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**Beach-Dune Performance Assessment of
New Jersey Beach Profile Network (NJBPN) Sites at
Northern Ocean County, New Jersey
After Hurricane Sandy Related to FEMA Disaster DR-NJ 4086**

November 28, 2012

Introduction;

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. As a result of the Presidential Disaster Declaration, the Federal Emergency Management Agency (FEMA) has termed the event DR-NJ-4086 for reporting/assistance purposes. The analysis for the developed portion of the northern Ocean County barrier-spit compares data collected during fall 2012 (mid-September) to data surveyed post-storm on November 8th, 12th, and 19th 2012. This initial report is focused on the impact to northern Ocean County's dunes and beaches from Hurricane Sandy. The damage details have been organized specific to each municipal segment of the barrier-spit starting in the north at Point Pleasant Beach and ending in the south at Seaside Park.

Hurricane Sandy's Impact on the Northern Ocean County Shoreline;

In general terms, the all forms of damage to beaches, dunes and public or private property was significantly worse on the north side of the storm's zone of coastal landfall in Atlantic County. Southern Cape May County fared best with limited overwash, dune scarping and loss of beach elevation. Many Cape May coastal communities were beneficiaries of either USACE or NJ State co-sponsored Shore Protection Projects that yielded wider beaches and dunes designed with specific storm resistance in terms of elevation and width. 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 on Long Beach Island, north along the remainder of the Jersey coast the intensity dramatically increased for dune breaching and overwash and/or complete erosion of the dunes, drastic lowering of the elevation on beaches with substantial sand transport onto and across Long Beach Island or Northern Ocean County's spit. Damage to oceanfront property (public and private) increased dramatically.

In addition to comparing pre- and post-storm profile data, the CRC has added results from the state-wide, beach-dune susceptibility assessment for the 100-year storm event (or 1% base flood event as classified by FEMA) for a preliminary validation of the model (for the time being, only visual observation – more testing is needed on the results). The beach-dune assessment started in 2006 and is funded through the NOAA Coastal Services Center.

The beach-dune assessment is based on year-2000 LiDAR elevation data and evaluates the storm protection performance potential of the oceanfront beach-dune system. The assessment was carried out by segmenting the beach-dune system, parallel to the shoreline from Manasquan Inlet to Barnegat Inlet (~23 miles), into 490 uniform zonal analysis areas, called "bins", that are 250-foot-wide. For each bin, several variables relating to dune width, height, seaward slope, beach elevation and width, and nearshore geomorphology. The presence of vegetation and structures (such as groins), were collected, compiled, and evaluated in order to determine the susceptibility of the dune system to potential damage from storm activity. These susceptibility variables were quantified and, using expert knowledge, assigned a "weight of influence" with respect to their individual abilities to withstand or counteract the effects of storm-induced erosion. LiDAR elevation and profile survey bathymetry data were used as data input to a wave run-up erosion simulation (USACE's SBEACH) to determine the failure point of the dune system for each bin (the point of failure is defined as the point when the dune crest is breached in response to landward recession of the foredune toe). The output of the erosion simulations were used to control how the susceptibility variables were integrated, and to classify the resulting susceptibility values into statistical intervals. The results for the 100-year storm are conveyed on a map as multicolored polygons that delineate the foredune prior to the storm simulation.

Beach/Dune Damage Assessment by Municipal Island Segment:

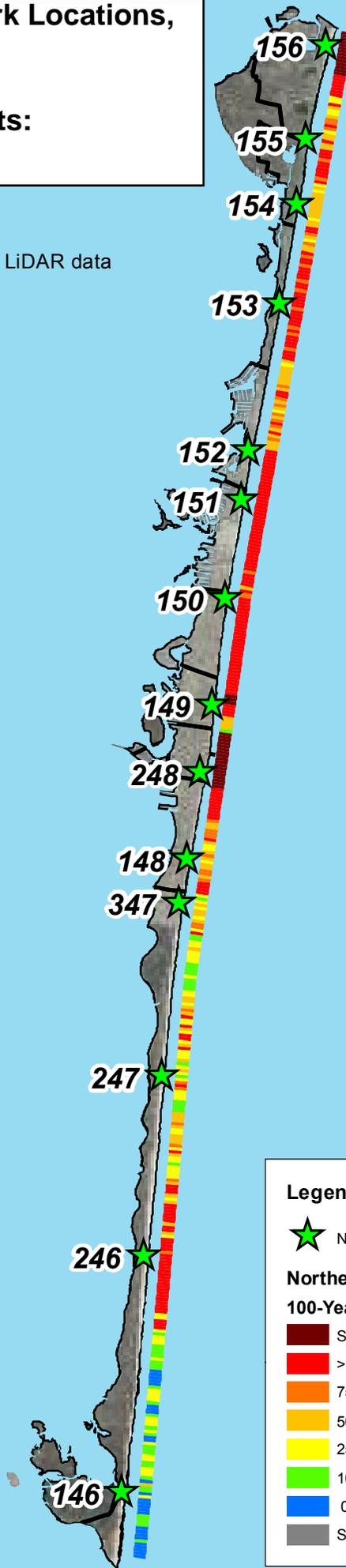
To measure the erosion, 11 of 14 pre-existing New Jersey Beach Profile Network (NJBPN) monitoring sites were used to provide an accurate comparison and assessment of storm related shoreline and beach volume changes. The data from the fall 2012 NJBPN survey, completed along the developed portion of northern Ocean County's shoreline by September 21st, provides an excellent indication of beach and dune conditions against which to show damages that occurred during the hurricane. Data collected at the 11 oceanfront beach profile locations cover the municipal beaches from Point Pleasant Beach to Midway Beach (Seaside Park). Island Beach State Park (IBSP) is a natural area and has not yet been surveyed for this initial report. It should be noted that no areas along the northern Ocean County barrier-spit shoreline have seen the USACE design plan for regional shore protection move to construction. There have not been any NJ State, County or local beach replenishment projects completed prior to Hurricane Sandy. Previous storm damage has been addressed by importing mainland quarry sand in piecemeal repairs to minor breaches or beach elevation loss on a local basis. The vast majority of the quarry sand has been delivered to Long Beach Island over the years. The Borough of Mantoloking obtained permits to place sand mined from the Ambrose Channel leading into New York Harbor in the 1990's, but that project failed to materialize.

Profile Locations: The following sites on the developed portion of the barrier-spit of northern Ocean County were surveyed during September 2012 and post-Sandy on November 8th, 12th, and 19th (Figure 1). Post-storm surveys were not completed for the three locations within Island Beach State Park. Information regarding shoreline and volume changes for those sites will be included in the annual 2012 report. *Below is a map showing the location of each profile.

NJBPN 156	Water St.	Point Pleasant	NJBPN 149	8 th Ave.	Ortley Beach
NJBPN 155	Maryland Ave.	Point Pleasant	NJBPN 248	Franklin Ave.	Seaside Heights
NJBPN 154	Johnson Ave.	Bay Head	NJBPN 148	4 th Ave.	Seaside Park
NJBPN 153	1117 Ocean Ave.	Mantoloking	NJBPN 147	6 th Lane	Midway Beach
NJBPN 152	Public Beach #3	Brick Township	NJBPN 247	North End	Island Beach SP
NJBPN 151	1 st Ave.	Normandy Beach	NJBPN 246	Parking Lot A7	Island Beach SP
NJBPN 150	White Ave.	Lavallette	NJBPN 146	South End	Island Beach SP

**New Jersey Beach Profile Network Locations,
Northern Ocean County
&
Beach-Dune Susceptibility Results:
100-year Storm**

Note: Assessment results are based on year-2000 LiDAR data



Legend

-  New Jersey Beach Profile Network Sites

**Northern Ocean County Dune Assessment
100-Year Susceptibility, Average**

-  Surge at Structure
-  > 90% Foredune Removed
-  75% - 90% Foredune Removed
-  50% - 75% Foredune Removed
-  25% - 50% Foredune Removed
-  10% - 25% Foredune Removed
-  0% - 10% Foredune Removed
-  Surge not at Structure



Point Pleasant Beach;

The two cross sections in Point Pleasant Beach demonstrated that with no dune system or a smaller, poorly vegetated dune system, there would be little resistance from the tidal surge and the associated waves to cross inland from the ocean. The entire beach and dune system along this segment of northern Ocean County experienced wide-scale overwash and breaching of dunes. The northern profile located at Water Street had no dune in front of the boardwalk, which was damaged and a large amount of sand from the beach was carried inland from wave action. Damage would have been more severe had there not been a 600-foot wide berm in front of the boardwalk. The southern profile at Maryland Avenue was significantly eroded (dune breach) with sand losses totaling 45.7 yds³/ft. along the profile due to the storm. By the time of the post-storm survey, the municipality had begun relocating sand from the berm to the former dune location.

Bay Head;

The entire beach and dune system along this segment of northern Ocean County experienced wide-scale overwash and breaching of dunes. Approximately 5,500 feet of this 9,500-foot municipal shoreline had a rock revetment constructed following the storm 50 years ago that did comparable damage to the State's shoreline. Since 1992 the rocks have been buried as the core of a continuous dune line fronting the development. The 1992 northeast storm over-topped the wall of rocks and put sand into the street ends without significant property damage. Restored shortly afterward, no storm since until Sandy approached stripping the sand from the rocks. Hurricane Sandy treated the rock revetment as if it were a speed bump. Sand and water poured down each street end to the tidewater several blocks inland. The beachfront homes were still standing, but had suffered substantial structural damage in many cases ranging up to the deposition of 2+ feet of sand on the building's lot without damage to the building. Sand was being excavated from the streets two blocks inland. Where there was no rock revetment, there was greater structural damage to homes and their surroundings. Accelerated erosion surrounded the larger groins present in the northern part of Bay Head due to wave energy reflecting off the northern side of the structure and adding to the incident wave coming onto the beach directly. Small segments of dune remained either between the revetment and the homes or where no revetment was built. Dense vegetation or a significantly wider cross section at a high elevation seemed to make the difference.

Mantoloking;

The Borough of Mantoloking extends for over two miles further south and has no regional shore protection hard structures on the beach. Individual owners have constructed private rock or timber structures across the front of private homes over time. The dunes have been maintained meticulously over the past decade in an effort to maximize the municipal shore protection they afford. The crest elevation exceeded 14 feet with some as high as 25 feet. The major problem was that insufficient sand was on the coastline to provide both a major dune system and a wide beach to force waves to break early and not on the dune slope. By late September a municipally-sponsored dune evaluation revealed that this year the Borough's situation was about as good as it was possible to make it without a major beach nourishment project. The highest, widest dunes served to protect homes on the southern segment of the Borough from damage, but a declining width of the dune base combined with lower average elevations allowed massive failure along the remainder of the municipality. The mid-section was the most heavily impacted with three channels cut across the entire peninsula into Barnegat Bay. The worst was seen at Herbert Street where a new bridge connects with mainland Ocean County. Here a tidally flowing inlet was generated that allowed in the storm surge flood and permitted several days of tidal flow erasing at least 12 properties. A second, small cut occurred at 1117 Ocean Avenue and a third occurred at Lyman Street all mostly due to narrow, lower elevation dunes with no significant beach width to absorb some of the wave attack.

Brick Township;

The wider, higher dunes existing just north of the municipal boundary in Mantoloking continued south into Brick Township. Here there was little municipal oversight of dune maintenance so elevations, low spots and placement of access stairways to the beach were at the option of individual owners. At the municipal beach #3, the dune failed to the south on the property and waves directly impacted a multi-family building that was built very close to the beach. Overwash was evident, especially to the south toward Normandy Beach.

Toms River Township (Normandy Beach);

The northern Township shoreline fared better than did the Ortley Beach section to the south, but significant overwash occurred in this section and many oceanfront and landward homes were damaged. This was due to beach-dune widths and elevations not adequate to withstand the tidal surge and wave action produced by Hurricane Sandy. Site #151 had losses of the dune and berm where 46.1 yds³/ft. of sand were removed during the storm.

