Final Report

Shoal Management Project

ISLE OF PALMS (SC)

Prepared for:

City of Isle of Palms
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[CSE–2384–FR]
July 2012

COVER PHOTO – Natural dune building at the Isle of Palms. Nourished beaches offer substrate for vegetation. As in the case of these sea oats, vegetation traps sand and builds dunes. Dunes, in turn, provide habitat for sea-turtle nesting and offer storm protection for structures.

[July 2012 photo by S Traynum]

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INTRODUCTION

This report is submitted following completion of the 2012 Isle of Palms Shoal Management Project. It provides a summary of the project, which was constructed March-April 2012 by Baker Infrastructure Group Inc (Garden City GA). The project was implemented to restore an erosional hot spot which has reduced the beach width at the eastern end of the island since the 2008 nourishment project. Work was authorized by federal and state permits (P/N 2010-1041-2IG) and financed by funds held in escrow by the City of Isle of Palms, South Carolina (Dick Cronin, Mayor; Linda Lovvorn Tucker, City Administrator). The project involved excavating 87,763 cubic yards (cy) of sand from the wet beach in a site of recent shoal attachments and deposition of the same volume in the erosional area. All work was completed by land-based equipment working daylight hours. Coastal Science & Engineering (CSE) was the project engineer.

The present report includes:

- Brief summary of the project setting, purpose, and project description.
- Summary of project planning and permitting.
- Description of bidding procedure and results.
- Summary of construction.
- Summary of beach volume and shoreline changes.
- Summary of permit-required monitoring.

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PROJECT AT A GLANCE

- Construction Cost — $245,019.35
- Pay Quantity Moved — 87,763 cubic yards
- Working Days — 21 from 12 March 2012 thru 10 April 2012
- Contractor — Baker Infrastructure Group, Garden City, GA
- Engineer — Coastal Science & Engineering, Columbia, SC
- Sponsor — City of Isle of Palms, SC
- Permit Number — 2010-1041-2IG
- Borrow Area (Fig 1) — 2,000 linear feet from station 276 to station 296 (Beach Club Villas I to Shipwatch)
- Fill Area (Fig 1) — 1,400 linear feet from station 306 to station 320 (Port O'Call to 18th fairway)
- Equipment Used — 1 track-hoe excavator; 3 off-road dump trucks, 1 bulldozer

FIGURE 1. General project plan showing the borrow and fill areas. Aerial image (July 2011) courtesy IMC Inc (Charlotte NC).

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BACKGROUND

The morphology and shoreline evolution of the eastern end of Isle of Palms has been studied in detail since the 1980s (Kana & Dinnel 1980, ATM 2006). This area is heavily influenced by Dewees Inlet and the process of shoal bypassing (Fig 2)—which is when volumes of sand are released from the offshore shoals (ebb-tidal delta) of the inlet, then migrate and attach to the beach. Periodic shoal bypassing accounts for the historical accretion along Isle of Palms; however, it is also a cause of localized erosion in the vicinity of each bypassing event. The bypass cycle consists of three stages:

- Stage 1 is the emergence of an offshore shoal and its release from the ebb-tidal delta.
- Stage 2 is onshore migration and initial attachment of the shoal and accompanying response of the beach.
- Stage 3 is the merging of the shoal with the shoreline and spreading of the shoal sand to adjacent areas.

Stage 2 is generally the period of maximum erosion along the shoreline flanking the shoal. The cycle moves to Stage 3 when the shoal fully merges with the beach. Waves then drive sand away from the bulge and spread it alongshore. Gaudiano and Kana (2001) found that bypassing events occur at the northeast end of Isle of Palms every ~6.6 years, on average (though the interval may be as short as two years or greater than ten years). Individual events can vary in size, adding from less than 100,000 cubic yards (cy) to well over 500,000 cy. The additions of sand near the downcoast limit of the ebb-tidal delta produce salients (ie – seaward bulges) at the attachment point. Accumulations of sand create the characteristic “drumstick” barrier-island shape with a wider upcoast end and a narrow spit at the downcoast end (Fig 3) (Hayes 1979).

Localized erosion associated with these shoal-bypass events has often led to the need for remedial action. Table 1 lists relevant studies and projects that have addressed erosion at the east end of Isle of Palms.

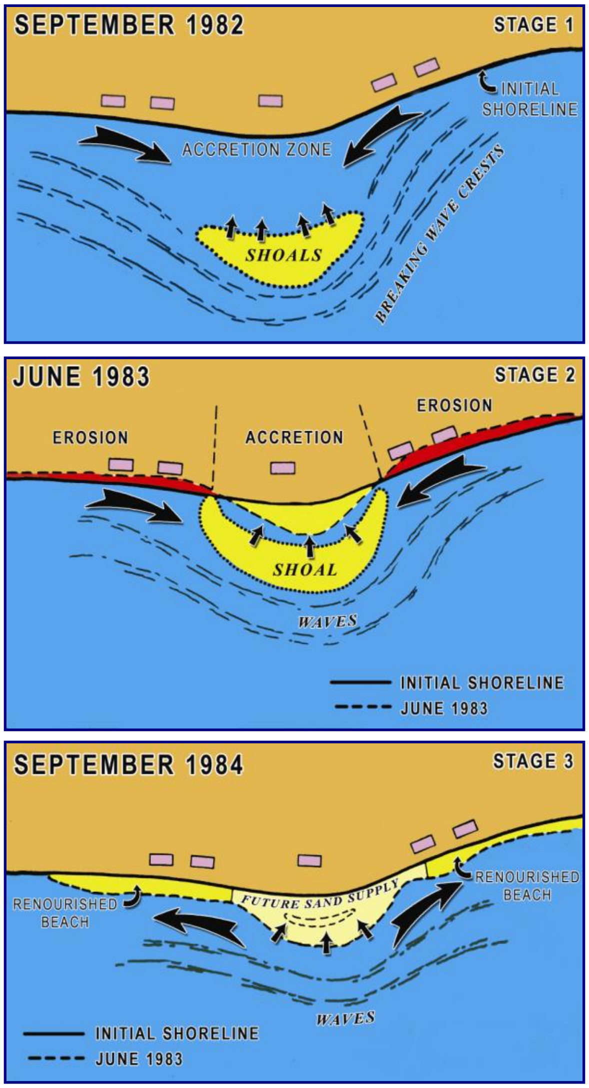

FIGURE 2.

[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.

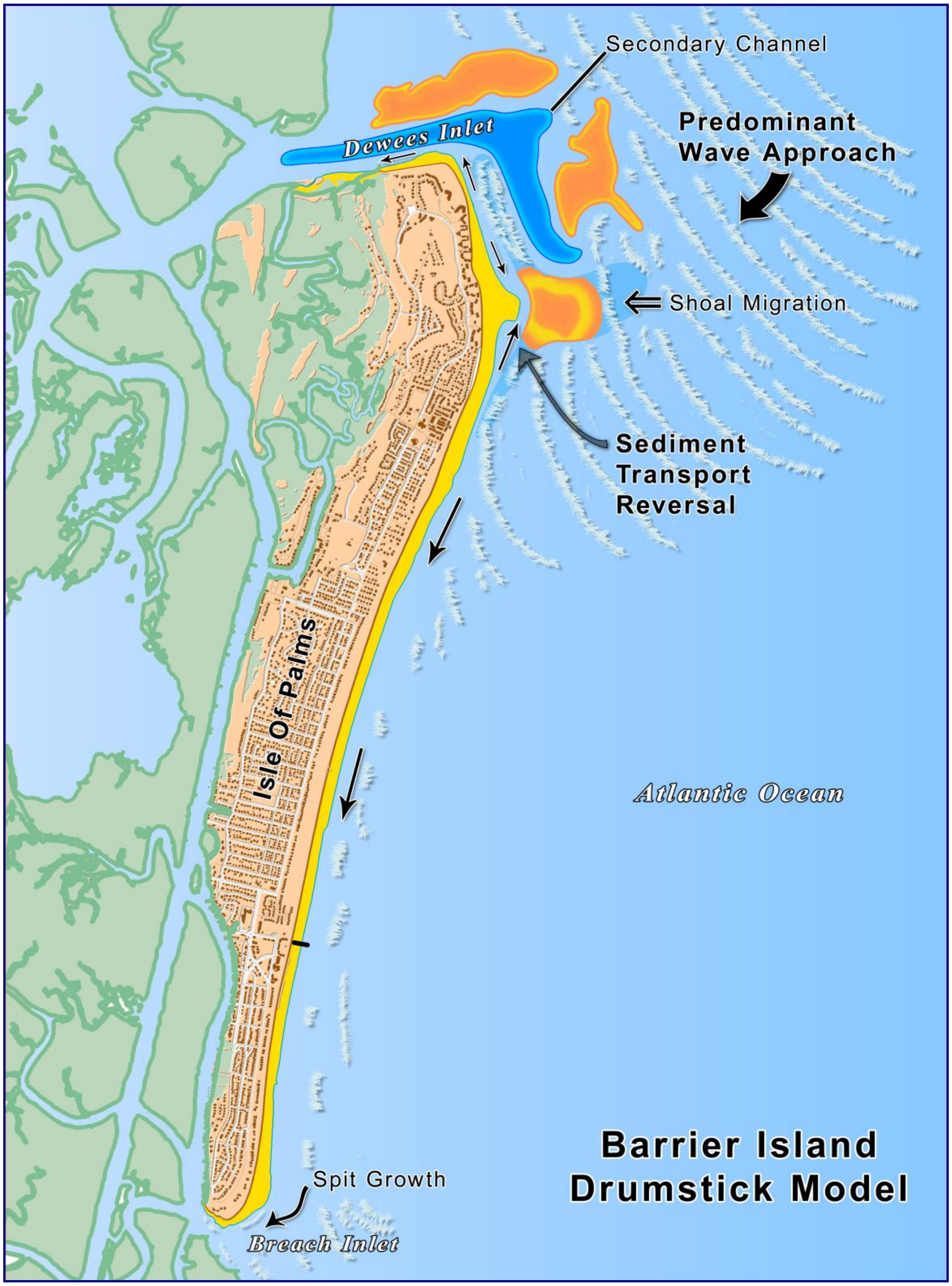

FIGURE 3. Isle of Palms is a typical "drumstick" barrier island (after Hayes 1979), where the upcoast end is wider due to sediment accumulation through shoal-bypass events, and the downcoast end usually forms a growing recurve spit. Other examples of drumstick barrier islands along South Carolina are 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 2).

TABLE 1. Relevant studies and projects concerning erosion at the eastern end of Isle of Palms.

