MONITORING AND ANALYSES OF THE 2013-2014
SAGAPONACK AND BRIDGEHAMPTON-WATER MILL
BEACH EROSION CONTROL DISTRICTS
NOURISHMENT PROJECT

2014 BEACH MONITORING

Prepared for:

Town of Southampton
Long Island New York

COASTAL SCIENCE & ENGINEERING

Monitoring and Analyses of the

2013–2014 Sagaponack and Bridgehampton Beach Erosion Control Districts Nourishment Project Southampton, Long Island, Suffolk County (NY)

2014
BEACH MONITORING REPORT

Prepared for:

Town of SOUTHAMPTON Long Island, NY

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[CSE2434–YR1]
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COVER PHOTOS: Aerial photo of Bridgehampton and Sagaponack looking east on 10 November 2014 (by TW Kana). As confirmed by CSE's November 2014 survey, 100 percent of the nourishment volume remained within the Sagaponack project boundaries out to the FEMA reference depth, and 106 percent of the nourishment volume remained within the Bridgehampton project boundaries out to the FEMA reference depth as detailed in this document.

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EXECUTIVE SUMMARY

Between October 2013 and February 2014, over 2.5 million cubic yards of sand (project volume) were pumped from offshore and spread along 5.6 miles of Sagaponack and Bridgehampton-Water Mill (Southampton, Long Island, NY) (Fig A). The purpose of the project was to widen the beach and provide better storm protection along oceanfront properties. The amount of sand dredged was equivalent to ~170,000 dump-truck loads or about 570 truck loads along a typical property with 100 feet (ft) of oceanfront. One year later, Sagaponack retains 100 percent and Bridgehampton-Water Mill retains 106 percent of the project volume. As of November 2014, about 37 percent of the nourishment sand was contained between the foredune and low-tide wading depth (beach zone). The remainder was contained between low-tide wading depth and a depth of 18 ft (underwater zone). Performance of the project, so far, exceeds the design expectation with negligible losses to downcoast areas.

This report presents detailed measurements of the beach in June and November 2014 for purposes of evaluating the performance of the project and providing a record for use by FEMA if a major storm impacts the south shore. The area of interest extends from Georgica Pond 1 mile east of the Sagaponack project limit at Town Line Road to the Village of Southampton Beach about 1.5 miles west of the Bridgehampton-Water Mill project limit at Flying Point Road.

FIGURE A. The Bridgehampton-Water Mill section of the 2013–2014 beach nourishment project under construction on 22 October 2013. Sand was dredged from offshore borrow areas and pumped one mile to the beach. Photo shows the pipeline discharging the sand slurry just west of Mecox Inlet which was diked off during construction. [Photo by First Coastal]

Nourishment sand shifts across the beach just as natural sand moves from the surf zone to the dry-beach area in summer or back to shallow water in winter. Upon initial placement, more of the nourishment sand is visible, but it quickly "equilibrates" by wave action to take on a natural profile. Much of the sand shifts to the underwater part of the beach, where it cannot be seen, but where it serves to create a necessary foundation for the visible beach.

CSE's basic approach for beach monitoring is to track the visible and underwater parts of the beach zone within the Sagaponack/Bridgehampton-Water Mill project area as a giant sand box. The sand volume of interest slopes gently across the box from the dune line to a reference depth offshore well beyond the outer bar. The total volume in the sand box is measured before nourishment and then compared with each survey after nourishment. The differences in volume provide a measure of sand losses (erosion) or gains (accretion) over time.

CSE calculates sand quantities out to about 1,500 ft offshore, which corresponds to the zone over which the majority of sand movement occurs from year to year. Underwater sand shifts toward shore in summer, producing a widening of the visible beach. The measurements also allow the beach to be subdivided into sections (reaches) along the coast so changes can be reported separately for Sagaponack or Bridgehampton-Water Mill, or the condition can be determined every 500 ft along the coast (stations) (Fig B). Further considered is how much sand is accumulating naturally along the dune line or building up along the outer bar. Volumes are calculated in various layers (lenses) across the sand box. Each lens is a slice of sand volume within particular elevation bands.

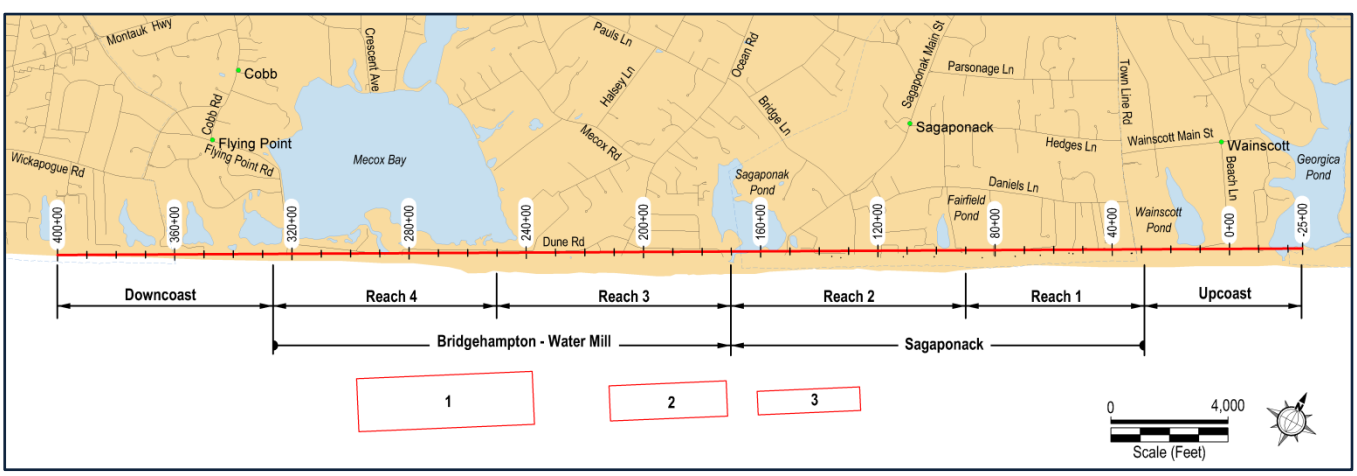


FIGURE B. The project area showing reaches (1–4) and stations (eg – 40+00, 200+00) evaluated by periodic surveys. The boxes offshore are the three dredge areas in water depths of ~40–60 ft which provided the "borrow sand" for the project.

One lens of interest, for example, is the "visible beach" measured from the toe of the foredune to the mean low water (MLW) mark. For consistency from survey to survey, specific elevation ranges are used for each lens. For the visible beach, the reference elevations appropriate for Southampton beaches are +7 ft and −1.2 ft NGVD.* The upper elevation more or less matches the normal level waves "swash" up the beach at high tide. The lower elevation equals MLW.

*[*NGVD (National Geodetic Vertical Datum) of 1929 which is a fixed reference elevation used by surveyors and FEMA for establishing flood levels. It approximated mean sea level when the datum was established. Tide levels, which vary along the coast, can be related site-specifically to this common datum.*]

The main text and appendices of this report provide numerous graphs and tables which break down the results in detail. This is useful for future nourishment designs as well as providing FEMA with documentation of where erosion has occurred within the project area (a requirement for post-disaster restoration funds under community assistance grants).

Many of the report graphs reference "unit volumes" which are a basic measure of how much sand is contained within a particular elevation band (lens) over a 1-ft length of beach (Fig C). Unit volumes (a three-dimensional measure) are used rather than beach width (a one-dimensional measure), because beach nourishment is a volume added to the beach. On a unit shoreline basis, the project added roughly 85 cy (~5.7 truck loads) along every foot of shoreline. For Sagaponack to Bridgehampton-Water Mill, **the project volume is expected to widen the visible beach an average of ~75 ft** after natural adjustment. The actual width increase from place to place will vary with the season (wider in summer than winter or after storms) and wider at some localities than others due to the natural waviness of the shoreline.

The main findings of the report are shown in Figures D and E. Figure D shows the additional amount of sand in the project area after nourishment in February, June, and November 2014 relative to the pre-project condition (August 2013). The left-hand group of bars represents sand volume gained along the foredune (results show an increase since construction ended). The right-hand group of bars represents the total volume gained between the foredune and the FEMA reference depth of −18 ft NGVD. These latter bars, representing the entire sand box, show ~100 percent remains along Sagaponack and ~106 percent remains along Bridgehampton-Water Mill. The increase in volume at Bridgehampton is due to some sand moving shoreward from deeper water, a common phenomenon after major hurricanes like *Sandy* (October 2012).

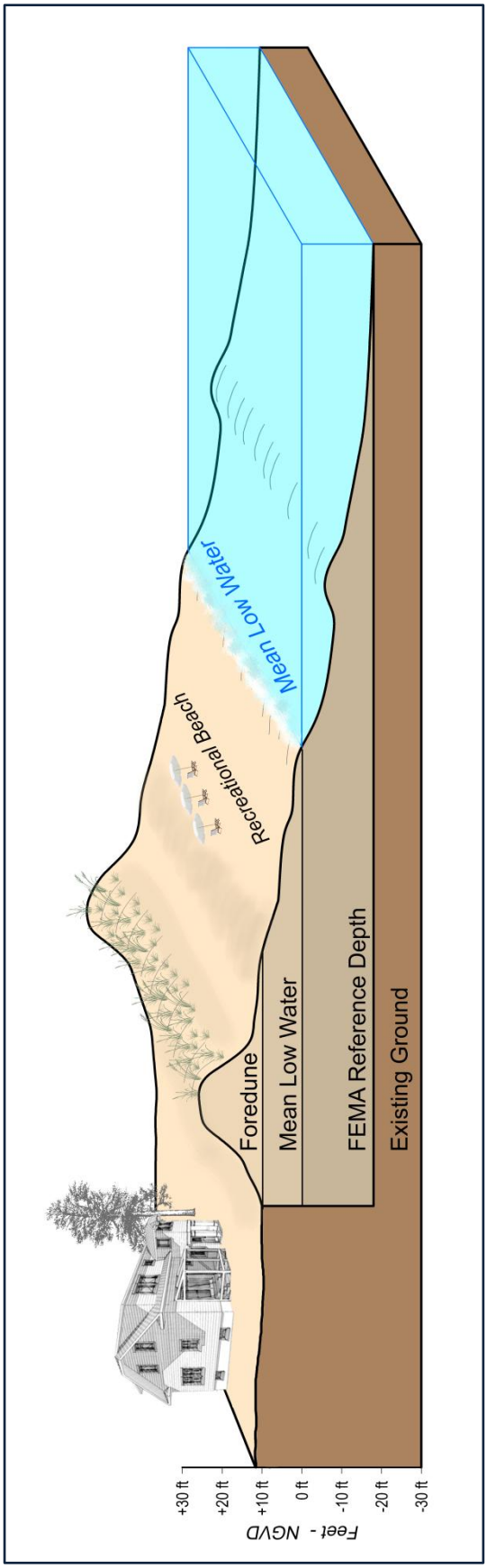


FIGURE C. The beach zone used for calculating sand quantities along Sagaponack and Bridgehampton-Water Mill. The zone of interest extends from the foredune to a specified offshore depth (FEMA reference at –18 feet), in effect, a large sand box over which waves shape the beach and shift sand around.

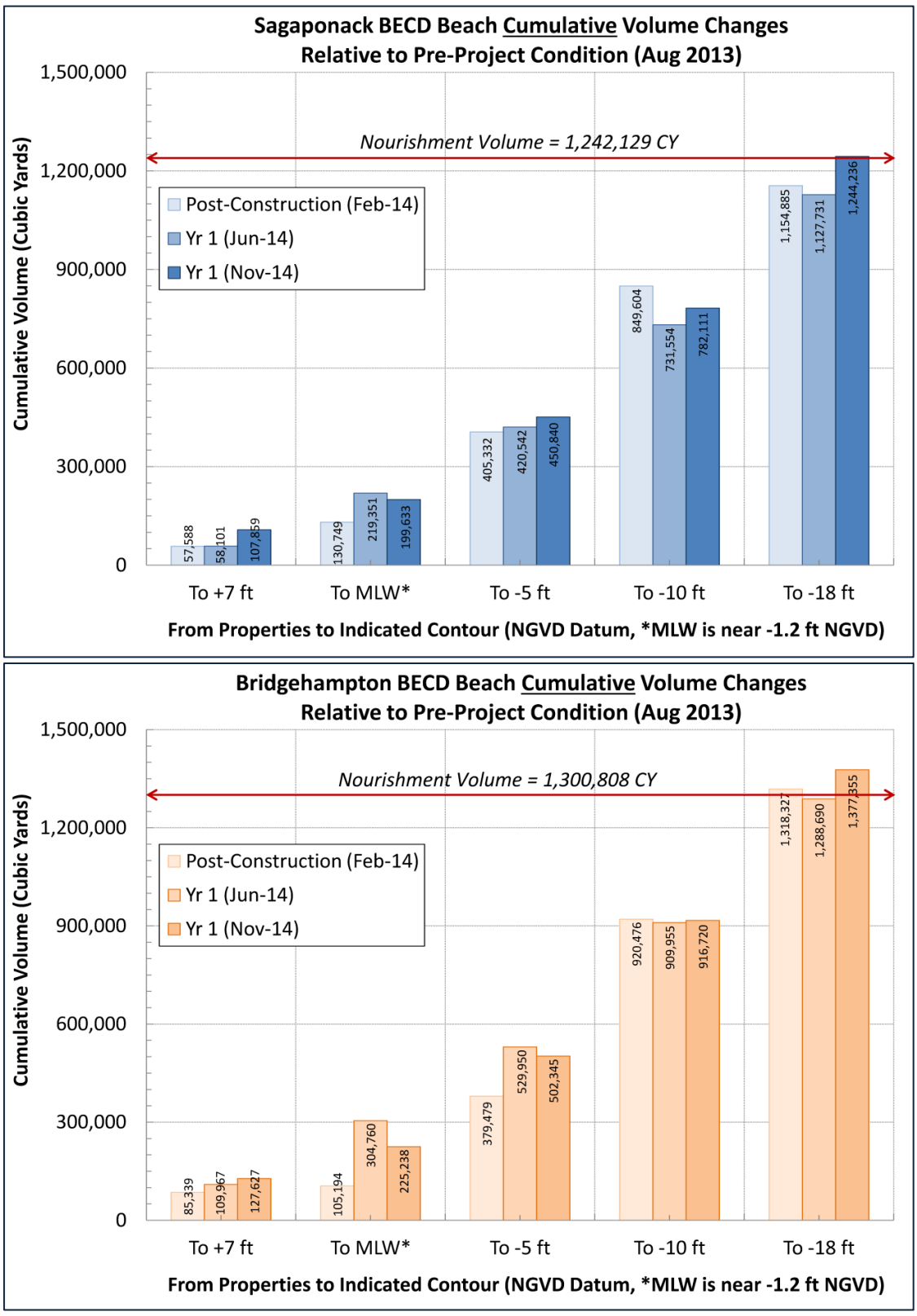


FIGURE D. The volume of nourishment sand within the project boundaries of Sagaponack (upper) and Bridgehampton (lower) relative to the pre-nourishment condition. The left-hand group of bars represent volume gains in the foredune (positive trend). The middle group of bars shows the volume from the foredune to low-tide wading depth (positive trend). The last set of bars tallies the volume to the FEMA reference depth offshore (positive trend).

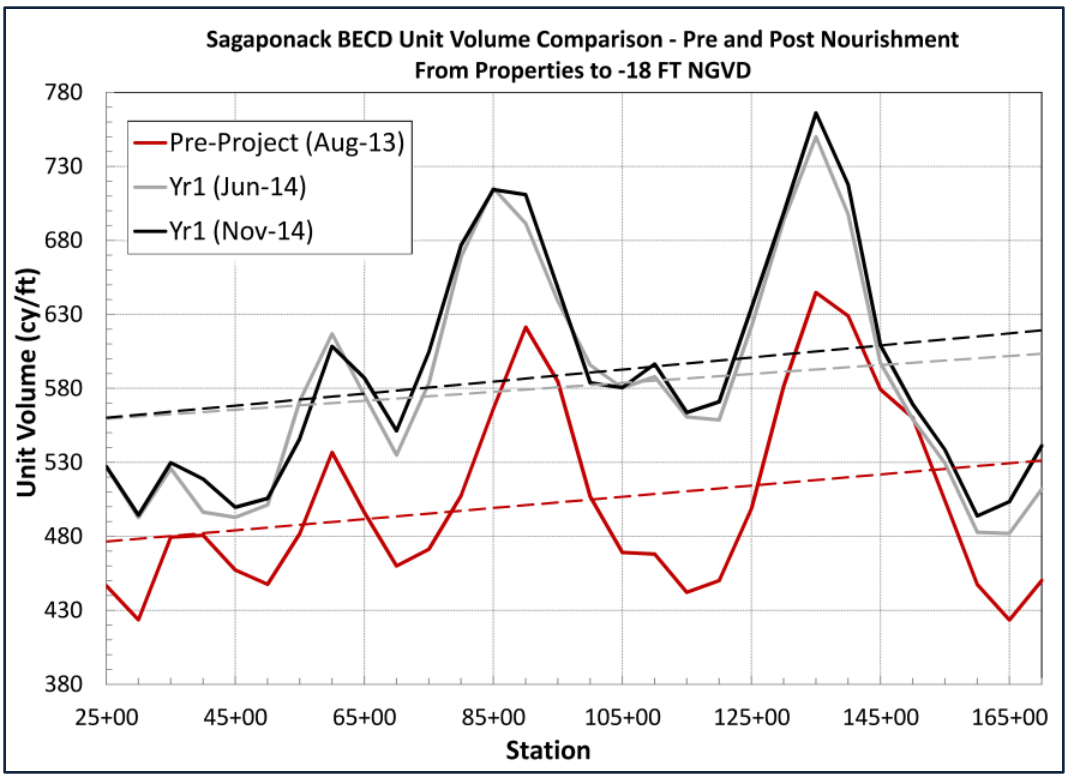
Figure E shows the station to station increase in unit sand volume due to the project. Conditions before nourishment are shown in red (dashed line is the average trend). Recent conditions (November 2014) are shown in black. The highs and lows from station to station reflect rhythmic variations in the bar and beach topography, a natural phenomenon of surf zones. Some of the differences also correspond to locations of Sagaponack Pond (station ~170+00) and Mecox Inlet (station 285+00 to station 290+00). Over time, the highs and lows of beach volumes tend to propagate slowly downcoast from east to west. This movement will be tracked each year because these undulations in the shoreline sometimes produce erosion "hotspots" along the project area.

Another important measurement was post-project sand sampling. Nourishment performance depends on quality sand matching the native sediment. The results of CSE's sampling in June 2014 confirmed the nourishment sand closely matches the sand on the visible beach in terms of color, texture, and size with the mean grain size averaging 0.445 millimeter (mm) before nourishment along Sagaponack and Bridgehampton-Water Mill. In June 2014, after nourishment, the mean grain size average ~0.408 mm. A cursory walk along the beach supports the general observation that the new sand looks and feels similar to the native sand. Importantly, the offshore borrow sediments contained negligible mud and very low percentages of gravel.

This report contains many details that will be of limited interest to the casual reader. However, the value of detailed monitoring is in the objective record of performance. By any measure, the project is performing well so far, and more sand remains within the project than expected one year after placement. [CSE expects losses to average ~120,000 cy per year, or almost 5 percent of the nourishment quantity to erode each year.] Residual effects of Hurricane *Sandy* have likely helped the project, with sand from deeper water slowly moving back into the "sand box" CSE uses for the calculations.

