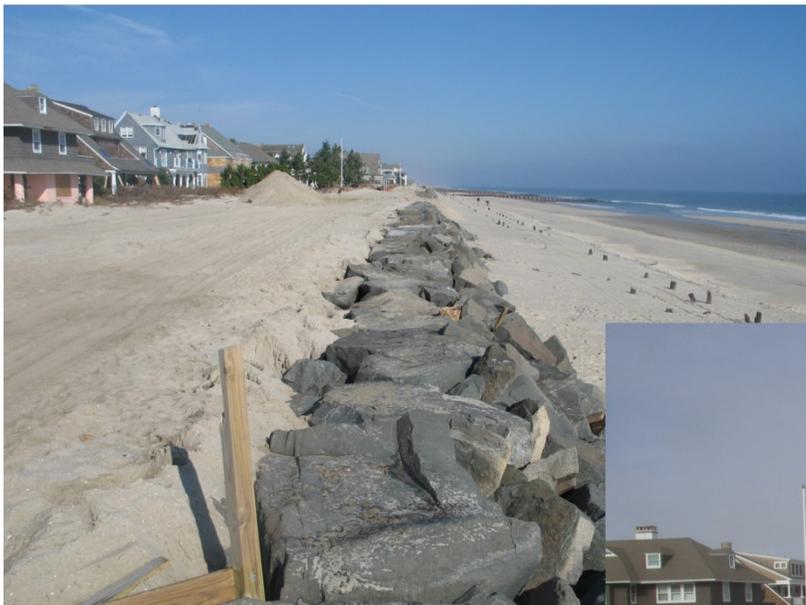


# STOCKTON UNIVERSITY COASTAL RESEARCH CENTER



*Johnson Avenue, Bay Head, NJ comparing a view from the Dune Crest north November 12, 2012 with the same view taken December 14, 2015 three years following Hurricane Sandy. The rock revetment reduced, but did not eliminate the damages to properties landward. Sand from overwash was picked up and returned to the beach/dune system.*

## New Jersey Beach Profile Network 2015 Annual Report on Shoreline Changes in New Jersey's Four Coastal Counties Raritan Bay to Delaware Bay Spring of 2014 Through Fall of 2015

Prepared for:

New Jersey Department of Environmental Protection  
Division of Construction and Engineering  
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May 31, 2016

# The Stockton University Coastal Research Center



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New Jersey Department of Environmental Protection  
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May 31, 2016

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## EXECUTIVE SUMMARY

The New Jersey Department of Environmental Protection (NJDEP) initially authorized the New Jersey Beach Profile Network (NJBPN) project in 1986. With Hurricane Sandy now three years behind us, the continued challenges are examined as major State and Federal projects have gone to completion and been exposed to a few storm events since Sandy. The report is divided into four coastal county segments and provides a summary of beach changes for each county.

The US Army Corps of Engineers (ACOE) undertook the restoration to design specifications all federally authorized, and constructed shore protection projects in the State. Funding under Public Law 113-2 allowed 100% federal payment to do restoration of existing projects in Monmouth, Ocean, Atlantic, Cape May Counties, and the tidal Delaware Bay/River shoreline. While the direct impact of Hurricane Sandy was published on the Coastal Research Center (CRC) website as soon as it was complete in December 2012, it has taken several years to follow both the direct sand placement as well as the slower rate of natural accretion. The report is also found on the website at [www.stockton.edu/crc](http://www.stockton.edu/crc).

### **Shoreline Management Endeavors since Sandy:**

State-wide the average beach profile gained 16.14 yds<sup>3</sup>/ft. between the spring of 2014 and the fall of 2015, while the average shoreline position advanced 25.3 feet seaward. This magnitude continues to be influenced by the massive federally funded effort along the NJ coast, but even the reaches where only natural changes occurred (northern Ocean County) the beach/dune system gained 5.02 yds<sup>3</sup>/ft. while the shoreline retreated 4.5 feet. On Long Beach Island where almost half the shoreline is under federal management the values were 36.89 yds<sup>3</sup>/ft. in sand volume gain with a 72.8-foot shoreline advance.

Natural recovery from Hurricane Sandy appears to have reached to within 80% of the maximum possible in the absence of counting the federal project impacts. The winter of 2014 to 2015 saw an average loss in Northern Ocean County of 2.40 yds<sup>3</sup>/ft. and a 2.0-foot shoreline retreat. Where no intervention has yet occurred on any major scale, the shoreline has reached a new equilibrium.

The survey data was analyzed to show changes in the four county shorelines and sand volume changes for the 18-month study interval. The three-month seasonal average sand volume changes for each county plus the 18-month summary are shown below. Beach nourishment projects in Monmouth, Long Beach Island (Ocean County), and Atlantic Counties produced the extensive sand volume increases previously.

Monmouth and Ocean Counties maintained a positive sand volume gain during the study interval while both Atlantic and Cape May Counties lost material during part of the interval. Atlantic County was the only county to lose sand for the entire study interval. Cape May County bounced back during the summer and fall of 2015, reversing two periods of losses. The recovery during the summer of 2015 was considerably greater than both the Cape May County seasonal losses combined. Since the completion of the majority of the post-Sandy beach restoration efforts, the rate of sand accretion declined across the entire NJ coast. Past storm events have demonstrated a logarithmic sand recovery rate where the majority returns in 18 months followed by a slow process that does not return an un-artificially nourished shoreline to its pre-storm sand volume by year five. The amount of permanent sand loss due to a storm is variable between 0 and 10% for major storms.

**Sand Volume Changes at the NJ Oceanfront**  
**S 14 – F 14    F 14 – S 15    S 15 – F 15    S 14 – F 15**  
**Cu. yds/ft.    Cu. yds/ft.    Cu. yds/ft.    Cu. yds/ft.**

<b>Monmouth County</b>	<b>3.94</b>	<b>2.68</b>	<b>6.06</b>	<b>11.76</b>
<b>Ocean County</b>	<b>0.74</b>	<b>5.45</b>	<b>14.92</b>	<b>20.77</b>
<b>Atlantic County</b>	<b>12.56</b>	<b>-9.34</b>	<b>-14.21</b>	<b>-14.76</b>
<b>Cape May County</b>	<b>-0.67</b>	<b>-7.86</b>	<b>32.25</b>	<b>23.89</b>

The shoreline change values represent the derived difference in horizontal distance to the zero elevation position (NAVD88) from the reference monument on the two profiles being compared. Advances seaward are positive and retreats landward are negative. Each number shown below is the average change for all the sites in each county.

**Shoreline Position Shifts Landward (-) or Seaward (+) at the NJ Oceanfront**

**S 14 – F 14    F 14 – S 15    S 15 – F 15    S 14 – F 15**  
**Feet            Feet            Feet            Feet**

<b>Monmouth County</b>	<b>2.31</b>	<b>12.95</b>	<b>-7.31</b>	<b>7.96</b>
<b>Ocean County</b>	<b>7.88</b>	<b>7.42</b>	<b>19.05</b>	<b>34.36</b>
<b>Atlantic County</b>	<b>-3.91</b>	<b>-0.45</b>	<b>-13.28</b>	<b>-29.04</b>
<b>Cape May County</b>	<b>3.74</b>	<b>-13.26</b>	<b>57.16</b>	<b>47.64</b>

Shoreline changes declined dramatically from last reporting due to the completion of most of the large federal projects in 2013. Continuing work in Deal, Elberon and Allenhurst provided an average advance value for Monmouth County during the summer of 2015. Ocean County had the most advance seaward of the shoreline position for naturally occurring reasons. Atlantic County was the most recessionary of the four counties with Cape May County adding a summer into fall advance that was the largest of all intervals for all four counties.

Following the 1992 northeaster, the subsequent survey data supported a 4-year time span for the natural recovery process to restore the amount of sand returning via cross-shore transport by waves to complete the observed rebuilding of the beach berm. Dune damage was frequently restored by municipal efforts with either their front end loading or bulldozing capabilities. The post-storm wave transfer of the offshore storm deposit back toward the beach is far faster than wind transport of sand from the beach into the dunes to replace storm losses in the dunes. The former happens in 4-5 years while depending on the wind for the rebuilding of a dune system of size, uniformity with vegetation takes at least 20 years.

## ACKNOWLEDGEMENTS

*This research was funded by the State of New Jersey Department of Environmental Protection, Division of Construction and Engineering under the Shore Protection legislation authorizing the stable funding of coastal projects (NJ PL 93 Chap 155). This is the final report under contract #4269-15.*

### INTRODUCTION:

The New Jersey Beach Profile Network (NJBPN) project provides local and regional information on coastal zone changes and is designed to document seasonal and storm-related damage assessments of the New Jersey shoreline. Each site has been visited annually in the fall since 1986. Semiannual visits, each spring and fall, began in 1994 following the passage of Public Law 93. The program was expanded to take surveys every spring following the winter northeasters and in the fall following summer beach accretion. In addition, new sites were established in the gaps of coverage and at all adjacent tidal inlet shorelines. The information collected consists of photographs of the beach/dune system at each site, a topographic profile of the dune, beach and seafloor to a minimum depth of 15-18 feet, and field notes on significant geologic changes. Also, construction activity is noted and necessary information regarding quantity and duration of such activity is gathered. The field data are used to generate graphical cross section plots, which can be used for comparison across the width of the active coastal zone. The cross section is also used to calculate sand volume and shoreline position changes. The 2015 report is focused on exactly how and where beach recovery has met expectations and what transpired to exceed expectations in terms of beach width and dune recovery. Continued focus on post-Sandy recovery showed that the hundreds of millions spent by the federal government, augmented by NJ shore protection money and some local enhancements did produce a better set of coastal shore protection conditions than existed prior to Sandy where such restoration work occurred. Recovery rates where no restoration effort was expended are less, arrayed in a pattern related to the general site's sand retention that developed over time. The information is arranged by county and sequential profile site location, and includes the survey cross sections, site photographs, and the description of significant changes. The tables of beach volume and shoreline change data are found after the county site descriptions for Cape May County in the appendix. A summary of each county's coastal zone activities follows the county profile site location diagram at the start of each county discussion. Conclusions on the study interval appear at the end of each county section.

### THE NEW JERSEY COASTAL ZONE:

The northern coast in Monmouth County is considered a headland beach (carved into older geologic sedimentary units that created a sandy beach backed by a bluff of the older sediments) which erodes during serious storm events. Hurricane Sandy produced a marker among the centuries of this sort of erosion which has created two major sand spits, one to the north from Long Branch (Sandy Hook), and the other to the south from Bay Head (Mantoloking to Barnegat Inlet). To the south of Barnegat Inlet, barrier islands compose the remainder of the NJ coastline where individual islands are separated from the mainland by a series of bays and tidal lagoons. The general geomorphological relationship among the coastal features between Sandy Hook and Barnegat Inlet was detailed by Fisher (1968), but the individual barrier islands had a different and unrelated origin as sea level rose and storms, tides and waves winnowed sand from continental shelf deposits forming the barrier island chain south of Barnegat Inlet. Hicks (1953) showed that the dark, denser minerals present in beach sand still had Monmouth County traits on Long Beach Island, but from Little Beach Island south to Cape May City, the sand was finer, with different dark minerals (magnetite/illmenite) from northern beaches (glauconite and garnet).

### STORM RECOVERY AND BEACH PROJECT EFFECTIVENESS:

While a sizable fraction of the sand eroded from the pre-Sandy shoreline was moved offshore into at least 10 feet of water, the rate of return was reassuring that similar results would come to pass similar to the post-1992 northeast storm recovery where 3-5 years after the event, much of the lost sand had returned. The combination of work completed by the US Army Corps and natural events has greatly enhanced the storm-damaged beaches.



# New Jersey Beach Profile Network

## Monmouth County

Raritan Bay and Sandy Hook  
to Manasquan Inlet

**NJBPN Profile #'s  
187 - 256**

# New Jersey Beach Profile Network Monmouth County Site Locations

The NJBPN shoreline monitoring sites in Monmouth County extend from three sites along the eastern beaches of the Raritan Bay, to the oceanfront shoreline of Sandy Hook, then south to Manasquan Inlet. Profile sites are located in: Cliffwood Beach in Aberdeen Township, the Borough of Union Beach, Port Monmouth in Middletown Township, Gateway National Seashore, the Borough of Sea Bright, the Borough of Monmouth Beach, the City of Long Branch, the Borough of Deal, the Borough of Allenhurst, the City of Asbury Park, Ocean Grove in Neptune Township, the Borough of Bradley Beach, the Borough of Avon-by-the-Sea, the Borough of Belmar, the Borough of Spring Lake, the Borough of Sea Girt, and the Borough of Manasquan. Monmouth County has the greatest number of beach profile sites due to the complexity of its shoreline. A combination of man-made structures, the natural variety of beach widths and distinct erosional and/or accretional areas made careful site selection a necessity. Several sites have been moved slightly as new development on the profile line created problems. The Union Beach site was moved from the original site because the shoreline was completely armored with rock. The new location is in the middle of a State-owned public beach about a quarter-mile away. Site #172 was reestablished north of Lake Tackanassee in southern Long Branch to track sand movement to the south derived from the ACOE project.

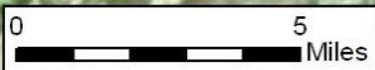


Figure 1. Survey site locations in Monmouth County.

## **Individual Site Descriptions:**

The restoration of the Sea Bright shoreline was essentially complete in 2013. The NY Corps District returned to the original borrow zone offshore to extract sand for the work. Work continued in 2013 and 2014 to finish all segments originally constructed (2.1 million cu. yds. (\$25.6 million) placed between Sea Bright and Monmouth Beach. Long Branch received 3.3 million cu. yds. (\$40.1 million), Asbury Park to Manasquan was enhanced with the placement of 2.3 million cu. yds. (\$43.6 million). During 2015 the final phase of the Monmouth County shore protection project got underway with the placement of sand along the Loch Arbor, Allenhurst and Deal shoreline. Work continues northward into Long Branch through the Elberon section (3.5 miles) leading to Lake Takanassee and the original project beaches beginning at West End Avenue (4.45 million cu. yds., \$38 million dollars). Work is scheduled to be complete with groin modifications plus storm water system changes by 2017 funded under PL 113-2 (Disaster Relief Appropriations Act of 2013)

The beaches along Raritan Bay were badly eroded, but some recovery was documented. The New York District Corps of Engineers (ACOE) undertook multiple efforts in restoration, spending \$36.9 million placing 875,000 cu. yds. of new sand along the Keansburg Raritan Bay shoreline. The Port Monmouth work involved 3,000 feet of shoreline and about a half-million cubic yards of new sand plus a western groin to hold in the sand and a new, longer fishing pier at the Spy House Museum location. In Union Beach, work in the design phases was reevaluated following Sandy via the Limited Re-evaluation Report that is currently underway and being conducted with non-federal partners, NJDEP and Borough of Union Beach, NJ. This project includes levees, floodwalls, tide gates, pump stations, and a dune and beach program. All these efforts are 100% federally funded under Public Law 113-2.

### **Cliffwood Park, Aberdeen; #187**

This is a small county park, established shortly before surveying commenced in 1986. The shoreline faces north, northeast into Raritan Bay and is subject to a significant wave fetch across the bay. Hurricane Sandy transported the entire dune landward into the parking and access areas for the park. Stability returned since the spring of 2014 with small changes to both the sand volume (-1.01 yds<sup>3</sup>/ft.) and shoreline position movements (4.7 feet advance) between spring of 2014 and the fall of 2015. There were no dramatic excursions from either the quantity of sand in the system or the position of the zero elevation in 18 months.

### **Union Beach; #286**

The Union Beach site is now located in the middle of the municipal bathing beach on Raritan Bay. The site was moved to provide more meaningful data on bay beach changes. Hurricane Sandy pushed sand landward beyond the parking lot, but did not severely affect the shoreline position. During 2013, Union Beach funded sand placement from Amboy Aggregates in the amount of 14,000 cubic yards by truck. During the current study interval the site has lost 4.11 yds<sup>3</sup>/ft. in sand volume with an 18-month change of -5.2 feet in the shoreline position. The planning and design effort on the part of the New York District Corps of Engineers would have a far more profound impact on this site than the 2013 sand placement effort.

### **Bay Shore Waterfront Park, Port Monmouth; #185**

The easternmost site along the Monmouth County Raritan Bay shoreline is positioned west of Highlands and Atlantic Highlands at a Monmouth County Park site dedicated to an historic building dating to the revolution. Significant shore rehabilitation work preceded Hurricane Sandy and served to absorb some of the impact. The New York District Corps of Engineers concluded pumping approximately a half-million cubic yards of sand onto 3,000 feet of the Port Monmouth shoreline adding a 150 yds<sup>3</sup>/ft. sand volume addition to the beach. This project includes a new, longer fishing pier and a rock groin on the west end to retain the bulge in the sand

shoreline now present. The 142.11 yds<sup>3</sup>/ft. sand volume reported as a result of the spring 2014 to fall 2014 survey reflects this project. The site has lost 4.79 yds<sup>3</sup>/ft. by spring 2015 and 16.67 yds<sup>3</sup>/ft. by fall 2015. The project shoreline advance of 261 feet saw a 1.7-foot and a 3.7-foot retreat over the next two surveys. This beach is performing very well thus far.

### **Gunnison Beach, Sandy Hook National Seashore; #285**

Gunnison Beach is the northernmost site on Sandy Hook National Seashore, but still a substantial distance south of the tip of Sandy Hook spit, a fact that will be addressed with new profile sites in 2016. Access to the shoreline further north is restricted by limited roads. The summer of 2014 saw a minor sand volume loss that was followed by two seasons of gain yielding a net change of 15.94 yds<sup>3</sup>/ft. The shoreline advanced substantially during the summer of 2015 yielding a net advance of 68.4 feet. This beach has grown wider almost every year since the NY District Corps of Engineers started its massive shore protection project in 1995.

### **Parking Lot E, Sandy Hook National Seashore; #284**

This public bathing beach was selected because it was located in the middle of Sandy Hook and represented both a public use area and an easy access point to conduct surveys. Two of three seasonal surveys produced negative sand volume numbers, but the winter of 2014 – 2015 produced a strong gain of 42.94 yds<sup>3</sup>/ft. The net for the year was 14.59 yds<sup>3</sup>/ft. The shoreline retreated sufficiently during the summer of 2015 to generate a net retreat of 27.4 feet.

### **Highlands Beach, Sandy Hook National Seashore; #184**

This was initially the northern coastal site, but data supported the need to add the two sites on Sandy Hook since it was clear that losses south of #184 were being deposited along the National Seashore beaches. After a summer of 2014 sand volume gain, two successive losses were recorded leaving a net sand volume loss of 29.26 yds<sup>3</sup>/ft. The shoreline position retreated 88.7 feet during the interval.

### **Via Ripa, Sea Bright; #183**

This northern Sea Bright location lies just south of the bridge to Atlantic Highlands across the entrance into the Shrewsbury and Navesink Estuaries. The Army Corps project added 43.1 yds<sup>3</sup>/ft. to the beach producing a shoreline position almost equal to pre-Sandy conditions. During this study interval the beach gained 6.16 yds<sup>3</sup>/ft. as the summer 2015 gain countered the previous two seasons of small losses. The shoreline position advanced a generous 92.3 feet on the back of a 160.2-foot summer of 2015 advance.

### **Shrewsbury Way, Sea Bright; #282**

This site was the only northern Monmouth County site along Phase I Federal project that had exceeded the initial sand volume placed on the beach (116%). The Army Corps project restored sand to the beach, but the shoreline fell 156 feet short of the pre-Sandy conditions as of April 2013. This site continued to gain sand since the Corps project concluded by adding 36.20 yds<sup>3</sup>/ft. with an outstanding 154-foot shoreline advance. This takes the site to a position where the current shoreline lies 96 feet further seaward than prior to Hurricane Sandy. There exists a certain stability to this site that differs from most other Sea Bright locations.

### **Sea Bright Public Beach, Sea Bright; #182**

The next location south was obtained by NJ State purchase 28 years ago and converted into a public bathing area with some off-street parking. There was a modest dune at the toe of the rocks, but the waves ramped up and over the rocks using that sand as a deposit forming the ramp. This beach contained 98% of the initial

Federal project's fill material as of fall 2011. No dune existed other than grass growing at the toe of the rock seawall. As of the fall of 2015, this site had gained just 1.99 yds<sup>3</sup>/ft. accompanied by a 17.7-foot shoreline advance to a condition exceeding the pre-Sandy shoreline and sand volume situation. Those conditions had been exceeded in 2014, so this study interval added to the overall enhancement of this location.

### **Sea Bright Municipal Beach; #181**

The peninsula widens here to include commercial businesses on both sides of Ocean Avenue plus parking for the beach. However, no rock seawall extended across a gap at the municipal beach. The federal project showed dramatically as a 76.32 yds<sup>3</sup>/ft. wedge of sand added to the beach by October 2013 advancing the shoreline 104 feet beyond that present prior to Sandy. During 2014 an additional 25.46 yds<sup>3</sup>/ft. of sand accumulated at the site producing a 12-foot advance seaward of the shoreline. This situation reversed during 2014 to 2015 with a loss of 23.31 yds<sup>3</sup>/ft. and a shoreline retreat of 65.2 feet, which is still ahead of the pre-Sandy shoreline location.

### **Sunset Court, Sea Bright; #180**

The location north of Cottage Road maintained 45% of the initial sand volume placed in 1999. The repeated deposition of maintenance material at Cottage Road moved north through this location. There was no dune, other than grass here and there among the rocks of the seawall. Sand appeared offshore in quantity as material was pumped onto the beach by the Federal project (82.94 yds<sup>3</sup>/ft.). More material was added to the outer beach by October 2013 (39.92 yds<sup>3</sup>/ft.) pushing the shoreline 65 feet further seaward from the March 2013 position. Between spring 2014 and fall 2015 the site lost 22.05 yds<sup>3</sup>/ft. in sand volume with a 82.6-foot shoreline retreat. A steeper beach slope was part of the shoreline adjustment generating the large retreat as contrasted with a modest sand loss.

### **Cottage Road, Monmouth Beach; #179**

The Cottage Road location has been the "Hot Spot" erosion area in an otherwise very successful Federal beach restoration project. Immediately south of this site a massive stone groin was privately built decades ago and acts to restrict sand movement north from the beach fronting a 19<sup>th</sup> Century private beach club. The groin obviously serves its intended purpose, but to the detriment of the Federal beach project's durability just north of the groin. The Cottage Road site commenced losing sand as soon as it was completed. Losses were replaced in 1997, 1999, 2001, and a modest sand volume was added in 2010 from Shrewsbury River dredging. There was only a narrow, dry beach that gets wet to the rocks under normal wave action at high tide. Just prior to Sandy the construction of a 2012 restoration had started here and was moving northward. The post-storm survey in late March 2013 showed even more loss at the low tide line. By October 2013, restoration had occurred where the berm was regenerated at elevation 10.0 feet and extended 500 feet from the seawall at that elevation. The spring to fall 2013 survey comparison found a shoreline advance of 293 feet due to the placement by the ACOE of 201.44 yds<sup>3</sup>/ft. in new sand. During 2014, the site lost 72.41 yds<sup>3</sup>/ft. and the shoreline retreated 133 feet. In the 2014 to 2015 interval the site lost 16.31 yds<sup>3</sup>/ft. net on two of three seasonal profiles with modest sand volume losses. The shoreline retreated three of three seasonal surveys for a total of -49.4 feet. Recent loss rates have been quite low given the site's long term history.

### **Monmouth Beach Club, Monmouth Beach; #178**

The Valentine Street site is located on the premises of the venerable Monmouth Beach Club with the survey starting point in the landward segment of the timber deck overlooking the seawall. Destroyed by the storm, this site has been rebuilt and the sand replaced to the initial federal project specifications. The dimensions of sand placement between March and October of 2013 is an impressive 181.20 yds<sup>3</sup>/ft. with a 231-foot shoreline

advance seaward. Since spring 2014 to fall 2015, the site lost just 1.30 yds<sup>3</sup>/ft. on single digit seasonal changes accompanied by a shoreline advance of 34.8 feet. This site lies within the up-drift depositional shadow cast by the rock groin causing grief at Site #179.

#### **Ocean Avenue Long Branch; #177**

This site was once a USO non-commissioned officer's beach recreation area for Fort Monmouth personnel. Presently part of the Seven-Presidents Park system belonging to Monmouth County, this site saw severe erosion during Sandy, followed by further losses offshore as some sand moved landward by March 2013. The federal sand placement project eventually put 123.04 yds<sup>3</sup>/ft. in new sand at the site producing a shoreline advance of 185 feet. Since then the site captured an additional 59.06 yds<sup>3</sup>/ft. as sand has traveled north along the shoreline. The shoreline position advanced 98.4 feet over this recent study interval.