1980	Kana & Dinnel	Provides detailed analysis of the causes of erosion on Isle of Palms along Dewees Inlet, documents sand circulation patterns, and recommends a terminal groin near the 17th tee of the golf course
1981	Project	Groin at 17th tee along Dewees Inlet
1982	Sexton & Hayes	Discusses the impacts of inlets on the adjacent shorelines and implications for shoreline management
1983	Project	Sand scraping and seawall construction – Mariners Walk, Beach Club Villas, etc
1984	Project	~350,000 cy nourishment (source – 41st Street marina basin)
1983	Kana, Siah & Williams	Review of historical shorelines and recommended 25-year setback for a proposed building (Shipwatch)
1982-1984	RPI	Annual beach monitoring reports
1984-1987	CSE	Annual beach monitoring reports
1985	Kana, Williams & Stevens	Review of the 1982-1984 shoal-bypass event which led to construction of a seawall and nourishment
1987	Williams & Kana	Review of the 1985-1987 shoal-bypass event and recommendations for shoal scraping and a monitoring program
1997	Project	Sand scraping
1999	Kana, Hayter & Work	Detailed review and conceptual model of shoal-bypass dynamics based on Dewees Inlet/Isle of Palms
2006	ATM	Erosion assessment and beach nourishment plan
2007	CSE	Shoreline assessment and long-range beach restoration plan
2008	IOP	Long-term beach management plan and recommended alternatives for mitigation
2008	Project	Beach restoration project (~900,000 cy) (source – offshore deposits ~2.5 miles south of Wild Dunes)
2012	Project	Shoal management project (~88,000 cy transferred)

The general findings of prior studies and projects are that:

- The portion of a beach near an inlet is typically the most dynamic area of an island.
- Inlet shoals are periodically released from the ebb-tidal delta and merge with the beach.

- Shoals add sand to Isle of Palms and spread quickly to other areas, leaving a net sand deficit at the east end.
- Erosion and accretion associated with the bypassing shoals are highly localized and can move the shoreline hundreds of feet in any given year.
- Localized erosion has necessitated remedial action including constructing seawalls, sand scraping, and nourishment.
- Borrowing sand from accretional areas for restoration of the erosional areas is the most cost-effective and least environmentally impacting alternative.

2008 Beach Restoration Project

A large shoal-bypass event began to impact the east end of Isle of Palms in 2004. An emergent shoal was migrating toward shore, centered near the Wild Dunes Property Owners Beach House. By 2006, characteristic erosional arcs adjacent to the attachment site resulted in insufficient dry beach in front of properties between the Summerhouse and Ocean Club units. Small sandbags (~1 cubic foot) were placed along the dune or face of the structures but quickly washed away. Larger sand bags (~1 cy) were then placed and maintained until the 2008 project (Fig 4). The shoal attached in 2007, creating a pronounced bulge in the shoreline and forming an ephemeral lagoon between the accreted bar and previous beach (Fig 5). CSE (2007) determined that due to the size and position of the shoal, and the severely eroded condition of the adjacent shoreline, the beach likely would not restore itself naturally (under Stage 3) within an acceptable time frame or to an acceptable extent along the impacted structures.

The City took the lead in implementing a restoration project which placed ~847,400 cy via hydraulic dredge in three reaches between 53rd Avenue and the 17th hole of the Links Course. The sources of borrow sand were several areas 2–3 miles from the beach (Fig 6). The project was completed over a period of 33 working days from 24 May 2008 through 25 June 2008 (CSE 2008). As part of the project, accessible sandbags were removed and discarded. The measured placed volume was 933,985 cy, a difference of ~10 percent from the design quantity. The difference was not a pay quantity. Average fill volumes were ~75 cubic yards per foot (cy/ft) in Reach A, ~104–180 cy/ft in Reach B, and ~27 cy/ft in Reach C. Nourishment increased the beach width by over 300 feet (ft) in some places (Fig 7).

FIGURE 4. Small sandbags were placed in front of structures (upper); however, these quickly washed away, and large sandbags were placed on top of the remaining sandbags (lower).
[Upper photo from Coastal Carolina University BERM Program]

FIGURE 5.

[UPPER] February 2007 oblique aerial image of the northeast end of Isle of Palms. Note the attaching bar and erosional arcs on either side of the shoal attachment area.

[LOWER] December 2007 image of Project Reach. Note how the shoal sand has merged with the beach, creating a temporary lagoon feature.

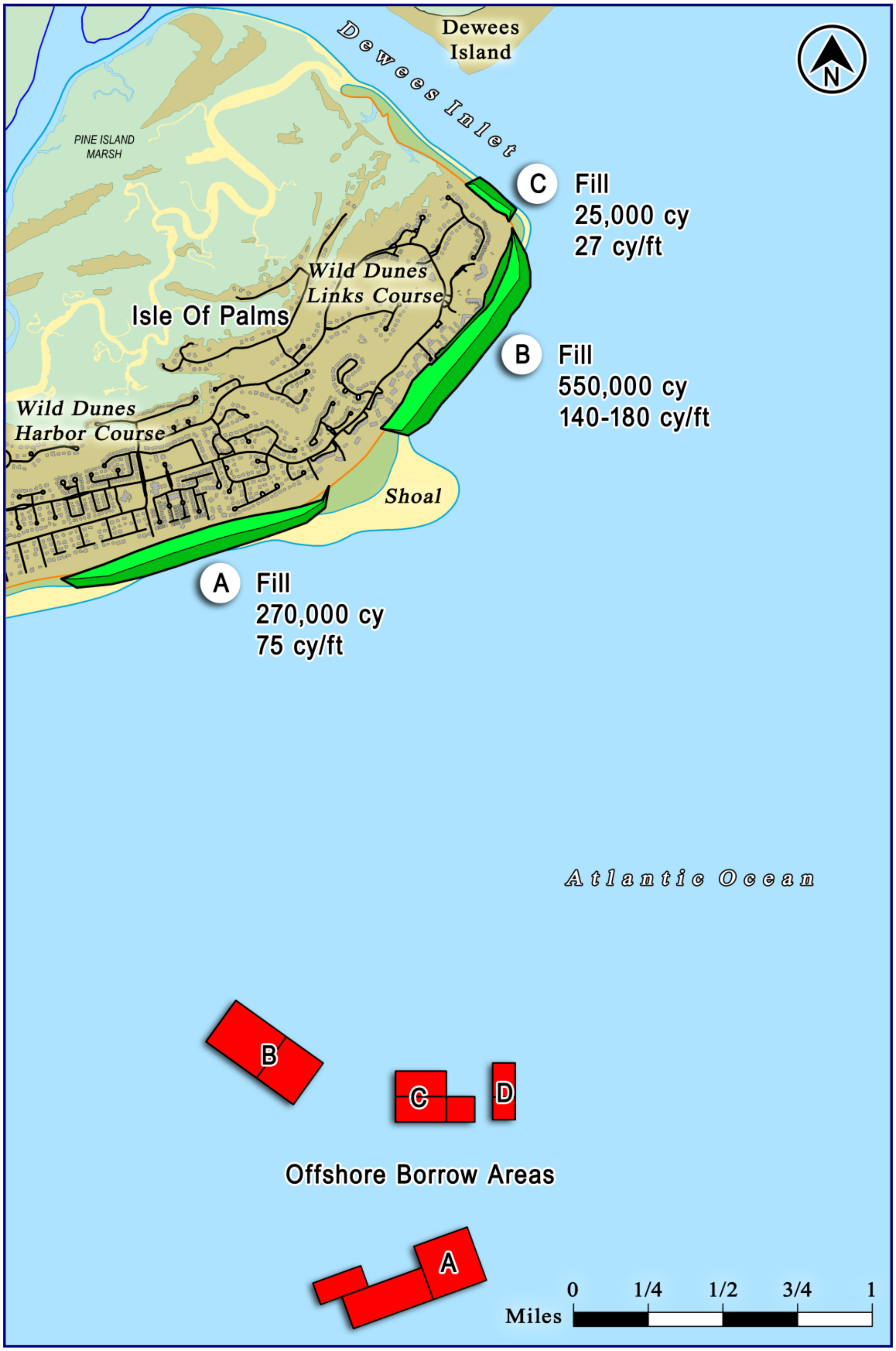

FIGURE 6. Project map of the 2008 restoration project. Fill was placed in areas showing focused erosion which had occurred from an ongoing shoal-bypass event.

FIGURE 7. Aerial and ground photos of Reach B of the project area before (left images) and after (right images) nourishment. Over 550,000 cy of sand were added to the area, widening the beach by over 300 ft. The northern end of this reach has been an erosional hot spot since the project and is the general location of the current shoal-management project.

Post-Nourishment Changes

CSE, at the direction of the City, completed post-project monitoring surveys in 2009, 2010, and 2011 encompassing the entire island and offshore delta of Dewees Inlet. Detailed results are presented in reports generated from monitoring data. In general, the project has performed well. Since 2008, two additional shoals emerged and attached to the beach, one attaching in 2009 and one in 2010. These shoals led to further accretion in the area near the Wild Dunes Property Owners Beach House and facilitated erosion of portions of the nourished area.

The most significant event since the project was the relocation of the Dewees Inlet main channel (Fig 8). In 2007, the channel (C in Fig 8) deflected southwest, running parallel to the shoreline until curving seaward in the vicinity of Shipwatch. A large offshore sand body (shoal – O) has been migrating southwest since 2007 (first available data), and has now closed off the old channel. A new channel (N) is forming to the northeast (in line with Dewees Inlet). The result is that the sand originally on the seaward side of the old channel has been "released" from the delta and is in the process of merging with the shoreline.

As of April 2012, the shoal (O) is less than 1,500 ft from the shoreline, and migrating at a rate of ~500 ft/yr (landward rate at station 292+00 from December 2011 to April 2012). The portion of the old ebb-tidal delta (associated with the original channel) is also migrating towards the beach, providing a source of sand to the southern portion of the project area (Reach A – Grand Pavilion area). As of June 2011 (three years after nourishment), ~66 percent of the nourishment volume remains within the fill limits, which includes 37 percent remaining in Reach A, 76 percent remaining in Reach B, and 129 percent remaining in Reach C. Lost sand has spread downcoast and led to accretion of non-nourished areas.

Two areas considered "erosional hotspots" have shown greater-than-average erosion since the project. One is near Beachwood East and the other is near Seascape, Ocean Club, and the 18th green of the golf course. The area near Beachwood East maintains a sufficient setback and dune protection, despite recent erosion. By 2011, the area near Ocean Club had eroded to a point where wave runup reached a dune walkover and encroached on the 18th green of the Links Course (Fig 9). Small additions of sand were added by private entities to rebuild the dune fronting the green, but this sand quickly washed away.