Lavallette;

Lavallette had no dunes and suffered damage from Hurricane Gloria in 1985. The municipality developed a dune system between the paved promenade and the beach, but areas where beach accessways were carved through the dune system created low areas allowing the intense waves riding on the evening storm surge to easily erode those areas and create a number of serious breaches. While some remnants of dunes remained following the storm in the northern portion of the municipality (proximal to site #150), beach-dune widths and elevations in areas to the south were not adequate, and wide-scale overwash and breaching occurred. This caused catastrophic damage to infrastructure and property. Following Hurricane Sandy, Site #150 had sand volume loss of 51.7 yds³/ft.

Toms River Township (Ortley Beach);

Ortley Beach had a 25-year history of shoreline retreat and sand volume loss as determined by the Coastal Center's 8th Avenue survey site. Ocean Avenue, the boardwalk and many homes were completely destroyed in this segment. Site #149 located at 8th Avenue showed a sand volume loss of 68.7 yds³/ft. with over 10 feet of dune removed and pushed landward in overwash deposits. Everything was stripped away leaving a flat, featureless beach sloping into the sea. This was the site of the worst and most wide spread structural damage in Northern Ocean County.

Seaside Heights;

This segment of the shoreline experienced catastrophic damage to infrastructure and property as a result of having no dune system and an approximate berm width of 250-feet. The boardwalk and piers sustained heavy damage and in some places were completely destroyed. The cross-section located at Franklin Avenue (site #248) showed a sand volume loss of 39.3 yds³/ft to the beach in front of the boardwalk.

Seaside Park;

The pre- and post-storm analysis for site #148 at 4th Avenue showed that a portion of the foredune was removed during the storm; however, the remainder of the dune provided protection to the landward structures. No overwash occurred at the profile location. The dune's approximate 25-foot elevation (NAVD88) and 150-foot width (at the base) combined with a 150-foot wide beach provided adequate protection from tidal surge and wave action. As has been noted in other areas along the northern Ocean County barrier-spit, areas where beach accessways were carved through the dune system created low areas that were more easily eroded, resulting in wave overwash and sand being transported landward of the beach-dune system into the streets and private properties. While homes

sustained flood damage in this segment from Barnegat Bay, loss of infrastructure and homes was minimized due to the larger beach-dune system hindering waves crossing over land.

Midway Beach (Berkeley Township);

Site 347 in Midway Beach showed significant sand losses to the beach and dune but a portion of the dune remained to protect the landward homes and infrastructure. While overwash covered some of the streets and properties with sand, much of the overwash was limited areas proximal to the street ends. There areas are where beach accessways were carved through the dune system, creating low areas that were more easily eroded, resulting in wave overwash. While homes sustained flood damage in this segment, loss of infrastructure and homes was minimized due to the larger beach-dune system.

Island Beach State Park;

The three locations within the state park were not surveyed following the storm because the focus of surveying activities was on the developed sections of the barrier-spit. The CRC has requested permission for access to the state park sites to survey the beach and nearshore by the end of 2012.

NJBPN 156 – Water Street, Point Pleasant

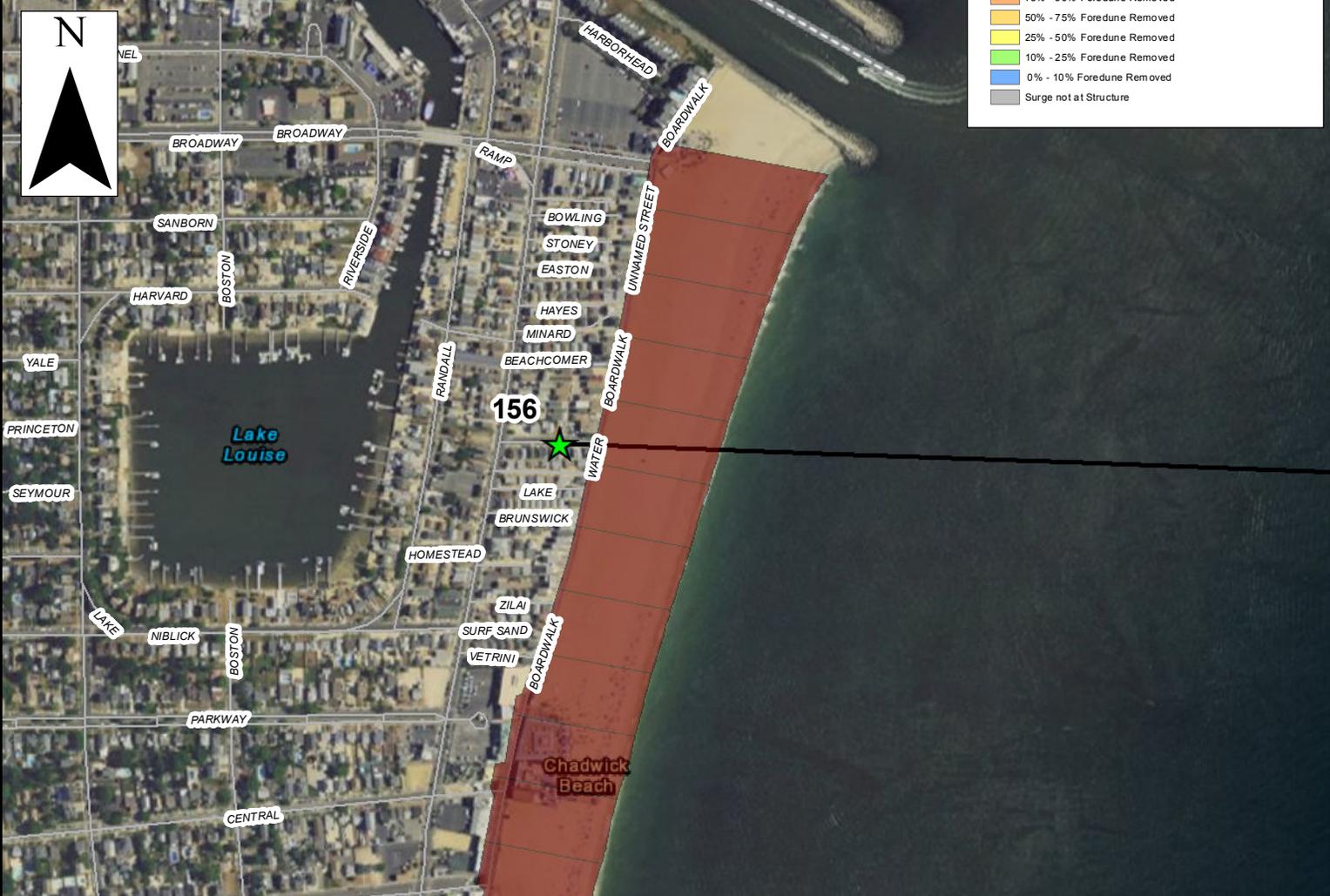


The photographs above were taken on September 21, 2012 (left) and November 12, 2012 (right).

Figure 2. The following figure shows the predicted impacts from a 100-year storm surge at Point Pleasant Beach. The predicted susceptibility was based upon the lack of an established dune system. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm where $62.7 \text{ yds}^3/\text{ft.}$ of sand were removed during the storm. The sand losses were extensive as predicted in the susceptibility study. This urban beach did not have a dune system but was spared from more severe damages by the over 600-foot protective berm.

NJBPN Site 156 Water Street, Point Pleasant Beach Before & After Hurricane Sandy

0 0.125 0.25 0.5 Miles



Legend

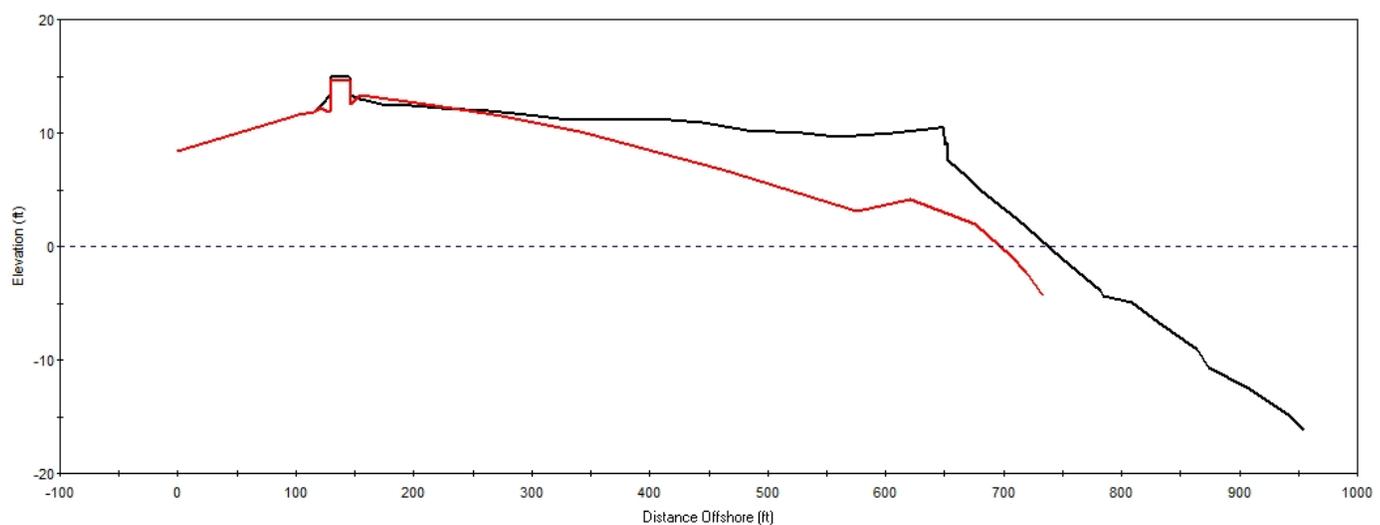
- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

Beach-Dune Susceptibility Assessment Results
100-year Storm Susceptibility

- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy
Site 156
Water St., Point Pleasant

Volume Change = -62.677 cu. yd/ft



— 156 9-21-2012 — 156 11-12-2012

NJBPN 155 – Maryland Avenue, Point Pleasant

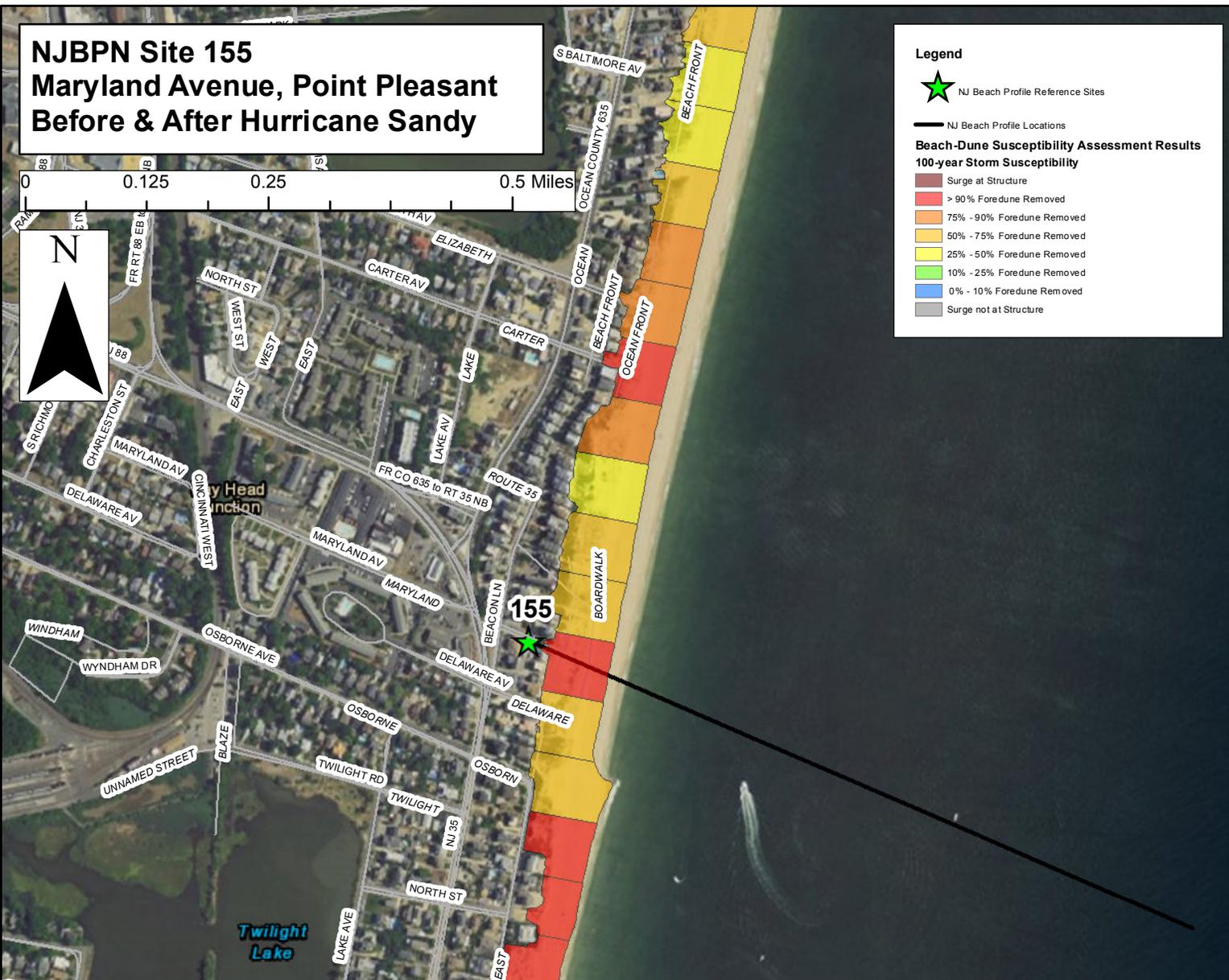


The photographs above were taken on September 17, 2012 (left) and November 12, 2012 (right).

