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THE RICHARD STOCKTON COLLEGE OF NEW JERSEY

**Beach-Dune Performance Assessment of  
New Jersey Beach Profile Network (NJBPN) Sites at  
Long Beach Island, New Jersey  
After Hurricane Sandy**

November 13, 2012

The Richard Stockton College of NJ Coastal Research Center (CRC) has initiated a post-storm survey and assessment of the New Jersey shoreline in response to severe beach erosion resulting from the impact and landfall of Hurricane Sandy. The analysis for Long Beach Island (LBI) compares data collected during the fall of 2012 to data surveyed post-storm between November 1<sup>st</sup> and November 2, 2012. This initial report is focused on the impact to Long Beach Island's dunes and beaches from Hurricane Sandy. The damage details have been organized specific to each municipal segment of the island starting at Barnegat Inlet and Barnegat Light Borough. Each segment of Long Beach Township has been evaluated separately in a north to south order.

In general terms the beach erosion was significantly worse on the north side of the storm. Southern Cape May County fared best with limited overwash, dune scarping and loss of beach elevation. Damages increased towards the region of landfall with moderate dune breaches, especially in southern Ocean City area, and damages to southern Absecon Island's oceanfront properties. Dune breaches, loss and scarping of dunes, beach width and elevation continued north into Brigantine. From the natural area of Holgate north along the remainder of the Jersey coast the intensity of breaches and overwash and erosion of the dunes, beaches and damage to oceanfront property increased dramatically.

**Beach/Dune Damage Assessment by Municipal Island Segment:**

To measure the erosion, pre-existing New Jersey Beach Profile Network (NJBPN) monitoring sites were used to provide an accurate comparison and assessment of storm related shoreline and beach volume changes. Using the data from the fall 2012 NJBPN survey, completed on Long Beach Island by September 12<sup>th</sup>, provides a good baseline for damages that occurred during the hurricane. Data collected at the 14 oceanfront beach profile locations cover the municipal beaches from Barnegat Light to the entrance of the Holgate Forsythe National Wildlife Refuge (including the three constructed USACE engineered beaches in Harvey Cedars, Surf City and Brant Beach).

**Profile Locations:** The following sites on LBI were surveyed during September 2012 and post-Sandy on November 1 and 2, 2012 (Figure 1). \*Below is a map showing the location of each profile.

<b>NJBPN 245</b>	10 <sup>th</sup> St.	Barnegat Light	<b>NJBPN 140</b>	32 <sup>nd</sup> St.	Long Beach Twp
<b>NJBPN 145</b>	26 <sup>th</sup> St.	Barnegat Light	<b>NJBPN 139</b>	81 <sup>st</sup> St.	Long Beach Twp
<b>NJBPN 144</b>	La Baia St.	Loveladies	<b>NJBPN 138</b>	124 <sup>th</sup> St.	Long Beach Twp
<b>NJBPN 143</b>	73 <sup>rd</sup> St.	Harvey Cedars	<b>NJBPN 137</b>	Taylor Ave.	Beach Haven
<b>NJBPN 142</b>	Tranquility Dr.	Harvey Cedars	<b>NJBPN 136</b>	Dolphin Ave.	Beach Haven
<b>NJBPN 241</b>	20 <sup>th</sup> St.	Surf City	<b>NJBPN 135</b>	Webster Ave.	Long Beach Twp
<b>NJBPN 141</b>	8 <sup>th</sup> St.	Ship Bottom	<b>NJBPN 234</b>	Holgate Forsythe Wildlife Refuge	

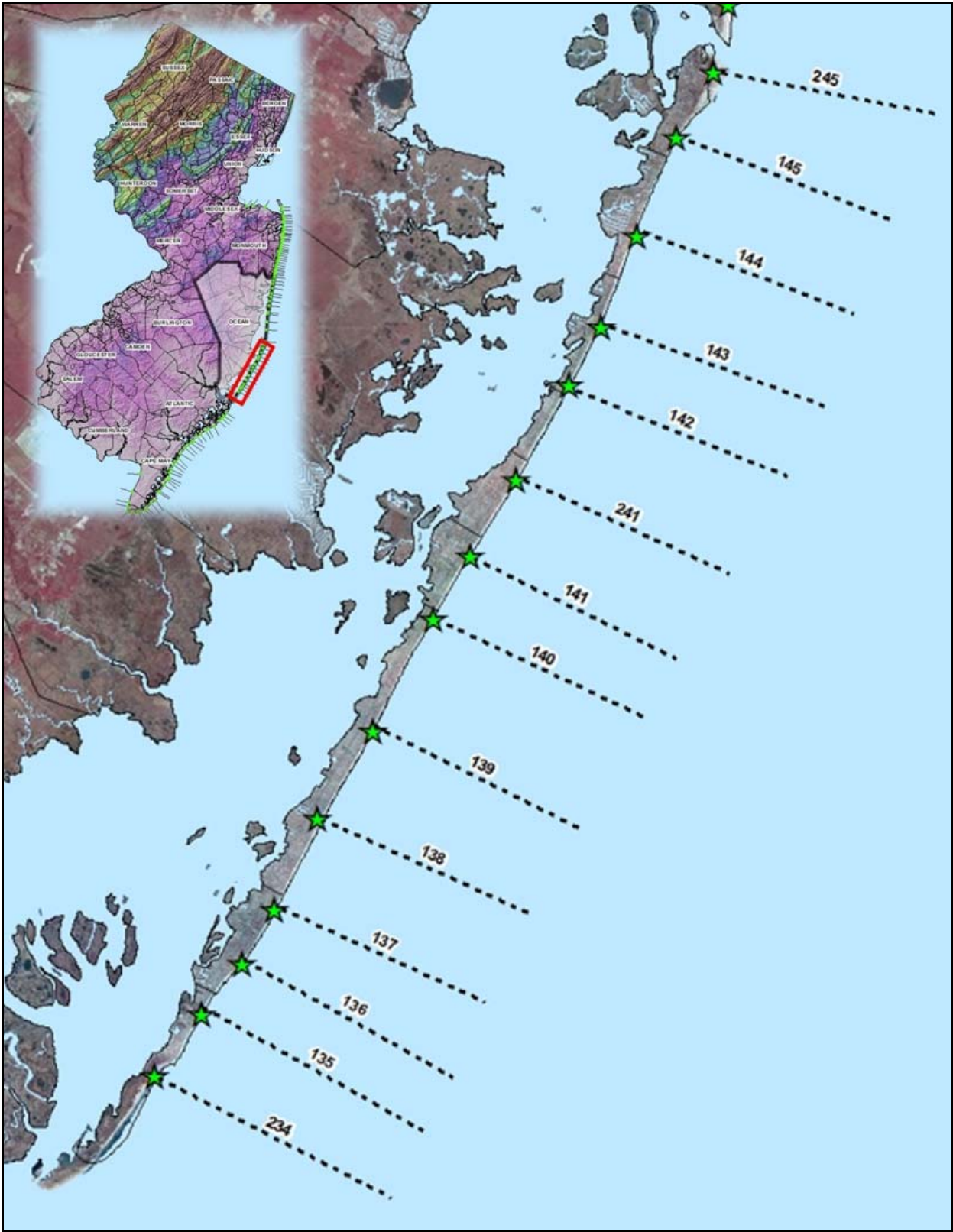


Figure 1. NJBPN Profile Locations, Long Beach Island, Ocean County, New Jersey

### **Barnegat Light Borough;**

The two profile sites in Barnegat Light Borough demonstrated that with a much larger than average dune system, there would be little impact from the tidal surge and the associated waves. The structure responsible for this hefty dune system was the 1988 to 1991 reconstruction of the south jetty to Barnegat Inlet parallel to the north jetty instead of the older "arrowhead" design originally built. The result was an accumulation of sand on the south side of the new jetty advancing the shoreline seaward by 2,400 feet at the jetty. This deposit tapers narrower to the south, but still produced a 450-foot shoreline advance at site 145 located at 26<sup>th</sup> Street in the Borough. The shoreline orientation is also a factor since the wave approach was almost parallel with the beach, not perpendicular to it. As a result there was no overwash, no sand in the streets, and no direct wave impact on any home.

### **Long Beach Township (Loveladies);**

The La Baia Street profile site did have dunes that survived, but at this location the public access pathway was at least 6 feet lower than the adjacent dune crests. The waves found the gap, cut it at least two house lots wider and water and sand flowed landward to the boulevard. This scenario was repeated many places where the simple expedient of having public works place sand and grade a dune cross over to the adjacent elevations could have prevented this particular overwash. Dune failure was likely related to individual access pathways to the beach from individual homes below the average dune elevation. The dune width was higher than average along this segment.