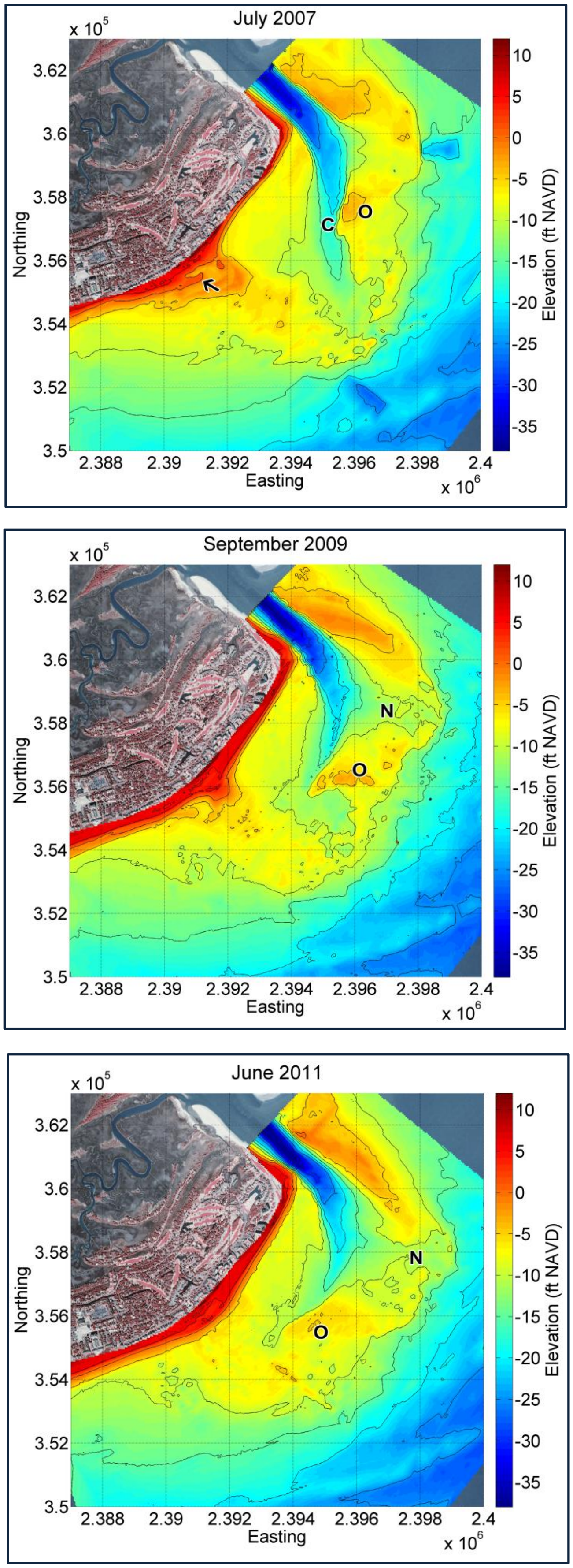

FIGURE 8.

Digital terrain models (DTMs) of the Dewees Inlet ebb-tidal delta. Blue shades represent deep water and the inlet channel. Yellow shades are shallow water; orange shades are shoals (breakers). The red area is the dry-beach/dune area.

Note the location of the inlet channel in 2007 ("C") and offshore shoals ("O").

By 2009, the shoal (O) had migrated south-west, encroaching on the channel. A new channel ("N") formed in a break in the delta.

By 2011, the old channel was completely closed, and the shoal began to migrate landward.

FIGURE 9. Condition of the shoal-management project fill area in August 2011 during Hurricane *Irene*, which passed offshore of South Carolina but produced significant wind and waves at Isle of Palms.

Due to the channel avulsion event occurring in Dewees Inlet, no new shoals were expected to attach to the beach and naturally rebuild the erosional hotspot near the Ocean Club units in sufficient time to avoid damage to infrastructure. Remedial action would be required to avoid a situation similar to the 2007 condition (sandbags fronting structures, no dune or dry beach). Alternatives included placing sandbags, small-scale nourishment via inland sources of sand, borrowing from shoal-attachment areas, and large-scale offshore nourishment.

The two alternatives in line with recommendations from the City's Long-Term Beach Management Plan (IOP 2008) were sand borrowing from the accretion zone, and large-scale nourishment via offshore sources. For the volumes involved, large-scale nourishment was not cost effective. Borrowing sand from the accretional area was considered the most cost effective and environmentally friendly alternative to rebuild the beach in the erosional hot spot. A monitoring survey in June 2011 revealed the condition of the beach and the potential borrow area, warranting a project within the next year. The City retained CSE for final design and project implementation services in anticipation of a project occurring in winter 2012.

Permitting

Anticipating the need to implement a sand redistribution project at some point in the future, the City authorized a permit application for a shoal management project. CSE met with representatives from regulatory and resource agencies on 2 September 2010 to discuss the intended goals and initial design of the project. CSE submitted a joint application to SCDHEC-OCRM and the USACE on 7 October 2010. Following submission of the application, CSE was informed that a Biological Assessment (BA) report and an Essential Fish Habitat (EFH) report would be required. These reports facilitate an evaluation by USFWS and NMFS of the impacts of the project on endangered and threatened species. The reports were submitted to the agencies in February 2011.

A joint public notice was issued on 2 December 2010, and CSE received public and agency comments in March 2011. CSE submitted a detailed response to the comments on 12 April 2011, and received additional comments 17 June 2011. CSE replied to these additional comments on 22 July 2011. OCRM issued the state permit (P/N 2010-1041-2IG) on 31 August 2011. The USACE issued the federal permit on 27 February 2012 and a modification letter on 9 March 2012 (allowing work to extend through April 30 and a pre-project lighting survey to be conducted in March rather than May).

The permit allowed for two events over a five-year period, with each event moving up to 250,000 cy of sand. The permits also included special conditions which required immediate post- and 1-year post-project surveys, lighting surveys, and sediment compaction monitoring. A trigger line was established that required that the +5 ft NAVD contour must be within 100 ft of structures in the erosional area before a project would be performed. Similarly, a buffer line was established in the borrow area 400 ft from the building line to ensure that an adequate beach remained in the borrow area following the project (Fig 10). No sand was to be borrowed landward of this line. The permit allows for borrowing or filling of any portion of the beach between 53rd Avenue and the groin near the 17th tee of the Links Course. This flexibility allows the City to manage the shoreline during shoal-bypass events, regardless of where they attach to the beach. An example plan is shown in Figure 11. Copies of the permit application, comment letters and responses, and permits are given in Appendix 1.

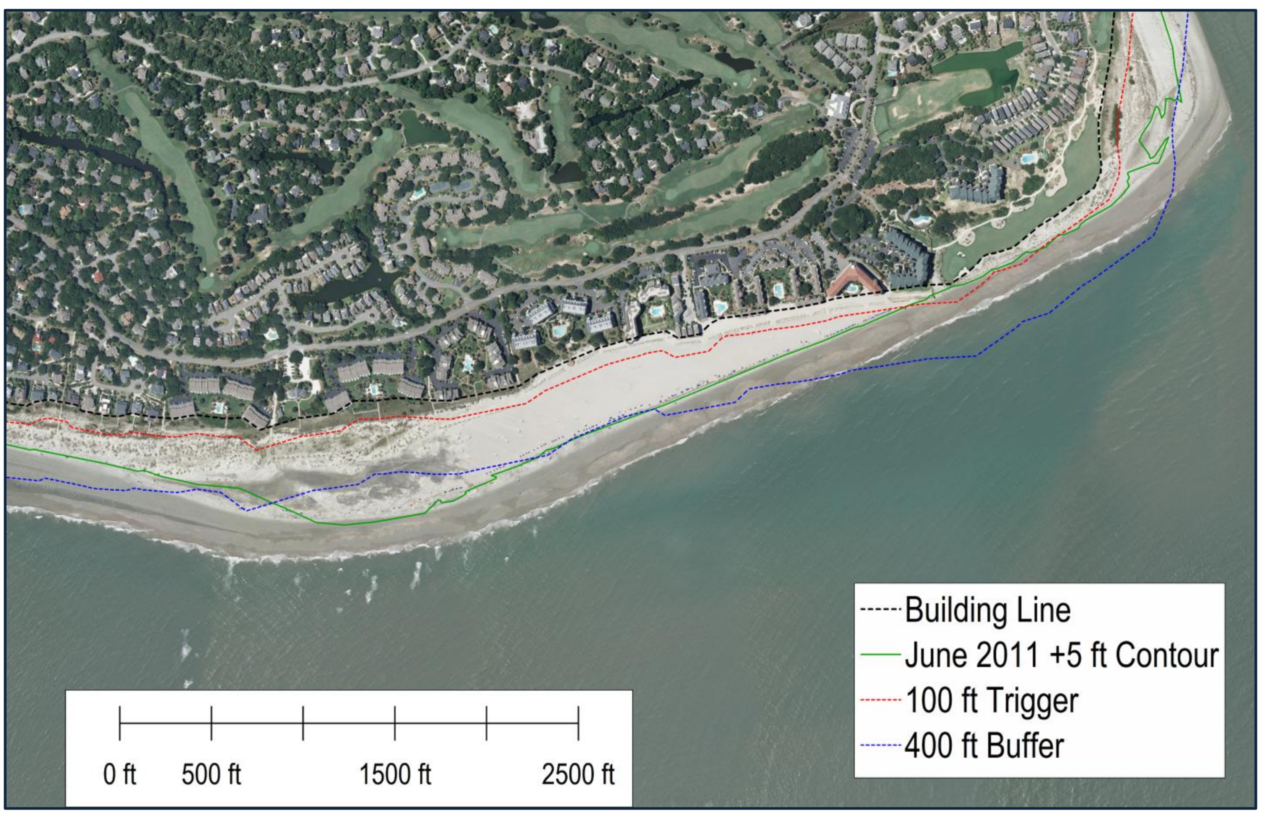

FIGURE 10. July 2011 aerial photo showing the 400-ft buffer line (blue), 100-ft trigger line (red), and position of the June 1022 +5-ft NAVD contour.

FIGURE 11. Permit drawing showing a potential scenario for a shoal-management project. Sand would be taken from an accreting area and placed in an eroded area. Under the permit, sand may be excavated or placed anywhere between 53rd Avenue and the groin along Dewees Inlet. [Note: This was not the final design for the project.]