#### **Seven Presidents Park, Long Branch; #176**

This site was converted into open parkland space 30 years ago with the purchase of all commercial and private buildings near the waterfront. The area has 25 foot dunes with several prominent gaps to allow public easy access to the beach. The Federal project was completed here in 1999 and 74% of the initial sand placed was still present in October 2011. The restoration effort provided 98.24 yds<sup>3</sup>/ft. and a 131-foot shoreline advance. The most recent study interval saw the gain of 5.51 yds<sup>3</sup>/ft. in small increments combined to produce a 25.7-foot shoreline position retreat landward. The losses occurred between spring 2014 and 2015 with an advance cancelling half the two retreat episodes with a summer 2015 advance of 25.9 feet.

#### **Broadway Avenue, Long Branch; #175**

Here the Corps project beach was at 79% of the as-built sand volume in the fall of 2011. The storm transferred sand offshore between the early October 2012 and March 2013 surveys with 22.72 yds<sup>3</sup>/ft. deposited on the beach from a loss seen offshore of 28.68 yds<sup>3</sup>/ft. by the time of the October 2013 survey. The ACOE provided 95.55 yds<sup>3</sup>/ft. in new sand causing a 103-foot shoreline advance here. Since then the beach lost 8.99 yds<sup>3</sup>/ft. in modest increments. The shoreline retreated 11.8 feet following a summer retreat (80.9 feet) offsetting a winter advance (71.4 feet). The loss was relatively modest leaving a healthy beach at this site.

#### **Morris Avenue, Long Branch; #174**

This site is positioned along the old Long Branch beachfront along the former Ocean Avenue now reduced to a pedestrian walk. Sandy took the boardwalk away at the top of the bluff above the rock seawall. Since the storm sand moved landward from offshore regenerating the beach to that present just prior to the hurricane. As of the fall 2014 survey it appears as if the City has moved the pedestrian walkway onto the eastern half of the remaining southbound road that once was Ocean Avenue. There has been no attempt to rebuild the boardwalk at the bluff's edge. The ACOE work completed by May 2014 placed 167.25 yds<sup>3</sup>/ft. in new sand at the site and generated a 200-foot shoreline advance as of fall 2014. Since then the site has lost 17.19 yds<sup>3</sup>/ft. with a 18.6-foot shoreline retreat. The changes were relatively small.

#### **West End Avenue, Long Branch; #173**

Located near the southern end of Phase I within the NY District Corps of Engineers Monmouth County beach restoration project, this site has a rock revetment protecting the base of the bluff, with the boardwalk positioned at the edge of the bluff some 15 feet above the revetment. In 1999 the initial beach replenishment was completed giving this location a 250-foot wide beach, but no dune was included. This site recovered in a similar pattern to the other Long Branch sites. Surveys prior to the storm were completed in October 2012, so

the spring 2013 coverage shows the extensive beach erosion and the transport of sand offshore. The October 2013 survey shows a relatively complete reversal to the pre-Sandy cross section by a year later. Sand did not return to the upper bluff however, the boardwalk position is gone and a replacement has been located on the old roadway, which was the original southbound roadway of a former four-lane Ocean Avenue along this segment. The ACOE placed 385.38 yds<sup>3</sup>/ft. in new sand that generated a 436-foot shoreline advance at the site as of spring 2014. During the past study interval the location lost during all three seasonal surveys totaling 160.69 yds<sup>3</sup>/ft. or approximately 41.7% of the placed fill. The shoreline retreat amounted to 250.8 feet, 57.5% of the 2014 project advance. The majority of these loss values occurred between spring 2014 and fall 2014 (-99.59 yds<sup>3</sup>/ft.).

### **Lake Takanassee, Long Branch; #272**

This new cross section designed to replace original site #172 abandoned years ago was positioned just south of a series of major condominium complexes between West End Avenue and the Lake. This is the northernmost “estuary lake” along the Monmouth County shoreline and, like the others has a fresh water drainage system constricted at the shoreline by a bay-mouth barrier. It was necessary to relocate the profile to the south, further from the condominium’s parking lot retaining bulkhead, so the post-Sandy cross sections appear to be dramatically different in backshore orientation and elevation. This is real and unavoidable. All changes since the storm were variations in cross shore sediment transfers leading to some beach accumulation as of the fall of 2013. The ACOE did place sand to this point adding 102.66 yds<sup>3</sup>/ft. and a shoreline advance of 79 feet. Since that time the site has lost 28.34 yds<sup>3</sup>/ft. with a 110.6-foot shoreline retreat dominated by the spring to fall survey of 2014.

### **Pullman Avenue, Elberon; #171**

The single cross section located in Elberon at Pullman Avenue demonstrated the susceptibility of even the high bluff located here (28 feet NAVD88) to major erosion from the storm surge and waves generated by Hurricane Sandy. The rock revetment and timber wall account for about 40% of the bluff height and were unaffected. Deposition during Sandy occurred offshore where 24.40 yds<sup>3</sup>/ft. of beach and bluff material was deposited. The scour at the base of the rock revetment protecting this coast was extensive taking sand to -10-foot elevations (as recorded with the Jan 13, 2013 survey 2.5 months later). Since then sand moved back landward, first by the spring 2013 survey back to the pre-Sandy elevations, then by the fall 2013 survey, depositing a dry sand beach over half way up the revetment adding 17.14 yds<sup>3</sup>/ft. of new material and creating the best “beach” ever recorded at this location since 1986. This location is well south of the end point in the Phase I beach restoration, so no project sand moves into the site from either direction. The change since 2014 commenced was a loss of 1.41 yds<sup>3</sup>/ft. and a 33-foot shoreline retreat. Sand moved into this location generating a fall 2014 to 2015 gain of 17.75 yds<sup>3</sup>/ft. and 26.76 yds<sup>3</sup>/ft. for the entire study interval. The shoreline advanced 49 feet generating a dry beach at the rock revetment at an elevation of 8.75 feet. This new deposit was 220 feet wide and unprecedented for this site. The bluff erosion during Sandy seems to be the plausible sand source generating today’s beach.

### **Roosevelt Avenue, Deal #170;**

The Roosevelt Avenue site is located north of the Deal sewage pumping station built in 1906 at the base of the sedimentary bluff. It is essentially a three-story building with just the top story presented at the end of Roosevelt Avenue. South of this street is a series of private homes built on the bluff with a decent sand beach seaward of the dune-mantled bluff edge. North of Roosevelt Avenue there is essentially no dry beach between closely-spaced groins. Site #170 has a 26-year history of a wet beach against the rocks. Occasional offshore

bars have migrated to the shoreline yielding a temporary dry beach less than 25 feet in width. Sandy's waves over-topped the rock wall and scoured deeply into the soil, fill debris (bricks etc.) and bluff sediments. Since Sandy the beach sand excavated at the base of the rock revetment and carried offshore has slowly returned so that the spring 2013 survey found that the sand profile closely matched the pre-Sandy condition. However, more material moved landward so that by October 2013 a dry beach was present at the base of the rocks as sand added to that deposited during the first few months following Hurricane Sandy. This condition slowly deteriorated as sand moved offshore in 2014. The site lost 18.77 yds<sup>3</sup>/ft. and the zero elevation shoreline retreated 54 feet. The beach was still present, but wet at high tide. The sand volume changes during the spring 2014 to fall 2015 were minor (-2.04, +2.73 and +7.50 yds<sup>3</sup>/ft.) totaling 8.44 yds<sup>3</sup>/ft. The shoreline advanced just 0.7 feet over the interval. No Phase III project sand here as yet. The lion's share of the sand volume gain occurred between -5 and -15.5-foot elevations at the outer end of the profile line and potentially derived from littoral movement north offshore from the current project work zone.

### **Southern Deal, Darlington Avenue #169;**

Deal is divided from Allenhurst by a massive boxed pair of groins that retain all sand on the Allenhurst beach, letting none past to the north. The Darlington Avenue site is about a mile north into Deal and was picked because there was a pocket beach centered at Darlington Avenue extending several blocks in either direction. The sediment bluff, once exposed 25 years ago had been armored by individual property owners over time with timber bulkhead "seawalls". The beach varied little over time. The spring 2013 survey shows the upper bluff sediment loss with a post-Sandy beach profile far below that seen in October 2012 just prior to the storm. By the fall 2013 survey approximately half the sand present prior to Sandy had returned from offshore. Another year later the site gained 4.72 yds<sup>3</sup>/ft. and the shoreline moved 4 feet seaward as a modest berm grew on the beach. Individual owners repaired the extensive damage to their bluff protection once again concealing the sedimentary deposits from inspection. This site did gain sand as the federal project got underway with 241.39 yds<sup>3</sup>/ft. added during the spring to fall 2015 interval. The net change was a sand volume gain of 231.44 yds<sup>3</sup>/ft. accompanied by a 350-foot shoreline advance.

### **Allenhurst – Loch Arbor;**

The site #168 at Allenhurst sits on top of an ancient concrete wall that drops vertically to the sand beach. There is a wooden walk elevated above the road just landward of the concrete wall. The boardwalk is 20 feet above sea level, behind a vertical concrete wall located about 100 feet from the low tide line on the beach. There was a recovery berm and offshore bar along the entire segment between the Deal boundary groin and the Deal Lake flume. Loch Arbor has only a two-block shoreline with half a public beach and half in private ownership. There has been a long history of storm waves washing through the private beach club into Deal Lake. This clearly had occurred as the road across the "estuary" lake bay mouth barrier was still closed months after Sandy. Deal Lake is the largest of the now-closed stream estuaries along the Monmouth County shoreline. It has been mapped as open to tidal flow as late as 1880, but closed by 1889. There was no paved road across the bay mouth sand bar until after 1920 according to the earliest aerial photography. There is a sizable weir and boxed flume carrying freshwater seaward to drain the lake. This was still functioning though sand had spilled into the lake at the seaward end. No Federal Project sand was deposited along this short segment, but over the past 13 years material has escaped by the large terminal groin in Asbury Park enhancing this small reach. The April 2013 survey represents a post-Sandy situation with a very narrow beach and deep scour offshore with sand extending beyond the range of these surveys to water 20 feet in depth. The spring 2013 to fall 2013 comparison shows that 46.93 yds<sup>3</sup>/ft. was deposited on the beach to the concrete wall transferring much of that sand back to the beach without any human intervention. The zero elevation shoreline position advanced 106 feet seaward and the October 2013 cross section very closely resembles that present October 5, 2012 (except to the offshore

portion where the pre-Sandy conditions favored shallower water 400 feet seaward of the reference location; -38.64 yds<sup>3</sup>/ft.). Since the fall 2013 survey, the beach has lost 9.20 yds<sup>3</sup>/ft. and the shoreline retreated 57 feet. During the winter of 2014 into spring 2015 the site gained 89.54 yds<sup>3</sup>/ft. as the ACOE project got underway. The shoreline advanced 110 feet at that time. The net changes amounted to an increase in sand volume of 104.09 yds<sup>3</sup>/ft. with a 115-foot shoreline advance.

### **Asbury Park; Sites 267 & 167**

The Federal project beach in Asbury Park had no dune, but the sand was ramped up to the elevation of the boardwalk. The impact of Hurricane Sandy can be seen with a comparison of the fall 2012 survey taken prior to Sandy with the spring 2013 cross section taken in April 2013. The beach at site 267 lost 39.61 yds<sup>3</sup>/ft. while 27.56 yds<sup>3</sup>/ft. were deposited offshore out to 915 feet from the reference. The shoreline retreated 81 feet in the process. By the fall of 2013, the shoreline had advanced 27 feet with 17.79 yds<sup>3</sup>/ft. returned to the beach. The ACOE provided an additional 92.68 yds<sup>3</sup>/ft. generating a 115-foot shoreline advance. Since the site has lost 15.82 yds<sup>3</sup>/ft. as the shoreline retreated 38 feet.

At site #167 on Third Avenue, the same process repeated with a storm loss of 29.66 yds<sup>3</sup>/ft. from the beach, an 84-foot shoreline retreat and sand moved well offshore beyond 17.6-foot depths (NAVD88). By October 2013 26.98 yds<sup>3</sup>/ft. had returned to the beach as 42.62 yds<sup>3</sup>/ft. migrated onshore or to the south from the storm deposits seaward. The shoreline advanced 68 feet. By the fall of 2014 the added sand amounted to 60.39 yds<sup>3</sup>/ft. and the shoreline advanced 35 feet seaward as a result of the ACOE project. Since the beach lost 11.44 yds<sup>3</sup>/ft. in sand volume as the shoreline retreated 28 feet.

### **Ocean Grove, Ocean Pathway, #166;**

Ocean Grove had severe damage to the beach and boardwalk focused to the south of Main Street. At Ocean Pathway the dune remained as did the large, open, but roofed seating area seaward of the boardwalk. The dune remained with the instrument monument about 1.5 feet from the scarp. The pre-Sandy survey shows the beach/dune system just prior to the storm. The April 2013 profile shows a narrow beach, cut dune and a deposit over 2 feet thick for 300 feet offshore (the profile extends to 950 feet to an elevation of -18.98 feet NAVD88). The April survey defined a storm loss of 35.07 yds<sup>3</sup>/ft. on the beach, dune and near shore with 32.64 yds<sup>3</sup>/ft. deposited offshore (94 feet of shoreline retreat). By the fall of 2013 22.65 yds<sup>3</sup>/ft. had recovered on the beach as 28.69 yds<sup>3</sup>/ft. migrated landward (the shoreline advanced 60 feet in the process). The 2014 activity added 35.79 yds<sup>3</sup>/ft. in new sand producing a 13-foot shoreline advance. The 2014 to fall 2015 survey interval added 6.19 yds<sup>3</sup>/ft. as the shoreline retreated 17 feet. The changes were relatively minor since the storm.

### **Bradley Beach, McCabe Avenue, #165;**

The McCabe Avenue site had some damage, but fared better than most locations. The recovery deposit seen in the April 2013 cross section amounted to 7.09 yds<sup>3</sup>/ft. extracted from overwash deposits on the uplands. Following the ACOE work in 2014, the site gained 75.40 yds<sup>3</sup>/ft. and the shoreline advanced 34 feet. Since then the beach gained 3.83 yds<sup>3</sup>/ft. all in small increments plus and minus with a net shoreline change of -2.7 feet.

### **Avon-by-the-Sea, Sylvania Avenue, #164;**

Avon has one site located at Sylvania Avenue where damage to the boardwalk was extensive extending to the structures adjacent to the boardwalk. Sand lost from the beach was carried inland, not deposited in a 2-foot thick wedge offshore. The recovered overwash material was pushed back onto the beach by the June survey

date in 2013 producing most of the recovery evidenced. Little further recovery occurred between June and September 2013. The ACOE effort added 99.16 yds<sup>3</sup>/ft. and a 108-foot shoreline advance seaward. Since then the beach gained sand volume (14.68 yds<sup>3</sup>/ft.) and the shoreline retreated 36 feet.

#### **Belmar; Sites #163 & #162;**

Belmar has two survey sites, one at 18<sup>th</sup> Avenue and the second at 5<sup>th</sup> Avenue near Shark River Inlet. The Belmar beach has a boardwalk between it and Ocean Avenue that suffered damage but was still largely present. Sand was washed into Ocean Avenue during the storm. The erosion is defined by the April 2013 survey data with some deep scour and offshore deposition in evidence at site #163, but there was less scour at site #162 and deposition offshore. Sand recovery was vigorously pursued in moving the overwash deposition back to the beach and appears to have contributed to the overall recovery prior to the ACOE work in 2014. Since the 5<sup>th</sup> Ave. site is extra wide due to the south jetty to Shark River Inlet, the ACOE does not add significant sand to this site. The beach gained just 7.85 yds<sup>3</sup>/ft. in 2014 with the shoreline position moving 4 feet seaward. Since then it gained 24.10 yds<sup>3</sup>/ft. with a 22-foot shoreline advance. The 18<sup>th</sup> Ave. site was augmented by vertical deposition raising the beach berm 2-3 feet across its entire width. The sand volume added was 66.17 yds<sup>3</sup>/ft. producing a 76-foot shoreline advance, which subsequently gained an additional 14.38 yds<sup>3</sup>/ft. and a 24-foot shoreline retreat.

#### **Spring Lake; Brighton Avenue and Salem Avenue, Sites #161 & #160;**

Two cross sections located in Spring Lake showed that the dune, developed decades ago landward of the boardwalk, was also insufficient to protect the town landward of it. The October 2012 survey preceded the storm, so the comparison between that and the April 2013 survey defines the Sandy impacts. Nearshore and beach scour with deposition offshore beyond the limits of surveying occurred both places. -36.15 yds<sup>3</sup>/ft. was lost from the beach and 25.40 yds<sup>3</sup>/ft. gained offshore to a point 857 feet from the reference at an elevation of -16.63 feet (NAVD88). By the end of 2014 the boardwalk was rebuilt on its original concrete supports and the ACOE provided 40.47 yds<sup>3</sup>/ft. in new sand at Brighton Ave. and 32.29 yds<sup>3</sup>/ft. at Salem Ave. Each shoreline position advanced 76 and 42 feet respectively. Brighton Ave. gained 51.67 yds<sup>3</sup>/ft. over the next 18 months as the shoreline advanced 32 feet, while Salem Avenue gained 31.74 yds<sup>3</sup>/ft. and the shoreline advanced 5 feet.

#### **Sea Girt Borough; New York Avenue and Trenton Avenue, Sites #159 & #158;**

Sea Girt is divided into two parts, each with a profile site. The southern site at Trenton Avenue typifies the coastal bluff with major homes and a wide, reasonably high dune landward of the boardwalk that protected the bluff face from erosion and kept the overwash out of the street ends. The New York Avenue site #159, represents northern Sea Girt where a shore-parallel Ocean Avenue allows vehicles to park at the boardwalk with easy public access. Homes exist across Ocean Avenue. Here there were incipient dunes built since Hurricane Irene in 2011, New York Avenue lost 69.52 yds<sup>3</sup>/ft. from the beach and nearshore. By the April 2013 a new dune had been placed on the beach using sand recovered from inland with a wider base, but about the same height. Deposition offshore amounted to 16.36 yds<sup>3</sup>/ft. that was documented 936 feet seaward from the reference monument. Clearly the majority of the sand was further seaward because by September 2013, 39.16 yds<sup>3</sup>/ft. had returned to the beach producing an 86-foot advance in the zero elevation position. During 2014 the ACOE provided 23.81 yds<sup>3</sup>/ft. advancing the shoreline 107 feet as of fall 2014.

A major Wreck Pond project has been implemented at this “estuary lake” entrance located between Spring Lake and Sea Girt with a goal to enhance water quality in the fresh water section of the drainage basin and preserve the incursion of salt water into the “estuary” portion of the water body. This new structure may influence sand

distribution in its vicinity. The last 18 months saw a sand volume loss of 9.65 yds<sup>3</sup>/ft. and a 44-foot shoreline position retreat so no major change has yet been seen.

The Trenton Avenue site saw similar erosion and deposition offshore (-67.07 yds<sup>3</sup> lost from the beach and 44.78 yds<sup>3</sup>/ft. gained offshore) with recovered sand positioned seaward of the boardwalk as a substantial restoration dune. Recovery saw 35.07 yds<sup>3</sup>/ft. added to the beach as sand from offshore moved landward. The shoreline advanced 34 feet seaward in the process. The 2014 effort added 94.20 yds<sup>3</sup>/ft. and pushed the zero elevation shoreline 121 feet further seaward as the shore protection project was restored. Since then the site lost 23.45 yds<sup>3</sup>/ft. while the shoreline retreated 31 feet.

### **Manasquan Borough; Riddle Way and Pompano Avenue, Sites #157 & #256;**

Manasquan is located at the southern limit of the NY District's massive Monmouth County beach restoration project and positioned just north of the Manasquan Inlet. Developed at the turn of the 20<sup>th</sup> Century, many small homes populate the former primary dune between the ocean and First Avenue. Prior to the ACOE project, the Borough had established a small dune system seaward of the paved promenade that is in front of the oceanfront homes. This was primarily in response to the December 1992 northeast storm that last damaged the community.

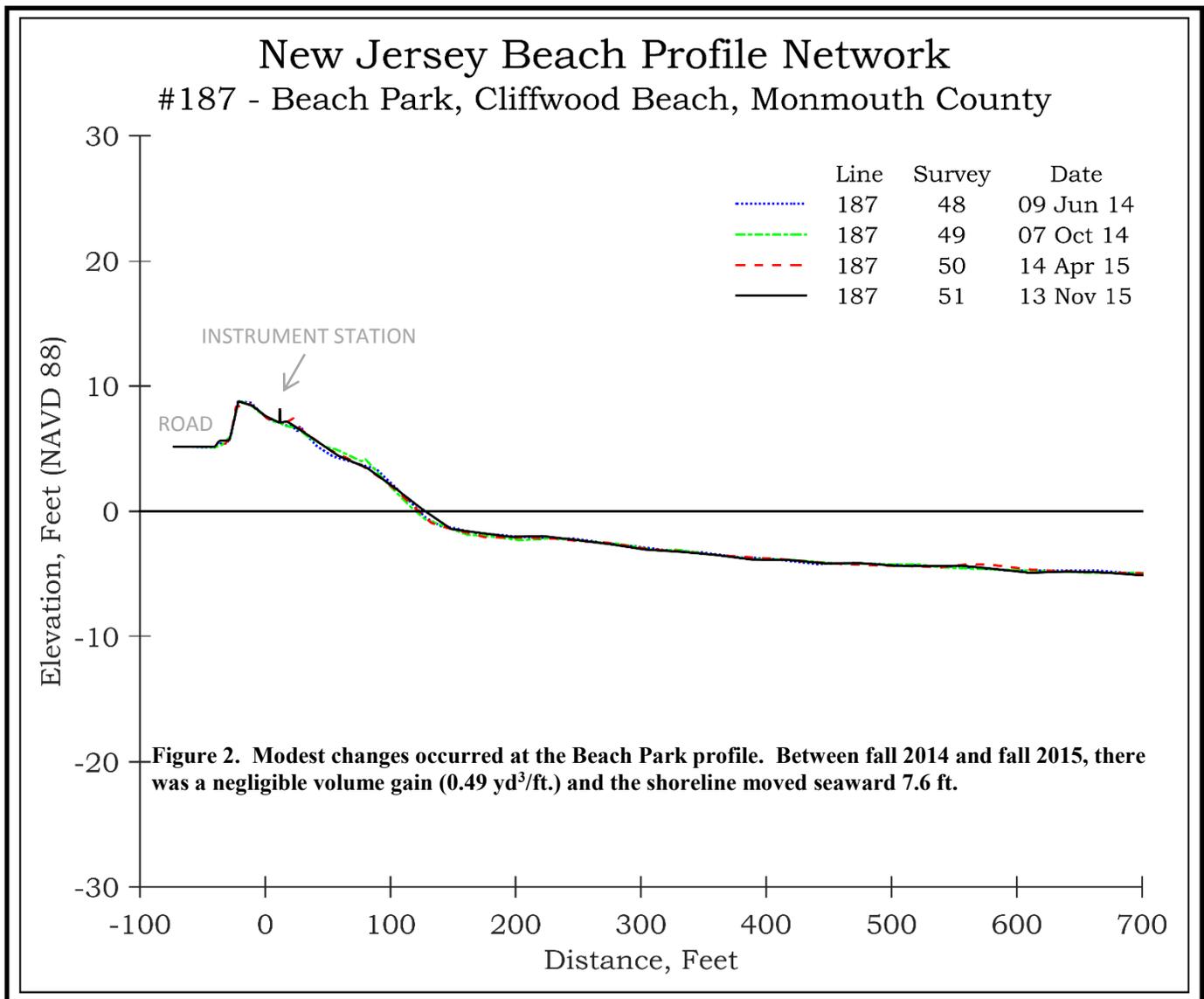
There are two cross sections in Manasquan. Following Sandy, no promenade remained at Pompano Avenue (site #256) with tiny remnant dunes present seaward of the asphalt promenade at Riddle Way (site #157). A ridge of excavated sand had been built along the alignment of the promenade at the south end of the Borough Beach. At Riddle Way the dune was all but removed, but the promenade surface remained intact. The dune provided 11.24 yds<sup>3</sup>/ft. of sand to the beach during the storm, but the beach lost and additional 13.75 yds<sup>3</sup>/ft. as the offshore added 59.07 yds<sup>3</sup>/ft. The shoreline retreated 24 feet. By the fall of 2014 the ACOE had added 94.17 yds<sup>3</sup>/ft. in new sand advancing the shoreline 92 feet seaward. However, there is still only a minimal dune just seaward of a fence line located at the edge of the promenade pavement. This site gained 3.25 yds<sup>3</sup>/ft. with a 19-foot shoreline retreat over the next 18 months all in small survey increments.