### **Harvey Cedars;**

Two cross sections located in Harvey Cedars crossed the 2009 Federal Shore Protection Project. In both cases the dune built seaward of the native dune experienced substantial cutting, but the crest was still intact. The wider beach helped by forcing the waves to break earlier in the approach to the dune. The sand elevation on the beach was substantially reduced with all of it retained on the shoreline, but deposited offshore. Recovery by mild weather waves pushing material back toward the shoreline was already underway. Since there were no direct losses due to overwash transport onto the island, there should be enough sand left to push a wedge of recovered sand up toward the dune scarp for enhanced protection from the coming winter northeast storms.

### **Long Beach Township (North Beach);**

This segment of the township shoreline is not covered by NJ Beach Profiling, but damage was apparent with overwash between homes extending landward to the Boulevard. There was no direct benefit from the fill activity on either side of this beach. Indirect sand migration along the beach did provide a measure of added width, but no enhancement to the dunes.

### **Surf City;**

Surf City was the initial Army Corps project effort in 2007. This was completed and in spite of the problems associated with including illegally dumped munitions parts in the fill sands, the net result was a survival of the dune with the crest elevation in place, but narrower. The beach fill was at a lower width than the original plan, but sufficient to help prevent wave overwash and damage to public and private infrastructure. The fact that these fill segments had abrupt starting and stopping points creating what are called "end-effects", each was very successful in cutting the damage costs incurred by the folks and public property living landward of the fill project beachfront.

### **Ship Bottom;**

While no fill was placed along the Ship Bottom shoreline, the loss from the Surf City section did improve the beach width along this reach. The dunes were wider as well and the combination prevented most overwash. The 8<sup>th</sup> Street site suffered removal of the seaward slope nearly to the crest, but a wide crest and minimal low spots allowed an excellent performance of this coastal segment of the island.

### **Long Beach Township (Brant Beach, Beach Haven Crest, Spray Beach);**

Brant Beach was the most recent segment of LBI to receive the Army Corps beach replenishment project completed in early 2012. This site showed similar results as seen in Harvey Cedars and Surf City where the dune and beach took the impact with losses to the beach width and elevation and erosion to the seaward dune slope. No overwash or wave damage was observed.

The story was different at Beach Haven Crest where the dune failed at 81<sup>st</sup> Street. The pre-Sandy photograph depicts a narrow dune with a 16-foot crest elevation. This proved insufficient to stop the wave assault and extensive damage resulted. Both beach width and dune mass are essential as a team to protect from wave damage because both are essentially piles of sand which do erode at fairly rapid rates. If a dune were to erode at a 10 feet per hour rate, then it would need to be 100 feet thick to withstand a 10 hour duration of a steady intensity storm. This approximates Sandy's level of violence over two high tide intervals on Monday October 29<sup>th</sup>.

The site at Old Whaling Road was different in Spray Beach due to a wider, higher dune. About a third of the dune was eroded taking all of the seaward slope, but the height prevented overwash and the properties landward were spared.

### **Beach Haven;**

Both survey sites in Beach Haven suffered dune failure. Overwash covered streets and properties with sand. House damage was evident at both sites. Observations north and south of both sites found remnants of dunes that remained, but in general overwash was common and extensive in its penetration across the island.

### **Long Beach Township (Holgate);**

The site #135 at Webster Avenue was typical of the wholesale damage done as the dune system was essentially erased and washed across the island into Barnegat Bay in many cases. Sand thickness of 3 to 4 feet were observed on the Boulevard and down the side streets to the bay. Low elevation homes were destroyed and even some larger structures showed serious impacts. The practice of oceanfront owners closing in the ground level area under the first habitable floor level with a concrete floor, insulated walls, and installing the furnace, hot water heater, the air conditioner compressor, and storing a myriad of possessions in an area designated as open space to allow waves to pass under the building with minimal impact, vastly increased the damage to individual properties as the wave of debris piled up against landward structures and penetrated into other ground level spaces. Individuals found that their space under the house now contained an intertwined complex of debris densely filling the entire area under the house. Clearly the dunes were too thin, too low and the beach too narrow to block Sandy in any meaningful way.

Among all the destruction, there were several oceanfront homes that had developed a wider, higher dune that hung together allowing the survival of the house including the landscaping.

### **Forsythe Wildlife Refuge site;**

In an effort to develop data on the NJ natural areas along the coastline the NJ Beach Profile Network includes surveys of all these natural areas. The Holgate Unit of Forsythe was established in 1994 near the start of the spit extending a mile to the south. The entire spit has been moving landward as sand is held to the north by the pair of groins guarding the beach at the south end of development in the Township. Sandy transported sand westward across the spit into Barnegat Bay causing about a hundred feet of shoreline retreat. This retreat has been documented over the past 18 years in spite of meager efforts to stabilize the immediate shoreline with waste concrete and geo-textile bags filled with sand. This retreat will ultimately produce a similar situation to that of Longport south of 11<sup>th</sup> Street where very expensive homes have zero beach/dune protection and depend on a low rock wall that failed them completely. The possibility of a new inlet through the spit always exists since there is a historical record of three break throughs, the last of which happened in 1920 during a severe northeast storm. Tucker's Beach became Tucker's Island and the "New Inlet" proceeded to migrate south erasing the newly formed island by 1940. The net result was a 500 to 700-foot retreat in the southern LBI shoreline landward that if repeated would render most of the Holgate section of Long Beach Township as part of the Atlantic Ocean. The solution will require both structural and sand volume enhancement to contain the changes slowly happening driven by exceptional storms.

## NJBPN 245 – 10<sup>th</sup> Street, Barnegat Light



The photo on the left was taken on September 12, 2012 and shows the dune and beach conditions before Sandy. Note the flourishing dense vegetation along the landward dune slope. In the photo on the right taken on November 2, 2012 from the same location looking south post Sandy shows the impact of the storm which is evident from the sand overwashed and blown landward across the dune burying but not killing the dense vegetation seen in the September picture.

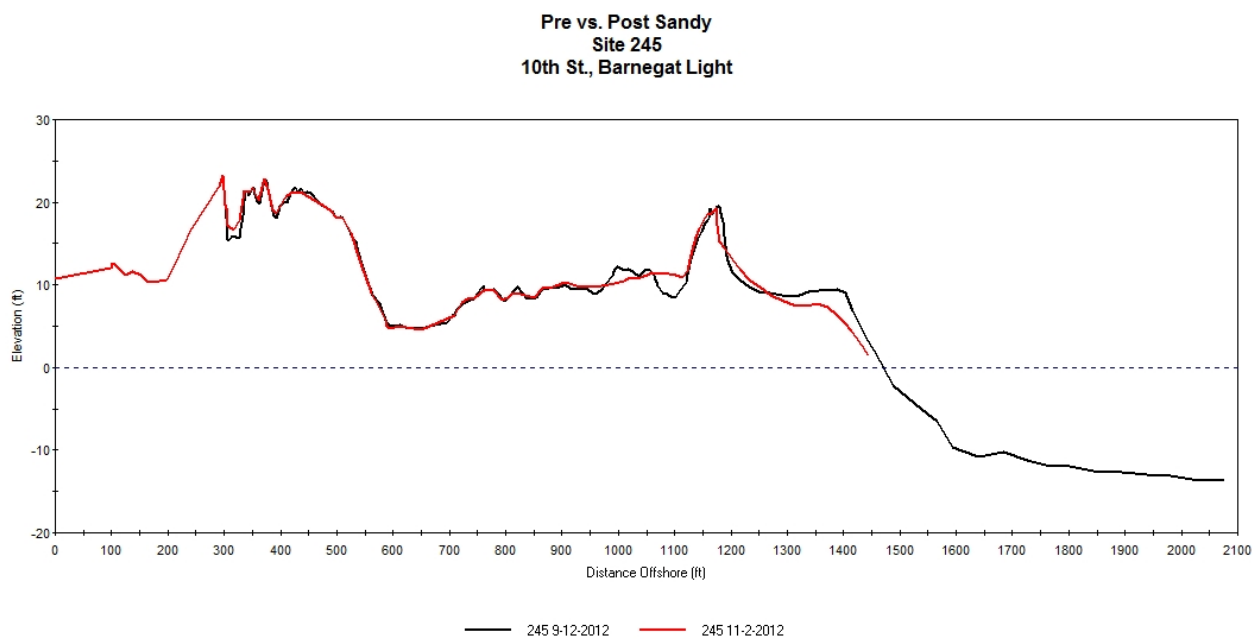


Figure 2. Above is a comparison plot between two surveys taken pre-storm on September 12, 2012 and the post-storm survey of November 2, 2012. The plot depicts the modest changes caused by the storm were limited to the berm crest and foredune ridge where 6.21 yds<sup>3</sup>/ft. of sand was removed during the storm. The massive dune system landward was essentially unaffected by Sandy. This region benefits from the shelter effect of the Barnegat Inlet jetty which protects this region from northeast wave approach, trapping and retaining sand south of the structure. This entire cross section developed following the completion of the replacement south jetty in 1991.