Downcoast areas also experienced gains in volume in the underwater portion of the profile during the past year. But, perhaps, the most favorable news for individual property owners is the gain along the foredune. During the past year, the equivalent of half a dump truck worth of sand has shifted to the dunes for every foot of beach. Windblown sand is accumulating around newly installed sand fencing, building up the foredune and improving the level of protection for all members of the Beach Erosion Control Districts.

CSE's next scheduled survey of the beach is June 2015.



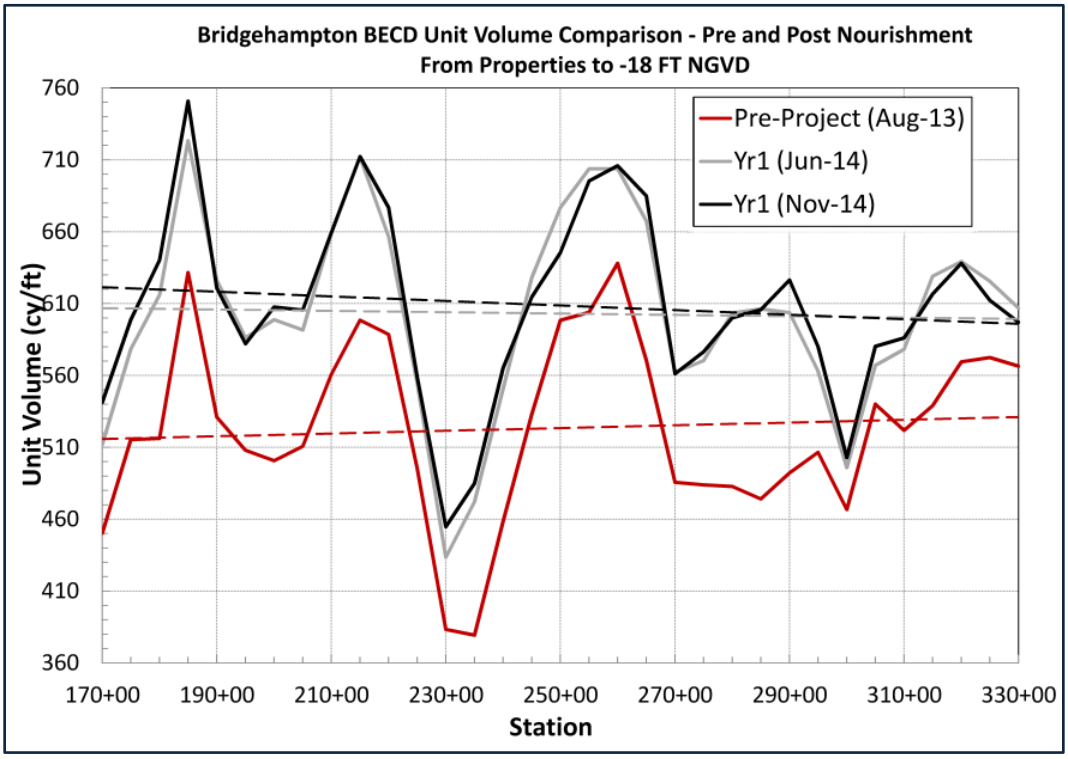


FIGURE E. Variation in sand volumes by stations before and after nourishment for Sagaponack (upper) and Bridgehampton-Water Mill (lower). The average trend is given in the dashed lines. High and low points on each graph reflect the natural waviness of the beach and offshore bar. Waves of sand tend to propagate slowly along the coast, shifting the low points (erosion "hotspots") to the west over time.

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ACKNOWLEDGMENTS

The Sagaponack–Bridgehampton-Water Mill beach nourishment project was sponsored by two Beach Erosion Control Districts (BECD) administered by the Town of Southampton (NY) (Anna Throne-Holst, supervisor). The Year 1 monitoring was funded by the Sagaponack BECD and Bridgehampton-Water Mill BECD. We thank the leaders of each BECD for their impetus and active participation in project planning and monitoring. We also thank the Town staff for their timely and enthusiastic support including Jennifer Garvey (assistant to the supervisor), Marty Shea, Kyle Collins, Chris Bean, and Kim Myers.

Coastal Science & Engineering deeply appreciates the support of First Coastal Corporation, including Mr. Aram Terchunian (president), Billy Mack, and Ben Spratford, during the monitoring effort.

Field data collection and analysis were directed by Dr. Haiqing Liu Kaczkowski (PE, NY 090164) with assistance by Drew Giles, Luke Fleniken, and Steven Traynum. The report was written by Dr. Kaczkowski and Dr. Tim Kana (PG, NC 1752), with assistance by Trey Hair and Diana Sangster.

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1.0 INTRODUCTION

This is the first annual report on the beach condition along ~5.7 miles of ocean shoreline at Sagaponack and Bridgehampton-Water Mill Beach Erosion Control Districts (BECDs) (Southampton, New York) following successful completion of the 2013–2014 beach nourishment project. The project was conducted between 15 October 2013 and 21 February 2014. Based on the contract between the Town of Southampton and the contractor, Great Lakes Dredge & Dock Company (GLDD), the Sagaponack reach was scheduled to receive 1,242,129 cubic yards (cy) of sand along ~2.7 miles of beach, and the Bridgehampton reach was to receive 1,300,808 cy of sand along ~3.0-miles of beach. The contractor's project record showed 1,244,556 cy of sand were placed along Sagaponack and 1,299,036 cy were placed along Bridgehampton-Water Mill. The actual placed volumes represented ~100 percent of designed volumes for both BECDs. Details of the project design and construction are contained in prior CSE (2014a,b) reports.

Before project commencement, a comprehensive beach condition survey was conducted by CSE in August 2013 to document the pre-project condition. Following project completion, a survey was conducted in February 2014 to confirm in-place nourishment volume; and two semi-annual surveys were completed in June and November 2014 (Year 1) to document the beach condition during the first year after project completion. The present report summarizes the two semi-annual survey results and compares them with the pre-project and post-project conditions. The report provides a summary of the surveys and the physical condition of the beach in Year 1 after nourishment and quantifies sand volume changes relative to pre-project conditions (August 2013). The survey results are used to evaluate the project performance, document volume changes within various calculation limits, and identify erosion hotspots.

This report includes:

- Brief review of the 2013–2014 beach nourishment project.
- Beach monitoring requirement and scope of survey work.
- Data collection methodology and survey control information.
- Beach and inshore surveys and profile comparisons.
- Profile volume analyses for representative contour intervals.
- Net volume changes by profile and reach.
- Calculation of nourishment volumes remaining in the project areas.
- Upcoast and downcoast volume changes.

- Representative aerial photos and ground photos.
- Monitoring and maintenance recommendations.

Certain information about the nourishment project and previous survey efforts are repeated in this monitoring report to aid the reader. The project planning, design, implementation, and initial performance are detailed in CSE's reports (2012a,b; 2014a,b).

1.1 Project Background, Design and Implementation

Sagaponack beach encompasses ~2.67 miles of ocean shoreline extending from Town Line Road at the eastern end to the mouth of Sagaponack Pond to the west. Bridge-hampton-Water Mill beach encompasses ~2.96 miles of ocean shoreline adjacent and west of Sagaponack beach extending from Sagaponack Pond at the eastern end to Flying Point Road at the western end of Mecox Bay to the west. The ~5.63-mile-long Sagaponack–Bridgehampton-Water Mill beach is a segment of the ~30-mile-long mainland bluff shoreline extending from Montauk Point to Shinnecock Bay along the south shore of Long Island (Fig 1.1). Georgica Pond is 1 mile to the east of Sagaponack, and Shinnecock Inlet is ~8 miles to the west of Water Mill. Net sand transport along the coast is east to west (USACE 1958), placing Sagaponack–Bridgehampton-Water Mill beach "downcoast" of Georgica Pond and its associated groins. Georgica Pond, Sagaponack Pond, and Mecox Bay include intermittent inlets which periodically flush the ponds and provide the primary interruptions to littoral transport along this segment of coast.

Sagaponack–Bridgehampton-Water Mill beach has sustained moderate erosion and loss of sand over the past century through normal processes of storm erosion and bluff recession, and portions of the beach were exceedingly narrow and lacked sufficient dune volume for protection of properties during storms. CSE's previous studies designated the −18-foot (ft) (NGVD) contour as the standard "FEMA" design limit which is consistent with boundaries used by Fire Island (NY) projects (CPE 2013; CSE 2012a,b; 2014a). Based on CSE's survey in July 2011 and the best-available historical data, an erosion rate of 4.5 cubic yards per foot per year (cy/ft/yr) was adopted in the beach restoration plan for Sagaponack and 3.5 cy/ft/yr for Bridgehampton. The total erosion rate is ~120,000 cy/yr for the two BECDs. Two reaches in each BECD were identified based on the sand deficit in the dune system, and different fill densities were assigned to each reach. Figure 1.2 shows the project limits along with the locations of the reaches and the three offshore borrow areas.

FIGURE 1.1. Project location map showing the Sagaponack–Bridgehampton-Water Mill beach nourishment project area situated along the mainland bluff shoreline of eastern Long Island. Net sand transport is east to west along the south shore of Long Island.

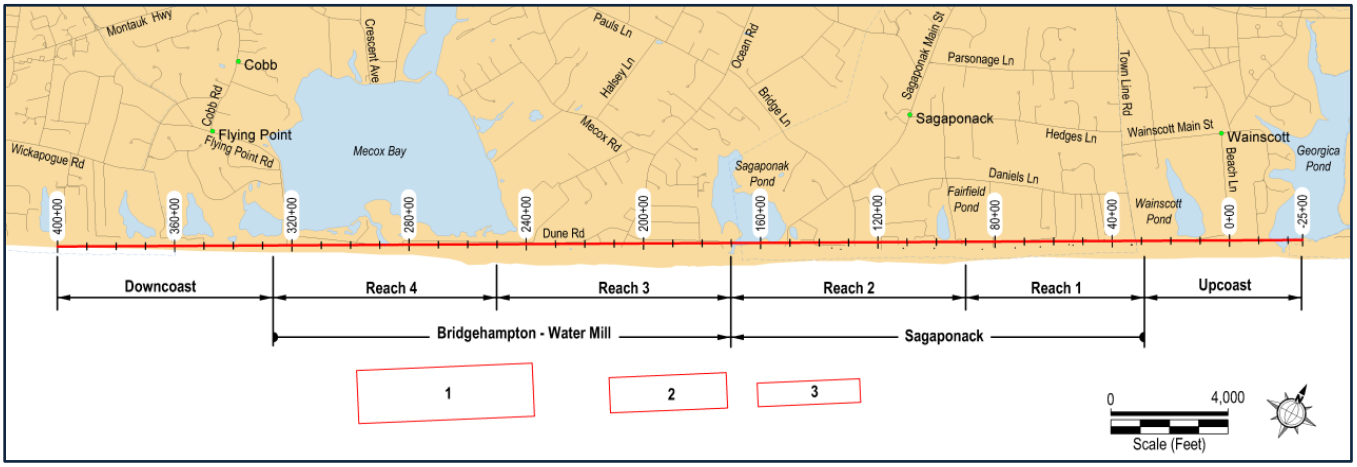

FIGURE 1.2. Project limits and monitoring ranges of the 1-mile upcoast (between stations -25+00 and 25+00) and 1.5-mile downcoast (between stations 330+00 and 400+00) along with offshore borrow areas.

The Town of Southampton with assistance by First Coastal Corporation (FCC) (Westhampton Beach NY) obtained permits from New York State Department of State (NYSDOS), New York State Department of Environmental Conservation (NYSDEC) (Permits 1-4736-07845/00001 & 1-4736-07846/00001) and U.S. Army Corps of Engineers–New York District (NYACE) (Permits NAN-2012-01092 and NAN-2012-01095) for Sagaponack–Bridgehampton-Water Mill (respectively) prior to the commencement of construction. The Town also issued Town Trustee Permits (10555 and 10556) and Town Coastal Erosion Hazard Area Permits for Sagaponack–Bridgehampton-Water Mill (respectively) to facilitate the nourishment.

CSE's survey in April 2013 confirmed there was a net loss of sand due to Hurricane *Sandy* (29 October 2012) and the 2013 winter storms in the probable range of 500,000–750,000 cy for the Sagaponack–Bridgehampton project area. The final combined project was designed to place a maximum of ~2.63 million cubic yards of beach-quality sand.

Following Hurricane *Sandy*, the Town requested a permit modification for increased volume which was approved by NYSDEC, NYSDOS, and USACE before project completion. Under the revised permits, the Town was authorized to excavate up to the maximum design volume (ie – ~2.63 million cubic yards of sand) from the designated offshore borrow areas (1, 2 and 3) and to deposit the material along ~5.63 miles of ocean shoreline.

The purpose of the project was to restore the recreational beach, maintain property values and the local tax base, and provide sufficient sand for ten years of erosion relief under normal circumstances within the boundaries of each BECD. The total project budget for construction, permitting, engineering, administration, and post-project monitoring was (~)$26 million with all funds generated by the BECDs and the Town of Southampton. No state or federal funds were involved. The Town of Southampton served as project owner and administrator.

Great Lakes Dredge & Dock Company (GLDD) submitted a bid below the project engineer's estimate which allowed an increase in the volume of sand by ~20 percent. Based on the Town's available construction budget, the final contracted volume of work was 2,542,938 cy at a bid cost not to exceed $21,943,036 (mobilization and construction). The net unit cost was (~)$8.63/cy.

The construction work was completed in one phase under a single contract between the contractor (GLDD) and the Town of Southampton.

The suction cutterhead dredge, *Illinois* (one of the largest such dredges in the U.S.), performed all excavations using three borrow areas offshore of the receiving beach. Beach-quality sand was excavated within the upper 7 ft of substrate in water depths of 40–60 ft and pumped ~1 mile to shore for subsequent spreading by dozers. The nourishment sand was shaped and graded to contours matching the native beach. Pumping operations began on 15 October 2013 and were completed by 21 February 2014 with over 50 days of delays during which wave conditions precluded safe operations. Work was completed without serious incident or injury to contractor personnel despite weather and wave conditions that were stormier than normal for these months. A no-cost time extension of 41 days was granted by the owner (Town of Southampton) for project completion. The project was completed on budget.

Table 1.1 lists the comparison of actual fill volumes and design volumes for each reach, and Figure 1.3 shows the cumulative changes in volume along each BECD between August 2013 (~2 months pre-construction) and February 2014 (post-construction). The results show ~29−35 percent of the placed sand settled within the recreational beach zone (foredune to low-tide wading depth at −5-ft), and the remainder was deposited between the −5-ft and −18-ft contour.

The post-project construction survey indicated the upcoast 1 mile (Town Line Road to Georgica Pond) and the downcoast 1.5 miles along the Village of Southampton eroded along the visible beach between August 2013 and February 2014, but experienced net gains in volume between the low-tide wading depth and the −18-ft depth contour. [Figure 1.2 showed the relative locations of upcoast and downcoast survey areas.]

TABLE 1.1. Summary of fill volume versus design volume for each reach based on before- and after-dredging surveys on the beach by GLDD. GLDD volume calculations were based on the methodology specified in the project manual (CSE 2013a). CSE volume calculations were from properties to −18 ft NGVD.

ACTUAL FILLED VS DESIGNED QUANTITIES								
DISTRICT	**REACH**	**LIMITS**	**LINEAR FEET (FT)**	**PERMIT ALLOWED (CY)**	**DESIGNED BASED ON BUDGET (CY)**	**GLDD REPORTED FILLED VOL (CY)**	**ACTUALVs. DESIGN (%)**	**CSE CONFIRMED VOL (CY)**
SAGAPONACK	1	28+84 TO 90+00	6,116	600,000	579,982	538,448	93%	593,720
	2	90+00 TO 170+09	8,009	685,000	662,147	706,108	107%	561,165
	SUB TOTAL	28+84 TO 170+09	14,125	1,285,000	1,242,129	1,244,556	100%	1,154,885
BRIDGEHAMPTON	3	170+09 TO 250+00	7,991	707,000	685,044	636,547	93%	672,130
	4	250+00 TO 326+35	7,635	635,500	615,764	662,489	108%	646,196
	SUB TOTAL	170+09 TO 326+35	15,626	1,342,500	1,300,808	1,299,036	100%	1,318,327
TOTAL		**28+84 TO 326+35**	**29,751**	**2,627,500**	**2,542,938**	**2,543,592**	**100%**	**2,473,212**

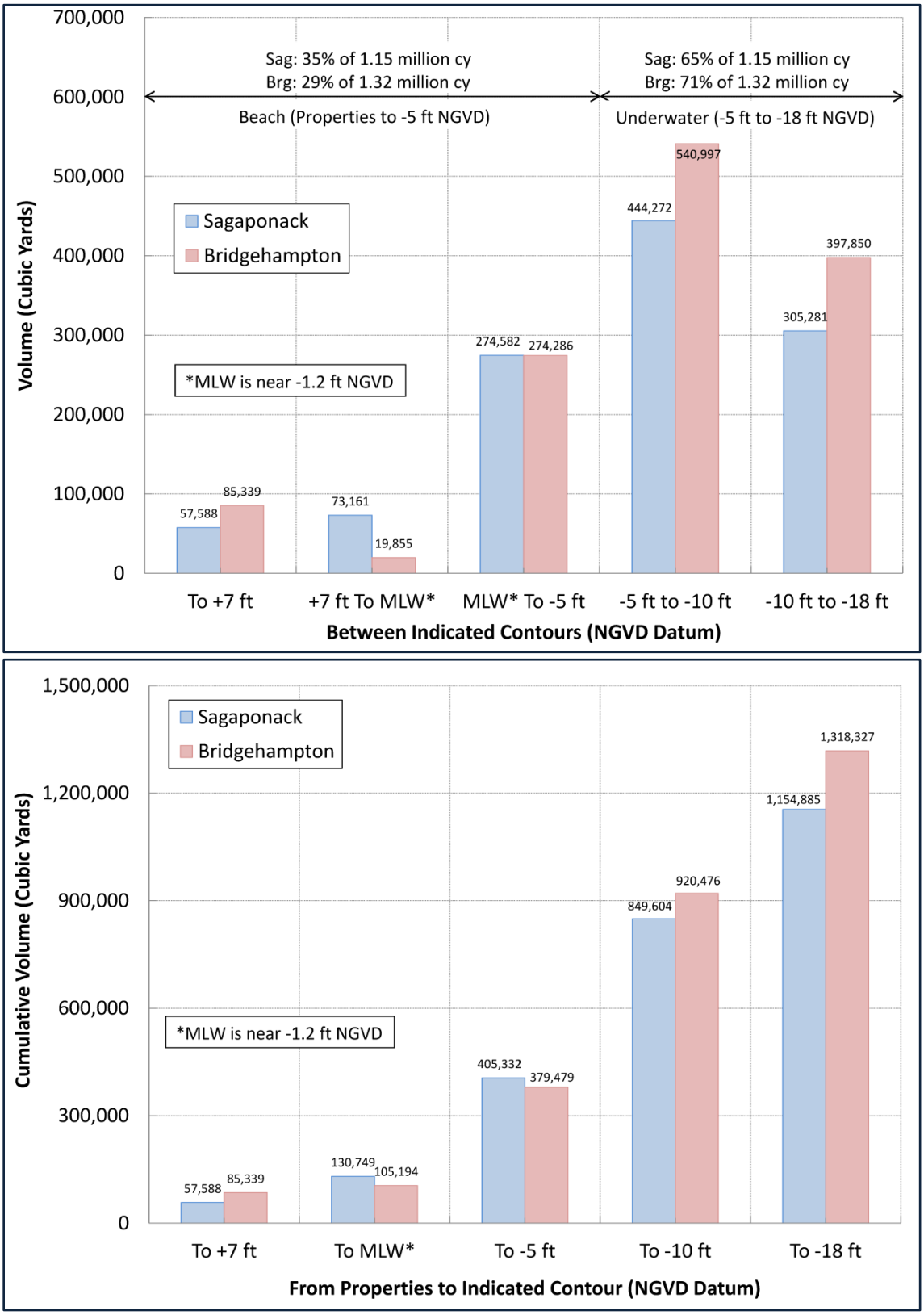

FIGURE 1.3. Beach volume changes between August 2013 and February 2014. **[UPPER]** Sand volume changes between representative contours. **[LOWER]** Cumulative volume changes between properties and the indicated contour.