PROJECT IMPLEMENTATION

Final Design

The final design of the project was determined by the condition of the erosional hot spot and availability of borrow material seaward of the 400 ft buffer line. The condition of the beach in December 2011 resulted in the project being limited to the available sand in the borrow area. CSE recommended the bid quantity be limited to a maximum of 90,000 cy with a base quantity of 60,000 cy. While more sand was present in the potential borrow area (~130,000 cy), the beach in the borrow area was in an eroding state.

CSE recommended a lower quantity to avoid the chance that the contractor would not be able to excavate the contract quantity (which could warrant a claim by the contractor). The maximum quantity of 90,000 cy would restore the fill area to its near post-nourishment condition, though spreading of the fill was expected. By setting the base bid at 60,000 cy, with an alternate of an additional 30,000 cy, the City had flexibility to end the project in the event the beach condition reached a point where additional excavations would leave the borrow area in an unacceptable condition.

The design berm was triangle-shaped, with the center of the triangle near station 314+00 (Ocean Club) and elevation of +6 NAVD. This shape was selected to prolong the life of the fill as it spreads naturally. The slope of the beach face was assumed to be 1 on 20. Fill limits were between station 306+00 (Port O'Call) and station 320+00 (18^{th} fairway) (Fig 12). Limits of the borrow area were from station 276+00 (Beach Club Villas I) to station 296+00 (Shipwatch) (see Fig 12). In the borrow area, excavations were designed to reach −6 ft NAVD and were restricted to the area seaward of the 400-ft buffer line. The plans did not dictate specific equipment or means by which the sand would be transferred (only that work must be performed "in-the-dry").

FIGURE 12. [following page] Final design of the 2012 shoal-management project showing limits of the borrow and fill areas and the project baseline.

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Figure 12 (11by17 foldout)

Bidding

Plans and specifications were made available to contractors on 27 January 2012. An advertisement for the work was published in the Post and Courier on 28 January 2012. The public bid opening was set for 17 February 2012 at City Hall. A mandatory pre-bid meeting was held 9 February 2012 at the Wild Dunes Property Owners Association Beach House. Representatives from 13 contractors were present as well as representatives of CSE, IOP, and Wild Dunes Community Association. Details of the project were discussed and questions were answered via an addendum to the bid package (Appendix 2). The work was bid as lump sum with separate pricing for the base quantity and alternate quantity.

Bids were received by the City until the public bid opening. The City received bids from seven contractors. Bids ranged from $250,500 to $930,000 for the maximum quantity (90,000 cy) with the low bidder being Baker Infrastructure Group Inc from Garden City (GA). The bid tabulation is given in Table 2. CSE reviewed the bid packages and interviewed references for Baker. City attorneys certified the bid bonds for the top three bidders. CSE recommended the City award Baker the contract for the base quantity, reserving the alternate quantity to be awarded after the beach condition could be evaluated during the project. Notice of Award was issued to Baker on 1 March 2012 for $177,000 to excavate and place 60,000 cy of material.

TABLE 2. Summary of bids received for the 2012 shoal-management project at Isle of Palms.

Bid Tabulation

Shoal Management Project - Isle of Palms, SC

Friday February 17, 2012 - 10:00 am

Owner Representatives: Linda Tucker, City Administrator; Emily Dziuban

Engineer Representatives: Haiqing Kaczkowski; Steven Traynum

Name	Addendum Acknowledged	Base Bid Unit Price	Base Bid Lump Sum Price	Alternate #1 Unit Price	Alternate #1 Lump Sum Price	Total Maximum Price	Bid Bond	Noncollusion Affidavit	List of Subcontractors	Equipment List	License Number	Bond Certified by Owner (Y/N)
Baker Infrastructure Group, Inc	Yes	$2.95	$177,000.00	$2.45	$73,500.00	$250,500.00	Yes	Yes		Truck (3); Excavator (1); Dozer (1)	G116262	
O.L. Thompson Construction Company, Inc	Yes	$3.45	$207,000.00	$3.25	$97,500.00	$304,500.00	Yes	Yes		Truck; Excavator; Dozer	G11395	
Weaver Contracting, LLC	Yes	$4.85	$291,000.00	$4.85	$145,500.00	$436,500.00	Yes	Yes		Truck (3); Excavator (2); Dozer (1)	G115713	
Richardson Construction Co. of Columbia SC, Inc.	Yes	$5.60	$336,000.00	$5.00	$150,000.00	$486,000.00	Yes	Yes		Truck (4); Excavator (2); Dozer (2)	G10951	
International Public Works, LLC	Yes	$5.93	$355,800.00	$5.93	$177,900.00	$533,700.00	Yes	Yes	Action (G113030)	Truck (3); Excavator (4);	G108340	
L-J, Inc	Yes	$9.15	$549,000.00	$6.90	$207,000.00	$756,000.00	Yes	Yes	Allston-Farrell Construction (G116897)	Truck (6); Excavator (2)	G112370	
Celek & Celek Construction, Inc	Yes	$10.50	$630,000.00	$10.00	$300,000.00	$930,000.00	Yes	Yes		Truck (3); Excavator (2); Dozer (3)	G11811	

Construction

A pre-construction meeting was held 8 March 2012 at City Hall. Representatives from Baker, CSE, the City, Isle of Palms Police Department, Wild Dunes Community Association, and Wild Dunes Resort were present. Details of construction were discussed, including public safety, truck counting, environmental protection, and work schedule. The contractor (Baker) began mobilizing equipment to Isle of Palms around 8 March. Notice to proceed was issued 9 March 2012.

Figures 13–15 show construction activities. The contractor mobilized two Volvo A25 and one Volvo A30 off-road dump trucks, one Komatsu 360 excavator, and one Komatsu 61px dozer to the site. Excavations began the morning of 12 March 2012. The work was accomplished by excavating rows of beach ~10 ft wide by ~150 ft long and ~3 ft deep. Excavations occurred near the waterline, following it out during falling tide and back in during a rising tide. Work ceased during high tide so all holes would infill. The excavator moved parallel to the beach from the south end of the borrow site to the north end, then moved back to the south end. This method allowed room for the trucks to maneuver between the excavated holes.

Loaded trucks drove along the wet-sand beach to the fill area, where they dumped piles in a line along the length of the fill area (sometimes placing more sand in a given area to meet the design template). The contractor chose to leave the piles overnight, allowing the high tides to erode and redistribute the sand in a natural profile. Occasionally, accumulated sand piles would be bulldozed to the design elevation (+6 ft NAVD) according to the plans. This strategy allowed the contractor to minimize equipment time and still produce a natural beach slope. Work progressed in this manner for the duration of the project.

Progress surveys were completed intermittently during construction. These surveys enabled monitoring the condition of the borrow area to ensure that sufficient sand was available for excavation and that the 400 ft buffer line was not breached. Following the condition survey of 19 March 2012, CSE recommended the City award the additional 30,000 cy to the contractor. Included was a caveat that the City could stop work in the event the beach condition reached a point where the City felt additional excavations should not occur. A change order was issued on 27 March for excavating and placing up to an additional 30,000 cy.

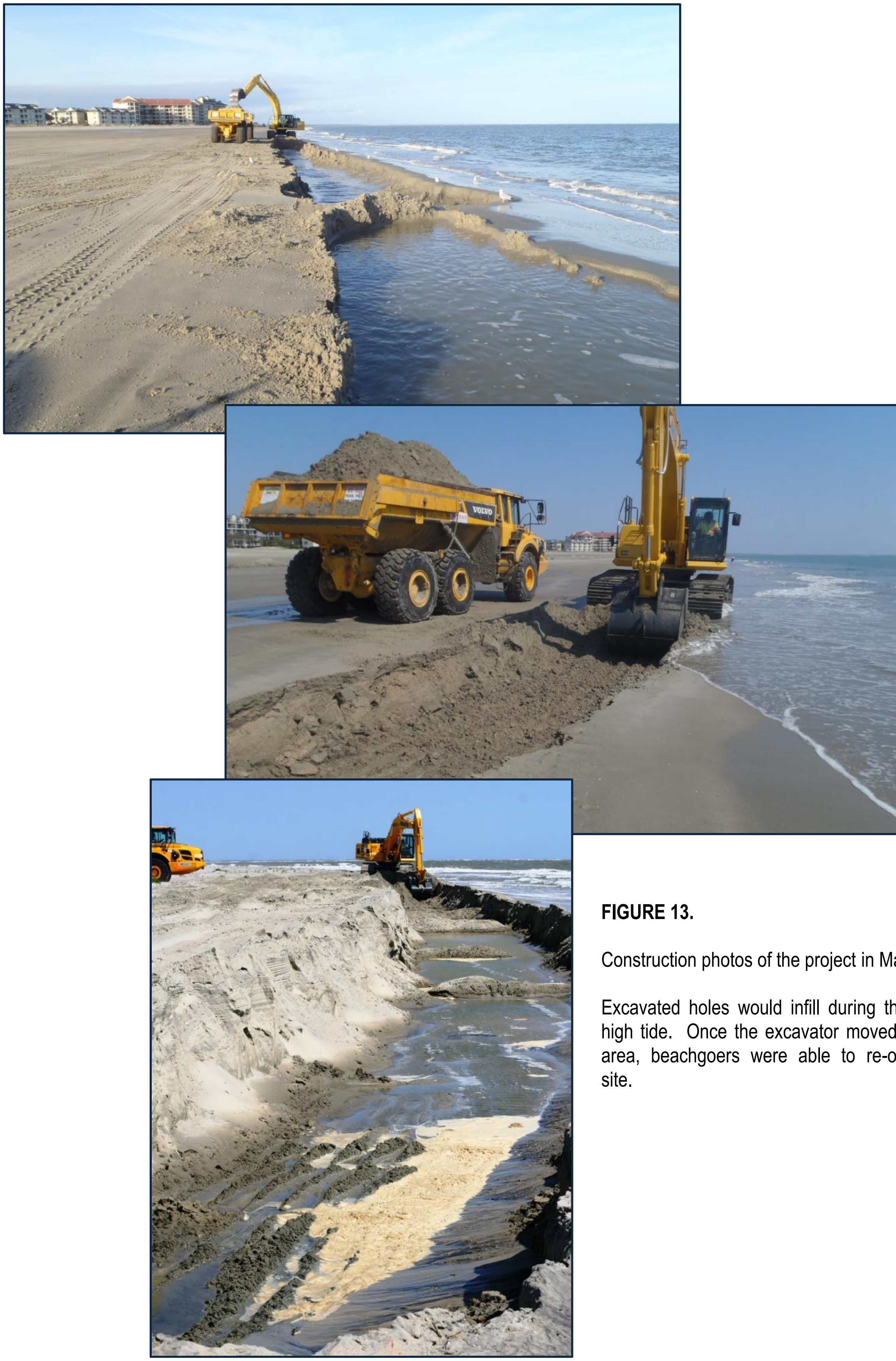


FIGURE 13.