## NJBPN 145 – 26<sup>th</sup> Street, Barnegat Light



The photo on the left was taken on September 12, 2012 and shows the dune and beach conditions before Sandy. Again note the flourishing dense vegetation along the seaward dune slope. In the photo on the right taken on November 2, 2012 from a similar location looking south post-Sandy the impact of the storm is evident from the sand overwashed and blown landward across the dune burying the dense vegetation seen in the September picture and by the narrower beach width.

Pre vs. Post Sandy  
Site 145  
26<sup>th</sup> St., Barnegat Light

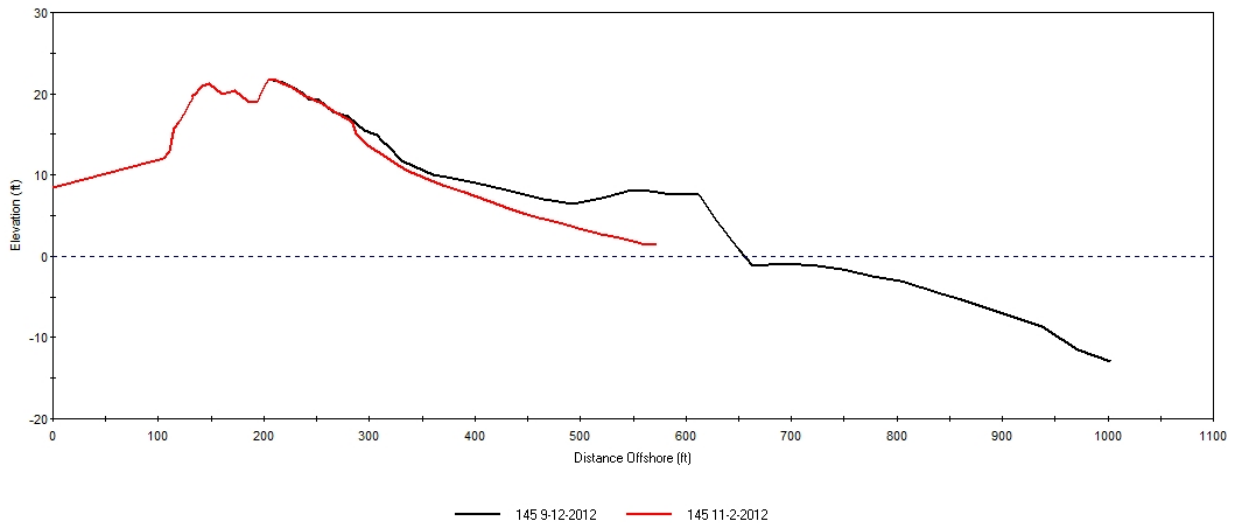


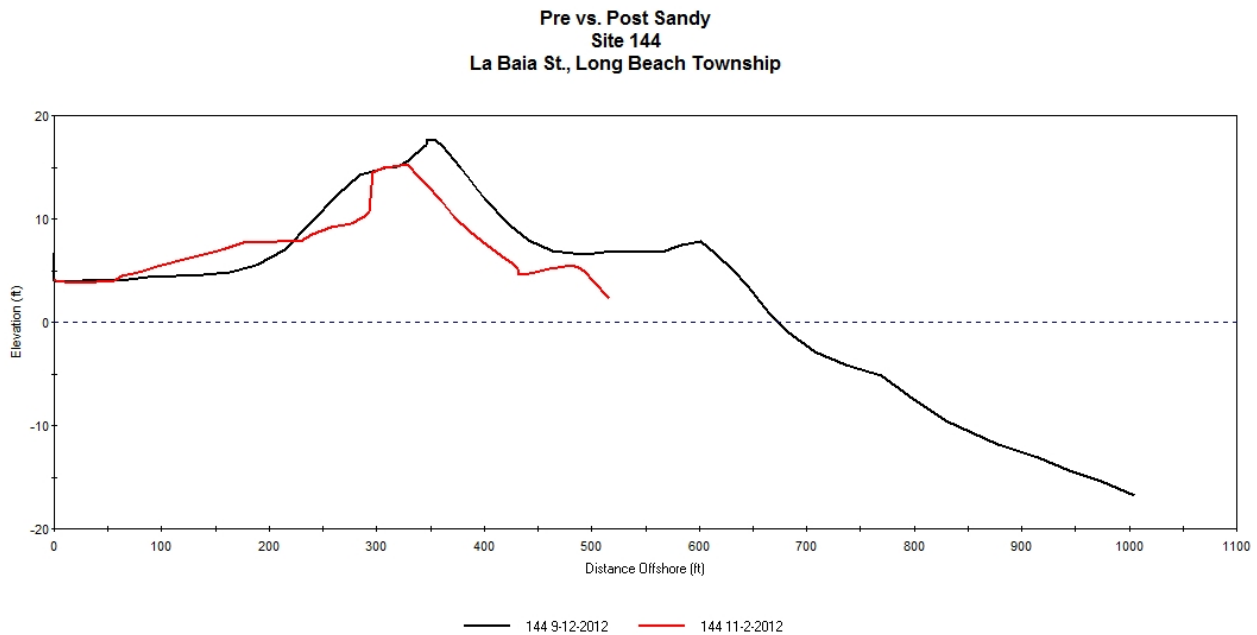
Figure 3. The above comparison plot between two surveys taken pre-storm on September 12, 2012 and the post-storm survey of November 2, 2012 shows significant beach erosion. At 26<sup>th</sup> Street the berm was removed, beach flattened and elevations lowered along with a cut that removed about 25 feet of the seaward dune slope leaving a 3-foot high modest scarp along the seaward dune toe. The 200-foot wide dune remained largely intact preventing major overwash into the street and damage to oceanfront property. The modest dune and moderate beach erosion caused by Sandy here removed 28.62 yds<sup>3</sup>/ft. of sand from this site but the lack of property damage and overwash demonstrates the value of wider beaches and a well-developed dune system. Data gathered over time shows that 75% of the sand now in the dune arrived on this shoreline following the construction of the new jetty.



## NJBPN 144 – La Baia Street, Loveladies



Above are two photos taken at La Baia Street before and after Sandy. The photo on the left was taken on September 12, 2012 and shows the dune and beach conditions before Sandy. In the photo on the right taken on November 2, 2012 from a similar location looking south post Sandy the impact of the storm is evident the dune seaward of the homes is obliterated the beach is lower in elevation and narrower in width. Sand was overwashed between the oceanfront homes, carried landward to the road.



**Figure 4.** The comparison plot above for surveys taken on September 12, 2012 and the post-storm survey of November 2, 2012 shows major beach erosion, significant dune failure and sand overwash landward to the reference location. The dune width is narrower seaward of the oceanfront properties than in Barnegat Light and provided less storm protection for the structures. The net volume change was fairly moderate with 21.63 yds<sup>3</sup>/ft. of sand lost but a significant volume of sand has been relocated to the landward toe and no longer providing storm protection for the seaward homes. The volume loss seaward of the properties was much more significant with a loss of about 125 feet of retreat in the beach width. A final volume total will require an offshore survey to assess losses below the zero elevation datum. A significant contributor to the damage at this location was the presence of a beach access pathway constructed at least 6 feet lower than the dune crest on either side of the pathway. The wave forces created the “Grand Canyon” of Long Beach Island in carving a two-house wide gap in the dunes. Fixing the problem seen at pathways can be a near cost-free means of reducing potential wave damages in the future.

**NJBPN 143 – 73<sup>rd</sup> Street, Harvey Cedars**



The two photos above taken at 73<sup>rd</sup> Street before and after Sandy show the dune and beach changes resulting from the storm. The photo on the left was taken on September 11, 2012 while the photo on the right was taken on November 2, 2012 from a similar location looking north. This site had recently received sand as part of the USACE beach restoration program for Long Beach Island. The project provided ample dune and beach width enhancement and storm protection for the oceanfront properties. Post-Sandy shows the impact of the storm with a significant dune scarp at the seaward crest and a narrow, lower elevation beach remaining. However there was no evidence that sand has overwashed the dune at this location.

