STOCKTON UNIVERSITY
COASTAL RESEARCH CENTER

Cape May City, NJ August 27, 2014 looking west toward Ocean Avenue at Baltimore Avenue where 25 years earlier this instrument location near the seaward toe of the dunes would have been over 150 feet out into the ocean in 1989. This illustrates the long term benefit realized with large-scale beach restoration.

New Jersey Beach Profile Network 2014 Annual Report on Shoreline Changes in New Jersey's Four Coastal Counties Raritan Bay to Delaware Bay Spring of 2013 Through Fall of 2014

Prepared for:
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Division of Construction and Engineering
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May 31, 2015

The Stockton University
Coastal Research Center

New Jersey Beach Profile Network
2014 Annual Report
On
Shoreline Changes In New Jersey
In the Four Coastal Counties
Raritan Bay to Delaware Bay

Prepared for:
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May 31, 2015

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EXECUTIVE SUMMARY

The New Jersey Department of Environmental Protection (NJDEP) authorized the New Jersey Beach Profile Network (NJBPN) project in 1986. The report is divided into four coastal county segments and provides a summary of beach changes for each county. Since it has been over two years since Hurricane Sandy, the objective is to report on exactly how each shoreline segment has responded to both extensive restoration efforts and situations where beach/dune recovery were more natural process driven.

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. Past reports are linked to the site so comparisons can be made to the 2012-2013 observations along the New Jersey coastline.

Key Data Summary Information Two Year Post-Sandy:

State-wide the average beach profile gained 23.01 yds^3/ft. between the spring of 2013 and the fall of 2014, while the average shoreline position advanced 40.36 feet seaward. Clearly the magnitude was 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 7.96 yds^3/ft. while the shoreline advanced 34.36 feet. On Long Beach Island where almost half the shoreline is under federal management the values were 20.99 yds^3/ft. in sand volume gain with a 41.54-foot shoreline advance.

The data from the December 1992 NE storm also demonstrated that sand recovery on the beach happens rapidly up to 50%, then declines (in the absence of subsequent severe storms) over time so that 5 years later about 85% of the sand lost from the beach and dunes returns, but not always in the same configuration. Natural recovery in the dunes is slower, dependent on wind transport that adds less than 3 cu. yards/foot of dune frontage per year.

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 over this study period. Since most work had already been completed in Cape May County by early 2013, these locations saw sand volume losses during 2013 that averaged considerably less by the summer of 2014.

The most dramatic change was seen in Monmouth County where the NY Corps District completed a near county-wide beach restoration with additional construction planned for 2015 to finish the work in Deal, Allenhurst and Elberon that were not done initially in 1995. The difference between northern Ocean County and Long Beach Island illustrate the impacts of these federally administered shore protection efforts where

extensive Sandy damage, breaching and overwash occurred where no federal work had occurred and next to no damage in areas of Long Beach Island where the federal project had been completed.

	S 13 – F 13 Cu. yds/ft.	F 13 – S 14 Cu. yds/ft.	S 14 – F 14 Cu. yds/ft.	S 13 – F 14 Cu. yds/ft.
Monmouth County	**13.57**	**46.42**	**3.91**	**64.13**
Ocean County	**14.72**	**-1.66**	**0.74**	**14.25**
Atlantic County	**30.11**	**-19.34**	**12.56**	**24.44**
Cape May County	**-8.87**	**-6.00**	**-0.67**	**-15.54**

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.

	S 13 – F 13 Feet	F 13 – S 14 Feet	S 14 – F 14 Feet	S 13 – F 14 Feet
Monmouth County	**48.62**	**41.06**	**83.02**	**92.02**
Ocean County	**65.18**	**-33.88**	**7.88**	**39.18**
Atlantic County	**33.14**	**-10.00**	**-3.91**	**19.23**
Cape May County	**-14.10**	**-2.81**	**3.74**	**-13.18**

Shoreline changes emphasize the beach restoration efforts in Monmouth County where the 18 month review between the Spring of 2013 and the Fall of 2014 surveys showed that nearly a 100-foot shoreline advance seaward occurred. The difference between northern Ocean County and Long Beach Island was a 7-foot difference in shoreline position with both the natural beach and the enhanced beaches showing decent shoreline shifts seaward by the fall 2014 survey.

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 #4262-14.

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 14-16 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 2014 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. With hundreds of millions spent by the federal government, augmented by NJ shore protection money and some local enhancements, the evaluation of the post-Sandy beach condition is of utmost relevance. 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.

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. These islands are the local sand supply to the beach and as a result the shoreline moves landward with rising sea level.

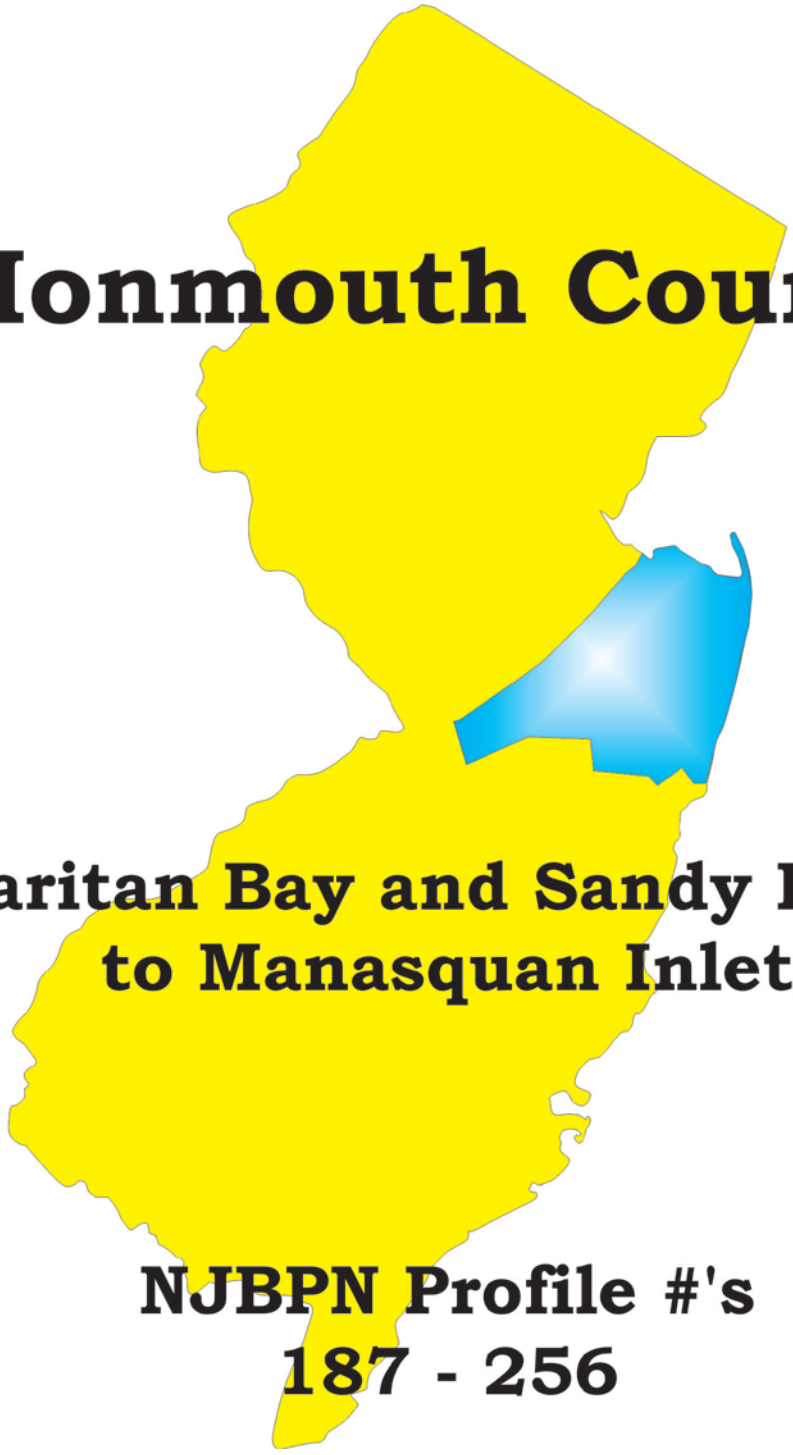
STORM RECOVERY AND BEACH PROJECT EFFECTIVENESS:

The CRC crews working immediately following Hurricane Sandy found that by just two weeks following the storm, there were sizable offshore ridges of sand that ranged between 2 and 3 feet in height and over 100 feet in width at each profile site surveyed into the post-storm period. Immediately after the storm, the beach was concave upward from where the dune once stood, across the beach and into the ocean with few topographic features. The offshore bars began marching onto the wet intertidal beach by mid-November and continued to advance through the winter of 2012 – 2013. New offshore bars have continued to form and move landward.