Construction photos of the project in March 2012.

Excavated holes would infill during the ensuing high tide. Once the excavator moved out of an area, beachgoers were able to re-occupy the site.

FIGURE 14. Construction photos of the project in March 2012.

FIGURE 15. Construction photos of the project in April 2012.

Payment Quantity

Payment for the work was to be for total volume excavated, hauled, and placed. This was determined via numbers of truckloads. Truckloads were counted by off-duty staff from the City. Volumes for each type of truck were determined by surveying a dumped pile and computing the volume from the survey data. Per terms of the contract, Baker reviewed the CSE load volume calculations and agreed to the nominal quantities proposed for each truck. The A25 trucks showed a volume of 28 cy per truck, while the A30 trucks hauled a volume of 31 cy per truck. This method provides a "loose" volume measure, meaning the actual in-place volume will be less due to sediment compaction when the sand is subject to breaking waves. The only way to compensate for the compaction factor is to either apply a correction factor to the measured volumes (~10–20 percent) or measure in-place volumes via detailed surveys. Either of these methods would result in a higher bid price for the work.

Payment quantity was determined by multiplying the total number of loads for each truck by that truck's haul volume. Work was completed over 21 working days between 12 March and 10 April 2012. **The volume moved was 87,763 cy for a total price of $245,019.35** (60,000 cy at the base price of $2.95/cy and 27,763 at the alternate price of $2.45/cy). On average, 4,179 cy were transported per day by the contractor. Table 3 summarizes daily loads/volumes for the project. Figure 16 shows photos of the completed fill area.

FIGURE 16.

Images of the completed fill area on 10 April 2012.

TABLE 3. Summary of daily load counts and volumes moved. Load volumes were based on surveys of individual loads and were agreed upon by the contractor, CSE, and the City prior to construction.

Isle of Palms Shoal Management Project - Daily Load Counts					
Truck number	1	2	3		
Truck type	A25	A30	A25		
Load Volume (cy)	28	31	28		
Date	**Truck 1 Loads**	**Truck 2 Loads**	**Truck 3 Loads**	**Total loads**	**Total Volume (cy)**
3/12/2012	30	32	29	91	2,644
3/13/2012	60	59	44	163	4,741
3/14/2012	70	72	31	173	5,060
3/15/2012	62	64	60	186	5,400
3/16/2012	20	19	21	60	1,737
3/19/2012	51	51	50	152	4,409
3/20/2012	62	26	62	150	4,278
3/21/2012	77	0	76	153	4,284
3/22/2012	78	6	77	161	4,526
3/23/2012	59	58	58	175	5,074
3/26/2012	59	59	59	177	5,133
3/27/2012	75	71	9	155	4,553
3/28/2012	92	93	0	185	5,459
3/29/2012	87	86	0	173	5,102
3/30/2012	32	27	0	59	1,733
4/2/2012	70	69	0	139	4099
4/3/2012	84	84	0	168	4956
4/4/2012	75	75	0	150	4425
4/5/2012	53	53	24	130	3799
4/9/2012	61	59	56	176	5105
4/10/2012	15	14	14	43	1246
Total	**1272**	**1077**	**670**	**3019**	**87,763**

Post-Construction Survey

CSE completed comprehensive surveys of the project area in December 2011 and April 2012. The December survey was used for final design and as the "pre-construction" condition of the beach. The April 2012 survey was used to provide a "post-construction" condition of the beach, including berm width in the borrow and fill areas. Surveys extended from the back-shore to the seaward side of the offshore shoal using RTK GPS. Sand volume was computed via the average-end-area method, where the average volume between two stations is multiplied by the distance between the stations to find the total volume. Unit volumes (volume of sand in the beach per linear foot — Fig 17) and total volumes are compared to the December 2011 (pre-project) and March 2008 (pre 2008 nourishment) conditions. Table 4 shows unit volumes and total volumes for selected dates in the project area. Profiles for all stations are given in Appendix 3.

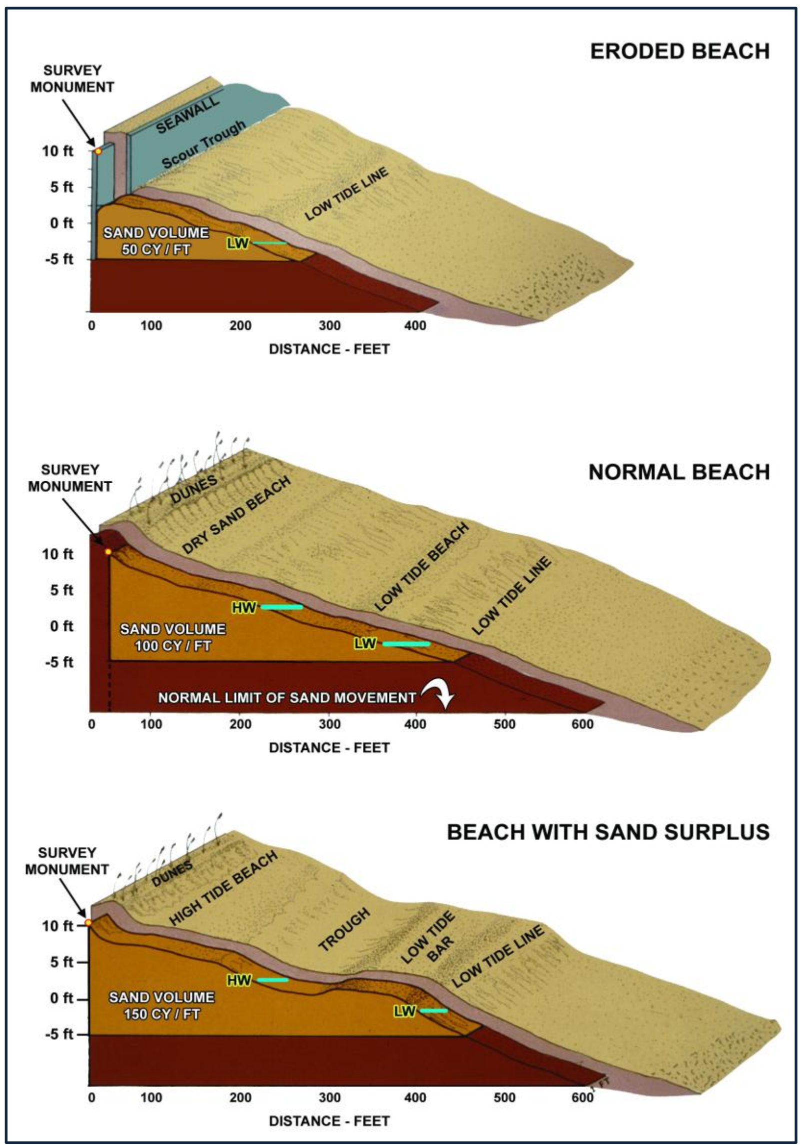


FIGURE 17.

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]

TABLE 4. Unit and total volumes for selected dates in the project area. The excavation area is highlighted in red and the fill area in green. Refer to Figures 11 and 12 for station locations. Calculations begin at a common backshore point for each station and extend to the −10-ft NAVD depth contour.

		Unit Volume (cy/ft)					Total Volume (cy)		Volume Change Since Previous (cy)	
Station	Distance	Mar-08	Jul-08	Jun-11	Dec-11	Apr-12	Dec-11	Apr-12	Jun '11 to Dec '11	Dec '11 to Apr '12
248	200	188.7	272.2	255.9	235.3	232.2	46,470	46,043	-3,983	-427
250	200	188.5	282.2	248.6	229.4	228.2	45,591	45,759	-3,847	168
252	200	197.9	291.9	245.8	226.5	229.4	45,266	45,947	-2,915	682
254	200	197.5	298.1	236.0	226.1	230.1	45,828	46,481	-1,130	653
256	200	212.3	313.2	233.6	232.1	234.7	45,346	45,503	315	157
258	200	201.7	297.6	216.7	221.3	220.3	44,456	44,417	1,130	-39
260	200	229.1	305.9	216.5	223.2	223.8	45,525	46,409	-1,232	885
262	200	283.5	346.2	251.1	232.0	240.3	43,256	43,932	-1,600	676
264	200	289.4	349.3	197.5	200.6	199.1	40,171	40,285	-2,352	114
266	200	303.7	374.3	227.7	201.2	203.8	40,964	42,333	-5,091	1,369
268	200	292.7	338.1	232.8	208.5	219.5	46,536	45,596	-3,467	-940
270	200	365.0	394.5	267.2	256.9	236.4	50,095	47,150	-4,394	-2,945
272	200	363.2	377.0	277.7	244.1	235.1	51,293	47,767	-5,813	-3,527
274	200	341.5	344.6	293.4	268.9	242.6	63,935	59,584	-7,133	-4,351
276	200	461.8	459.1	417.3	370.5	353.3	71,477	66,510	-12,875	-4,967
278	400	463.2	415.2	426.2	344.3	311.8	147,692	134,075	-29,293	-13,617
280	200	461.0	436.6	458.7	394.2	358.5	77,633	71,075	-9,390	-6,559
282	200	501.0	440.4	411.5	382.2	352.2	82,377	76,090	-8,540	-6,287
284	200	515.3	522.2	497.7	441.6	408.7	85,738	78,866	-9,297	-6,872
286	200	445.3	471.8	452.7	415.8	380.0	83,333	76,291	-6,193	-7,042
288	200	333.0	423.8	442.6	417.6	382.9	82,049	74,904	-3,480	-7,145
290	200	255.4	357.3	412.7	402.9	366.1	82,061	75,672	-1,553	-6,390
292	200	246.8	355.6	423.4	417.7	390.6	82,854	78,048	924	-4,806
294	200	235.7	363.0	395.9	410.9	389.9	79,909	76,833	2,825	-3,076
296	200	213.5	354.7	375.0	388.2	378.5	75,490	74,651	2,344	-839
298	200	191.1	354.1	356.5	366.7	368.0	71,258	71,227	1,641	-31
300	200	173.6	347.5	339.7	345.9	344.2	66,842	66,532	1,114	-310
302	200	149.8	339.3	317.6	322.5	321.1	61,649	61,715	655	66
304	200	141.5	333.2	292.3	294.0	296.0	60,534	61,688	219	1,154
306	200	171.7	372.6	310.8	311.4	320.8	57,834	60,444	655	2,610
308	200	155.4	341.0	260.9	267.0	283.6	49,756	54,484	-932	4,729
310	200	152.6	312.9	245.9	230.6	261.2	43,096	49,723	-760	6,627
312	200	111.2	281.0	192.6	200.4	236.0	35,474	43,274	613	7,800
314	200	86.9	246.1	156.0	154.4	196.8	37,979	44,950	-1,156	6,972
316	200	136.4	309.3	235.4	225.4	252.7	43,959	50,733	-2,518	6,774
318	200	128.2	312.0	229.4	214.2	254.6	45,150	50,809	-1,668	5,659
320	200	140.9	324.5	238.8	237.3	253.5	48,848	51,476	-1,762	2,628
322	200	205.4	368.5	267.3	251.2	261.3	50,762	52,259	-3,046	1,498
324	200	212.3	361.7	270.8	256.5	261.3	48,994	50,534	-3,910	1,540
326	200	174.1	291.2	258.3	233.5	244.0	49,637	50,465	-2,151	828
328	200	241.0	285.3	259.6	262.9	260.7	26,289	26,065	328	-224