**Pre vs. Post Sandy  
Site 143  
73rd St., Harvey Cedars**

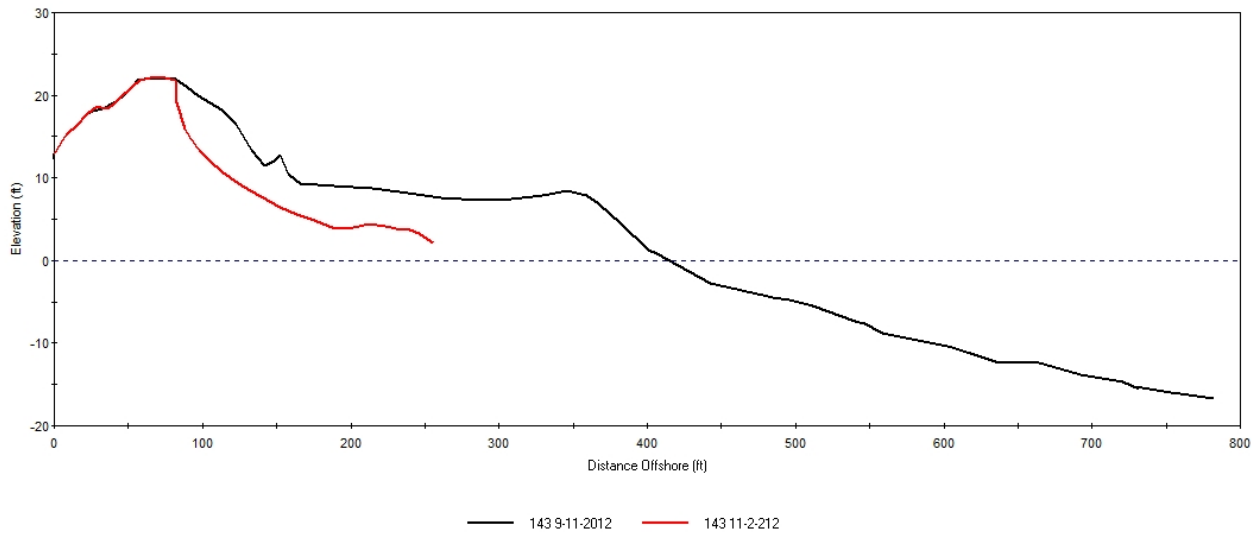


Figure 5. The above comparison plot between two surveys taken pre-storm on September 11, 2012 and the post-storm survey of November 2, 2012 shows significant dune and beach erosion. At 73<sup>rd</sup> Street the berm was removed, beach flattened and elevations lowered along with a cut that removed nearly the entire seaward dune slope leaving a steep 6-8 foot high scarp along the seaward dune crest. The 22-foot high dune remained intact from the seaward crest landward preventing major overwash into the street and damage to oceanfront properties. The significant dune and beach erosion caused by Sandy removed 32.95 yds<sup>3</sup>/ft. of sand from this site and about 125 feet of beach width.

**NJBPN 142 – Tranquility Drive, Harvey Cedars**



Above are two photos taken at Tranquility Drive before and after Sandy. The photo on the left was taken on September 11, 2012 and shows the dune and beach conditions of the USACE engineered beach before Sandy. On the right the photo taken on November 2, 2012 from a similar location looking north post-Sandy shows the impact of the storm evident the significant loss of dune seaward of the homes, the beach is lower in elevation and narrower in width. Despite the significant loss of dune to the landward crest of the engineered dune, overwash did not occur and the oceanfront property was protected from wave damages.

**Pre vs. Post Sandy  
Site 142  
Tranquility Dr., Harvey Cedars**

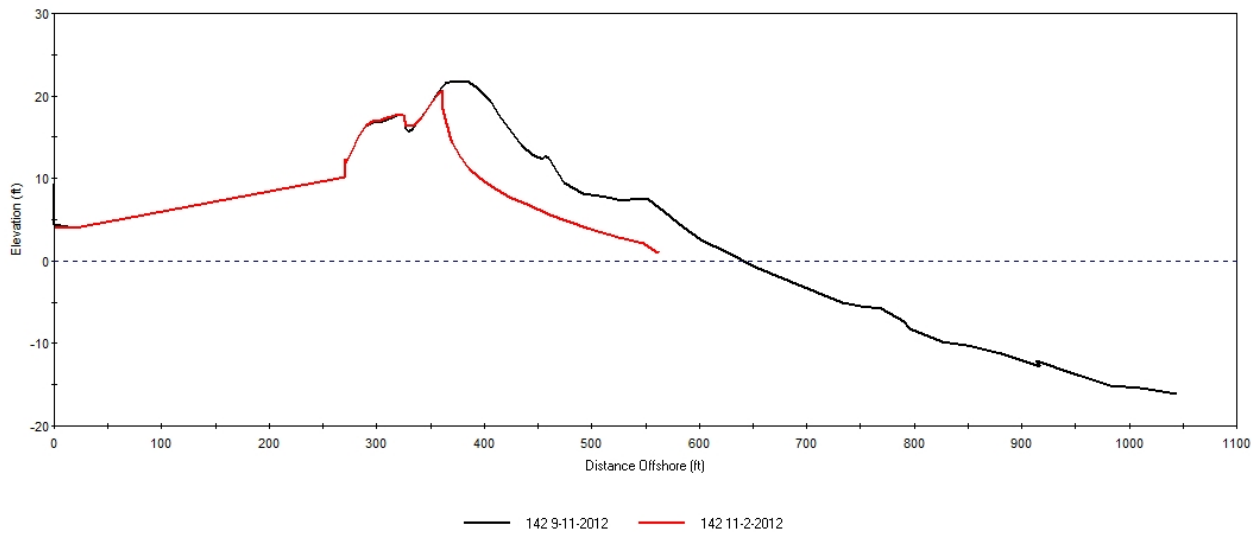


Figure 6. Above is a comparison plot between two surveys taken pre-storm on September 11, 2012 and the post-storm survey of November 2, 2012. Despite the significant loss of beach width and dune to the landward crest of the engineered project dune, overwash did not occur, prevented by the remaining project dune and the pre-construction dune remnants along the landward slope. The beach was flattened and lowered in elevation with significant shoreline retreat of between 75-100 feet. Sandy caused major erosion at this site with a loss of 48.19 yds<sup>3</sup>/ft. of sand but the USACE project provided the protection needed to prevent serious property damage for the oceanfront homes and public infrastructure.



## NJBPN 241 – 20<sup>th</sup> Street – Surf City



The photographs above were taken on September 11<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view of 20<sup>th</sup> Street (site 241) looking south. This location Surf City received a beach replenishment in 2007, which increased the sand volume and width of the dune and berm. The dune and berm both experienced substantial erosion; however no overwash occurred at this location.

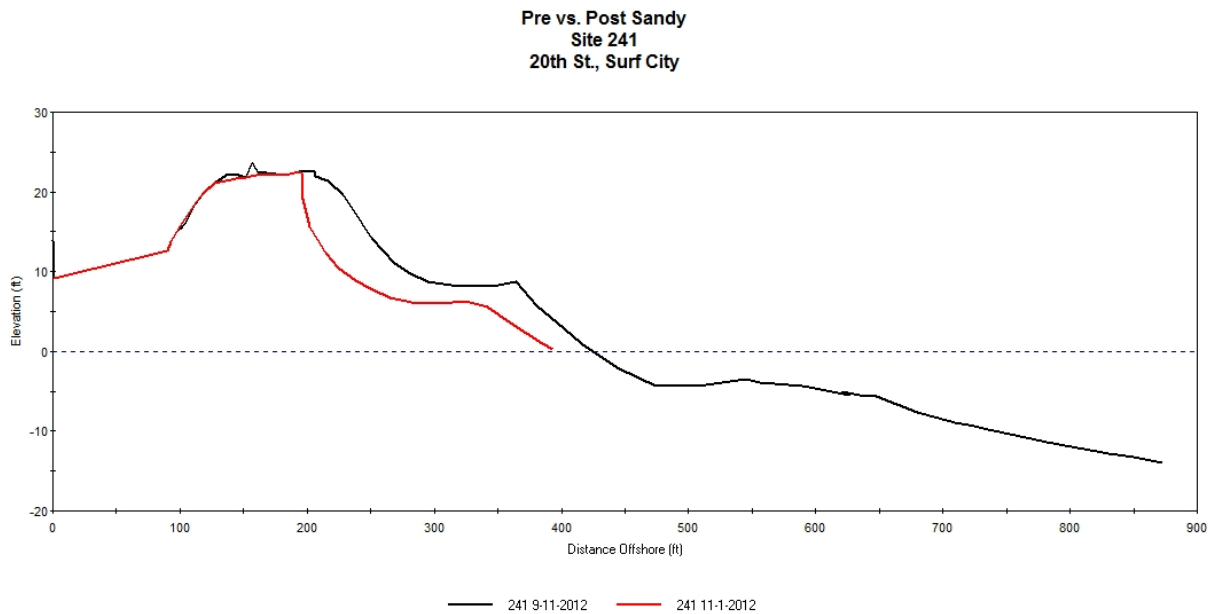


Figure 7. Between September 11<sup>th</sup> and immediately following Hurricane Sandy on November 1<sup>st</sup>, site 241 had a sand volume loss of 36.4 yds<sup>3</sup>/ft. This site received beach replenishment in 2007 as part of the US Army Corps Long Beach Island Shore Protection Project. The engineered beach and dune suffered substantial retreat at the foredune slope, but dune remains intact and was not breached. The engineered berm was also substantially eroded, with that sand most likely being transported into the nearshore at this location.