The volume changes after nourishment are shown in Figure 1.4. The gains were small, suggesting only a minimal portion of the nourishment had been transported out of the project area by February 2014.

Prior to the project, a total of 14 beach fills (~2.9 million cubic yards) were placed at various points between Shinnecock Inlet and Montauk Point over an ~60-year period (sources: USACE unpublished records, Suffolk County Department of Public Works, Kana 1999). The present project is nearly as large as all previous nourishments **combined** east of Shinnecock Inlet. The Sagaponack–Bridgehampton-Water Mill project is also the first project east of Westhampton Dunes to utilize offshore borrow areas.

Detailed aspects of project design synopsis, construction procedure, survey methodology, beach volume analysis, upcoast and downcoast changes, and maintenance recommendations, etc., were included in the previous reports (CSE 2014a,b).

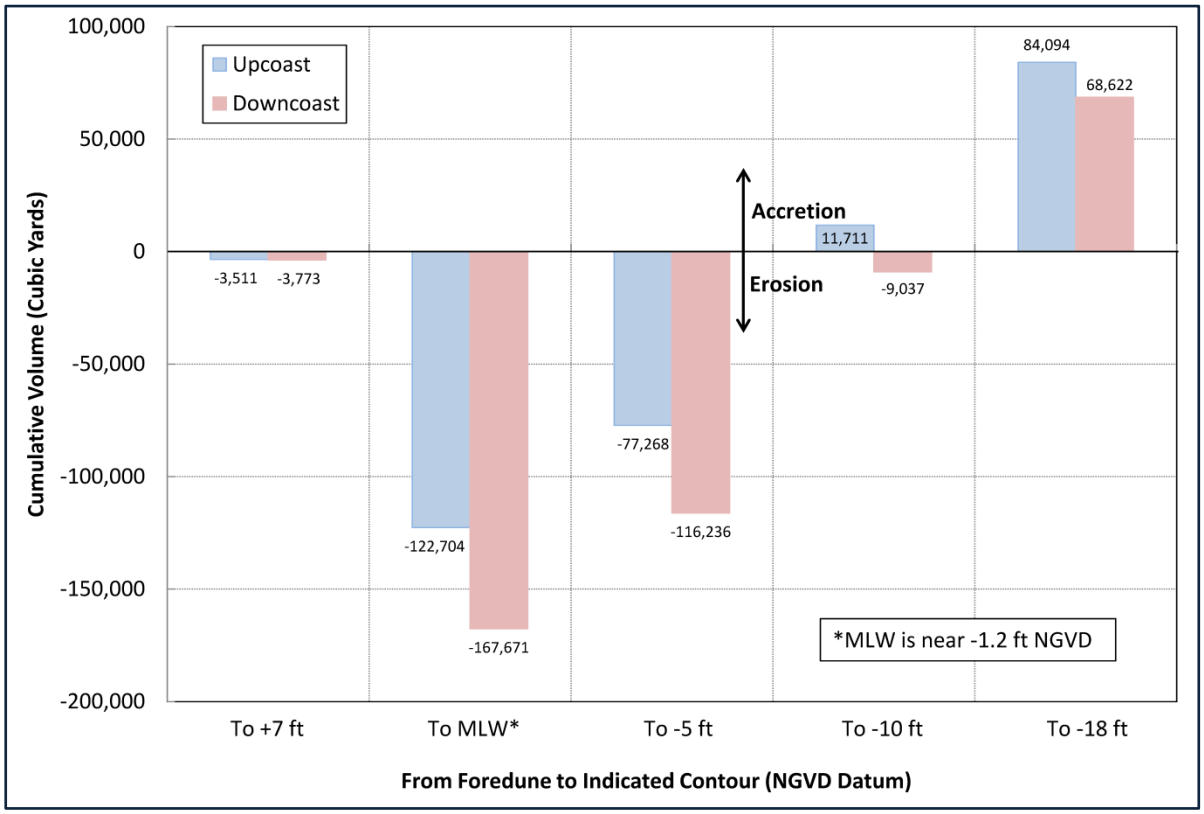

FIGURE 1.4. Cumulative beach volume changes to the indicated contours between August 2013 and February 2014 upcoast (east) and downcoast (west) of the project area.

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2.0 BEACH MONITORING METHODOLOGY AND SCOPE OF WORK

2.1 Purpose of Monitoring

Periodic post-project (physical) monitoring is a prerequisite for post-disaster restoration funds from the Federal Emergency Management Agency (FEMA) under Category G–Community Assistance Grants. If a major storm such as Hurricane *Sandy* (27 October 2012) impacts the project area and there is a presidential declaration of disaster, each BECD and the Town of Southampton may be eligible for funds to restore sand losses due to the storm. Such losses are computed for specified project boundaries (original alongshore length and cross-shore to the −18-ft NGVD depth contour) using annual monitoring surveys and post-storm surveys after the event. Therefore, an annual survey is scheduled around June to obtain beach conditions and calculate beach volumes within project boundaries before the hurricane season of each year. For Year 1 (ie – 2014), an additional condition survey was performed in November to track the beach adjustment following nourishment in greater detail.

2.2 Data Collection Methodology

Hydrographic data collection methodology followed procedures set forth in the USACE Hydrographic Surveying Manual (EM 1110-2−1003; January 2002, updated April 2004).

Data collection control was established with connection to the New York Continuously Operating Reference Stations (NYCORS). Data were collected in the horizontal datum of North American Datum of 1983 (NAD'83) and measured in U.S. survey feet using State Plane Coordinates in the zone NY-3104 for New York Long Island. The vertical datum was North American Vertical Datum of 1988 (NAVD'88) measured in feet. Data collected in NAVD'88 were then converted to National Geodetic Vertical Datum of 1929 (NGVD'29) by an offset of 1.08 ft. Key reference datums for a station on the ocean at Shinnecock Inlet (NY), located ~8 miles west of the project area, are shown in Figure 2.1. Geoid Model 12a (GEOID12a) and World Geodetic System of 1984 (WGS'84) were used for the geoid and ellipsoid.

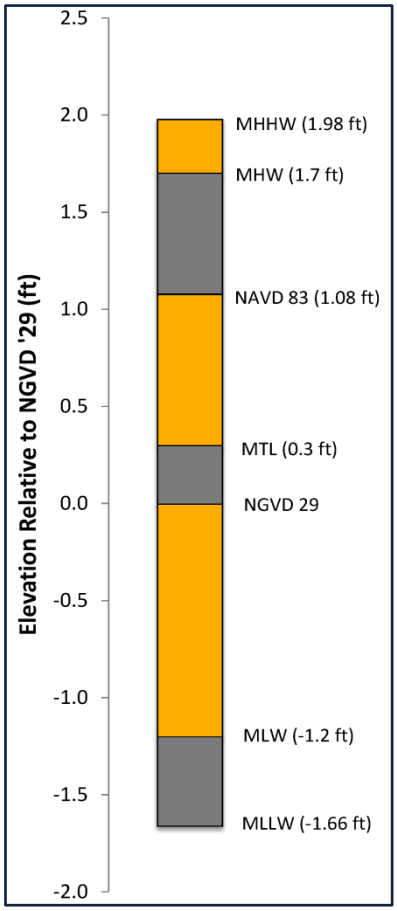


FIGURE 2.1. Key reference datums at Shinnecock Inlet (NY) ~8 miles west of the project area.
[Source: NOAA-NOS]

CSE's survey was completed using an RTK-GPS (Trimble™ Model R8 GNSS) for data collection. The offshore work was performed using the Trimble™ linked to an Odom™ Echotrac CV100 precision survey fathometer for direct measurements of the bottom without the need for tide corrections. Measurements over subaerial portions of Southampton extended to low-tide wading depth.

Offshore profiles were collected at 5 Hz (ie – five elevation readings per second) at high tide overlapping the wading-depth measurements and then filtered in the office to eliminate spikes and provide a 5–7 point floating average. Smoothed inshore data were edited to a manageable size and merged with subaerial data. Survey baseline and control USACE/CSE station coordinates and azimuths are listed in Appendix 1.

Ground photos were taken at representative monitoring stations and compared to pre- and post-project photos of the same areas. This offers a simple visual assessment of dry beach width, dune condition, vegetative growth, escarpments, and general condition of the beach through time. Photos were also taken of any areas or features of particular importance or interest observed during the monitoring event. If a declared storm impacts the project area, pre- and post-storm surveys confirm sand losses within the calculation boundaries, and the Town decides to apply for the post-disaster funds, the photos will provide a convenient visual record for illustrating beach conditions to FEMA officials and the community.

Oblique aerial photos were taken from an aircraft for purposes of obtaining views of the overall project. Representative images are included in the monitoring report along with pre- and post-construction images to illustrate the general condition of the beach.

An aerial orthophoto of the project area will be taken around the third year (ie – 2016) after project completion. Orthophotography provides a spatially rectified image representing the earth's surface in the area of coverage. It can be imported and utilized in the creation of a Geographic Information System (GIS) Map and defined coordinate system. The most recent orthophotography for Sagaponack and Bridgehampton-Water Mill BECDs was obtained on 18 April 2013 before construction, and the 2016 orthophoto will be the only one scheduled during the five-year monitoring period between 2014 and 2018.

3.0 BEACH AND INSHORE SURVEYS AND PROFILE COMPARISONS

CSE collected beach and inshore profile data following the protocols stated in Section 2. After the data were collected, CSE performed QA/QC on all data by a combination of procedures including measurement of speed of sound, sounding-bar checks, direct soundings in deep water, real-time overlays with historical data using Hypack™ software and cross-check lines for statistical analysis of survey accuracy.

Field data were entered into CSE's beach profile analysis system (BPAS) and combined with historic profile data. Each profile was checked for proper juxtaposition and datum correction with previous profile data. Consistent with previous reports (CSE 2014a,b), the pre-nourishment survey in August 2013 was used as the baseline condition to calculate volume changes. Overall volume changes were computed by extrapolating unit volume changes over representative shore lengths.

3.1 Beach Volume Analysis Method

The basic approach for beach monitoring is to track the beach zone within the project area as a sand box filled nearly to the top along one edge (the dune line) and tapering to a thin layer along the opposite edge (ie – in deep water). The total volume in the sand box is measured before nourishment then compared with a survey after nourishment. The differences between the volumes provide a measure of sand losses (erosion) or gains (accretion) over time. This section describes the methodology used by CSE for objective data collection and analyses.

Profile volumes are a convenient way to determine the condition of the beach and compare one area with another. They convert a two-dimensional measure of the beach to a "unit volume" measure. Unit volume, given in cubic yards per linear foot, is a measure of the amount of sand contained in a 1-ft (unit) length of beach. This unit-volume concept is illustrated in Figure 3.1. Specific volumes reflect a quantity in a wedge of sand extending from the dune line or seawall to a particular depth offshore.

Unit volumes for each survey date and unit-volume changes between selected dates were calculated to determine the quantity of sand in 1 linear foot of beach at each station. These unit volumes were used to calculate the station-to-station net volumes, the net volumes of reaches, and finally the net volume for the entire project.

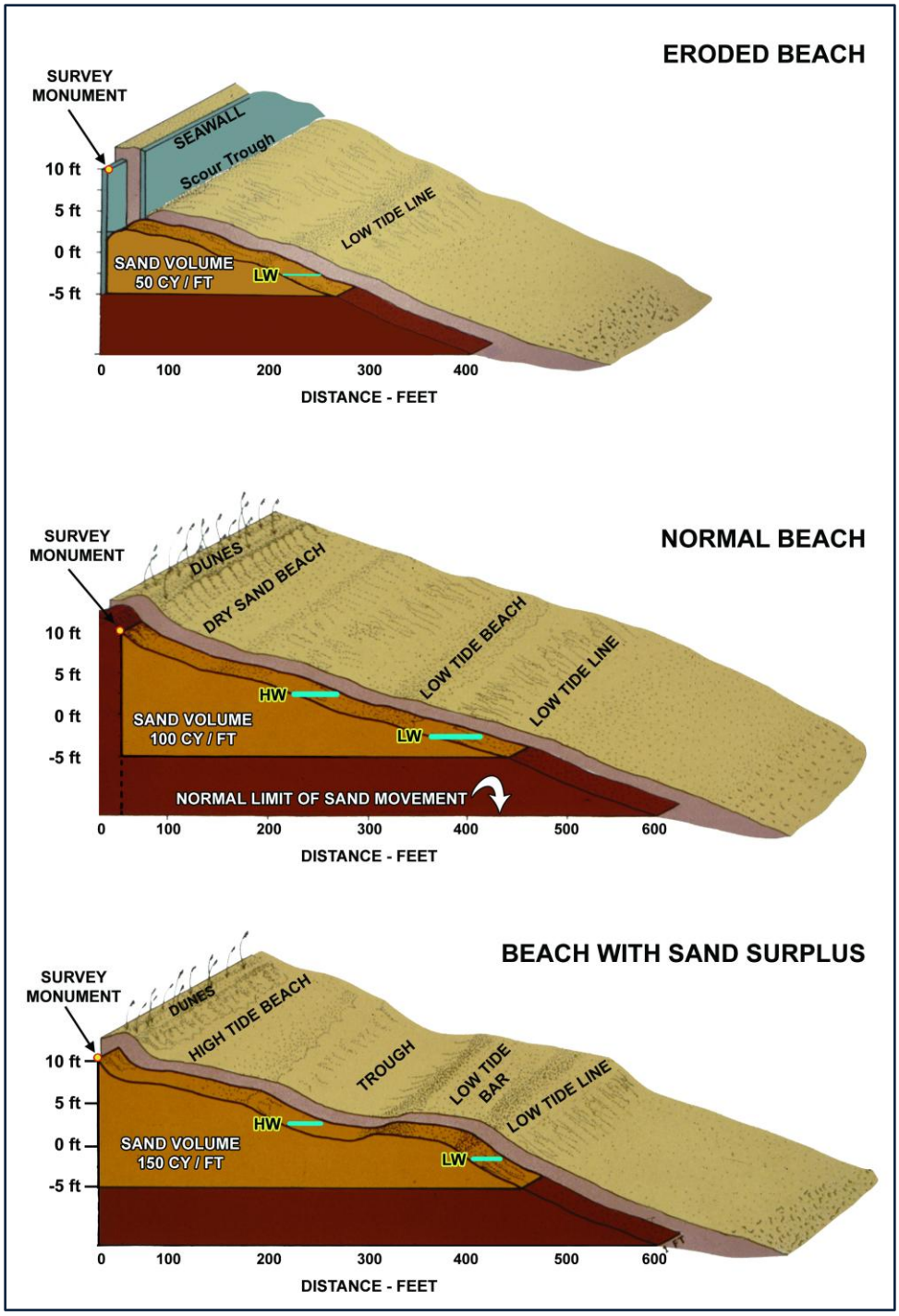


FIGURE 3.1. The concept of unit-width profile volumes for a series of beach profiles showing an eroded beach with a deficit, a normal beach, and a beach with a volume surplus. [After Kana 1990]

Changes in unit volume (or beach width, etc) can be determined by overlaying sequential profiles and computing the differences in cross-sectional area. The change in cross-section (in two dimensions) is extrapolated between adjacent profiles to yield net volume change (in cubic yards) in that section. Using standard statistical techniques (average-end area method), the overall (net) change is computed by summing the changes from profile to profile for subreaches and for total project reach.

Profile volumes integrate all the small-scale perturbations across the beach and provide a simple objective measure of beach condition (Kana 1993). They provide quantitative estimates of sand deficits or surpluses when compared against a target or desirable beach condition. The examples of profile volumes in Figure 3.1 show a "normal beach" with a typical unit volume of 100 cy/ft measured to low-tide wading depth. The other profiles in the graphic illustrate values for an eroding beach (in this case, backed by a seawall) and a beach with a sand surplus.

The unit volume of the eroded profile is much lower than the normal beach. Beaches near inlets often incorporate wide low-tide bars resulting in a surplus of sand relative to beaches away from inlets. The calculation limits can be arbitrary as long as they are consistently applied. Ideally, they should encompass the entire active zone of profile change for the time period(s) of interest.

Volume changes for the Sagaponack and Bridgehampton "sand box" were estimated using standard methods (average-end-area method) and common cross-shore boundaries and contour datums. Five (5) lenses (ie – volumes between particular reference contours) were used in the present analysis for purposes of evaluating levels of dune protection, dry beach and construction berm adjustments, wet beach condition, inshore surf zone, and the outer surf zone.

Lens 1) Volume Above +7 ft NGVD — The 2013–2014 nourishment construction berm was designed at +7 ft NGVD. The volume above the +7 ft elevation is a measure of the sand quantities shifted toward the dunes and upper beach, and therefore a measure of storm and flood protection levels associated with the project or gains in dune volume due to post-project buildup above the contour.

Lens 2) Recreational Beach (+7 ft to MLW) — This lens includes the dry-sand and wet-sand beach ("berm") from the construction berm elevation to around MLW (−1.2 ft NGVD). This is the primary recreational portion of beach.

Lens 3) Inner Surf Zone (MLW to −5 ft) — This lens includes the portion of the surf zone where most wave-breaking occurs between MLW and low-tide wading depth at −5 ft NGVD.

Lens 4) Outer Breaker Zone (−5 ft to −10 ft NGVD) — This lens generally encompasses the outer breaker zone and the top of the outer bar, which is a more or less permanent feature of the Long Island south shore in deeper water.

Lens 5) Outer Surf Zone (−10 ft to −18 ft NGVD) — This lens represents the "lower foreshore" extending seaward of the bar to the normal yearly limit of bottom change along Sagaponack–Bridgehampton-Water Mill beach. It is the area beyond which there is relatively little change in the bottom. The outer depth is also consistent with the standard FEMA reference depth for post-storm restoration funds. It includes the "longshore bar," which is a common feature of Long Island profiles and the trough between the bar and the beach.

When sufficient data from multiple survey dates become available, it will be possible to define a site-specific seaward limit of sand movement [ie – *closure depth* where successive profiles tend to converge (or close) over time], suggesting measurable changes in bottom elevation are not occurring beyond that point. RPI (1982, 1985) and Kana (1995) assumed closure depths of ~24–27 ft for the south shore of Long Island using limited data.

Note: For the present report and to be consistent with results presented in CSE's (2014b) report, five lenses are presented along with results combining groups of lenses. Future monitoring reports will utilize fewer lenses to simplify interpretation.

