completely push the shoal against the original shoreline, and a new beach line and dune system were formed more than 2,000 feet (ft) seaward of the original shoreline. This created a lagoon between the new and old shorelines, along with a roughly 2-mile-long barrier beach (Fig 2.7). The recent shoal-bypass events showed how rapidly barrier islands can form, even in the presence of sea-level rise and other erosional forcing (Kana 2002).

By 2004, the shoals had completely attached at the eastern end but remained offshore at the western end as sand migrated westward, reaching near the (old) Ocean Course Clubhouse (Fig 2.7). The shoals had not completely attached at the western end due to a natural channel maintained by tidal flushing of the lagoon. CSE (2005) estimated the two shoals added ~5 million cubic yards to Kiawah Island. Due to the overwhelming quantity of sand added at the eastern end, the shoreline near the Ocean Course jumped seaward and changed orientation. This protrusion altered the direction of approaching waves and caused focused erosion along the Ocean Course.

As longshore transport moved the shoal westward, the flushing channel migrated with the shoal, encroaching on the Ocean Course, specifically the 16<sup>th</sup> and 18<sup>th</sup> holes. The beach at the original Ocean Course Clubhouse (near OCRM monument 2775) retreated over 500 ft between 2000 and 2005. The magnitude of the bypassing event was so great, it was apparent that severe erosion would continue for several years before the cycle would be complete (Gaudio & Kana 2001). The Ocean Course remained vulnerable to erosion as the shoal and flushing channel migrated westward. This led to the plan for beach restoration by CSE (2005).



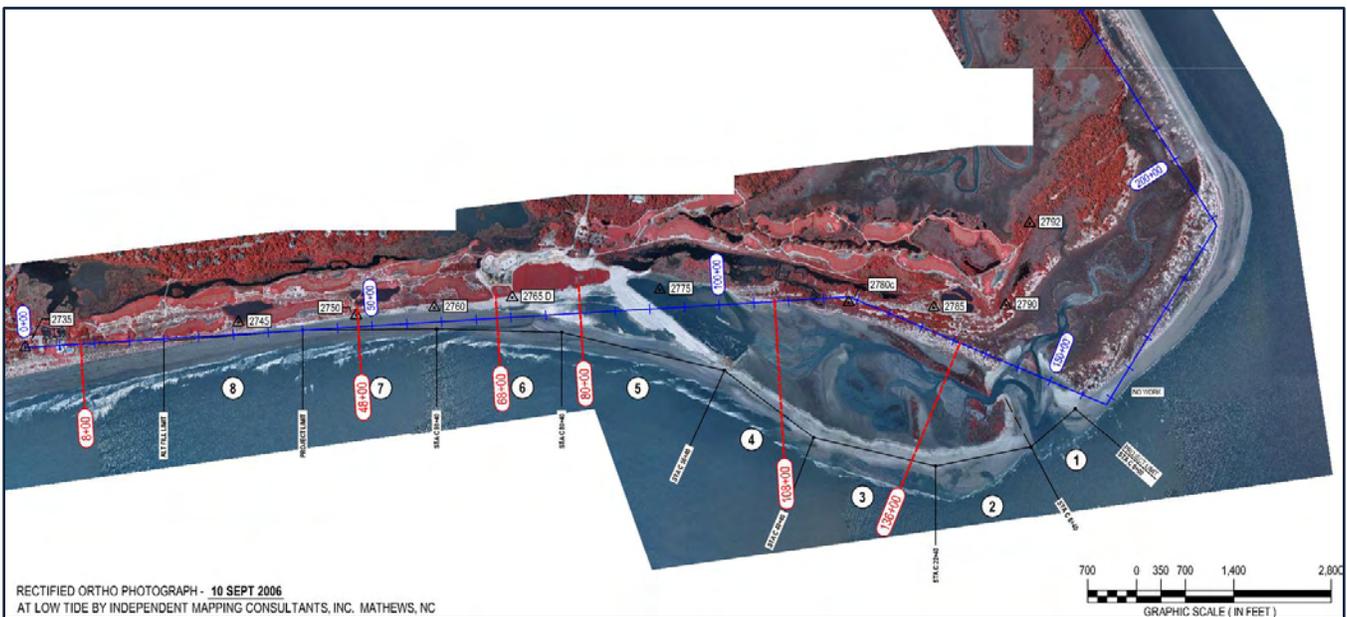
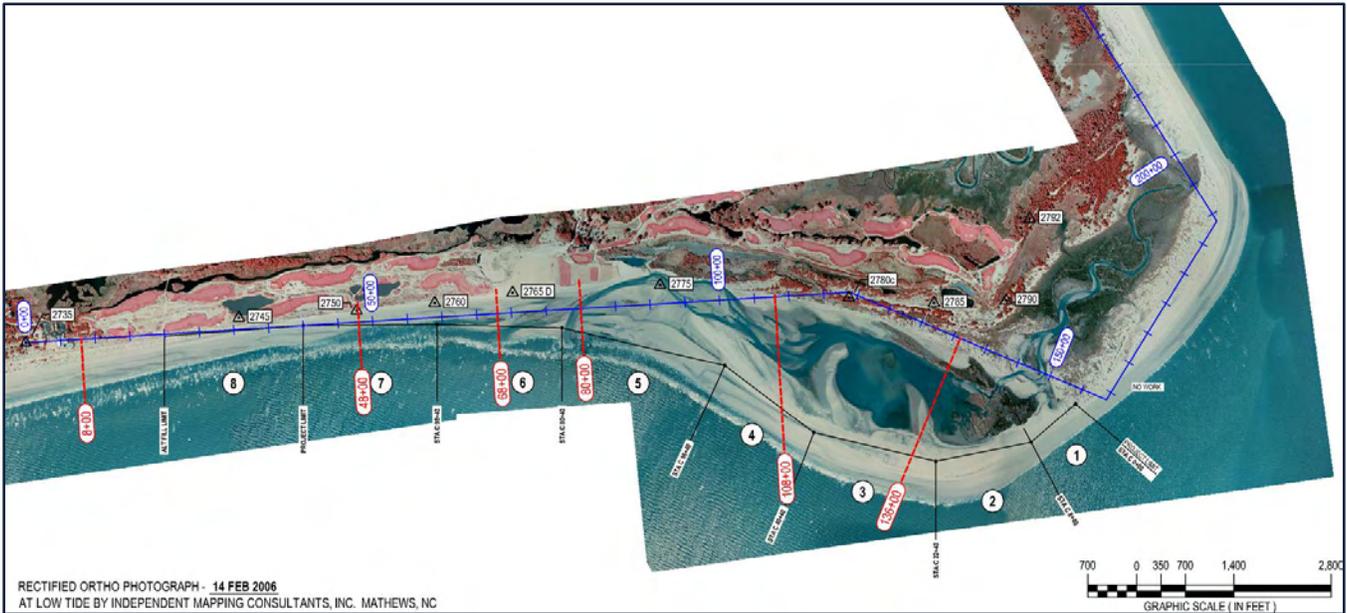
**FIGURE 2.7.** The eastern end of Kiawah Island in December 1998 (upper) and February 2005 (lower). Note the 1989 shoreline situated well inland from the outer beach. Shoals 1 and 2 added upward of 5 million cubic yards to Kiawah in the 1990s. As waves pushed the new sand shoreward, an incipient barrier island/lagoon/marsh formed. The new lagoon was flushed via a channel at the western end of the accreted beach. [From CSE 2007]

### 2.3 2006 East End Beach Restoration Project

In June and July of 2006, the east end beach restoration project (SCDHEC–OCRM permit No P/N 2005-1W-310-P, USACE permit No 2005-1W-310) was completed by L. Dean Weaver Company Inc. This project sought to artificially create Stage 3 of the shoal-bypassing cycle and avoid further erosion of the Ocean Course. The details of the project are given in the *2006 East End Erosion and Beach Restoration Project: Kiawah Island Final Report* (CSE 2007). The objectives of the project were to:

- Accelerate the shoal-bypassing cycle so as to restore westerly sand transport along Kiawah Island.
- Eliminate rapid erosion along the Ocean Course, particularly around the 16<sup>th</sup>, 17<sup>th</sup>, and 18<sup>th</sup> fairways and the driving range.
- Maintain viable, piping plover beach habitat along the newly accreted barrier spit east of the Ocean Course, including areas of frequent washovers and the adjacent incipient dune habitat.
- Preserve the environmental, cultural, and aquatic resources of the Town.
- Provide protection to oceanfront recreational facilities and community infrastructure as a resource of tax revenue and income.
- Maintain the economic viability of tourism, the Town's largest industry.
- Make a new source of sand from the accreting shoal more readily available for natural nourishment along downcoast areas.

The project consisted of closure of the existing flushing channel, creation of a new channel to maintain the tidal environment of the lagoon, and excavation and transfer of nourishment sand from the new inlet and accreted shoal areas to eroded downcoast areas. These actions were designed to provide a smoother transition between Kiawah's main beach and the accreted shoal. The contracted volume for the project was 550,000 cubic yards (cy), the majority of which was placed between the new clubhouse and just west of the old flushing channel. The new flushing channel was positioned at the apex of the attached shoal in Reach "1" (Fig 2.8).



**FIGURE 2.8.** Rectified aerial photos of the project area showing pre-construction (February 2006, upper) and post-construction (September 2006, lower). The channel in Reach 5 was closed, and a new channel was constructed in Reach 1. Sand from Reach 1 to Reach 4 was excavated and transferred to Reaches 5–7.

A major goal of the project was to maintain habitat for piping plovers, which migrate to the area in early fall and utilize the area for foraging through the spring. Piping plovers make use of washover areas with little vegetation, particularly where the habitat is adjacent to sheltered tidal flats (M Bimbi, pers comm, April 2006). To maximize habitat, elevations along the new outer beach were maintained below +4.5 ft NAVD. This elevation allows frequent overtopping by waves during minor storm events. As recommended by the US Fish & Wildlife Service (USFWS), yearly monitoring of critical habitat for piping plovers was incorporated into the project and is being supervised by staff biologists for the Town of Kiawah Island.

In 2007, the constructed flushing channel naturally closed while a new flushing channel opened in Reach 4 (Fig 2.9). Several factors potentially led to the closure of the original flushing channel. The emergence of an offshore shoal to the west of the channel caused wave-focusing and significant erosion to the shoreline in the vicinity of the constructed channel. Sand lost from the dunes adjacent to the channel was deposited in and behind the channel. By September 2007, the constructed channel had completely infilled, and a new flushing channel had opened in Reach 4 (see Fig 2.8 for construction reach boundaries). The low elevations of the outer beach in Reaches 2–4 (intended to maintain washover habitat) left that reach susceptible to a breach. The new channel location provided a more efficient path for tidal flow. The emergent shoal off Reach 2 also increased the likelihood of a breach in Reach 4 because of wave-focusing around the sand bar.

The opening of the breach channel in Reach 4 was not surprising given that the goal of the project was to maintain washover habitat. By limiting the outer beach to a height less than storm tides and reducing the volume of sand in the profile so as to prolong the washover habitat, the project allowed the system to develop a channel in a more efficient location. The inlet of the new channel intersected monitoring station 104+00. It was ~75 ft wide at mean low water (MLW) at its narrowest point, and ~600 ft wide at mean higher high water (MHHW); however, at high tide, much of the area was subject to washover, and flow was not restricted through the inlet.

Between August 2009 and April 2010, the flushing channel had relocated ~2,500 ft to the east. This was facilitated by erosion of the outer barrier due to the most recent shoal-bypass event. This erosion left relatively little sand volume on the outer beach, making it susceptible to breaching. Southerly migration of the old channel was also inhibited by large sand volumes in the closure dike area. Section 4 contains details of the evolution of the lagoon along with pre-project and post-project changes in sand volumes and habitat areas.



**FIGURE 2.9.**

**[UPPER]**

Aerial view of the outer beach in the project area between Reaches 1 and 4 on 17 February 2007. Note shoaled flushing channel at right side of image (Reach 1).

**[LOWER]**

The same area at low tide on 5 December 2007 after formation of a breach channel in Reach 4 and natural closure of the constructed channel.



### 3.0 METHODOLOGY

This section describes the methodologies of the topographic survey and habitat mapping used by CSE to monitor changes at Kiawah Island.

#### 3.1 Survey

The present survey was conducted by RTK-GPS\* (Trimble™ R8 GNSS system) in late October 2013. Profiles along Kiawah Island were surveyed perpendicular to the local shoreline (CSE baseline) azimuth from the control points to a minimum of -12 ft NAVD (the depth equal to the normal limit of sand movement in this setting) or at least 3,000 ft from the dune. Surveys were conducted by combining a land-based survey and a bathymetric survey (Fig 3.1). Land surveys were accomplished using an RTK-GPS between the foredune and low-tide wading depth [(~)-6 ft NAVD], whereas overwater work was accomplished via RTK-GPS combined with a precision echo-sounder mounted on CSE's shallow-draft boat, the *RV Southern Echo*.

[\*Real-time kinematic global positioning system]



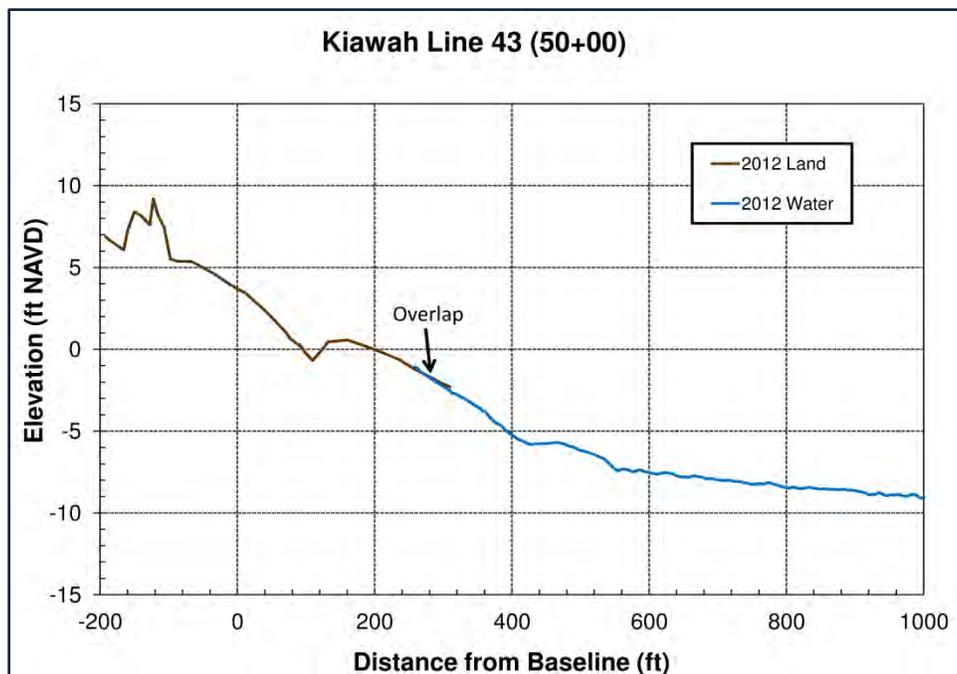
**FIGURE 3.1.**

CSE's monitoring methods include land-based data collection via RTK-GPS (upper left) and hydrographic data collection via RTK-GPS linked to a precision echo-sounder.

CSE's shallow-draft vessel the *RV Southern Echo* is shown in the lower image.

Working around the tidal cycle, data collected on land were extended into shallow depths in the surf zone at low tide. Then data were collected from the boat at high tide such that overlap of the two surveys occurred close to shore (Fig 3.2). Appendix A includes profiles for the most recent survey compared to earlier surveys. CSE has updated profile sheets to include profile volume and aerial images showing profile locations.

The 2013 survey represents the second survey of the Kiawah Island beach since satisfactory completion of project-required monitoring in 2011. At the request of the Town, CSE modified the scope of services for the 2012 and future monitoring to reduce overall costs while providing more detail of the beach condition west of the project area. Surveys conducted from 2007 to 2011 involved 23 stations west of the project area (using existing OCRM monuments spaced ~1,000 to 2,500 ft apart) and 64 stations in the project area spaced 400 ft apart. The present baseline reduces the maximum spacing in the downcoast profiles to ~1,000 ft. CSE also reduced the total number of lines in the project area from 64 to 24 by increasing the spacing from 400 ft to 1,000–1,200 ft. The baseline was also modified at the east end to reduce the number of turns in the baseline and to simplify volume calculations.