## NJBPN 141 – 8<sup>th</sup> Street, Ship Bottom



The photographs above were taken on September 10<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view of 8<sup>th</sup> street (site 141) looking north. This location in Ship Bottom experienced erosion of the beach and dune, however the dune was not breached and no overwash occurred at this location.

**Pre vs. Post Sandy  
Site 141  
8th St., Ship Bottom**

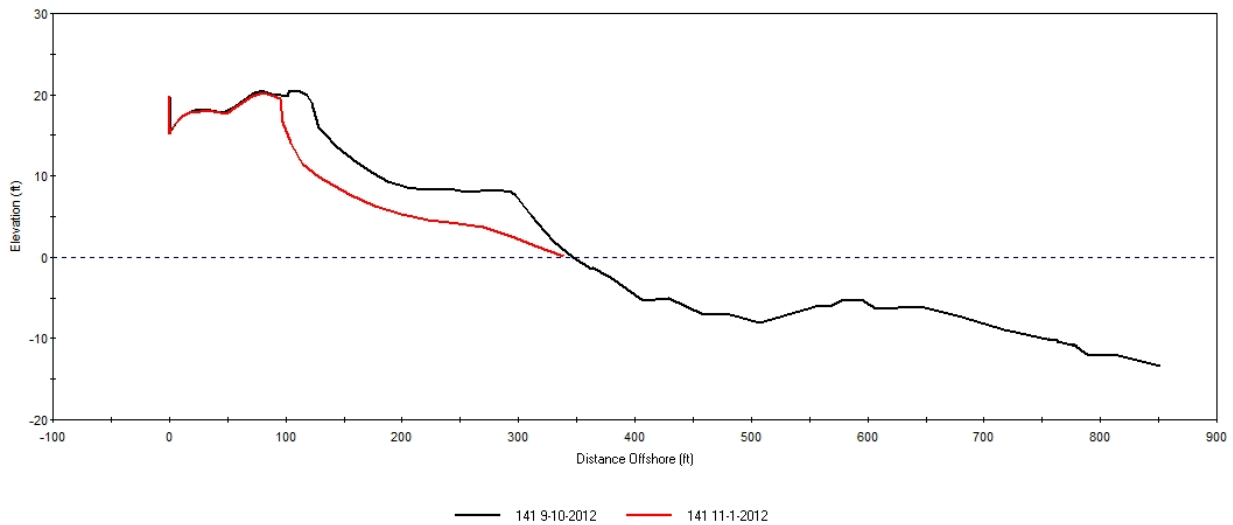


Figure 8. Between September 10<sup>th</sup> and immediately following Hurricane Sandy on November 1st, site 141 had a sand volume loss of 40.3 yds<sup>3</sup>/ft. The foredune and berm experienced substantial losses in sand volume, but over half of the dune remains intact and was not breached. The elevation of the beach berm has been lowered and the majority of sand was most likely transported into the nearshore at this location.

## NJBPN 140 – 32<sup>nd</sup> Street, Long Beach Township



The photographs above were taken on September 10<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view of 32<sup>nd</sup> street (site 140) looking north. This location in the Brant Beach section of Long Beach Township received beach replenishment in spring 2012, which increased the sand volume and width of the dune and berm. The foredune slope experienced minor erosion, while the berm was severely eroded. No overwash occurred at this location. The park bench remained in its original position.

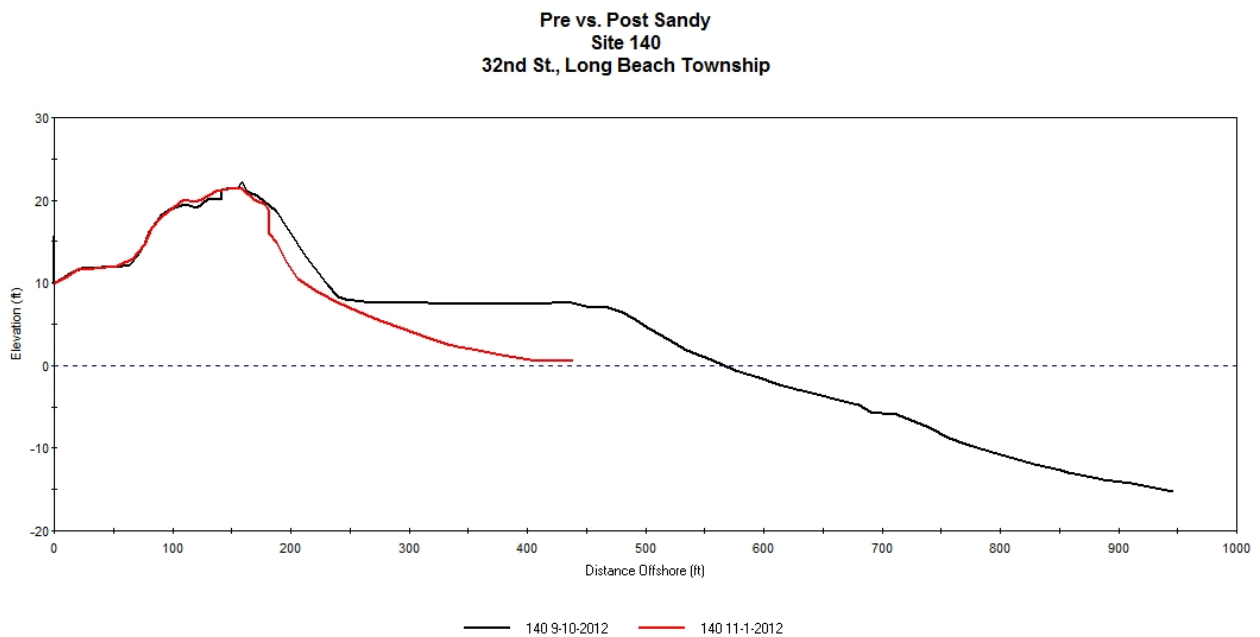


Figure 9. Between September 10<sup>th</sup> and immediately following Hurricane Sandy on November 1st, site 140 had a sand volume loss of 40.4 yds<sup>3</sup>/ft. This site received beach replenishment in spring 2012 as part of the US Army Corps Long Beach Island Shore Protection Project. The engineered dune experienced a minor retreat at the foredune slope, but dune remains intact and was not breached. The majority of erosion at site 140 occurred on the berm, with that sand most likely being transported into the nearshore at this location.



## NJBPN 139 – 81<sup>st</sup> Street, Long Beach Township



The photographs above were taken on September 10<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view of 81<sup>st</sup> street (site 139) looking south. It is evident in the photographs that the existing dune was completely eroded away and overwash occurred, with waves pushing water and sand under the oceanfront homes and into the streets landward of them. The dune elevation was about 16 feet.