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

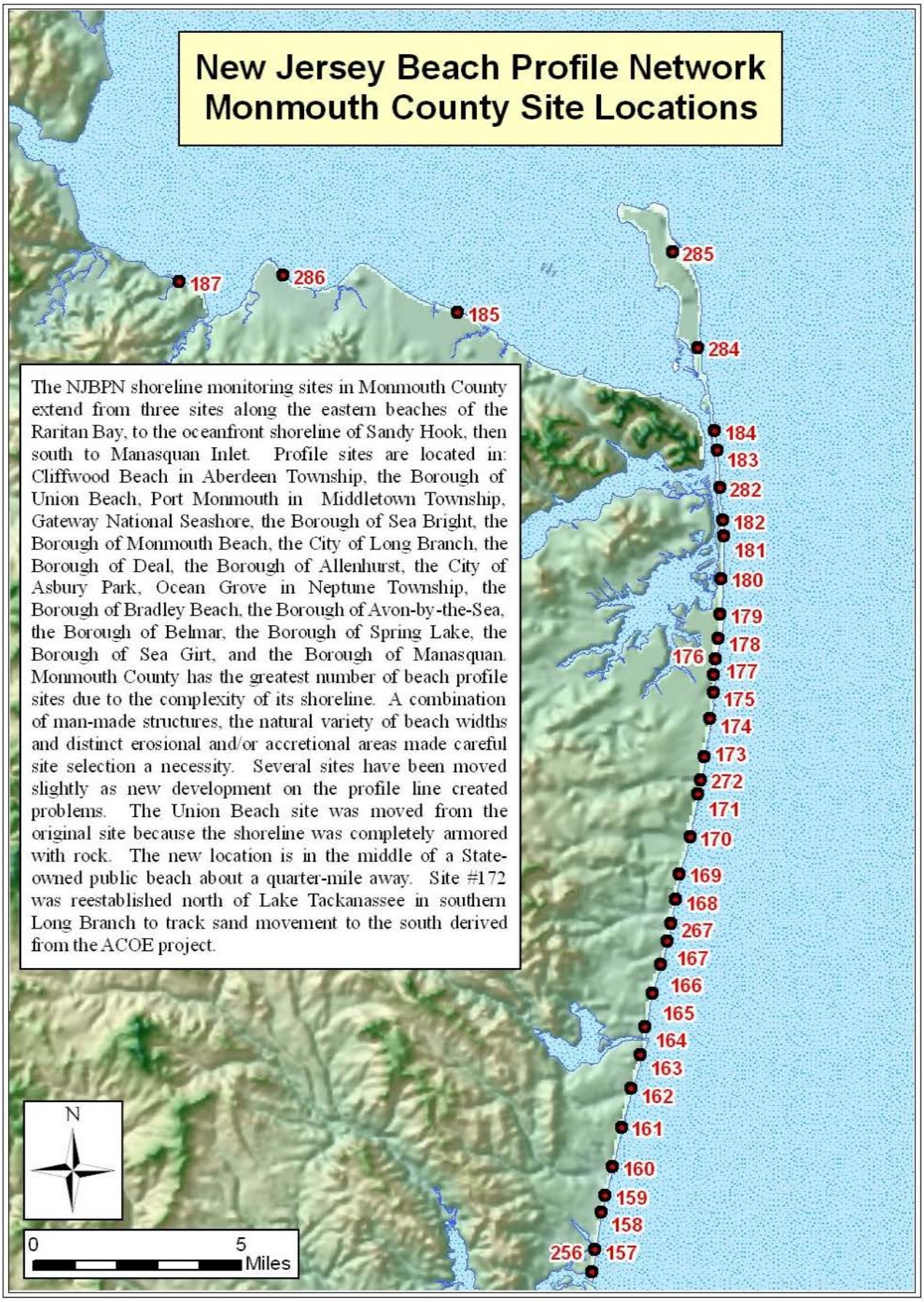


Figure 1. Survey site locations in Monmouth County.

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)). Work continues to get ready to construct the reach between Long Branch and Loch Arbor to close the gap in the Monmouth County shoreline.

The beaches along Raritan Bay were badly eroded, but some recovery has been 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. All these efforts were 100% federally funded under Public Law 113-2 passed by Congress in 2013. Long Branch (Elberon to Loch Arbor) to Asbury Park work will commence placing an initial shore protection project between the two earlier efforts. This will not be 100% federally funded, but revert back to 65% federal and 35% State and local (NJ splits these costs 75-25% with the local municipalities on a prorated shoreline proportional cost of the entire project).

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. Retreat dominated the last 18 months of study with the shoreline moving 20 feet landward and the offshore section losing the most material (-5.121 yds^3/ft.) Losses above the zero datum were far less (-1.257 yds^3/ft.).

Union Beach; #286

The Union Beach site is now located in the middle of the municipal bathing beach on Raritan Bay. Formerly, positioned about 1,000 feet south along the bayshore, the old site was hardened with rock revetment over ten years ago and this effort virtually eliminated any change above low tide. 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. Since then the site has gained 9.49 yds^3/ft. above the zero datum with an 18-month change of 8.37 yds^3/ft. overall. The shoreline advanced 3 feet seaward.

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^3/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. This represents many times the shoreline retreat documented since 1986 projecting a beautiful new beach into Raritan Bay.

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. Access to the shoreline further north is restricted by limited roads. Sandy's storm waves sliced over 40 yds^3/ft. from the active beach, did not transport much of that material onto the wide, normally dry beach and appeared to deposit 50.88 yds^3/ft. directly offshore within 350 feet of the low tide line. During the past 18 months the shoreline has advanced 100 feet seaward as 46.314 yds^3/ft. in new sand was added to the beach. Offshore 16.00 yds^3/ft. were lost as material moved landward. This shoreline is presently 2,100 feet from the dune reference position.

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. Sandy obliterated the dune at the site, washing the material landward. Since the spring of 2013 42.67 yds^3/ft. in new sand has been added above the zero datum (43.37 yds^3/ft. for the entire cross section) as the shoreline advanced 32 feet seaward.

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. The sand deposited at the seawall was stripped away during Sandy and the shoreline retreated 46 feet as well. Since the ACOE work was completed 94.964 yds^3/ft. in new sand has been added with an even split between sand deposited on the beach and sand deposited offshore. The shoreline advanced 83 feet seaward during the 18-month 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. Hurricane Sandy severely reduced the beach volume, but did deposit abundant sand offshore (-38.31 yds^3/ft. from the beach, depositing 39.65 yds^3/ft. offshore). Since Nov 26, 2012 natural recovery added 30.59 yds^3/ft. to the beach as 40.14 yds^3/ft. moved landward. The Army Corps project added 43.1 yds^3/ft. to the beach producing a shoreline position almost equal to pre-Sandy conditions. During 2014 and additional 35.13 yds^3/ft. accumulated as the shoreline retreated 26 feet.

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%). Even so, the storm waves broke over the Sea Bright seawall as they ramped up the sand against the rocks allowing wave run-up to crest the 28-foot wall. The beach profile was cut by 52.52 yds^3/ft. and the shoreline retreated 88 feet during Sandy. Natural recovery shifted some sand back to the beach from offshore, but the site continued to lose sand volume from the beach (-25.55 yds^3/ft.). 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. During 2014, 27.14 yds^3/ft. was added producing a 94-foot shoreline advance meaning that the shoreline position now lies 60 feet from the pre-Sandy location.

Sea Bright Public Beach, Sea Bright; #182

The next location north was obtained by NJ State purchase 25 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. The federal project was complete at this side by March 2013 with some berm adjustment occurring over the summer. The current shoreline lies 62 feet seaward of the pre-Sandy conditions.

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. An ancient timber bulkhead was the back shot position for the survey and it had gaps cut in it to allow easy public access to the beach. Sand washed inland during Sandy was hauled back to create a sizable dune ridge by March 2013 and some material was added to the post-Sandy beach as well. The federal project shows dramatically as a 76.32 yds^3/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^3/ft. of sand accumulated at the site producing a 12-foot advance seaward of the shoreline.

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^3/ft.). More material was added to the outer beach by October 2013 (39.92 yds^3/ft.) pushing the shoreline 65 feet further seaward from the March 2013 position. During 2014 and additional 19.17 yds^3/ft. in sand was added not reversing a 25-foot shoreline retreat.

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. Here a massive stone groin was privately built decades ago acts to restrict sand movement north from the beach fronting a private beach club from the 19th Century. 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 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^3/ft. in new sand. During 2014, the site lost 72.41 yds^3/ft. and the shoreline retreated 133 feet. The problem continues to persist.

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^3/ft. with a 231-foot shoreline advance seaward. Since October 2013 the site has gained 48.31 yds^3/ft. and the shoreline has retreated 101 feet.

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^3/ft. in new sand at the site producing a shoreline advance of 185 feet.

Seven Presidents Park, Long Branch; #176

This site was converted into open parkland space 25 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^3/ft. and a 131-foot shoreline advance.

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^3/ft. deposited on the beach from a loss seen offshore of 28.68 yds^3/ft. by the time of the October 2013 survey. The ACOE provided 95.55 yds^3/ft. in new sand causing a 103-foot shoreline advance here.

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^3/ft. in new sand at the site and generated a 200-foot shoreline advance as of fall 2014.

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 288.46 yds^3/ft. in new sand that generated a 306-foot shoreline advance at the site as of fall 2014. Minor loss can be seen between the May and November surveys in 2014, but the site remains in good shape.

Lake Tackanassee, 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^3/ft. and a shoreline advance of 79 feet.

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^3/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^3/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^3/ft. and a 33-foot shoreline retreat. It will be interesting to follow changes should the construction of this phase of the ACOE project be completed in 2015.

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^3/ft. and the zero elevation shoreline retreated 54 feet. The beach is still present, but wet at high tide.

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 4.72 yds^3/ft. and the shoreline moved 4 feet seaward as a modest berm grew on the beach. Hard structure repairs have been made covering the exposed bluff sediments once again.

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 is 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. Deal Lake is the largest of the now-closed stream estuaries along the Monmouth County shoreline. It has been mapped as open to the tide 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^3/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^3/ft.). Since the fall 2013 survey, the beach has lost 9.20 yds^3/ft. and the shoreline retreated 57 feet. This site would likely benefit from sand placement since the exit pathway is almost non-existent due to the rock groins bracketing the beach.

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^3/ft. while 27.56 yds^3/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^3/ft. returned to the beach. The ACOE provided an additional 92.68 yds^3/ft. generating a 115-foot shoreline advance.

At site #167 on Third Avenue, the same process repeated with a storm loss of 29.66 yds^3/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^3/ft. had returned to the beach as 42.62 yds^3/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^3/ft. and the shoreline advanced 35 feet seaward as a result of the ACOE project.

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^3/ft. on the beach, dune and near shore with 32.64 yds^3/ft. deposited offshore (94 feet of shoreline retreat). By the fall of 2013 22.65 yds^3/ft. had recovered on the beach as 28.69 yds^3/ft. migrated landward (the shoreline advanced 60 feet in the process). The 2014 activity added 35.79 yds^3/ft. in new sand producing a 13-foot shoreline advance.

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^3/ft. extracted from overwash deposits on the uplands. Following the ACOE work in 2014, the site gained 75.40 yds^3/ft. and the shoreline advanced 34 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^3/ft. and a 108-foot shoreline advance seaward. This site saw vertical growth in berm elevation across the majority of the beach width.

Belmar; Sites #163 & #162;

Belmar has two survey sites, one at 18th Avenue and the second at 5th 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 strom. 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 5th 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^3/ft. in 2014 with the shoreline position moving 4 feet seaward. The 18th 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^3/ft. producing a 76-foot shoreline advance.

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^3/ft. was

lost from the beach and 25.40 yds^3/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^3/ft. in new sand at Brighton Ave. and 32.29 yds^3/ft. at Salem Ave. Each shoreline position advanced 76 and 42 feet respectively.

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^3/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^3/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^3/ft. had returned to the beach producing an 86-foot advance in the zero elevation position. During 2014 the ACOE provided 23.81 yds^3/ft. advancing the shoreline 107 feet as of fall 2014.

The Trenton Avenue site saw similar erosion and deposition offshore (-67.07 yds^3 lost from the beach and 44.78 yds^3/ft. gained offshore) with recovered sand positioned seaward of the boardwalk as a substantial restoration dune. Recovery saw 35.07 yds^3/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^3/ft. and pushed the zero elevation shoreline 121 feet further seaward as the shore protection project was restored.

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 20th 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 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^3/ft. of sand to the beach during the storm, but the beach lost and additional 13.75 yds^3/ft. as the offshore added 59.07 yds^3/ft. The shoreline retreated 24 feet. By the fall of 2014 the ACOE had added 94.17 yds^3/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.

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^3/ft. deposited). Since April 2013 only 12.80 yds^3/ft. has returned to the beach, but 32.27 yds^3/ft. of that deposit has moved elsewhere either landward or toward the Manasquan Inlet. The Army Corps placed 82.26 yds^3/ft. at this site generating a 113-foot shoreline advance, but there is no significant dune present along the rebuilt promenade.

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, 2013. The photo on the right shows the beach, the transition to the bay floor and a modest dune (taken on October 7, 2014).