Volume changes between December 2011 and April 2012 do not equal the payment quantity for two reasons. The most significant is that natural erosion and/or accretion occurred between the two surveys before and during the project. Sand that was added or lost from the borrow and fill areas naturally will sum with the volume moved during the project. The other factor is that the work was measured by trucked volumes, which are based on a "loose" sand measure, not a compacted, in-place volume. This decreases the net volume from what was moved to what remains in place after waves sort and compact the sand. The project could have been paid for by utilizing in-place volumes; however, this generally means increased survey costs as well as higher bid prices. The dynamic nature of the project area would have been another complicating factor, as rapid spreading of sand would be difficult to account for using in-place surveys.

Volume analyses show that the beach within the borrow limits lost 66,760 cy between December 2011 and April 2012, which is ~76 percent of the project volume. For comparison, this same area lost 76,870 cy between June and December 2011. This shows that the scale of the project was not greater than typical beach changes occurring naturally due to erosion/accretion associated with shoal-bypass events. Including some adjacent stations, which were likely impacted by the project as the beach adjusted to the excavations, the volume loss was ~78,760 cy (stations 270+00 thru 300+00), which is closer to the payment quantity. Unit volume change in the borrow area showed that the maximum losses were on the order of 35 cy/ft in the most heavily excavated areas, while adjacent areas showed relatively little change (Fig 18). The difference between the measured volume and the project volume is the background beach volume change from December 2011 to April 2012.

Between December 2011 and April 2012, the fill area showed a net gain of 41,171 cy within the fill limits and a gain of 48,883 including nearby stations (which likely received sand that spread from the fill area). The difference between this gain and the payment quantity (a difference of 38,880 cy) is the background erosion between December 2011 and April 2012 and volume loss due to compaction of hauled sand. This area lost ~17,000 cy between June and December 2011; and is assumed to have a greater background erosion rate between December 2011 and April 2012 based on limited profile data collected and visual observations at the beginning of the project (for example, station 304 was stable from June to December 2011, but lost ~2,660 cy from December 2011 to March 2012, calculated to -6 ft NAVD). Unit volumes in the fill area increased by up to 40 cy/ft (Fig 18).

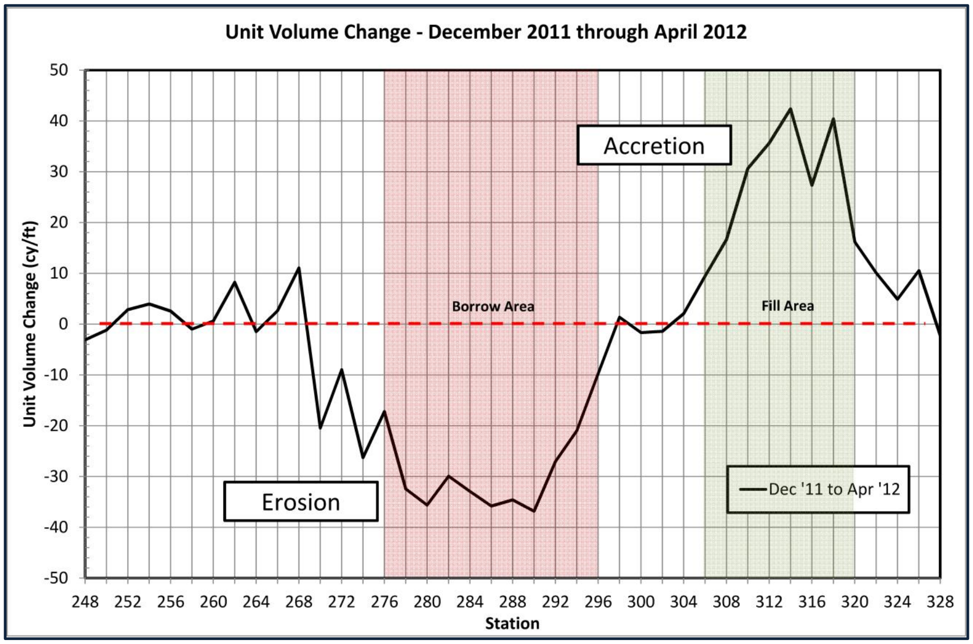


FIGURE 18. Unit volume change between December 2011 (pre-nourishment) and April 2012 (post-nourishment). The borrow area is highlighted in red and the fill in green. These values include background erosion and accretion between the two surveys.

Compared to the March 2008 condition (pre-nourishment), the southern half of the borrow area shows significant erosion while the northern half has an equal amount of accretion (Fig 19). Despite the shoal management project, which produced a volume loss up to ~35 cy/ft in the borrow area, the northern half shows a net accretion of 50-150 cy/ft compared to March 2008. The southern half has been steadily eroding following the shoal attachment in 2007, though there still is a wide protective berm/dune area between the water and structures. Currently, the beach between station 260+00 and station 286+00 (2,600 linear ft from Beachwood East to Beach Club Villas II) shows less volume than the pre-nourishment condition (red dotted line in Fig 19). The beach between stations 290+00 and 320+00 (Mariners Walk to the 18th fairway) retains at least 100 cy/ft more sand than the pre-nourishment (March 2008) condition (measured to the −10-ft NAVD contour).

For a simple beach condition assessment tool, the position of the mean lower low water (MLLW) contour (-3.1 ft NAVD) is plotted in Figure 20 compared to the March 2008 (pre-nourishment) condition. When the lines fall above zero (red dotted line), the shoreline is further seaward than it was in March 2008. When the line is below zero, erosion has occurred. Generally, stations south of 288+00 (Mariners Walk) show landward retreat of the MLLW contour up to 400 ft near the Wild Dunes Property Owners Beach House. Between December 2011 (red line) and April 2012 (black line), the MLLW contour receded up to 70 ft, averaging 37 ft. In the fill area, the MLLW contour was 100 ft seaward of the pre-nourishment position as of December 2011. After the shoal management project, the contour moved up to 90 ft seaward, returning it to near the March 2009 position.

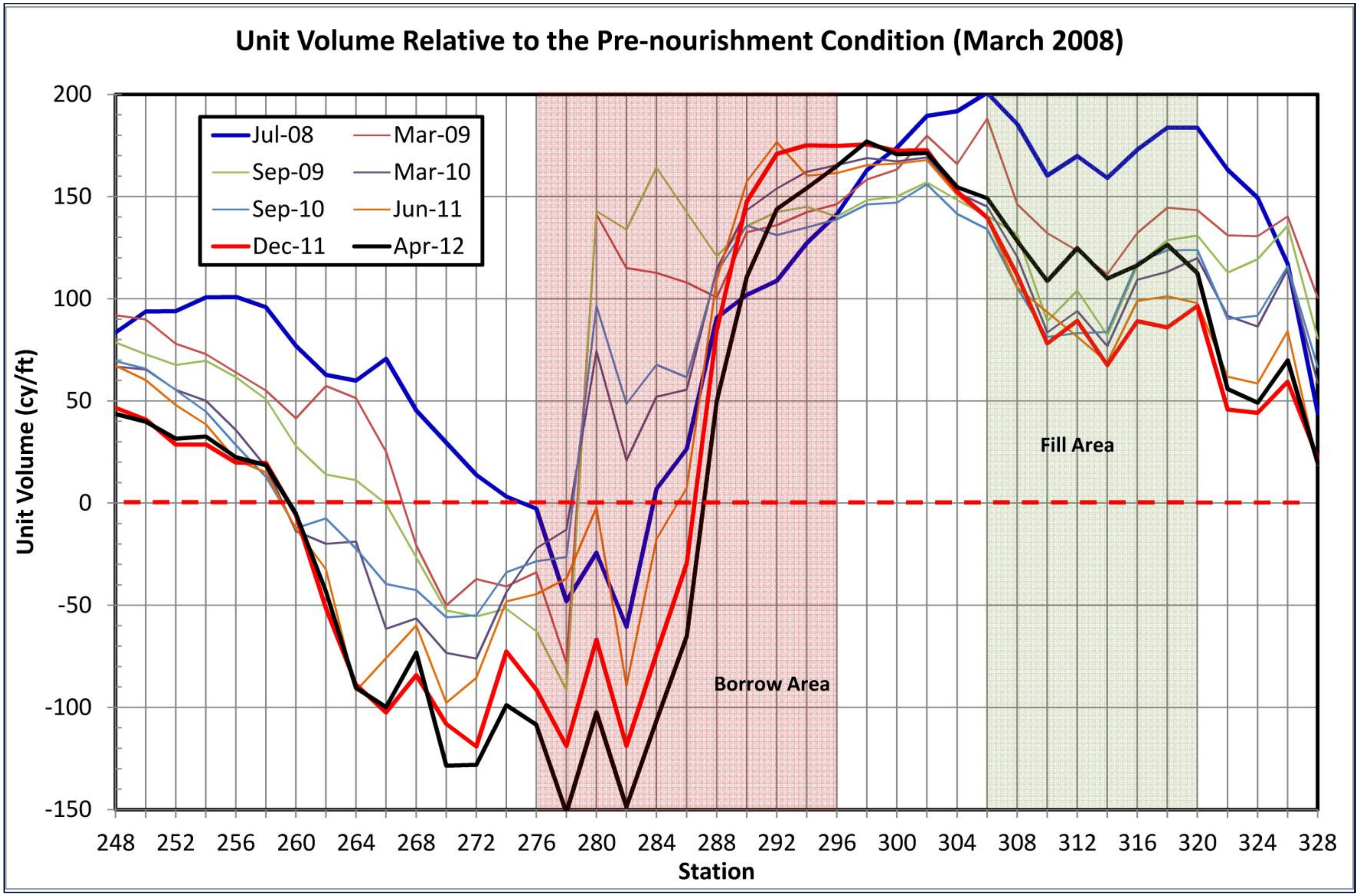


FIGURE 19. Unit volume (to −10 ft MAVD) relative to the beach condition prior to the 2008 project. Positive values represent a healthier beach than the March 2008 condition. The difference between the red and black lines represents the project change (and background change). The difference between the blue and black lines represents the current condition compared to the post-nourishment condition.