**FIGURE 3.2.** CSE combines land-based and hydrographic data collection to produce continuous profiles of the beach. Land-based work is accomplished at low tide, while hydrographic work is performed at high tide. This allows for overlap of the two data collection methods and ensures quality data and a complete profile.

The present baseline is comprised of 61 profiles with lines 1–37 representing the shoreline west of the 2006 project area and lines 38–61 representing the project area and east end of the island (Table 3.1). The baseline is shown in Figure 3.3. Line numbering increases from west to east—Line 1 is at Captain Sams Inlet ~1.2 miles southwest of the Beachwalker Park vehicle access. Line 61 is at the tip of the sand spit at the junction of the Stono River and Penny’s Creek. OCRM monument names and CSE project stationing are indicated where the new profile lines coincide with previous stations (ie — Line 35 is OCRM station 2725). The current reaches (Fig 3.3) are defined in Table 3.2.

Volume calculations for the lagoon were obtained via digital terrain models (DTMs) produced from CSE survey data. This eliminates the need for volume adjustments due to differing baseline and beach configurations, but does not provide the detailed comparative profiles between earlier surveys and the new data. Rather than comparing repetitive survey lines, the DTMs allow for generation of “sections,” which are interpolated depictions of the beach profiles. These can be produced for multiple surveys to determine beach condition changes.

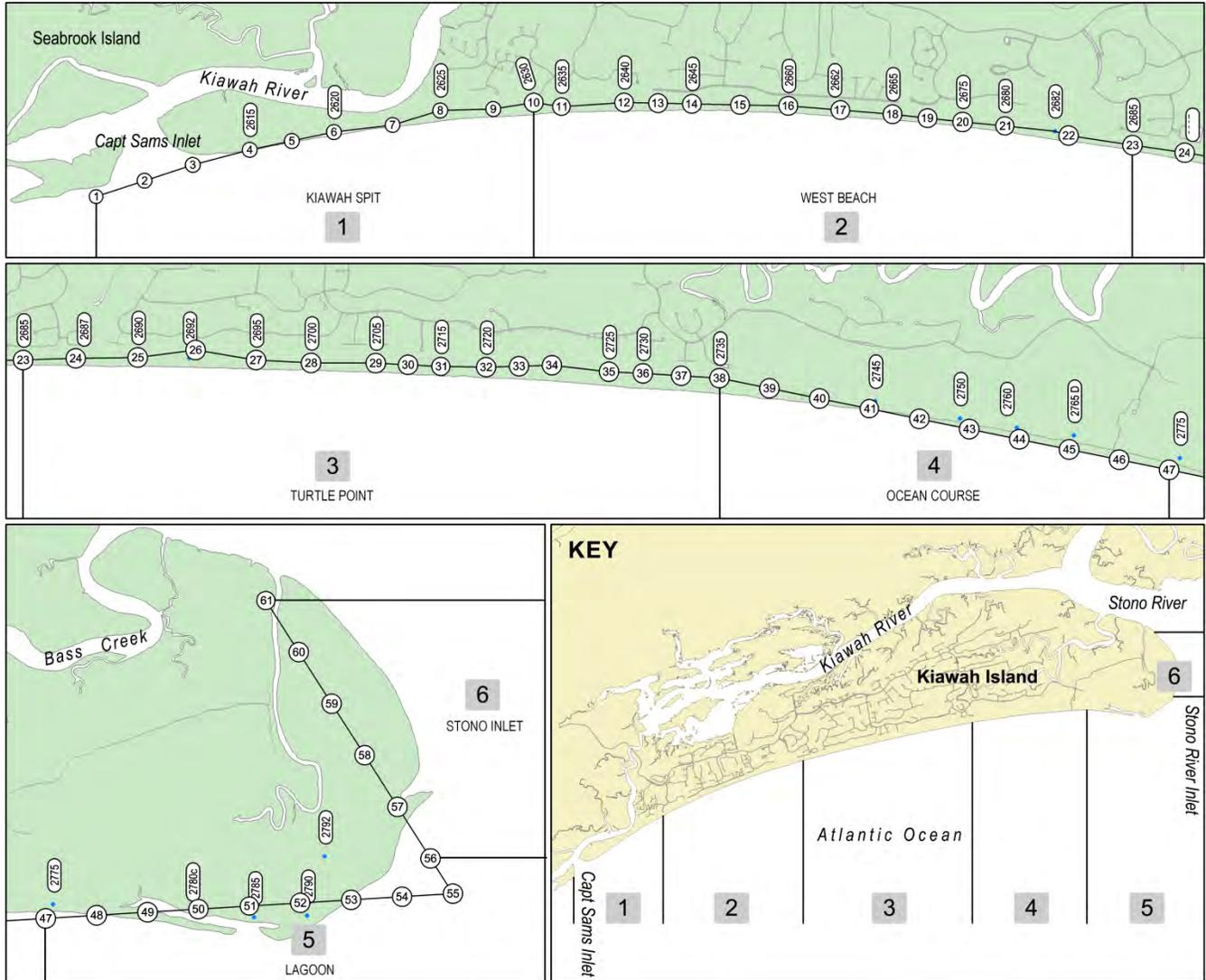
### **3.2 Volume Calculations**

To estimate changes in the sand volume along Kiawah Island, survey data were entered into CSE’s in-house custom software, Beach Profile Analysis System (BPAS), which calculates volumes based on 2-D profile data (in x–y format) and distances between subsequent lines. The resulting volumes provide a more quantitative and objective way of determining beach condition, including the ideal minimum beach profile and how sand quantities at a site (volume per unit length of shoreline) compare with the desired condition (Kana 1993). Volume results calculated via this method integrate all the small-scale perturbations across the beach and yield a simple measure of its condition which is less susceptible to seasonal fluctuations in the profile, a problem with shoreline change studies that are based on movement of a single contour.

Unit-volume calculations allow for distinguishing 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. Figure 3.4 depicts the profile volume concept. The reference boundaries are site-specific but ideally encompass the entire zone over which sand moves each year—dune to the depth of closure (DOC\*), which is the depth of water where little sand movement to or from the beach occurs. [*\*DOC is the depth beyond which there is negligible change in bottom elevation.*]

**TABLE 3.1.** Kiawah Island beach monitoring stations referenced in the present report. Order is generally west to east. Offset and cutoff refer to distances from the benchmark/baseline for the start and end of beach volume calculations.

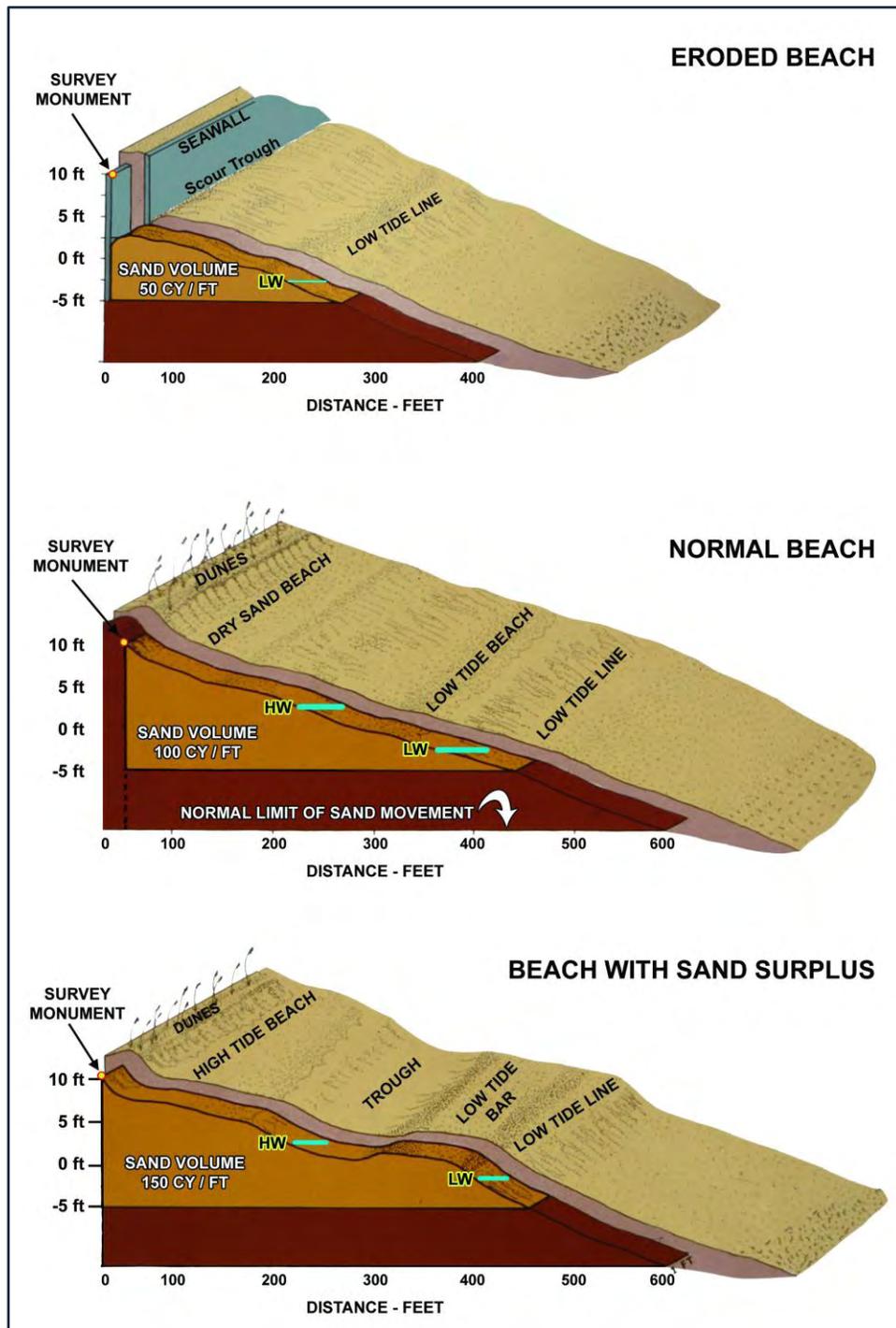
Line	Reach	Name	Offset	Cutoff	Distance to Next	Easting	Northing	Line	Reach	Name	Offset	Cutoff	Distance to Next	Easting	Northing		
1	1		-200	2,500	1,000	2262721.7	271034.2	32		OCRM 2720	208	1,500	645	2289526.0	282752.7		
2			300	2,500	997	2263451.4	271718.0	33			309	1,700	646	2290143.9	282937.6		
3			250	2,500	1,153	2264178.6	272399.3	34	3	OCRM 2722	436	1,600	1,125	2290763.1	283122.9		
4			140	1,500	844	2265064.0	273138.6	35			OCRM 2725	322	1,600	666	2291875.6	283288.9	
5			93	2,500	845	2265739.8	273644.8	36			OCRM 2730	316	1,600	666	2292526.8	283430.6	
6			OCRM 2620	86	1,500	1,157	2266414.9	274152.4	37			319	1,700	752	2293263.8	283580.0	
7			28	2,500	978	2267397.7	274763.4	38		0+00	320	1,600	1,000	2294001.1	283729.5		
8		OCRM 2625	189	1,500	1,040	2268125.0	275417.0	39		10+00	165	1,700	1,000	2294999.2	283790.2		
9			92	1,500	806	2269055.6	275882.0	40		20+00	30	1,500	1,000	2295997.4	283850.9		
10		OCRM 2630	152	1,500	547	2269723.8	276332.8	41	4	30+00	-55	1,500	1,000	2296995.5	283911.6		
11		OCRM 2635	41	1,500	1,232	2270247.2	276490.7	42			40+00	-120	1,500	1,000	2297993.6	283972.3	
12		OCRM 2640	94	1,500	665	2271326.8	277083.3	43			50+00	-219	1,500	1,000	2298991.7	284033.0	
13			67	1,400	665	2271935.3	277351.5	44			60+00	-295	1,500	1,000	2299989.8	284093.8	
14		OCRM 2645	47	1,200	945	2272543.9	277619.7	45			70+00	-370	1,500	1,000	2300988.0	284154.5	
15			27	1,400	946	2273408.4	278001.2	46			80+00	-300	1,500	1,000	2301986.1	284215.2	
16	2	OCRM 2660	28	1,100	1,025	2274273.9	278383.2	47		90+00	-374	1,800	1,000	2302984.2	284275.9		
17			15	1,400	1,026	2275234.5	278740.9	48		100+00	-250	2,000	1,000	2303982.3	284336.6		
18			OCRM 2665	22	1,000	891	2276196.1	279099.0	49		110+00	0	2,500	1,000	2304980.4	284397.3	
19			12	1,400	892	2276850.6	279320.6	50	5	120+00	350	3,200	1,000	2305978.6	284458.0		
20		OCRM 2675	0	1,100	831	2277505.6	279542.3	51			130+00	780	3,500	1,000	2306976.7	284518.8	
21		OCRM 2680	46	1,300	1,266	2278288.1	279822.4	52			140+00	615	3,500	1,000	2307974.8	284579.5	
22			16	1,400	1,627	2279502.6	280179.9	53			150+00	0	2,800	1,000	2308972.9	284640.2	
23		OCRM 2685	10	1,200	1,033	2280718.1	280537.6	54			160+00	0	1,500	1,000	2309971.0	284700.9	
24		OCRM 2687	40	1,500	1,215	2281707.1	280837.2	55			170+00	-775	1,000	0	2310969.2	284761.6	
25		OCRM 2690	93	1,300	1,145	2282876.3	281167.0	56	6	Inlet 0+00	540	1,300	1,200	2310528.3	285452.3		
26		OCRM 2692	279	1,500	1,205	2283935.3	281602.5	57			Inlet 12+00	805	1,420	1,200	2309882.6	286463.7	
27	3	OCRM 2695	119	1,400	1,080	2285131.1	281719.2	58			Inlet 24+00	920	1,420	1,200	2309237.0	287475.2	
28			OCRM 2700	100	1,400	1,269	2286187.8	281943.8		59		Inlet 36+00	920	1,420	1,200	2308591.3	288486.6
29			OCRM 2705	130	1,500	635	2287413.8	282268.9		60		Inlet 48+00	912	1,720	1,200	2307945.7	289498.1
30				143	1,500	643	2288034.7	282401.8		61		Inlet 60+00	640	1,520	1,200	2307300.1	290509.5
31		OCRM 2715	145	1,500	889	2288663.4	282536.4										



**FIGURE 3.3.** General location of beach stations and reaches monitored for the present report. Line numbers are shown in circles.