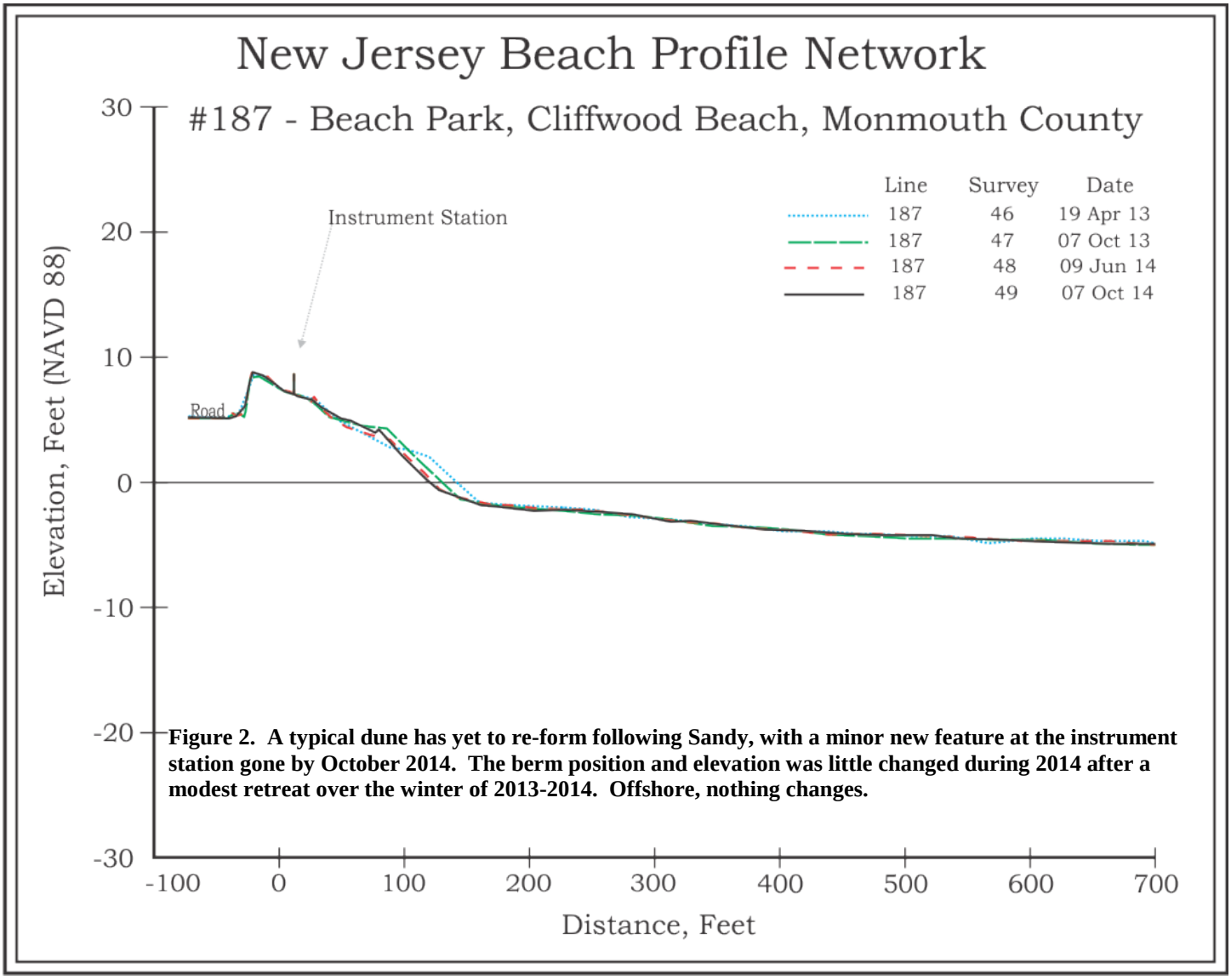


Figure 2. A typical dune has yet to re-form following Sandy, with a minor new feature at the instrument station gone by October 2014. The berm position and elevation was little changed during 2014 after a modest retreat over the winter of 2013-2014. Offshore, nothing changes.

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, 2013 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 following Sandy (taken on October 7, 2014).

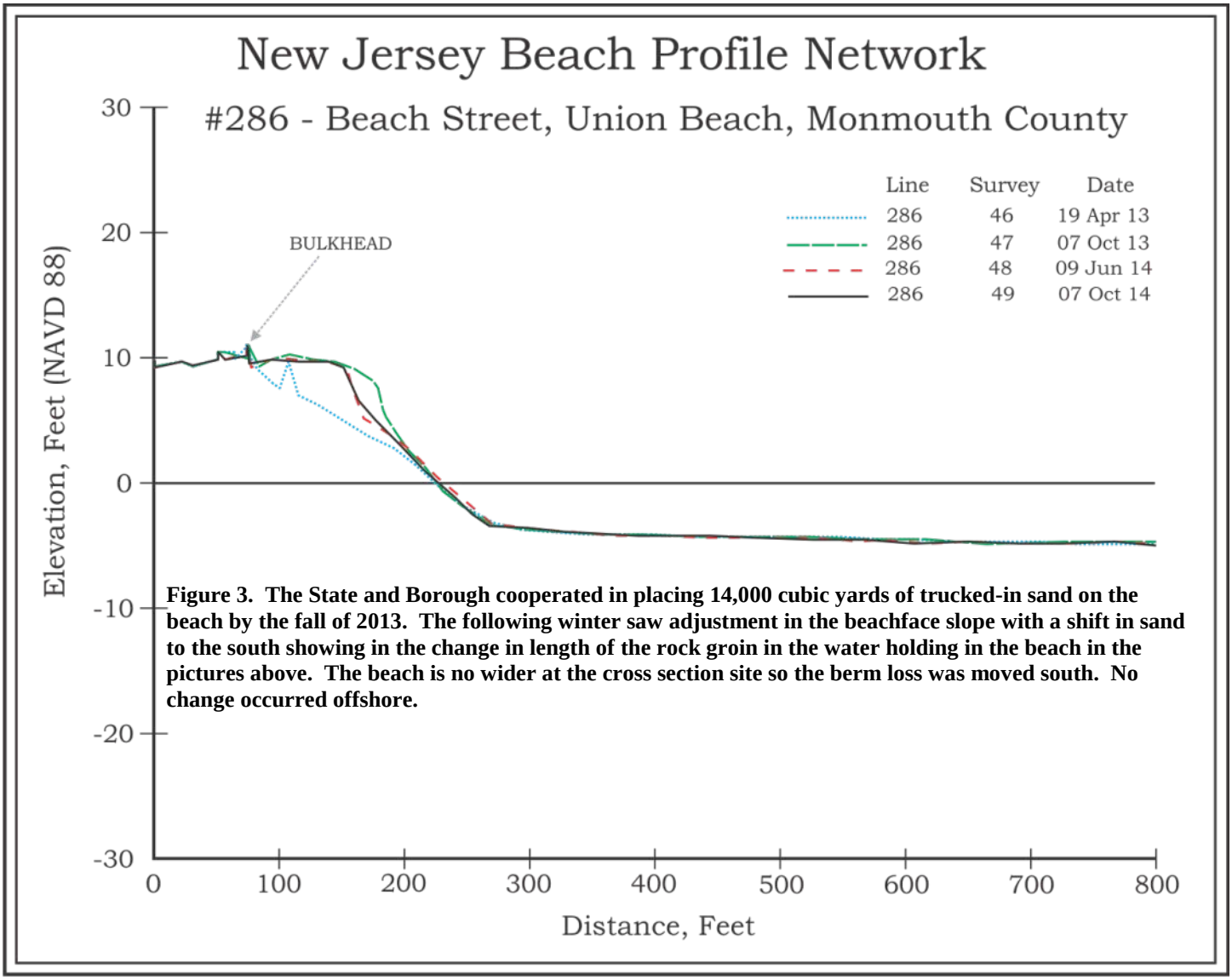


Figure 3. The State and Borough cooperated in placing 14,000 cubic yards of trucked-in sand on the beach by the fall of 2013. The following winter saw adjustment in the beachface slope with a shift in sand to the south showing in the change in length of the rock groin in the water holding in the beach in the pictures above. The beach is no wider at the cross section site so the berm loss was moved south. No change occurred offshore.

NJBPN 185 – Bay Shore Waterfront Park, Port Monmouth

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, 2013. The right picture was taken October 7, 2014 as a massive beach restoration was being completed.