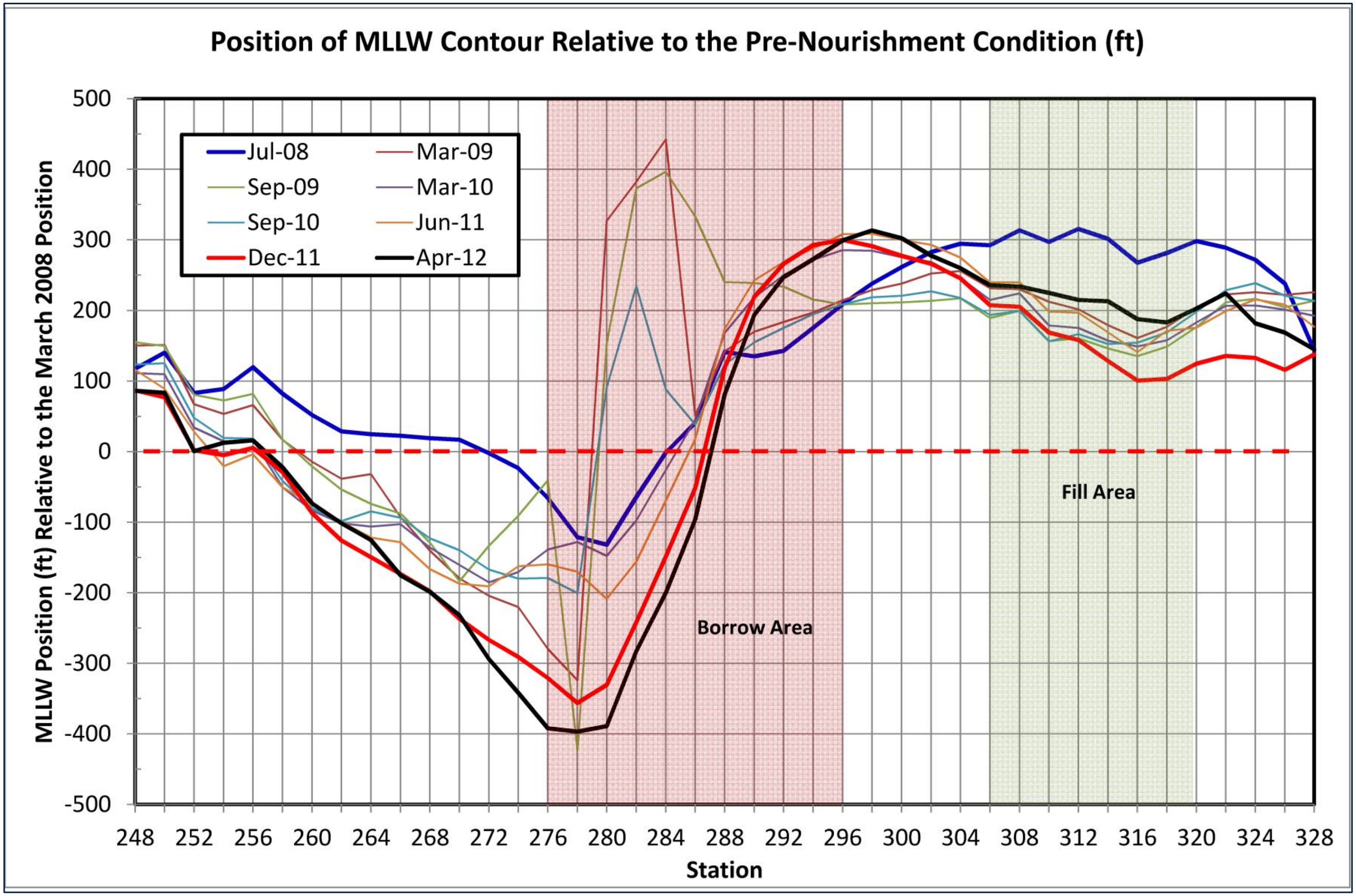
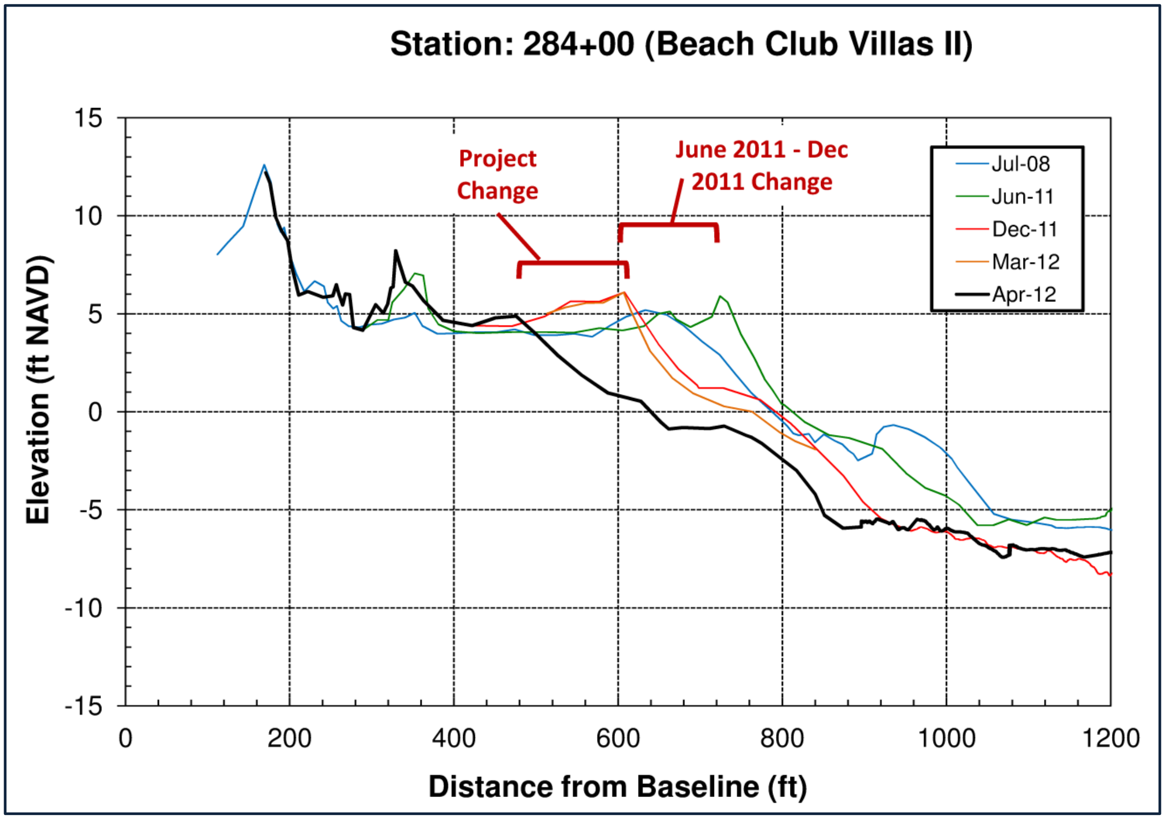


FIGURE 20. Position of the −3.1-ft NAVD contour (mean lower low water line) compared to the March 2008 (pre-nourishment) condition. Positive values indicate seaward movement of the contour.

Profiles from station 284+00 (Beach Club Villas II) in the borrow area are shown in Figure 21 (upper). On the upper plot, the beach area is shown to have eroded ~115 ft between June and December 2011. During the project, the beach eroded ~130 ft. While the shoreline change was slightly greater during the project window (December–April), the net volume loss was actually greater during the earlier window (June–December). The June–December 2011 period showed a unit volume loss of ~56 cy/ft, while the December 2011 to April 2012 period only lost ~33 cy/ft of sand. CSE believes the beach between Beach Club Villas II and Summer House is beginning to respond to the offshore shoal, which is approaching Stage 2 of the bypass cycle (see Fig 2). This portion of the beach is in the lee of the oncoming shoal, and should show higher rates of accretion as the shoal gets closer to shore over the next year or two. The shoal migrated ~250 ft landward from December 2011 to April 2012 and is currently ~1,500 ft from the beach at this profile (Fig 21, lower).

Profiles from station 314+00 (Ocean Club), at the apex of the triangular fill template, are shown in Figure 22. The project displaced the +5 ft contour ~115 ft seaward (horizontal difference between the red and black lines). For comparison, the immediate post-nourishment condition of July 2008 (blue line) showed the +5 ft contour another ~50 ft seaward of the April 2012 location. This station gained 42.4 cy/ft between December 2011 and April 2012, leaving it with a total unit volume of 196.8 cy/ft, very similar to the March 2009 condition (198.9 cy/ft). In March 2008 (pre-nourishment), this station only showed a unit volume of 86.9 cy/ft measured to −10 ft NAVD.