Figure 3. The following figure shows the predicted impacts from a 100-year storm surge at the second location in Point Pleasant Beach. The predicted susceptibility shows possible impacts created by the shore-perpendicular accessway as those areas tend to be lower in elevation. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm and poorly vegetated dune system where 45.7 yds³/ft. of sand were removed during the storm. By the time of the post-storm survey, the municipality had begun relocating sand from the berm to the former dune location.

NJBPN Site 155 Maryland Avenue, Point Pleasant Before & After Hurricane Sandy

0 0.125 0.25 0.5 Miles



Legend

- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

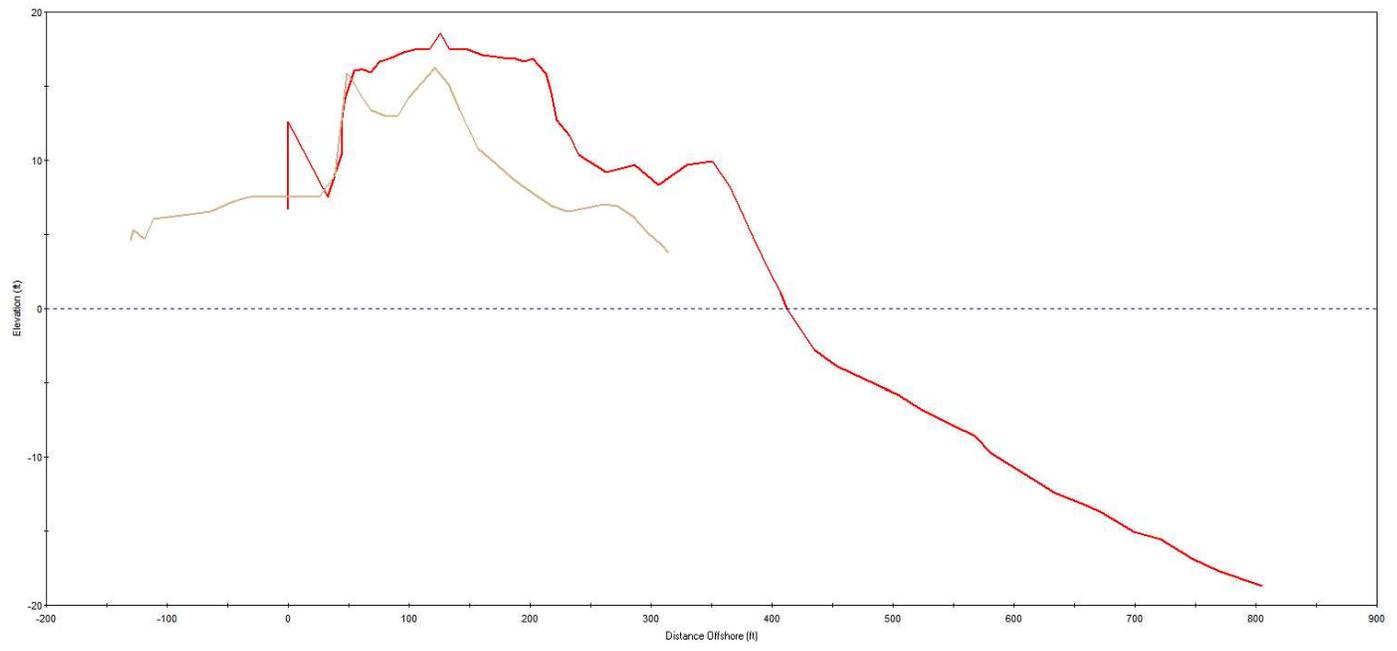
Beach-Dune Susceptibility Assessment Results

100-year Storm Susceptibility

- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy
Site 155
Maryland Avenue, Point Pleasant

Volume Change = -45.752 cu. yd/ft



155 9-17-2012 155 11-19-2012

NJBPN 154 – Johnson Avenue, Bay Head

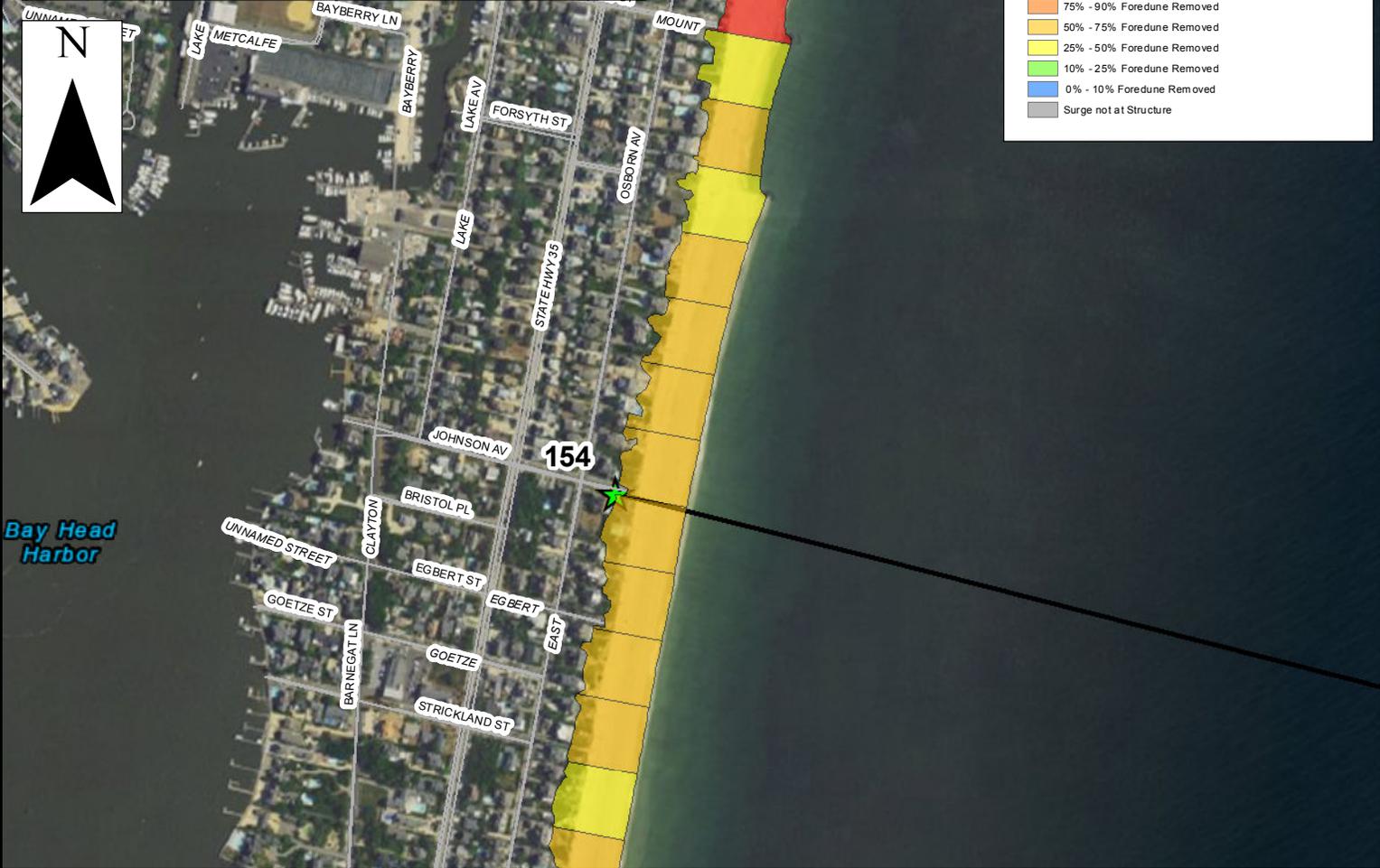


The photographs above were taken on September 17, 2012 (left) and November 12, 2012 (right).

Figure 4. The following figure shows the predicted impacts from a 100-year storm surge at Bay Head located at the northern section of the barrier spit complex. Susceptibility to a 100-year storm event was based upon the low dune elevation and limited size of the berm. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm and moderate dune where 19.6 yds³/ft. of sand were removed during the storm. The dune seaward of the homes was obliterated during the storm and exposed a base rubble-mound revetment layer. The beach was lowered, and sand was overwashed between the oceanfront homes and carried landward to the backbarrier.

NJBPN Site 154 Johnson Street, Bay Head Before & After Hurricane Sandy

0 0.125 0.25 0.5 Miles



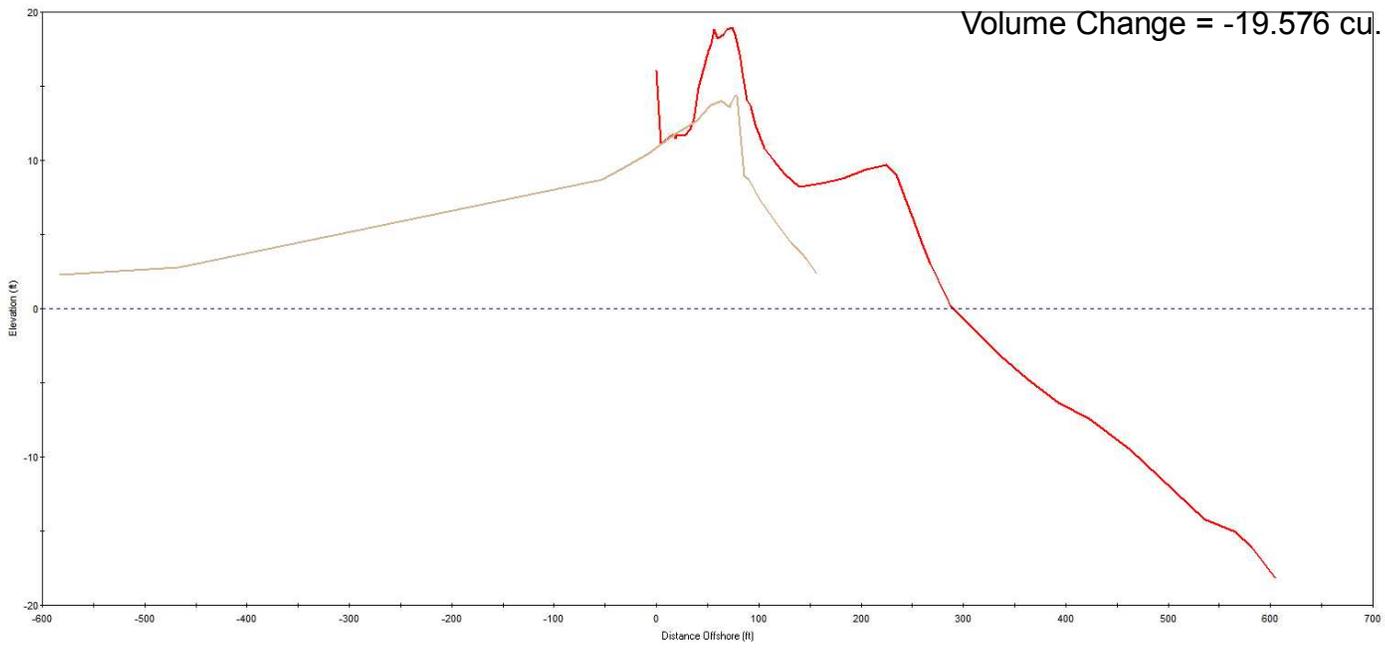
Legend

- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

Beach-Dune Susceptibility Assessment Results
100-year Storm Susceptibility

- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy
Site 154
Johnson Street, Bay Head



Volume Change = -19.576 cu. yd/ft

154 9-17-2012 154 11-19-2012



The photographs above were taken on September 17, 2012 (left) and November 5, 2012 (right). This profile location is within 300 feet from the temporary channel that opened during Sandy. The home at 1117 Ocean Avenue was completely removed from its location. See comparison screen captures below and the home circled in red.