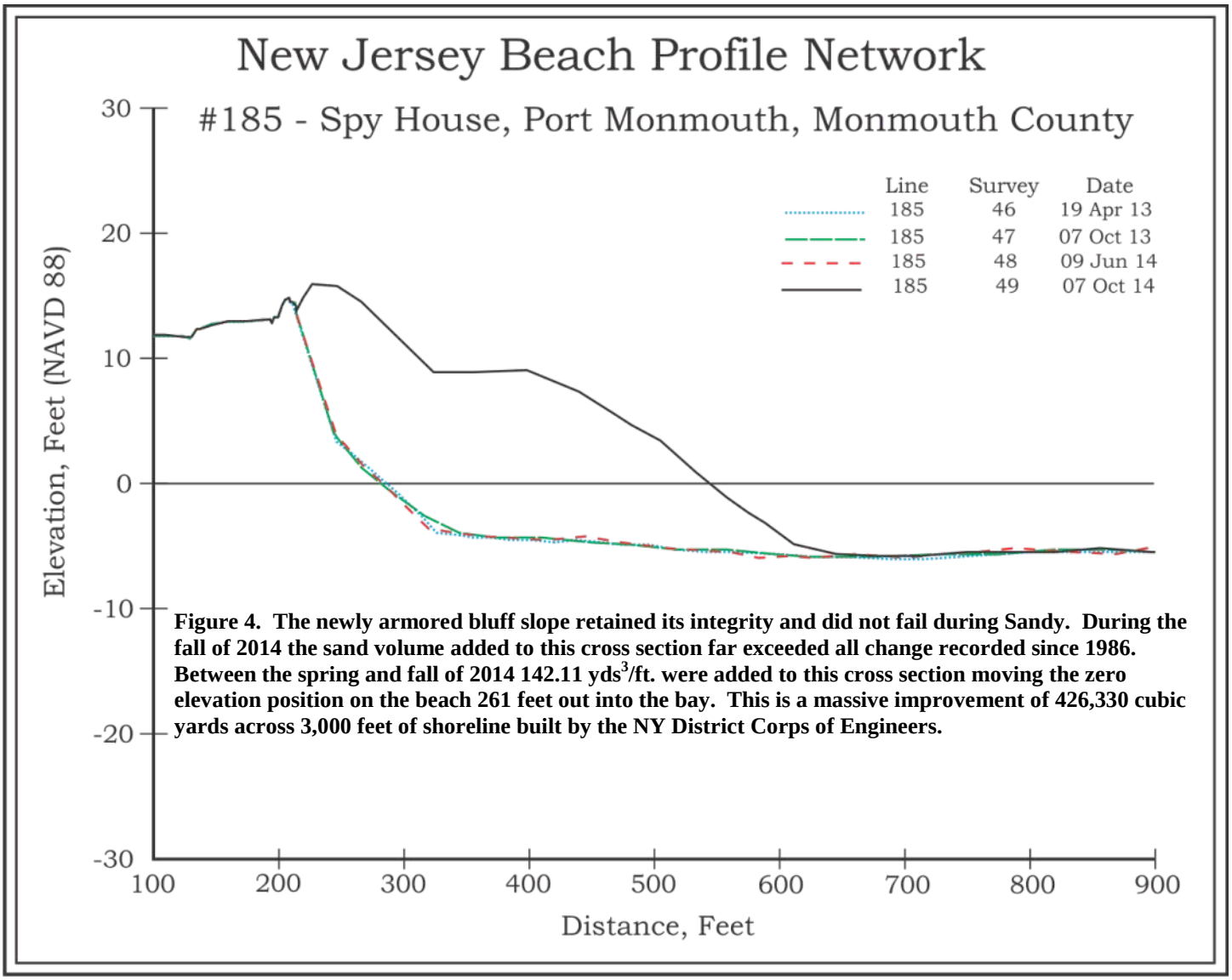


Figure 4. The newly armored bluff slope retained its integrity and did not fail during Sandy. During the fall of 2014 the sand volume added to this cross section far exceeded all change recorded since 1986. Between the spring and fall of 2014 142.11 yds^3/ft. were added to this cross section moving the zero elevation position on the beach 261 feet out into the bay. This is a massive improvement of 426,330 cubic yards across 3,000 feet of shoreline built by the NY District Corps of Engineers.

NJBPN 285 – Gunnison Beach, Sandy Hook National Seashore

This is the northernmost ocean NJBPN site that has shown advances in the berm position since 1999. The photograph on the left shows the October 29, 2013 beach looking north; on the right is the same view from the toe of the dune Nov. 19, 2014.

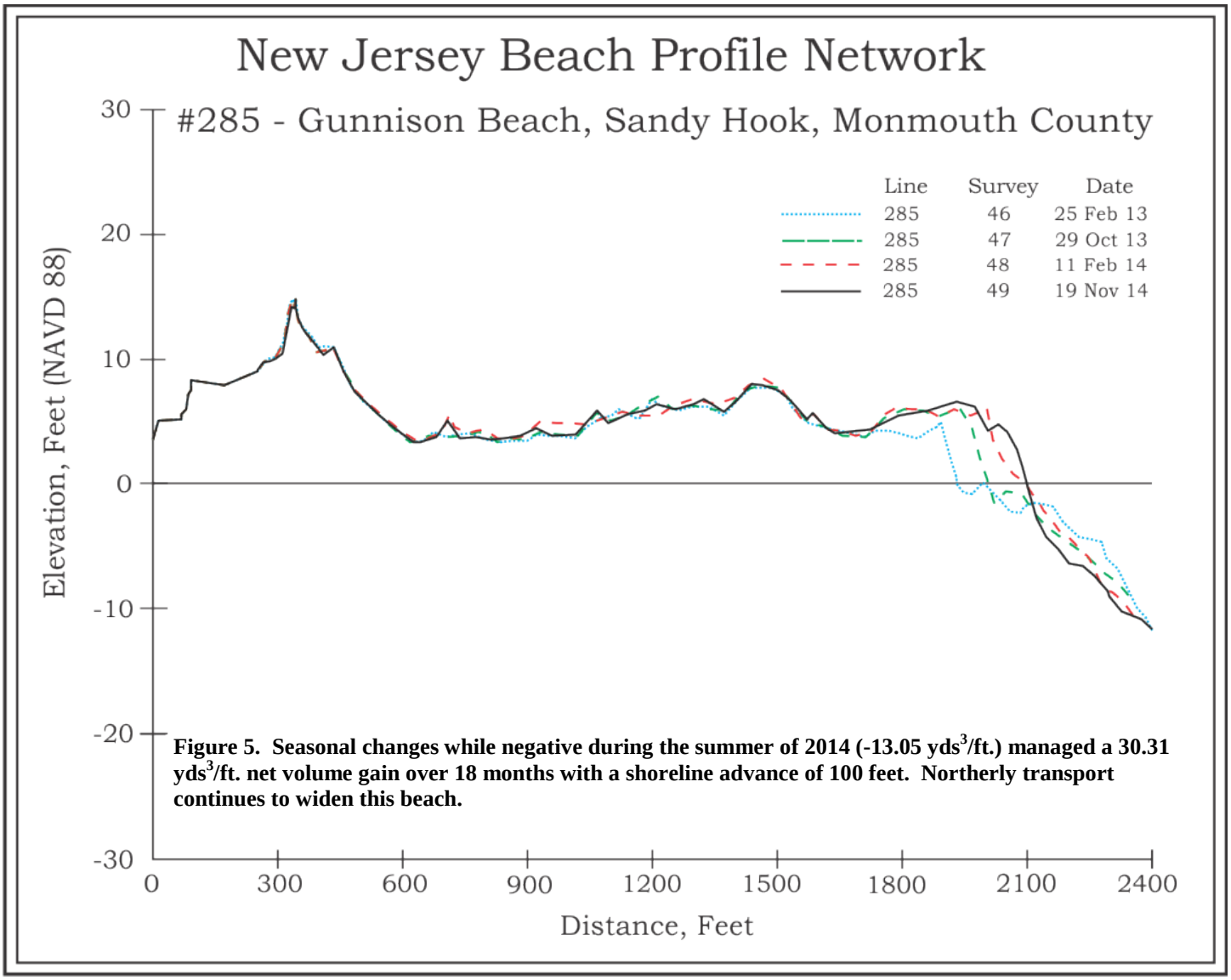


Figure 5. Seasonal changes while negative during the summer of 2014 (-13.05 yds^3/ft.) managed a 30.31 yds^3/ft. net volume gain over 18 months with a shoreline advance of 100 feet. Northerly transport continues to widen this beach.

NJBPN 284 – Parking Lot E, Sandy Hook National Seashore

On the left is a beach picture from October 29, 2013 looking north along the shoreline. The same perspective on November 19, 2014 shows a slightly wider beach with an essentially identical configuration.

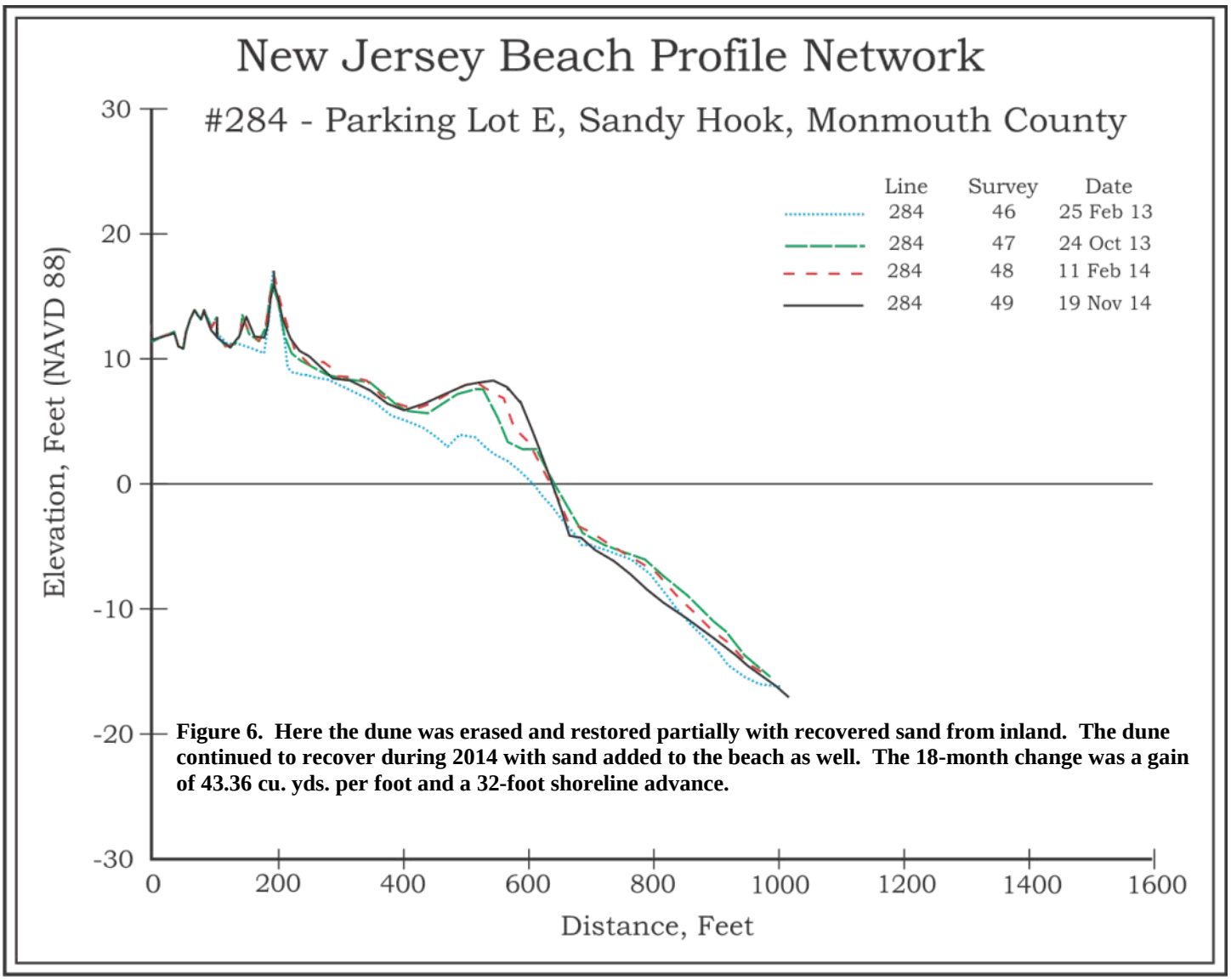


Figure 6. Here the dune was erased and restored partially with recovered sand from inland. The dune continued to recover during 2014 with sand added to the beach as well. The 18-month change was a gain of 43.36 cu. yds. per foot and a 32-foot shoreline advance.

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 October 29, 2013 after the ACOE had returned and placed sand to design template cross section. Erosion of the berm is evident following a minor NE storm. By November 19, 2014 added sand had extended the profile seaward. Coastal littoral transport moved sand north from sites further south.