**TABLE 3.2.** Kiawah Island reaches referenced in the present report. Figure 3.3 shows reach boundaries.

Reach	Approximate Geographic Boundaries	Line Numbers	Reach Length (ft)
Kiawah Spit	West end of Kiawah Island to Beachwalker Park	1–10	8,820
West Beach	Beachwalker Park to Turtle Point	10–23	11,798
Turtle Point	Turtle Point Area	23–38	13,614
Ocean Course	Ocean Course Area	38–47	9,000
Lagoon	Lagoon Area	47–55	8,000
Stono Inlet	Stono Inlet Shoreline	56–61	6,000

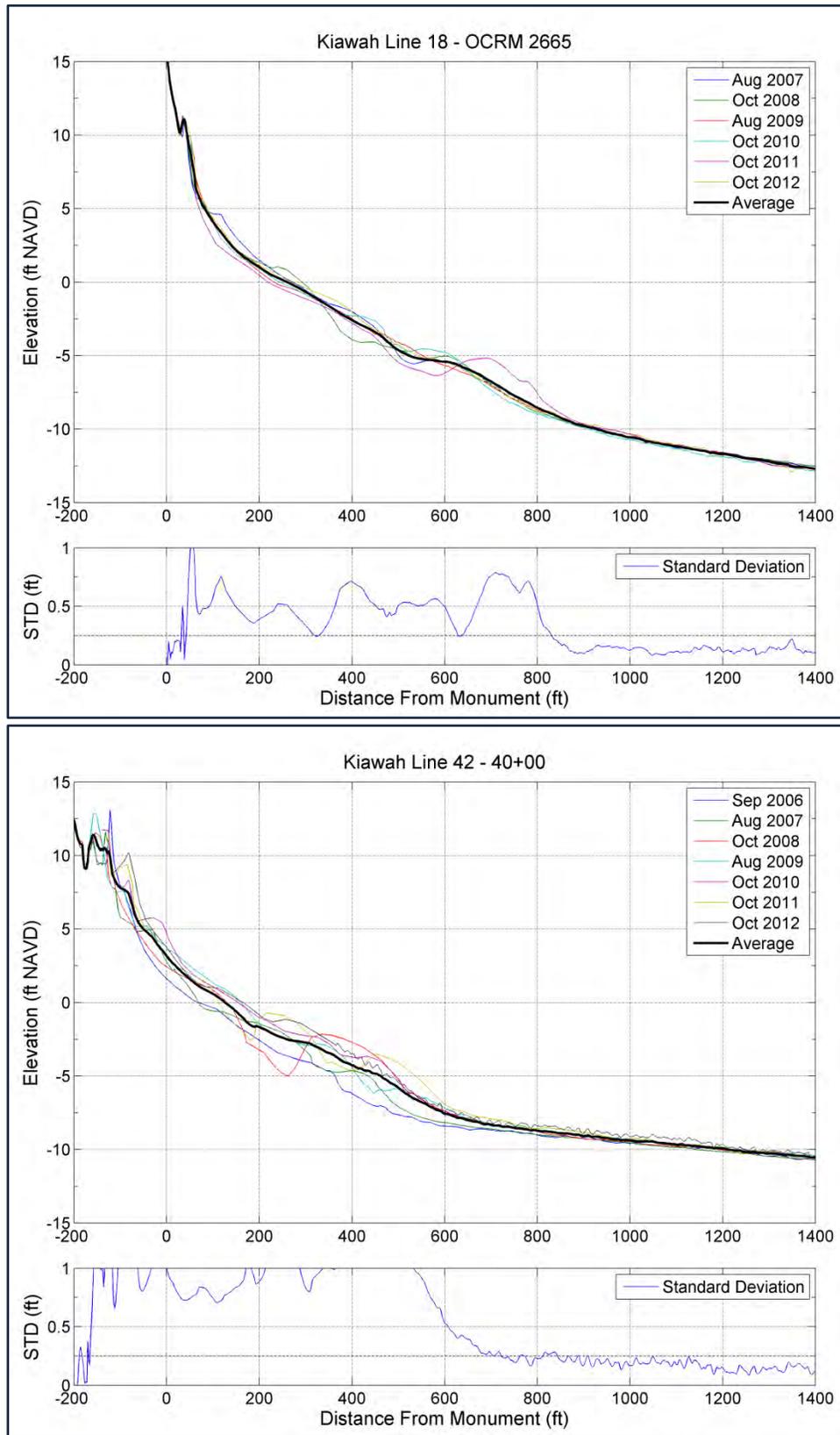


**FIGURE 3.4.** The concept of profile volumes – the volume of sand between defined contours over a 1-ft (unit) length of beach. [After Kana 1990]

For the present survey (2013), sand volume was calculated between the primary dune and -10 ft NAVD. The -6 ft NAVD contour has been used in past reports for consistency with earlier studies and limitations of pre-2007 data. While most sand movement occurs above -6 ft NAVD, some profile changes do occur between -6 ft and -10 ft NAVD. Significant changes can occur within this lens when underwater bars form or change and as shoals move onshore and alter morphology. Especially at the northeastern end, volume calculations were cut off at a set distance (profile specific) due to data coverage or morphological considerations (ie – the profile flattens over the ebb-tidal delta before reaching -10 ft NAVD). Profiles and calculation limits are shown in Appendix A.

Figure 3.5 shows representative profiles from two reaches over an approximate five-year period. The lower portion of each graph tracks the standard deviation in elevation based on the mean profile elevation of the set of profiles at a station. A standard deviation of <0.25 ft over several hundred feet at the outer end of a profile is evidence of little change in bottom elevation over the period encompassed by the data. This analysis confirms that nearly all measurable volume change along Kiawah’s beach occurs above -10 ft NAVD and that a realistic value for DOC at decadal scales is <10 ft.

Comparative volumes and volume changes were computed using standard procedures. [CSE incorporates the 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.] Volume results at each profile line were extrapolated to the next line. Net volumes were calculated for each profile as well as for project reaches (see Tables 3.1 and 3.2).



**FIGURE 3.5.** The lower portion of each graph tracks the standard deviation (variation from the average elevation) at any given point along a set of profiles. A standard deviation of <0.25 ft over several hundred feet is evidence of little change (ie – approximate depth of closure).

## 4.0 RESULTS

Results from the 2013 monitoring survey are given in the following sections. The first section generally describes changes in the project area. Section 4.2 presents the volume change calculations within the project area. Section 4.3 provides detailed sand volumes for the length of Kiawah west of the 2006 project site. The 2013 data are compared with 1999 volumes to quantify changes over the last 14 years.

### 4.1 Project Area Observations

CSE has monitored the 2006 project yearly for the Town of Kiawah Island. CSE expected the project area (west lagoon) to evolve into a similar system as the eastern lagoon with dense marsh and incised tidal channels (CSE 2005). This process is facilitated by sand overtopping the outer beach during high tides and storm events. Erosion and washovers shift the beach landward and deposit sand in the lagoon, building up intertidal areas and creating suitable elevations for marsh propagation.

Two significant, but related, events have occurred in the project area since construction. The first was formation and emergence of an inlet shoal near the southern apex of the bulge created by the previous bypassing events (Fig 4.1). This shoal followed the typical shoal-bypass progression, reaching Stage 3 in 2010. While in Stage 2, the breakwater effect of the shoal contributed to severe erosion of portions of the outer beach adjacent to the shoal while accretion occurred in its lee. The attachment site has eroded over the past year, contributing to gains in adjacent areas consistent with Stage 3 of the bypassing cycle (cf — Fig 2.6). A new shoal is currently migrating toward the beach (Fig 4.2) and is beginning impact the shoreline as it enters Stage 2 of the shoal-bypass cycle.

Rapid and large-scale volume changes led to closure of the original (constructed) flushing channel and the opening of a new channel in the summer of 2007 (cf — Fig 2.6). The new flushing channel was located near the center of the west lagoon and migrated west between 2007 and 2009. It began to encroach on the constructed dike as it continued to migrate west. During this time (2007–2009), the outer barrier eroded via overtopping and sand spreading to the lee of the shoal, leaving it low, narrow, and susceptible to another breach. A new breach occurred between August 2009 and April 2010, and the old channel closed naturally. The new inlet was again located near the central portion of the west lagoon near the attachment site of the western edge of the incipient shoal. The seaward end of the channel meandered between 2010 and 2012; however, the channel throat remained in the same general location. The channel migrated further west from 2012 to 2013, encroaching on the 2006 closure dike and emptying in front of the Ocean Course clubhouse.



**FIGURE 4.1.** Oblique aerial photos of the west lagoon at the northeastern end of Kiawah Island. In December 2006 (upper left), an incipient shoal was present offshore of the eastern end of the lagoon. By May 2008 (upper right), the shoal was nearing attachment. A shoreline salient had formed on the outer barrier, as sand eroded from adjacent areas was deposited behind the shoal. The flushing channel had also relocated to the west and migrated westerly into the closure dike. The shoal had attached by April 2010 (middle), creating a small lagoon (black arrow) seaward of the original outer barrier. The flushing channel again relocated from the closure dike area (red arrow) to the central portion of the lagoon. Erosion of the shoal attachment site and downcoast spreading of sand rounded off the point of land from 2010 to November 2013 (bottom). Note formation and expansion of salt marsh in the west lagoon over the seven-year period represented by the photos.



**FIGURE 4.2.** Seaward aerial view of the Stono Inlet delta in November 2013. While the main channel exits the inlet parallel to the interior inlet, a significant secondary channel is present. The attaching shoal is visible in the foreground. Measurement of the inlet shoals is outside the scope of CSE’s present monitoring agreement with the Town.

Notable changes in the 2006 project area between 2012 and 2013 included:

- Continued erosion of the “2007” shoal attachment site (seaward bulge of the shoreline near lines 50 and 51).
- Westward and landward migration of the lagoon flushing channel leading to erosion of the 2006 closure dike.
- Approximately 700 ft of landward migration of the offshore shoal (at line 50). The shoal was ~800 ft from the beach in October 2013.
- Buildup of intertidal area from line 45 to line 48.
- Variable erosion and accretion along the eastern lagoon area and the Stono Inlet shoreline.

## 4.2 Project Area Sand Volumes

Shoal-bypassing events are dynamic; therefore, typical volume analysis in the vicinity of bypassing events can often be misleading. Large volumes of sand can move quickly from one location to another in both the exposed and sheltered areas of the attachment site. Comparing sand volumes for individual profile lines from one year to the next may not fully represent the processes controlling morphologic change in the system.

For this report, volume changes are reported for all profiles surveyed in the project area as well as for the entire beach to Kiawah spit. [The reaches used in this report are illustrated in Figure 3.3.] In the project area, reach-wide volume changes yield a better representation of actual changes in the system. In most cases, local changes observed in individual profiles are due to evolution of the lagoon and recent shoal-bypass events, and general trends are not easily interpreted. Volume changes are reported in Tables 4.1 and 4.2. Figure 4.3 shows reach unit volumes in the downcoast area since 1999 and in the project area since 2006. Profiles are given in Appendix A.

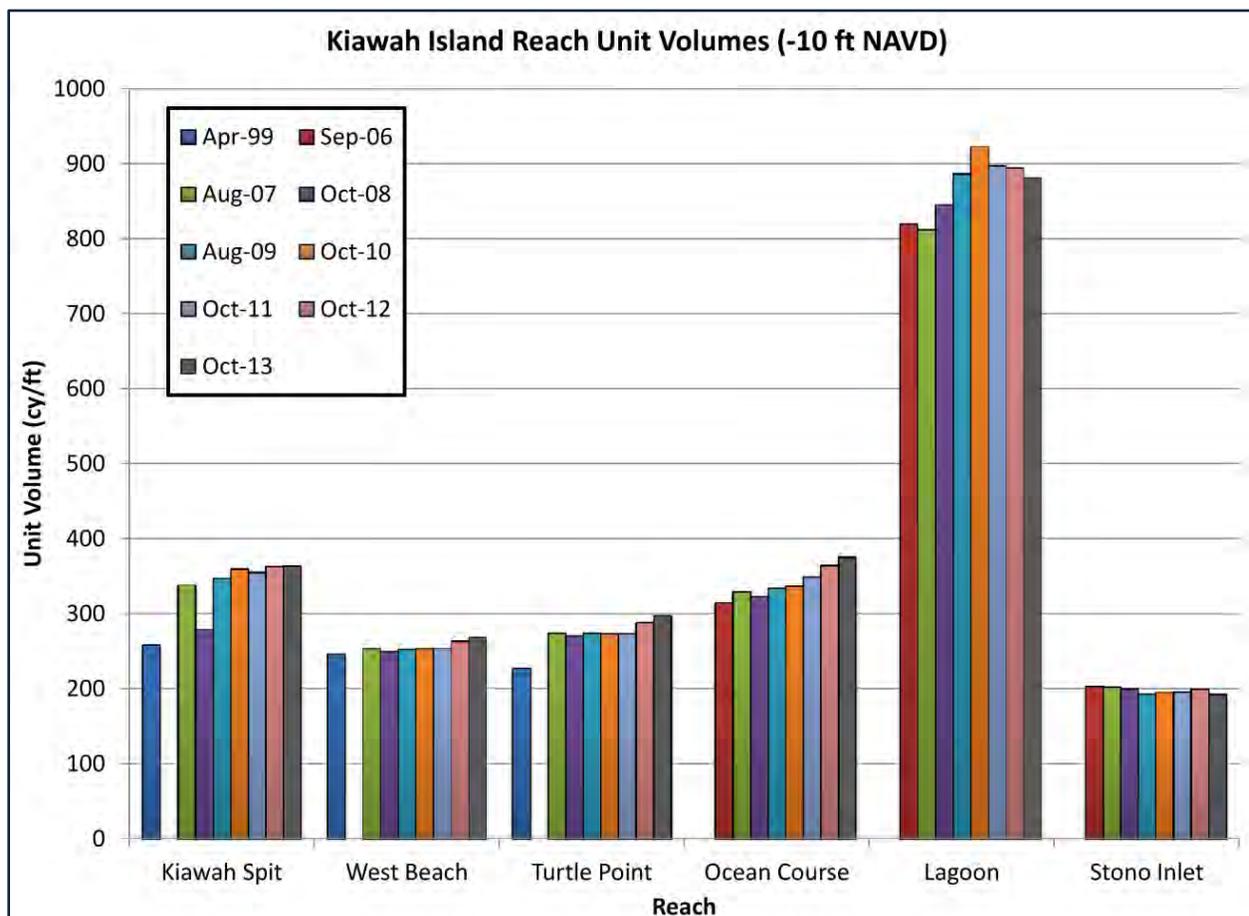


FIGURE 4.3. Reach unit volumes at Kiawah Island since 1999 measured to -10 ft NAVD.

**TABLE 4.1.** Unit volumes and unit volume changes (cy/ft) for Kiawah Island monitoring stations from April 1999 to October 2013.