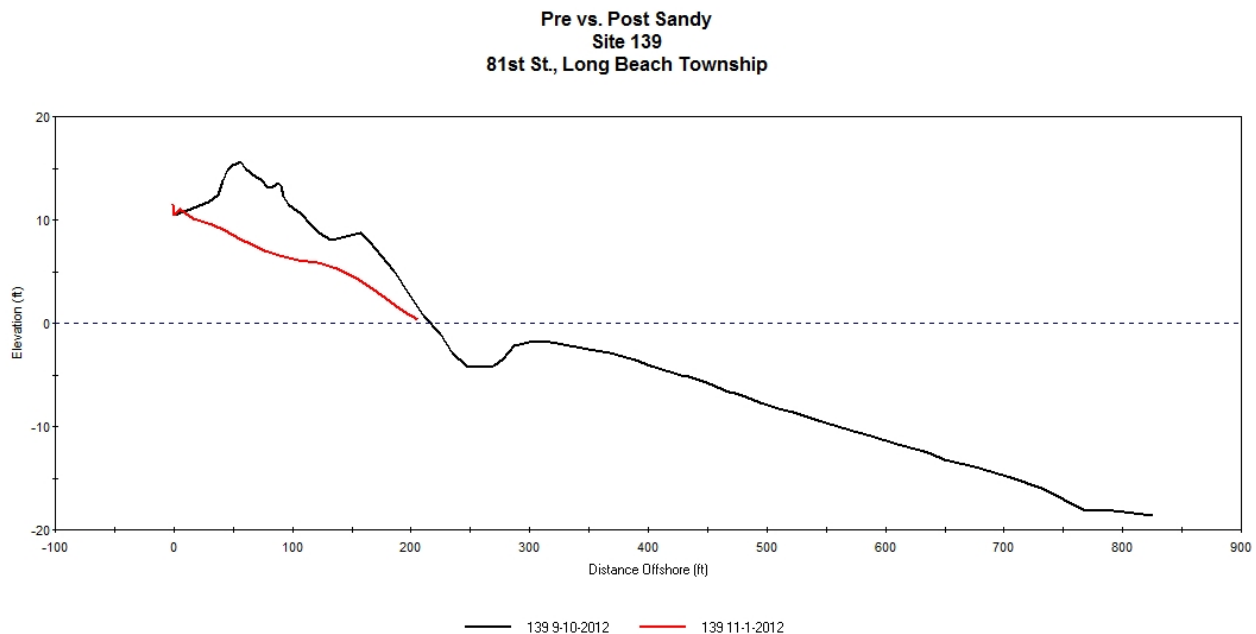


Figure 10. Site 139 experienced severe erosion and overwash between September 10<sup>th</sup> and immediately following Hurricane Sandy on November 1<sup>st</sup>, which resulted in a sand volume loss of 29.5 yds<sup>3</sup>/ft. The entire dune has been removed with the majority of sand being transported by waves landward of the profile and offshore. Damage occurred as waves swept any and all appliances, water heaters, air conditioner compressors, barbecue grills etc landward from under each of the homes on pilings. Piling supported structures fostered by FEMA back in 1968 at its onset did pay dividends since those homes on pilings were not destroyed completely.



**NJBPN 138 – Old Whaling Road (124<sup>th</sup> Street), Long Beach Township**



The photographs above were taken on September 7<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view of Old Whaling Road (site 138) looking south. The existing dune experienced erosion, however it was not completely removed and no overwash occurred at this location. Surprisingly, two blocks to the north a dune of comparable size and shape was eroded away and overwash occurred.

**Pre vs. Post Sandy  
Site 138  
Old Whaling Rd., Long Beach Township**

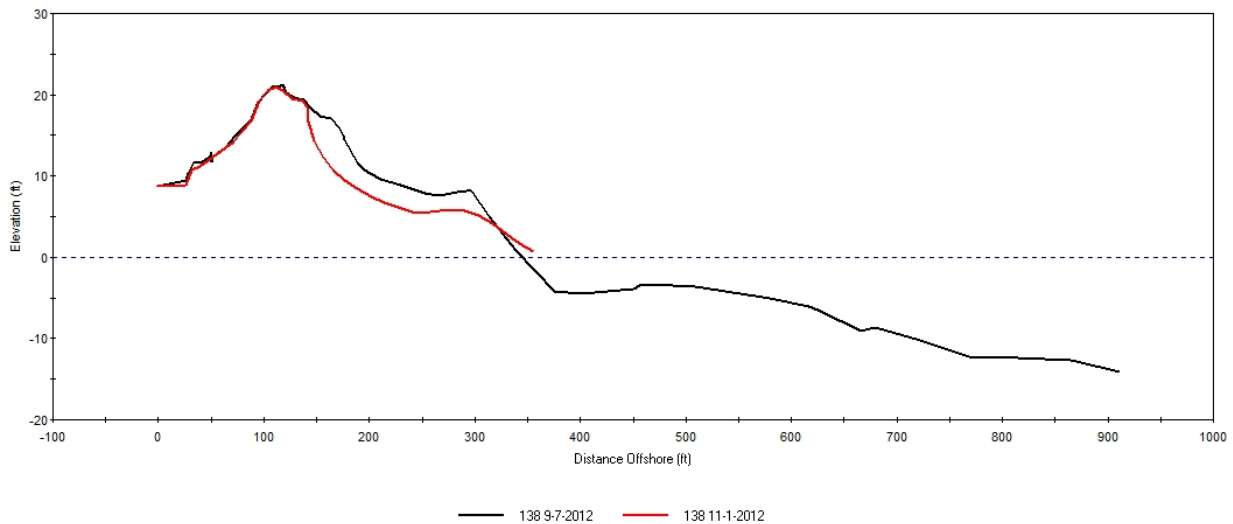


Figure 11. Between September 7<sup>th</sup> and immediately following Hurricane Sandy on November 1<sup>st</sup>, site 138 had a sand volume loss of 19.1 yds<sup>3</sup>/ft. The seaward dune toe experienced a modest retreat, but over half of the dune remains intact and was not breached. The elevation of the beach berm has been lowered. The majority of erosion at site 138 occurred in the foredune slope and berm, while the majority of sand was most likely transported into the nearshore at this location. This location was NOT in a ACOE project beach zone, but it did have a wider and higher elevation dune than most of the non-Federally managed beaches.

## NJBPN 137 – Taylor Avenue, Beach Haven



The photographs above were taken on September 7<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view of Taylor Avenue (site 137) looking north. It is evident in the photographs that the existing dune was completely eroded away and overwash occurred, with waves pushing water and sand under the oceanfront homes and into the streets landward of them. The crib timber structure in the above right photograph was instrumental in saving the home from significant damage. The cribbing was back-filled with rocks and masonry debris and provided an effective barrier to direct wave impacts.

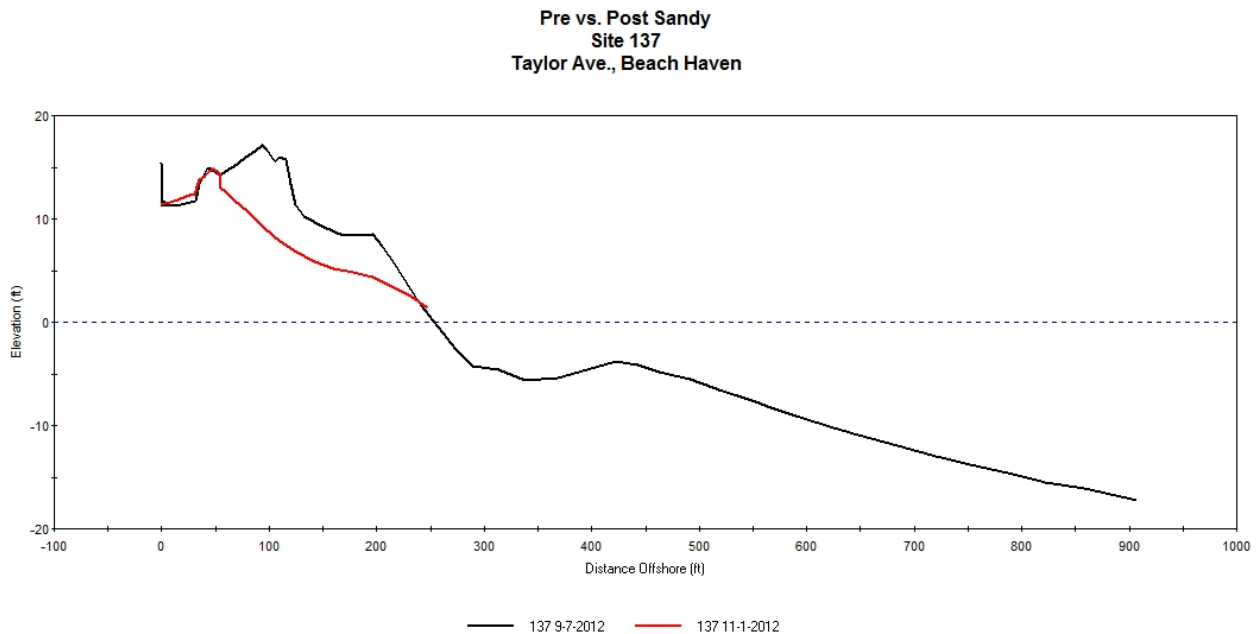


Figure 12. Site 137 experienced severe erosion and overwash between September 7<sup>th</sup> and immediately following Hurricane Sandy on November 1<sup>st</sup>, which resulted in a sand volume loss of 27.3 yds<sup>3</sup>/ft. The entire dune has eroded away, with the majority of sand being transported by waves landward of the profile as well as offshore. The red “bump” on the November cross section was material already hauled back to the beach from the roads inland.

## NJBPN 136 – Dolphin Avenue, Beach Haven



The photographs above were taken on September 6<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view of Dolphin Avenue (site 136) looking north. It is evident in the photographs that the existing dune was completely eroded away and overwash occurred, with waves pushing water and sand under the oceanfront homes and into the streets landward of them. Damage was clear and very common.