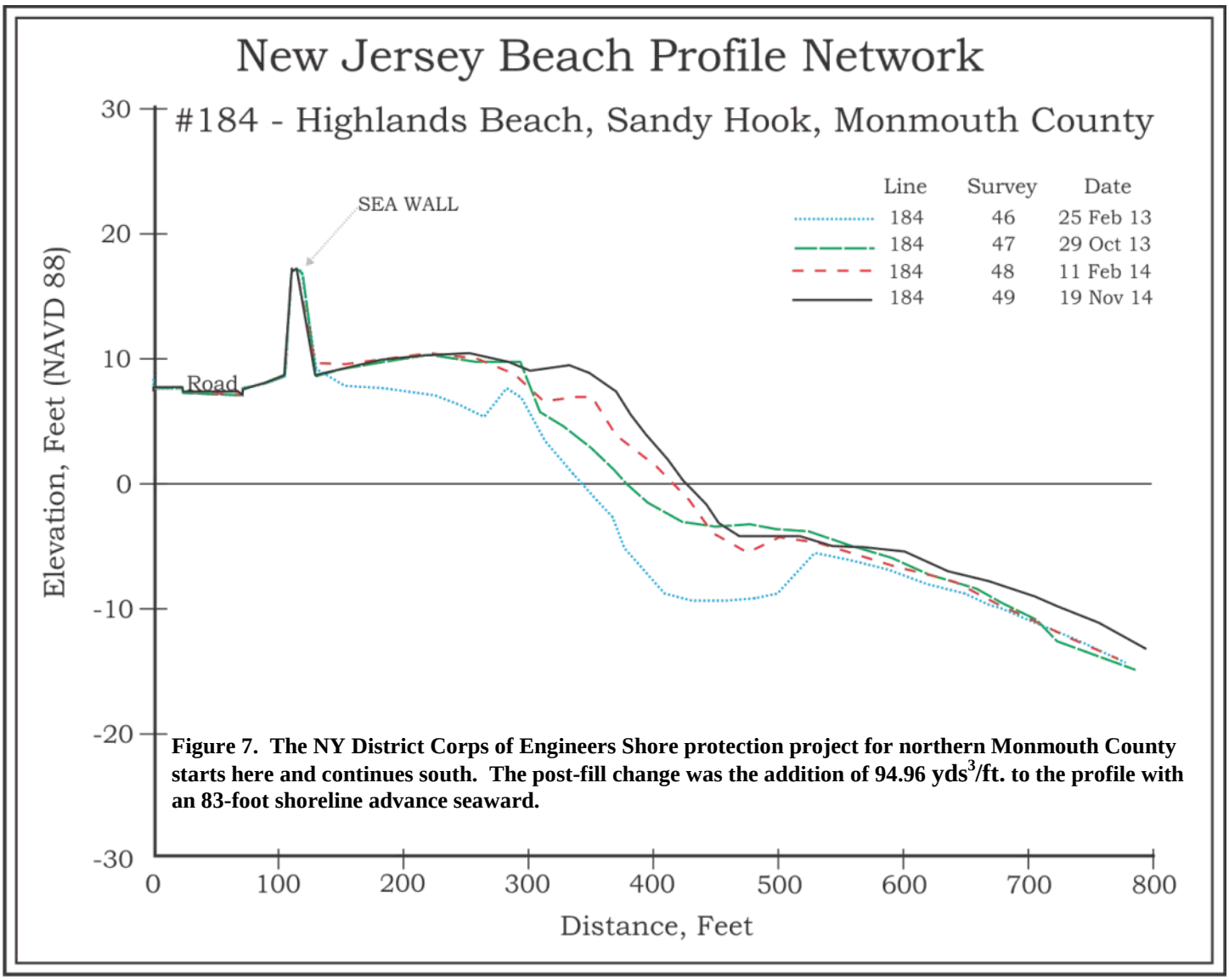


Figure 7. The NY District Corps of Engineers Shore protection project for northern Monmouth County starts here and continues south. The post-fill change was the addition of 94.96 $yds^3/ft.$ to the profile with an 83-foot shoreline advance seaward.

NJBPN 183 – Via Ripa Street, Sea Bright

This site is near the northern limit of the initial Federal shore protection. The left side shows the results of the placement of 40.12 yds^3/ft. of new sand on the beach by Oct 17, 2013, while the right side (Oct. 8, 2014) shows the added dune.

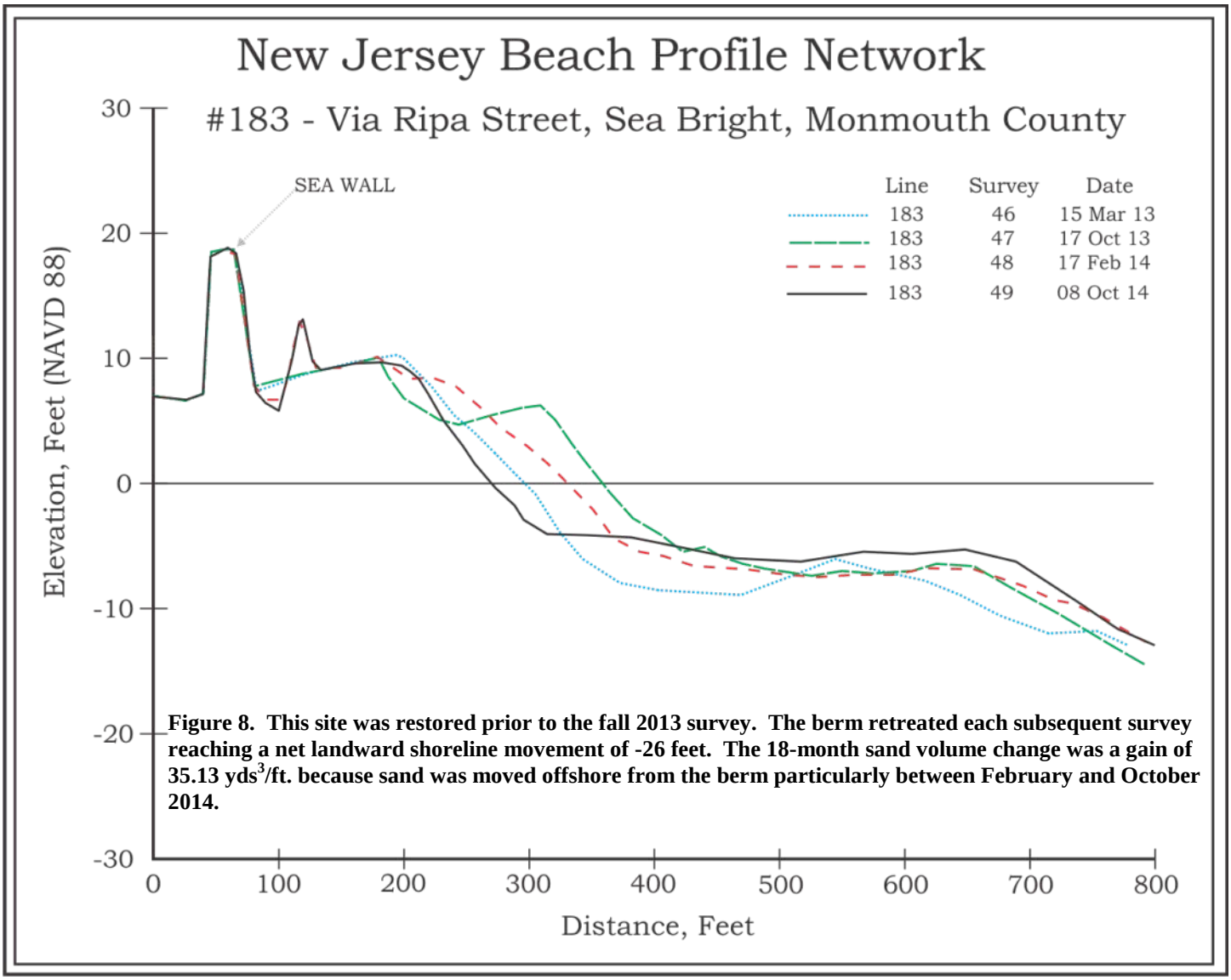


Figure 8. This site was restored prior to the fall 2013 survey. The berm retreated each subsequent survey reaching a net landward shoreline movement of -26 feet. The 18-month sand volume change was a gain of 35.13 yds^3/ft. because sand was moved offshore from the berm particularly between February and October 2014.

The left view shows ACOE pumped sand back to the original design cross section and the sand the storm pushed up the seaward face of the seawall was extracted and formed into the dune seen on the left view October 17, 2013. A wide, new berm accumulated between February and October 2014 adding 42.25 yds^3/ft. to the profile.

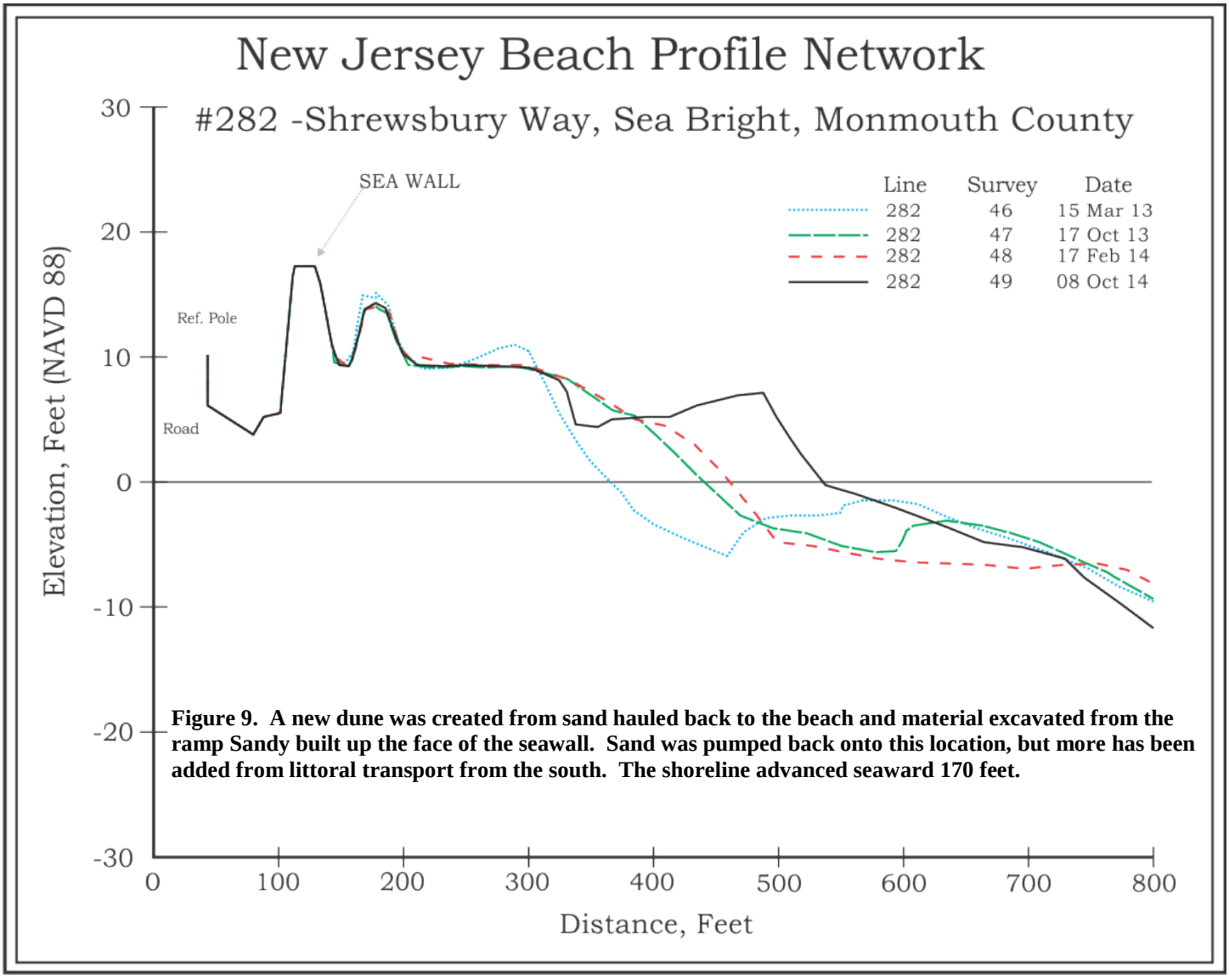


Figure 9. A new dune was created from sand hauled back to the beach and material excavated from the ramp Sandy built up the face of the seawall. Sand was pumped back onto this location, but more has been added from littoral transport from the south. The shoreline advanced seaward 170 feet.