At the Pompano Avenue site (#256) the dune was removed as well as the entire promenade with most of the sand transported inland. A huge bar appeared offshore (59.36 yds<sup>3</sup>/ft. deposited). Since April 2013 only 12.80 yds<sup>3</sup>/ft. has returned to the beach, but 32.27 yds<sup>3</sup>/ft. of that deposit has moved elsewhere either landward or toward the Manasquan Inlet. The Army Corps placed 82.26 yds<sup>3</sup>/ft. at this site generating a 113-foot shoreline advance, but there is no significant dune present along the rebuilt promenade. Between spring 2014 and fall 2015 the site gained 14.03 yds<sup>3</sup>/ft. with a 37-foot shoreline retreat. Many of the Monmouth County towns have taken to pushing ridges of sand up as winter approaches generating a "dune ridge" of beach sand about mid-way across the berm width as added storm protection. This ridge appears on the December 2015 profile surveys below in numerous cases.

NJBPN 187 – Beach Park, Cliffwood Beach



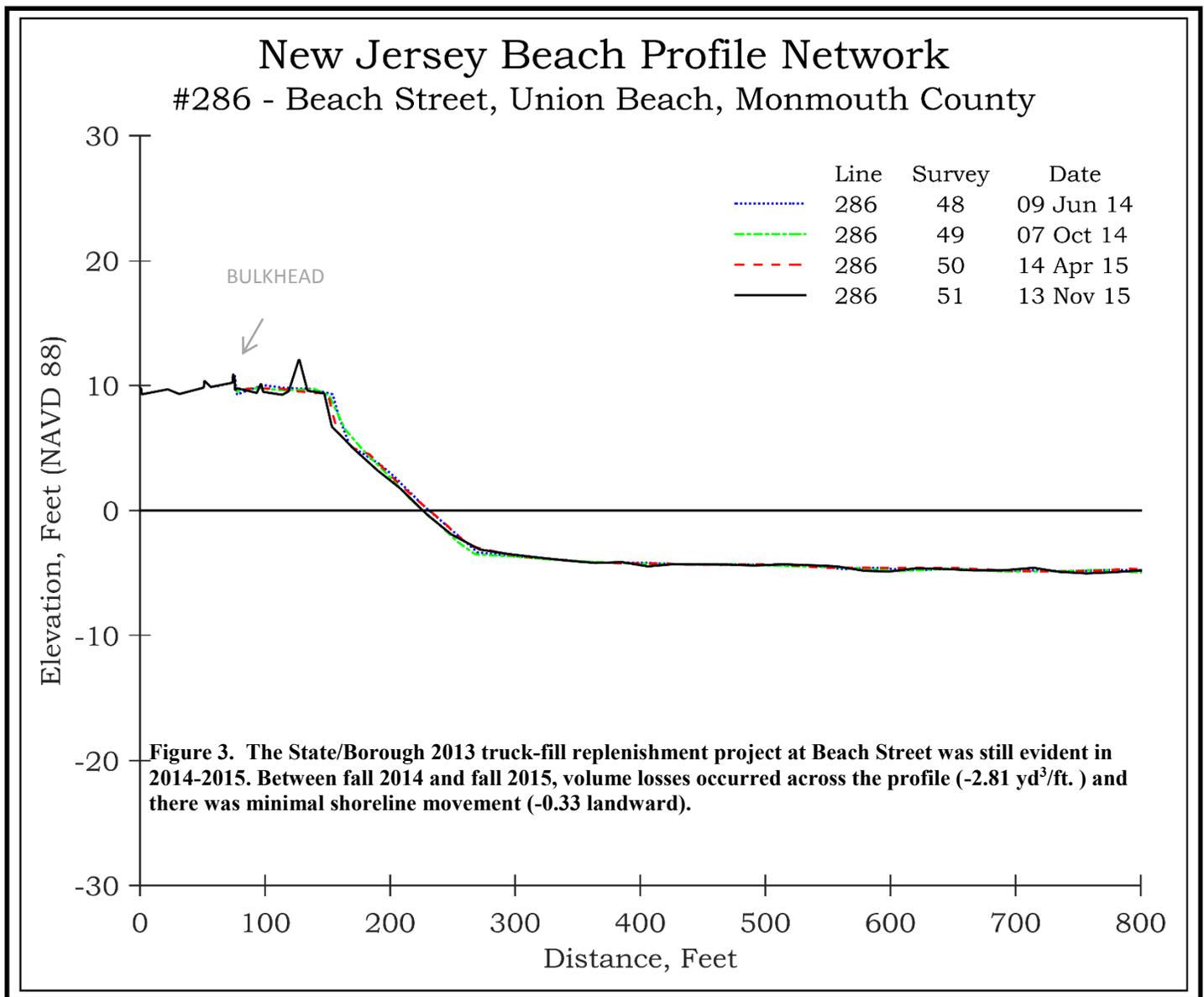
This is the westernmost NJBPN site located on Raritan Bay. The photograph on the left shows the shoreline on October 7, 2014. The photo on the right shows the beach, the transition to the bay floor and a modest dune taken on November 13, 2015.



**NJBPN 286 – Beach Street, Union Beach**

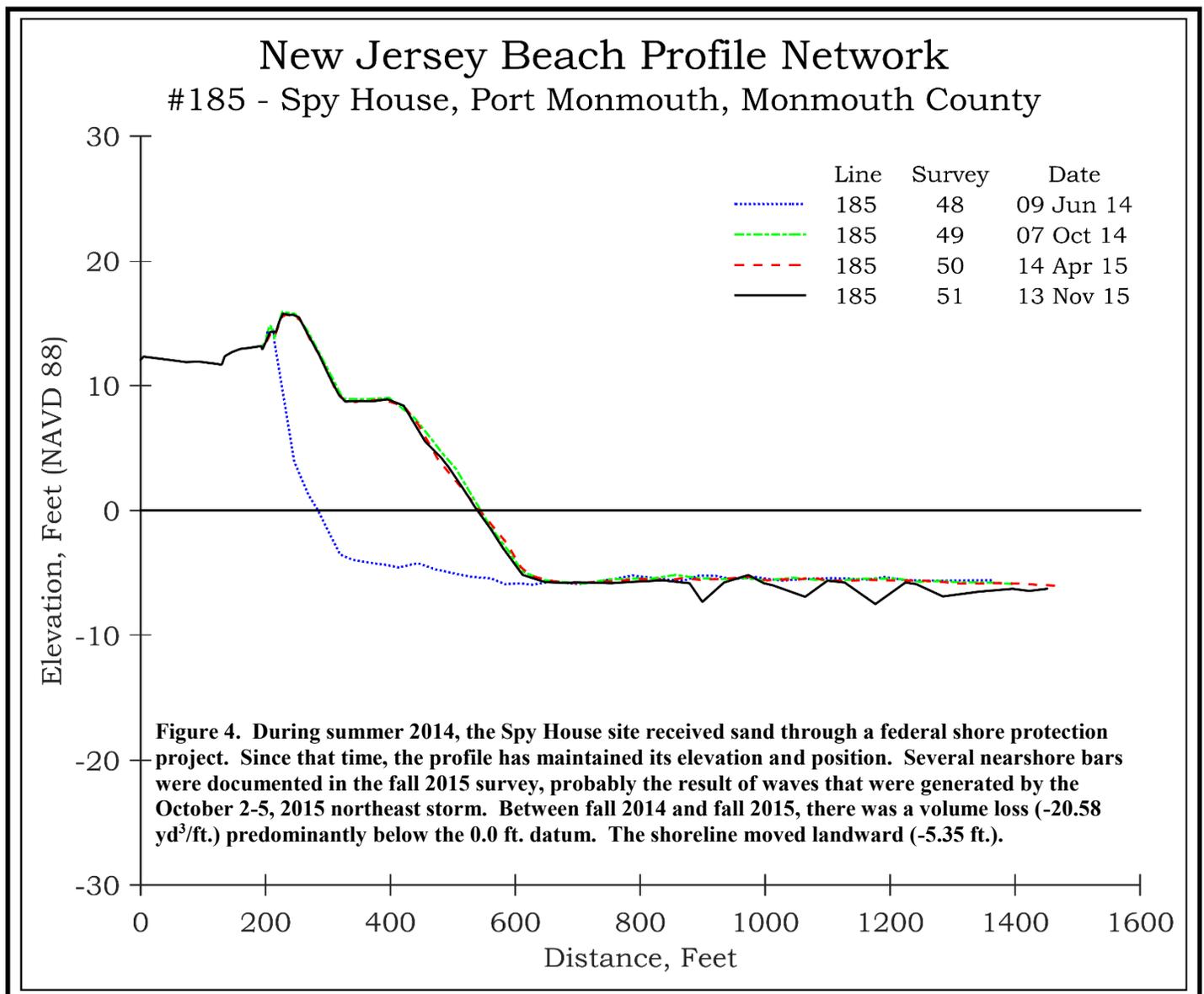


This site was moved to the public bathing beach in 2009. The photograph on the left shows the shoreline on October 7, 2014 following the addition of 14,000 cu. yds. of added sand. The photo on the right shows the adjustment in beach width over a year following the municipality's efforts in replacing lost sand by adding a ridge late in 2015 (taken on November 13, 2015).



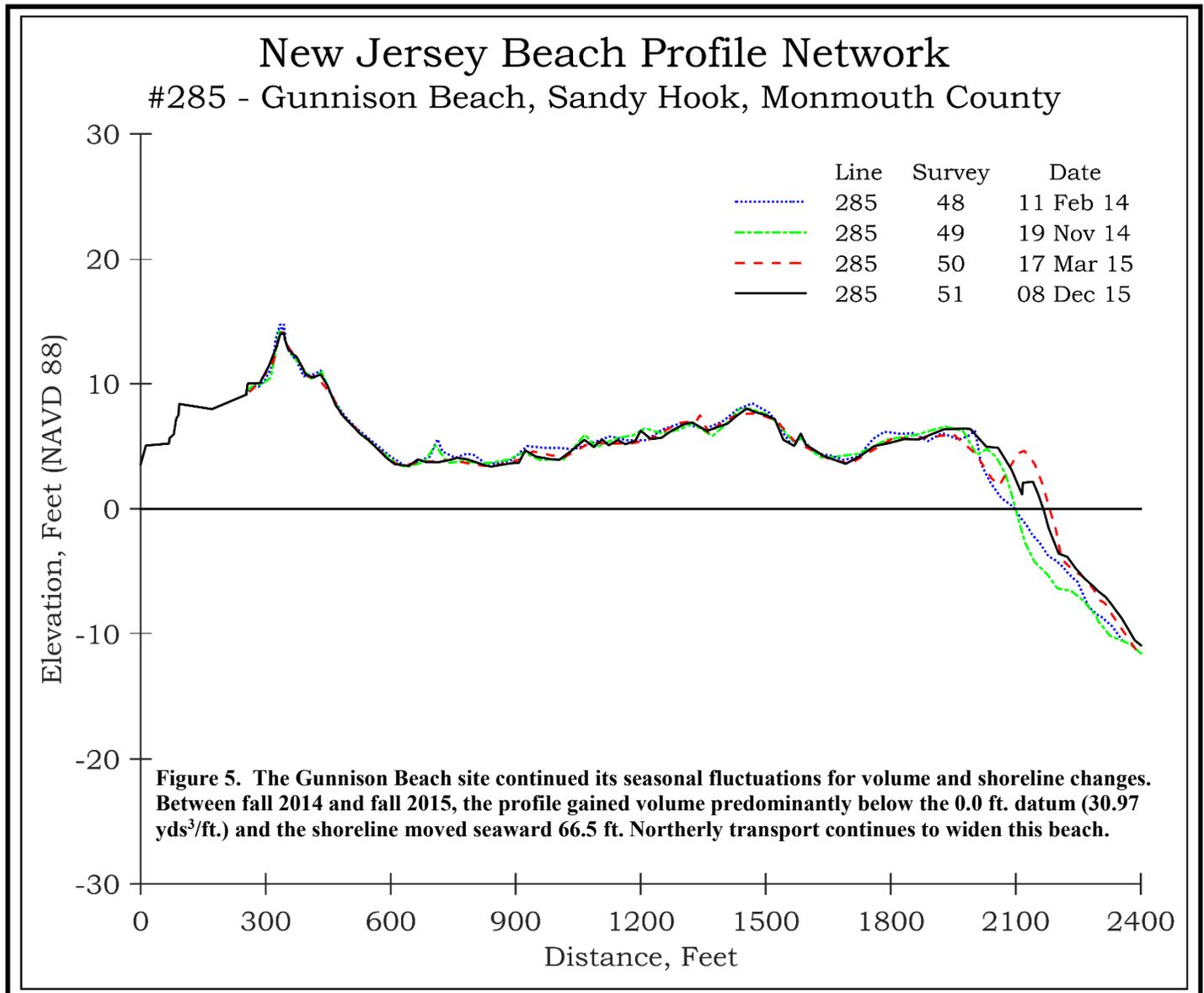


This site was enhanced by adding slope protection to the eroding uplands bluff prior to Sandy. The photograph on the left shows the shoreline on October 7, 2014 following the ACOE project’s completion. The right picture was taken November 13, 2015 where scarping has cut into the “as-built” profile and sand was pushed up to provide storm protection.



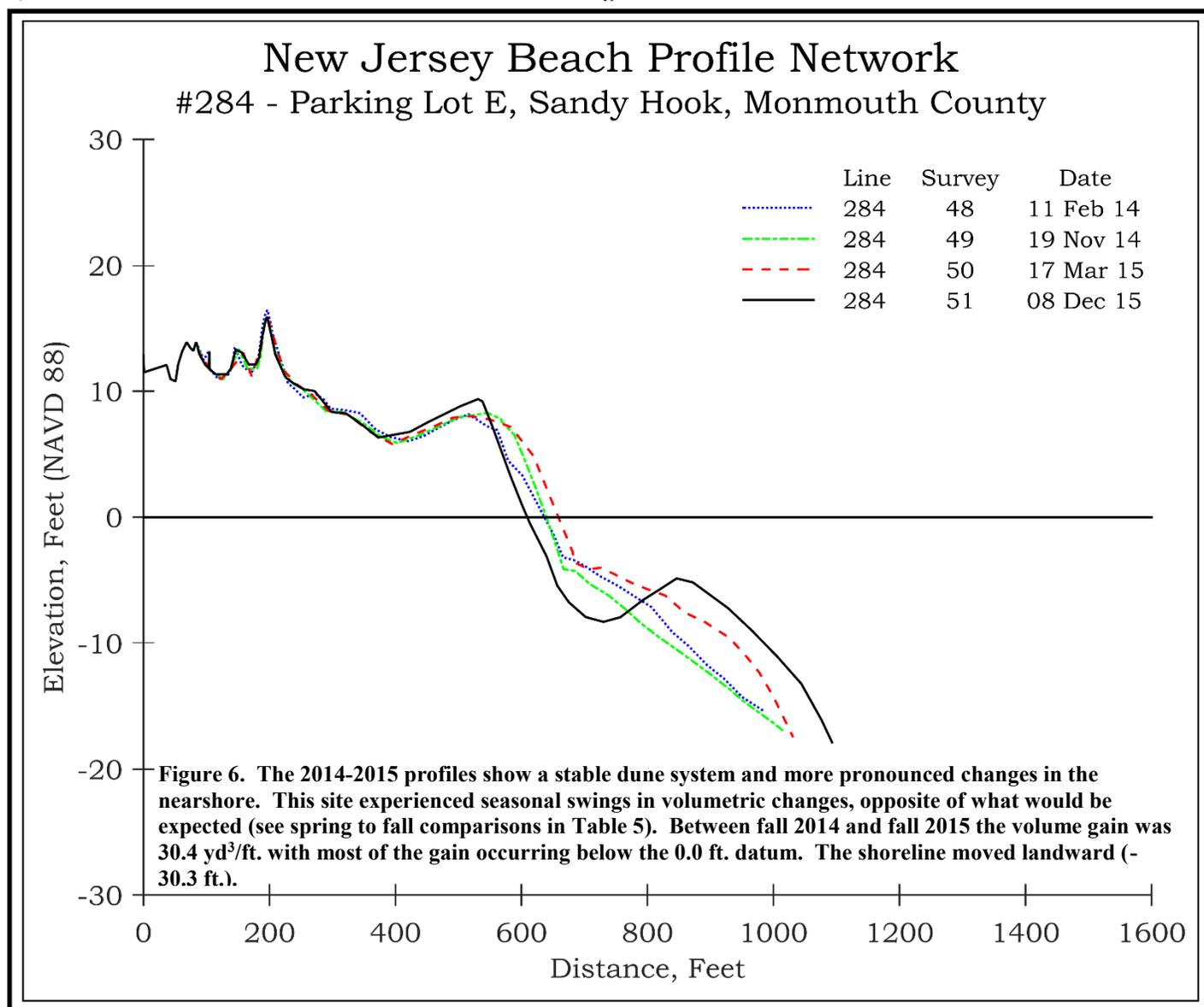


This is the northernmost ocean NJBPN site that has shown advances in the berm position since 1999. The photograph on the left shows the Nov. 19, 2014 beach looking north; on the right is the same view from the toe of the dune Dec. 7, 2015. A single picture cannot grasp the enormity of this section of beach over 1,500 feet in width from the edge of the dune grass.



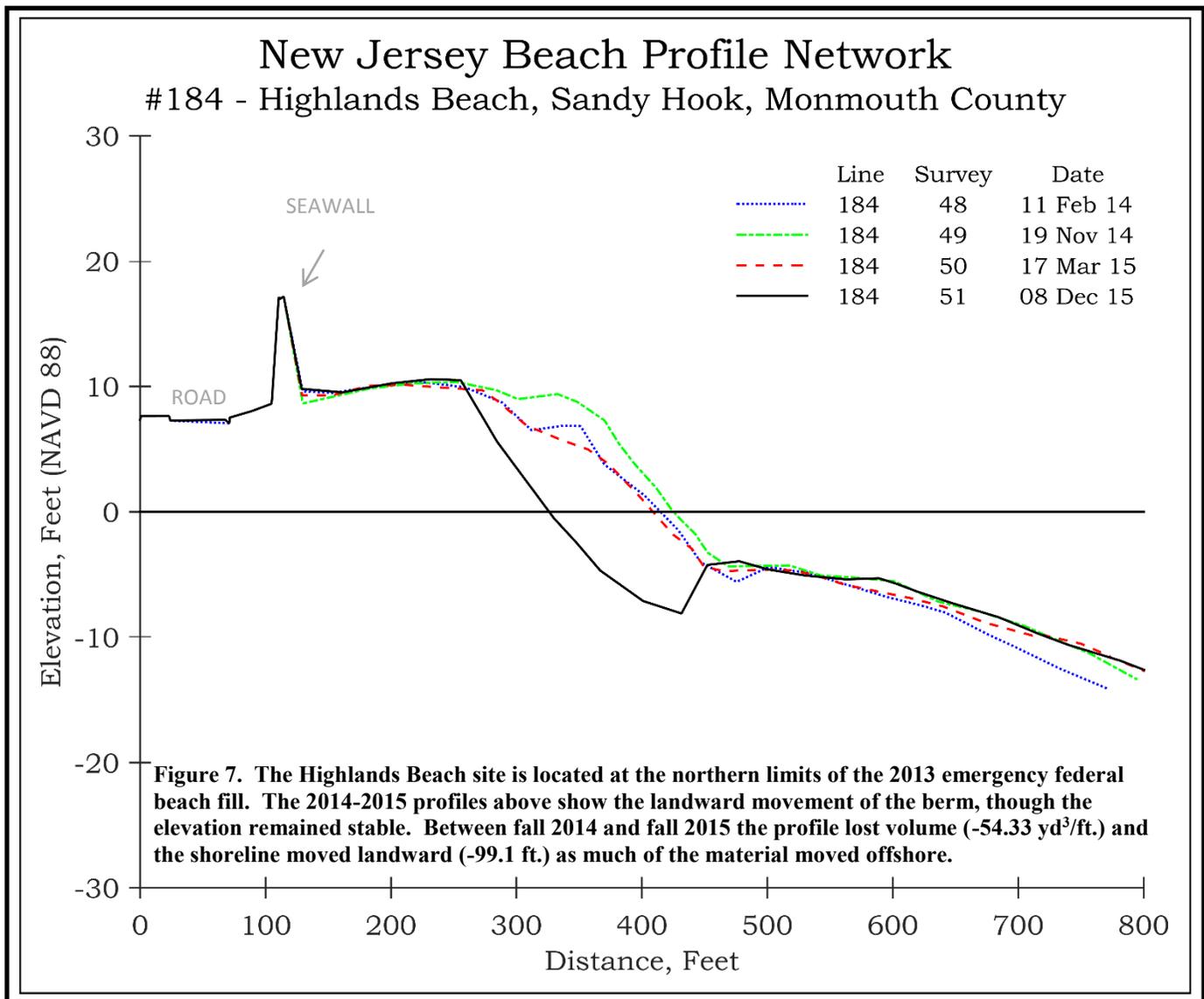


On the left is a beach picture from November 19, 2014 looking north along the shoreline. A different perspective on December 12, 2015 shows the width of the beach from the dune toe looking south from the instrument station.



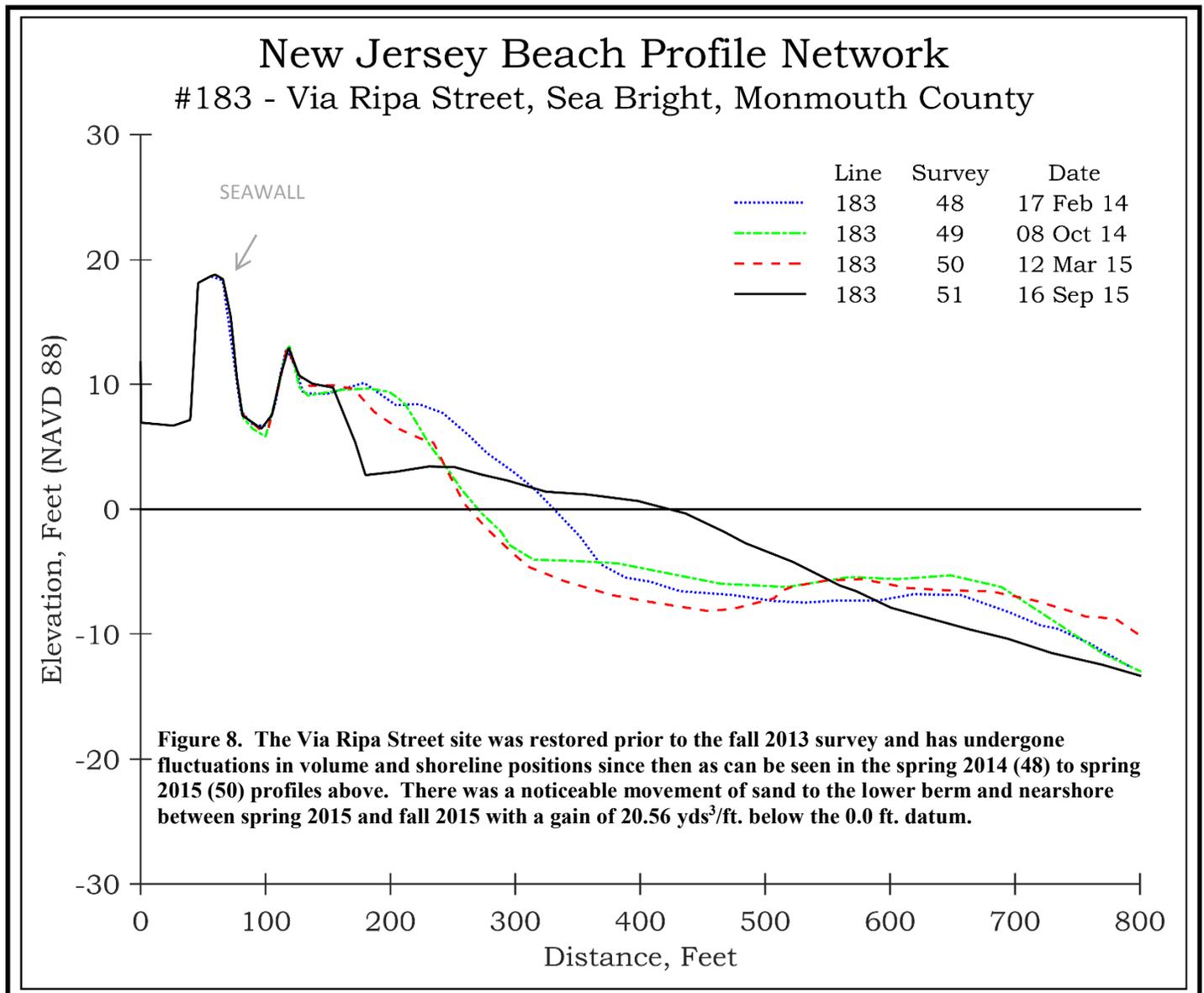


This southern Sandy Hook site is located near the entrance to the park and has gained in volume since the 1995 start of the federal shore protection project. The left view was taken November 19, 2014 after the USACE had returned and placed sand to design template cross section. By December 8, 2015 (following an October event), significant erosion had taken place on the beachface and nearshore regions.