Kiawah Island 2013 Monitoring Survey			Unit Volume (cy/ft)									Unit Volume Change Since Previous (cy/ft)						
Reach	Line	Distance to Next (ft)	Apr-99	Sep-06	Aug-07	Oct-08	Aug-09	Oct-10	Oct-11	Oct-12	Oct-13	Aug-07	Oct-08	Aug-09	Oct-10	Oct-11	Oct-12	Oct-13
1 - Kiawah Spit	1	1,000								601.9	577.7	-	-	-	-	-	-	-24.2
	2	997								319.8	320.2	-	-	-	-	-	-	0.4
	3	1,153								339.7	346.1	-	-	-	-	-	-	6.4
	4	844	300.2		392.4	0.0	391.9	406.7	392.1	388.2	384.7	92.2	-	-0.5	14.8	-14.6	-3.9	-3.5
	5	845								384.3	384.5	-	-	-	-	-	-	0.2
	6	1,157	252.5		361.9	361.1	375.2	384.1	380.9	381.9	381.4	109.3	-0.8	14.2	8.9	-3.2	1.0	-0.5
	7	978								364.0	362.0	-	-	-	-	-	-	-2.0
	8	1,040	240.6		309.0	309.9	321.6	334.7	331.0	347.6	353.8	68.4	0.9	11.7	13.1	-3.7	16.7	6.2
	9	806								340.9	341.1	-	-	-	-	-	-	0.2
	10	547	268.3		300.9	299.1	303.6	318.5	317.1	335.8	339.8	32.6	-1.7	4.5	14.9	-1.3	18.7	3.9
2 - West Beach	11	1,232	255.0		289.3	290.4	300.2	307.1	312.3	323.8	327.7	34.4	1.0	9.9	6.9	5.1	11.5	3.9
	12	665	232.9		261.1	257.9	273.1	273.1	275.4	284.8	293.0	28.2	-3.2	15.1	0.1	2.2	9.4	8.2
	13	665								277.8	281.6	-	-	-	-	-	-	3.8
	14	945	251.9		252.3	248.5	257.7	258.2	259.3	270.7	278.3	0.4	-3.8	9.2	0.5	1.1	11.5	7.5
	15	946								267.5	273.3	-	-	-	-	-	-	5.9
	16	1,025	235.6		254.5	252.8	258.3	260.3	253.0	265.4	269.6	19.0	-1.8	5.5	2.0	-7.3	12.4	4.2
	17	1,026								251.6	256.6	-	-	-	-	-	-	5.0
	18	691	228.6		236.9	229.7	231.1	232.6	229.9	237.9	247.9	8.3	-7.3	1.5	1.5	-2.6	8.0	10.0
	19	692								242.8	245.5	-	-	-	-	-	-	2.7
	20	831	273.3		243.8	239.0	239.3	237.4	239.2	247.5	252.7	-29.5	-4.8	0.3	-1.9	1.8	8.3	5.2
	21	1,266					222.0	220.0	226.8	234.1	238.9	-	-	-	-2.0	6.9	7.2	4.8
	22	1,627								246.0	246.4	-	-	-	-	-	-	0.4
3 - Turtle Point	23	1,033	234.3		253.9	249.0	252.2	253.0	257.3	261.3	271.2	19.6	-4.8	3.2	0.7	4.4	4.0	10.0
	24	1,215					257.1	255.3	259.0	265.4	274.7	-	-	-	-1.8	3.7	6.4	9.3
	25	1,145	219.7		250.7	244.3	248.7	245.3	248.4	262.3	270.9	30.9	-6.4	4.4	-3.4	3.1	13.9	8.6
	26	1,205					259.9	251.7	258.3	265.2	278.2	-	-	-	-8.2	6.6	6.9	13.0
	27	1,080	266.2		262.7	274.3	279.7	270.2	277.2	287.6	304.5	-3.5	11.6	5.4	-9.5	7.0	10.5	16.9
	28	1,269	299.2		278.2	291.8	295.2	292.3	300.8	307.4	324.3	-21.0	13.6	3.4	-3.0	8.5	6.7	16.9
	29	635	268.3		321.9	313.4	325.8	323.1	322.1	344.5	360.4	53.6	-8.5	12.3	-2.7	-1.0	22.4	15.9
	30	643								345.7	354.7	-	-	-	-	-	-	9.0
	31	889	265.3		322.6	325.1	326.4	331.6	326.8	347.1	353.9	57.3	2.5	1.3	5.2	-4.8	20.3	6.8
	32	645	286.4		306.2	302.0	306.9	309.3	305.3	323.3	330.2	19.8	-4.1	4.9	2.3	-4.0	18.0	6.9
	33	646								282.4	299.6	-	-	-	-	-	-	17.2
	34	1,125					224.2	229.8	225.6	241.8	249.5	-	-	-	5.6	-4.1	16.2	7.6
	35	666	217.0		252.1	250.3	253.3	254.5	245.4	269.3	267.0	35.1	-1.8	3.0	1.2	-9.0	23.9	-2.3
	36	666	252.2		257.4	204.2	259.9	263.7	257.8	275.8	275.7	5.2	-53.2	55.7	3.7	-5.8	18.0	-0.1
37	752								271.7	274.2	-	-	-	-	-	-	2.6	
4 - Ocean Course	38	1,000		241.6	247.0	247.8	251.4	256.6	251.2	266.7	266.2	5.5	0.8	3.6	5.2	-5.4	15.6	-0.5
	39	1,000								277.5	276.9	-	-	-	-	-	-	-0.7
	40	1,000		251.1	251.6	257.3	276.6	279.3	276.4	288.9	291.4	0.4	5.7	19.3	2.7	-2.9	12.5	2.4
	41	1,000								285.1	274.2	-	-	-	-	-	-	-10.9
	42	1,000		216.1	232.2	248.2	259.7	271.1	272.1	281.1	282.4	16.0	16.0	11.5	11.4	1.0	9.0	1.2
	43	1,000								325.7	310.4	-	-	-	-	-	-	-15.3
	44	1,000		294.9	355.1	346.9	351.5	362.9	356.3	371.2	364.1	60.3	-8.2	4.5	11.4	-6.6	15.0	-7.2
	45	1,000								454.2	527.4	-	-	-	-	-	-	73.2
5 - Lagoon	46	1,000		505.6	500.1	453.5	465.3	441.4	486.7	537.7	572.5	-5.5	-46.7	11.8	-23.9	45.3	51.0	34.7
	47	1,000								647.9	696.4	-	-	-	-	-	-	48.5
	48	1,000		617.4	578.8	541.8	561.5	562.6	689.5	758.3	839.2	-38.6	-37.1	19.7	1.1	126.9	68.8	80.9
	49	1,000								980.9	978.9	-	-	-	-	-	-	-2.0
	50	1,000								1012.4	1005.7	-	-	-	-	-	-	-6.7
	51	1,000								929.1	838.9	-	-	-	-	-	-	-90.2
	52	1,000								967.5	881.7	-	-	-	-	-	-	-85.8
	53	1,000								984.6	934.2	-	-	-	-	-	-	-50.4
	54	1,000								604.7	593.3	-	-	-	-	-	-	-11.4
6 - Storm Inlet	55	0								588.4	621.0	-	-	-	-	-	-	32.6
	56	1,200		322.0	312.4	269.6	219.4	187.0	220.3	237.2	229.9	-9.6	-42.8	-50.2	-32.4	33.2	16.9	-7.3
	57	1,200		169.0	168.2	186.0	184.6	176.3	154.5	163.2	165.7	-0.8	17.7	-1.3	-8.3	-21.8	8.7	2.5
	58	1,200		146.2	143.4	140.7	137.1	156.6	163.7	169.4	158.5	-2.8	-2.7	-3.5	19.5	7.1	5.7	-10.9
	59	1,200		167.6	166.9	165.4	168.1	180.7	178.6	173.7	162.1	-0.8	-1.4	2.6	12.7	-2.1	-4.9	-11.6
	60	1,200		150.0	156.8	154.8	157.1	173.5	173.1	161.2	147.4	6.8	-2.0	2.3	16.4	-0.4	-11.9	-13.8
	61	1,200		108.9	111.3	123.7	137.5	146.2	144.4	146.2	159.6	2.4	12.4	13.7	8.7	-1.8	1.9	13.4

**TABLE 4.2.** Beach volume and volume changes for monitoring reaches from April 1999 to October 2013. Depth limit of calculations is -10 ft NAVD. These data show Kiawah Island has gained over 1.5 million cubic yards since 2007.

			Reach Total Volume (cy)								
Reach	Name	Length	Apr-99	Sep-06	Aug-07	Oct-08	Aug-09	Oct-10	Oct-11	Oct-12	Oct-13
1	Kiawah Spit	8,820	2,328,514		3,097,296	3,094,685	3,181,691	3,276,726	3,221,628	3,269,265	3,266,644
2	West Beach	11,798	2,903,774		2,994,556	2,949,260	2,978,605	2,991,545	3,000,541	3,108,310	3,170,302
3	Turtle Point	13,614	3,097,370		3,736,350	3,679,389	3,734,117	3,724,681	3,726,666	3,921,035	4,049,840
4	Ocean Course	9,000		2,832,947	2,964,385	2,903,690	3,005,533	3,026,626	3,135,711	3,278,923	3,380,461
5	Lagoon	8,000		6,559,380	6,499,468	6,763,197	7,090,470	7,385,476	7,175,787	7,156,897	7,056,459
6	Stono Inlet	6,000		1,219,056	1,213,419	1,198,757	1,155,841	1,173,275	1,176,151	1,195,114	1,156,125
1-6	All	57,232			20,505,475	20,588,979	21,146,257	21,578,329	21,436,484	21,929,544	22,079,831

			Reach Unit Volume (cy/ft)								
Reach	Name	Length	Apr-99	Sep-06	Aug-07	Oct-08	Aug-09	Oct-10	Oct-11	Oct-12	Oct-13
1	Kiawah Spit	8,820	264.0		351.2	350.9	360.7	371.5	365.3	370.7	370.4
2	West Beach	11,798	246.1		253.8	250.0	252.5	253.6	254.3	263.5	268.7
3	Turtle Point	13,614	227.5		274.4	270.3	274.3	273.6	273.7	288.0	297.5
4	Ocean Course	9,000		314.8	329.4	322.6	333.9	336.3	348.4	364.3	375.6
5	Lagoon	8,000		819.9	812.4	845.4	886.3	923.2	897.0	894.6	882.1
6	Stono Inlet	6,000		203.2	202.2	199.8	192.6	195.5	196.0	199.2	192.7
1-6	All	57,232			358.3	359.7	369.5	377.0	374.6	383.2	385.8

			Reach Volume Change Since Previous (cy)								
Reach	Name	Length			Aug-07	Oct-08	Aug-09	Oct-10	Oct-11	Oct-12	Oct-13
1	Kiawah Spit	8,820				-2,611	87,006	95,035	-55,098	47,637	-2,622
2	West Beach	11,798				-45,296	29,345	12,940	8,996	107,769	61,992
3	Turtle Point	13,614				-56,961	54,728	-9,437	1,986	194,369	128,805
4	Ocean Course	9,000			131,439	-60,695	101,843	21,093	109,085	143,212	101,538
5	Lagoon	8,000			-59,912	263,729	327,273	295,006	-209,689	-18,890	-100,438
6	Stono Inlet	6,000			-5,637	-14,662	-42,916	17,434	2,875	18,963	-38,989
1-6	All	57,232				83,504	557,279	432,072	-141,844	493,060	150,287

			Reach Unit Volume Change Since Previous (cy/ft)								
Reach	Name	Length			Aug-07	Oct-08	Aug-09	Oct-10	Oct-11	Oct-12	Oct-13
1	Kiawah Spit	8,820				-0.3	9.9	10.8	-6.2	5.4	-0.3
2	West Beach	11,798				-3.8	2.5	1.1	0.8	9.1	5.3
3	Turtle Point	13,614				-4.2	4.0	-0.7	0.1	14.3	9.5
4	Ocean Course	9,000			14.6	-6.7	11.3	2.3	12.1	15.9	11.3
5	Lagoon	8,000			-7.5	33.0	40.9	36.9	-26.2	-2.4	-12.6
6	Stono Inlet	6,000			-0.9	-2.4	-7.2	2.9	0.5	3.2	-6.5
1-6	All	57,232				1.5	9.7	7.5	-2.5	8.6	2.6

Volumes for the present report were calculated to -10 ft NAVD'88. Cross-shore calculation limits (offset and cutoff distances) were also adjusted as necessary to match available data. Total and unit volumes were recalculated using these new limits for all available surveys (see Table 3.1 for station-by-station limits). CSE computed volumes for the Lagoon Reach via Digital Elevation Models (DEMs). This was necessary due to the large fluctuations of the shoreline in response to the 2007 shoal-bypass event and data availability.

Data in the lagoon area is limited because it is becoming difficult to conduct land-based surveys through the expanding marsh in the west lagoon. Elevation models were produced for all surveys since September 2006. LIDAR data from 2012 provided by NOAA were used to fill in gaps in the landward portion of the lagoon. The area covered by the LIDAR data has remained fairly stable since 2010. An area encompassing the outer beach ridge (berm) and subtidal zone was selected to compute volumes to -10 ft NAVD for each survey date (Fig 4.4). This allows for a simple and consistent approach to measuring beach volume. The remaining reaches were characterized by more typical shoreline changes, and volumes were computed via traditional average-end-area methods.

### ***Stono Inlet Reach***

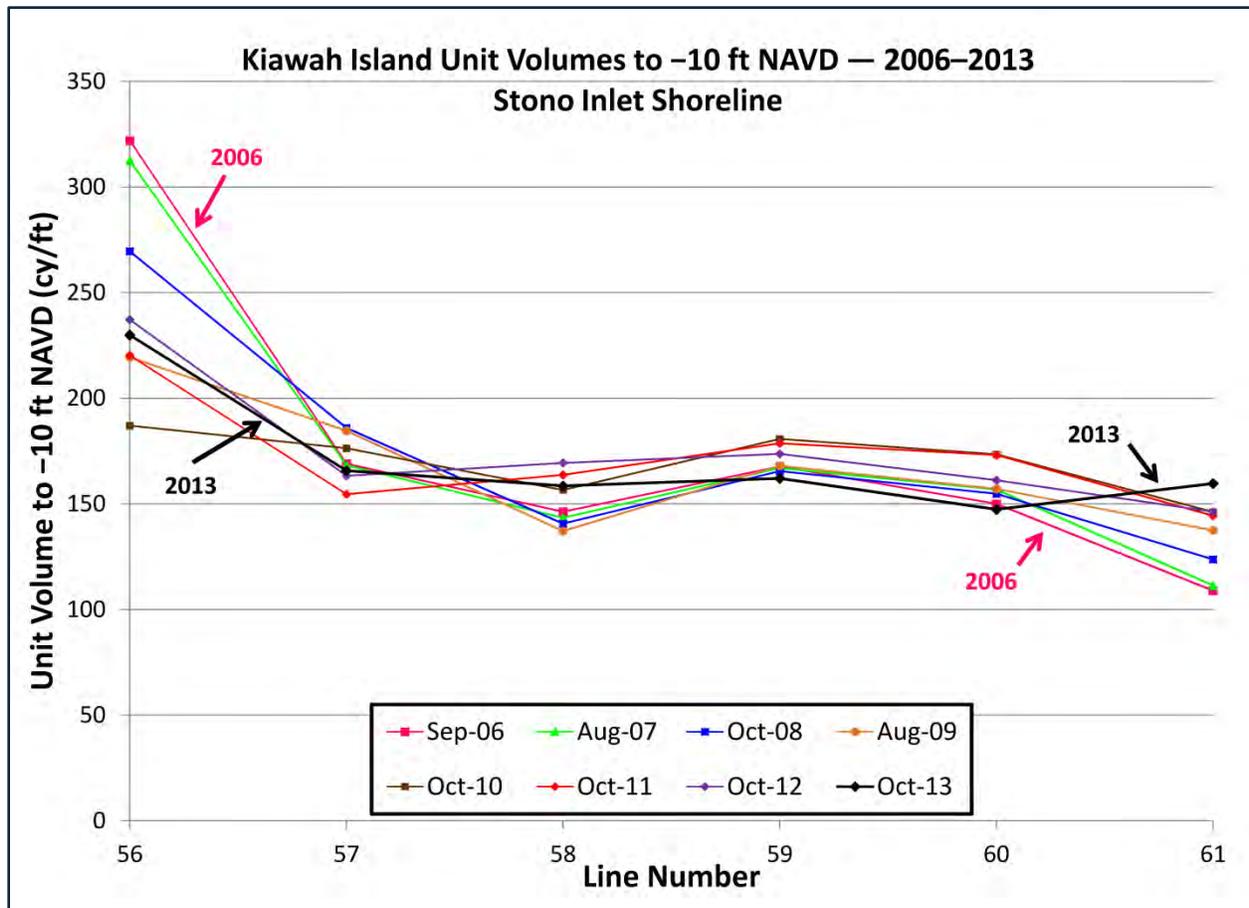
The Stono Inlet Reach spans ~6,000 ft from Line 56 (at the easternmost point of the island) to Line 61 near Penny's Creek. Beach profiles in this reach are steeper than the front-beach reaches due to the presence of Stono Inlet and reduced wave energy along the inlet. Unit volumes for the Stono Inlet Reach are shown in Figure 4.5.

The reach has been relatively stable since monitoring began in 2006 with individual profiles within the reach showing variable periods of erosion and accretion. Overall, the reach lost ~39,000 cy (6.5 cy/ft) over the past year. This is the second highest annual erosion rate observed since 2006. The Stono Inlet shoreline is the only reach which shows a net loss of sand since 2007 with an average loss of 1.5 cy/ft per year (total of 9,300 cy/yr). The ends of the reach have been the most dynamic with Line 56 at the seaward boundary of the reach losing 82.5 cy/ft since 2007 and Line 61 (inland boundary of the reach) gaining 48.3 cy/ft since 2007. The remaining four lines show unit volume changes ranging from -9.4 cy/ft to +15.1 cy/ft since 2007. Over the past year, Lines 57 and 61 gained sand, while the remaining lines lost an average of 10.9 cy/ft.



**FIGURE 4.4.** Boundary for the Lagoon Reach used to compute beach volumes for the present report. Elevation models were produced for surveys between 2006 and 2013, and total beach volume within the boundary was calculated to -10 ft NAVD. Coordinates below are in SC State Plane 3900 (ft).