NJBPN 182 – Public Beach, Sea Bright

By October 8, 2013 the ACOE 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 was modified over the winter with more material deposited as a berm.

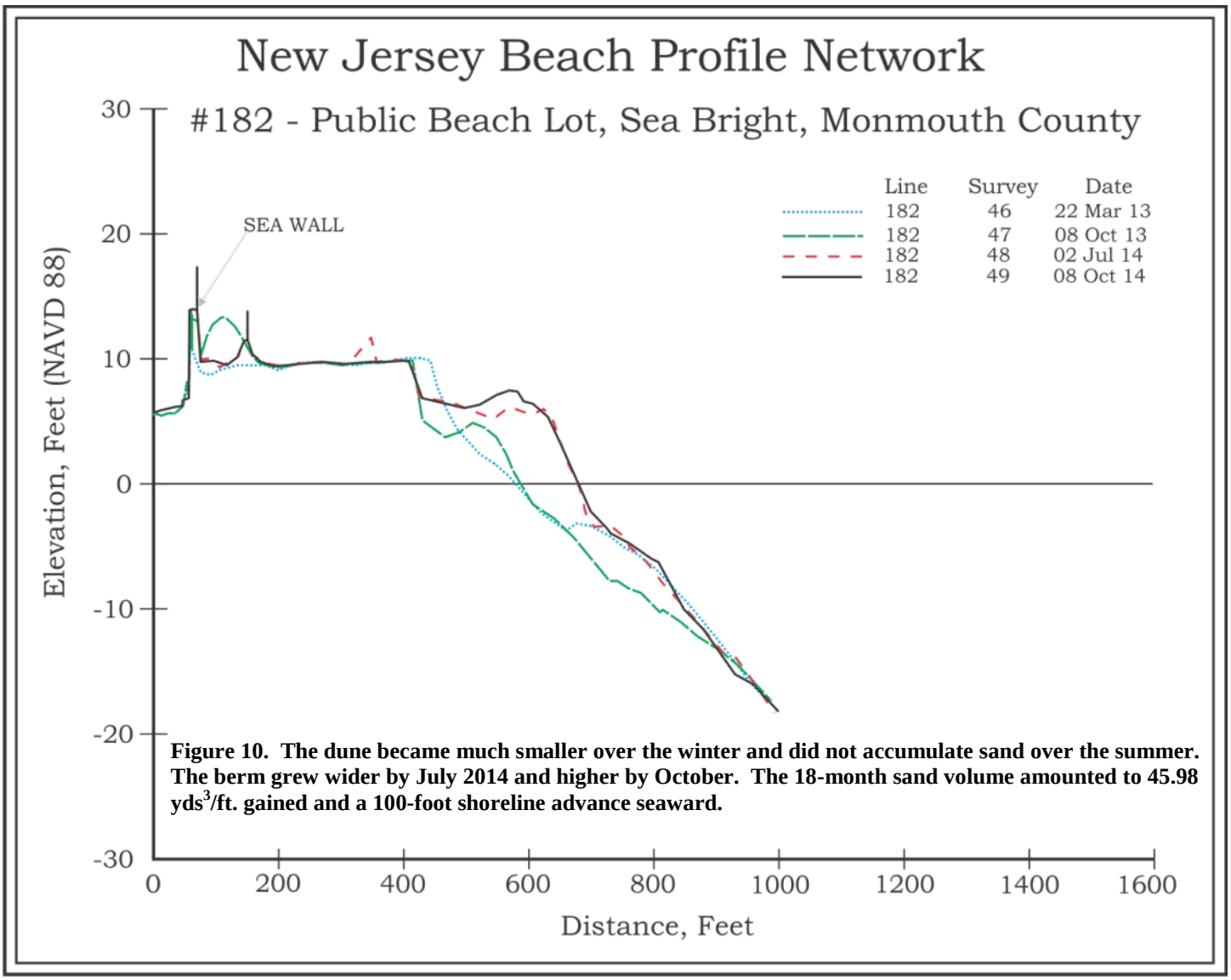


Figure 10. The dune became much smaller over the winter and did not accumulate sand over the summer. The berm grew wider by July 2014 and higher by October. The 18-month sand volume amounted to 45.98 yds^3/ft. gained and a 100-foot shoreline advance seaward.

NJBPN 181 – Municipal Beach, Sea Bright

By October 8, 2013 the ACOE had deposited 110.88 yds^3/ft. to restore the design cross section. The view one year later (Oct. 8, 2014) shows the new deck and access ramp to the beach.

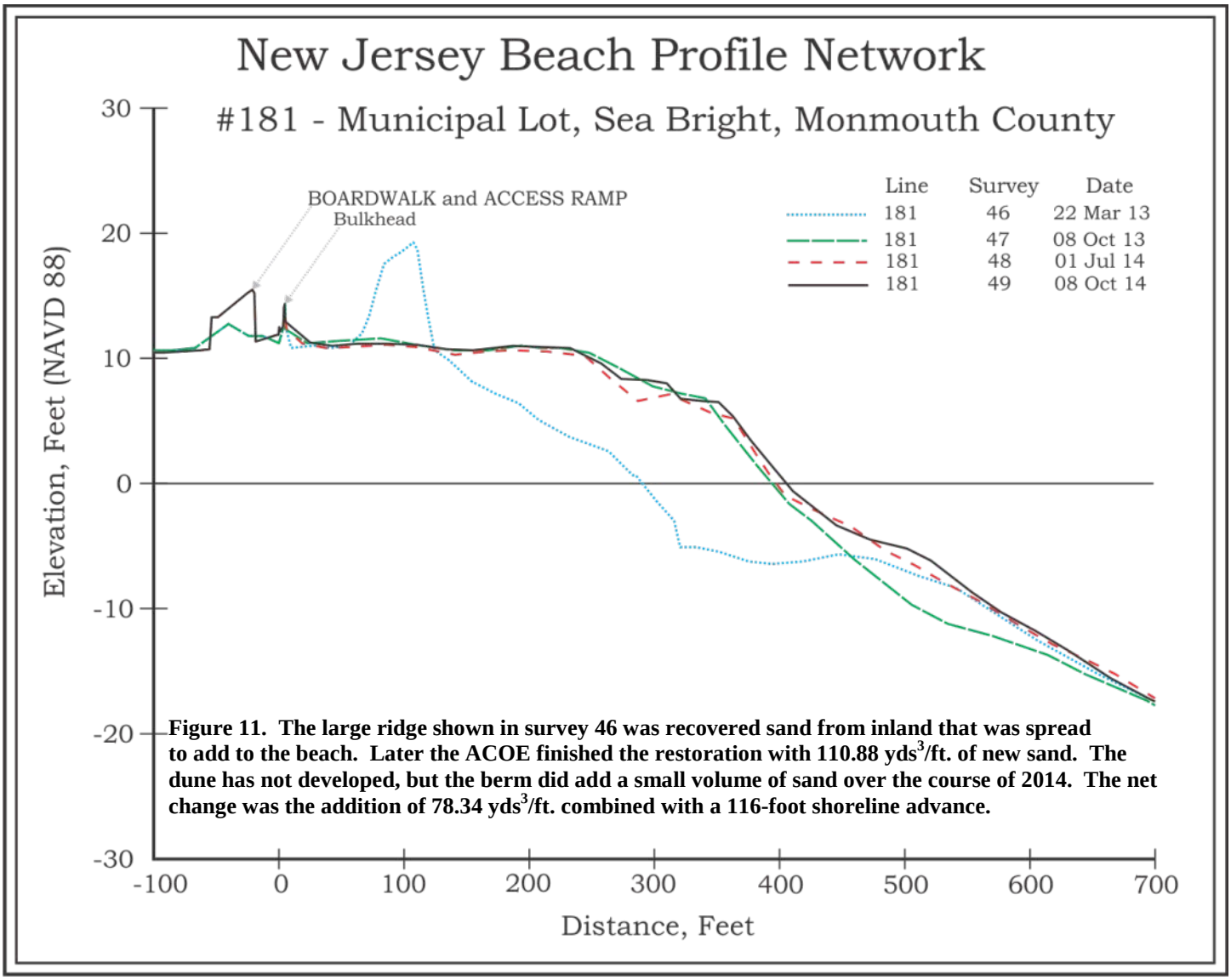


Figure 11. The large ridge shown in survey 46 was recovered sand from inland that was spread to add to the beach. Later the ACOE finished the restoration with 110.88 yds^3/ft. of new sand. The dune has not developed, but the berm did add a small volume of sand over the course of 2014. The net change was the addition of 78.34 yds^3/ft. combined with a 116-foot shoreline advance.

NJBPN 180 – Sunset Court, Sea Bright

The restoration by the ACOE had just been completed in the left photo taken October 8, 2013 with the addition of 101.64 yds^3/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 over the course of 2014.