- **Lens 1 to Lens 3 encompass the active beach to low-tide wading depth (from properties to −5 ft NGVD); and**
- **Lens 4 and Lens 5 represent the surf zone extended to the FEMA reference depth (from −5 ft to −18 ft NGVD).**

Unit volumes for Sagaponack and Bridgehampton profiles were calculated to determine the quantity of sand in one linear foot of beach at each lens at each survey line. These unit volumes were then used to calculate the profile-to-profile net volumes, the reach net volumes, and finally the net volume for the entire project. The profile-to-profile net volumes are proportional to the distance between survey lines and represent the alongshore distribution of sand volume in the project area. The net volumes by reach were subsequently divided by the applicable reach lengths to yield weighted average unit volumes, taking into account the variations in applicable shoreline distances from line to line.

Conveniently, the stations for Sagaponack and Bridgehampton are evenly spaced at 500 ft. If they are not evenly spaced, the station-to-station net volumes should be proportional to the distance between stations in order to represent the actual alongshore distribution of sand volume. Beach profiles at CSE survey stations are plotted in Appendix 2, and unit volumes and total volumes of the five lenses (and three additional lenses for project record purposes) at each survey line are given in Appendix 3 for comparisons with the pre-project survey (ie – August 2013). Unit volumes of representative lenses and cumulative lenses are discussed in detail in this section, and total volumes will be discussed in Section 4.

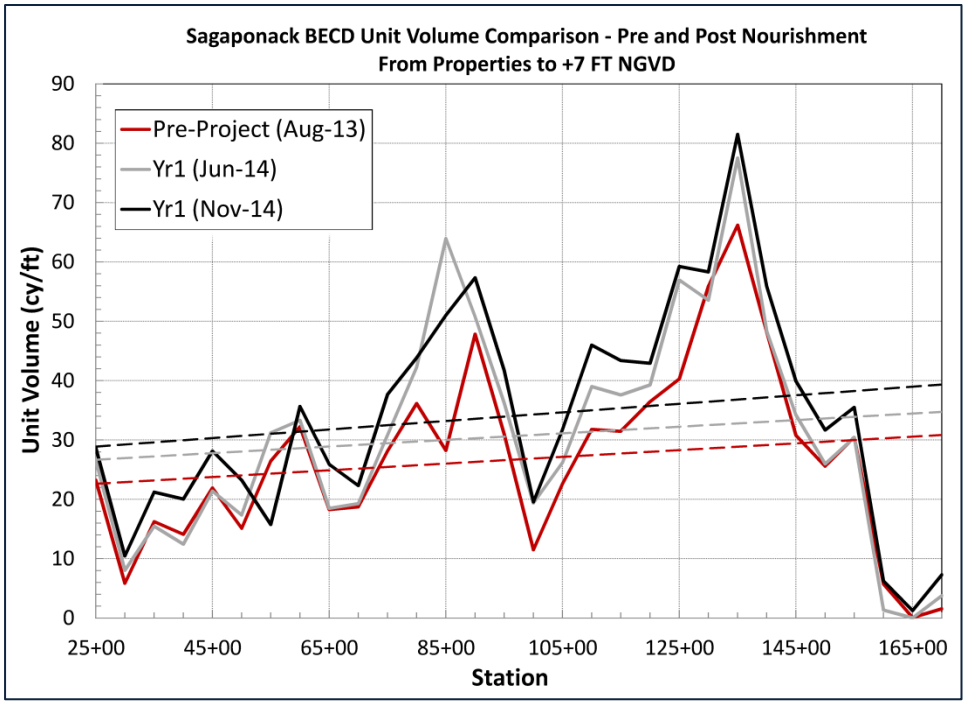
3.2 Unit Volume Results

3.2.1 Lens 1 (from properties to +7 ft NGVD)

CSE expected the higher dry beach (formed by storm overwash and a landward shift of some sand after the completion of the 2013–2014 project) would remain dry most of the time and would serve as a feeder for dune growth. Unit volumes of Lens 1 from properties***** to +7 ft NGVD **by station** along Sagaponack and Bridgehampton are shown in Figure 3.2. For graphic clarity, only unit volumes for June and November 2014 (grey and black lines in the graphic, respectively) are plotted against the pre-construction condition (red line in the graphic).

*[*Landward limit of this lens was originally determined at the properties at the time of project planning and design (CSE 2012a,b). It remains the same for most stations unless there are significant changes landward of a station (eg – structure or fencing) that prevent data collection. If the landward limit of a station is changed, volumes at this station will be re-calculated for all survey dates so volume comparison will be based on the same portion of beach.*]

Before nourishment, west Sagaponack had higher unit volumes than east Sagaponack (red dashed line shows the linear trend in the upper graph of Figure 3.2), indicating the overall dune condition of the west was healthier than the east and had more storm protection than the east. The westernmost stations between 160+00 and 170+00 had zero volume because of the existence of Sagaponack Pond. The 2013–2014 nourishment project did not place sand above +7 ft NGVD (ie – did not place sand in this lens), but June and November 2014 survey results showed there was more sand in this lens than pre-project, indicating natural sand accumulation in this lens. Grey and black dashed lines representing the linear trend of June and November surveys (respectively) show an obvious increase along the project area. As of November 2014, the average unit volume was ~7.4 cy/ft more than the pre-project condition (August 2013).



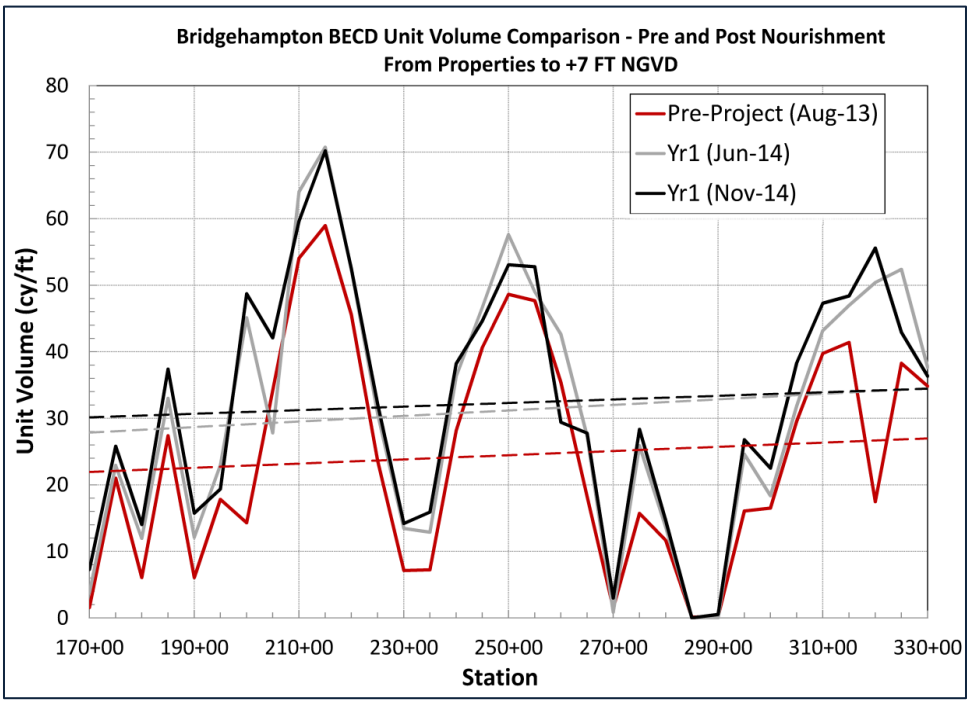


FIGURE 3.2. Comparison of unit volumes along Sagaponack and Bridgehampton-Water Mill from properties to the +7 ft NGVD contour before nourishment (August 2013) and for Year 1 survey conditions (June and November 2014). Dashed lines represent the trend of the lines of the corresponding colors. Unit volumes increased after the project at most stations, indicating the natural sand accumulation in this lens after nourishment. Unit volumes in previous surveys (April 2012, April 2013, and February 2014) can be found in CSE (2012a,b; 2014a,b).

Unit volumes at Bridgehampton-Water Mill in this lens are fairly uniform from east to west with variations from station to station. Stations near Mecox Bay (ie – stations 285+00 and 290+00) had near-zero volume The increase of volumes after nourishment is similar to Sagaponack as shown in the dashed, trend-lines comparison in Figure 3.2 (lower), representing an average of ~7.9 cy/ft gain between August 2013 and November 2014.

3.2.2 Lens 2 (+7 ft to MLW)

Unit volumes of this lens by station along Sagaponack and Bridgehampton-Water Mill are shown in Figure 3.3. This lens represents the recreational portion of beach or visible beach. It was confirmed a small portion of nourishment sand remained in this lens after project initial adjustment in February 2014 (see Fig 1.3, upper), equivalent to a small gain of ~5 cy/ft and ~1.2 cy/ft in February 2014 relative to August 2013. Both June and November 2014 surveys showed most of the stations gained sand in this lens in the first year after the project. As of November 2014, there were ~13.8 cy/ft and ~6.1 cy/ft more sand in Sagaponack and Bridgehampton-Water Mill (respectively) than the pre-project condition. The higher volume in the visible beach equates to a wider dry beach for people to use. For west Bridgehampton, unit volume declined for the beach near station 330+00 between June and November 2014, probably due to sand losses into Mecox Bay. The dry-beach volume of this lens along that portion of beach was close to the pre-project condition as of November 2014.

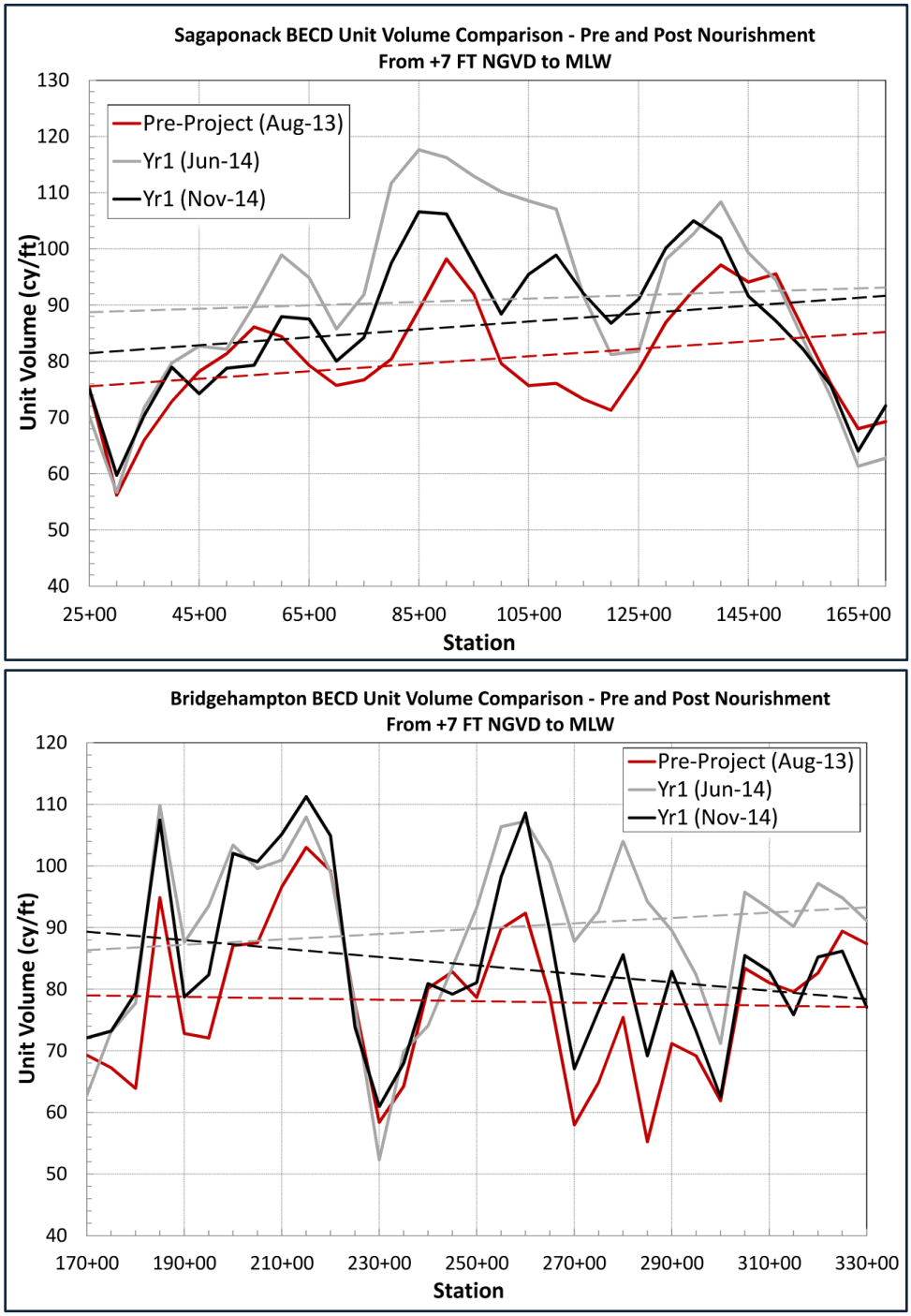


FIGURE 3.3. Comparison of unit volumes along Sagaponack and Bridgehampton-Water Mill from the +7 ft NGVD contour to mean low water at −1.2 ft NGVD before nourishment (August 2013) and Year 1 survey conditions (June and November 2014). Dashed lines represent the trend of the lines of the corresponding colors.

3.2.3 Lens 1–3 — Cumulative Unit Volumes (from properties to −5 ft NGVD)

Cumulative unit volumes are discussed herein for Lens 1 to Lens 3, representing the active beach to low-tide wading depth. Figure 3.4 shows cumulative unit volume comparisons by station in August 2013 (pre-project) and June and November 2014 (Year 1 surveys). All stations except station 55+00 in Sagaponack gained sand above low-tide wading depth with an average gain of ~31 cy/ft in both BECDs relative to August 2013. [Results for individual Lens 3 are detailed in Appendix 3.]

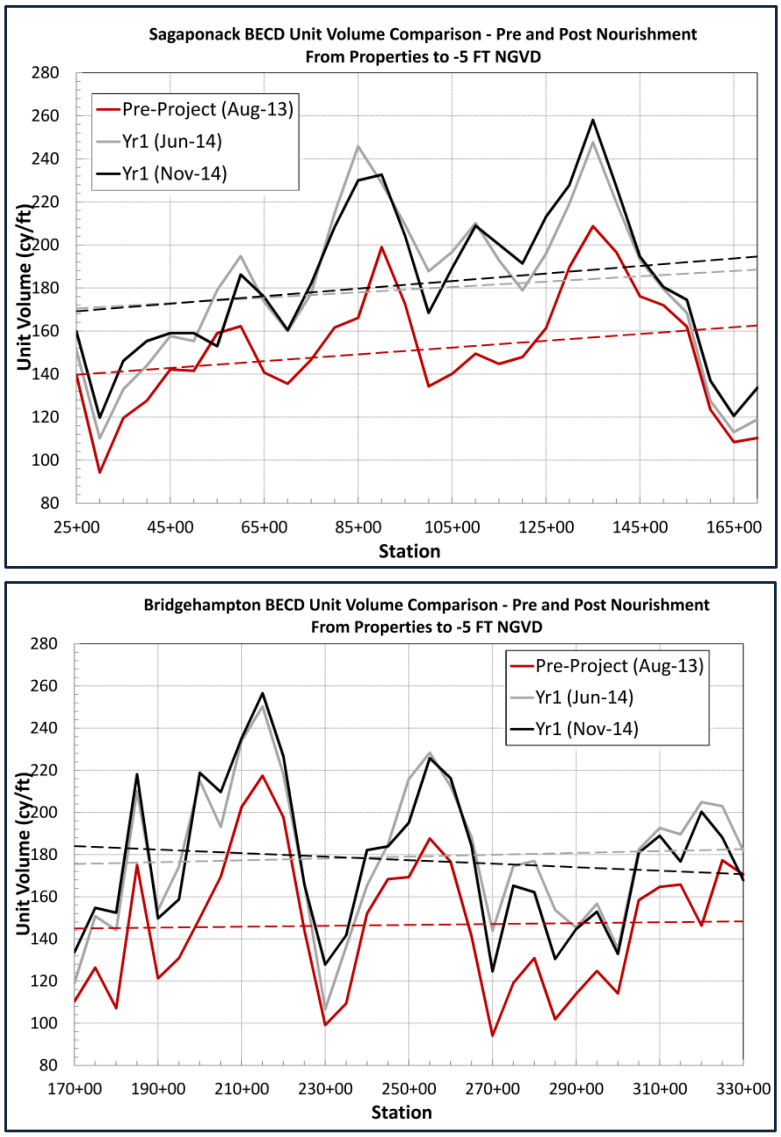


FIGURE 3.4. Cumulative unit volumes comparison along Sagaponack and Bridgehampton-Water Mill from properties to low-tide wading depth around −5 ft NGVD before nourishment (August 2013) and Year 1 survey conditions (June and November 2014). Dashed lines represent the trend of the lines of the corresponding colors.

3.2.4 Lens 4 (from −5 ft to −10 ft NGVD)

Lens 4 represents the inner breaker zone where temporary bars may exist. It is an important wave dissipation zone as well as a feeder area for buildup of the summer beach. Sand in this lens may move inshore under favorable wave action and add volume to the visible beach (Lenses 2 and 3). Figure 3.5 shows the significant volume gain in 2014 relative to August 2013 due to the nourishment project and profile adjustment after construction. The nourishment sand placed above low-tide wading depth shifted offshore under wave action, and the initial steeper-than-normal beach face created by nourishment equilibrated to a more natural slope with complex bar topography. Average unit volumes did not change much between June and November 2014 (before and after the hurricane season) (shown by the grey and black dashed lines), indicating the relatively calm season in 2014.

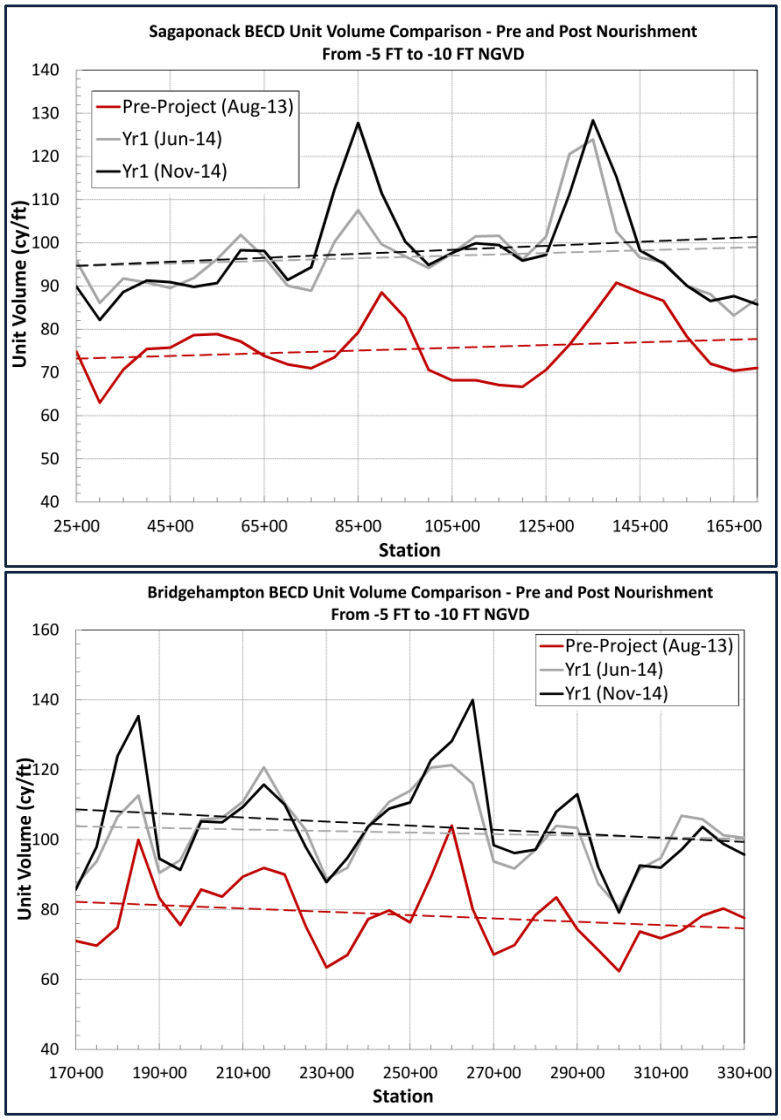


FIGURE 3.5. Comparison of unit volumes along the project area between −5 ft and −10 ft NGVD.