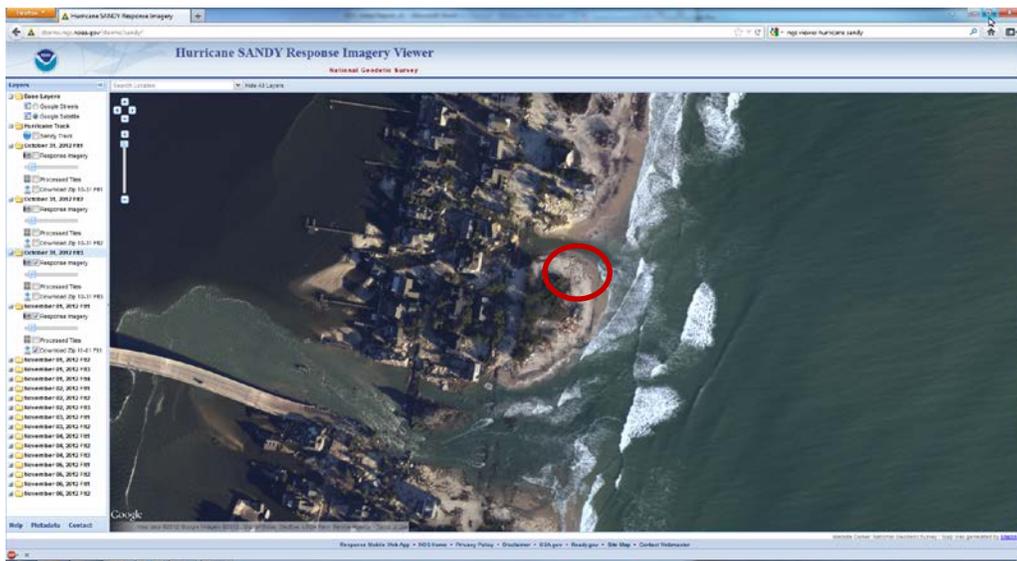
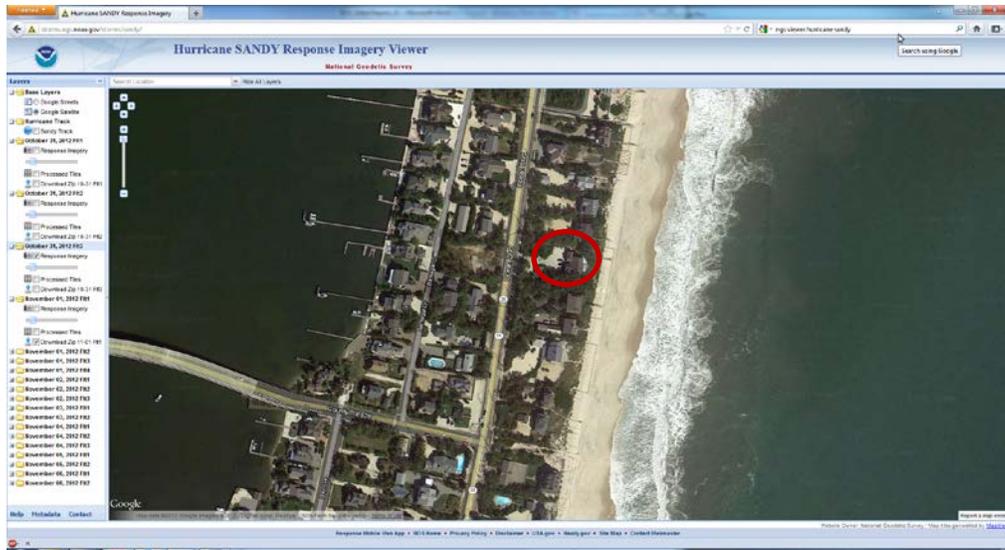


Figure 5. The following figure shows the predicted impacts from a 100-year storm surge at Mantoloking. The predicted susceptibility was based upon the relatively short beach and moderate dune system. Also shown is the

comparison plot between the pre- and post-storm surveys. As predicted, there was significant damage to the beaches and dunes. The plot depicts the changes caused by the storm and the losses of the berm where 109.6 yds³/ft. of sand were removed during the storm. This site suffered the greatest sand losses of all of the profiles in Northern Ocean County. The loss here is far greater due to the presence of the storm-generated inlet and deep scours into the area landward of the dunes. The sand loss volume includes the dune, the land between Route 35 and the current shoreline, but based on a uniform slope from Route 35 to the original back-shot position at the landward limit of the dune. This site was an incipient inlet breach north of the main cut at Herbert Street. (See comparison aerial photos shown above.) The shoreline wrapped landward toward the beach opening. While the closure of the flow was accomplished by November 5th, the original shoreline had retreated 150 feet. Here the dune width was far too narrow in spite of a 20-foot maximum elevation. Hurricane Irene took almost half the dune volume in August 2011.

NJBPN Site 153
1117 Ocean Avenue, Mantoloking
Before & After Hurricane Sandy

0 0.125 0.25 0.5 Miles



Legend

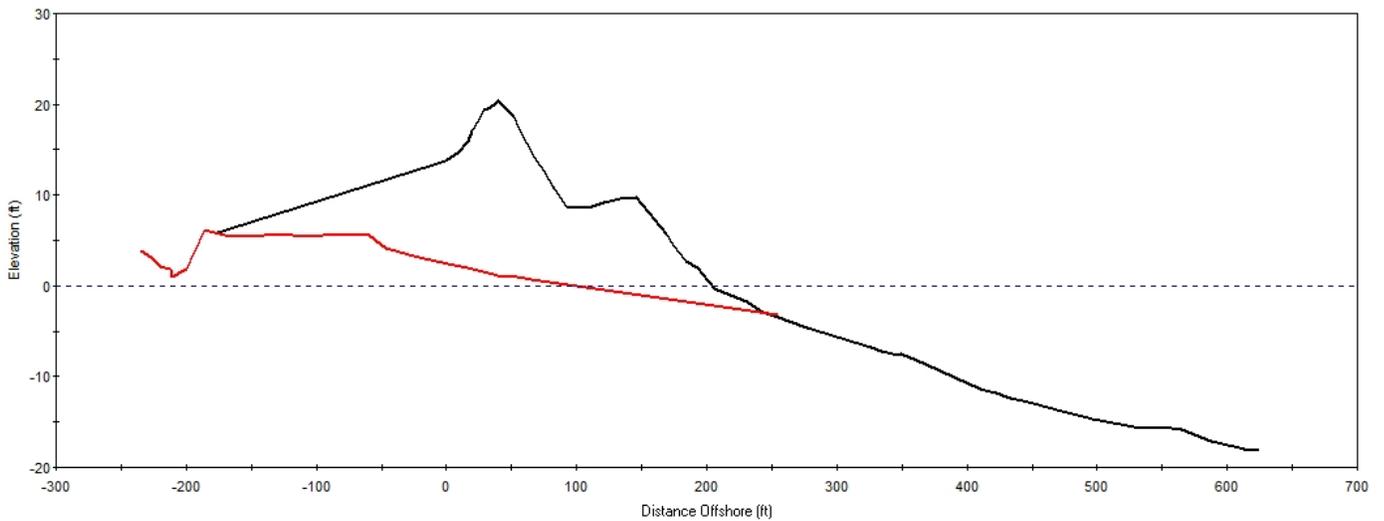
- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

Beach-Dune Susceptibility Assessment Results
100-year Storm Susceptibility

- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy:
Mant 3
1117 Ocean Ave.

Volume Change = -109.595 cu. yd/ft



— Mant 3 9-20-2012 — Mant 3 11-5-2012



The photographs above were taken on September 14, 2012 (left) and November 8, 2012 (right).

Figure 6. The following figure shows the predicted impacts from a 100-year storm surge at the Public Beach in Brick Township. The predicted susceptibility was based upon the moderate berm width. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm and moderate dune where 42.0 yds³/ft. of sand were removed during the storm. Prior to Sandy, the bulkhead was buried at least 10 feet below the dunes. Sand was transported landward in overwash deposits and several landward homes were damaged.