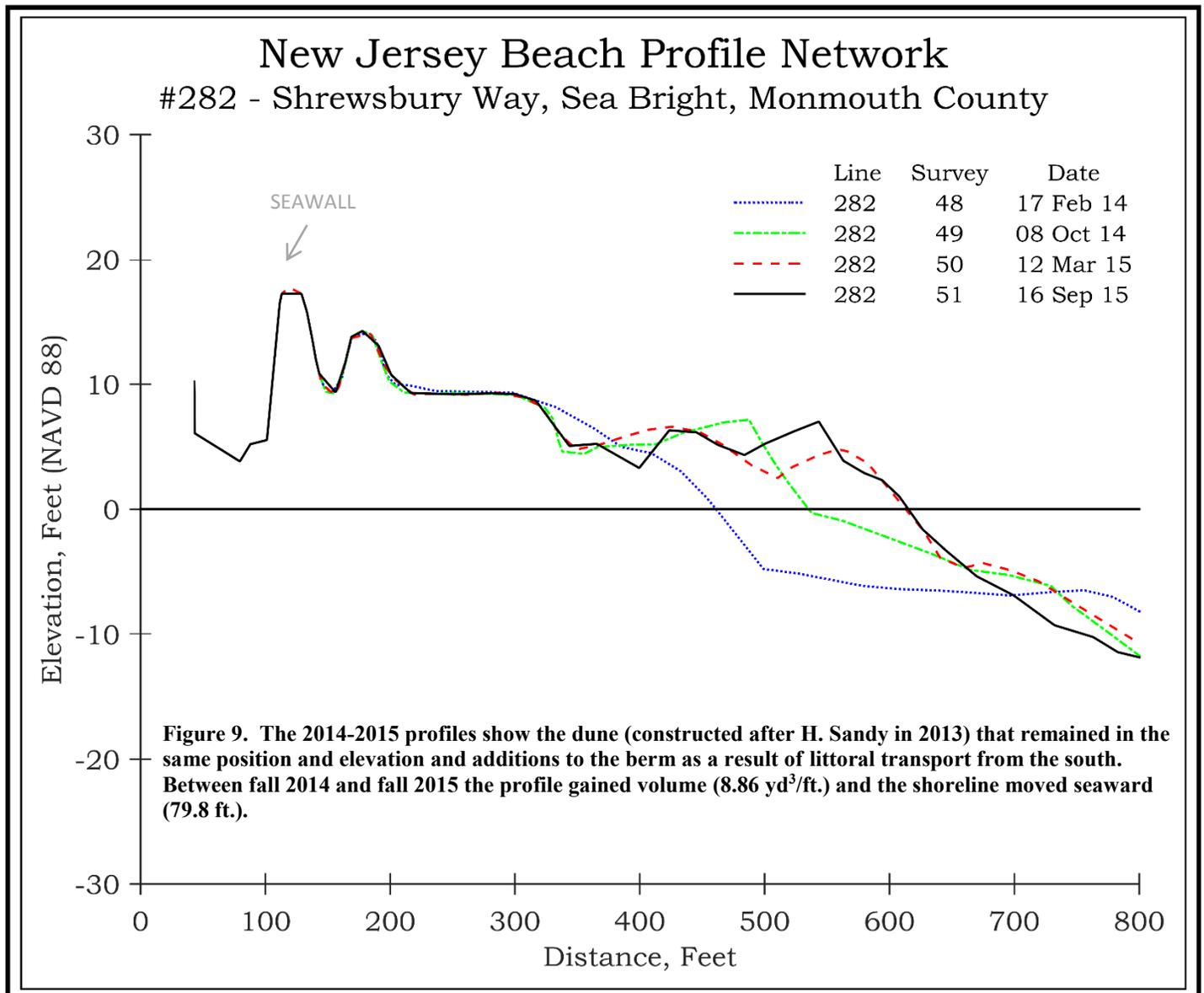


This site is near the northern limit of the initial Federal shore protection. The left side shows the results a year after the placement of 40.12 yds<sup>3</sup>/ft. of new sand and a new dune on the beach by Oct. 8, 2014, while the right side (Sept. 16, 2015) shows how well the dune grass developed and added material to the dune.



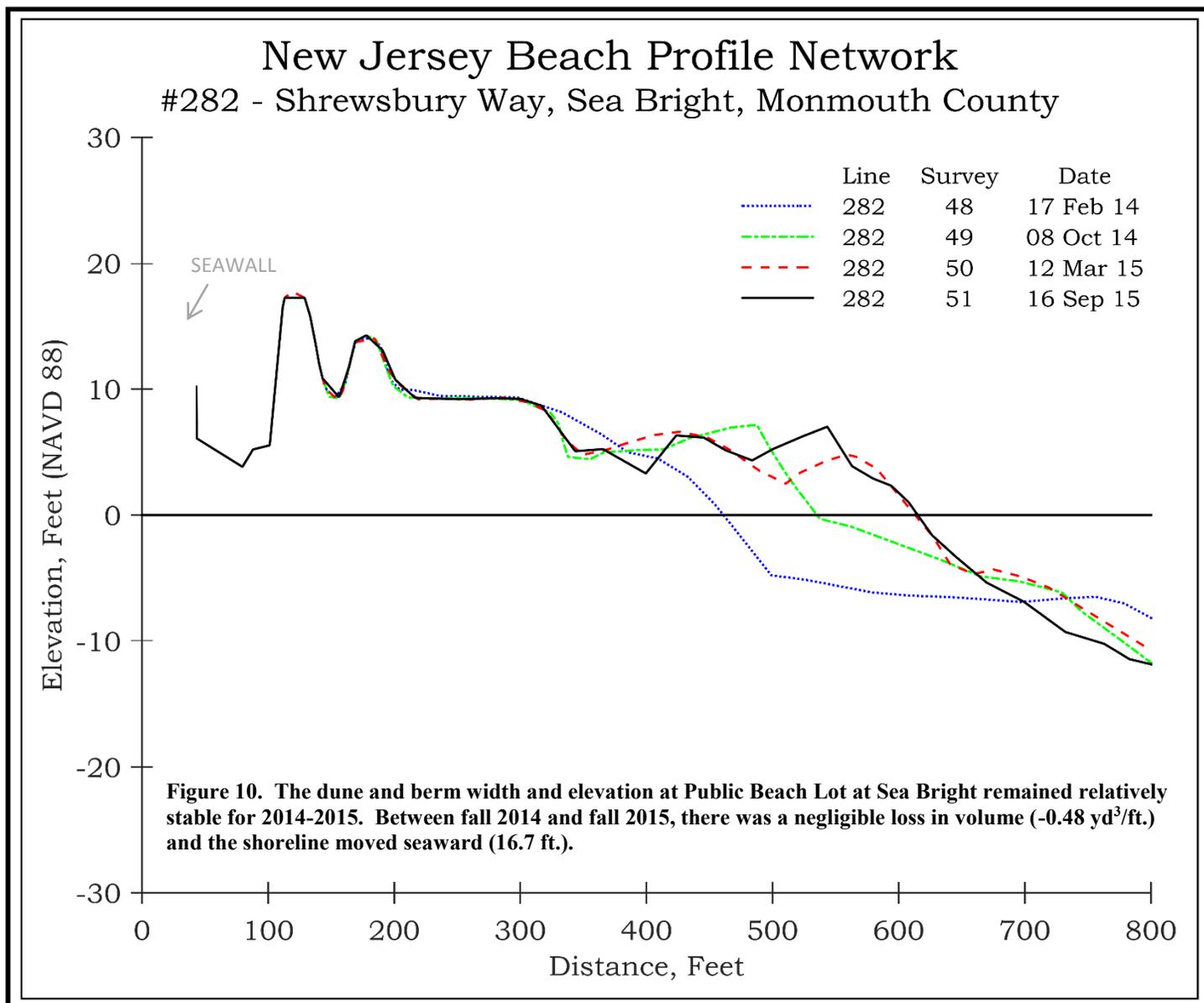


The left view shows the federal restoration project design cross section and the dune that was sand the storm pushed up the seaward face of the seawall was extracted and formed into the dune seen on the left view October 8, 2014. This dune has become well vegetated over the past year (September 16, 2015).





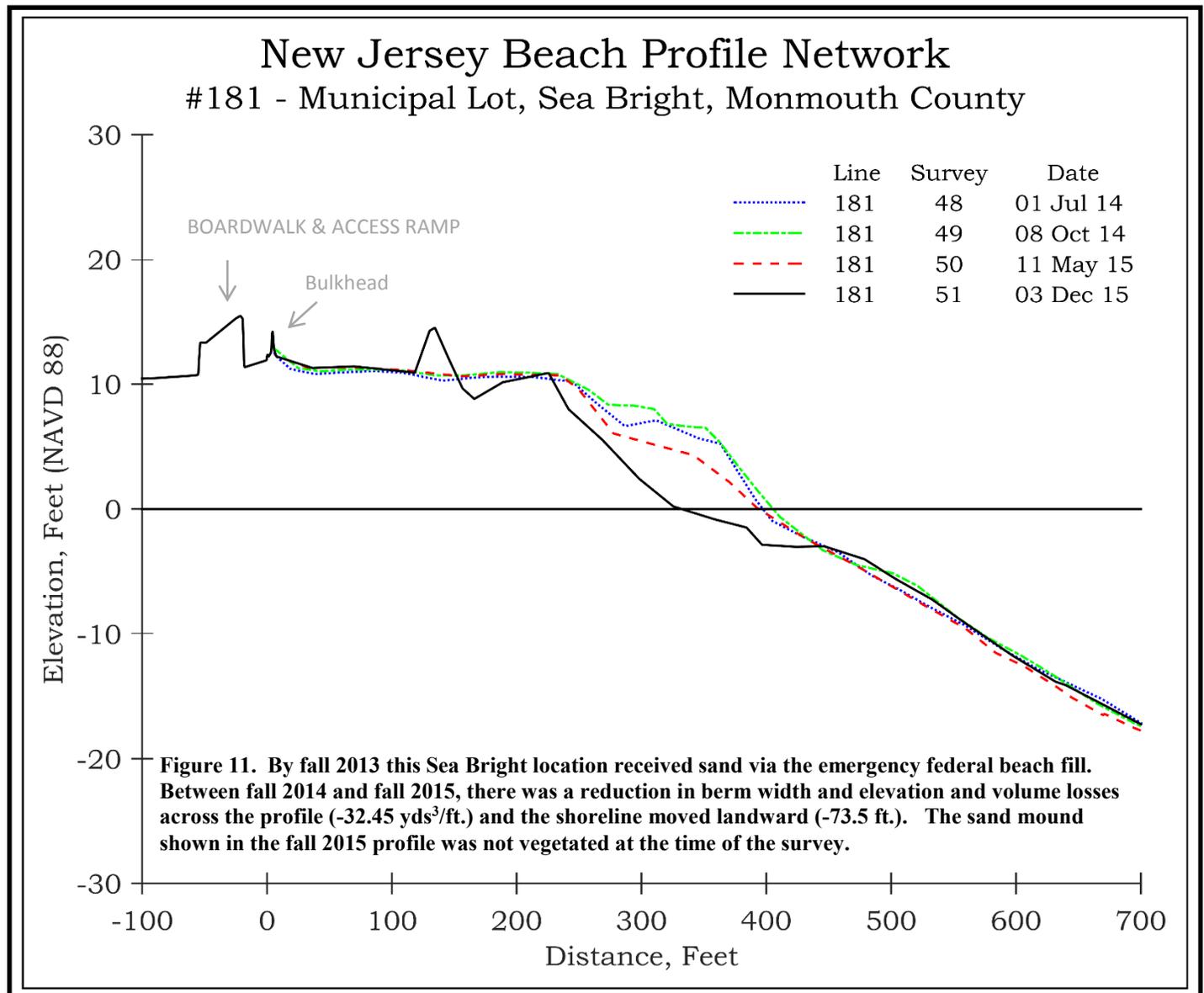
By October 8, 2014 the USACE had restored the beach width and a dune was added from sand extracted from inland and the material ramped up to the rock seawall. The dune developed and by Sept. 16, 2015 was well vegetated with a wide, dry sand beach seaward shown by the view to the north including the fencing that defines the property line.



# NJBPN 181 – Municipal Beach, Sea Bright



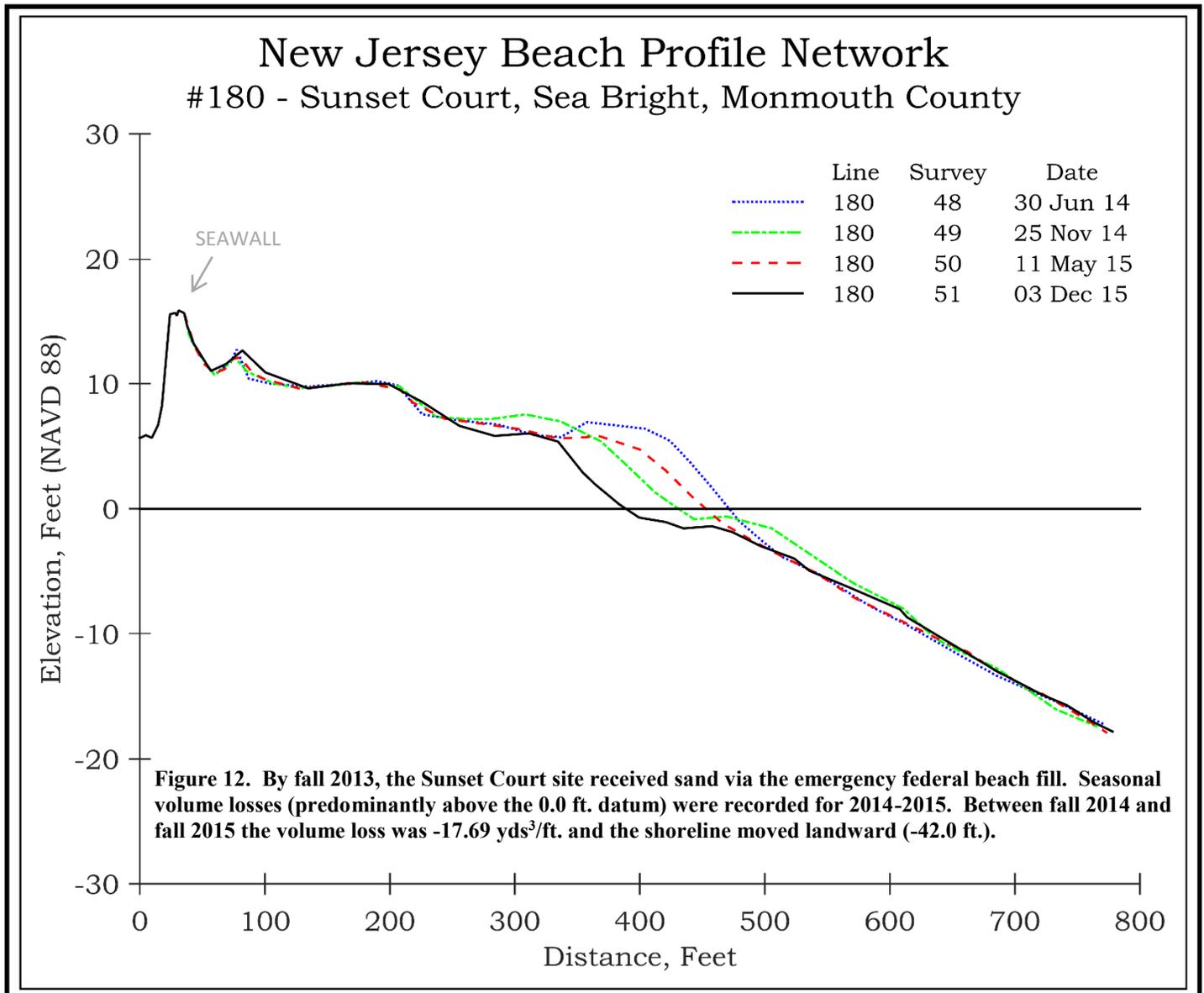
By October 8, 2014 the ACOE had restored the design cross section. The view one year later (Dec. 2, 2015) shows the wide dry beach seaward of the new dunes and the deck and access ramp to the beach.



**NJBPN 180 – Sunset Court, Sea Bright**



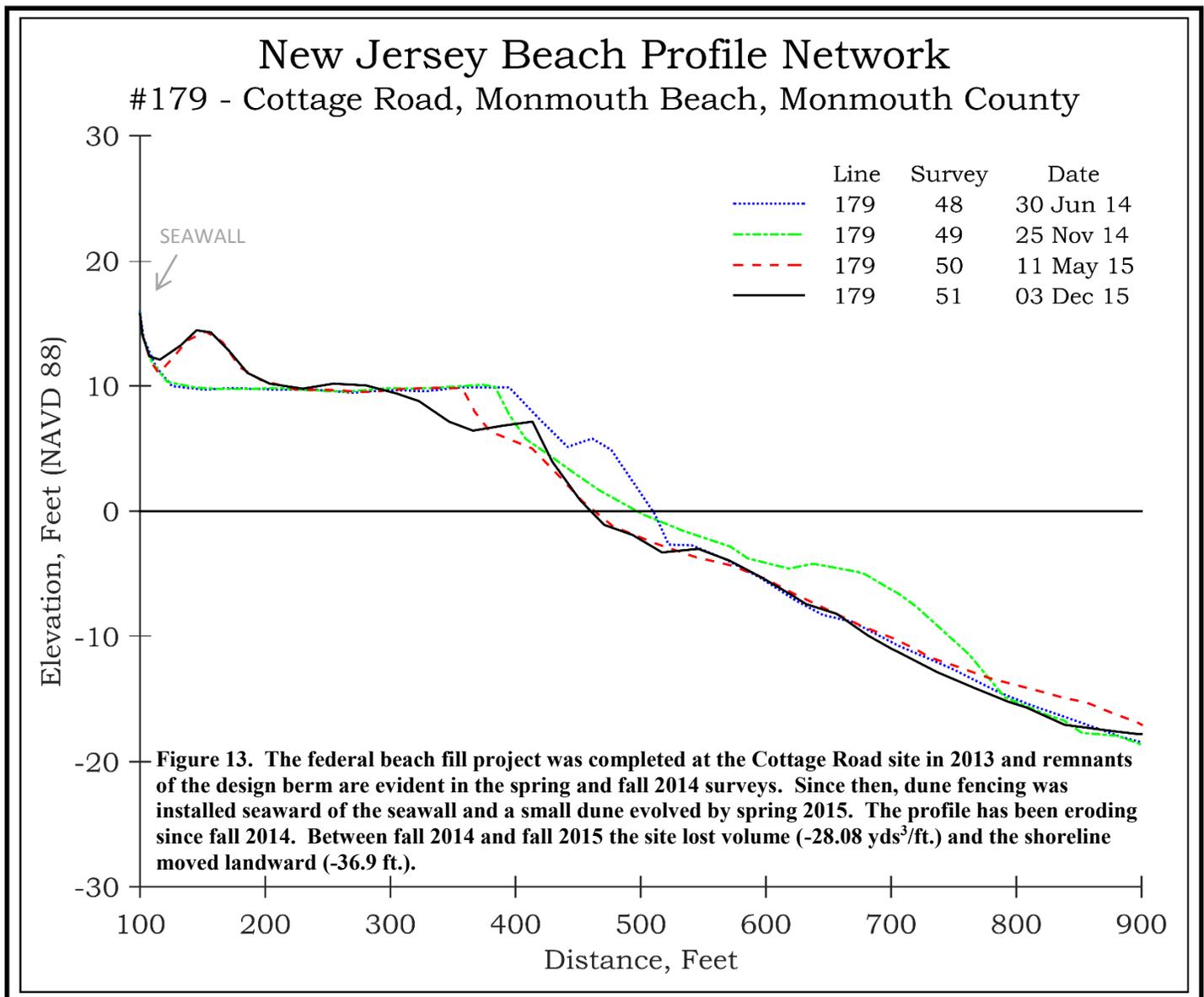
The restoration by the USACE had been completed in the left photo taken November 25, 2014 for a year, with the addition of 101.64 yds<sup>3</sup>/ft. to the profile's cross section. A small dune was added by the summer of 2014 as sand was redistributed somewhat at the water's edge and enhanced by December 24, 2015 with wind transported sand.



NJBPN 179 – Cottage Road, Monmouth Beach



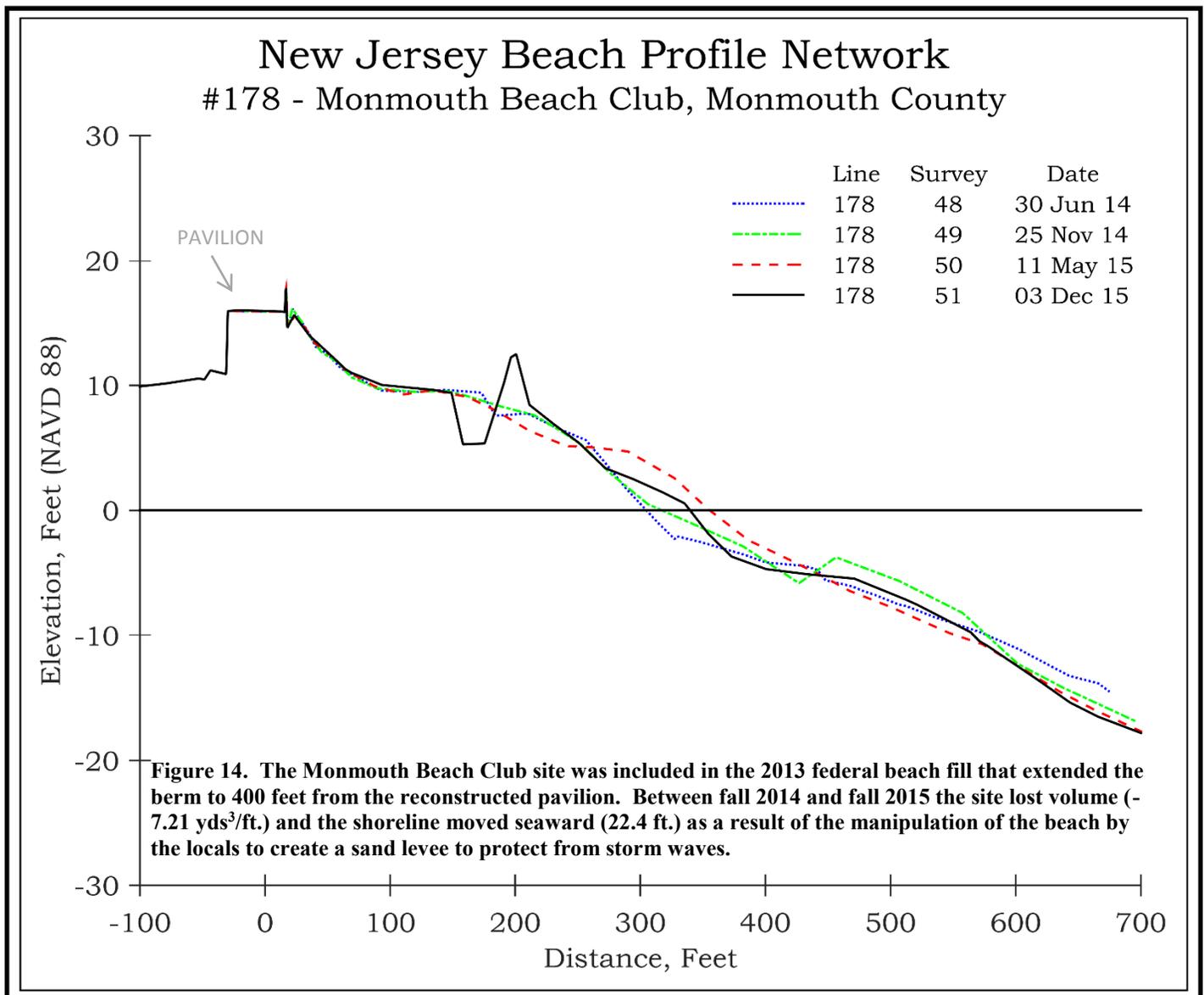
This site has the worst erosion history of any site in Monmouth County. The left photograph Nov. 25, 2014 shows the completed work by the USACE after one year following a 180-foot berm crest retreat. On the right the existing beach has narrowed further with a single straight line of snow fencing in place to start a dune on site as of Dec. 24, 2015.