Kiawah Island — Lagoon Volume Boundary		
Vertex Number	X	Y
1	2302949.72	284877.32
2	2304169.62	284601.84
3	2304963.51	284436.43
4	2307218.36	283850.98
5	2308259.76	283884.69
6	2309971.04	284700.91
7	2310912.68	285639.28
8	2310652.94	281648.20
9	2307785.75	280369.45
10	2303489.97	281338.50
11	2302949.72	284877.32

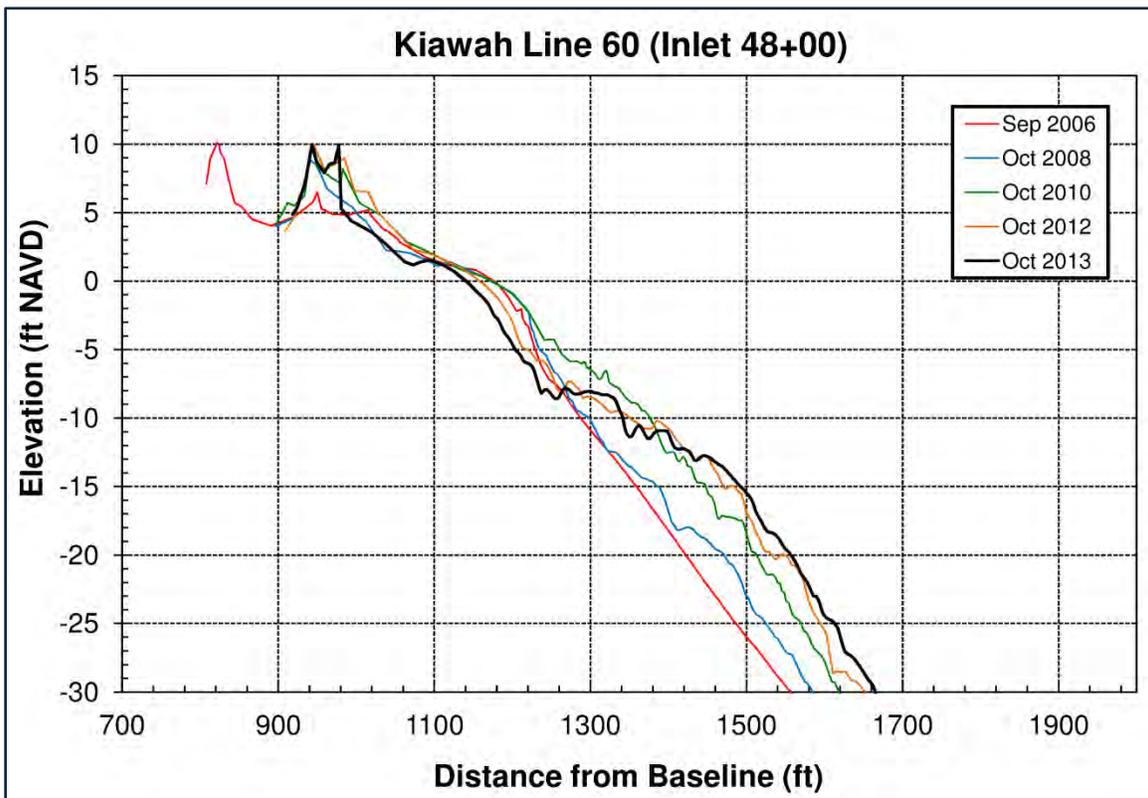
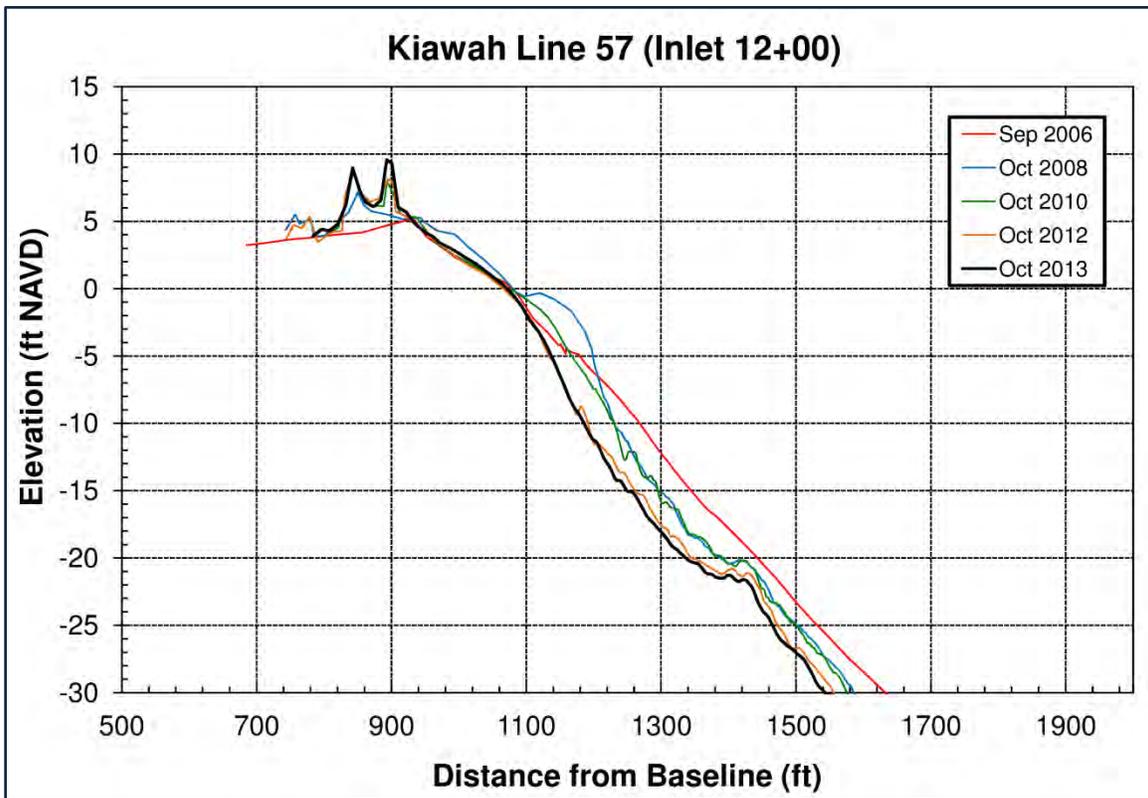


**FIGURE 4.5.** Unit volumes along the Stono Inlet reach. The seaward end of this reach (left side of graph) eroded from 2006 to 2010, but has since accreted. The central and inland areas have been more stable.

Erosion over the past year is evident in ground photos (Fig 4.6), which show an erosional escarpment in October 2013 spanning Lines 58–60, and was most significant at Line 59 (~2–3 ft high). If these ground photos are compared to the aerial image in Figure 4.6 (taken approximately two weeks after the ground photos), it appears that the beach near Lines 58 and 59 was recovering, while an escarpment had formed near Line 57. Profiles show the year-to-year variability in contour positions (Fig 4.7) with Line 56 the only profile showing significant dune recession since 2006. Rapid changes such as these are the result of recent storm occurrences or variable wave directions and sediment availability. Near the inlet, breaks in the shoals of the inlet delta can also cause shifts in sediment deposition under varying wave directions. Long-term monitoring averages out these short-term fluctuations to provide a better understanding of typical erosion patterns.



**FIGURE 4.6.** [UPPER] Aerial image (14 November 2013) of the Stono River inlet shoreline. Accumulation of wrack suggests this location was recovering during the first two weeks of November. [LOWER LEFT] Ground photo (29 October 2013) from Line 57. [LOWER RIGHT] Ground photo (29 October 2013) from Line 58 showing an escarpment present at the time of the photo.



**FIGURE 4.7.** Beach profiles from Line 57 and Line 60 in the Stono Inlet Reach. Line 57 eroded from 2007 to 2011, but has since accreted. The central and inland portion (Line 60) of the reach has accreted since 2007, although most of the gain has been in the dune or underwater.

## ***Lagoon Reach***

The Lagoon Reach spans 8,000 ft from the 2006 closure dike (Line 47 near the east end of the Ocean Course Driving Range) to Line 55 at the eastern point of the island (Fig 4.8). Monitoring reports for the 2007–2011 surveys subdivided this reach into the eastern and western lagoons. The 2012 report combined these reaches and adjusted the baseline to simplify data collection and reporting, and the present report continues this method. This reach encompasses the area of the island most influenced by shoal-bypass events (see Section 1).

Due to the rapid shoreline fluctuations and varying shoreline directions in this reach, CSE has elected to compute beach volumes using DTMs created from survey data. These volumes represent the volume of sand within the established boundaries and to a set depth. The analogy of a sandbox is often used, where the volume of sand is measured within the same sandbox each year. DTMs are also used to create contours at specified elevations for each survey, which can then be compared to provide a visual representation of the linear shoreline change.

The latest shoal-bypassing event attached to the beach in late 2009, and the shoreline has been adjusting since then. Since 2009, the general observation in the Lagoon Reach is erosion of the shoal attachment site and accretion to the west of the attachment site. The shoal attachment site (Lines 50–53) eroded up to 300 ft between 2011 and 2012, and another ~250 ft between 2012 and 2013.

Line 55 (eastern end of the reach) gained sand over the past year, although the underwater portion of the profile accounted for most of the accretion. The central portion of the reach continued to erode as sand spreads from the apex of the bulge created from recent shoal-bypass events. Lines 49, 50, and 54 showed minor erosion and negligible movement of the berm position, while Lines 51–53 all lost more than 50 cy/ft and showed more than 100 ft of berm recession. Lines 47 and 48 were influenced by migration of the flushing channel, which meandered westward and landward between 2012 and 2013. The meandering caused recession of the dry beach upward of 150 ft at Line 47; however, substantial gains were observed in the intertidal and subtidal beach at both lines. Despite erosion of the dry beach, Lines 47 and 48 gained 48.5 cy/ft and 80.9 cy/ft (respectively) since 2012.

Overall, the Lagoon Reach lost ~100,000 cy (12.6 cy/ft) of sand over the past year. Since 2007, yearly volume change has ranged from –210,000 cy to +327,000 cy, averaging +90,200 cy/yr (11.3 cy/ft/yr).



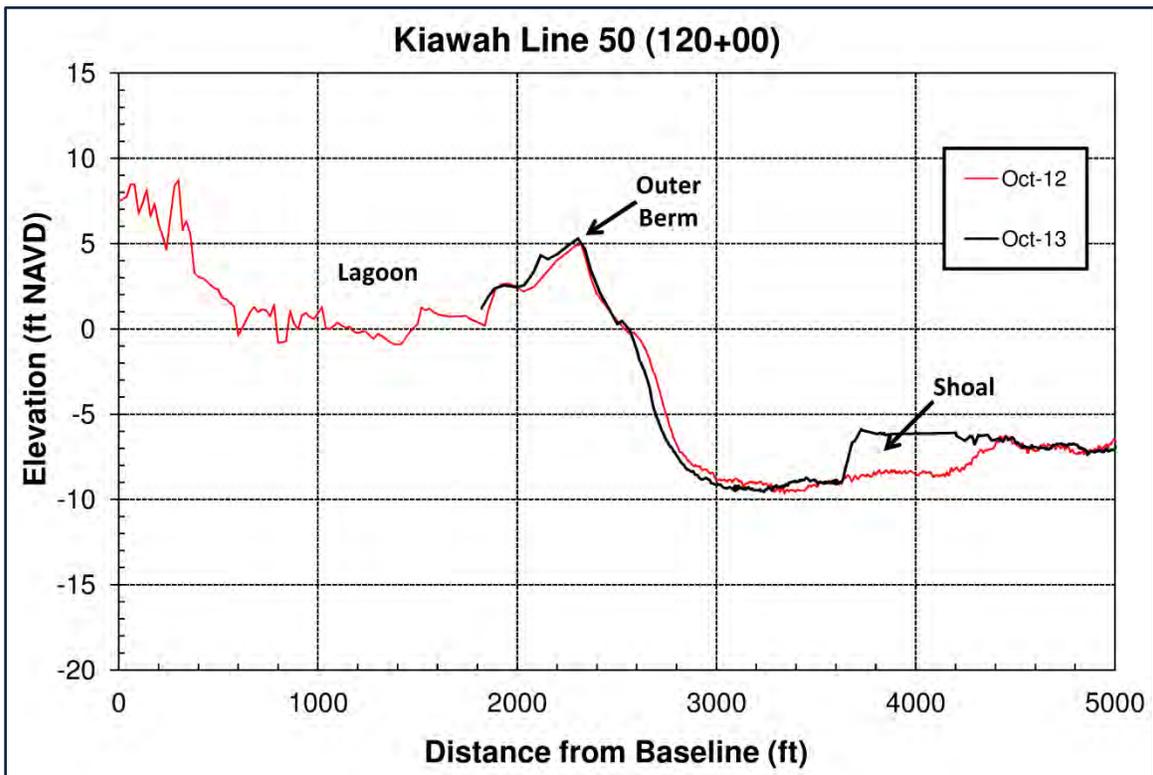
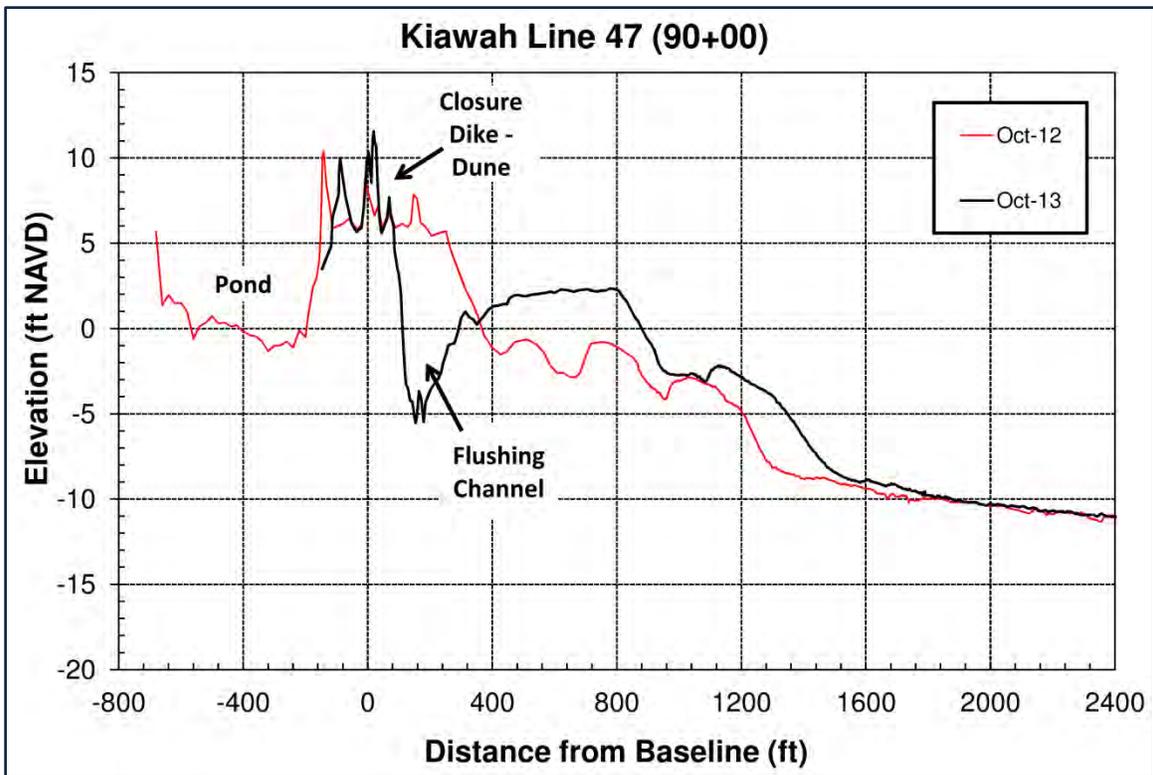
**FIGURE 4.8.** November 2013 aerial images of the Lagoon Reach. **[UPPER]** Westward view of the eastern lagoon area. The 2006 channel position is noted. **[MIDDLE]** At the time the image was taken, the flushing channel ran parallel to the beach and was causing dune erosion at Line 47. **[LOWER]** Eastward view of the flushing channel and fill berm.

The next shoal-bypass event is currently in Stage 1, migrating toward the beach. In 2012, the incoming shoal was positioned ~1,700 ft from the beach and was still far enough offshore to only have limited impacts to the beach. Between 2012 and 2013, the shoal migrated ~700 ft (Fig 4.9 – Line 50) landward. The elevation of the shoal remained approximately –6 ft NAVD, similar to 2012. The leading edge of the shoal is closest to the beach near Line 50, where it is presently ~800 ft from the beach and is likely beginning to impact the beach condition. As the shoal nears the beach, the breakwater effect increases and produces the characteristic accretion of the beach in the lee of the shoal (and erosion on the flanking beach).