**NJBPN Site 152
Public Beach #3, Brick Township
Before & After Hurricane Sandy**

0 0.125 0.25 0.5 Miles

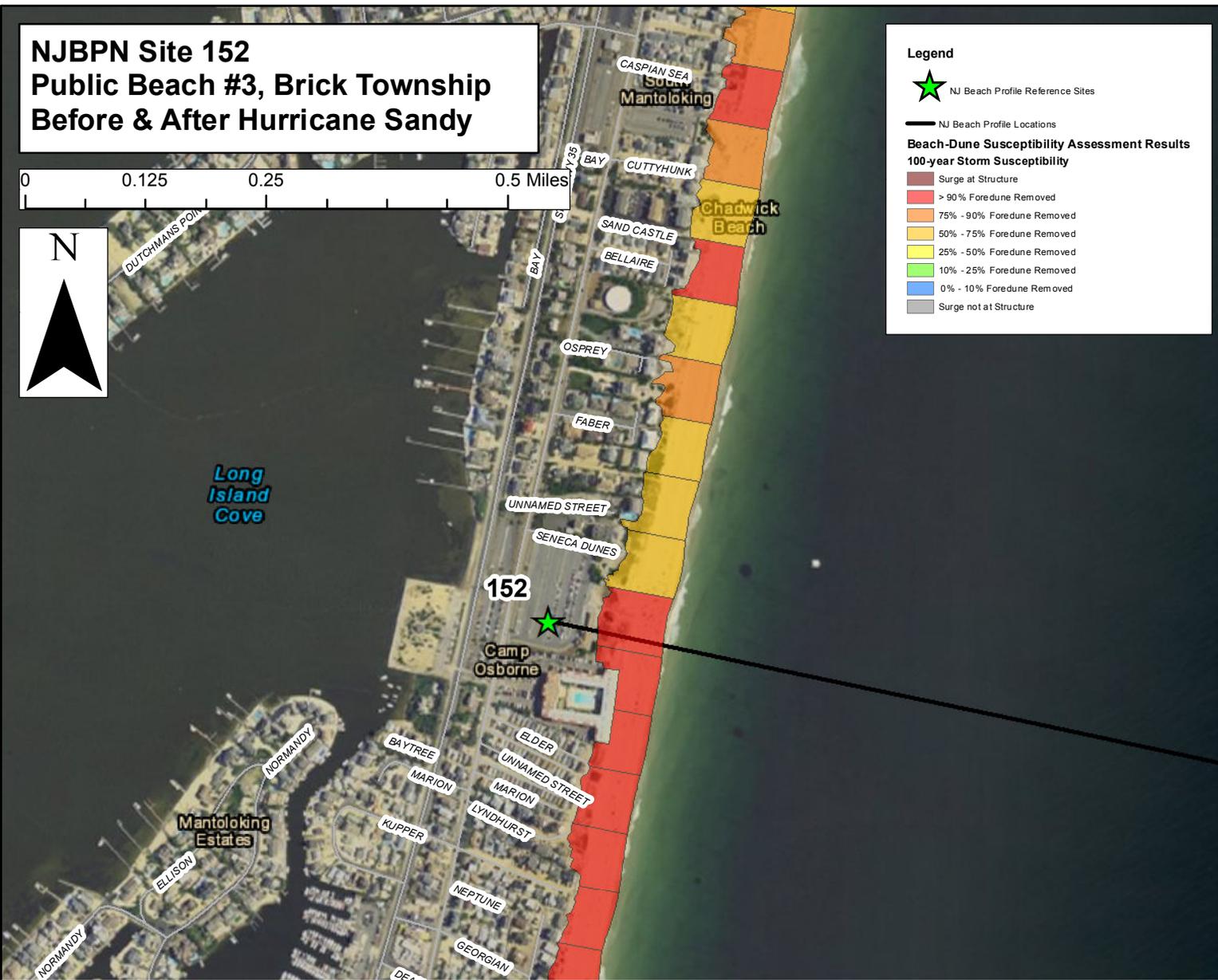


Legend

- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

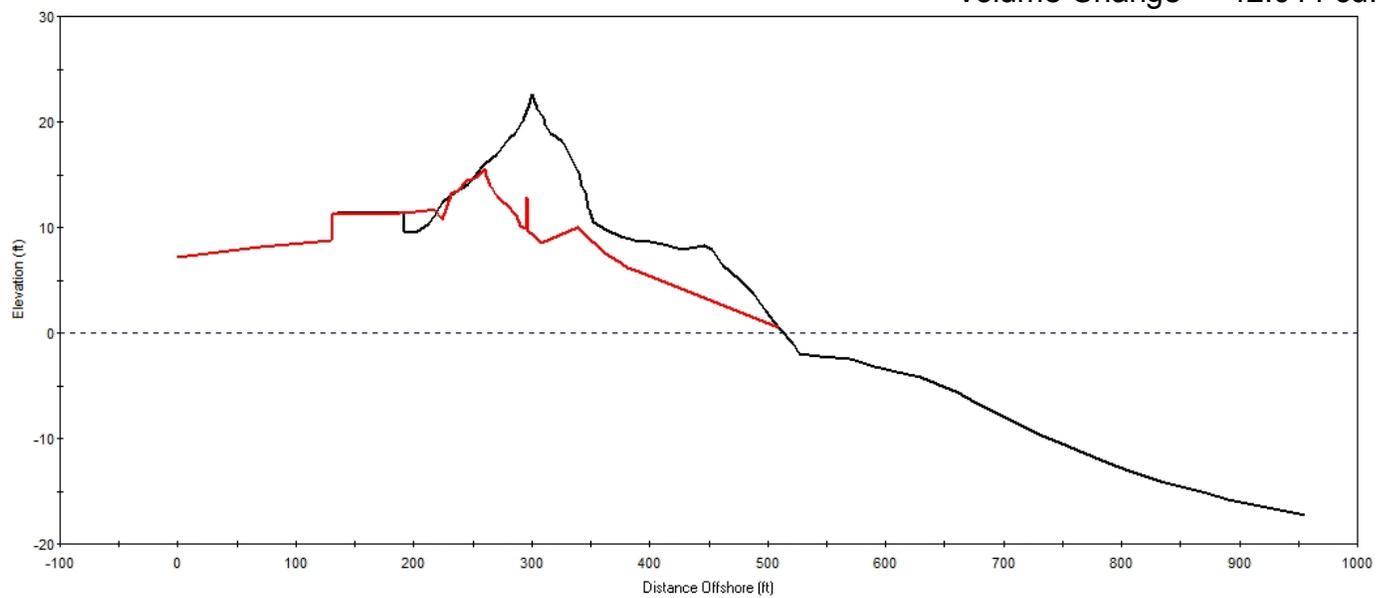
**Beach-Dune Susceptibility Assessment Results
100-year Storm Susceptibility**

- Surge at Structure
- > 90% Fore dune Removed
- 75% - 90% Fore dune Removed
- 50% - 75% Fore dune Removed
- 25% - 50% Fore dune Removed
- 10% - 25% Fore dune Removed
- 0% - 10% Fore dune Removed
- Surge not at Structure



**Pre vs. Post Sandy
Site 152
Public Beach #3, Brick Township**

Volume Change = -42.014 cu. yd/ft



— 152 9-14-2012 — 152 11-8-2012

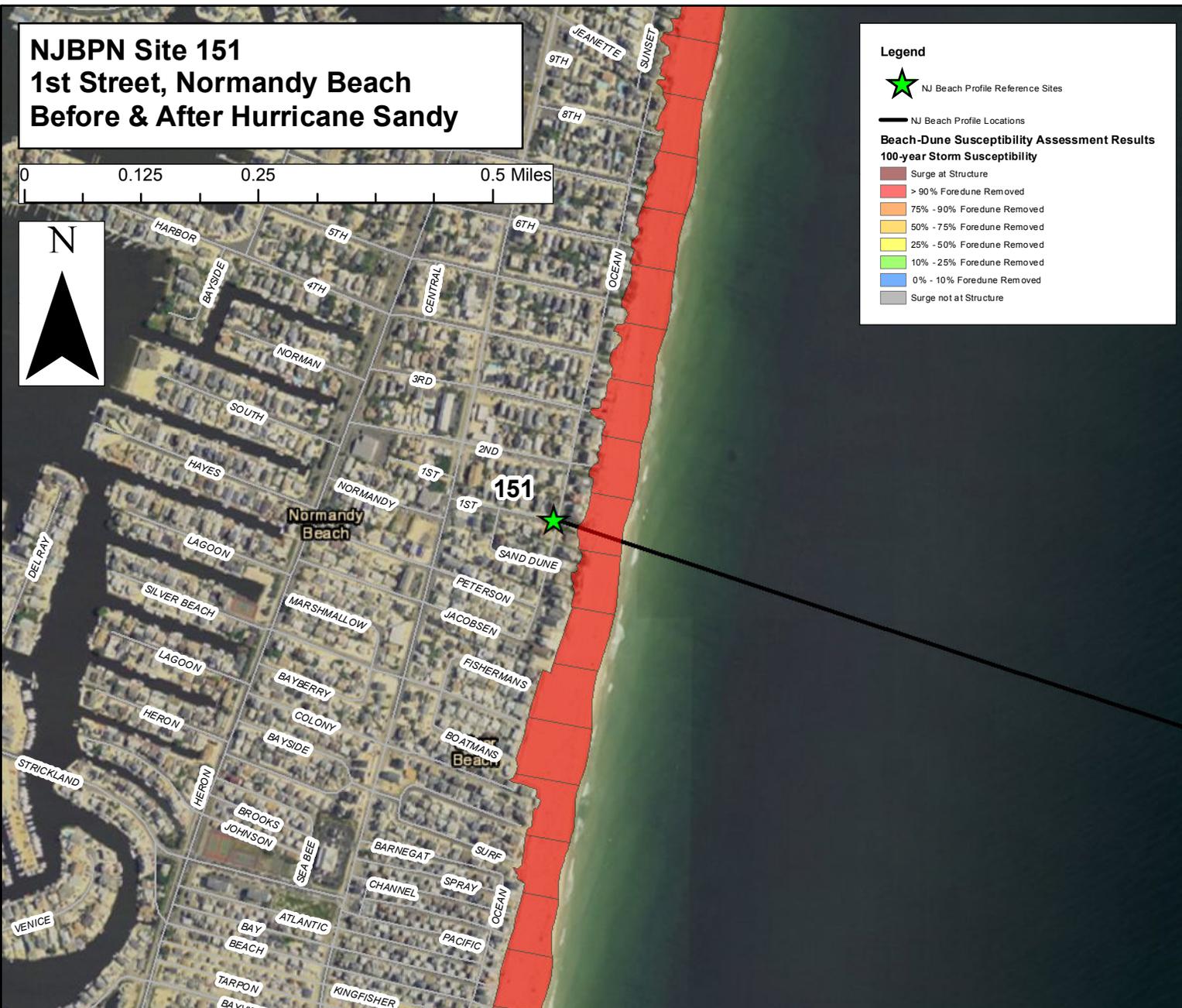


The photographs above were taken on September 14, 2012 (left) and November 8, 2012 (right).

Figure 7. The following figure shows the predicted impacts from a 100-year storm surge at Normandy Beach. The predicted susceptibility was based upon the lack of an established dune system and minimal berm. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm where $46.1 \text{ yds}^3/\text{ft.}$ of sand were removed during the storm. Significant overwash occurred at this site and many oceanfront and landward homes were damaged.

NJBPN Site 151 1st Street, Normandy Beach Before & After Hurricane Sandy

0 0.125 0.25 0.5 Miles

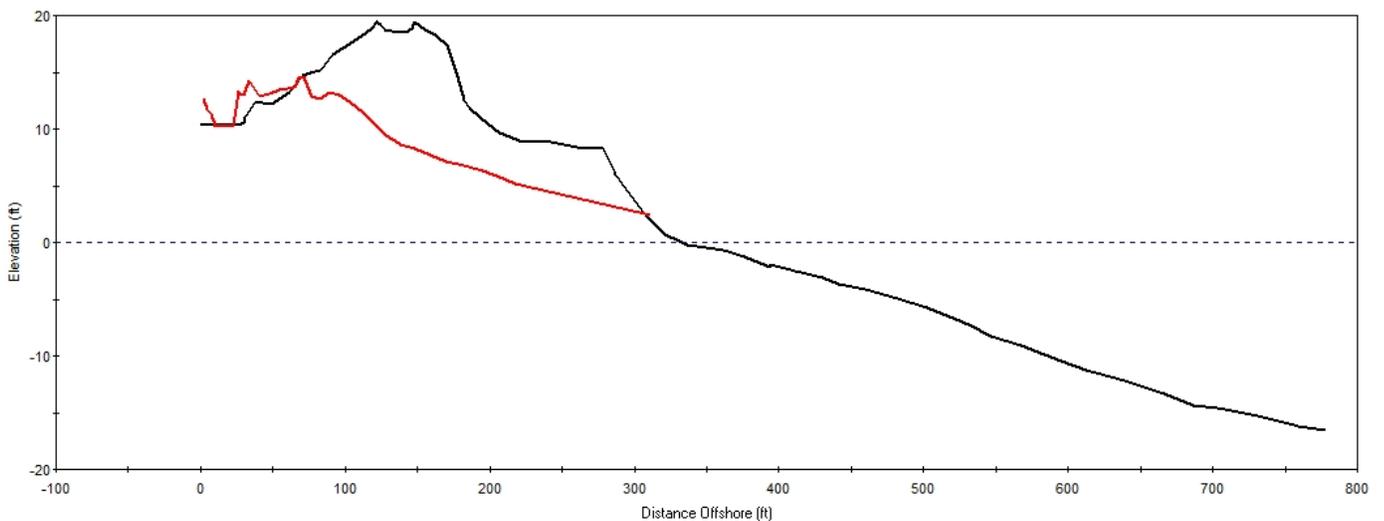


Legend

- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations
- Beach-Dune Susceptibility Assessment Results**
- 100-year Storm Susceptibility**
- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy
Site 151
1st Ave., Normandy Beach

Volume Change = -46.139 cu. yd/ft



— 151 9-14-2012 — 151 11-8-2012



The photographs above were taken on September 14, 2012 (left) and November 8, 2012 (right).

Figure 8. The following figure shows the predicted impacts from a 100-year storm surge at Lavallette. The predicted susceptibility was based upon the moderate berm width. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm and dune where $51.7 \text{ yds}^3/\text{ft.}$ of sand were removed during the storm. This location experienced beach and dune erosion; however, overwash only occurred where the dune was lower and breached.