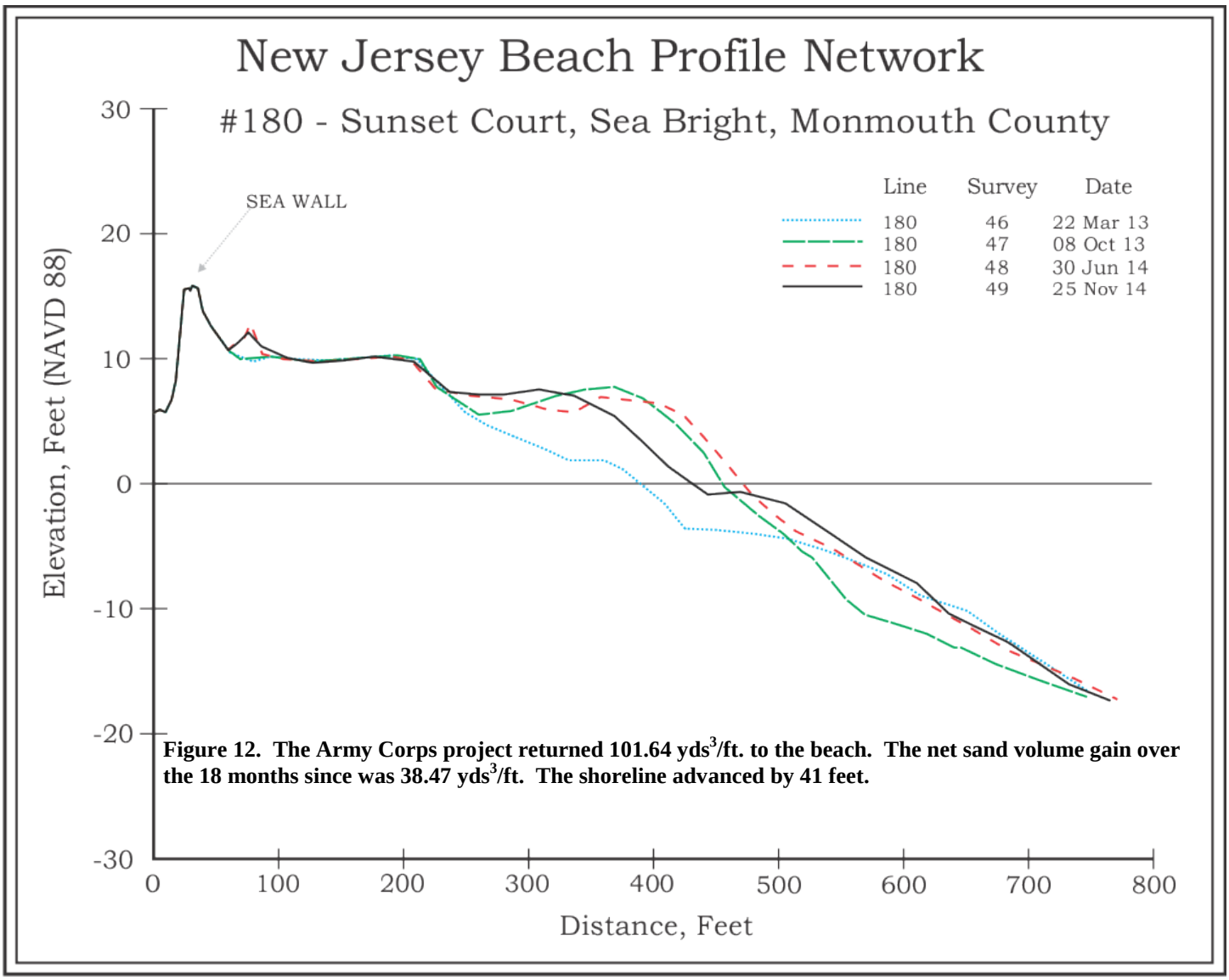


Figure 12. The Army Corps project returned 101.64 yds^3/ft. to the beach. The net sand volume gain over the 18 months since was 38.47 yds^3/ft. The shoreline advanced by 41 feet.

NJBPN 179 – Cottage Road, Monmouth Beach

This site has the worst erosion history of any site in Monmouth County. The left photograph Oct. 4, 2013 shows the completed work by the ACOE (182.99 yds^3/ft. added to the beach). On the right the existing beach has narrowed with no dune built on site.

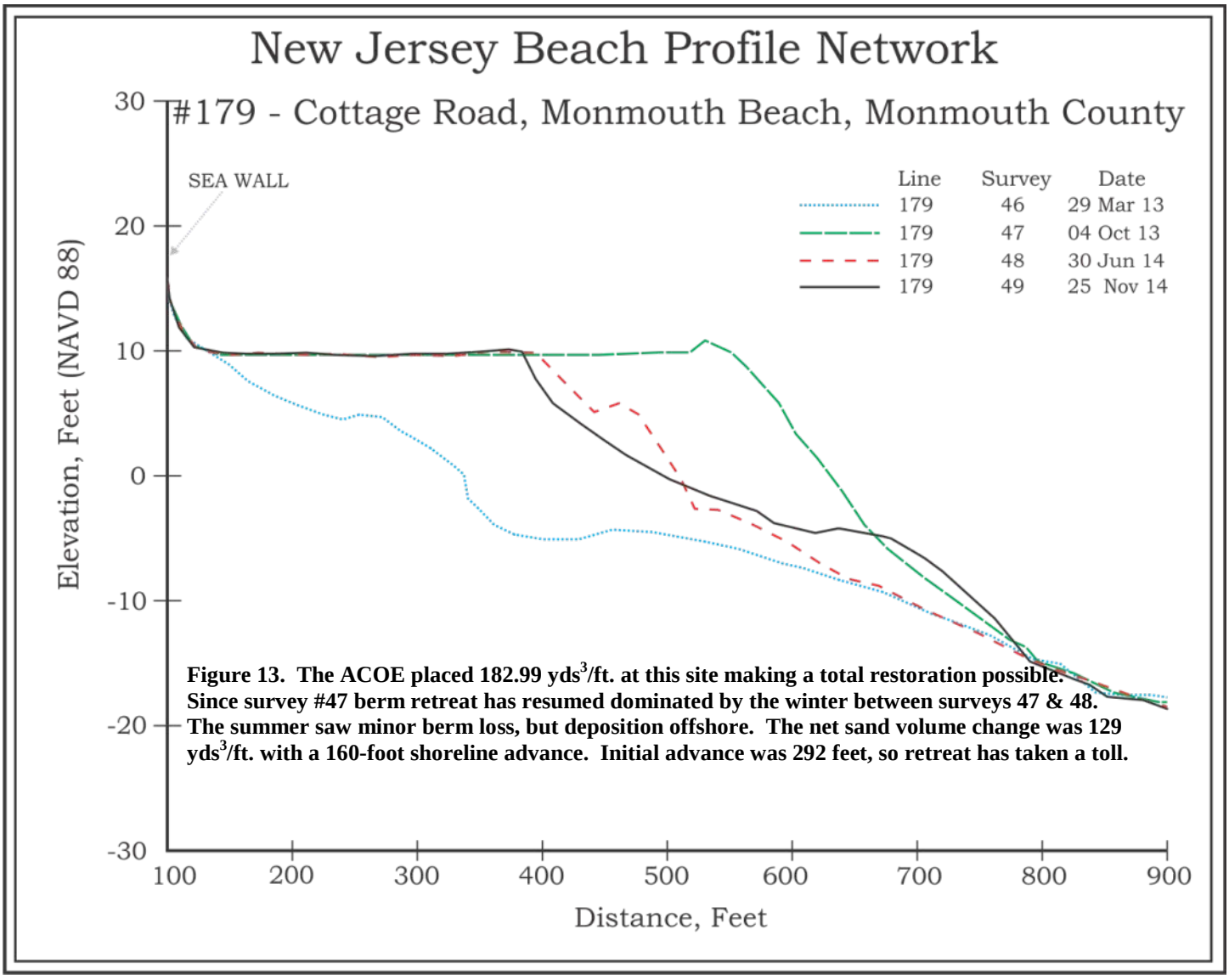


Figure 13. The ACOE placed 182.99 yds^3/ft. at this site making a total restoration possible. Since survey #47 berm retreat has resumed dominated by the winter between surveys 47 & 48. The summer saw minor berm loss, but deposition offshore. The net sand volume change was 129 yds^3/ft. with a 160-foot shoreline advance. Initial advance was 292 feet, so retreat has taken a toll.

NJBPN 178 – Monmouth Beach Club, Monmouth Beach

The left photo taken October 4, 2013 shows the results of the ACOE work to restore the project to design specifications (140.98 yds^3/ft. of added sand). To the right the beach remains substantial by November 25, 2014.

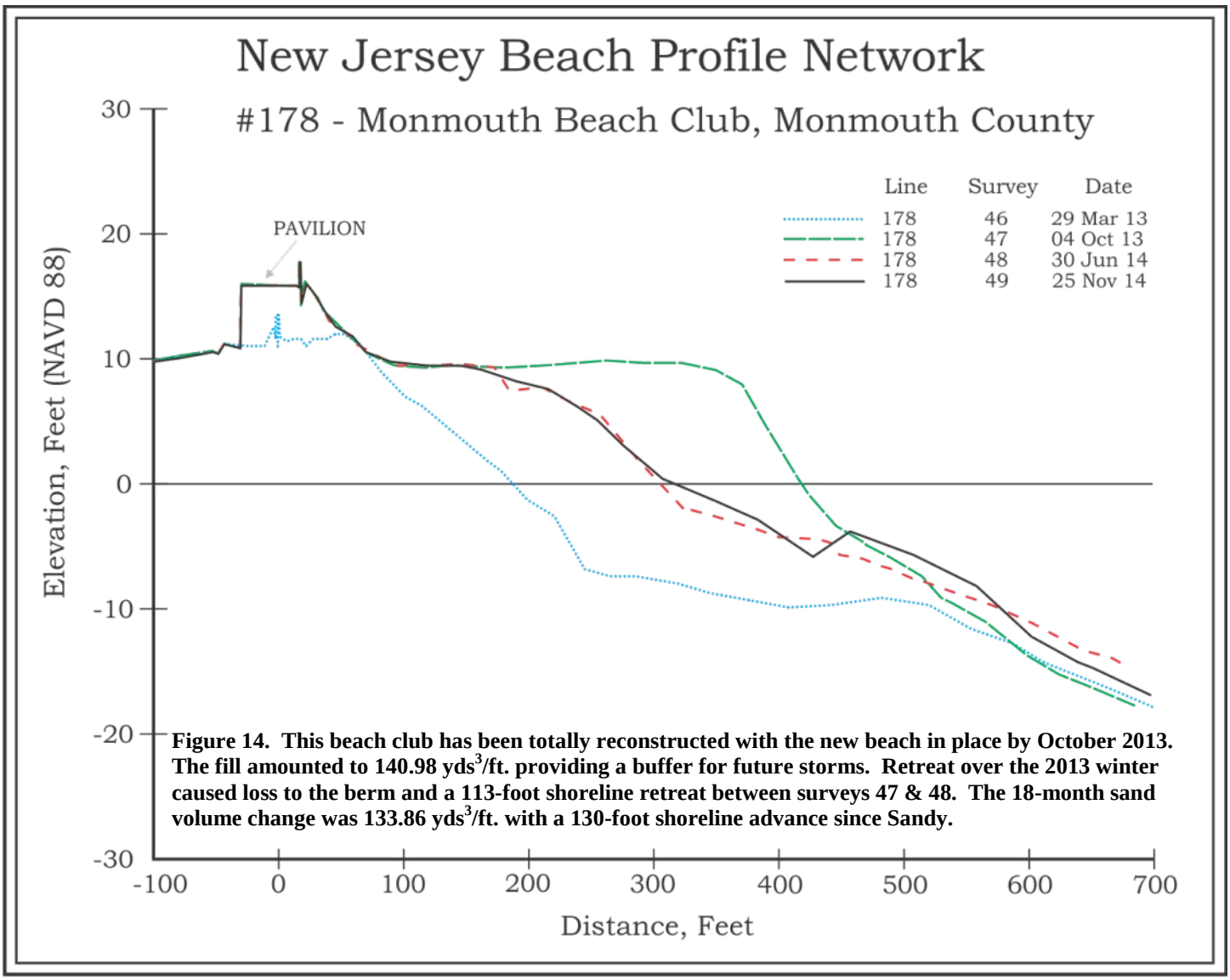


Figure 14. This beach club has been totally reconstructed with the new beach in place by October 2013. The fill amounted to 140.98 yds^3/ft. providing a buffer for future storms. Retreat over the 2013 winter caused loss to the berm and a 113-foot shoreline retreat between surveys 47 & 48. The 18-month sand volume change was 133.86 yds^3/ft. with a 130-foot shoreline advance since Sandy.