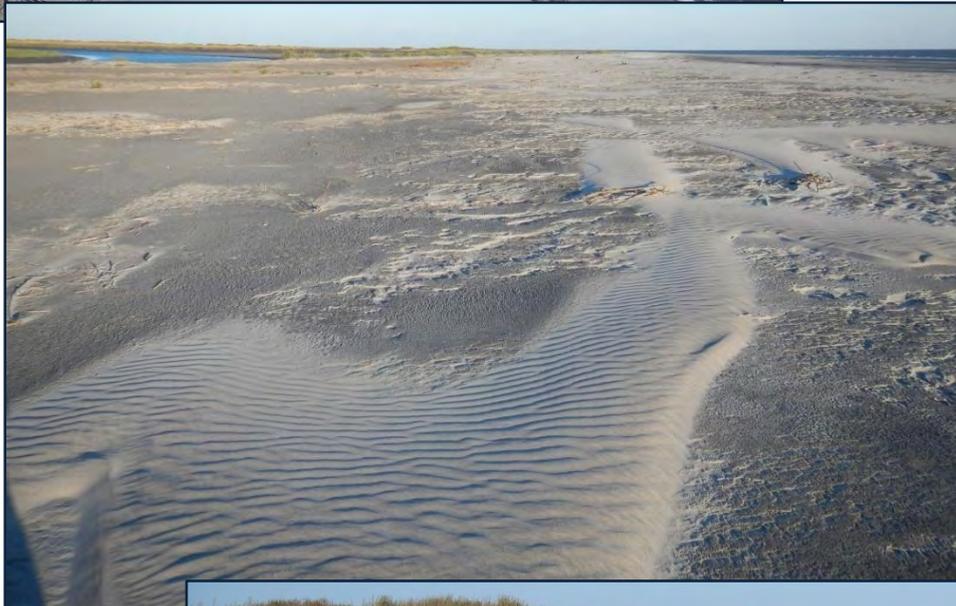
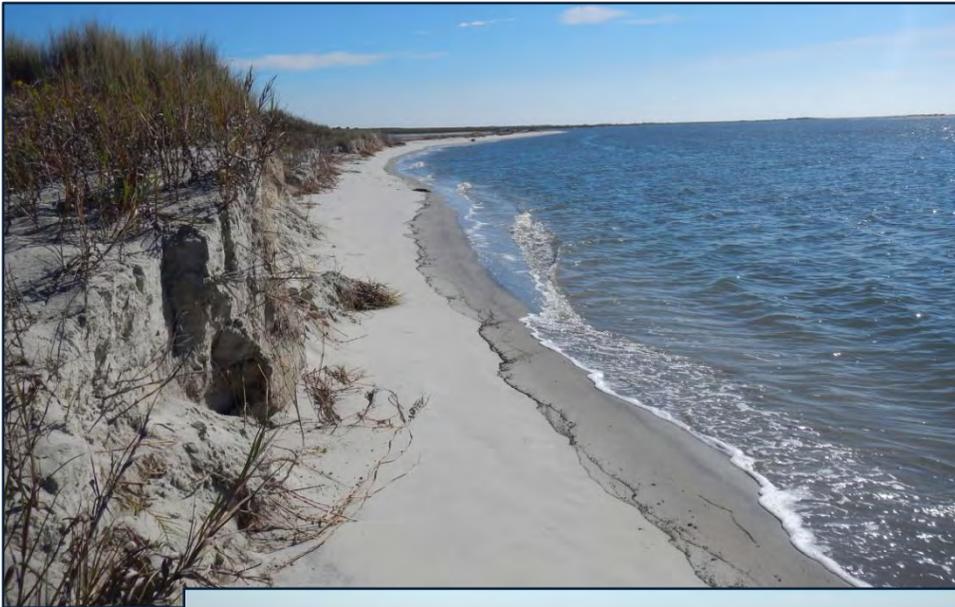
Based on the ~700–750 ft migration rate observed over the past two years, CSE expects the shoal to be close to attachment in the fall of 2014 and attached in 2015. The magnitude of shoreline change will increase over this upcoming year as sand will build in the lee of the shoal (Lines 50–51) and adjacent areas are likely to erode. Analysis of the DTM created from the 2013 survey data shows that the shoal contains ~290,000 cy above the –9 ft contour (typical seafloor elevation without a shoal). This volume will be attaching to the beach in the next two years and will provide natural nourishment to Kiawah Island.

The other significant event occurring over the past year was the migration of the flushing channel which has meandered across the western lagoon area over the past several years. Between 2012 and 2013, the channel moved further westward than it has at any point since the 2006 project (Fig 4.10). The migration caused erosion of the 2006 dike and fill area, up to ~150 ft at Line 47 (Fig 4.9 – Line 47). The eroded area consisted of dry berm and dune habitat which also serves as a shorebird roosting and nesting area.

The erosion of the habitat plus the potential for additional erosion of the fill berm is a concern for two reasons. The first is that loss of nesting habitat is obviously detrimental to shorebirds. The second is that continued erosion will eliminate the fill area placed in the 2006 project and could lead to loss of beach and dune protection fronting the Ocean Course. If left alone, the channel may eventually return to the pre-project location, causing erosion of the driving range and threatening certain holes on the golf course. The likelihood of this happening is uncertain, but CSE considers it low due to the large volume of sand currently present landward of the channel. Natural breaches in the outer lagoon berm have occasionally allowed the channel to relocate further east, a process which will likely continue into the future. However, the dynamic nature of the area leaves open the possibility of the channel's continued migration to the west. As of this writing, the Town is seeking to discuss this issue with regulatory agencies to determine the most appropriate course of action regarding the channel migration.



**FIGURE 4.9.** [UPPER] Profiles from Line 47 showing encroachment of the dune by the migrating flushing channel. [LOWER] Line 50 (near the southern apex of the east end) shows migration of the current shoal-bypass event which moved ~700 ft landward over the past year.



**FIGURE 4.10.**

October 2013 ground photos.

**[UPPER]** This near-high-tide image of Line 47 shows the flushing channel eroding the 2006 constructed dike.

**[MIDDLE]** View east from Line 49. Note the washover habitat separating the lagoon and ocean.

**[LOWER]** View east from Line 54 toward the more stable portion of the reach fronting the older eastern lagoon.

### ***Ocean Course Reach***

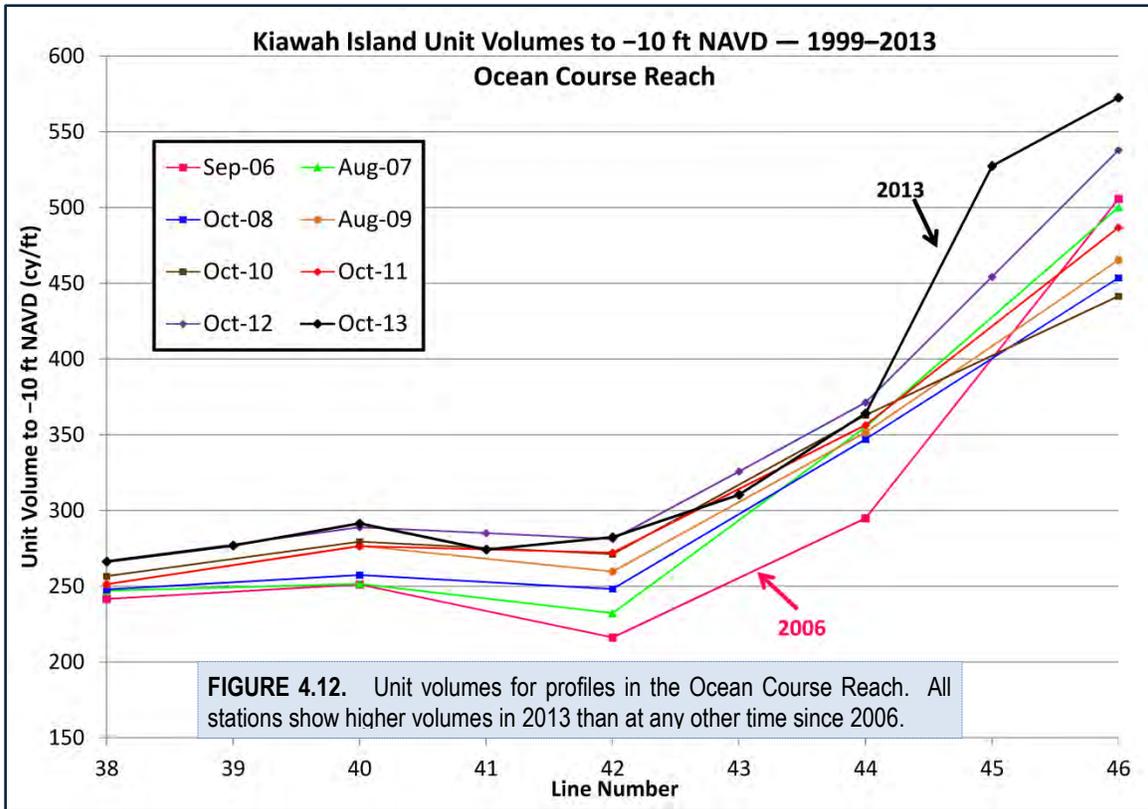
The Ocean Course Reach is the most westward reach in the project area. This transition zone, between the washover/lagoon reaches in the project area and the developed sections of Kiawah Island, contains a more typical beach profile away from the influence of Stono Inlet. Comparative profiles are, therefore, more applicable for estimating volume changes at specific locations. The reach spans 9,000 ft of shoreline, fronting the Ocean Course from Line 38 (project station 0+00) to Line 47 (project station 92+00) (Fig 4.11). It received the majority of the nourishment fill in the 2006 project.

The Ocean Course Reach has been accretional since completion of the 2006 project, gaining sand during every monitoring event since 2006 except for the 2007–2008 period. The reach has gained a total of 547,500 cy (60.8 cy/ft) since 2006, including 101,500 cy (11.3 cy/ft) over the past year. Accretion has averaged 7.7 cy/ft/yr since 2007 (Fig 4.12). Individual stations show net gains of 25-70 cy/ft since 2006 generally increasing from west to east.

Individual lines showed unit volume changes ranging from -15.3 cy/ft to +73.2 cy/ft from 2012 to 2013. Ground photos from the reach are shown in Figure 4.13. Lines 45 and 46, at the east end of the reach (near the Clubhouse) were the most accretional, gaining 73.2 and 34.7 cy/ft (respectively). Most of the gain was in the intertidal and underwater portion of the profile and was due to sediment buildup at the seaward end of the flushing channel (Fig 4.14). The remainder of the reach showed lower volume change rates and varied between erosion and accretion (see Table 4.1). No dune erosion was evident at any of the lines in the Ocean Course Reach.



**FIGURE 4.11.** The Ocean Course Reach in February 2006 (left) and November 2013 (right). The 2006 restoration project relocated the flushing channel (arrow), which was eroding the driving range, and renourished the reach. Natural accretion following the project has led to dune growth and propagation of vegetation along all of the Ocean Course. While the configuration of the shoreline is remarkably similar for each date, there is a much wider dune/berm buffer seaward of the driving range and the 18<sup>th</sup> fairway. [Red "+" indicates the same position on the images.]



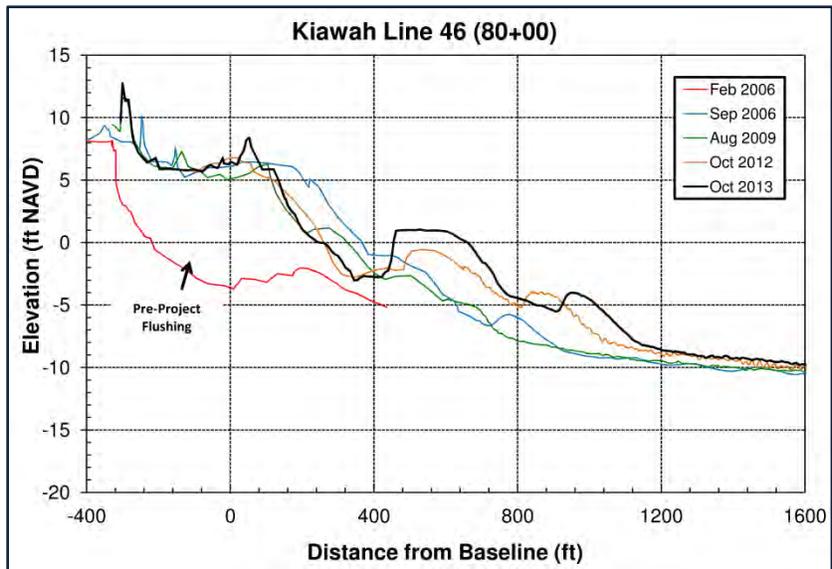
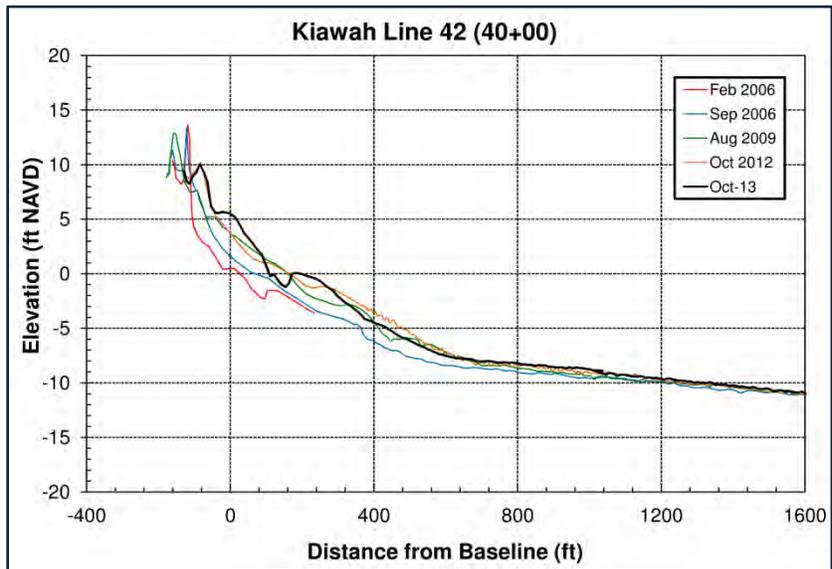
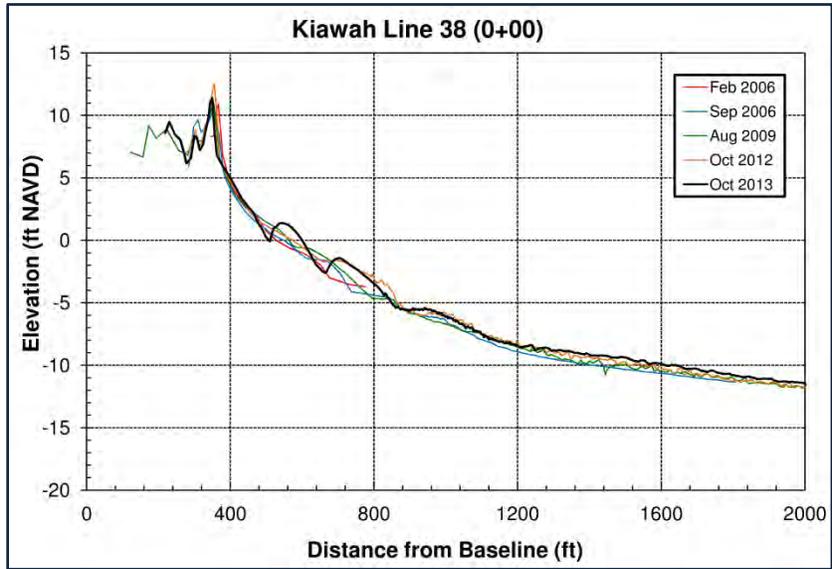
**FIGURE 4.13.**  
Ocean Course Reach in October 2013.

**[UPPER LEFT]**  
Looking east from Line 39 (Hole 14).

**[UPPER RIGHT]**  
View west from Line 43 (Hole 17).

**[LOWER RIGHT]**  
View west from Line 45 (Club House).





**FIGURE 4.14.**

Beach profiles from the Ocean Course Reach.

Line 38 is at the western end of the reach (Kiawah Beach Club) and has been stable since 2006.

Accretion increases moving east to Line 42 (16<sup>th</sup> hole) and Line 46 (Ocean Course Driving Range).