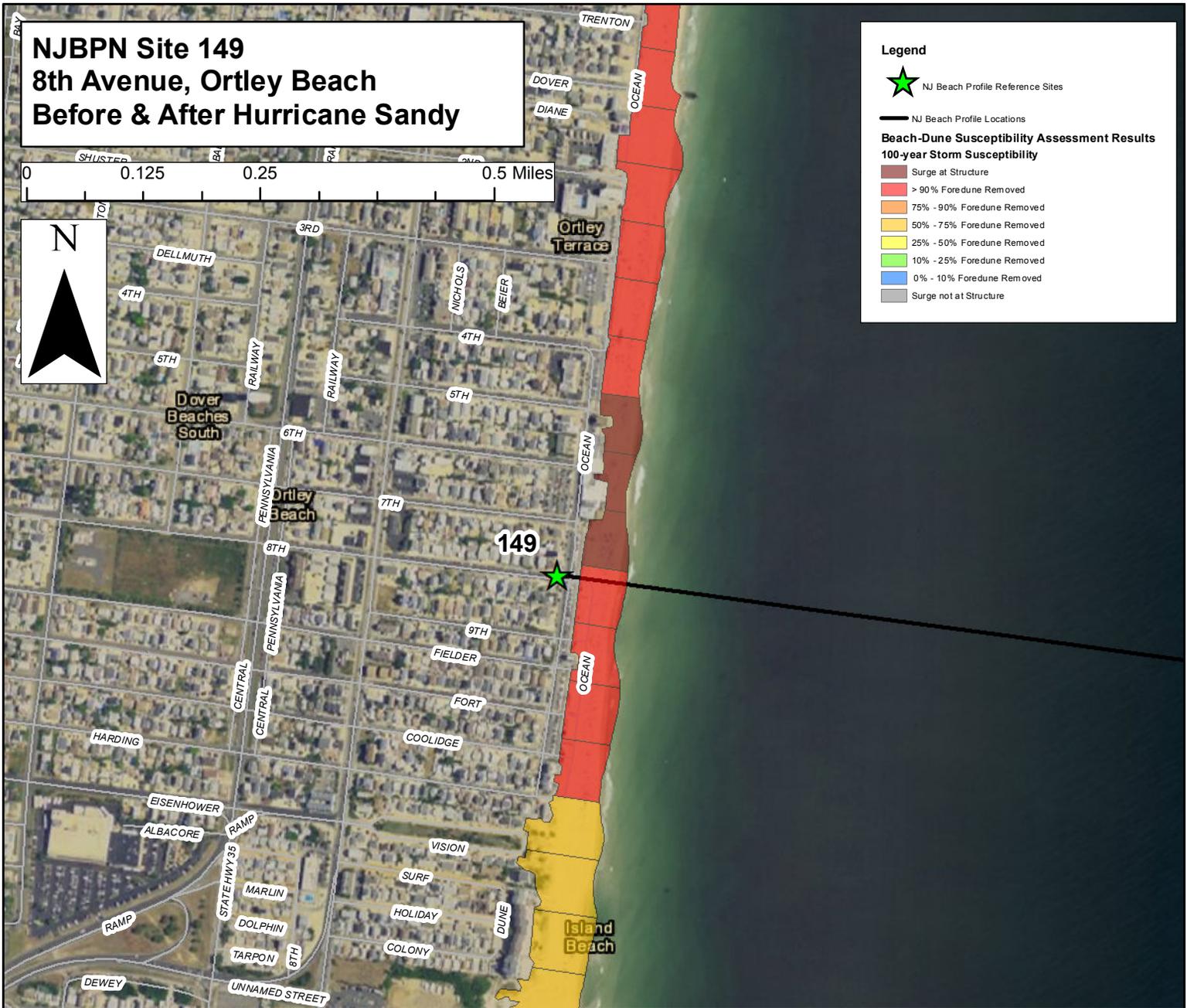


The photographs above were taken on September 14, 2012 (left) and November 8, 2012 (right).

Figure 9. The following figure shows the predicted impacts from a 100-year storm surge at Ortley Beach. The predicted susceptibility was based upon the lack of an established dune system and minimal berm width. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm and dune where $68.7 \text{ yds}^3/\text{ft.}$ of sand were removed during the storm. Over 10 feet of dune was removed and pushed landward in overwash deposits. Ocean Avenue was completely destroyed as well as several homes. The photo on the right shows a classic planed beach caused by the large waves. Follow-up surveys will determine whether some of the sand moved seaward into nearshore bars.

NJBPN Site 149 8th Avenue, Ortle Beach Before & After Hurricane Sandy

0 0.125 0.25 0.5 Miles



Legend

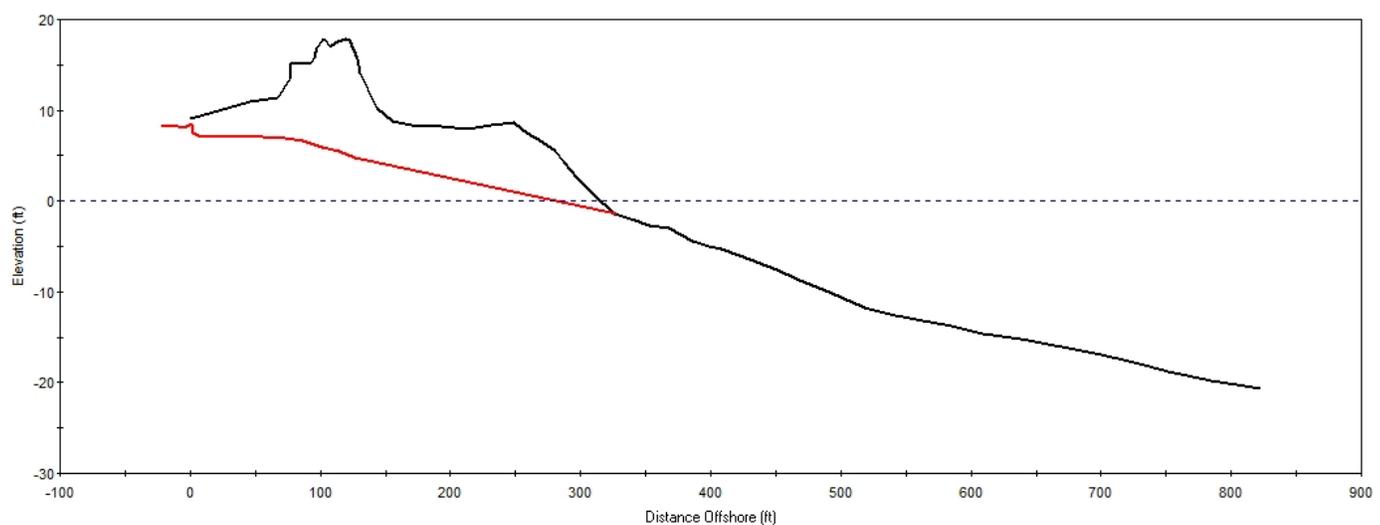
- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

**Beach-Dune Susceptibility Assessment Results
100-year Storm Susceptibility**

- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy
Site 149
8th Ave., Ortle Beach

Volume Change = -68.744 cu. yd/ft



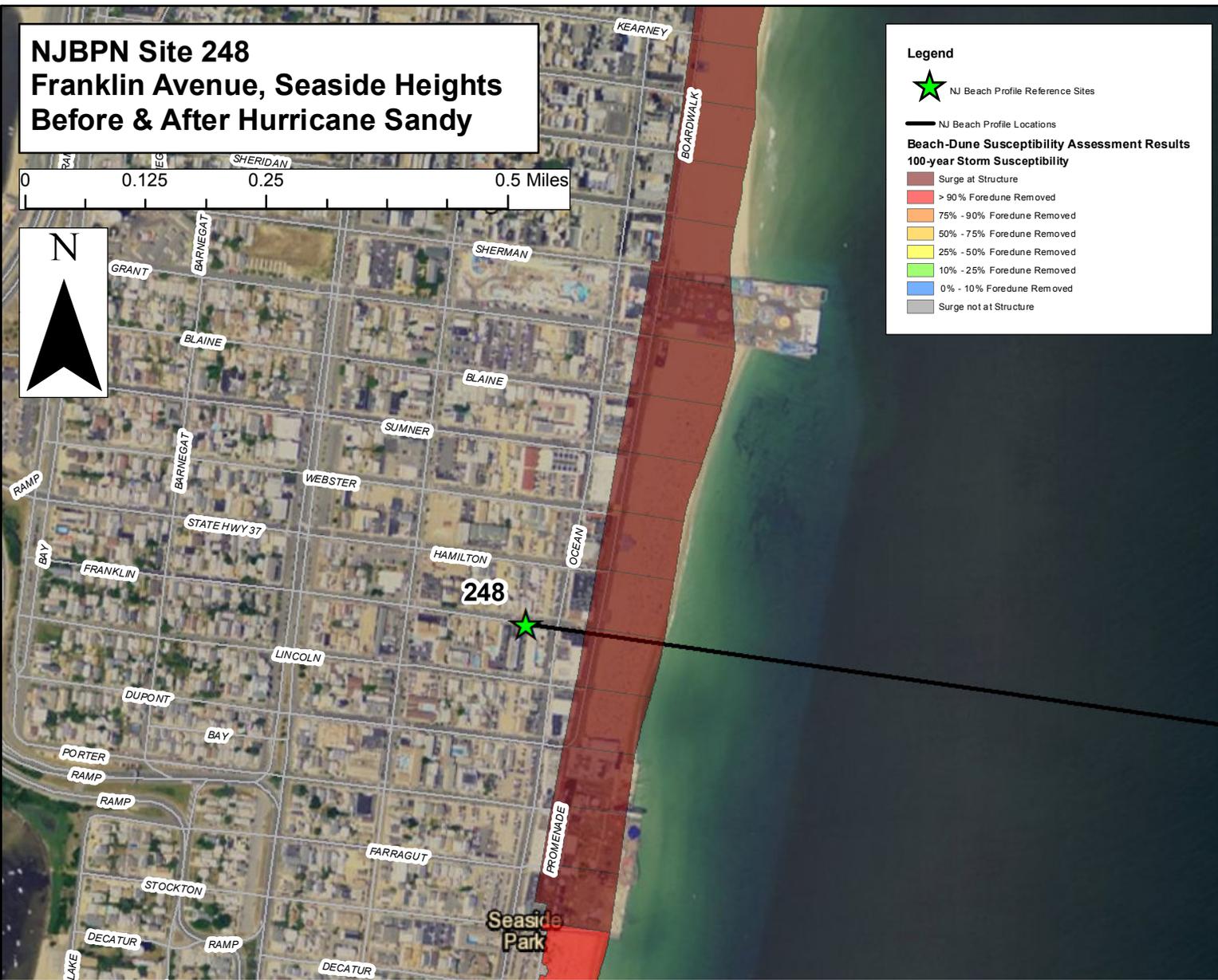
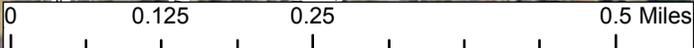
— 149 9-14-2012 — 149 11-8-2012



The photographs above were taken on September 13, 2012 (left) and November 8, 2012 (right).

Figure 10. The following figure shows the predicted impacts from a 100-year storm surge at Seaside Heights. The predicted susceptibility was based upon the lack of an established dune system and minimal berm width. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm where $39.3 \text{ yds}^3/\text{ft.}$ of sand were removed during the storm. This urban beach did not have a dune system and the photo on the right shows the obvious damages to the pier and amusements. As predicted in the susceptibility study, storm surge damaged the boardwalk and structures landward of it.