NJBPN 178 – Monmouth Beach Club, Monmouth Beach

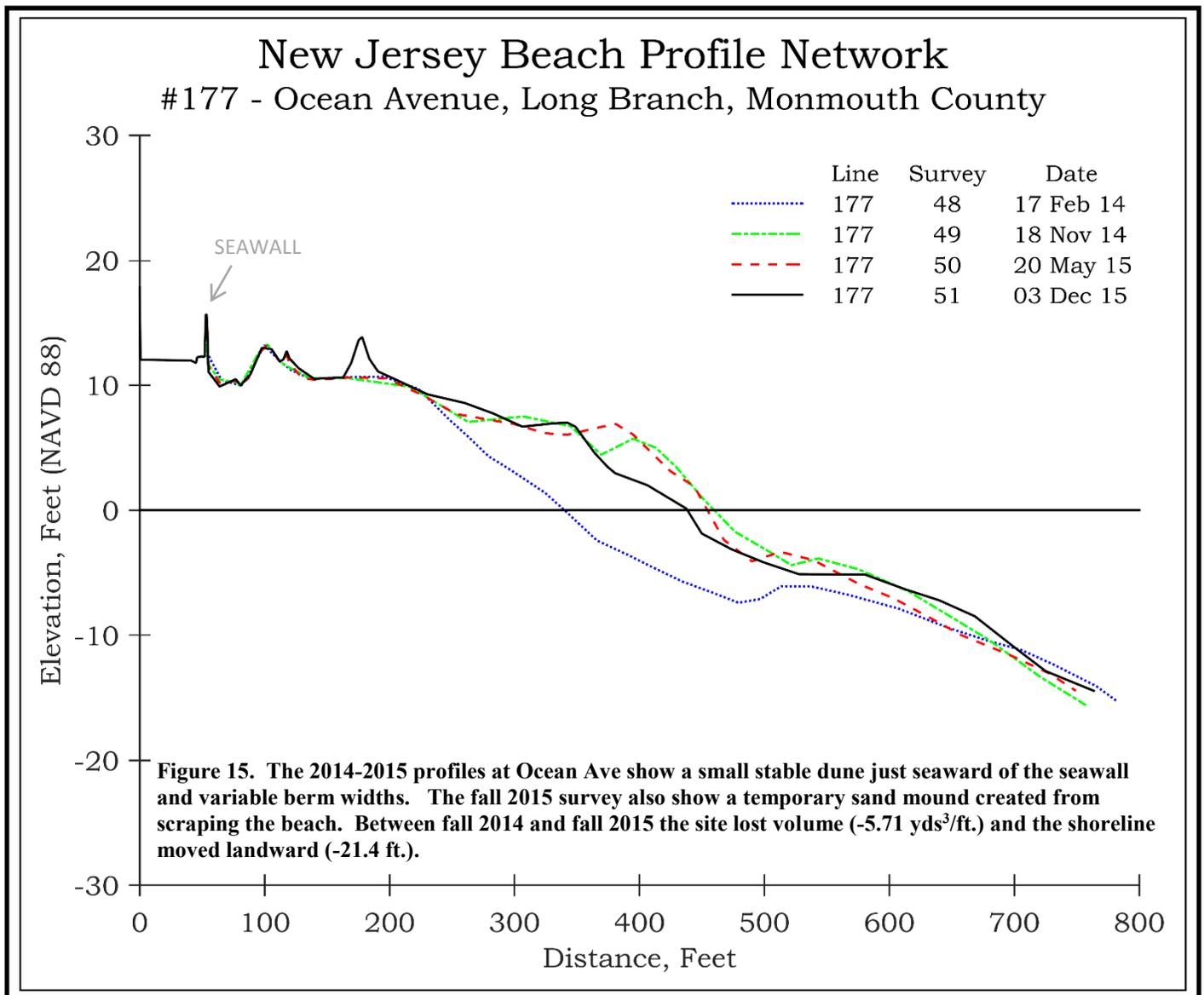


The left photo taken November 25, 2014 shows the results of the USACE work to restore the project to design specifications a year following completion. To the right the beach has narrowed exposing the groin by December 3, 2015.

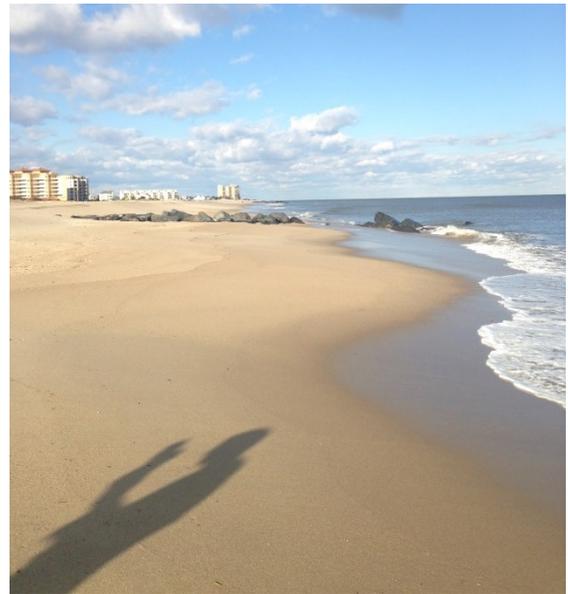




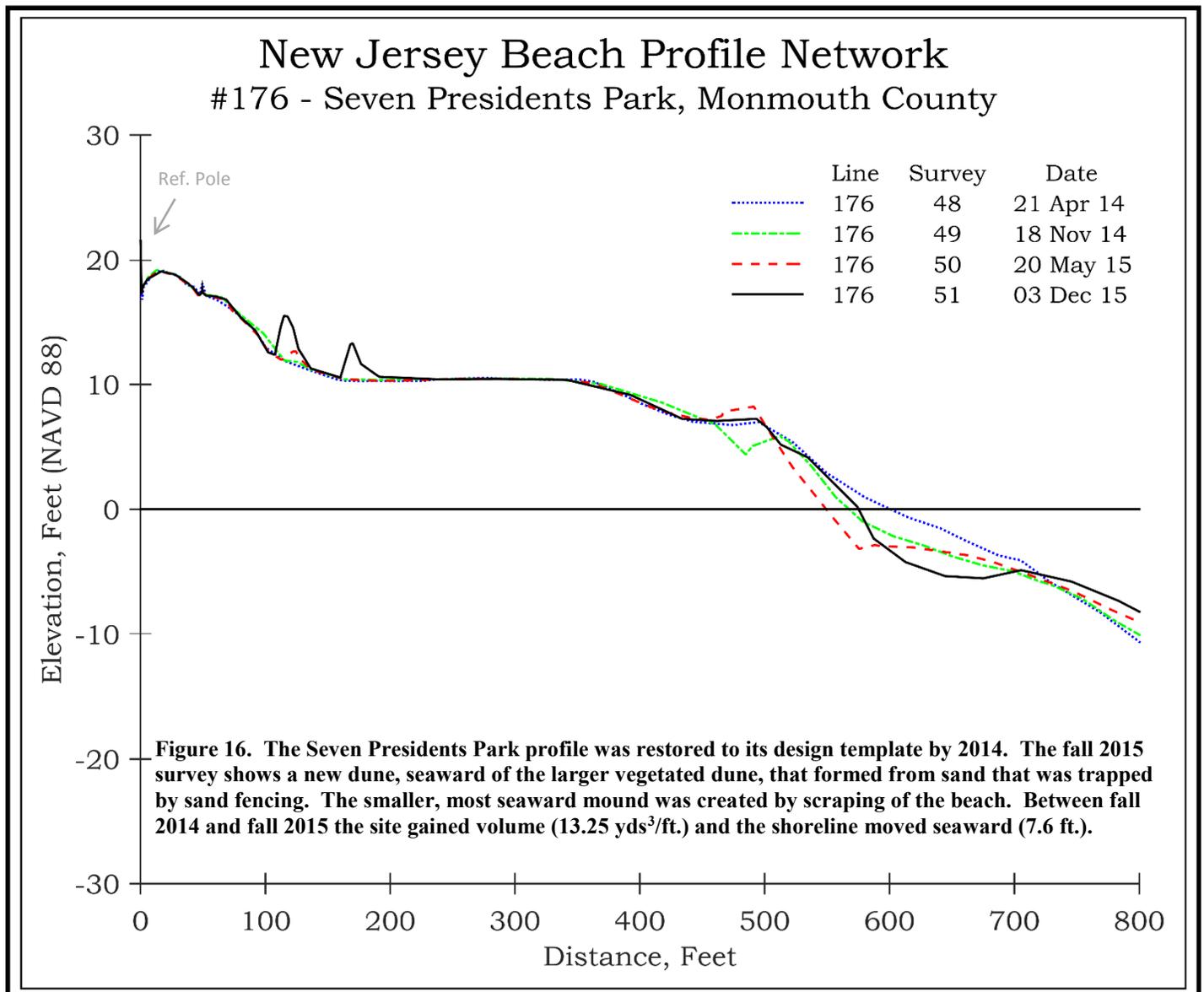
The left photo was taken November 18, 2014 following the addition of 123.04 yds<sup>3</sup>/ft. on the beach after the arrival of the USACE to complete the northern segment of their project. By December 3, 2015 the beach was similar but a little narrower.



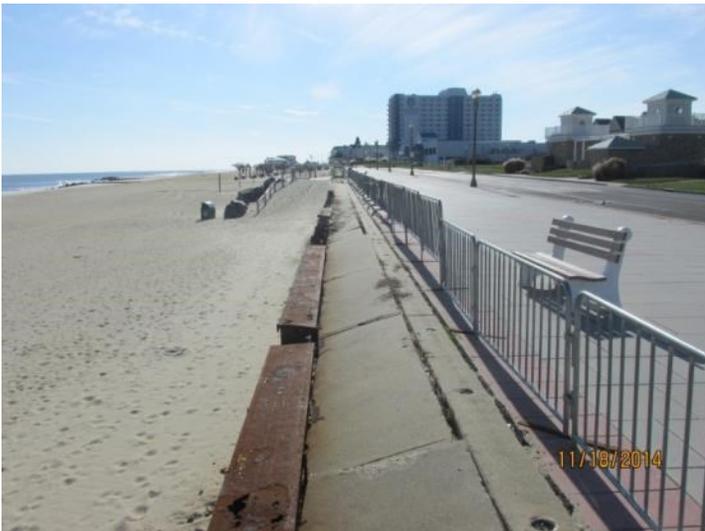
NJBPN 176 – Seven President’s Park, Long Branch



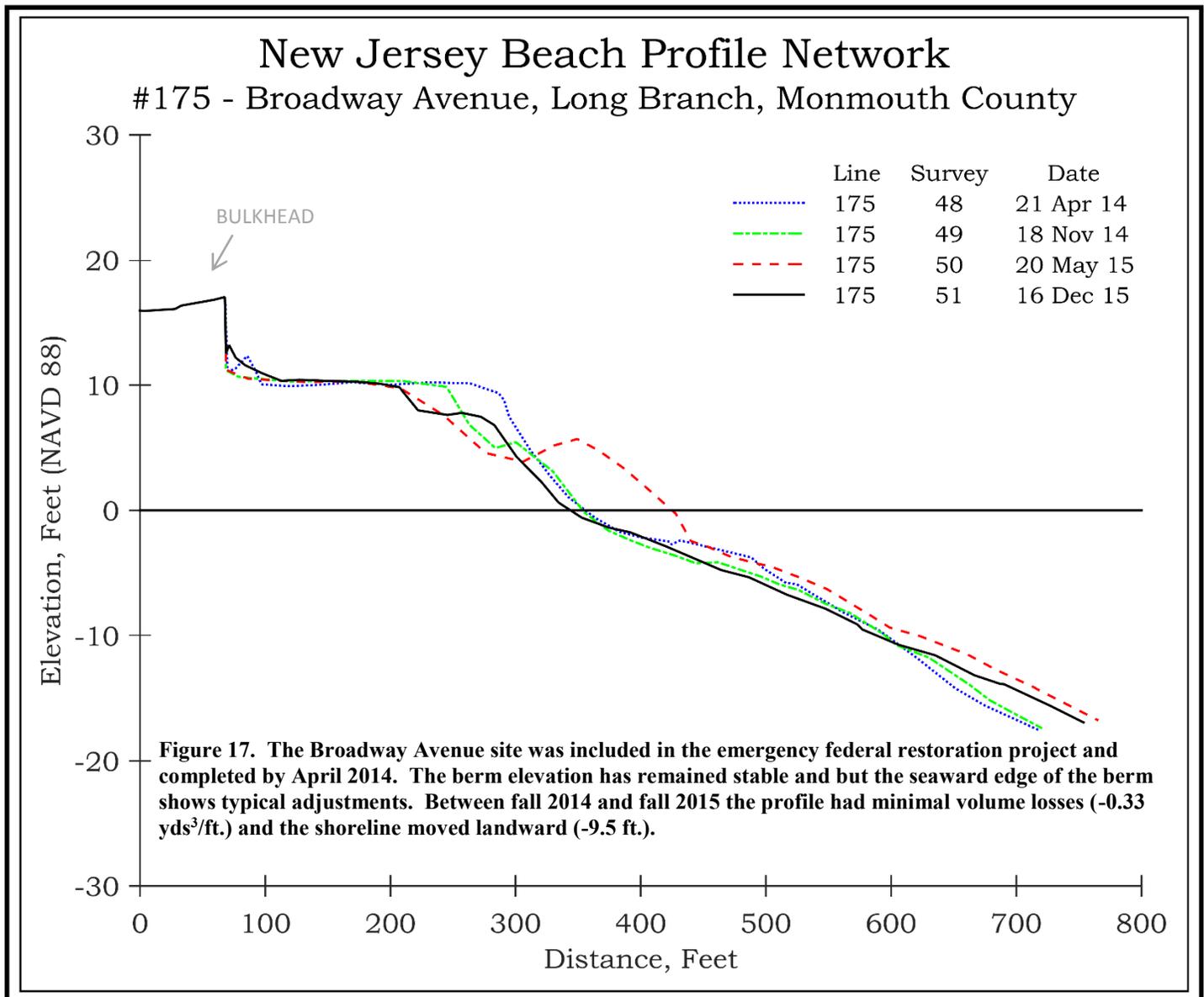
This site is a popular recreational park with a partial ridge of 25-foot elevation dunes. By survey #48, the sand volume increased by 115.73 yds<sup>3</sup>/ft. as a result of ACOE work (November 18, 2014 left photo). The right-hand view shows some shoreline retreat as the rock jetty to the north is re-exposed at low tide (Dec 3, 2015).



NJBPN 175 – Broadway Avenue, Long Branch



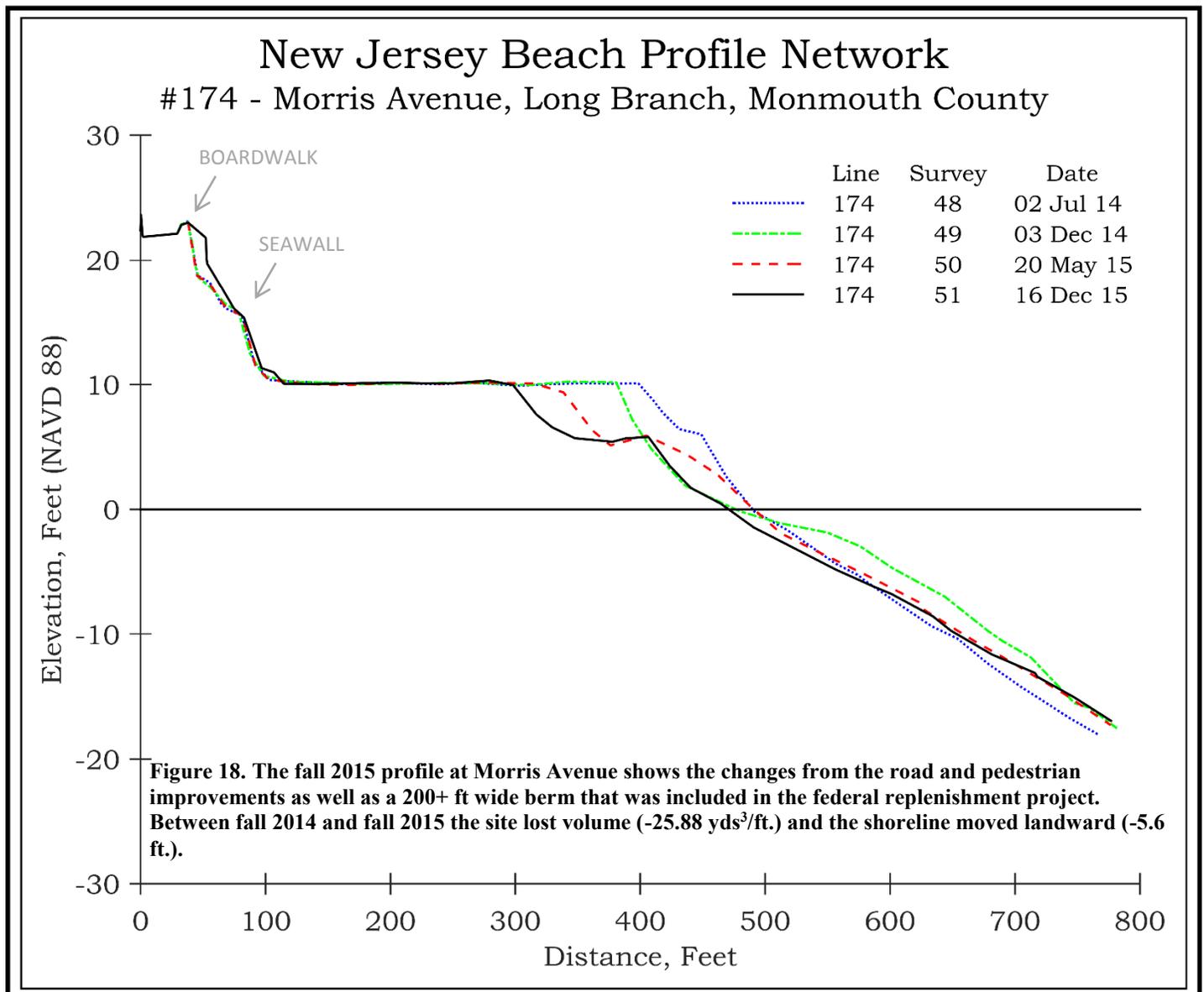
The left photograph taken November 18, 2014 shows the beach six months following the ACOE project completion at this location. By December 15, 2015 the beach is a little narrower, but still wider relative to the rock groins originally exposed following Sandy.



NJBPN 174 – Morris Avenue, Long Branch

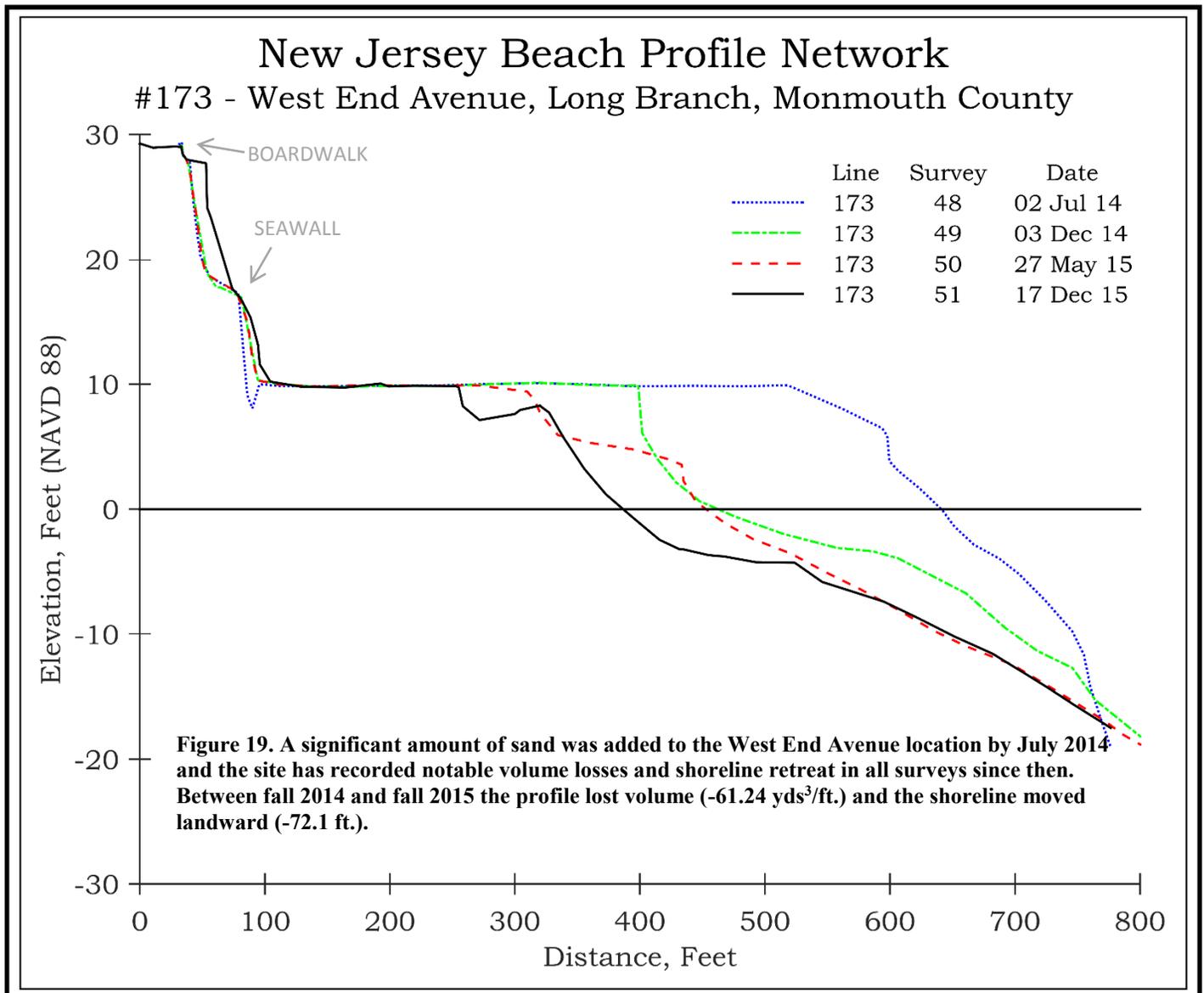


It appears as if the City has moved the pedestrian walking zone onto half the remaining southbound roadway that once existed here as a dual road as Ocean Avenue plus the boardwalk in 1960. The ACOE activity is very evident in the left picture taken December 3, 2014 (complete as of survey #48). By December 16, 2015 a new roadside bulkhead was installed and a graded slope to the rock revetment completed the storm damage repairs. The beach remains in good condition.



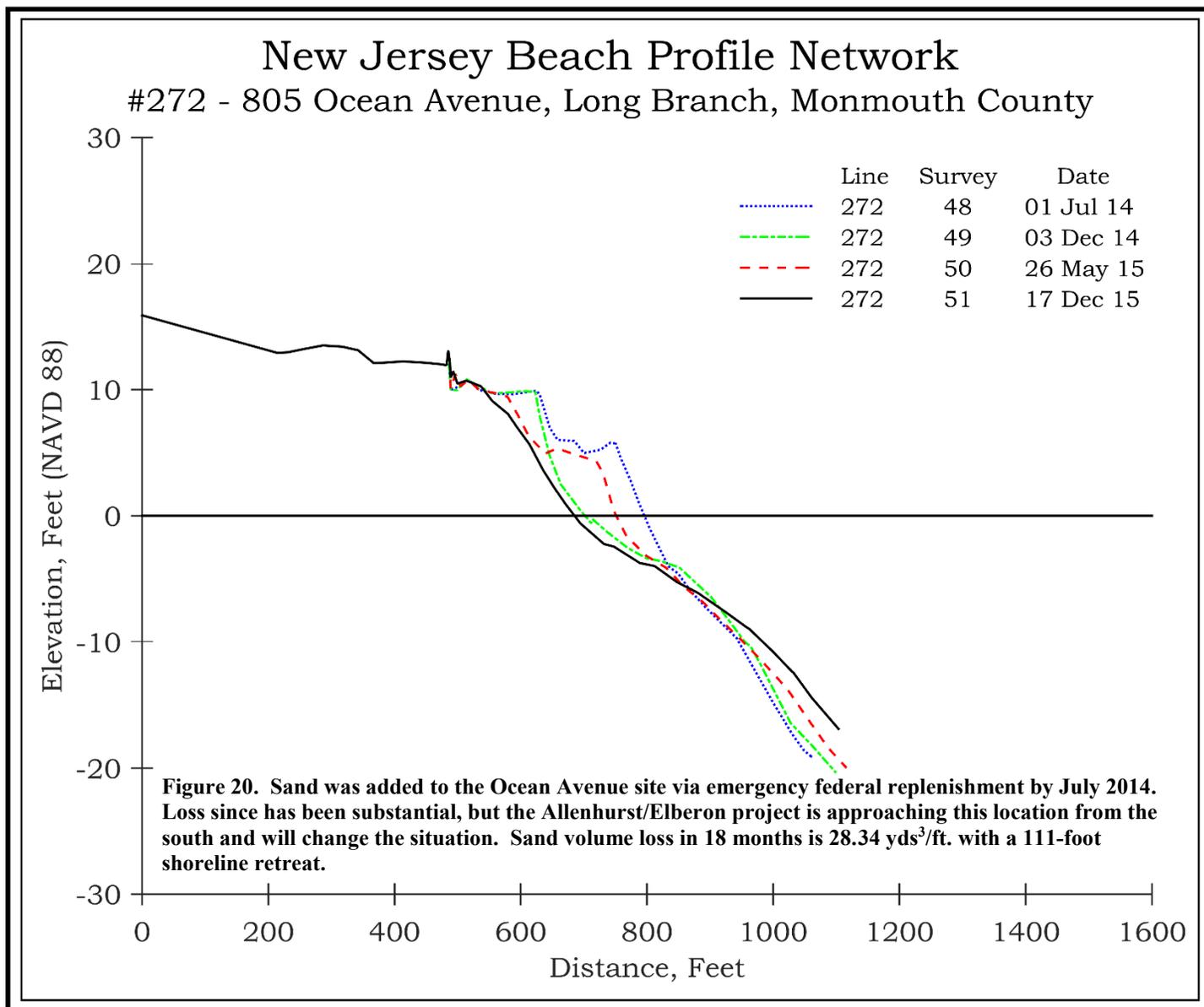


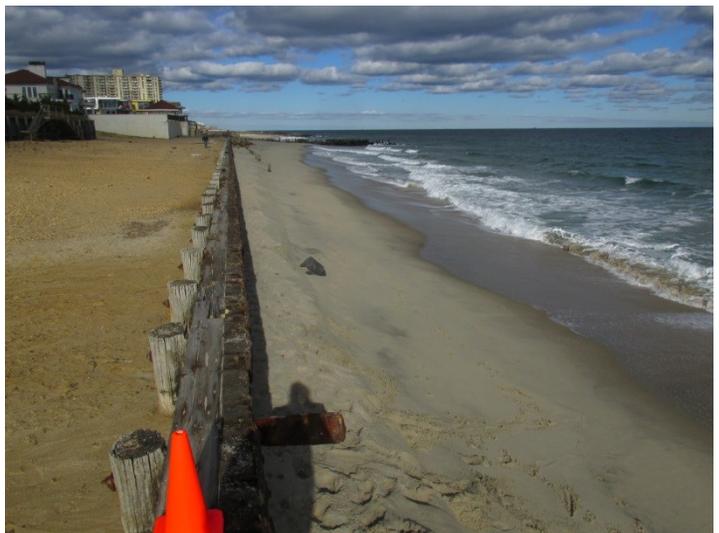
This site is located near the southern limit of the Federal beach nourishment project. The fencing keeping people out has been removed with the walkway moved onto the southbound road once part of Ocean Avenue. The December 3, 2014 view shows artwork on one revetment rock re-deposited on the seawall, looking over the new federal beach. The December 16, 2015 view on the right illustrates berm erosion followed by bar welding onto the beach generating a new berm position.