3.2.5 Lens 5 (from −10 ft to −18 ft NGVD)

Lens 5 represents the offshore bar area and encompasses an 8-ft elevation difference. Figure 3.6 shows the significant volume gain in 2014 relative to August 2013 due to the nourishment project and profile adjustment after construction. Little nourishment sand was placed directly in this lens during construction, but sand shifted offshore under wave action, and the profiles in 2014 equilibrated to a more natural slope into deeper water. The profiles in Appendix 2 generally show a broad, longshore bar positioned ~800 ft to 1,600 ft offshore in the Lens 5 depth zone.

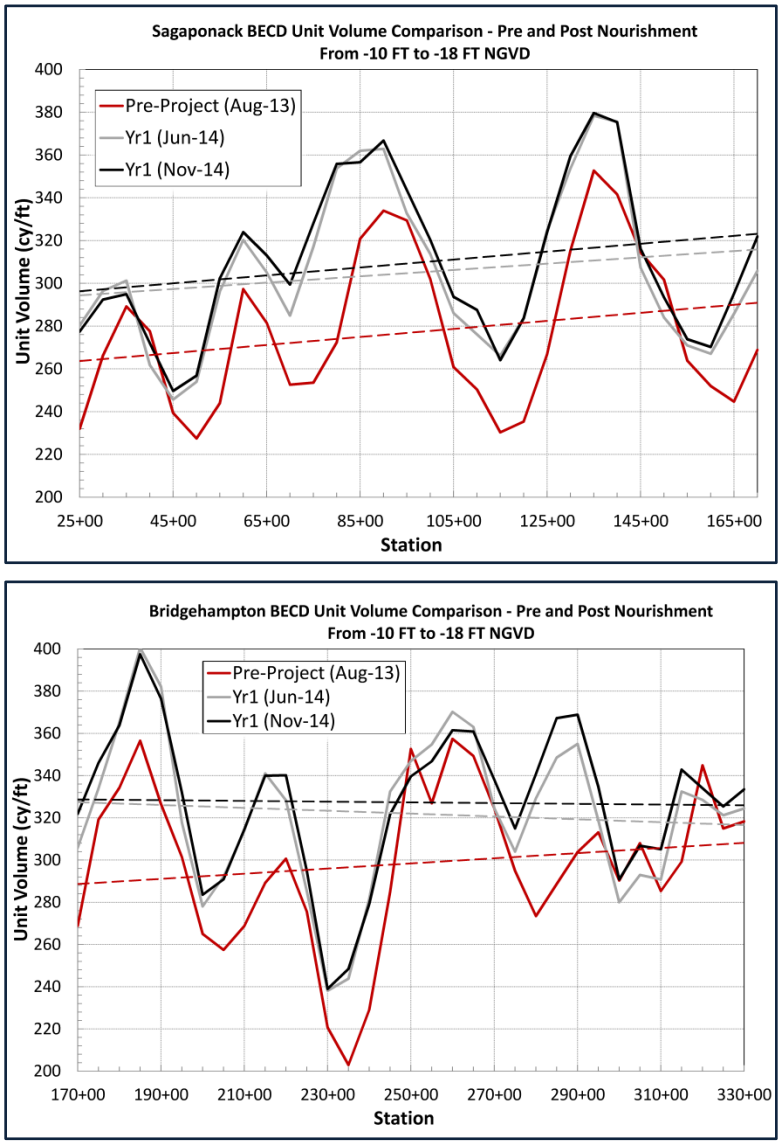


FIGURE 3.6. Comparison of unit volumes along the project area between −10 ft and −18 ft NGVD.

3.2.6 Lens 4–5 — Cumulative Unit Volumes of Underwater Lenses (−5 ft to −18 ft NGVD)

Cumulative unit volumes of Lens 4 and Lens 5 represent the underwater volumes. Following nourishment construction, CSE confirmed in February 2014 that 65 percent of the nourishment volume was placed in these lenses for Sagaponack, and 71 percent for Bridgehampton-Water Mill. The trends shown in Figure 3.7 are similar to the individual Lens 4 and Lens 5. The volume remaining in the underwater lenses will be discussed in the next section.

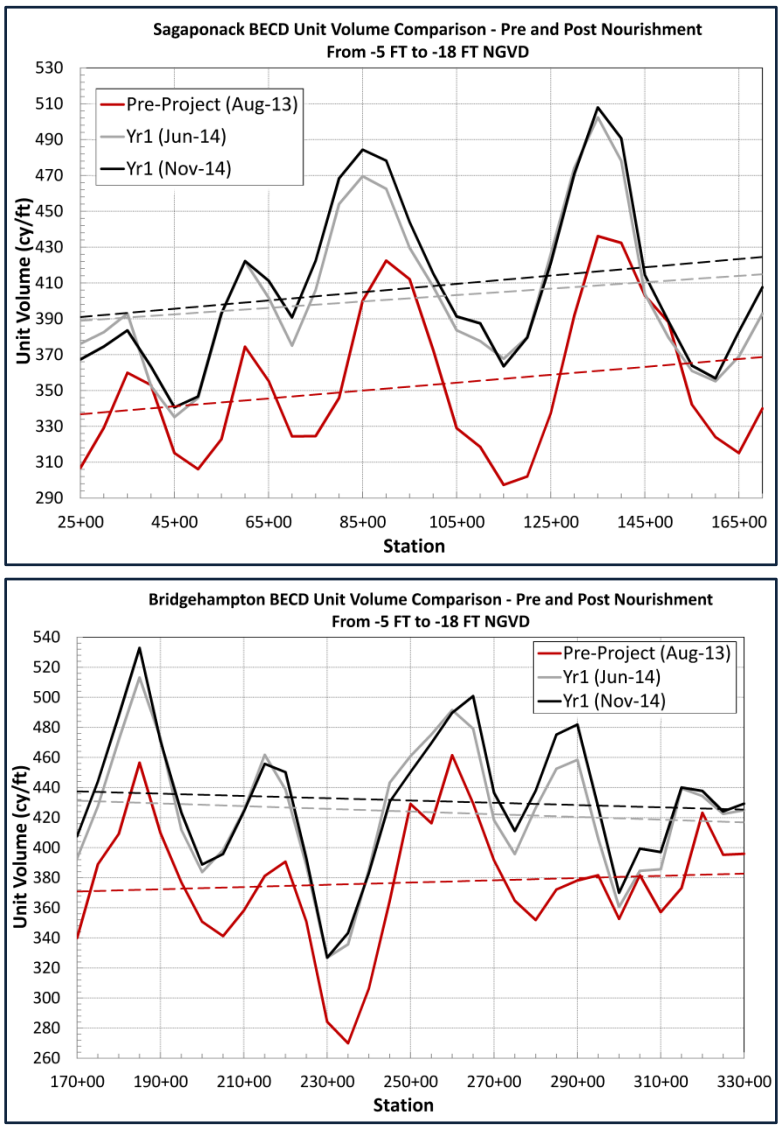


FIGURE 3.7. Comparison of cumulative unit volumes by station between −5 ft and −18 ft NGVD.

3.2.7 Lens 1–5 — Cumulative Unit Volumes of All Lenses (from properties to −18 ft NGVD)

Figure 3.8 shows the cumulated unit volumes along the beach from Lens 1 to Lens 5 (ie – from properties to −18 ft NGVD—FEMA reference depth). The overall increase in unit volume is obvious by comparing the two dashed lines in the graphic. The designed average fill density was ~88 cy/ft for Sagaponack and ~83 cy/ft for Bridgehampton. CSE's survey in February 2014 confirmed an average of ~82 cy/ft were gained along the Sagaponack beach during the nourishment project, and ~84 cy/ft were gained for Bridgehampton. As of November 2014, an average of ~88 cy/ft of sand remained along both Sagaponack and Bridgehampton, indicating both BECD retained the full amount of nourishment sand during Year 1 since project completion.

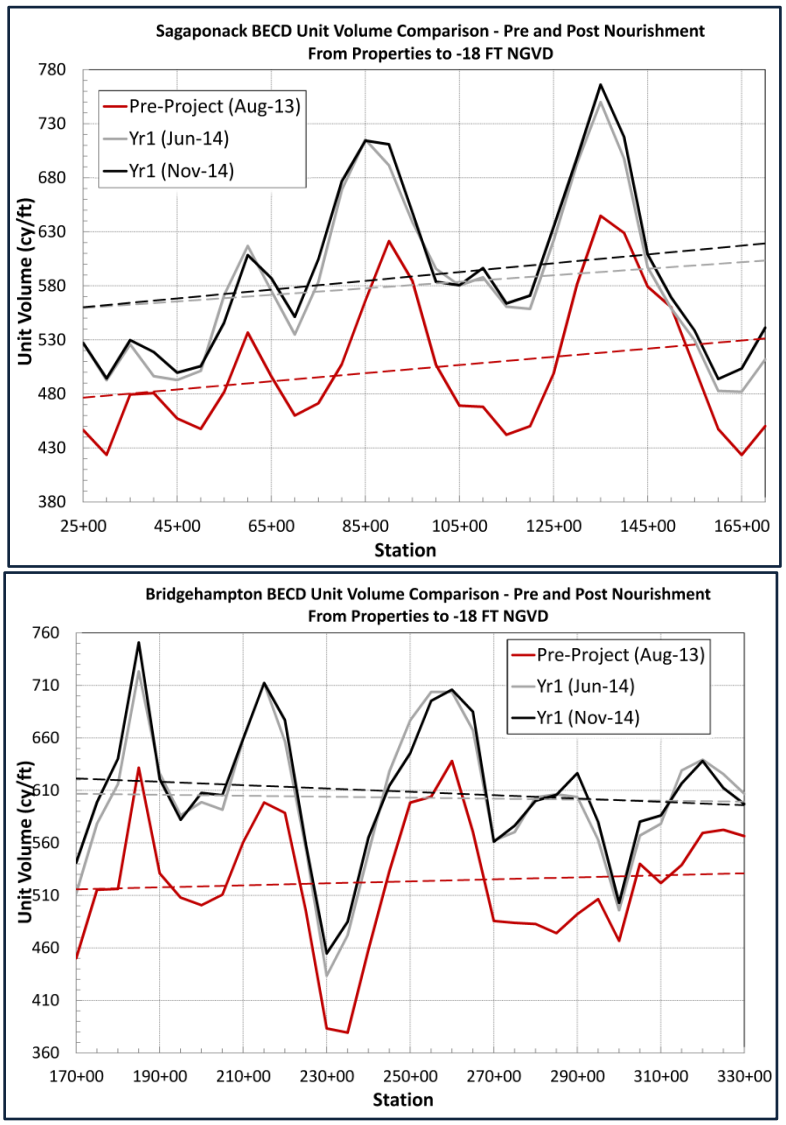


FIGURE 3.8. Comparison of cumulative unit volumes between properties and −18 ft NGVD.

3.2.8 Variations in Unit Volumes

The volume results show systematic variations in sand quantity from station to station before and after nourishment with some localities appearing to contain much more sand than adjacent areas (eg – stations 60+00, 85+00, and 135+00 in Sagaponack; and stations 185+00, 215+00, and 260+00 in Bridgehampton-Water Mill). The spacing of these high points is typically ~3,000 to 4,000 ft.

Differences such as this reflect rhythmic variations in the outer bar. While the dune vegetation line often appears straight along the south shore east of Shinnecock Inlet, the visible beach will vary in width, often exhibiting waves of buildup alternating with narrow beach areas. These rhythmic features are often spaced every half-mile or so (Hayes 1972, Thevenot & Kraus 1995). These features tend to mirror topography in the nearshore zone.

The longshore bar will contain periodic breaks which serve as underwater inlets for return flows. These areas will be deeper and therefore contain less sand. Where the bar builds up the most (between breaks in the bar), volumes will be greatest. The shape and position of the offshore bar changes over time, shifting high zones and bar breaks down the coast. The visible beach responds with “sand waves” propagating slowly to the west in the project area.

As more surveys are obtained, CSE expects to see shifts of these high and low volume locations as sand propagates to the west. The next monitoring report will evaluate these rhythmic features in more detail. What is most important at this early stage of project evolution is the total quantity of sand retained within the project limits. This is discussed in the next section.

4.0 TOTAL VOLUME CHANGES AND VOLUME REMAINING

The total beach volume was estimated by applying the unit volume calculated at each measured profile over an applicable shoreline distance. The method (known as the average-end-area method) uses the average unit volume of two adjacent profiles multiplied by the distance between the profile stations to estimate the volume of sand between the two profiles. The total volume of sand in the project area is simply the sum of the individual section volumes measured to common vertical datums.

Since Sagaponack and Bridgehampton stations are evenly spaced, the trends in total volume along the project site are similar to results using unit volumes. The same five lenses were used to estimate the total volume, and detailed numbers for each station are listed in Appendix 3.

During the 2013–2014 Sagaponack and Bridgehampton-Water Mill beach nourishment project, the contractor (GLDD) reported 2,543,592 cy of sand were placed along the ~5.63-mile project area based on their before- and after-dredging surveys on the beach. *[The comparison of contractor's reported volumes and CSE's confirmed volumes (based on the post-project survey in February 2014) along with design volume for each reach were listed in Table 1.1 in Section 1 of this report.]* The in-place volume (ie – pay volume to the contractor) represented ~100 percent of the design volume with negligible discrepancy of 655 cy. To facilitate comparisons, the design volume(s) (ie – 1,242,129 cy for Sagaponack and 1,300,808 cy for Bridgehampton) will be used as the "target" in the analysis of nourishment volume remaining in this monitoring report and similar reports thereafter.

CSE conducted two surveys in 2014 (the first year after the project)—one in June before the hurricane season, and the other in November after the hurricane season. The volume changes relative to August 2013 (before the project) are plotted in Figures 4.1 and 4.2. Results for each BECD are presented in a similar format and discussed separately.

4.1 Sagaponack

Figure 4.1 (upper) provides volume changes between reference contours relative to August 2013. The first set of bars represents net volume changes along the upper beach and foredune between properties and +7 ft NGVD (nourishment berm elevation). The November 2014 survey results show there has been an increase of over 50,000 cy (a gain rate of ~3.6

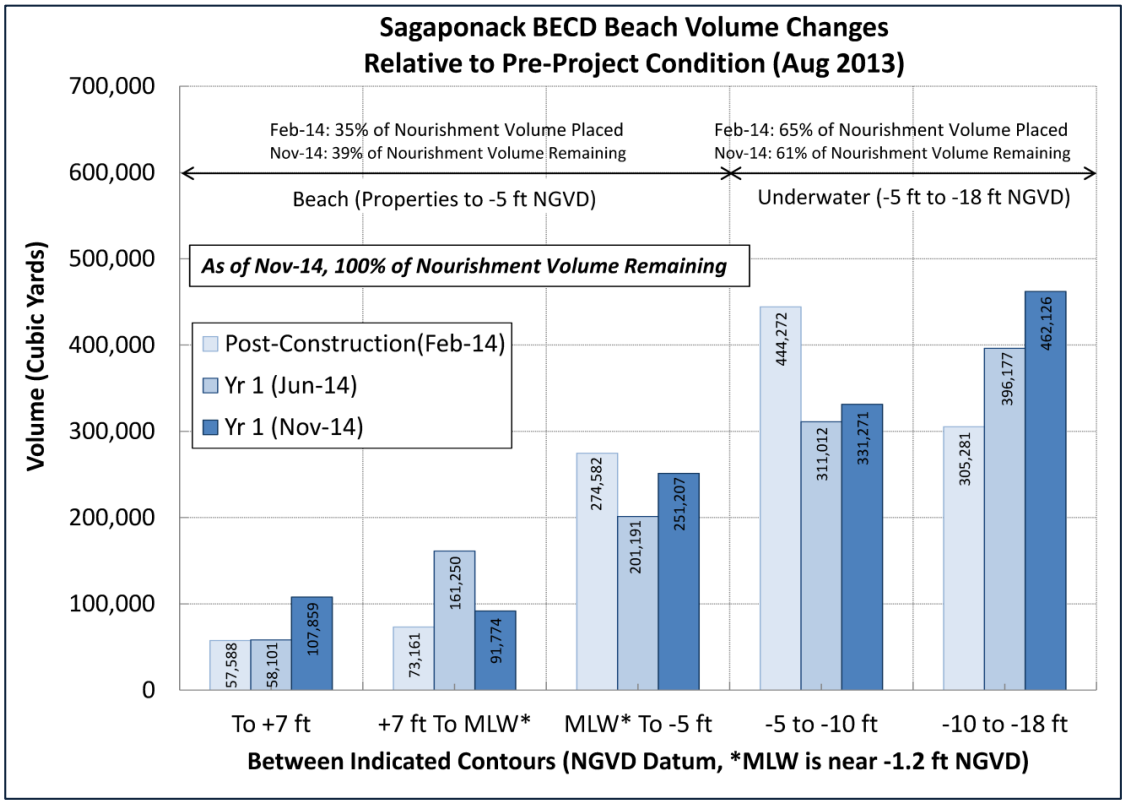
cy/ft) since the completion of construction (February 2014) and ~108,000 cy (a gain rate of ~7.6 cy/ft) more sand than the condition before nourishment (August 2013).

After the nourishment, some homeowners in Sagaponack hired contractors and placed sand on the upper beach to enhance the dune. FCC confirmed ~3,000 cy of sand were placed on the dune along Sagaponack following project completion. This volume is significant to the properties involved but represents a small portion (~6 percent) of the total gain to the dune line along the project area since February 2014. The majority of the volume gain above +7 ft NGVD (ie – in the upper portion of the beach and dune area) was the result of natural growth drawing sand from the new dry sand beach.

Dune-enhancement measures conducted by individual home owners, such as sand-fencing (or snow-fencing) installation and vegetation planting, have concentrated sand along the back beach and enhanced the foredune. The extra volume and elevation in the dunes will provide a higher level of surge protection and help reduce damages during future storms.

The next set of bars in Figure 4.1 (upper) represents the total volume changes in the visible beach between +7 ft and MLW (−1.2 ft NGVD). The November 2014 survey shows ~18,600 cy more sand contained on the visible beach than the condition at project completion (February 2014), but this volume is ~69,500 cy less than the volume in June 2014. The difference (loss) between June and November reflects normal seaward adjustment and narrowing of the visible beach during fall and winter. The November survey indicated much of the “lost” volume between June and November shifted underwater, while part of the lost volume shifted landward to higher elevations, contributing to the dune growth by winds.