NJBPN Site 248 Franklin Avenue, Seaside Heights Before & After Hurricane Sandy



Legend

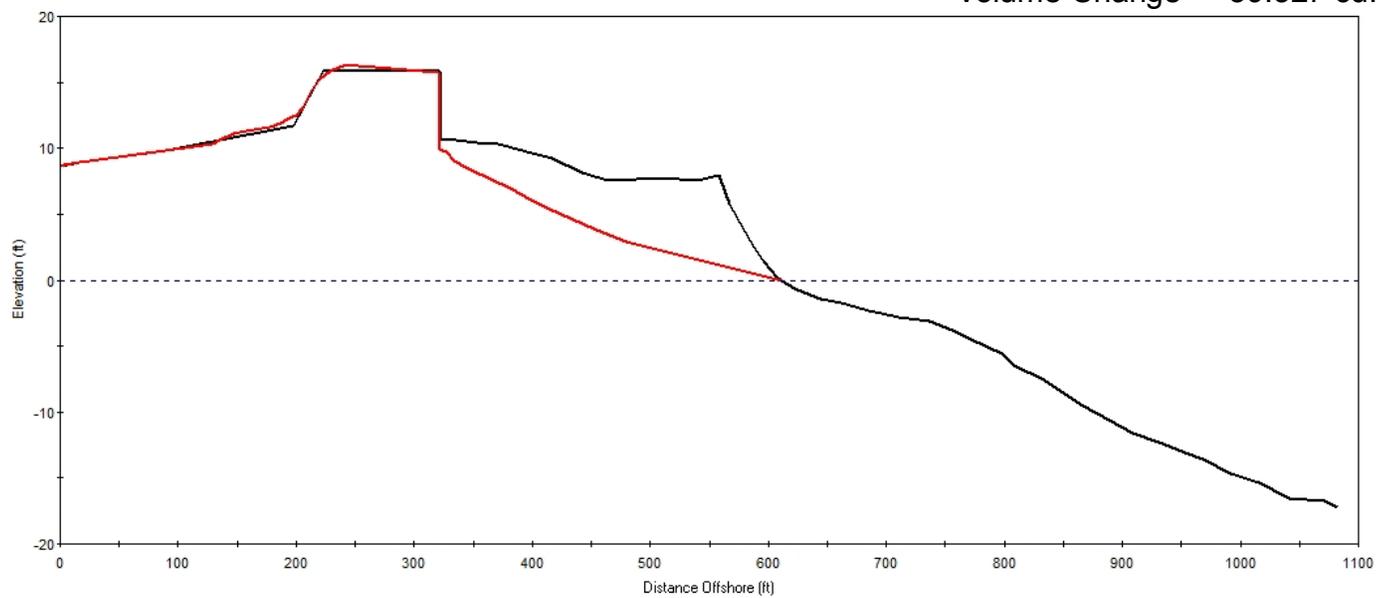
- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

Beach-Dune Susceptibility Assessment Results
100-year Storm Susceptibility

- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy
Site 248
Franklin Ave., Seaside Heights

Volume Change = -39.327 cu. yd/ft



— 248 9-13-2012 — 248 11-8-2012

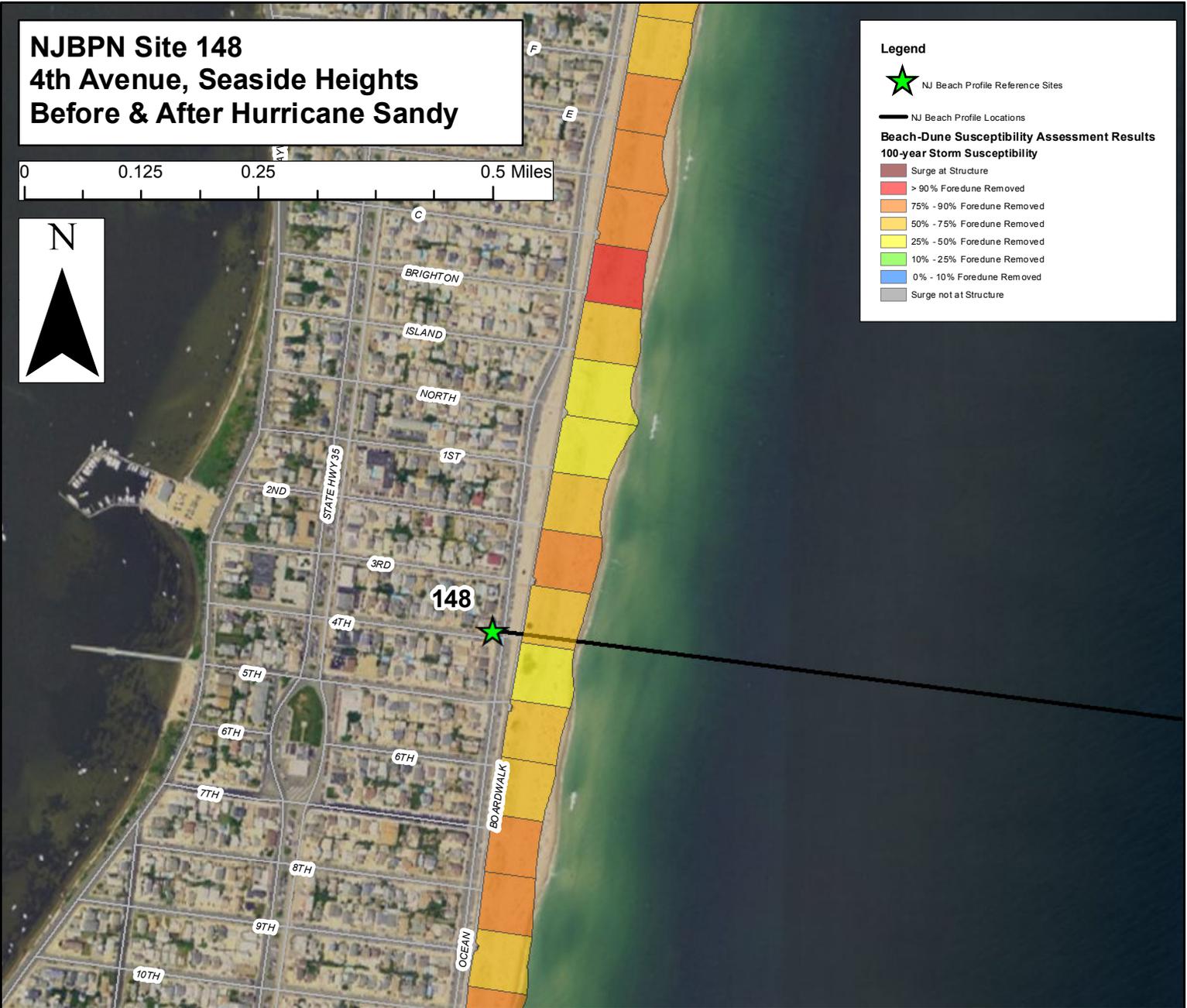


The photographs above were taken on September 13, 2012 (left) and November 8, 2012 (right).

Figure 11. The following figure shows the predicted impacts from a 100-year storm surge at Seaside Park. The predicted susceptibility was based upon the established dune system. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm and dune where $43.7 \text{ yds}^3/\text{ft.}$ of sand were removed during the storm. As predicted in the susceptibility study, a portion of the foredune was removed during the storm; however, the remainder of the dune provided protection to the landward structures. No overwash occurred at this location.

NJBPN Site 148 4th Avenue, Seaside Heights Before & After Hurricane Sandy

0 0.125 0.25 0.5 Miles



Legend

- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

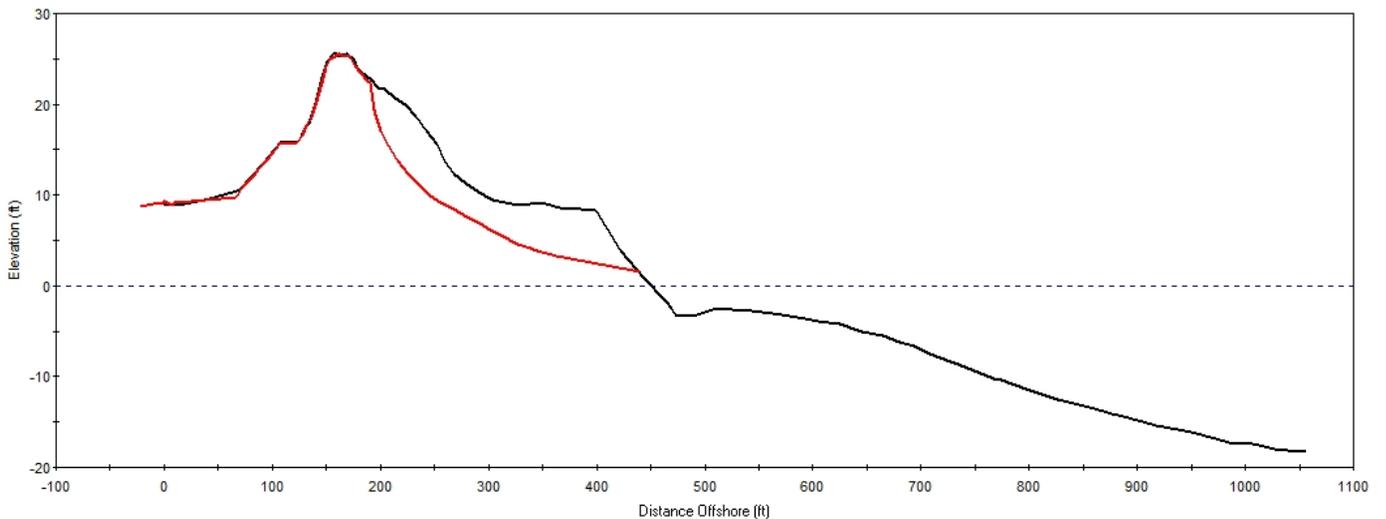
Beach-Dune Susceptibility Assessment Results

100-year Storm Susceptibility

- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy
Site 148
4th Ave., Seaside Park

Volume Change = -43.722 cu. yd/ft



— 148 9-13-2012 — 148 11-8-2012

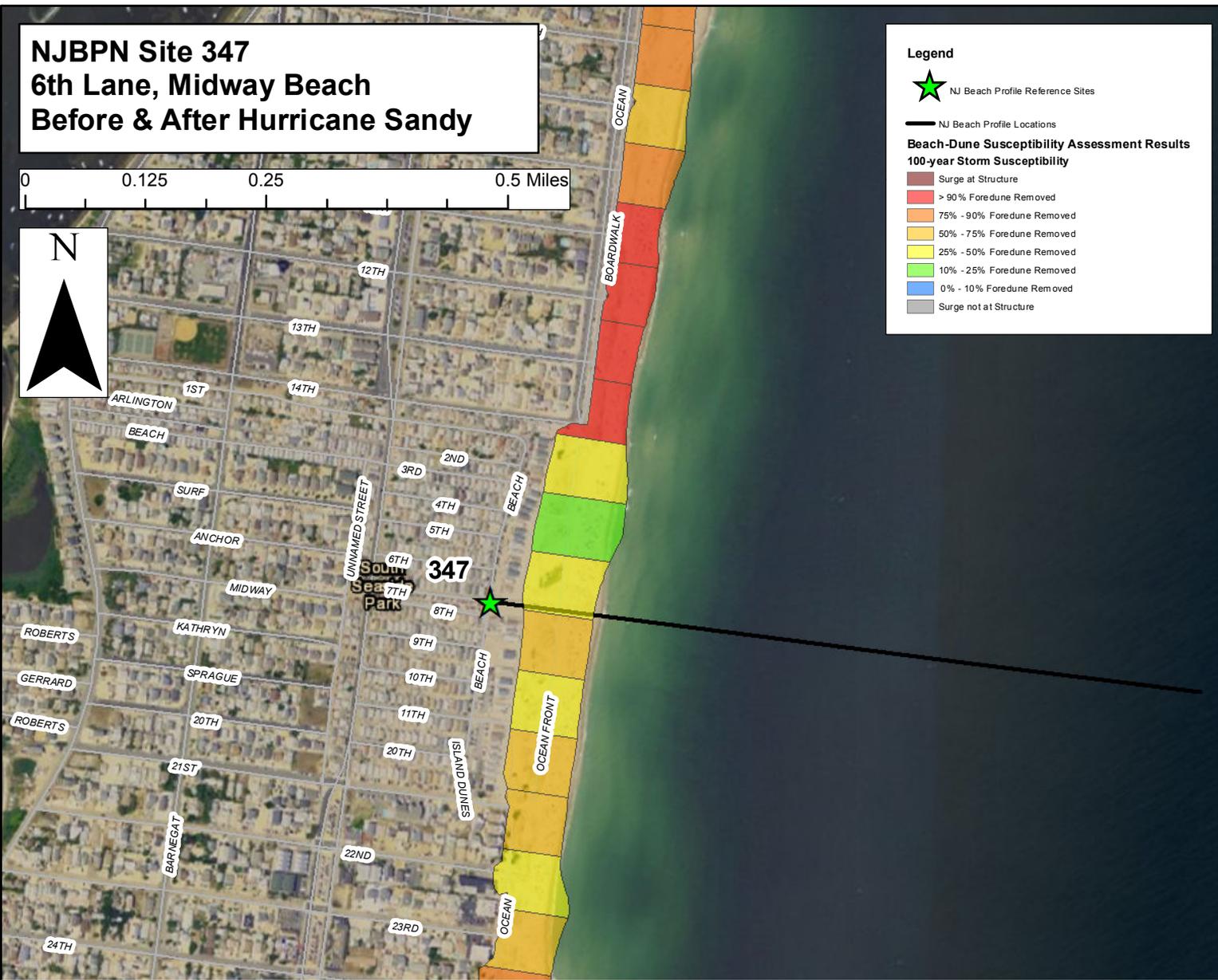


The photographs above were taken on September 13, 2012 (left) and November 8, 2012 (right).