### **Summary of East-End Changes**

Kiawah Island's eastern end lost ~38,000 cy (1.6 cy/ft) of sand between October 2012 and October 2013. This compares to a gain of 143,000 cy the previous year. The three east-end reaches have gained nearly one million cubic yards since completion of the 2006 project, all by way of natural migration of sand onto the beach. The gain equals an average annual accretion rate of 6 cy/ft/yr over the 23,000-ft east-end shoreline. Marsh continues to propagate and mature in the western lagoon. The outer berm of the western lagoon continues to be a washover-type beach and is now being influenced by the next shoal-bypass event, which should attach to the beach in late 2014 or 2015. The flushing channel is meandering across the intertidal beach and, as of October 2013, was encroaching into the dune adjacent to the eastern end of the driving range.

### **4.3 Downcoast Reaches**

The 2013 monitoring data for reaches downcoast of the east end project area were compared to 1999 and 2006–2012 data. Profiles in these areas use OCRM monuments and newly (2012) created profiles so that profile spacing does not exceed 1,267 ft. CSE added new lines for the present monitoring agreement with the Town to better monitor local beach changes along the “populated” beach. CSE has collected data at certain downcoast stations since the early 1980s. Historically, the West Beach Reach has been stable, while the Turtle Point Reach and Kiawah Spit Reach have been accretional. Profiles are given in Appendix A.

At several of the downcoast stations, the 1999 profile lines terminate before reaching -10 ft NAVD. At these stations, volumes were computed to -6 ft NAVD and then adjusted by a factor of 1.95 to produce a representative volume to -10 ft. This scale factor was computed from volume analysis of the 1999 profiles which did extend to -10 ft NAVD. The importance of collecting and analyzing data to the depth of closure is evident in the volume changes between 2010 and 2011.

In 2011, a significant underwater bar was present at most of the profiles in the downcoast reaches. Most of the sand volume associated with the bar was positioned vertically between -6 ft and -10 ft NAVD. Thus, volume change calculations to -6 ft NAVD miss the volume in the bar and do not provide a full accounting of beach condition. For example, at station 2695, the unit volume change to -6 ft NAVD (low-tide wading depth) was -4.7 cy/ft from 2010 to 2011. However, the volume change between -6 ft and -10 ft NAVD was +11.7 cy/ft, yielding a more realistic total volume change of +7.0 cy/ft. While the underwater volumes in bars may not provide immediate benefit to the visible beach, they indicate the likelihood of future beach buildup.

Future monitoring should strive for a full accounting of sand volumes into deeper water because the resulting data provide the most objective measure of beach condition.

Figure 4.15 shows unit volumes for each station in the downcoast reaches. It is apparent that the present condition along the majority of the beach is much healthier than it was in 1999. Only at Line 20 (OCRM 2675 near Sea Forest Drive) does the current condition have less volume than in 1999. Overall, the downcoast reaches have gained 2.16 million cubic yards of sand since 1999, equivalent to an average annual accretion rate of 4.3 cy/ft/yr\* over the ~6-mile beach length. Over the past year, the downcoast beach was accretional, gaining a total of 188,000 cy (5.5 cy/ft) of sand. This compares to a gain of ~350,000 cy over the previous year. Since 2012, 32 of the 37 profiles in the downcoast reaches gained sand.

*[\*A gain of 4.3 cy/ft/yr is roughly equivalent to a beach widening of 6–7 ft/yr in settings like Kiawah Island, where DOC is relatively shallow (Kana et al 2013). Over the 14-year period (1999–2013), this rate of sand accumulation has widened Kiawah’s beach by an average of roughly 100 ft.]*

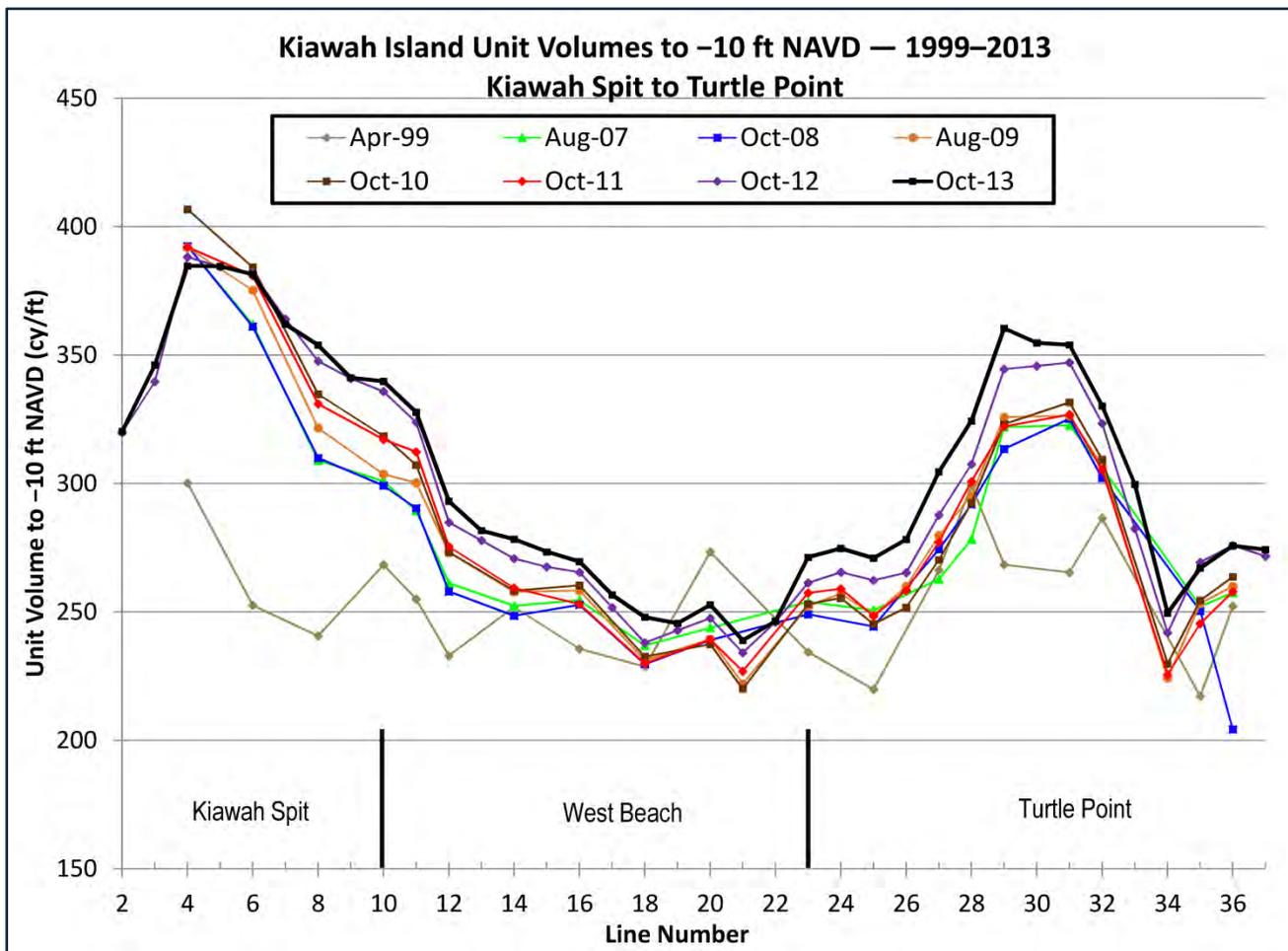


FIGURE 4.15. Unit volumes for each station in the downcoast reaches.

### ***Turtle Point Reach***

The Turtle Point Reach (Fig 4.16) extends 13,614 ft from Line 23 (OCRM 2685 at the 16<sup>th</sup> hole of Turtle Point Golf Course) to Line 38 (OCRM 2735 at Kiawah Beach Club). The reach was fairly stable from 2007 to 2011, showing yearly unit volume changes ranging from -4.2 cy/ft to +4.0 cy/ft. The reach was much more accretional from 2011 to 2012, gaining 14.3 cy/ft, and continued the higher accretion trend between 2012 and 2013 as the reach gained 9.5 cy/ft (128,800 cy). Individual stations ranged between 2.3 cy/ft erosion to 17.2 cy/ft accretion. The western half of the reach was more accretional than the eastern half, which is the reverse of the 2011–2012 trend. Stations with data from 1999 show between 23.5 cy/ft and 92.0 cy/ft more sand than the 1999 conditions.

Beach profiles (Fig 4.17) show dune heights range between +10 ft NAVD and +15 ft NAVD (note data may not extend to the highest dune due to vegetative cover or difficulty accessing densely vegetated areas). In the central portion of the reach, the dune line has moved over 100 ft seaward since 1999. At the east and west ends of the reach, the dune line has grown ~50 ft seaward since 1999. A wide and relatively-low-elevation dune field exists throughout the Turtle Point Reach (Fig 4.18). At the eastern end of the reach, mature dune vegetation (typically wax myrtle) is propagating. Expectations are that the central and western ends of the reach will continue to mature (if left alone) with vegetation into a thicket of wax myrtle 12–15 ft above existing ground level. A couple of decades from now, large trees will emerge through the thicket, creating a climax forest of palmetto, loblolly pine, cedar, and live oak trees.

### ***West Beach Reach***

The West Beach Reach encompasses the beach between Lines 10 and 23 (Sand Alley to the 16<sup>th</sup> tee of Turtle Point Golf Club) (Fig 4.19, upper). Historically, this reach has been fairly stable compared to remaining reaches. Although the reach has experienced periods of erosion, properties within the reach are sufficiently set back to allow for a substantial vegetated buffer between the ocean and the structures (Fig 4.19, lower).

The reach lost 3.8 cy/ft of sand from 2007 to 2008, but has accreted during every monitoring interval since then, including gaining 5.3 cy/ft (62,000 cy) from 2012 to 2013. Similar to the previous year, all stations within the reach gained sand over the past year. Accretion ranged from 0.4 cy/ft at Line 22 to 10.0 cy/ft at Line 18. There was no distinct trend of volume change for the various areas within the reach. Profiles show the high dune was fairly stable over the past year, and accretion was generally observed along the intertidal beach (Fig 4.20).



**FIGURE 4.16.** November 2013 aerial image of the Turtle Point Reach. Shrub vegetation (typically waxed myrtle) continues to propagate between sparsely vegetated foredunes. CSE expects the shrub zone to expand and eventually be transformed to forest vegetation.

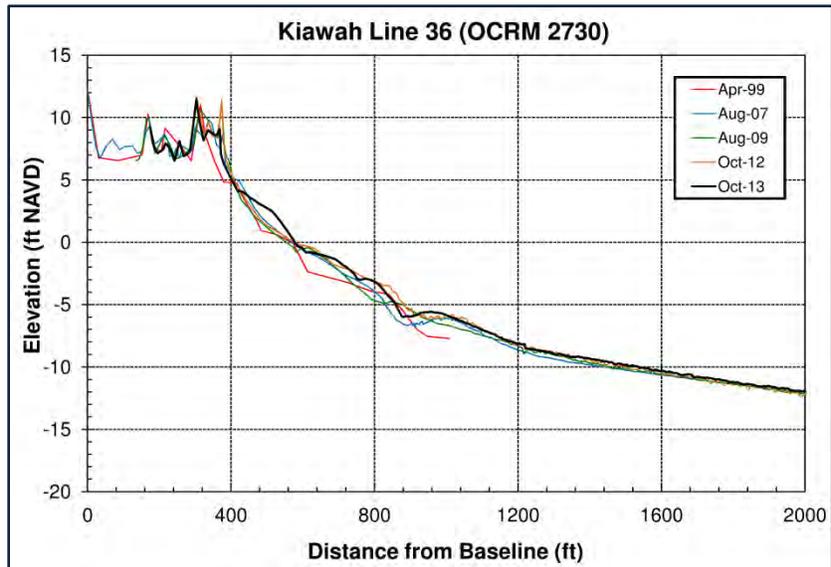
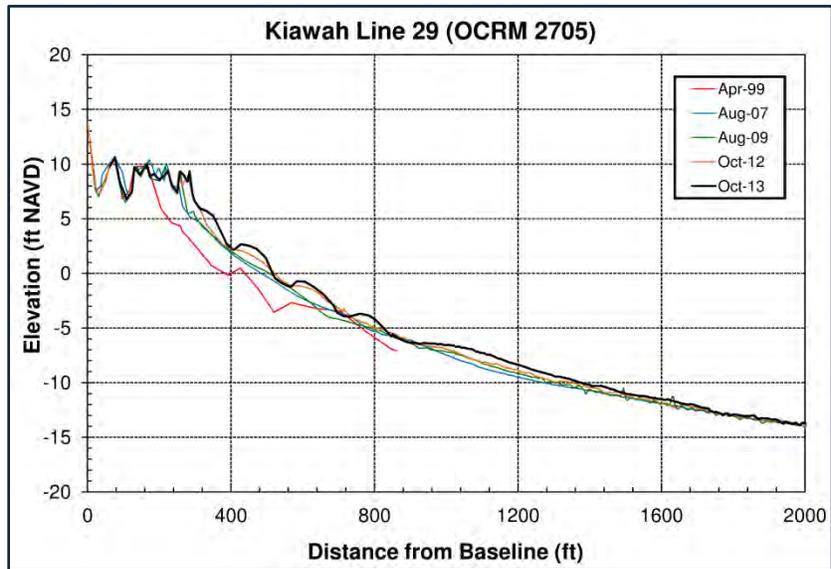
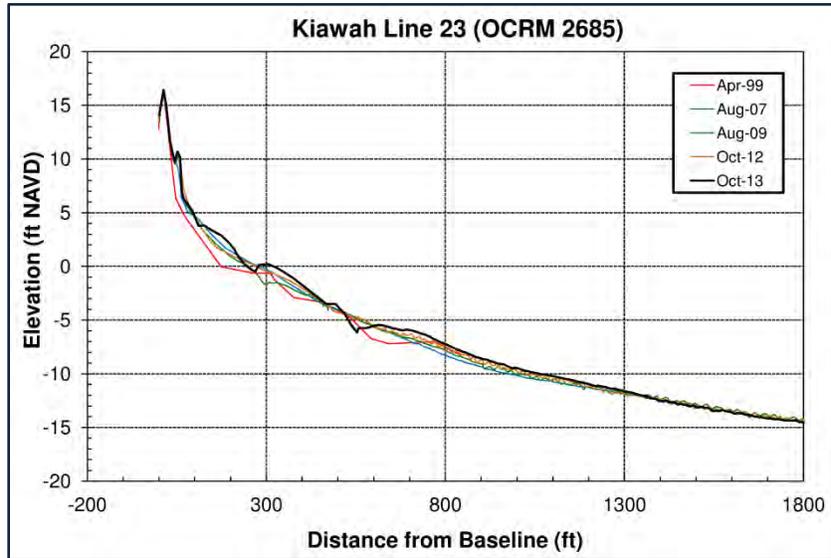
**FIGURE 4.17.**

Beach profiles from the Turtle Point Reach.

Line 23 is located ~1,000 ft east of The Sanctuary.

Line 29 is near Jackstay Court.

Line 36 is near Bally Bunion Drive.





**FIGURE 4.18.** October 2013 ground photos of the Turtle Point Reach. Note the low, wide dune field and narrow dry berm.