The third set of bars in Figure 4.1 (upper) shows volume changes along the inner surf zone between MLW and the low-tide wading depth (−5 ft NGVD). The November survey shows there are ~23,000 cy less sand in this lens than in February 2014, but ~50,000 cy more sand than in June 2014. The volume changes in this lens also reflect the seasonal variation of the beach and the process of beach profile adjustment after nourishment. The post- construction survey in February 2014 confirmed ~22 percent of the nourishment volume was placed between MLW and low-tide wading depth, and as of November 2014, ~20 percent of the nourishment volume was detected within this zone, suggesting nourishment sand in this zone has remained relatively stable since the completion of the project.



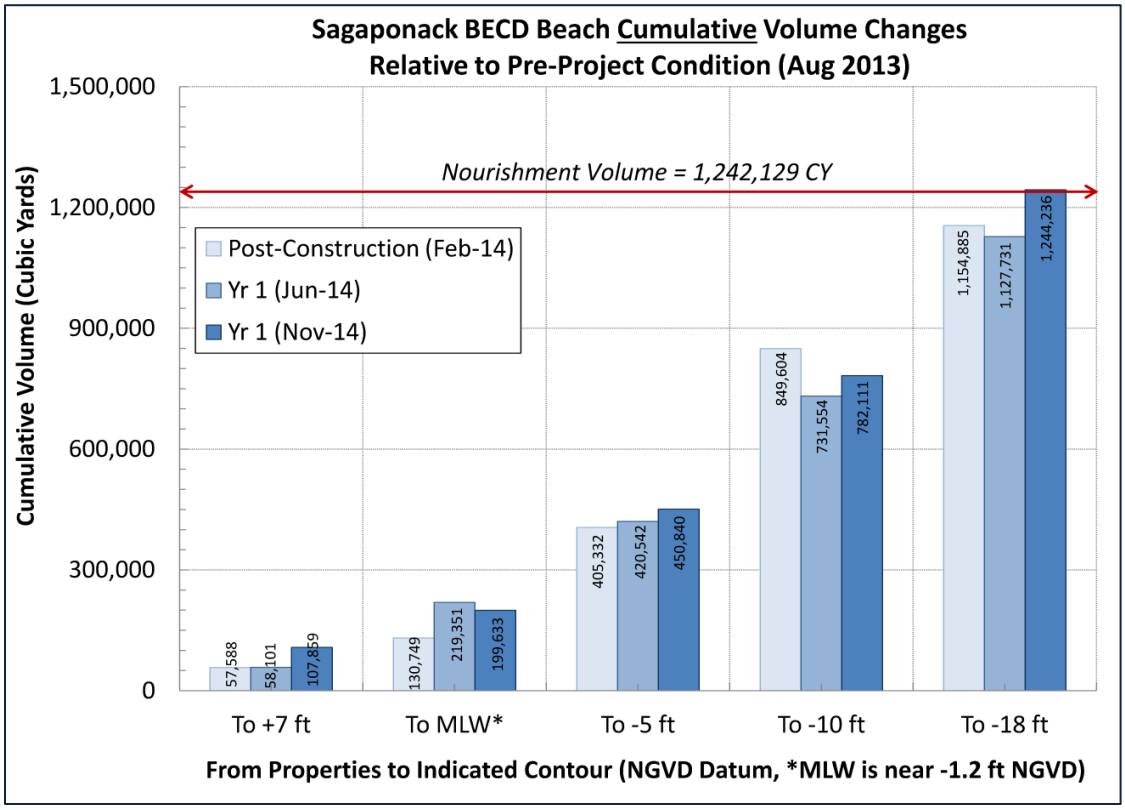


FIGURE 4.1. Sagaponack beach volume changes relative to August 2013 survey results. **[UPPER]** Between indicated contours. **[LOWER]** Cumulative volume changes between properties and indicated contours.

The last two sets of bars in Figure 4.1 (upper) represents volume changes underwater in the outer surf zone out to the bar between −5 ft and −10 ft NGVD and the zone seaward of the bar between −10 ft and −18 ft NGVD. The November 2014 survey shows ~113,000 cy (~8.0 cy/ft) eroded from the outer surf zone after project completion, but ~156,800 cy (~11.1 cy/ft) accumulated beyond the outer bar zone. It is likely a small portion of sand moved up the profile and contributed to the gain in sand on the visible beach since February. As confirmed in the surveys, 65 percent of the nourishment volume was placed underwater between −5 ft and −18 ft NGVD and as of June 2014, 61 percent of the volume remained within this zone.

Figure 4.1 (lower) shows the cumulative volumes remaining along the project area relative to August 2013. The first set of bars in Figure 4.1 (lower) is the same as Figure 4.1 (upper). Starting from the second set of bars, volumes in Figure 4.1 (lower) represent the cumulative results from properties to the indicated contours. In relation to Figure 4.1 (upper), the second set of bars is the summation of the first two sets of bars in Figure 4.1 (upper), and the third set of bars in Figure 4.1 (lower) is the summation of the first three sets of bars in Figure 4.1 (upper). Therefore, the last (fifth) set of bars in Figure 4.1 (lower) represents the summation of all five sets of bars in Figure 4.1 (upper) [ie – the cumulative volume changes between properties and −18 ft relative to the pre-project condition (August 2013)].

Compared to the condition at project completion (February 2014), as of November 2014, **Sagaponack beach contains more sand in the upper beach and dune areas or on the visible beach (from properties to low-tide wading depth around −5 ft NGVD).** The volume gain shown in the first and second sets of bars in Figure 4.1 (lower) was offset by the loss between MLW and the −10 ft contour as shown in the fouth set of bars. The gains and losses between various contours (see Fig 4.1, upper) balance when calculated to the −18 ft contour, and there are nearly 90,000 cy more sand in November than in February. **The 1,244,236 cy of sand remaining within the project boundaries out to the FEMA reference depth in November 2014 is equal to *100 percent* of the nourishment volume placed along Sagaponack beach after the dune reconstruction volume (~3,000 cy) is excluded.**

4.2 Bridgehampton-Water Mill

Similar to Figure 4.1 for Sagaponack, Figure 4.2 provides volume changes along the Bridgehampton project area between reference contours relative to August 2013.

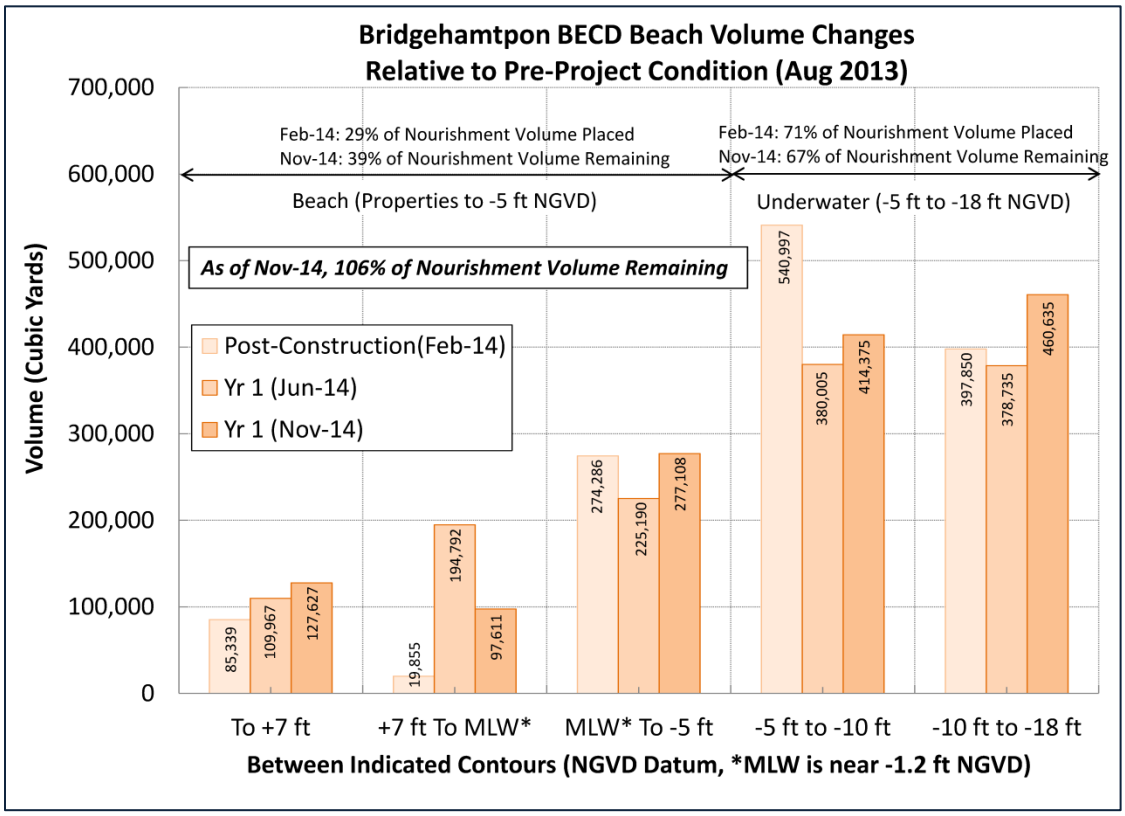
The first set of bars in Figure 4.2 (upper) represents net volume changes along the upper beach and foredune between properties and +7 ft NGVD (nourishment berm elevation). The November 2014 survey results show there has been an increase of nearly 42,300 cy (a gain rate of ~2.7 cy/ft) since the completion of construction (February 2014) and ~127,600 cy (a gain of ~8.2 cy/ft) more sand than the condition before nourishment (August 2013).

The wide dry beach constructed by nourishment provided a new sand source for dune growth. Dune enhancement measures conducted by individual home owners, such as sand-fencing installation and vegetation planting, have helped concentrate sand along the back beach and enhanced their foredunes. The extra volume and elevation in the dunes project-wide will provide a greater surge protection, and help reduce damages during future storms.

The next set of bars in Figure 4.2 (upper) represents the total volume changes in the visible beach between +7 ft and MLW (−1.2 ft NGVD). The November 2014 survey shows ~77,700 cy (~5 cy/ft) more sand contained on the visible beach than the condition at project completion (February 2014). Similar to the Sagaponack beach condition, this volume is less than the volume in June 2014 due to seasonal sand redistribution from the visible beach to the inner surf zone.

The third set of bars in Figure 4.2 (upper) shows volume changes along the inner surf zone between MLW and low-tide wading depth (−5 ft NGVD). The November survey shows there have been negligible volume changes since project completion. The volume loss between February and June was balanced by the gain between June and November in this lens. The post-construction survey in February 2014 confirmed 21.1 percent of the nourishment volume was placed between MLW and low-tide wading depth, and as of November 2014, ~21.3 percent of the nourishment volume was detected within this zone, indicating the inner surf zone volume has remained stable since project completion.

The last two sets of bars in Figure 4.2 (upper) represent volume changes underwater in the outer surf zone between −5 ft and −10 ft NGVD and seaward of the outer bar between −10 ft and −18 ft NGVD. Similar to Sagaponack, the February 2014 survey in Bridgehampton shows a relatively large portion of the nourishment was placed in the outer surf zone.



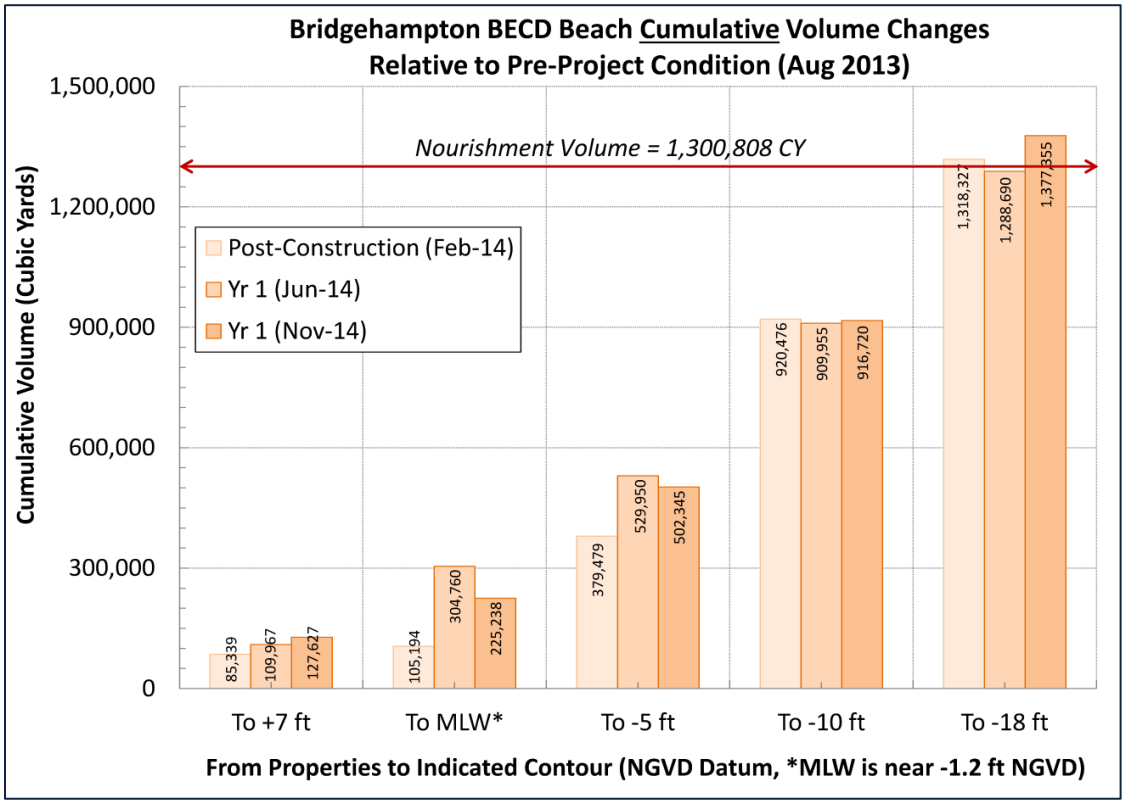


FIGURE 4.2. Bridgehampton beach volume changes relative to August 2013 survey results. **[UPPER]** Between indicated contours. **[LOWER]** Cumulative volume changes between properties and indicated contours.

Between February and November, ~126,600 cy (~8.1 cy/ft) shifted from this area to other lenses (depth intervals). About ~62,800 cy (~4.0 cy/ft) accumulated seaward of the outer bar. As confirmed in the surveys, 71 percent of the nourishment volume was placed underwater between −5 ft and −18 ft NGVD; and as of November 2014, 67 percent of the volume remained within this zone.

Figure 4.2 (lower) shows the **cumulative** volumes remaining along the project area relative to August 2013. The first set of bars in Figure 4.2 (lower) is the same as Figure 4.2 (upper). Starting from the second set of bars, volumes in Figure 4.2 (lower) represent the cumulative results from properties to the indicated contours. In relation to Figure 4.2 (upper), the second set of bars is the summation of the first two sets of bars in Figure 4.3, and the third set of bars in Figure 4.2 (lower) is the summation of the first three sets of bars in Figure 4.2 (upper). Therefore, the last (fifth) set of bars in Figure 4.2 (lower) represents the summation of all five sets of bars in Figure 4.2 (upper) [ie – the cumulative volume changes between properties and −18 ft relative to the pre-project condition (August 2013)].

The November 2014 survey confirms **a gain of ~123,000 cy since February from the dunes to low-wading depth** (the third set of bars in the lower graph of Figure 4.2)**.** Between properties and the −10 ft contour there was essentially no variation in volume since project completion (the fourth set of bars). Seaward of the −10-ft contour (represented by the fifth set of bars), nearly 60,000 cy accumulated leaving **a total of 1,377,355 cy (*106 percent* of the nourishment volume) remaining within the project boundaries out to the FEMA reference depth in November 2014.**

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5.0 UPCOAST AND DOWNCOAST CHANGES

As part of the annual condition surveys, CSE obtained profiles upcoast and downcoast of the project area to evaluate the impact of the nourishment project along these beach segments. CSE extended the survey limits ~1 mile east and 1.5 miles west of the project boundaries. The upcoast dataset covers station −25+00 (in front of Georgica Pond) to station 25+00 (near the Sagaponack project limit at station 28+84), and the downcoast dataset covers station 330+00 (near the Bridgehampton-Water Mill project limit at station 326+35) to station 400+00 (Village of Southampton).

Changes in the downcoast and upcoast beaches partly reflect spreading of nourishment volume away from the project. Some changes are also associated with onshore and offshore transport (ie – the seasonal shift of sand from the surf zone to the visible beach and back again). Data are available for August 2013 (pre-project), February 2014 (post-project), and June and November 2014. Available profiles are included in Appendix 2. Unit volumes and total volumes at each downcoast or upcoast station to various reference-depth contours are included in Appendix 4.

Figure 5.1 shows the cumulative volume changes as of November 2014 relative to the pre-project condition between the foredune or properties and the indicated depth contour along upcoast and downcoast reaches. The results suggest both upcoast and downcoast areas gained sand in the upper portion of beach above +7 ft NGVD, which is the same phenomena as the project area. The dry beach between +7 ft NGVD and MLW lost sand, especially in the downcoast area.

Sand volume changes were negligible when measured to low-tide wading depth at −5 ft NGVD for the downcoast area. However, if measured across the active surf zone and continued offshore beyond the outer bar to the FEMA reference depth (−18 ft), there was a net gain of ~143,500 cy along the ~1-mile upcoast area and ~180,500 cy along the 1.5-mile downcoast area. The net gain in sand volume inside the −18 ft contour and zero volume losses within the project area provide evidence of natural onshore transport from deeper water.

Following large storms like *Sandy* (which occurred before the nourishment project), sand that shifts into deep water (ie – −18-ft to −30-ft depths) commonly migrates back to shore. This will be analyzed in more detail in future monitoring reports. One positive effect of this is that it counteracts the natural tendency for nourishment sand to spread east and west into

unnourished areas. More sand is expected to shift west over time since the net longshore sediment transport direction is from east to west under normal conditions.