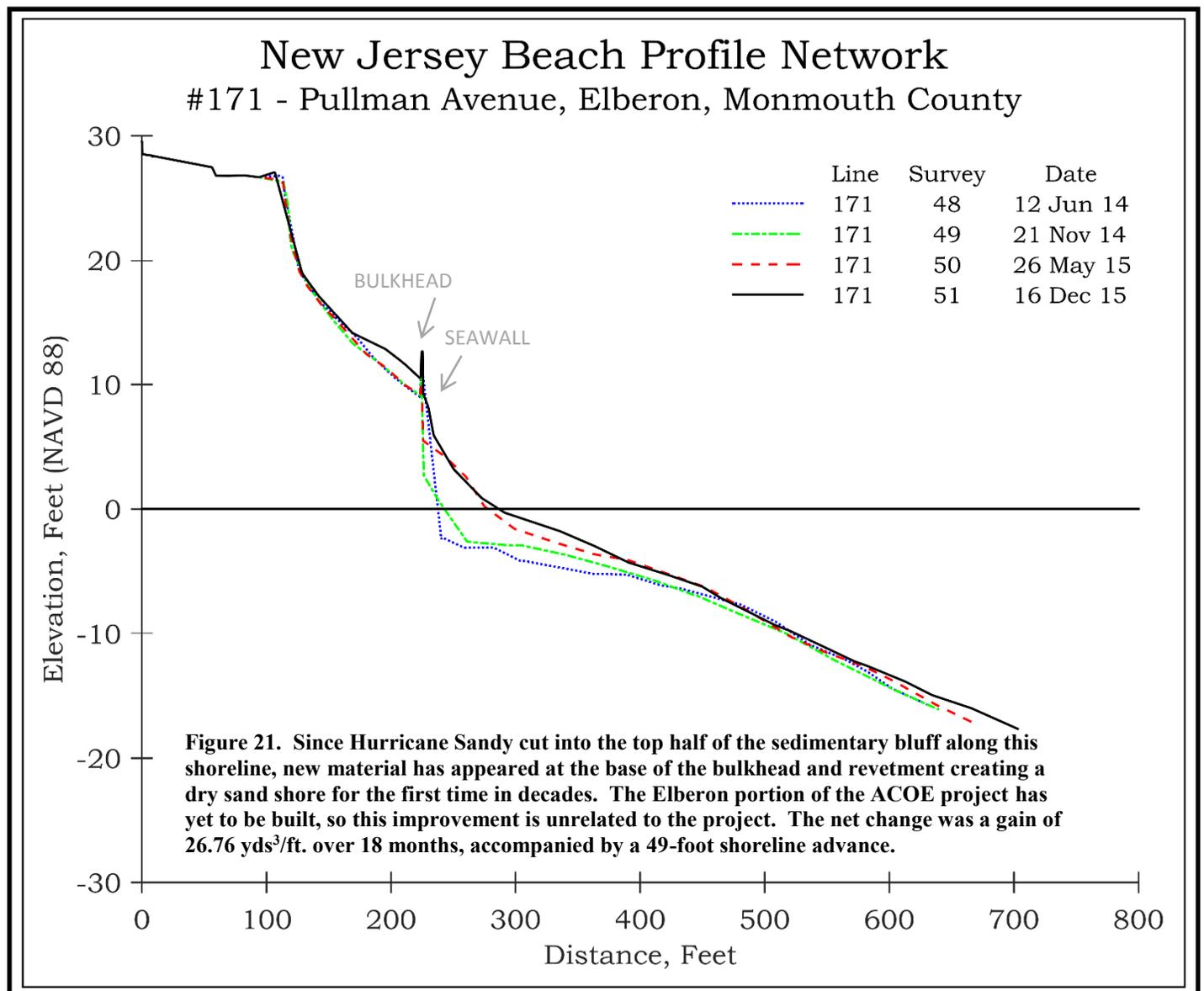


This site, established in 2010, is located on the northeastern edge of Lake Takanassee and within a groin compartment. On the left (Dec. 3, 2014) the swash zone and beach extends to the north. The USACE restoration effort extended to the south into Elberon during 2014. The right view (December 17, 2015) shows a narrower beach with construction work underway to re-engineer the discharge from Lake Takanassee that had re-opened to the sea during Sandy.



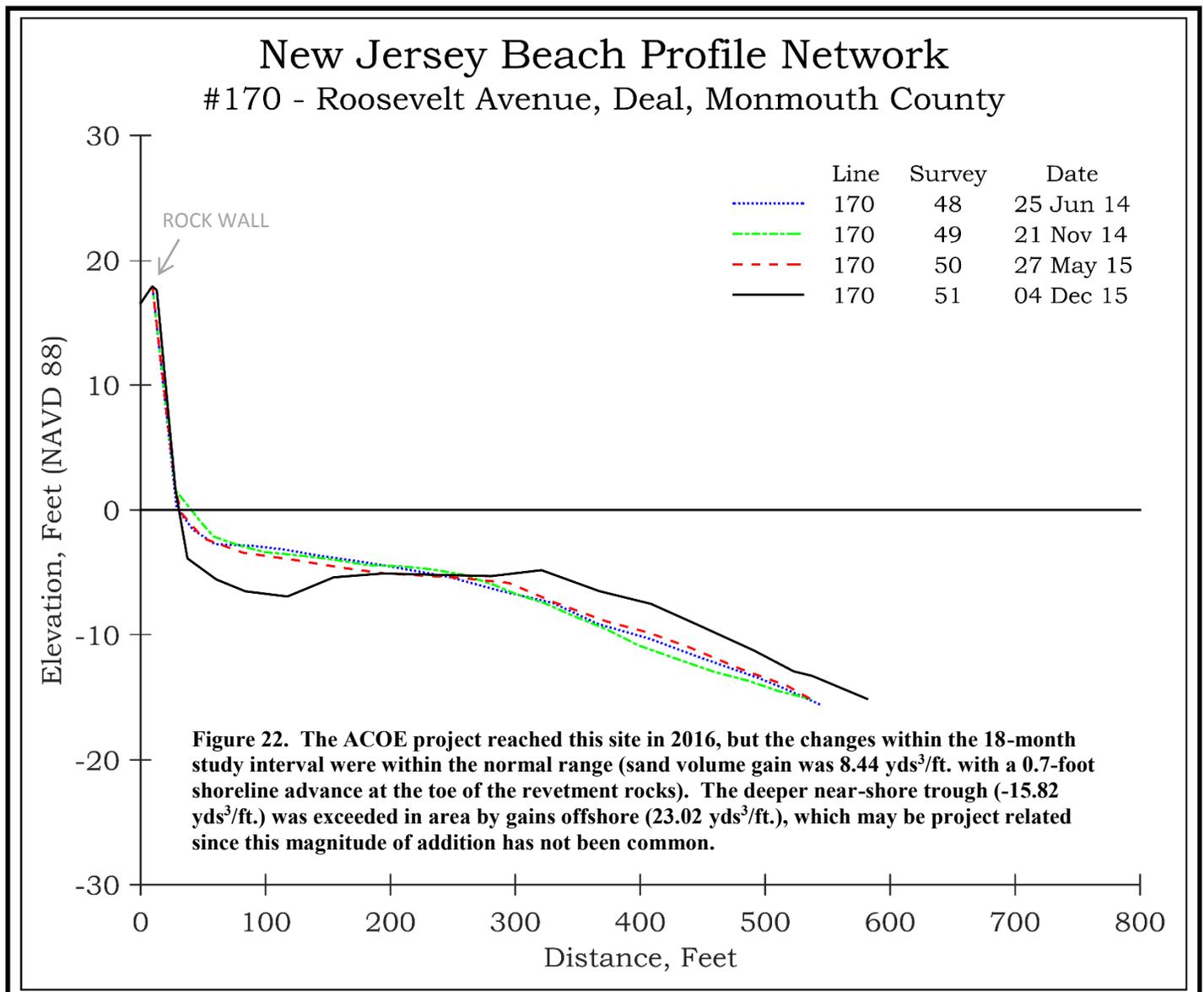


This site is located on the highest point along the bluff shoreline and erosion of the bluff generated the first dry beach ever seen after Sandy that remained by November 14, 2014. By December 16, 2015 this beach was wider as the sand extracted from the sedimentary bluff returned to the shoreline. The USACE project has yet to reach this location.



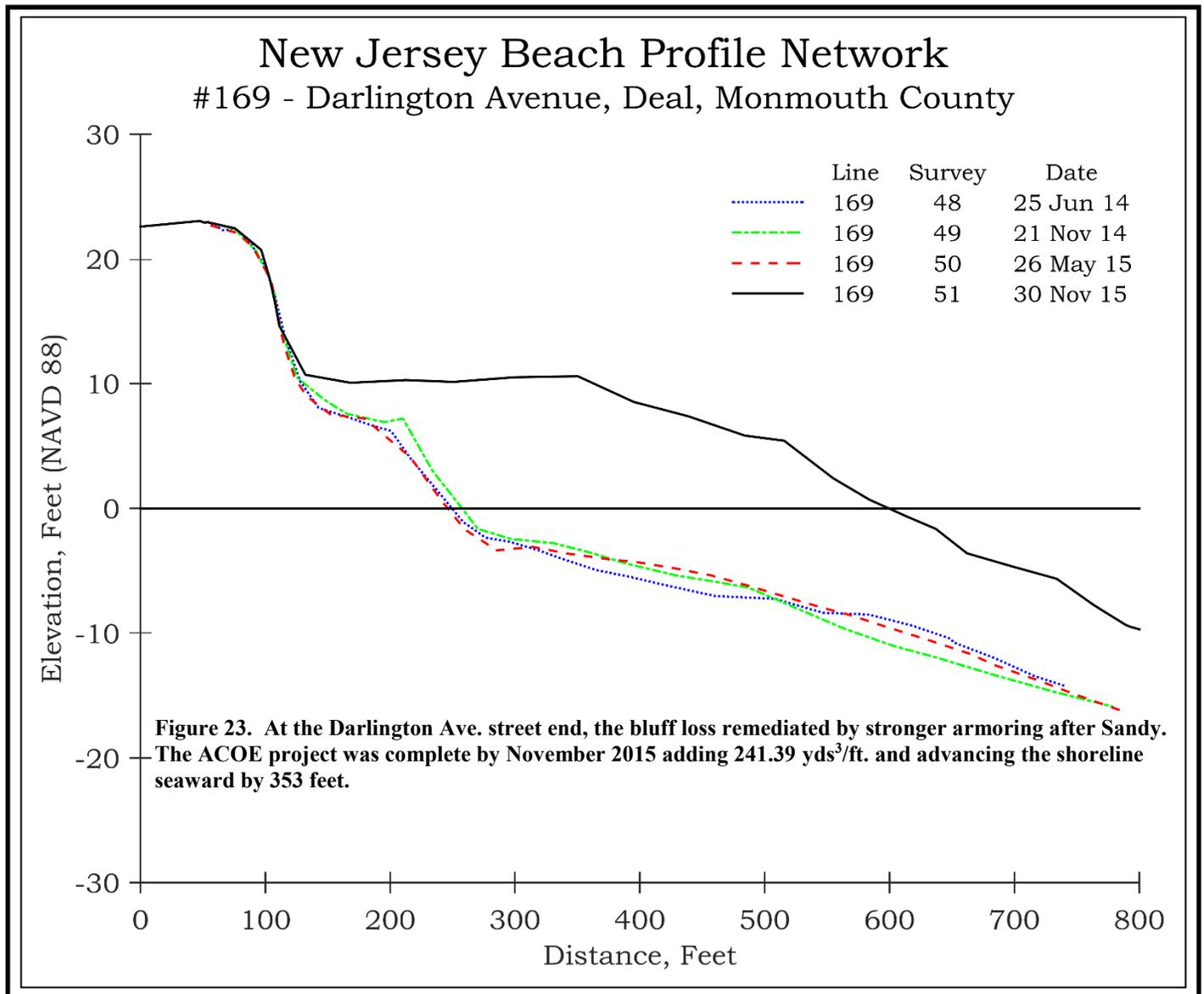


This profile is located between two rock groins that limit sediment movement. This area has never received sand from direct beach nourishment. The photo on the left (taken November 21, 2014) shows the deposit of sand derived from the storm erosion of the bluff. By December 4, 2014 sand moved offshore and adjusted lower at the rocks.



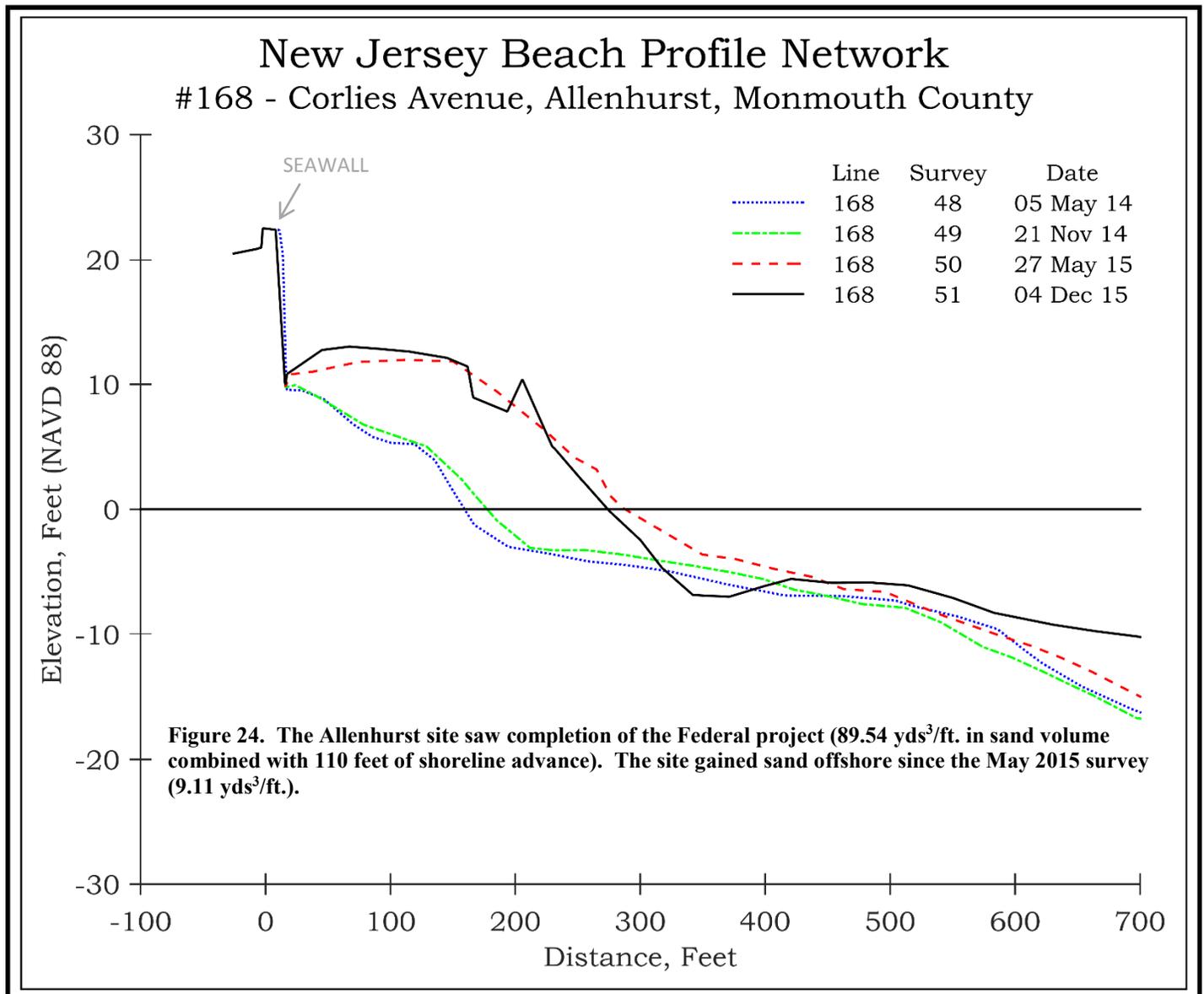


The Darlington site has a small sub-aerial beach contained between two larger groins. The upland bluff was eroded significantly during Sandy and added to the beach sand. By November 14, 2014 (left) natural recovery added 26.32 yds<sup>3</sup>/ft. back to the beach with some reconstruction of bluff protection structures. A year later (Nov. 30, 2015) the USACE project was underway adding dramatically to the beach with additional groin work in progress as well.



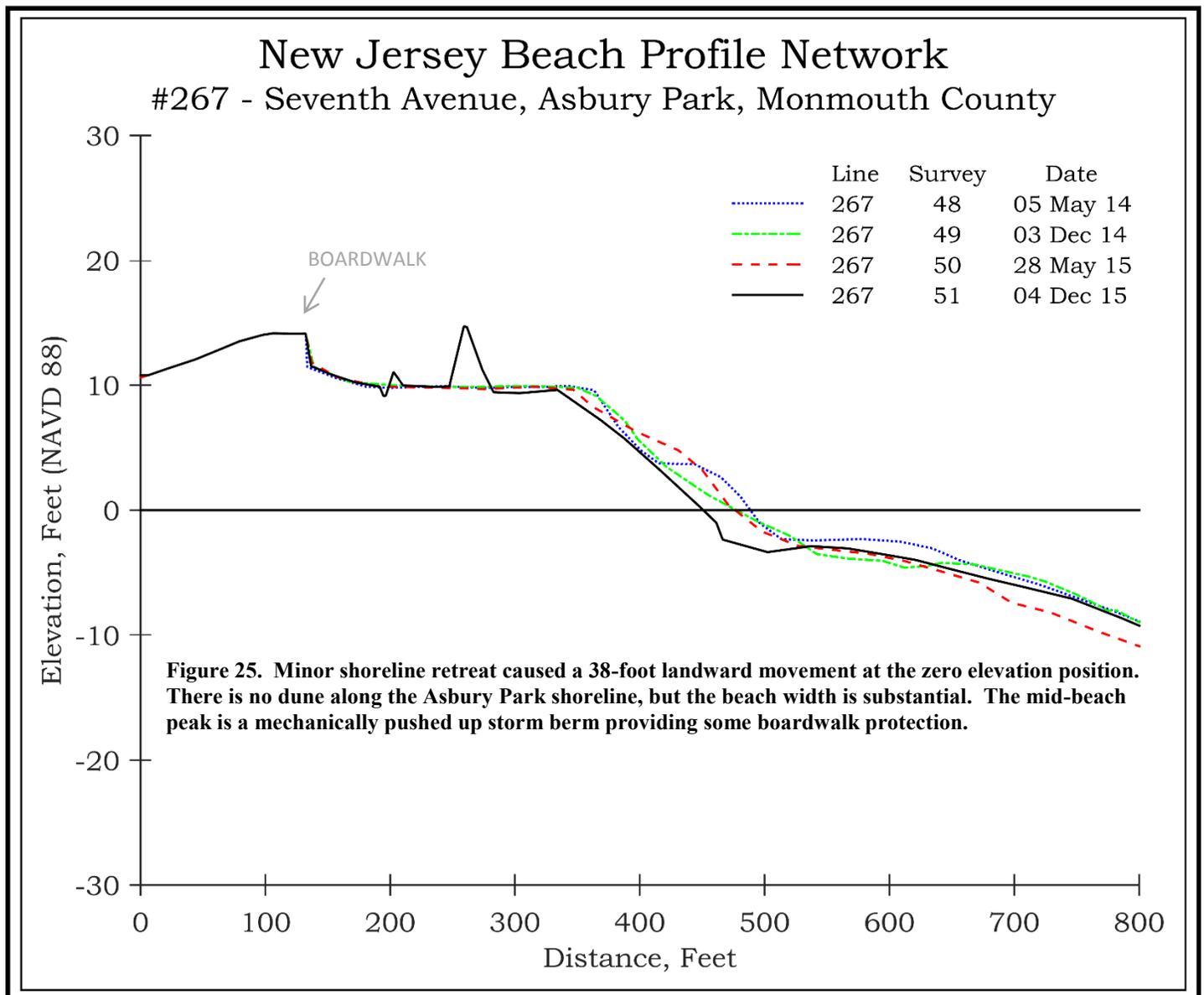


This site in Allenhurst also represents the shoreline conditions for Loch Arbor’s 2-block shoreline. Here an old concrete wall protects the sedimentary bluff. The left photograph shows conditions as of November 21, 2014 prior to the federal project starting. By November 30, 2015 a wide beach was present protected by a massive groin complex at the Deal border.