**[UPPER LEFT]** Line 36 near Bally Bunion Drive.

**[MIDDLE RIGHT]** Line 32 east of Royal Beach Drive.

**[MIDDLE LEFT]** Line 28 west of Forestay Court.

**[LOWER RIGHT]** Line 23 near Turtle Point's 16<sup>th</sup> hole (east of The Sanctuary).

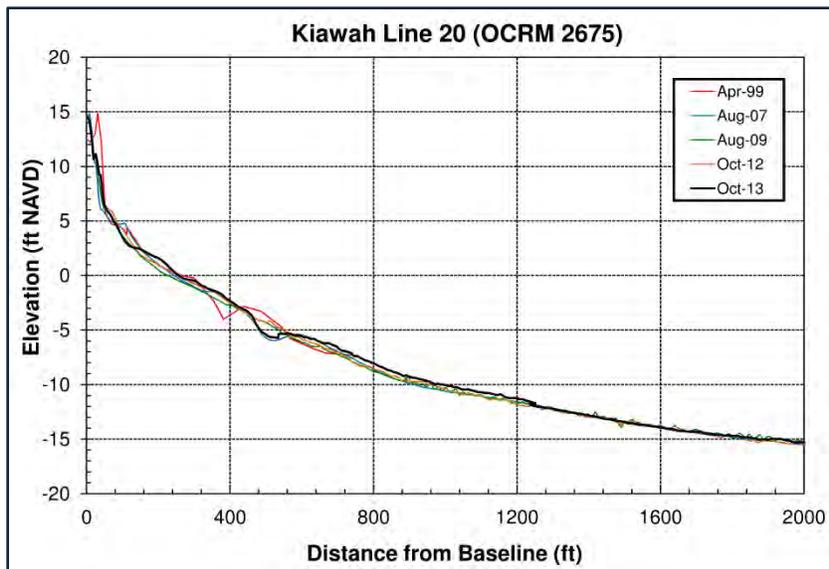
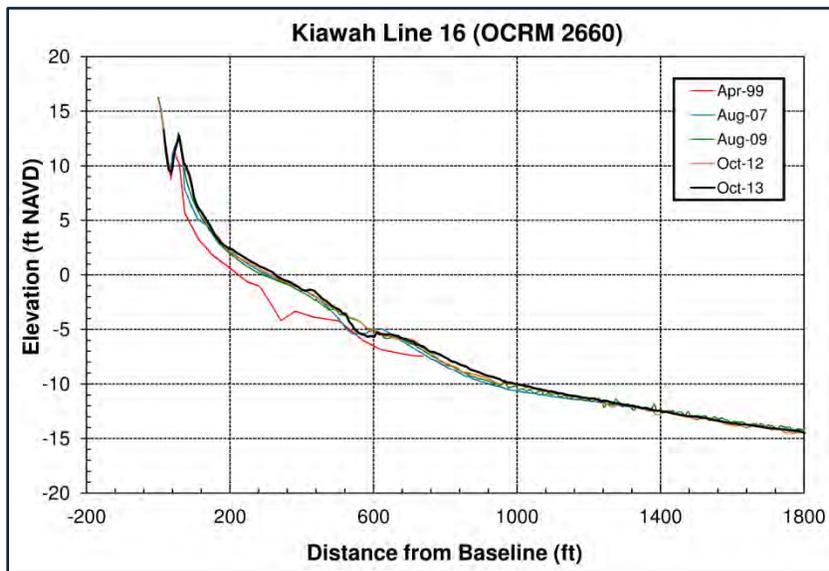
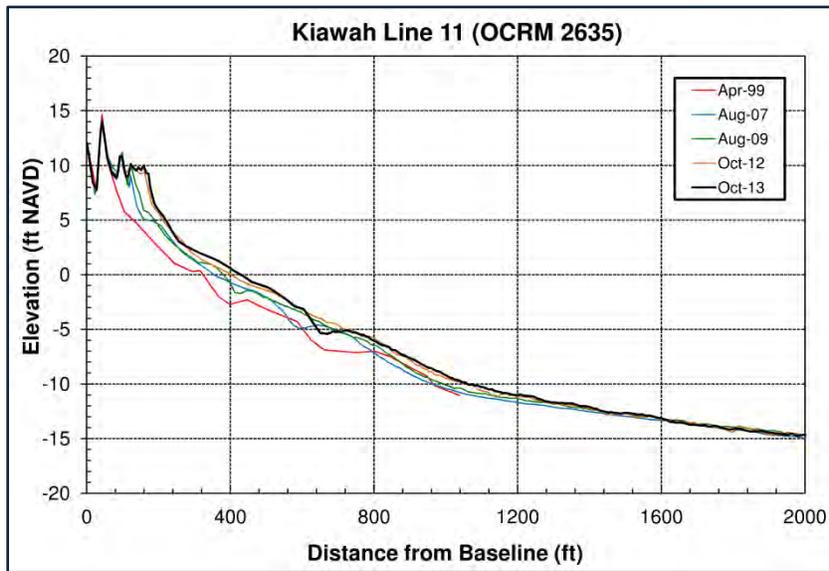


**FIGURE 4.19.** November 2013 aerial views of various areas in the West Beach Reach.

**[UPPER]** The Sanctuary at the eastern end of the reach. Turtle Point's 16<sup>th</sup> hole is visible to the right.

**[MIDDLE]** The central portion of the reach along Eugenia Avenue has a narrower dune field than other reaches. However, houses are still set back from the water a sufficient distance for moderate storm protection.

**[LOWER]** The western end of the reach near Shipwatch Drive.



**FIGURE 4.20.**

Profiles from the West Beach Reach.

The western end of the reach has been more accretional than the rest of the reach. Line 20 is the only line on the island showing less volume than the 1999 condition.

Ground photos show evidence of a recent escarpment along the central and eastern portions of the reach (Fig 4.21—upper, middle), visible as truncated vegetation (distinct seaward boundary of vegetation) along the foredune. The escarpment had healed by the time of the photos and sparse vegetation is beginning to recolonize the lower foredune. Compare the upper three photos to the lower image in Figure 4.21, which shows a more variable vegetation line, indication that the area shown (Line 11) did not have a recent escarpment.

Accretion over the past two years is a significant increase compared to the 2007–2011 time period when the reach was stable (averaged zero net change). Over the past two years, accretion has averaged 7.2 cy/ft/yr. Since 1999, the West Beach Reach has shown an average gain of 1.6 cy/ft/yr. The dune line at the eastern end of the reach has been stable to mildly accretional, gaining up to ~25 ft of width since 1999. The central and western portions of the reach have grown 100–150 ft seaward since 1999.

### ***Kiawah Spit Reach***

The Kiawah Spit Reach encompasses the downcoast end of the island (Fig 4.22). It acts as a collection site for sand transported by longshore currents from upcoast areas. As wave action transports sand to the west, it feeds the spit, causing growth into Captain Sams Inlet and forcing the inlet to migrate toward Seabrook Island.

Previous shoreline monitoring reports by CSE referenced three OCRM monuments in this reach. CSE has added six additional lines to better account for beach changes along the spit with the most westward line located near the current position of Captain Sams Inlet. To compare equivalent shoreline segments, CSE extrapolated volume to the western end of the spit for the lines without 1999–2011 data. This was accomplished by applying the percent of volume change at the most westward line with data (Line 4) to the lines without data, beginning at the 2011–2012 change and working back in time.

For example, the 2011–2012 volume change at Line 4 was –390 cy, which is –0.03 percent of the 2011 volume. This percentage was applied to the 2012 volume at Lines 1–3 to obtain 2011 volumes for each of those lines. The 2010–2011 volume change at Line 4 was then applied to these new 2011 volumes for Lines 1–3 to provide new 2010 volumes, and so on. While the method is obviously limited in accuracy, it does provide a rough volume estimate of the lines west of Line 4 to compare with more recent results.



**FIGURE 4.21.** October 2013 ground photos of the West Beach Reach.

**[UPPER LEFT]** Line 21 looking east with The Sanctuary visible.

**[MIDDLE RIGHT]** Line 19 looking west. The image shows a recent dune escarpment is healing with sparse new vegetation at the toe of the foredune.

**[MIDDLE LEFT]** View east from Line 15 near the center of Eugenia Avenue.

**[LOWER RIGHT]** View east from Line 11. The western end of the reach has a much wider, but low, dune field.



**FIGURE 4.22.**

November 2013 aerial images of the Kiawah Spit Reach.

The spit has grown seaward ~200 ft since 1999.

The Kiawah Spit Reach was generally stable over the past year, losing 2,600 cy (0.3 cy/ft). Most of the erosion is attributed to Line 1, adjacent to Captain Sams Inlet, which lost 24.2 cy/ft (resulting in a net volume loss of ~12,000 cy). Losses at Line 1 were restricted to the underwater profile as the washover beach showed signs of dune growth (area from -400 ft to 0 ft from the baseline in Figure 4.23). The remainder of the reach (Lines 2–9) gained 9,300 cy, averaging unit gains of 0.9 cy/ft. Line 4 has gained ~200 ft of dune width since 1999, although most of the accretion occurred prior to 2007. Since 2007, the beach has remained fairly stable while dune height has increased by ~5 ft. The eastern end of the reach, near Beachwalker Park, has been consistently accretional since 1999 and is also ~200 ft wider than the 1999 condition. Ground photos are shown in Figure 4.24.

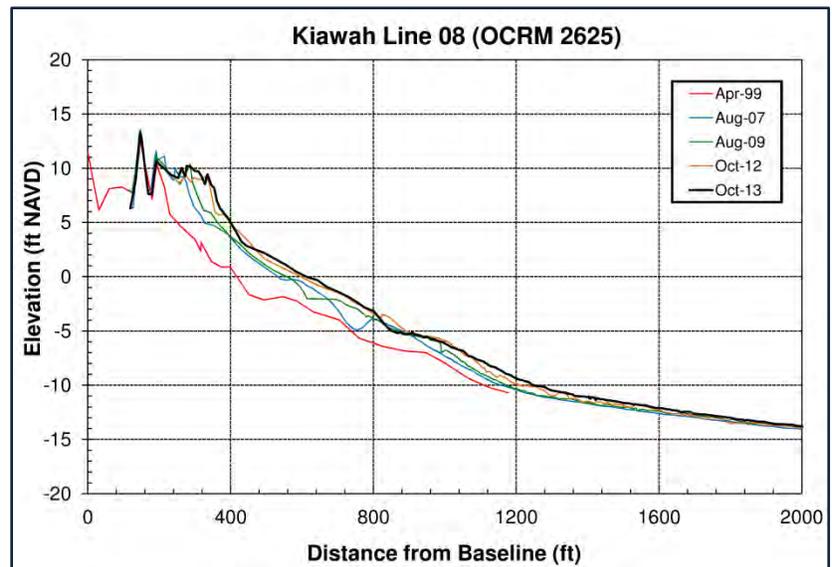
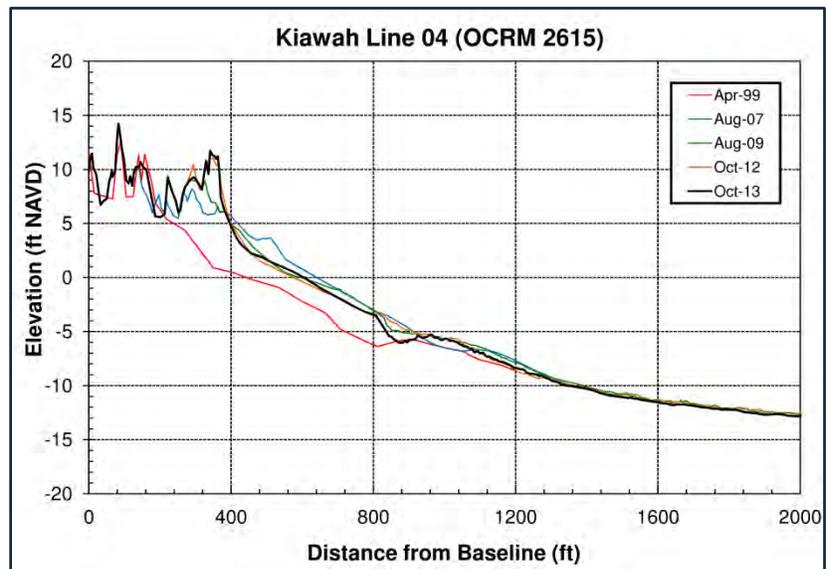
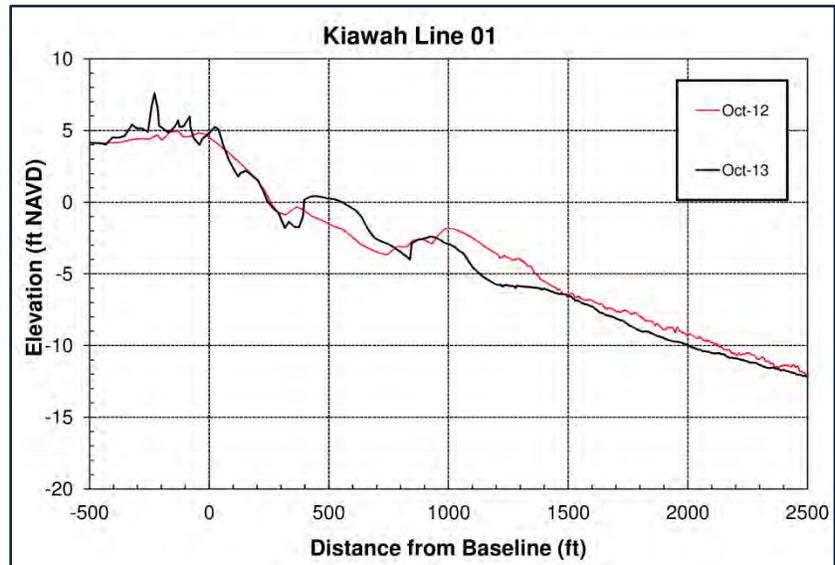
Overall, the Kiawah Spit Reach has gained 938,000 cy (106.4 cy/ft) of sand since 1999. This translates into an average annual accretion rate of 64,600 cy/yr (7.3 cy/ft/yr).

**Island wide, Kiawah gained 150,000 cy (2.6 cy/ft) of sand from October 2012 to October 2013.** Since 2007, the island has gained nearly 1.4 million cubic yards of sand, measured to -10 ft NAVD. This is an average annual accretion rate of 4.5 cy/ft/yr since 2007. Kiawah continues to be one of the healthiest beaches on the South Carolina coast, and monitoring results continue to suggest that this trend will continue in the near future.

**FIGURE 4.23.**

Profiles from the Kiawah Spit Reach.

The dune line in this reach has built nearly 200 ft seaward since 1999. The sand volume gain from 1999 to 2013 between the original foredune and -10 ft NAVD is 113.3 cy/ft at station 2625.





**FIGURE 4.24.** October 2013 ground photos of the Kiawah Spit Reach. **[UPPER LEFT]** Line 8 looking west (new Beachwalker vehicle access). **[MIDDLE RIGHT]** Line 4 looking west. **[MIDDLE LEFT]** Looking west near the end of the spit. **[LOWER]** January 2014 image of the dune field just west of Beachwalker Park.

## 5.0 SUMMARY OF FINDINGS

The 2013 monitoring survey, conducted in late October, is the seventh annual monitoring event since completion of the 2006 beach restoration project at the eastern end of Kiawah Island. Data show that the eastern end continues to evolve in response to shoal-bypass events, which have added over 6 million cubic yards of sand to the beach in recent decades. The lagoon that was present during the 2006 restoration project is developing into a mature marsh system, while the new outer beach is constantly moving in response to local sediment supply and wave conditions. The most evident changes over the past year were continued erosion of the southern apex of the eastern end, westward and inland migration of the lagoon flushing channel, landward migration of a new shoal-bypass event, and continued accretion of the downcoast shoreline.

The island was accretional from 2012 to 2013. The Kiawah Spit, Lagoon, and Stono Inlet Reaches lost sand, while the West Beach, Turtle Point, and Ocean Course Reaches accreted. The most significant erosion was measured at the Lagoon Reach, areas of which lost up to 90 cy/ft over the past year. The majority of the profiles along the developed front beach gained sand. Overall, the eastern end (Ocean Course to the east) lost ~38,000 cy (1.6 cy/ft) over the past year, while the remainder of the island gained ~188,000 cy (5.5 cy/ft).

Overall, the island gained 150,000 cy (2.6 cy/ft) of sand over the past year. This is equivalent to an average beach widening of ~4 ft. Beach profiles show increasing dune heights or seaward movement of the dune line. Kiawah Island has gained nearly 1.4 million cubic yards of sand since 2007, which is an average accretion rate of ~255,000 cy (4.5 cy/ft) per year. As of October 2013, there were no significant erosion problems along the ocean-facing shoreline. The lagoon flushing channel is meandering across the active beach east of the Ocean Course and is beginning to encroach on the 2006 closure dike and nourishment berm. CSE is working with the Town to evaluate the channel and develop a plan should the erosion reach the extent where significant threats to habitat or infrastructure develop.

Kiawah Island represents one of the healthiest beaches along the U.S. East Coast and offers an unparalleled example of the accretionary dynamics which maintain mixed-energy barrier islands. While monitoring of any sort entails some cost, its value lies in prediction of localized problems such as the events that led to the 2006 project. CSE is scheduled to repeat annual monitoring in the fall of 2014.

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