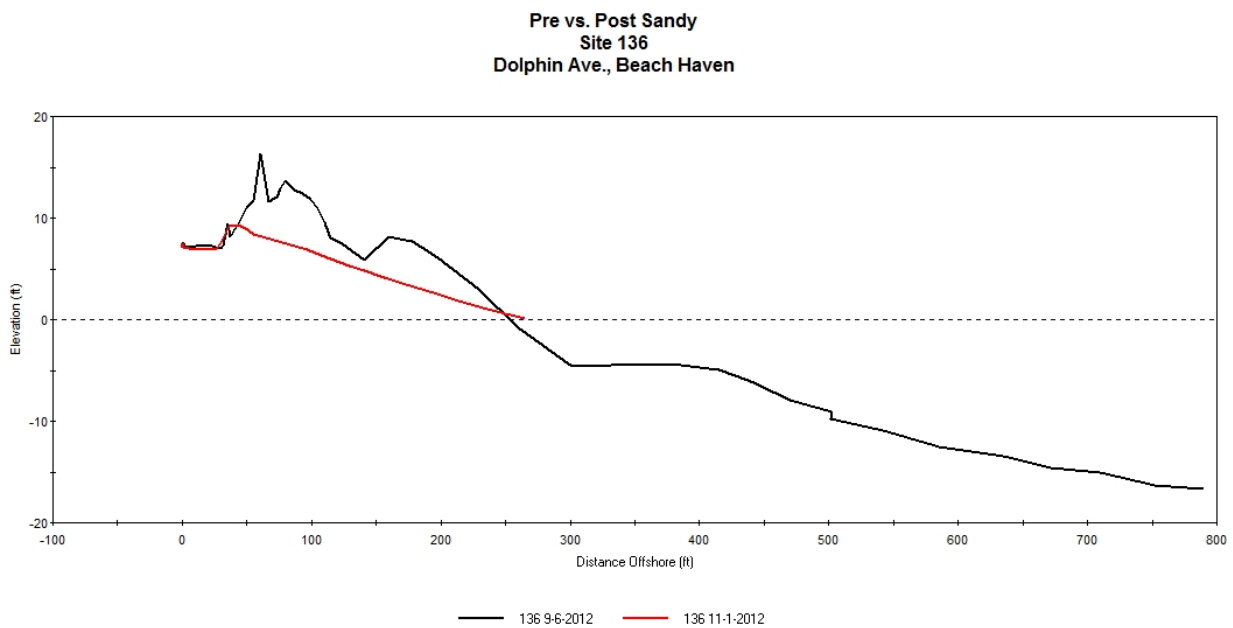


Figure 13. Site 136 experienced severe erosion and overwash between September 6<sup>th</sup> and immediately following Hurricane Sandy on November 1<sup>st</sup>, which resulted in a sand volume loss of 24.1 yds<sup>3</sup>/ft. The entire dune has been removed with the majority of sand being transported by waves landward of the profile and offshore.

## NJBPN 135 – Webster Avenue, Long Beach Township



The photographs above were taken on September 6<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view of Webster Avenue in Beach Haven (site 135) looking south. It is evident in the photographs that the existing dune was completely eroded away and overwash occurred, with waves pushing water and sand under the oceanfront homes and into the streets landward of them exposing the timber section of an old groin long forgotten under the dune.

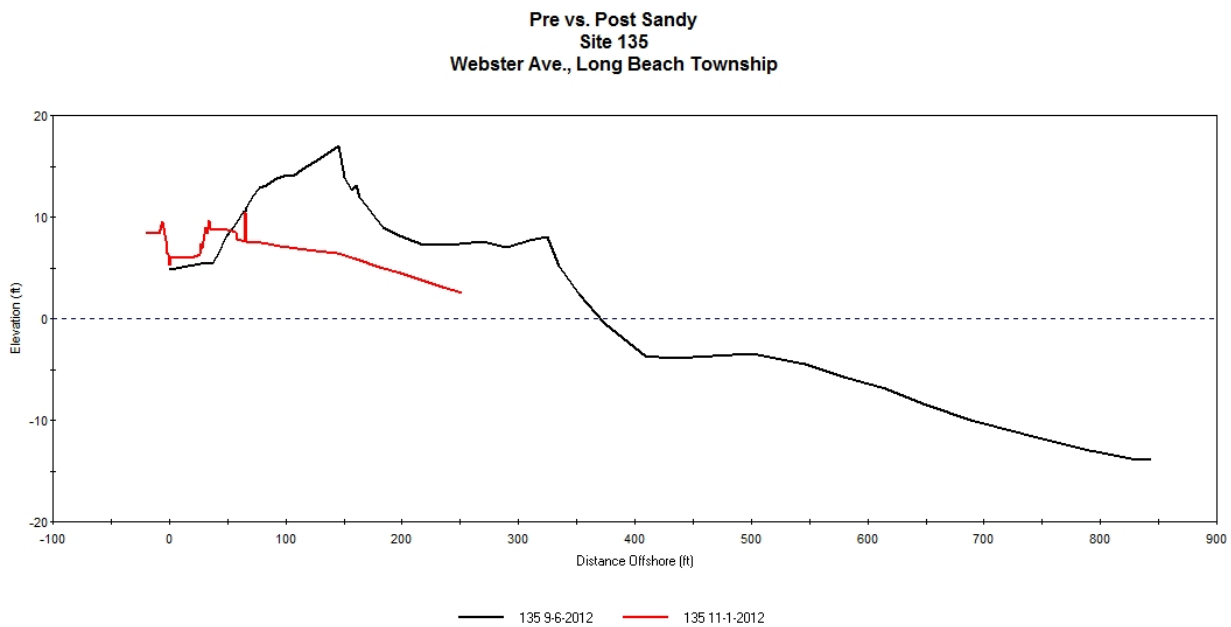


Figure 14. Site 135 experienced severe erosion and overwash between September 6<sup>th</sup> and immediately following Hurricane Sandy on November 1<sup>st</sup>, which resulted in a sand volume loss of 37.9 yds<sup>3</sup>/ft. The entire dune has been removed with the majority of sand being transported landward of the profile and offshore. The cut was the excavation already completed to open the road to travel. Sand was pushed back onto the beach. Occasional dune segments remained seaward of a few homes, which in one case still had intact landscaping unharmed.



**NJBPN 234 – Forsythe National Wildlife Refuge, Holgate Entrance, Long Beach Township**



The photographs above were taken on September 6<sup>th</sup>, 2012 (left) and November 1<sup>st</sup>, 2012 (right). Both images show the view looking north at the beach-buggy entrance to the Forsythe Refuge (site 234). Wide-scale overwash occurred that extended to Barnegat Bay at this location due to the effect of Hurricane Sandy.

**Pre vs. Post Sandy  
Site 234  
Natural Area, Long Beach Township**

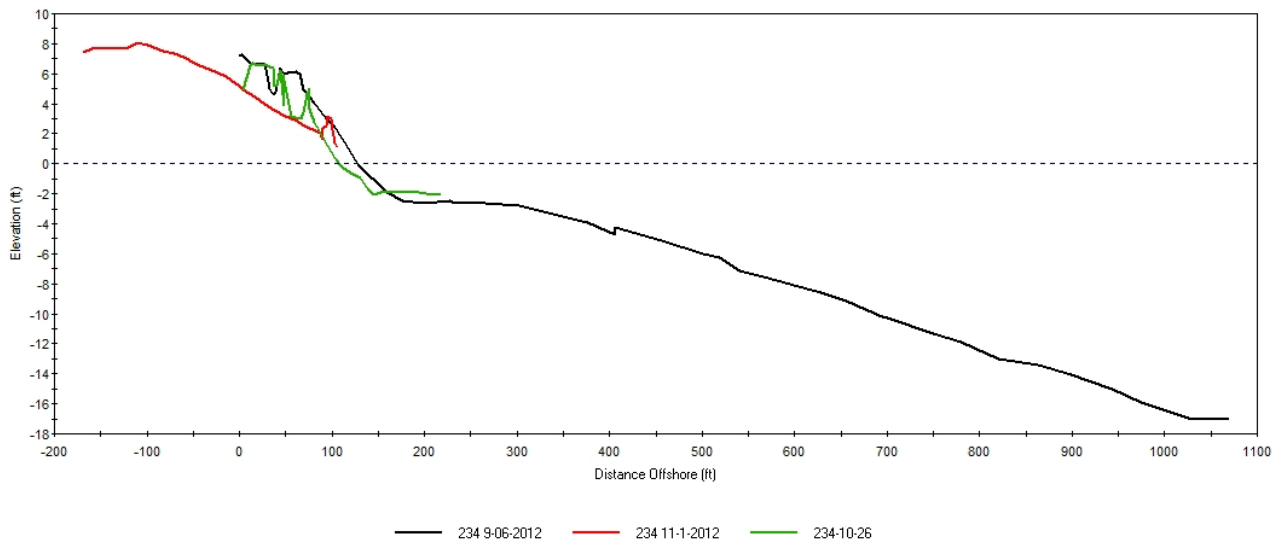


Figure 15. For many years, the natural area Long Beach Island has been experiencing substantial erosion and overwash due to the terminal groin cutting off the natural longshore transport of sand to the south. As a result of Hurricane Sandy, between September 6<sup>th</sup> and immediately following the storm on November 1<sup>st</sup>, site 234 suffered a loss of 7.8 yds<sup>3</sup>/ft. Wave action and overwash removed sand and temporary shore protection features (sand bags) from the refuge entrance roadway (and beach directly east) and added it to the region west of that area (backdune area). The green line represents a pre-Sandy survey done because the crew was in the locality on another mission to see differences between the September survey and an immediately pre-Sandy set of conditions. Some erosion had already made a bad situation worse prior to the hurricane.