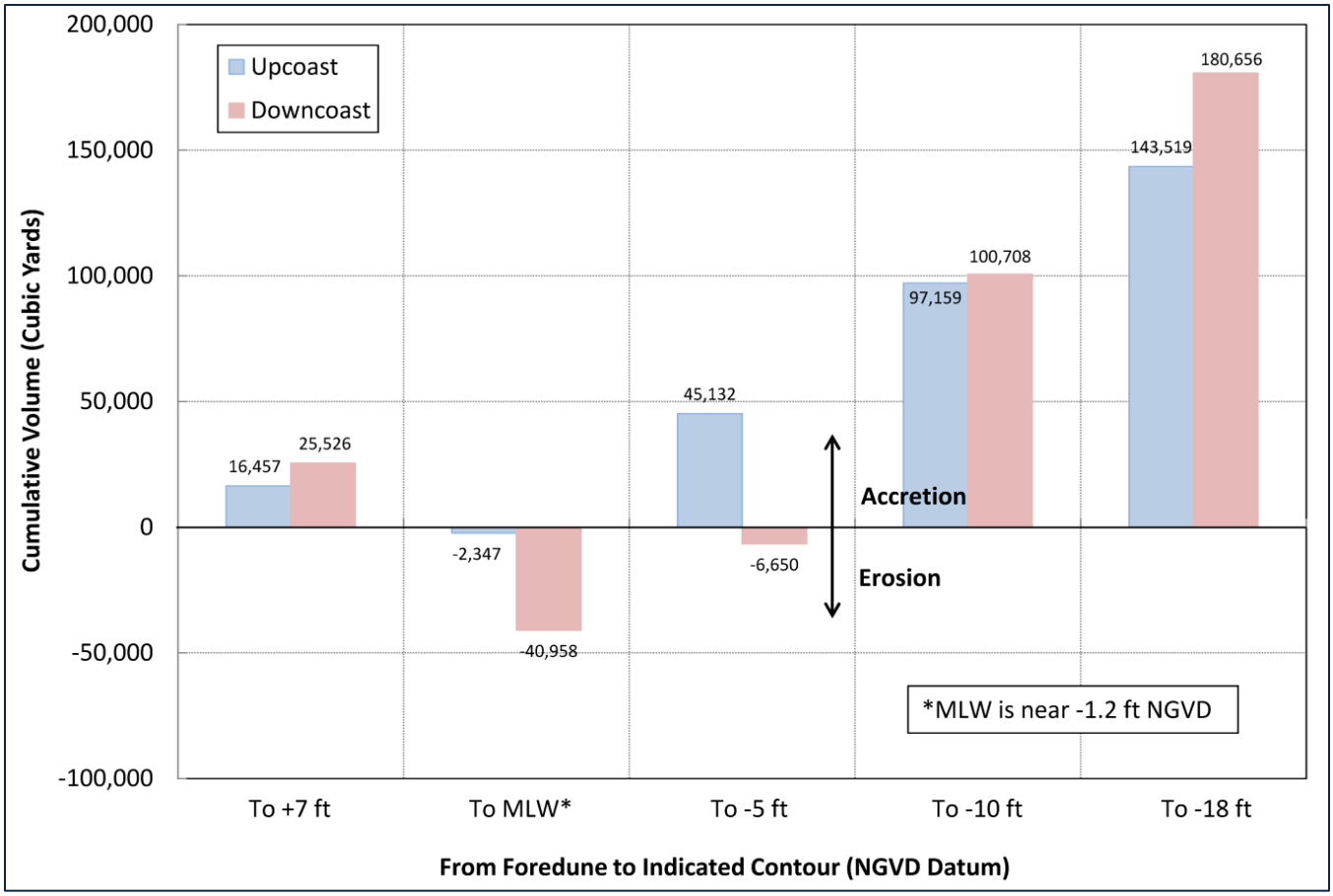


FIGURE 5.1. Cumulative volume changes from the foredune or properties to the indicated contour relative to the August 2013 condition along upcoast and downcoast stations outside the project area.

6.0 BEACH SEDIMENTS

In accordance with the monitoring plan, CSE collected representative sediment samples from the project area and immediately adjacent unnourished sections east of Sagaponack for purposes of documenting changes in sediment texture. *[Note: CSE's monitoring plan calls for two semi-annual beach condition surveys in the first year after project completion, but CSE assumes samples collected in the first semi-annual survey in June 2014 will be sufficient to represent the Year 1 beach sediment condition.]*

6.1 Pre-Project Sediment Analyses for the Recipient Beach and the Borrow Areas

6.1.1 Recipient Beach

Sediment samples of the native beach were collected by CSE at 12 shore-perpendicular transects in July 2011 (CSE 2012a,b). At each transect, five sets of samples (60 total) were obtained including samples from the toe of dune, mid berm, berm crest, beach face (approximate MHW), and low-tide terrace (LTT). The positions of the 12 transects are noted in Figure 6.1, and the five sample positions across each profile are illustrated in Figure 6.2.

The mean grain size of all native beach sand samples (from dune to LTT) ranged from 0.373 millimeters (mm) to 0.488 mm, and averaged 0.42 mm with the average standard deviation of 0.70 mm. The shell content averaged 0.5 percent, and no samples contained sediment in the gravel (4.76 mm or greater) size class.

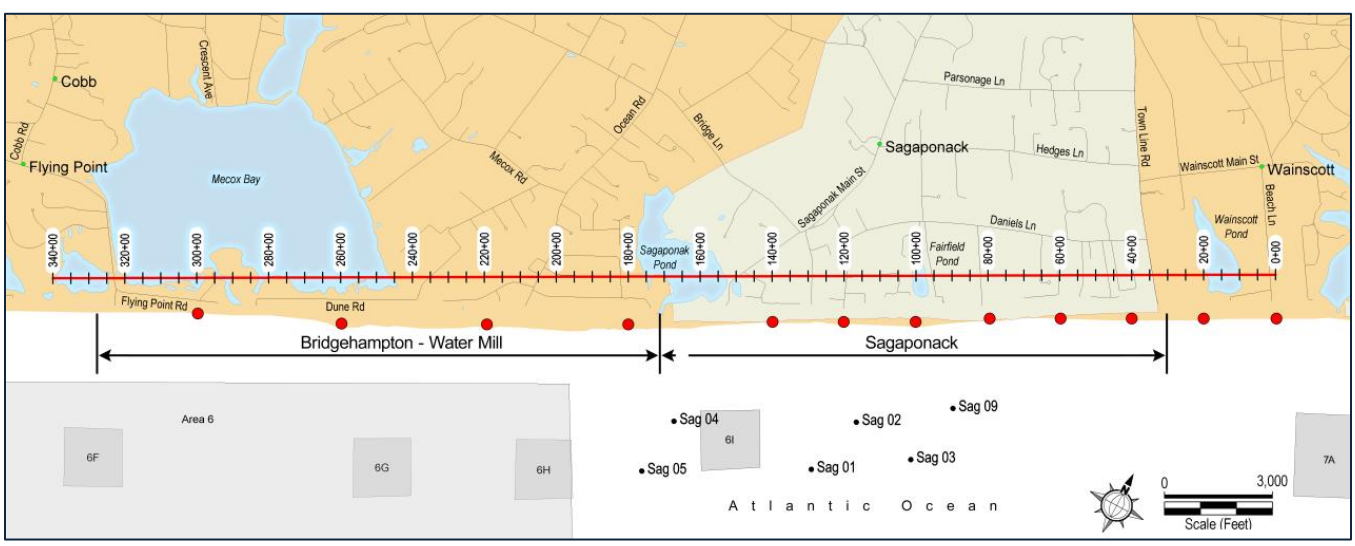


FIGURE 6.1. Location of sediment samples collected at Sagaponack and Bridgehampton marked by red dots.

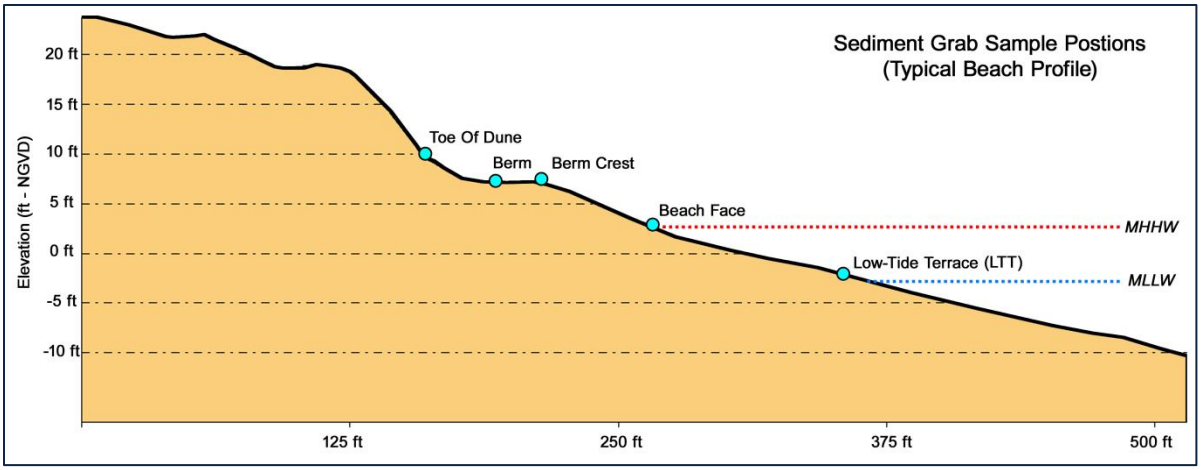


FIGURE 6.2. Sampling locations of the five samples per transect from dune to low-tide terrace (green dots) used to characterize the recipient beach at Sagaponack and Bridgehampton.

6.1.2 Borrow Areas

CSE collected six borings in July 2011 and 50 borings in August 2012 in the potential borrow areas. Mean grain size for the offshore samples was generally uniform with sparse areas of fine and coarse sand occurring (CSE 2012a,b; 2014a). Based on the results of the isopach maps, three borrow areas were delineated for the project. Mean grain size in borrow areas ranged from 0.424 mm for Area 1, to 0.437 for Area 2, to 0.464 mm for Area 3. The cores within each borrow area were observed to contain very small amounts of fine-grained material. Gravel-sized (or greater) sediment comprised negligible amounts in the offshore samples. Shell content was also relatively minor, generally <2 percent. The similarity of the sand-size classes and shell content in sediment analyses for the recipient beach and the borrow areas suggested the sand would look and perform well once placed on the beach. Minimal turbidity would be expected during construction.

6.2 Sediment Analysis during Construction Phase

During the 2013–2014 nourishment construction, CSE collected a composite-grab sample every 500 ft from the stations completed during construction observations. A composite sample consisted of a series of grab samples at ~10-ft spacing along a transect from the landward limit of fill to the low-tide line mixed together to form one representative sample for the given station. Some additional single-point grab samples in the vicinity of the discharge point were also collected. Selected sand samples were analyzed to determine grain-size

characteristics and shell content as a means of monitoring the quality of the material actually placed on the beach.

Nourishment sand placed on the beach was found to be consistent with the borings obtained by CSE. It contained negligible mud, little shell material, and was compatible, clean, and free of debris and clay. The mean grain size of all samples collected during project construction was remarkably consistent for ~90 percent of the samples. It was calculated to be 0.446 mm (ranging from 0.348 mm to 0.824 mm), which is classified as medium to coarse sand (CSE 2014b). For Sagaponack, the mean grain size ranged from 0.348 mm to 0.824 mm and averaged 0.447 mm. For Bridgehampton, the mean grain size ranged from 0.357 mm to 0.714 mm and averaged 0.443 mm.

6.3 Sediment Analysis in Year 1 — June 2014

CSE collected sediment samples in June 2014 (Year 1) at the same 12 transects (~2,000-ft to 4,000-ft spacing) as the pre-project studies. Five samples per transect were collected between the toe of the dune and the low-tide wading zone. *[Positions of the transects and cross-shore sample locations are given in Figures 6.1 and 6.2.]* Samples were split for granulometric and shell analysis and were tested in the lab using standard ASTM procedures. Grain-size distributions were based on 0.25-phi intervals (21 sieves in the sand-size range). Additional coarse sieves were used for samples which showed significant concentrations of coarse-shell or gravel material. Fines were reported as a percentage of the total based on the quantity passing the #230 sieve (ie − <0.0625 mm diameter).

The results, composited by station, were compared with pre-project and construction data by means of tables and graphs. Results of individual grain-size distributions are reported in Appendix 5 using the Method of Moments as well as traditional graphic methods for calculating mean grain size and related sorting and skewness statistics.

Abbreviations corresponding to morphologic features listed on laboratory data sheets are as follows:

- Dune Toe near base of dune at the primary change in slope.
- Berm on top of the dry beach between the dune and the berm crest.
- Berm Crest near the high-tide swash line and seaward edge of the dry beach.

- Beach Face about midway along the sloping beach face in the swash zone.
- LTT near the low-tide mark, wave plunge point.

As the cross-section in Figure 6.2 showed, the samples collected in June 2014 represent the primary features of the visible beach. Typical grain sizes by position on the beach were produced by averaging the results of the individual samples. The primary size statistics for the dune, berm, berm crest, MHW, LTT, and all samples combined are listed in Table 6.1. The texture and classification at the beach were determined to be quartz sand, medium in size, and moderately well sorted.***** The average content of shell material ($CaCO_3$) was 0.4 percent.

*[*Sorting indicates textural maturity. Well-sorted sediment samples imply the sediments were transported over a great distance or have been in place for a long period of time, causing the grains to become well-rounded and well-sorted. Moderate to poor sorting indicates relatively shorter transport distances, or in the case of a renourished beach, more recent placement of sand.]*

The results indicate the June 2014 samples did not contain significant gravel-sized sediment, and the mean grain size of the nourished beach ranged from 0.305 mm to 0.554 mm, averaging **0.408 mm with standard deviation of 0.742 mm**.

Beach sediments in June 2014 were 0.012 mm finer than the pre-project condition. Size distributions along the length of the beach in June 2014 were slightly less uniform than before the project (higher standard deviation, 0.742 versus 0.70).

Sediment characteristics along the beach vary moderately in both the alongshore and cross-shore directions as shown in Table 6.2 and Figure 6.3. It is common for surficial grab samples to vary according to the wave and tide conditions that affect the sediment around the time of sampling. The June 2014 mean sediment sizes at different cross-shore positions were relatively uniform, varying from 0.375 mm on the dune to 0.472 mm at low-tide terrace (in comparison to the 2011 samples which varied from 0.372 mm on the dune to 0.478 mm at low-tide terrace). As Figure 6.3 suggests, the results in 2011 were skewed by a few samples (dune at stations 20+00 and 220+00; and LTT at stations 20+00 and 220+00), but the results in June 2014 were more uniform from dune to low-tide terrace.

The foregoing results confirm the nourished beach retains virtually similar sediment size distributions, confirming the similarity between native beach sands and offshore borrow sands.

TABLE 6.1. Summary of sediment characteristics for June 2014 samples at the 12 stations along Sagaponack and Bridgehampton and the adjacent beach.

Bridgehampton and Sagaponack Beach Sediment		Method of Moments						Folk Graphical Method				Shell and Gravel	
		mm		Phi				phi					
Station	Location	Mean	STD	Mean	STD	Skewness	Kurtosis	Mean	STD	Skewness	Kurtosis	% Shell	% >2mm
0+00	Dune	0.394	0.722	1.344	0.470	-0.425	6.166	1.213	0.415	-0.030	1.122	-	0.3
0+00	Berm	0.434	0.753	1.205	0.410	-0.377	4.994	1.085	0.398	-0.083	1.017	-	0.1
0+00	Berm Crest	0.467	0.769	1.098	0.378	-0.060	3.532	0.970	0.378	-0.038	0.918	-	0.0
0+00	Beach Face	0.350	0.774	1.515	0.369	0.002	4.175	1.393	0.355	0.009	1.165	-	0.0
0+00	LTT	0.447	0.724	1.163	0.467	-0.984	7.032	1.057	0.415	-0.045	1.023	-	0.6
20+00	Dune	0.413	0.778	1.274	0.361	0.107	4.419	1.150	0.355	-0.036	1.110	-	0.0
20+00	Berm	0.435	0.765	1.201	0.386	-0.169	3.809	1.078	0.378	-0.085	1.037	-	0.0
20+00	Berm Crest	0.554	0.712	0.852	0.489	0.046	3.010	0.730	0.510	0.103	0.899	-	0.1
20+00	Beach Face	0.379	0.785	1.401	0.348	-0.109	3.855	1.273	0.335	-0.075	1.063	-	0.0
20+00	LTT	0.479	0.752	1.061	0.410	0.144	3.636	0.930	0.408	0.024	0.990	-	0.0
40+00	Dune	0.382	0.750	1.387	0.414	0.204	4.301	1.253	0.365	-0.005	1.148	-	0.0
40+00	Berm	0.351	0.718	1.509	0.478	0.232	4.286	1.377	0.443	0.085	1.199	-	0.0
40+00	Berm Crest	0.424	0.716	1.238	0.482	-0.057	4.341	1.110	0.450	-0.076	1.112	-	0.1
40+00	Beach Face	0.418	0.791	1.258	0.338	-0.098	3.762	1.135	0.340	-0.100	1.060	-	0.0
40+00	LTT	0.499	0.733	1.003	0.448	-0.101	2.721	0.878	0.463	-0.060	0.875	-	0.0
60+00	Dune	0.355	0.708	1.494	0.498	0.139	3.913	1.367	0.463	0.065	1.201	-	0.0
60+00	Berm	0.358	0.698	1.483	0.518	0.057	5.535	1.357	0.458	0.106	1.226	-	0.2
60+00	Berm Crest	0.339	0.695	1.562	0.525	0.165	3.785	1.440	0.515	0.129	1.096	-	0.1
60+00	Beach Face	0.360	0.768	1.472	0.380	-0.199	5.065	1.348	0.338	-0.017	1.230	-	0.0
60+00	LTT	0.547	0.621	0.871	0.687	-1.072	5.016	0.798	0.555	-0.226	1.224	-	3.9
80+00	Dune	0.418	0.716	1.259	0.481	-0.002	4.137	1.128	0.460	-0.027	1.040	-	0.1
80+00	Berm	0.358	0.748	1.482	0.418	0.249	3.778	1.352	0.398	0.052	1.192	-	0.0
80+00	Berm Crest	0.374	0.769	1.417	0.378	0.172	3.816	1.282	0.358	-0.012	1.066	-	0.0
80+00	Beach Face	0.381	0.755	1.393	0.405	0.226	3.901	1.258	0.373	0.022	1.072	-	0.0
80+00	LTT	0.432	0.744	1.210	0.426	-0.111	3.424	1.087	0.430	-0.096	1.010	-	0.0
100+00	Dune	0.364	0.766	1.457	0.384	0.189	4.044	1.320	0.355	0.021	1.184	0.3	0.0
100+00	Berm	0.411	0.784	1.284	0.350	-0.195	4.125	1.167	0.338	-0.096	1.102	0.4	0.0
100+00	Berm Crest	0.410	0.795	1.285	0.331	0.185	4.047	1.163	0.325	-0.022	1.059	0.2	0.0
100+00	Beach Face	0.427	0.713	1.226	0.488	-0.470	4.126	1.112	0.463	-0.160	1.102	0.3	0.0
100+00	LTT	0.503	0.748	0.992	0.419	0.065	3.045	0.867	0.430	-0.004	0.925	0.2	0.0
120+00	Dune	0.342	0.714	1.550	0.485	0.457	3.559	1.415	0.468	0.153	1.155	-	0.0
120+00	Berm	0.439	0.676	1.186	0.566	-1.550	7.881	1.110	0.425	-0.200	1.352	-	1.4
120+00	Berm Crest	0.495	0.723	1.015	0.467	-0.355	3.962	0.895	0.460	-0.092	0.904	-	0.1
120+00	Beach Face	0.332	0.769	1.592	0.379	-0.012	3.856	1.475	0.350	0.029	1.076	-	0.0
120+00	LTT	0.444	0.662	1.173	0.595	-0.909	4.559	1.068	0.548	-0.239	1.085	-	0.5
140+00	Dune	0.322	0.785	1.633	0.350	0.599	4.583	1.497	0.328	0.132	1.116	-	0.0
140+00	Berm	0.350	0.742	1.513	0.430	0.298	4.020	1.380	0.408	0.070	1.213	-	0.0
140+00	Berm Crest	0.329	0.752	1.602	0.411	0.367	3.932	1.475	0.375	0.140	1.112	-	0.0
140+00	Beach Face	0.421	0.764	1.248	0.388	0.007	4.251	1.118	0.383	0.001	1.110	-	0.0
140+00	LTT	0.514	0.753	0.961	0.409	0.137	3.921	0.837	0.413	0.044	0.965	-	0.0
180+00	Dune	0.379	0.747	1.399	0.421	0.395	5.037	1.260	0.355	0.032	1.167	-	0.0
180+00	Berm	0.398	0.766	1.329	0.385	0.240	4.708	1.203	0.350	0.019	1.107	-	0.0
180+00	Berm Crest	0.447	0.748	1.161	0.420	-0.283	5.381	1.033	0.405	-0.044	0.956	-	0.2
180+00	Beach Face	0.305	0.779	1.712	0.361	0.340	3.467	1.582	0.365	0.110	1.057	-	0.0
180+00	LTT	0.440	0.726	1.184	0.463	-0.260	3.979	1.060	0.455	-0.056	1.023	-	0.1
220+00	Dune	No Sample Due to Plovers											
220+00	Berm	0.425	0.727	1.234	0.460	-0.115	5.403	1.108	0.410	-0.046	1.181	-	0.0
220+00	Berm Crest	0.484	0.698	1.048	0.519	-1.000	5.115	0.943	0.448	-0.260	1.185	-	0.3
220+00	Beach Face	0.416	0.765	1.265	0.386	-0.374	3.938	1.147	0.375	-0.110	1.106	-	0.0
220+00	LTT	0.466	0.764	1.101	0.388	-0.347	3.178	0.975	0.393	-0.131	0.958	-	0.0
260+00	Dune	0.401	0.724	1.320	0.466	-0.168	4.044	1.185	0.435	-0.039	1.115	0.4	0.0
260+00	Berm	0.381	0.715	1.391	0.483	-0.144	4.230	1.272	0.440	-0.015	1.152	1.6	0.0
260+00	Berm Crest	0.497	0.599	1.008	0.740	-0.654	3.739	0.913	0.665	-0.234	1.158	0.4	1.4
260+00	Beach Face	0.495	0.766	1.014	0.385	-0.322	3.850	0.895	0.393	-0.099	0.991	0.3	0.0
260+00	LTT	0.522	0.740	0.939	0.435	-0.419	4.345	0.827	0.423	-0.073	0.954	0.4	0.1
300+00	Dune	0.354	0.781	1.500	0.356	0.250	4.242	1.368	0.345	0.050	1.099	-	0.0
300+00	Berm	0.345	0.768	1.537	0.380	0.178	4.159	1.412	0.363	0.013	1.179	-	0.0
300+00	Berm Crest	0.402	0.747	1.313	0.420	-0.064	3.760	1.185	0.408	-0.090	1.066	-	0.0
300+00	Beach Face	0.358	0.755	1.483	0.406	0.037	4.403	1.360	0.390	-0.034	1.146	-	0.0
300+00	LTT	0.370	0.776	1.433	0.365	0.035	3.545	1.297	0.345	-0.033	1.059	-	0.0
320+00	Dune	0.337	0.765	1.571	0.386	0.051	4.730	1.443	0.370	0.047	1.050	-	0.0
320+00	Berm	0.348	0.734	1.525	0.446	0.232	3.917	1.397	0.430	0.035	1.118	-	0.0
320+00	Berm Crest	0.375	0.757	1.414	0.402	-0.502	4.525	1.293	0.353	-0.104	1.148	-	0.0
320+00	Beach Face	0.353	0.732	1.504	0.451	-0.152	3.310	1.388	0.443	-0.048	1.071	-	0.0
320+00	LTT	0.347	0.784	1.526	0.352	0.103	3.835	1.400	0.345	0.036	1.098	-	0.0
All		**0.408**	**0.742**	**1.309**	**0.433**	**-0.096**	**4.237**	**1.186**	**0.408**	**-0.027**	**1.089**	**0.4**	**0.2**