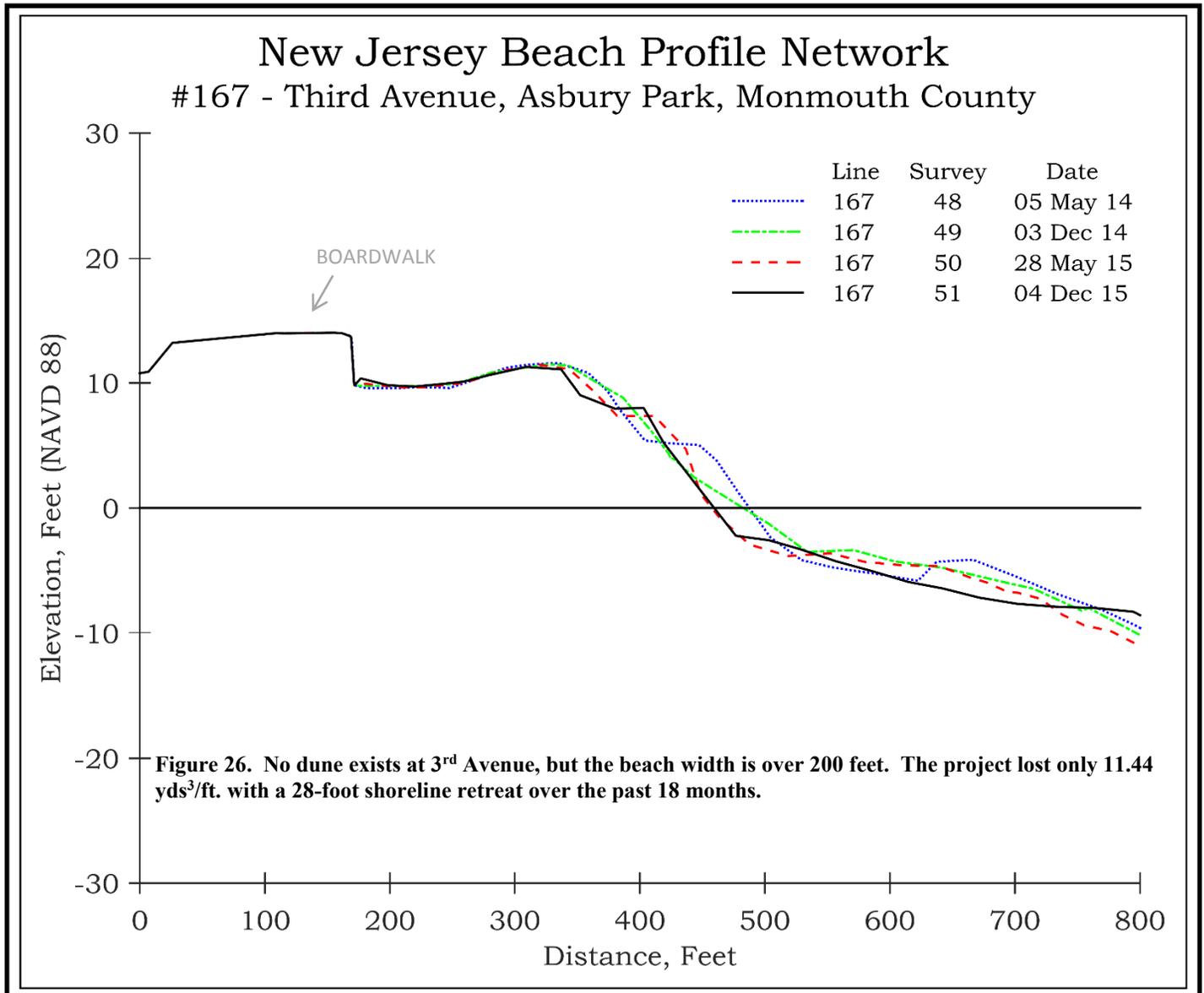


This site is the northernmost site included in the Federal shore protection’s southern project segment. The left photo (taken on December 3, 2014) shows that the federal project added 92.68 yds<sup>3</sup>/ft. and produced a 100-foot shoreline advance. By November 30, 2015, conditions remained similar, but with a pushed-up ridge of sand in the mid-beach area.



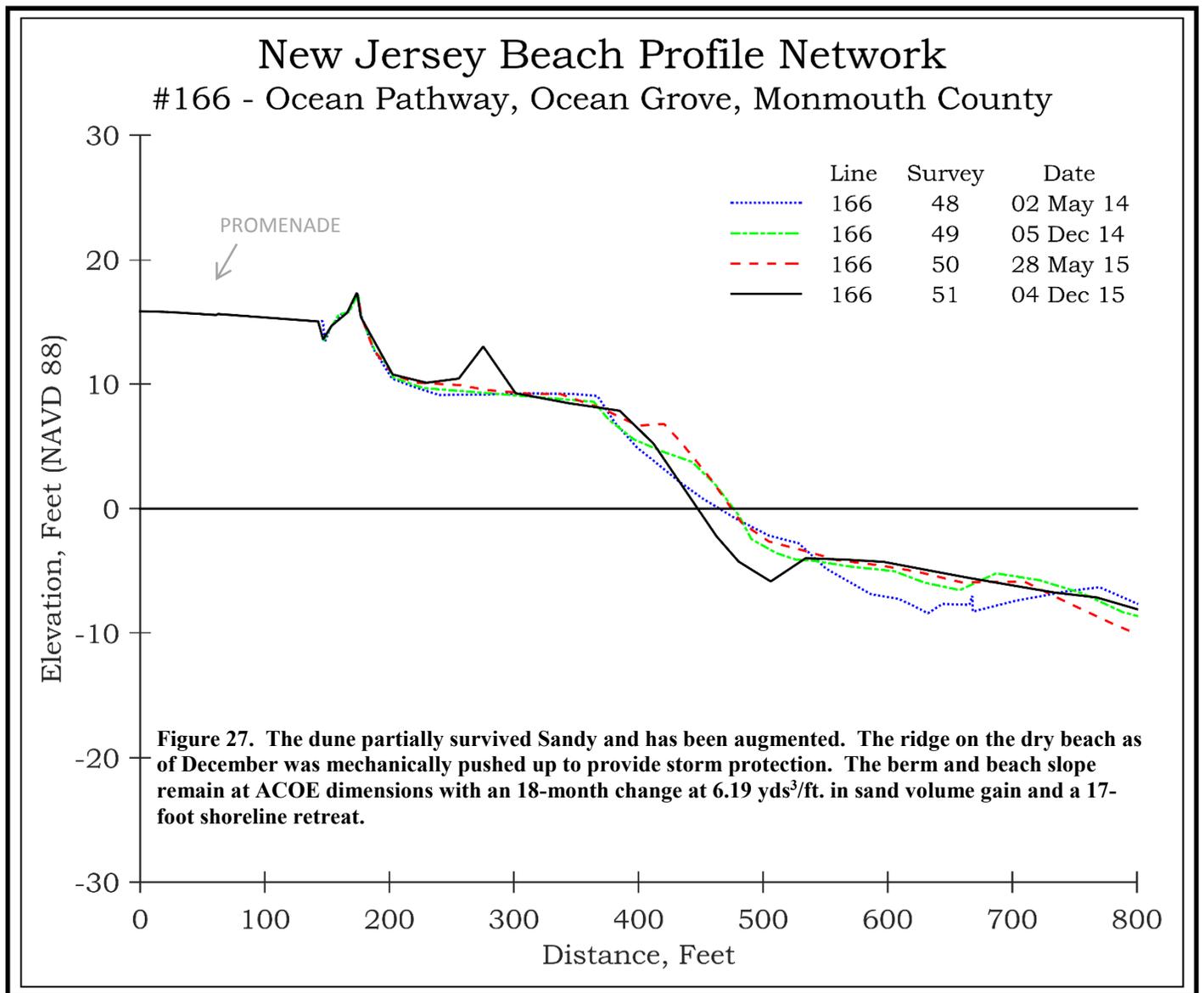


The USACE work added the berm as more sand accumulated offshore as of survey #48. The December 3, 2014 view on the left shows the restored beach. By December 4, 2015 some shoreline retreat had occurred, but the project remains in good shape.



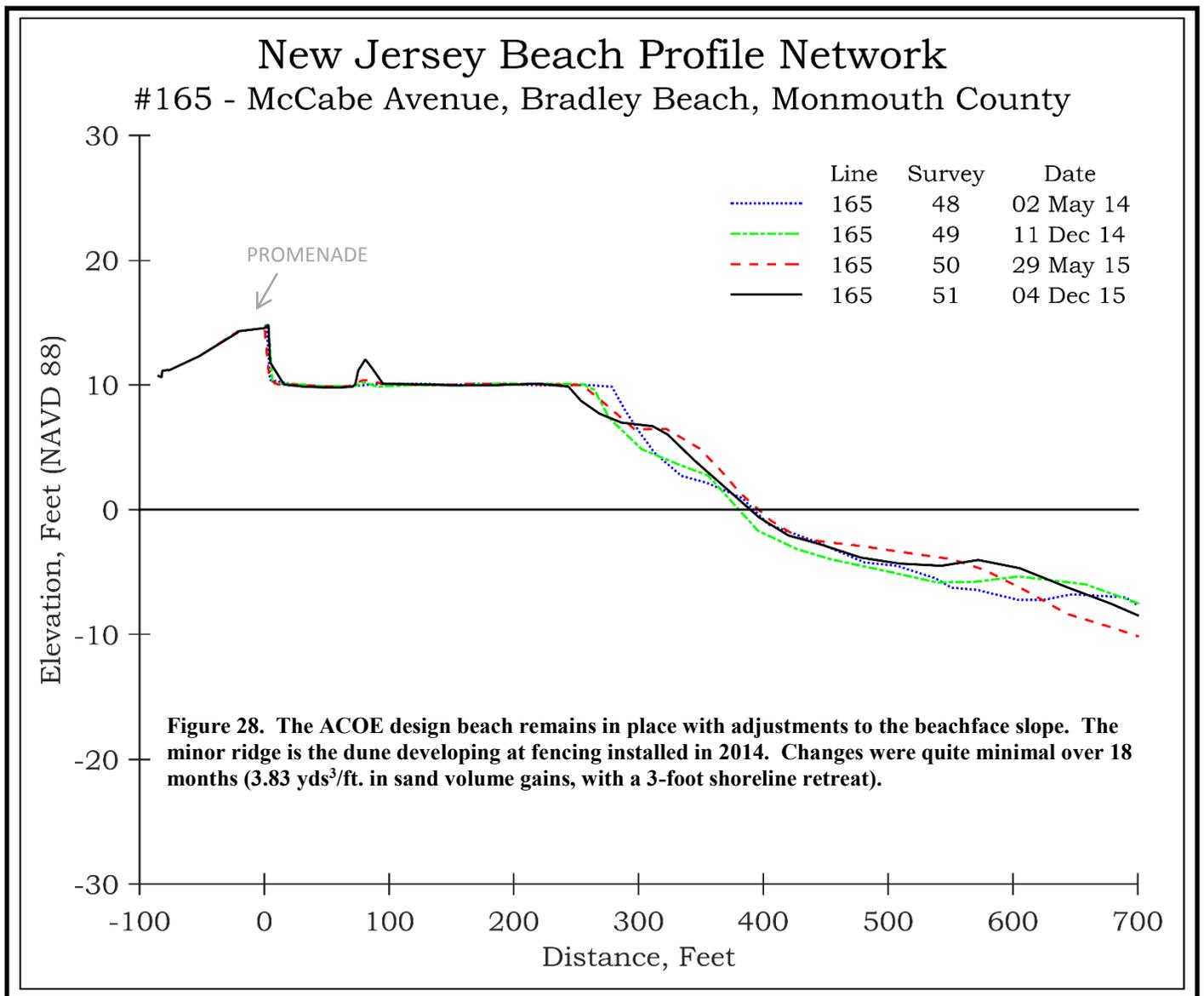


The sand volume added during 2014 amounted to 35.79 yds<sup>3</sup>/ft. with a 12-foot shoreline advance (12/11/2014). By December 4, 2015 the beach remained in good shape with minor shoreline retreat.



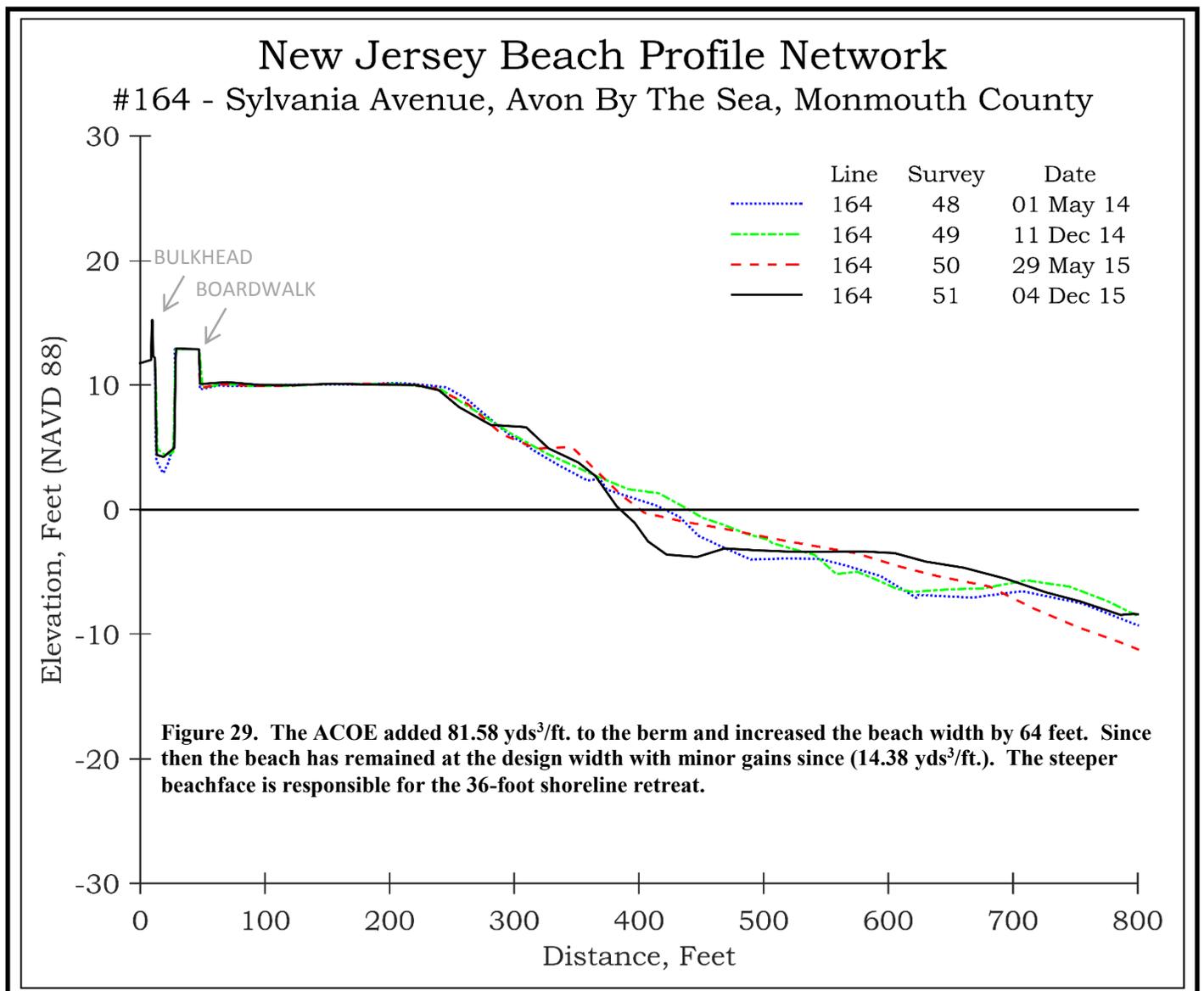


The beach and fencing was restored as of December 11, 2014 adding elevation to the beach if not much width. By December 3, 2015 a small dune zone had been established and the beach retained most of the applied material.



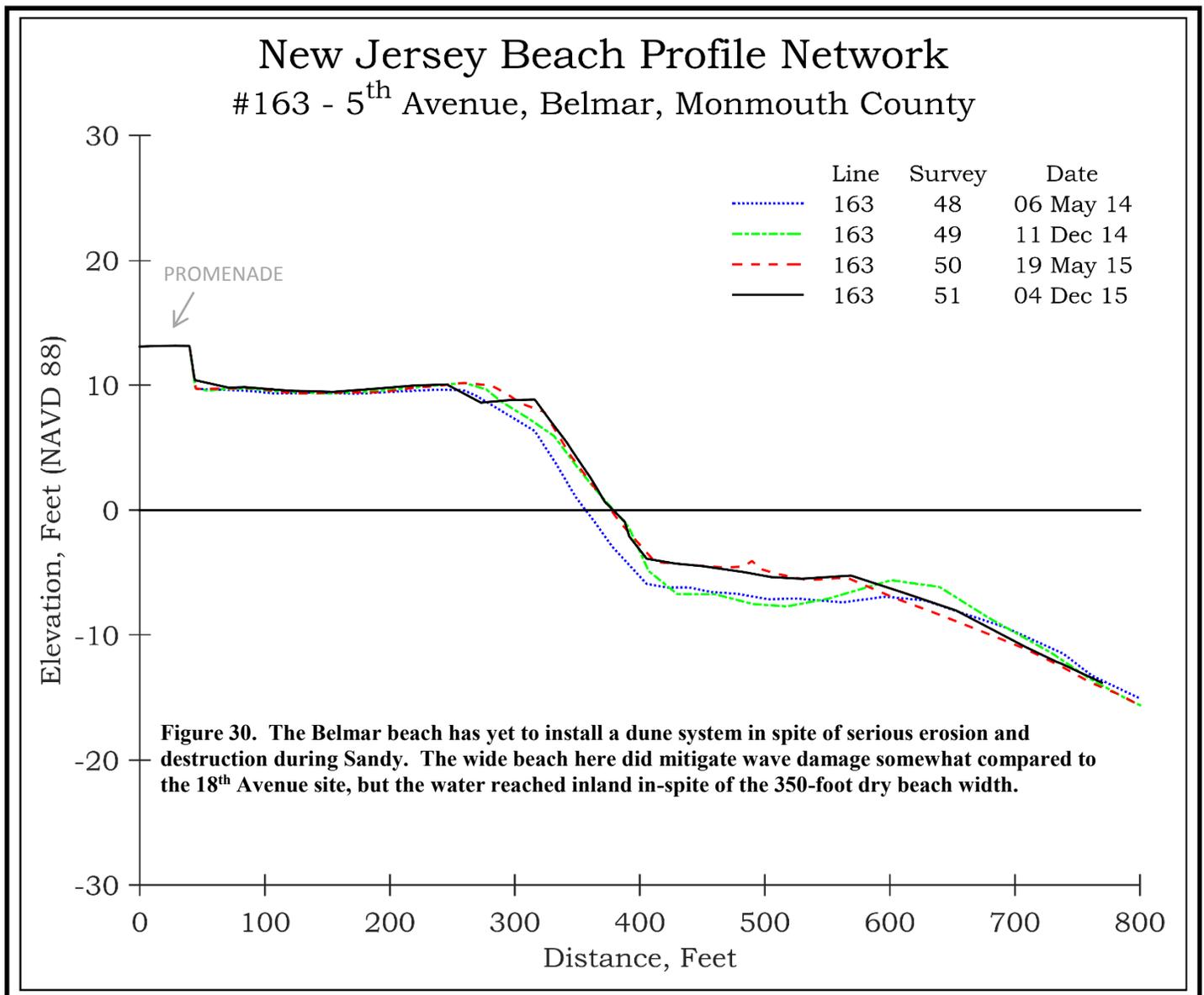


This site is located north of the Shark River inlet. By the spring of 2014 the site had received Sandy-recovery sand with a higher berm and wider beach (survey #48). The December 11, 2014 left view shows that beach extending to the groins. By December 4, 2015, the groin appears to be offshore beyond the wave breaker zone (extreme right edge of the right photo).



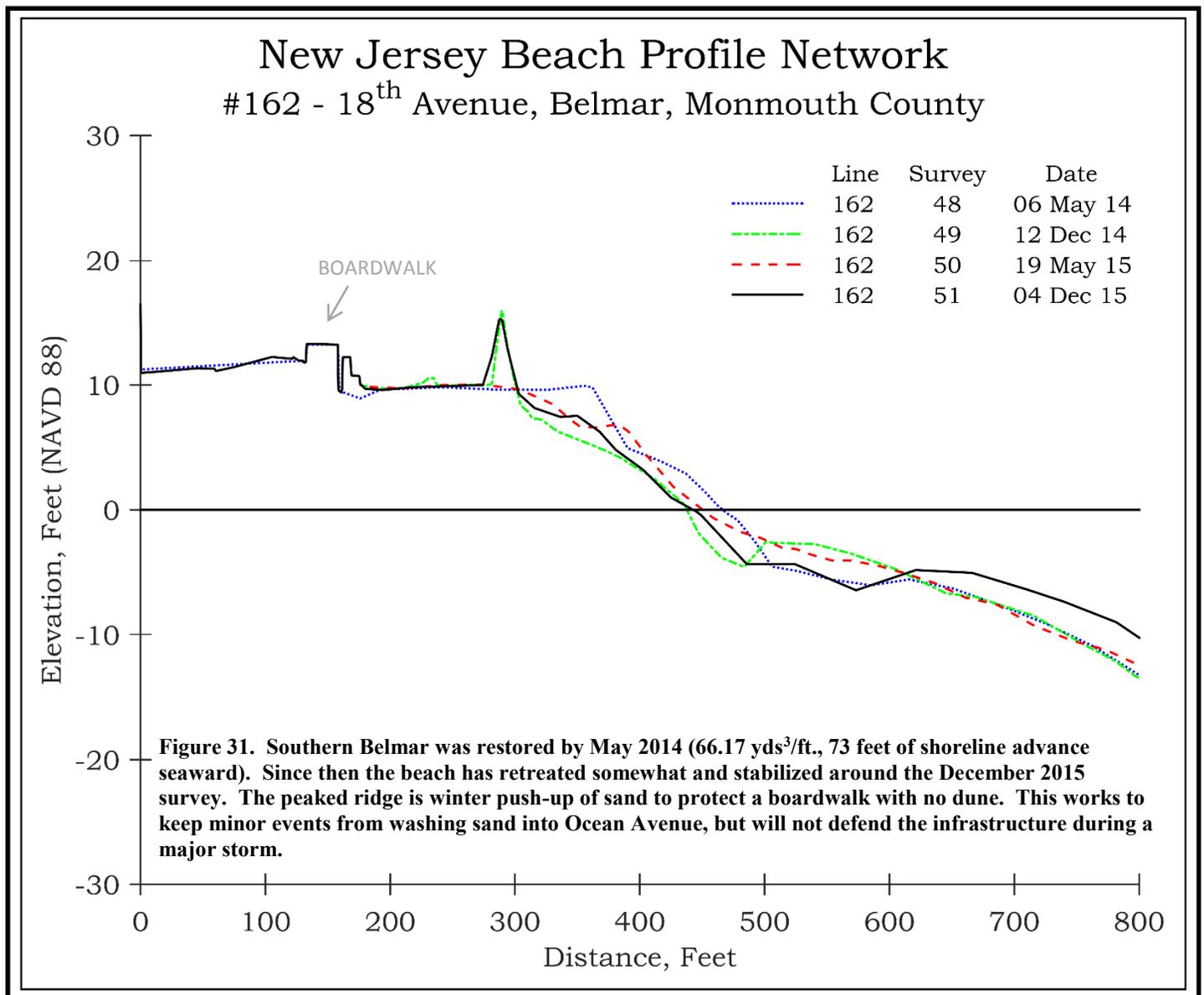


This site did not have a dune prior to Sandy but had a wide, dry beach. Natural recovery brought sand back to the site allowing the USACE to accept this width as sufficient to their design. The December 4, 2015 (right) shows a steeper beach reaching essentially the same position on the left (Dec. 11, 2014).





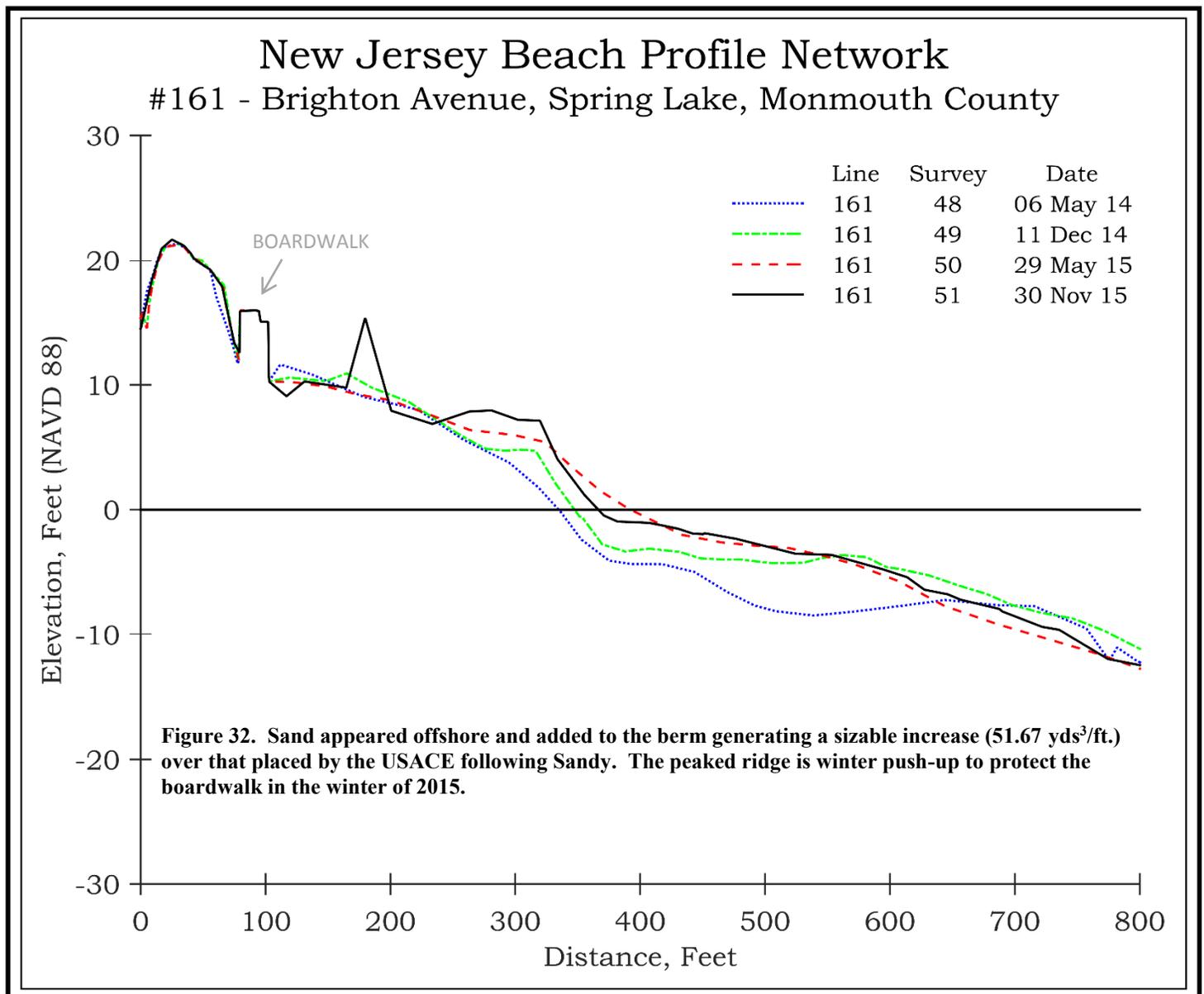
USACE work was in progress on December 12, 2014 to widen the beach and add sand. By December 4, 2015 the beach had a sand ridge pushed up to act as a winter “dune”. Its performance during the late January 2016 northeast storm was marginal.