## Summary & Conclusions

<i>Long Beach Island Post Sandy Volume Changes</i>			
<b>Site</b>	<b>Vol Change cu yds per ft</b>	<b>Dune Failure</b>	<b>Recent Beach Fill</b>
234	-7.8	Y	N
135	-37.9	Y	N
136	-24.1	Y	N
137	-27.3	Y	N
138	-19.1	N	N
139	-29.5	Y	N
140	-40.4	N	Y
141	-40.3	N	N
241	-36.4	N	Y
142	-48.2	N	Y
143	-33	N	Y
144	-21.6	Y	N
145	-28.6	N	N
245	-5.2	N	N

Figure 16 shows a table of values for the 14 profile site locations. The sand volume lost per foot of shoreline represents loss from the dune and the beach, but not including the offshore regions. These surveys were completed as rapidly as possible so no swimmers were brought to these sites. The swimming portion of the survey takes 75% of the time at each site and the crew was trying to cover as many sites as possible each day following Sandy. There are 105 sites to cover.

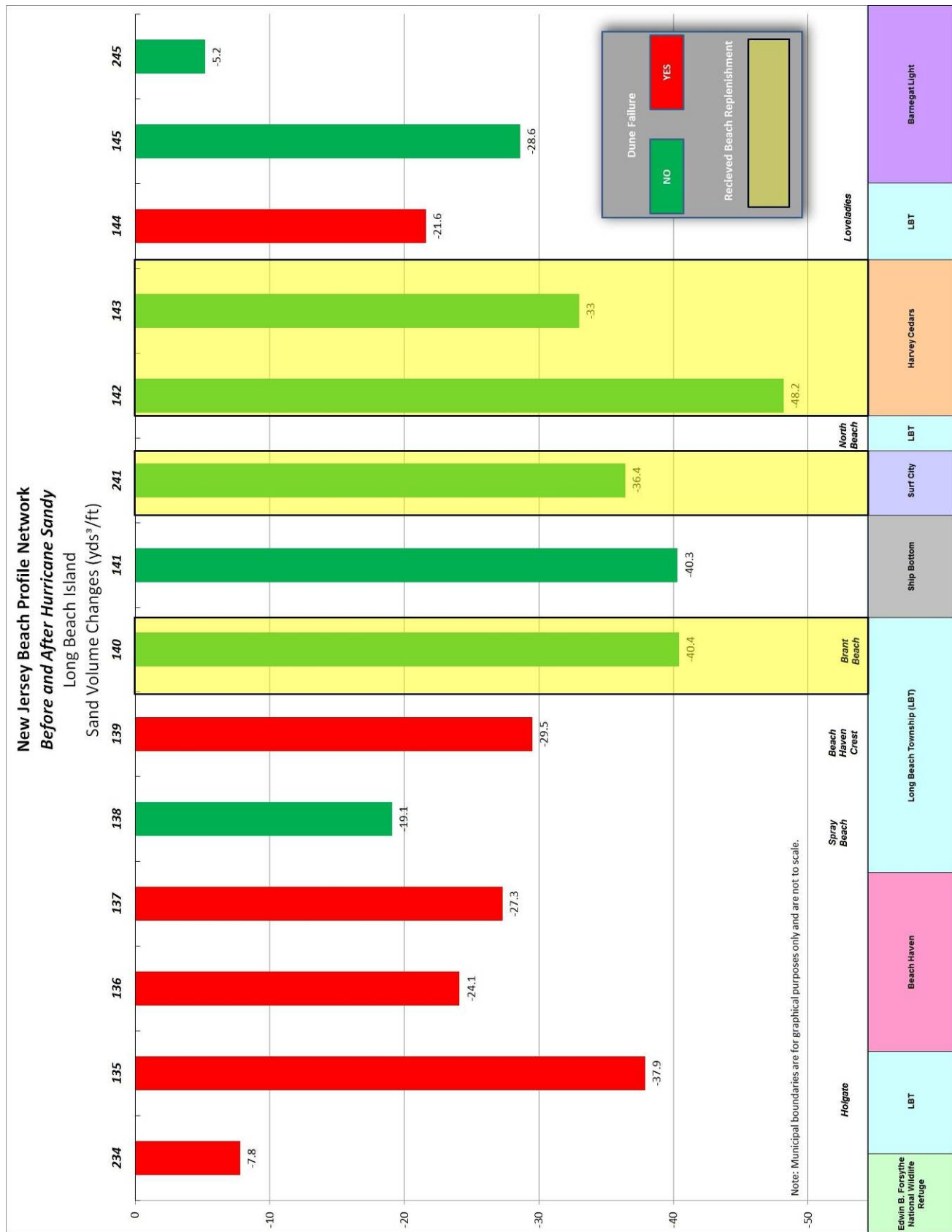


Figure 17. This graphic combines the loss figures with the presence or absence of the Federal Shore Protection Project and the occurrence of dune failure. It became perfectly clear that the ACOE shore protection design was sufficient to preclude structural damage along the extent of the LBI coastal shoreline where it had been completed.



*Long Beach Island*

MUNICIPALITY	Site #	Vol Change (cu yds/ft)	Average Volume Between Sites	Dune Failure	Recent ACOE Beach Fill	REF POINT Distance (FEET)	Vol Change - Cubic Yards Between Profiles (South to North)
Forsythe Wildlife Refuge	234	-7.80		Y	N	0	0
Holgate - Long Beach Township	135	-37.90	-22.85	Y	N	5,643	-128,941
Beach Haven	136	-24.10	-31.00	Y	N	5,114	-158,543
Beach Haven	137	-27.30	-25.70	Y	N	5,268	-135,393
The Dunes - Long Beach Township	138	-19.10	-23.20	N	N	8,654	-200,780
Beach Haven Crest - Long Beach Township	139	-29.50	-24.30	Y	N	8,559	-207,972
Brant Beach - Long Beach Township	140	-40.40	-34.95	N	Y	10,774	-376,558
Ship Bottom	141	-40.30	-40.35	N	N	6,027	-243,205
Surf City	241	-36.40	-38.35	N	Y	7,522	-288,466
Harvey Cedars	142	-48.20	-42.30	N	Y	8,082	-341,858
Harvey Cedars	143	-33.00	-40.60	N	Y	6,618	-268,691
Loveladies - Long Beach Township	144	-21.60	-27.30	Y	N	7,018	-191,603
Barnegat Light	145	-28.60	-25.10	N	N	8,992	-225,688
Barnegat Light	245	-5.20	-16.90	N	N	5,155	-87,117
<b>Long Beach Island Sand Loss =</b>							<b>-2,854,815</b>

Figure 18 is a summation of all the individual site sand volume losses from the dune and beach to the limit of the post-Sandy survey. The total is derived by adding two adjacent site losses and dividing by two, then multiplying by the distance in feet between the two sites. This is known in the dredging industry as “closed-end averaging” to obtain dredged volume along a channel. It is acknowledged that sand resources reside seaward of the short post-storm surveys, but the need for speed dictated that taking additional time to survey to 15-16 feet of water offshore would not add significantly to the losses seen on the beach/dune system. These longer surveys will be completed in due course however. No estimate was made for the sand loss values south of the Forsythe Refuge site positioned a short distance from the terminal groin on LBI. Likewise there was a small additional sand loss north of site #245 in Barnegat Light Borough to the Barnegat Inlet south jetty, but at 5.2 cubic yards per foot, a 1000 feet distance yields only a 5,000 cy addition to the 2.85 million cubic yard total emerging from this study. Speculation on what percentage of the lost sand lies unrecoverable on LBI and in Barnegat Bay could range up to a million cubic yards that will need to come from offshore or mainland borrow zones/quarries. Perhaps as much as 500,000 cubic yards could be recovered over time as sand carried offshore by Sandy moves back toward the beach. All sand lost from the dunes will require human intervention to replace, groom and re-vegetate in order to have the protection in place quickly. A natural dune system developing from scratch would require 15 to 20 years to re-establish close to what was lost.