TABLE 6.2. Sediment characterization for 12 recipient beach transects in June 2014 along Sagaponack- Bridgehampton-Water Mill beach. (Grain size in millimeters).

Station	Dune	Berm	Berm Crest (BC)	Beach Face (BF)	Low-tide Terrace (LTT)	Average
0+00	0.394	0.434	0.467	0.350	0.447	0.418
20+00	0.413	0.435	0.554	0.379	0.479	0.452
40+00	0.382	0.351	0.424	0.418	0.499	0.415
60+00	0.355	0.358	0.339	0.360	0.547	0.392
80+00	0.418	0.358	0.374	0.381	0.432	0.393
100+00	0.364	0.411	0.410	0.427	0.503	0.423
120+00	0.342	0.439	0.495	0.332	0.444	0.410
140+00	0.322	0.350	0.329	0.421	0.514	0.387
180+00	0.379	0.398	0.447	0.305	0.440	0.394
220+00	-	0.425	0.484	0.416	0.466	0.448
260+00	0.401	0.381	0.497	0.495	0.522	0.459
300+00	0.354	0.345	0.402	0.358	0.370	0.366
Average	**0.375**	**0.390**	**0.435**	**0.387**	**0.472**	**0.413**

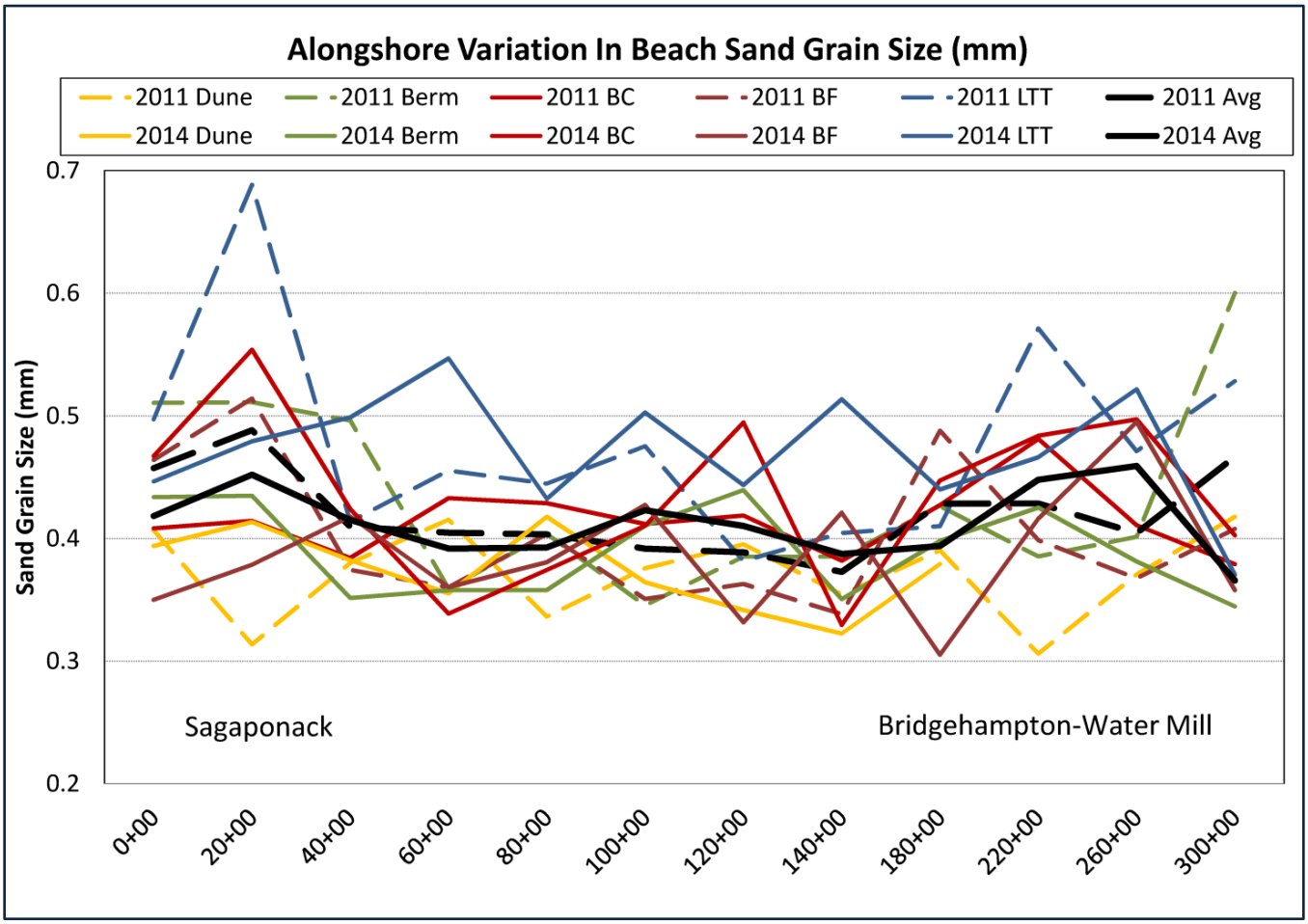


FIGURE 6.3. Alongshore sediment distribution of average grain size at specific cross-shore locations for all transects at Sagaponack and Bridgehampton-Water Mill in June 2014 compared to the pre-project condition in July 2011.

7.0 MONITORING & MAINTENANCE RECOMMENDATIONS

In accordance with FEMA Publication 321 and Code of Federal Regulations 44 CFR 206.226(j), a maintenance program involving periodic renourishment of sand must be established and adhered to by the Town of Southampton to qualify for FEMA post-disaster assistance. The purpose of such a program is to track the physical condition of the beach after nourishment, quantify sand-volume changes, and determine whether the project qualifies for emergency renourishment following declared disasters. It is also intended to identify erosion hotspots and recommend small-scale maintenance renourishment, placement of sand fencing, and/or sand scraping so as to increase the life of the project.

CSE recommends the Town of Southampton continue to conduct an annual assessment of the physical condition of the nourished shoreline. The beach should be surveyed annually using the transect plan established by CSE. Such surveys will give the Town an annual assessment of the beach condition and will reveal problem areas or erosion hotspots that require attention. Annual surveys should be conducted in May or June before the hurricane season. They will serve to document the beach condition prior to the occurrence of a major erosion event, such as a hurricane.

Should a major storm event occur, a post-storm survey should be completed for damage assessment as soon as possible after the storm. Since the project is an engineered beach fill, the annual and post-storm surveys can provide a basis for reimbursement and reconstruction of the beach with federal disaster funds under a community assistance grant (eg – FEMA Category G post-storm restoration funds).

Sand (or snow) fencing and vegetation has been installed along numerous properties by individual owners since project completion, often with the assistance of team partner, FCC (Fig 7.1). Based on New York State Standards and Specifications for Erosion and Sediment Control (by NYDEC dated August 2005), the use of sand (or snow) fencing is effective if a broad area of dry-sand beach is available. Sand (or snow) fencing installed after nourishment has been proven to effectively trap sand and to facilitate dune growth. Artificially sprigged dune grasses will provide a jump-start on native vegetation propagation. CSE encourages the Town to establish a line seaward of which sand fencing is prohibited. This will help to eliminate erosion and washout of fencing materials. In general, the position of sand fencing should be as far landward as practicable.

FIGURE 7.1. Sand fencing installed and vegetation planted following project completion in the project area. [Photo on 10 November 2014.

The construction of such fencing should follow the NYDEC specifications as follows:

> *"… a minimum of 100 feet (horizontal distance) from the MHT line in two (three or four rows may be used where sufficient land area and sand is available) parallel lines 30 or 40 feet apart. The fences should be roughly parallel to the water line and yet be as nearly as possible at a right angle to the prevailing winds.*
>
> *"Where this is not possible, erect a single line of fence parallel with the water at least 140 feet from the MHT line and space 30 foot long perpendicular spurs 40 feet apart along the seaward side to trap lateral drift. As the fences fill with sand, additional sets of fence can be placed over those filled until the barrier dune has reached a protective height. To widen an old dune, the fencing should be set seaward at a distance of 15 feet from the old dune base.*

Materials of sand fence or snow fence should:

> *"Use standard 4-foot sand (snow) fence. The fence should be sound and free of decay, broken wire, and missing or broken slats. Wood posts, for fence support should be black locust, red cedar, white cedar, or other wood of equal life and strength. They do not need to be treated. They should be a minimum of 6 ft. 6 in. long and a minimum diameter of 3 inches. Standard fence post length is usually 7 ft.—8 ft. and should be used where possible. Four (4) wire ties should be used to fasten the fence to the wood posts. Weave fence between posts so that every other post will have fence on ocean side of posts. Tie wires should be no smaller than 12 gauge galvanized wire. The bottom of the fence should be set about 3 inches into the sand, or a mechanical grader could be used to push some sand against the bottom of fence.*

The next physical monitoring activity scheduled between the Town of Southampton and CSE under the present agreement is a full condition survey in June 2015 before the hurricane season.

8.0 SELECTED PHOTOGRAPHS

PHOTO 1 — Sagaponack Pond looking east on 22 October 2013 after project commencement, but nourishment has not reached the area shown in the photo.

[Photo by First Coastal]

PHOTO 2 — Sagaponack Pond looking west (upper) and north (lower) on 28 April 2014 – two months after project completion. [Photo by First Coastal]

PHOTO 3

Sagaponack Pond looking southeast during Year 1 monitoring period.

[UPPER] 12 June 2014

[LOWER] 10 November 2014

(Photos by CSE)

PHOTO 4 — Mecox Bay on 22 October 2013 during construction. A temporary sand berm was placed across the inlet landward of the strand to facilitate sand pumping in the area. Note pipeline discharging sand on the west side of Mecox Inlet. [Photo by First Coastal]

PHOTO 5 — Mecox Bay during Year 1 monitoring period. **[UPPER]** 19 June 2014 (Image by Google Earth). **[LOWER]** 10 November 2014 (Photo by CSE).

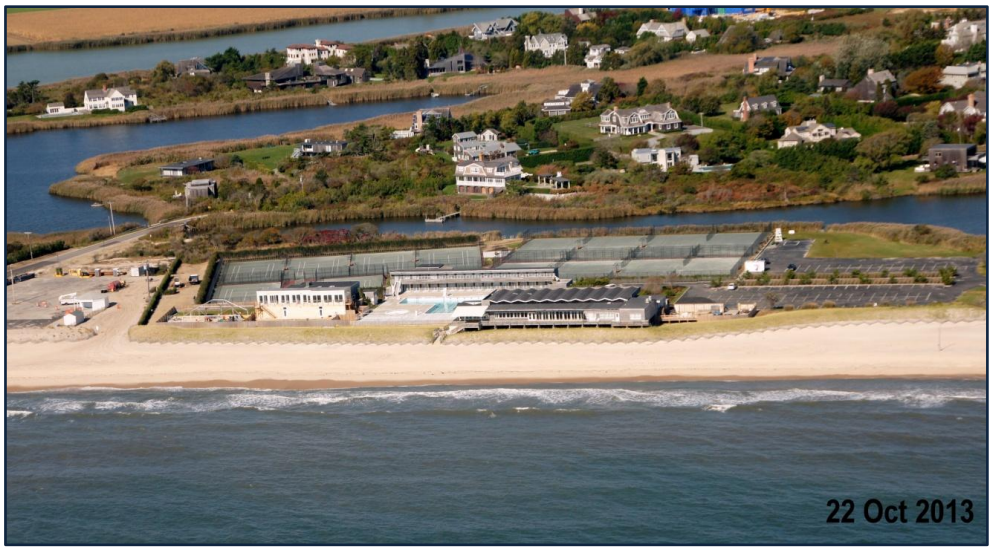
PHOTO 6

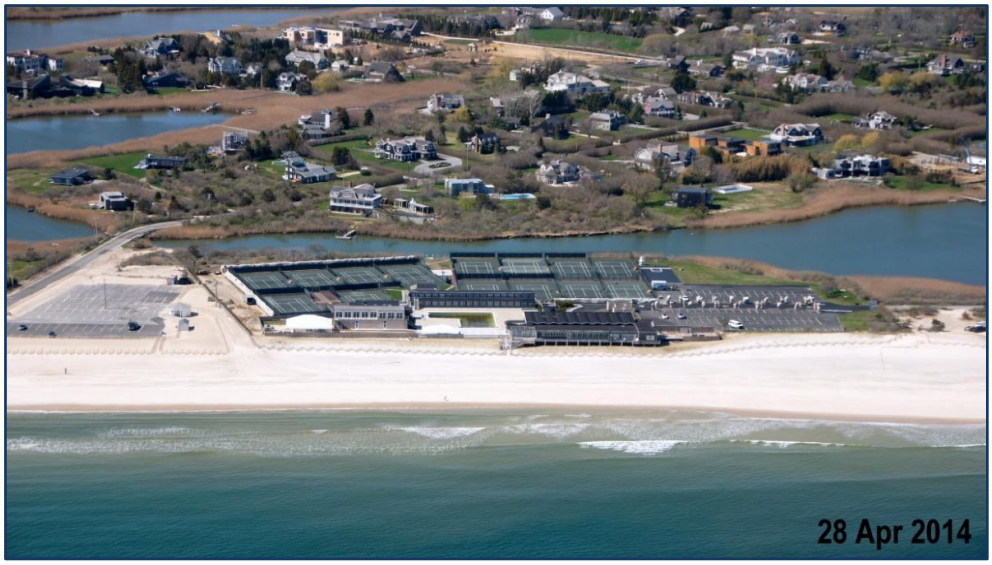
East of Jobs Lane near station 230+00 in Bridgehampton-Water Mill BECD.

[UPPER]
22 October 2013 before nourishment (photo by First Coastal).

[MIDDLE]
28 April 2014 two months after nourishment (photo by First Coastal).

[LOWER]
12 June 2014 during Year 1 monitoring period (photo by CSE).





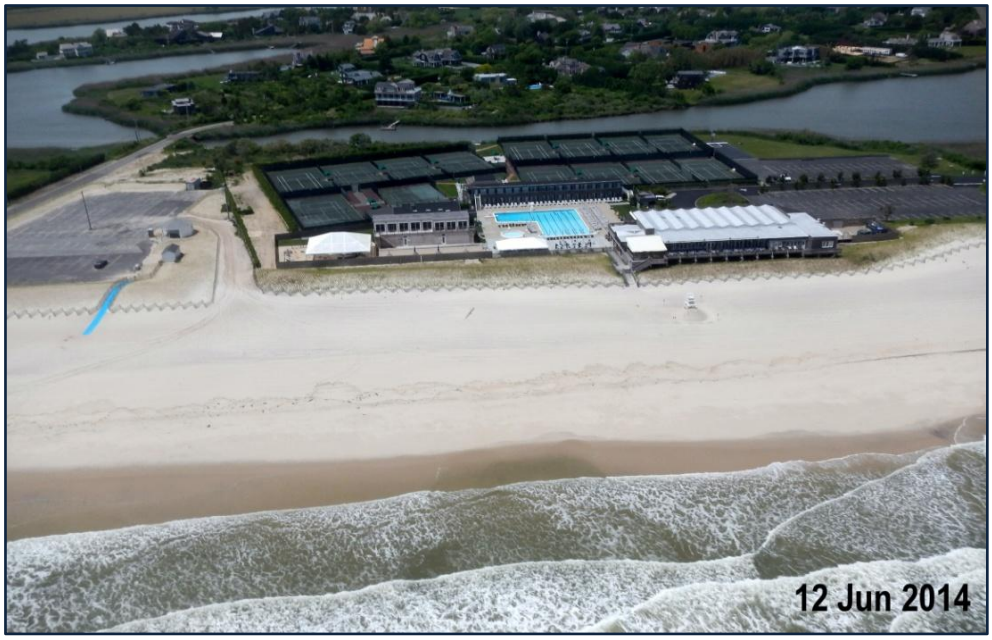


PHOTO 7

West of Peters Pond Lane near station 90+00 in Sagaponack BECD.

[UPPER]
22 October 2013 before nourishment (Photo by First Coastal)

[MIDDLE]
28 April 2014 two months after nourishment (Photo by First Coastal)

[LOWER]
12 June 2014 during Year 1 monitoring period (Photo by CSE)

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