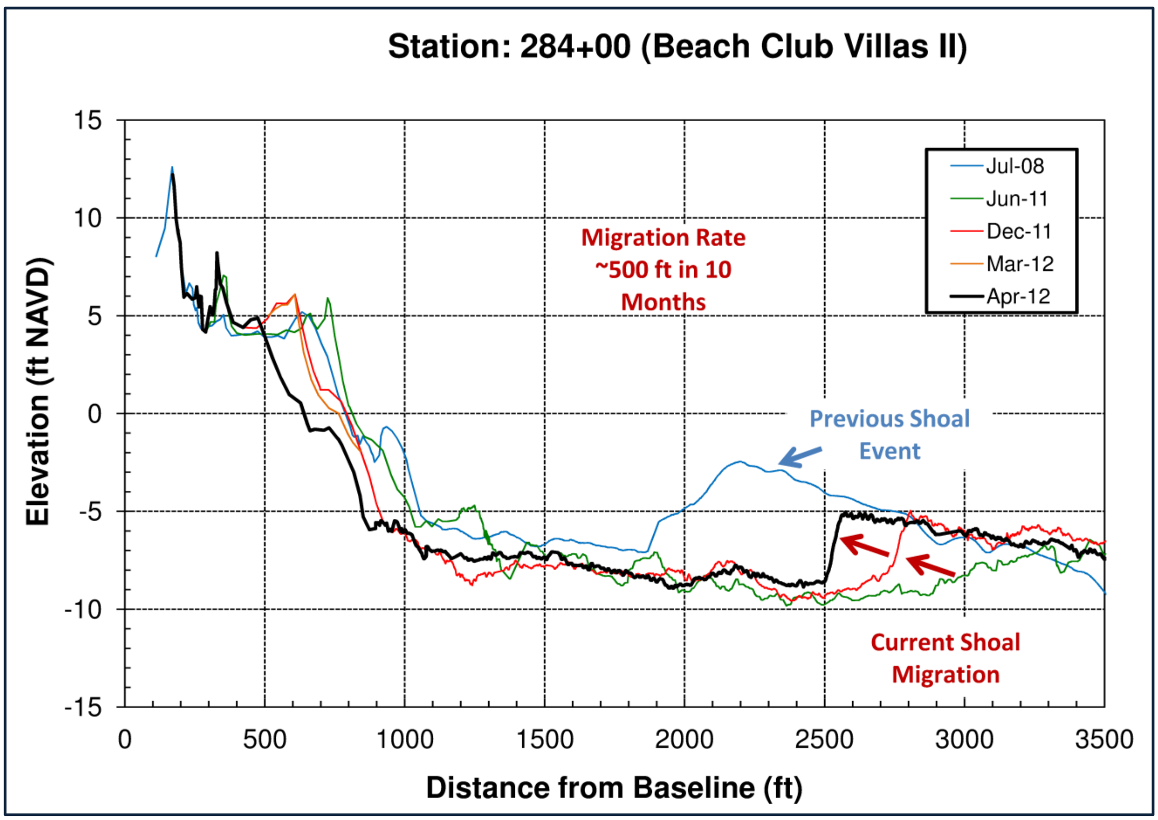


FIGURE 21. Profiles from station 284 near Beach Club Villas II. The upper plot shows the active beach area and recession of the berm crest ~130 ft from December 2011 to April 2012. The lower plot shows the offshore shoal migrating toward the beach at a rate of over 500 ft per year.

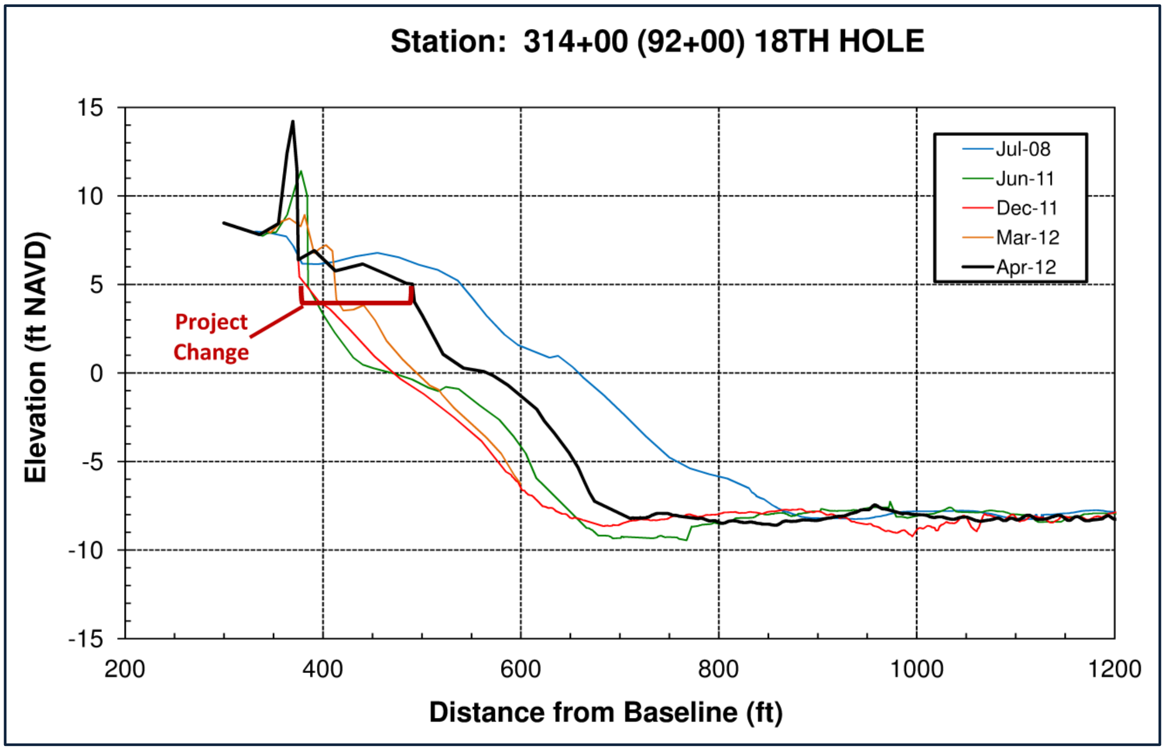


FIGURE 22. Profiles from station 314 near the Ocean Club building and the 18th green. The March 2012 profile is from an in-project condition survey. The blue line is the condition following the 2008 project.

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ADDITIONAL REQUIREMENTS

Per special conditions of the permit, the City is required to complete additional monitoring of the project area. The specific requirements are:

- Surveying the project area one year after completion.
- Measuring sediment compaction for three years after completion.
- Conducting lighting surveys of the area the year of and the year after the project.

The one-year post-project survey will be accomplished as part of the island-wide monitoring effort to which the City has committed (scheduled ~June 2013). It will include collection and analysis of profile data extending from the backshore to ~6,000 ft offshore using methods similar to previous studies CSE has completed for the City. Results will be submitted to resource agencies to satisfy the permit requirement.

Sediment compaction was measured immediately post-project and results were submitted to USACE, SCDNR, and USFWS. Results showed that compaction was similar to the native beach, and USFWS deemed no tilling was necessary. Results of the first compaction tests are included in Appendix 4. Compaction will be measured around February or March of each year for the next three years (if a dry berm remains in the project area).

Lighting surveys were included in the permit conditions to document artificial lights illuminating the beach. This involves walking the project area at night and recording the location and type of visible lighting (including direct and indirect lighting). These data are used to inform the City so that education and enforcement efforts may be enacted. The first survey was conducted in March 2012 (at the initiation of the project). Three additional surveys are scheduled for July 2012, May 2013, and July 2013. Results of the first lighting survey are included in Appendix 4.

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DISCUSSION

The 2012 Isle of Palms shoal management project was conducted to restore an erosional hot spot and in anticipation of future erosion and accretion associated with an ongoing shoal-bypass/channel avulsion event. The project used sand from an area of the beach which has received sand in recent years from separate shoal-bypass events. This strategy was used at Isle of Palms in the 1980s and 1990s; however, resource agencies have become increasingly concerned about using littoral sands (in the active beach system) as borrow sources because no new sand is added to the system. This is a valid concern on many long, straight beaches away from inlets and with a net sediment deficit. At Isle of Palms, there is a sand surplus due to shoal-bypassing from Dewees Inlet. The beach condition at the northeast end is not determined from long-term erosion but rather short-term fluctuations in response to bypass events. This makes sand borrowing a viable, affordable, and environmentally neutral approach to managing the beach.

The project permit allowed for transfer of up to 250,000 cy of sand during each event. The 2012 project was limited by the volume of available sand seaward of the 400-ft buffer line. Maintaining this buffer is essential to a successful project in that it maintains integrity of all parts of the beach. Maintaining support of the community (and especially ocean front properties) will facilitate cooperation if another project needs to occur.

For the 2012 project, the borrow area contained over 130,000 cy of sand in December 2011. In anticipation of additional erosion between December 2011 and startup of the project, the base bid volume was set at 60,000 cy with an alternate quantity of up to an additional 30,000 cy. CSE recommended the City only award the base bid and reserve the alternate quantity until the beach could be assessed during the project. Condition surveys during the project proved that a portion of the alternate could be moved, and CSE recommended the City award the alternate with a caveat that they can stop the project when the borrow area reached a desired condition. This condition was met just before the full 90,000 cy were moved, giving a final payment quantity of 87,763 cy.

The goal of the project is to restore the beach in the fill area and provide a sufficient volume of sand to allow for future erosion anticipated during the ongoing shoal-bypass event. There is a high level of uncertainty regarding the rate and magnitude of erosion which will occur as the shoal migrates landward. Ideally, project sand will provide enough of a buffer to allow for erosion until such time that the shoal attaches and sand spreads naturally or by another project (Stage 3 of the bypass cycle). CSE expects a new shoal to attach to the beach in 2–3 years, although the shoreline will show shoal-related changes much sooner (and evidence suggests that the beach is beginning to already exhibit signs of accretion in the lee of the shoal).

The project restored the fill area to its near-March 2009 condition, widening the beach by ~115 ft at the apex of the fill and tapering to either side. It is expected that the fill will spread laterally, producing a higher erosion rate at the center (Ocean Club). The sand was placed in a triangular form (view of berm from top) to prolong the protective life of the fill in the most severely eroded areas. The borrow area showed a retreat of up to 70 ft, which was a similar erosion rate to the changes between June and December 2011. This shows that the scale of the project was similar to natural changes associated with shoal-bypass events and, therefore, should not be considered to have a long-term detrimental effect to the beach or organisms.

The project was bid below expectations, and the contractor (Baker Infrastructure Group Inc) proved to be fully capable of completing the work in a safe and efficient manner with only three trucks, one excavator, and one dozer. One unavoidable negative aspect of the project was the construction window. Due to delays in obtaining the federal permit, the project occurred during the beginning of the busy tourist season, and the City received a few complaints regarding impacts to vacationers and rentals. Now that the permit is in hand, the next project (if needed) can be completed during the less busy season (permit window is August 15th to April 30th).

The City has committed to future monitoring of the beach and shoals, which will provide out-year updates on the condition of the borrow and fill areas, as well as documenting the rate and impacts of shoal migration over the next few years. It is uncertain what orientation the new shoal will take as it approaches the shore, and if or when the remnants of the old ebb-tidal delta will coalesce and merge with the main shoal. Likely, some form of lagoon will form between the shoal and leeward beach (similar to what was present in 2007). If the beach condition in the 2012 fill area (or any other area between 53rd Avenue and the 17th tee) reaches a point where remedial action is necessary, another project may be warranted. If the ongoing shoal-bypass event triggers need for another project, it will likely require a greater transfer volume to straighten the accretional "bulge" and restore eroded areas. CSE will provide recommendations and expectations as future monitoring data provide more conclusive information.

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