NJBPN 161 – Brighton Avenue, Spring Lake



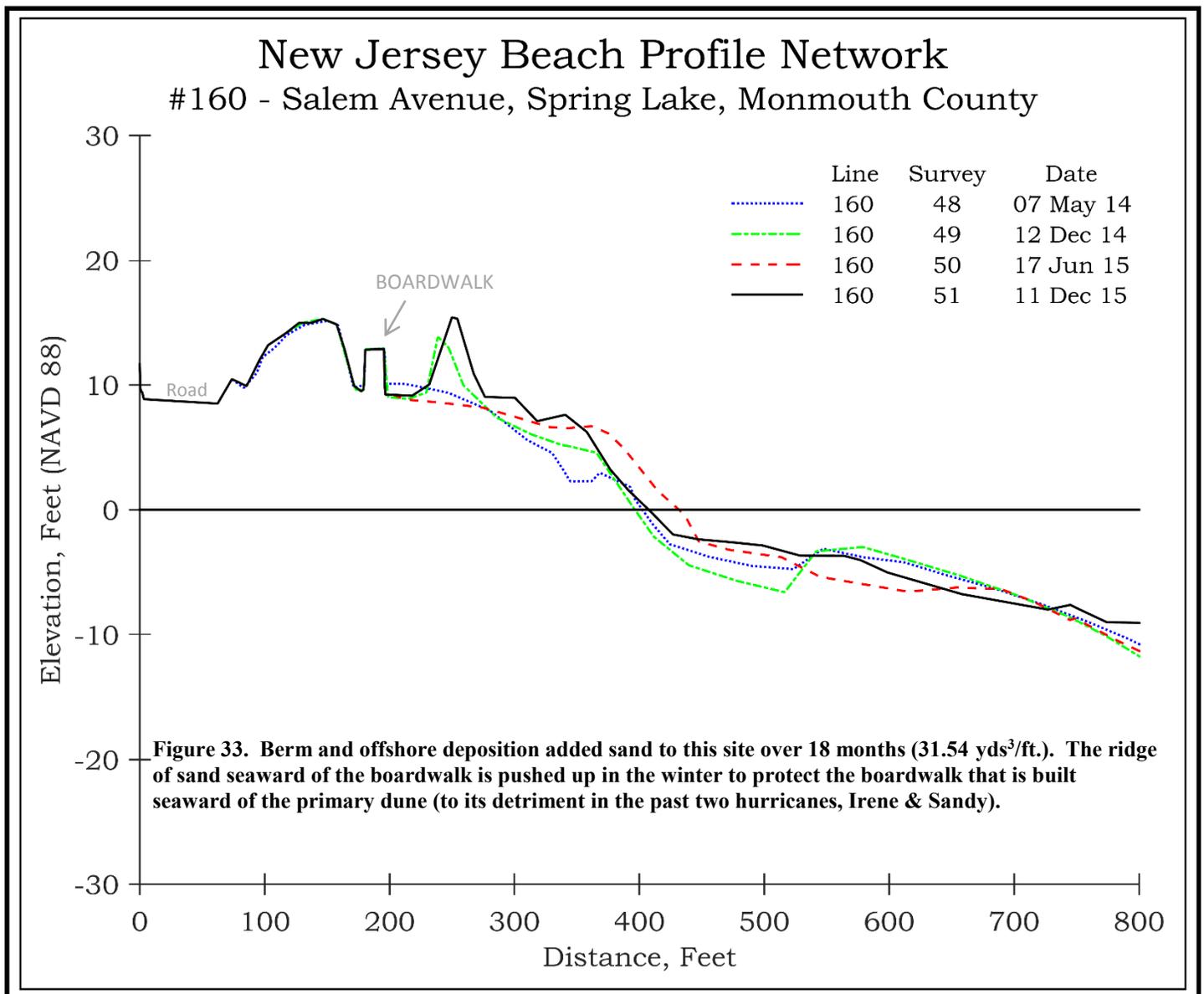
By December 11, 2014 (left) the USACE had added 40.47 yds<sup>3</sup>/ft. in new sand advancing the shoreline by 13 feet. The right view on November 29, 2015 shows the wide beach with an active surf zone breaking on an offshore bar.



NJBPN 160 – Salem Avenue, Spring Lake

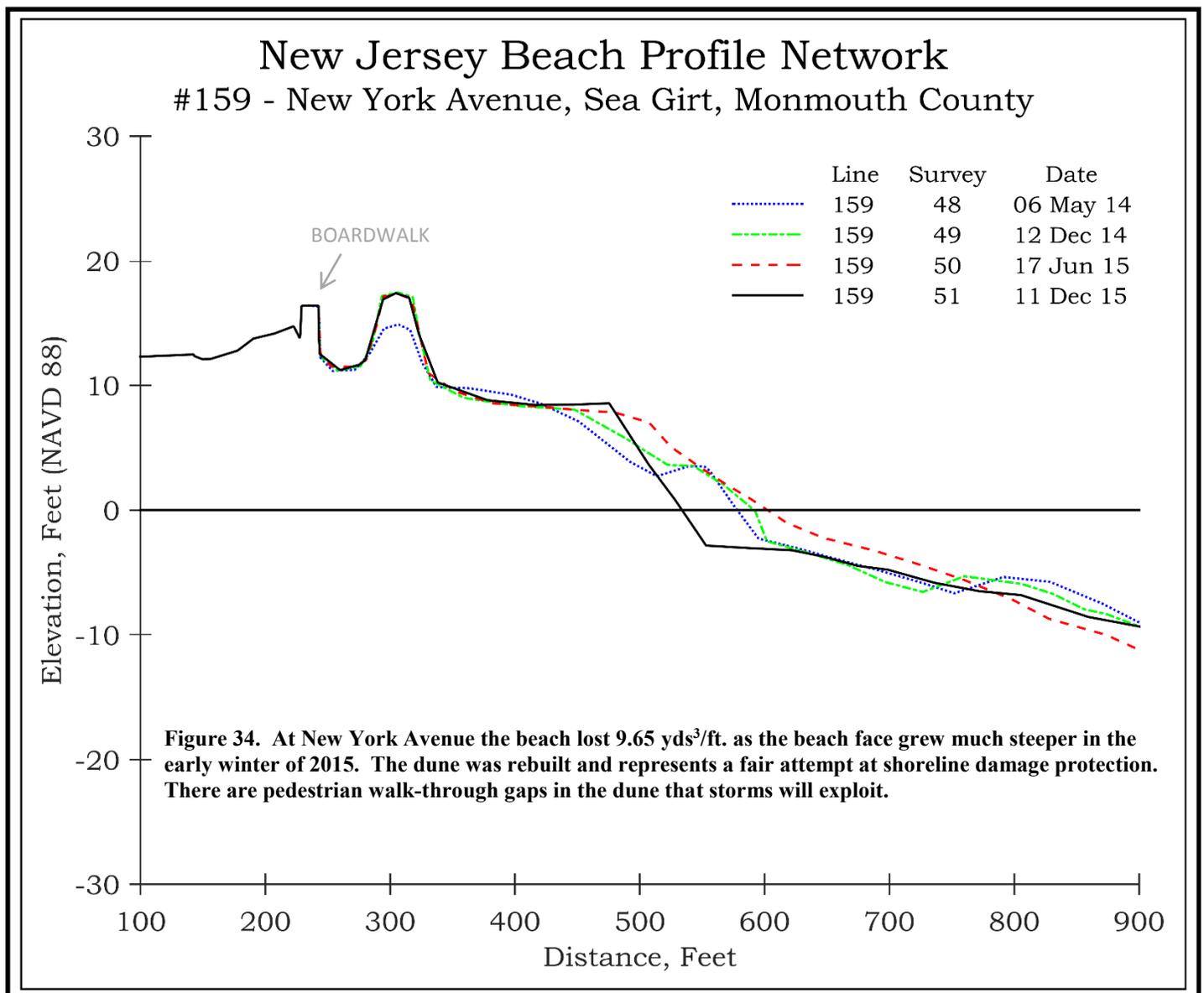


The USACE completed restoration in 2014 adding 32.29 yds<sup>3</sup>/ft. The view on December 11, 2015 shows a similar beach width with the winter storm “dune” in place seaward of the boardwalk. The vegetated dune still exists landward of the boardwalk.





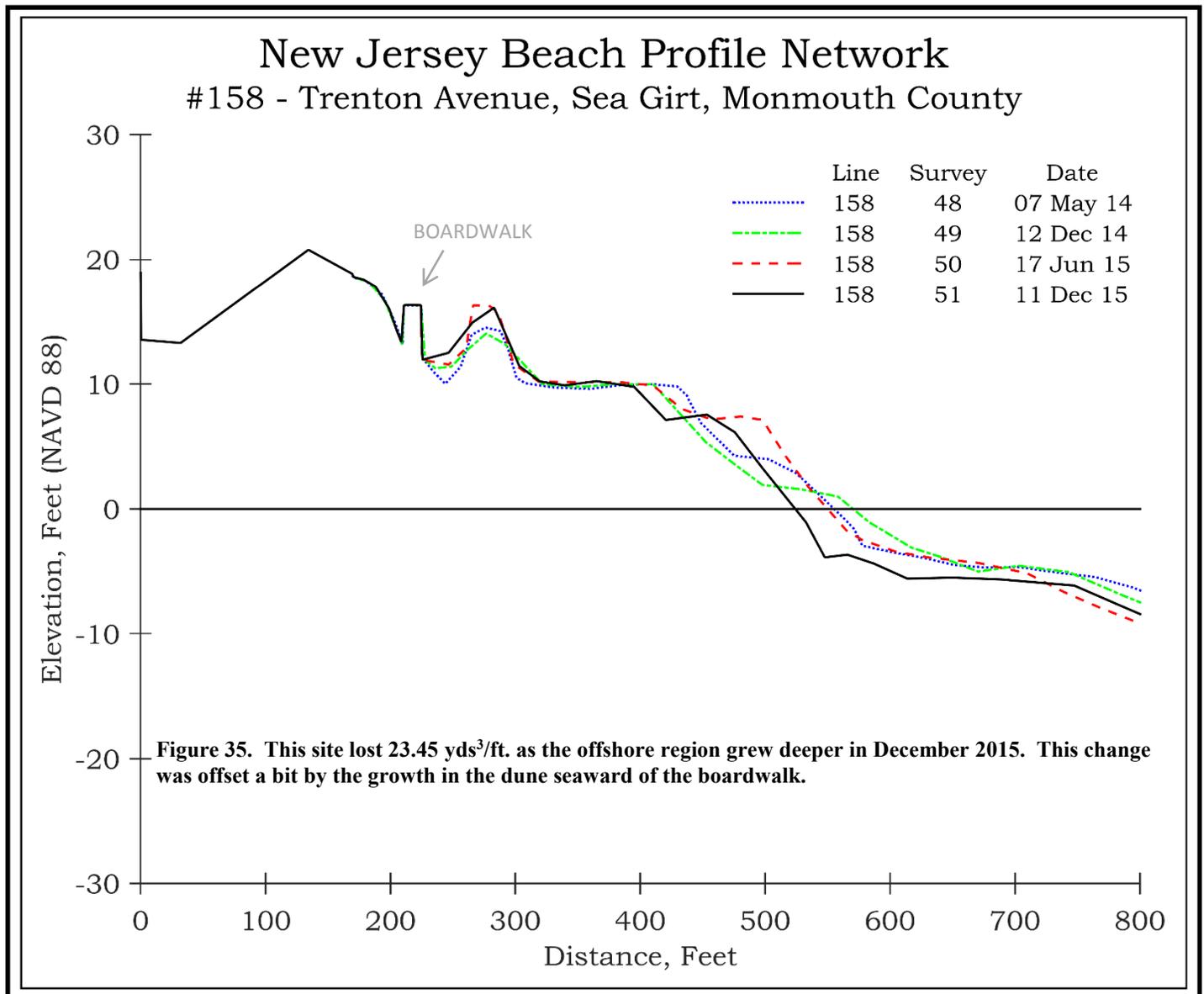
Modest additions were made by the USACE during 2014 (23.81 yds<sup>3</sup>/ft.) and the beach was wider (on left 12/12/2014). By December 11, 2015 the small dune seaward of the boardwalk has grass and gains some sand.



NJBPN 158 – Trenton Avenue, Sea Girt



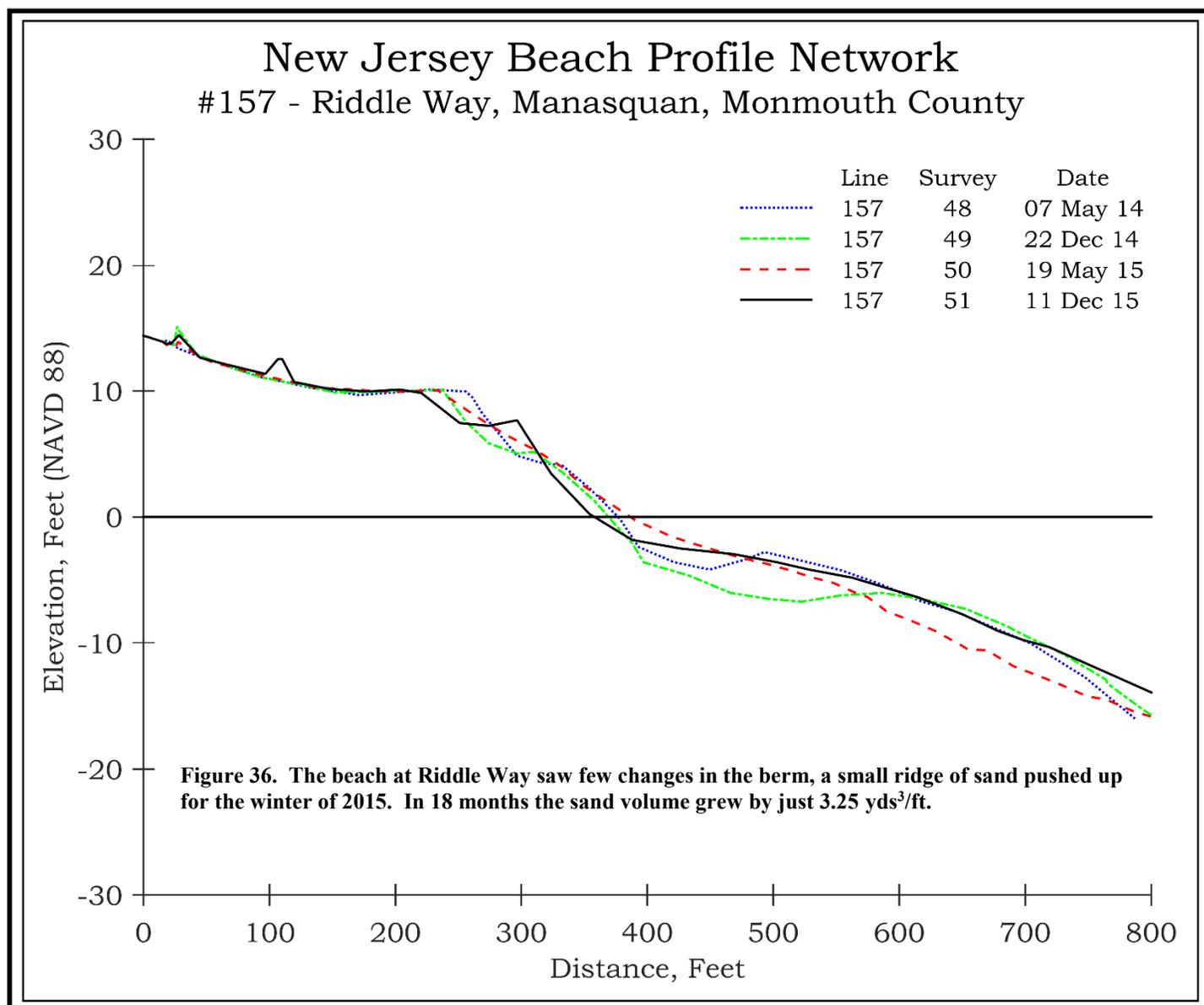
Sand was added by the USACE in early 2014 and the recovered sand was molded into a dune ridge at the toe of the primary dune (left view 12/12/2014). The same view on December 11, 2015 shows wind deposits landward of the dune ridge, some grass growth and a similar width to the beach.



NJBPN 157 – Riddle Way, Manasquan



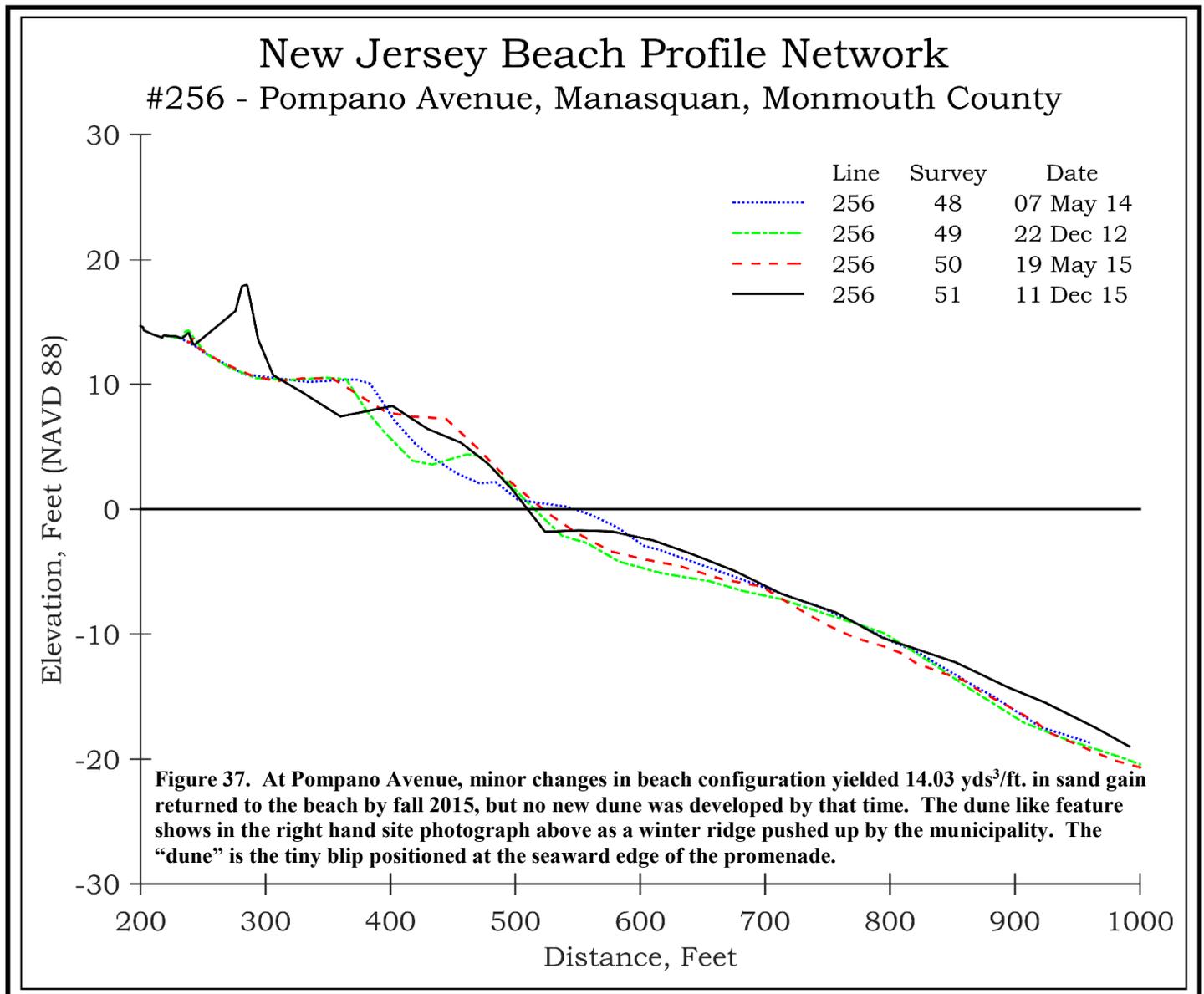
By May 2014 the USACE had added sand to the beach, but with the shoreline-parallel sand fencing located at the promenade, there has been little dune development since Sandy (left view 12/22/2014). A year later (Dec. 11, 2015) the same width appears to be present on the beach and the sand fence has accumulated a little sand. No real dune exists yet though.



NJBPN 256 – Pompano Avenue, Manasquan



By May of 2014 the beach had 82.26 yds<sup>3</sup>/ft. in new sand added by the USACE resulting in a 113-foot shoreline advance. The Dec. 22, 2014 view on the left shows a single fence and no dune, while the Dec. 11, 2015 view on the right shows that the municipality had pushed up a sand ridge as a winter “dune”. This precludes any sand building around the fence line.



## Summary & Conclusions

The Sea Bright to Monmouth Beach segment restoration effort took 2.1 million cubic yards of sand pumped for \$25.6 million. The Long Branch section took 3.3 million cy and cost \$40.1 million. The Asbury Park to Manasquan section was completed for \$43.6 million with 2.3 million cubic yards placed. Therefore, the entire Federal Shore Protection project was restored to the original design specifications. Work commenced in 2015 starting in Loch Arbor/Allenhurst and moved north into Deal. As this is written, work continues into Elberon with a goal of completion in 2016, making the entire Monmouth County oceanfront shoreline one continuous beach management project. Sandy Hook really is part of the project, since most project losses are moving onto the hook along the 6-mile reach. The Gunnison Profile site (#285) boasts a 2,500-foot wide dry beach half of which has accumulated since 1998 shortly following the initial work in Sea Bright.

The Raritan Bay restoration took place at Port Monmouth adding a half-million cubic yards of sand at a site covered by NJBPN site #185. More sand was added at Keansburg and has been surveyed for results since placement under a separate NJDEP contract.

As of April 17, 2015 the State and the US Army Corps of Engineers celebrated the start-up of construction on the Loch Arbor to Elberon segment of the Monmouth County Shore Protection Project. The ceremony was held at noon on April 17<sup>th</sup> at Allenhurst with the NJDEP Commissioner, the ACOE commander, Congressional representatives and the NJ State Coastal Engineering representatives present as sand pumping commenced on this long-awaited final section of the county coastline. A similar ceremony was held earlier in the day at Ocean City, NJ for the commencement of the Ludlam Island Shore Protection project. With these two projects underway, the developed NJ coast requires work to begin on the Northern Ocean County section, the remainder of Long Beach Island, and the Wildwoods in Cape May County to have 100% of the developed oceanfront shoreline under federal management.

The average sand volume that migrated back to the shoreline since Sandy was 33.56 yds<sup>3</sup>/ft. and represents 92.3% of the sand lost due to Sandy (-36.27 yds<sup>3</sup>/ft.). This does include the work done by the ACOE in 2014 minus losses up to fall 2015 survey data. Work in progress in Deal and Long Branch has not yet been counted.

Monmouth County saw an average of 11.76 yds<sup>3</sup>/ft. in sand added to the 36 cross sections producing an 8-foot average shoreline advance between April 2014 and December 2015. The 8 Sea Bright sites averaged a loss of 5.98 yds<sup>3</sup>/ft., the 6 Long Branch sites averaged a loss of 20.38 yds<sup>3</sup>/ft., and the 13 sites between Asbury Park and Manasquan averaged a gain of 8.00 yds<sup>3</sup>/ft. Thus, the southern segment performed better than did the northern section with the largest losses seen in the City of Long Branch. Material cannot arrive into the completed section of Long Branch from the south, so if sand progresses north along the beach, the loss zone will be emphasized at the southern limit of sand placement at West End Avenue to Morris Avenue. This process may see a reduction in loss rates once the Elberon to Long Branch section is complete and structural changes are made to the groins in this reach.