Figure 12. The following figure shows the predicted impacts from a 100-year storm surge at Midway Beach. Of all the northern Ocean County NJBPN developed shoreline sites, this one was predicted to have the least amount of foredune removal. Also shown is the comparison plot between the pre- and post-storm surveys. The plot depicts the changes caused by the storm and the losses of the berm and dune where 48.7 yds³/ft. of sand were removed during the storm. Though there were measured losses of the berm and dune, a portion of the dune remained to protect the landward homes and infrastructure.

NJBPN Site 347
6th Lane, Midway Beach
Before & After Hurricane Sandy

0 0.125 0.25 0.5 Miles



Legend

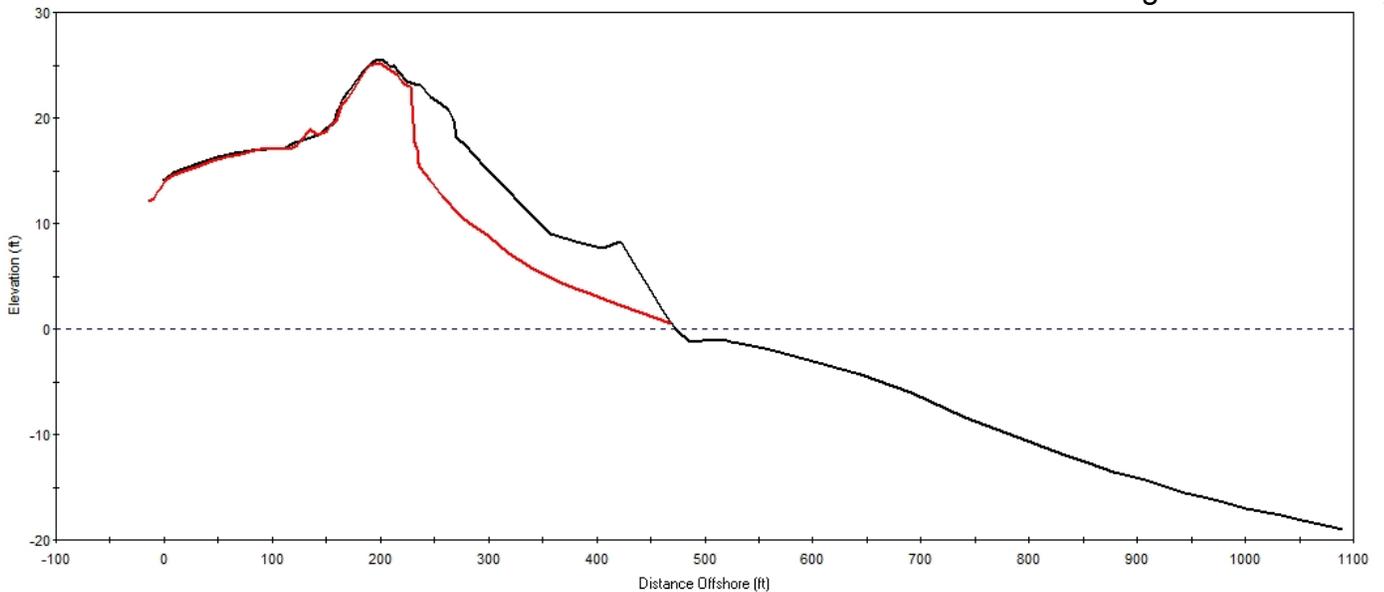
- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

Beach-Dune Susceptibility Assessment Results
100-year Storm Susceptibility

- Surge at Structure
- > 90% Foredune Removed
- 75% - 90% Foredune Removed
- 50% - 75% Foredune Removed
- 25% - 50% Foredune Removed
- 10% - 25% Foredune Removed
- 0% - 10% Foredune Removed
- Surge not at Structure

Pre vs. Post Sandy
Site 347
6th Ln., Midway Beach

Volume Change = -48.673 cu. yd/ft



— 347 9-13-2012 — 347 11-8-2012

<i>Northern Ocean County Post Sandy Volume Changes</i>			
Site	Vol Change cu yds per ft	Dune Failure	Recent Beach Fill
347	-48.673	N	N
148	-43.722	N	N
248	-39.327	Y	N
149	-68.744	Y	N
150	-51.687	Y	N
151	-46.139	Y	N
152	-42.014	Y	N
153	-109.595	Y	N
154	-19.576	Y	N
155	-45.752	Y	N
156	-62.677	Y	N

Figure 13 shows a table of values for the 11 developed shoreline profile site locations in northern Ocean County. The sand volume lost per foot of shoreline represents loss from the dune and the beach and does not include changes in the offshore region. 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 statewide.

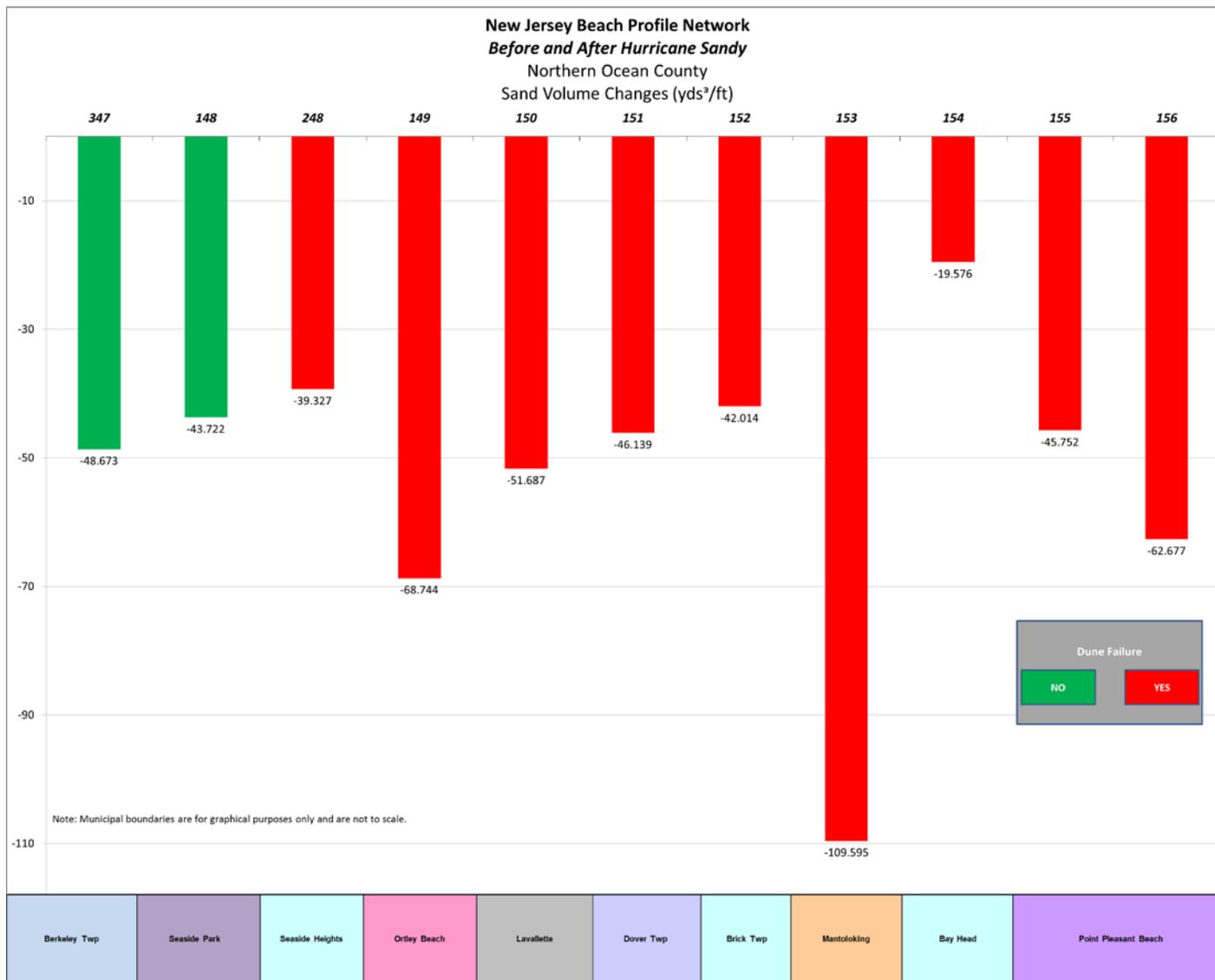


Figure 14. This graphic shows the sand volume loss figures for each of the communities within the developed sections of the northern Ocean County Atlantic shoreline. No Federal shore protection projects have occurred along this portion of the New Jersey shoreline. All sites experienced berm erosion and dune losses. Sites 347 and 148 contained a greater dune volume prior to the storm and though dune losses were recorded, there was no dune failure. The losses measured at Site 153 were enhanced due to the presence of a newly-opened inlet (with depths measured at approximately 18 feet). The dune at Site 154 contained a rock/timber core that was included in the pre-storm dune volume calculation.

Northern Ocean County Post Sandy Volume Changes

MUNICIPALITY	Site	Vol Change cu yds per ft	Average Volume Between Sites	Dune Failure	Recent Beach Fill	REF POINT Distance (FEET)	Vol Change - Cubic Yards Between Profiles (South to North)	Cumulative Volume Change - Cubic Yards (South to North)
Berkely Township	347	-48.673		N	N	0.00	0.00	0
Seaside Park	148	-43.722	-46.20	N	N	4,607.59	-212,859.05	-212,859.05
Seaside Heights	248	-39.327	-41.52	Y	N	9,074.11	-376,798.01	-589,657.06
Ortley Beach	149	-68.744	-54.04	Y	N	7,154.30	-386,586.18	-976,243.25
Lavallette	150	-51.687	-60.22	Y	N	11,087.76	-667,654.81	-1,643,898.06
Dover Twp	151	-46.139	-48.91	Y	N	10,393.85	-508,394.46	-2,152,292.51
Brick Twp	152	-42.014	-44.08	Y	N	5,184.78	-228,527.02	-2,380,819.53
Mantoloking	153	-109.595	-75.80	Y	N	15,628.24	-1,184,691.26	-3,565,510.79
Bay Head	154	-19.576	-64.59	Y	N	10,487.40	-677,333.97	-4,242,844.76
Point Pleasant Beach	155	-45.752	-32.66	Y	N	6,800.90	-222,144.64	-4,464,989.40
Point Pleasant Beach	156	-62.677	-54.21	Y	N	9,971.70	-540,610.46	-5,005,599.86
Total Volume Loss for Northern Ocean County =								-5,005,599.86

Figure 15. This table provides a summary 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 within 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 Berkeley Township site (347) in the natural areas of Island Beach State Park. A percentage of the sand carried offshore by Sandy will move back toward the beach over time in the absence of future storms. 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.