NJBPN 177 – 404 Ocean Avenue, Long Branch

The left photo was taken October 4, 2013 following the recovery of 22.93 yds^3/ft. on the beach naturally, prior to the arrival of the ACOE to complete the northern segment of their project. The beach gained 123.04 yds^3/ft. over the 18-month interval. The shoreline advanced 185 feet as well.

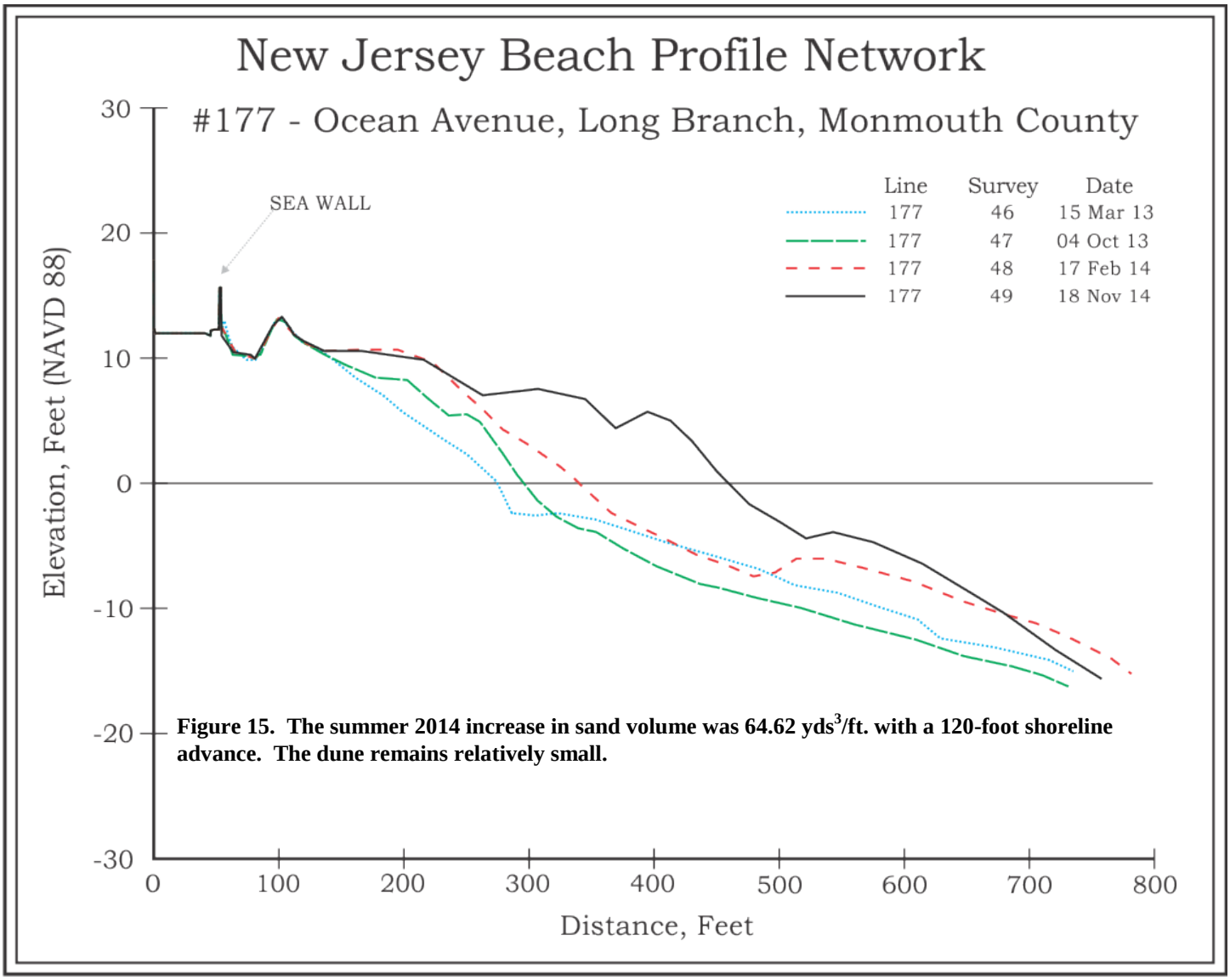


Figure 15. The summer 2014 increase in sand volume was 64.62 yds^3/ft. with a 120-foot shoreline advance. The dune remains relatively small.

NJBPN 176 – Seven President's Park, Long Branch

This site is a popular recreational park with a partial ridge of 25-foot elevation dunes. Natural recovery added 20.68 yds^3/ft. to the beach prior to the ACOE work (left photo taken October 3, 2013) and by survey #48, the sand volume increased by 115.73 yds^3/ft.

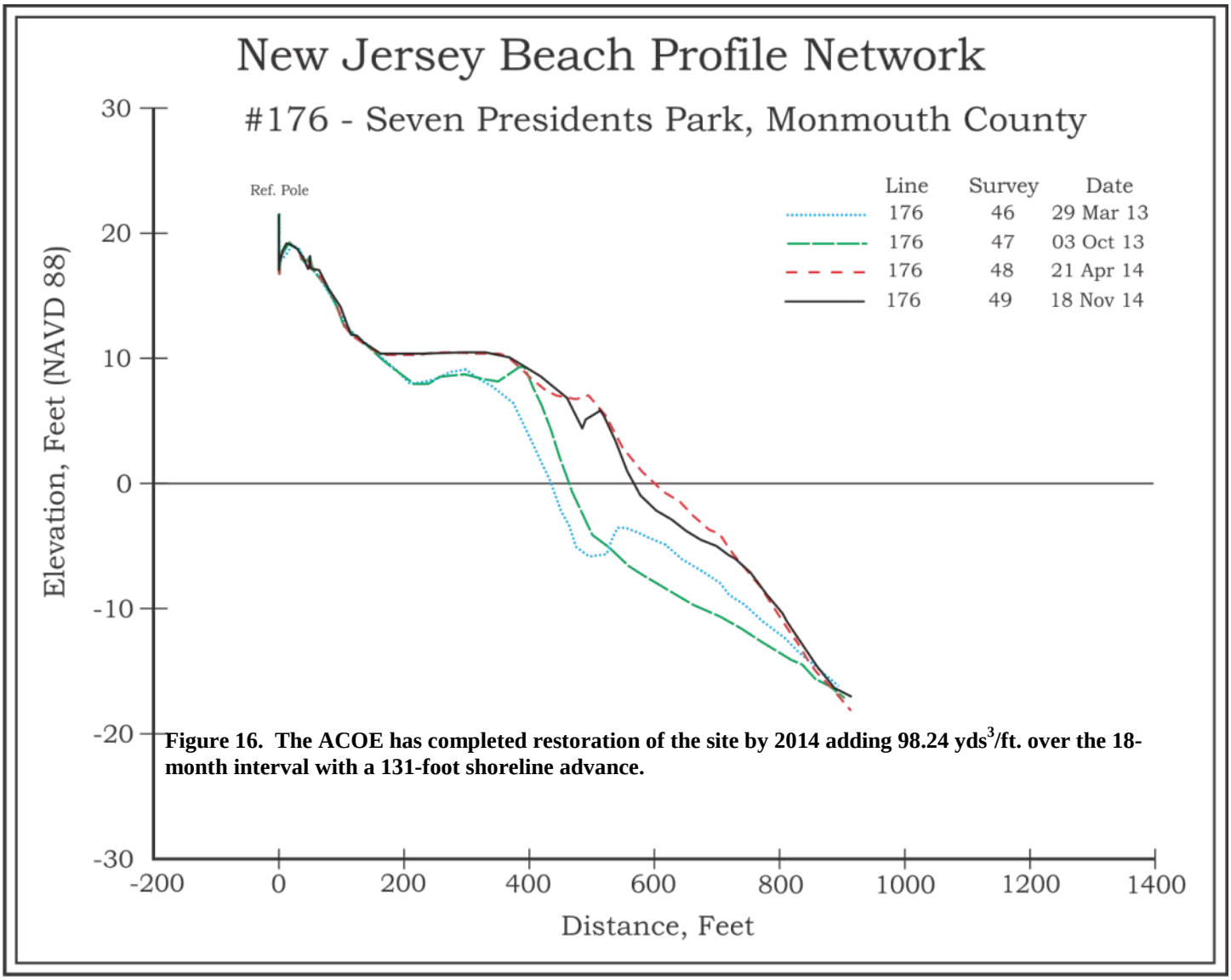
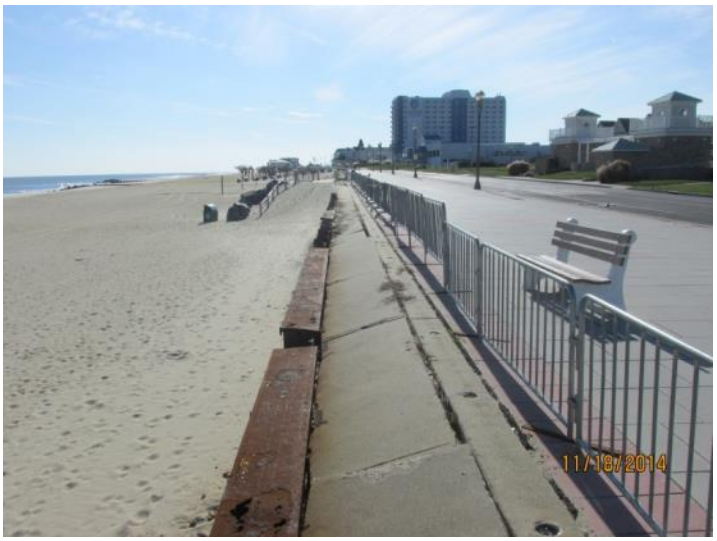


Figure 16. The ACOE has completed restoration of the site by 2014 adding 98.24 yds^3/ft. over the 18-month interval with a 131-foot shoreline advance.

NJBPN 175 – Broadway Avenue, Long Branch



Natural recovery from the offshore deposits added 22.72 yds^3/ft. to the beach prior to 2014 ACOE restoration activities. The right photograph taken November 18, 2014 shows a wider beach relative to the rock groins compared to the left photo.

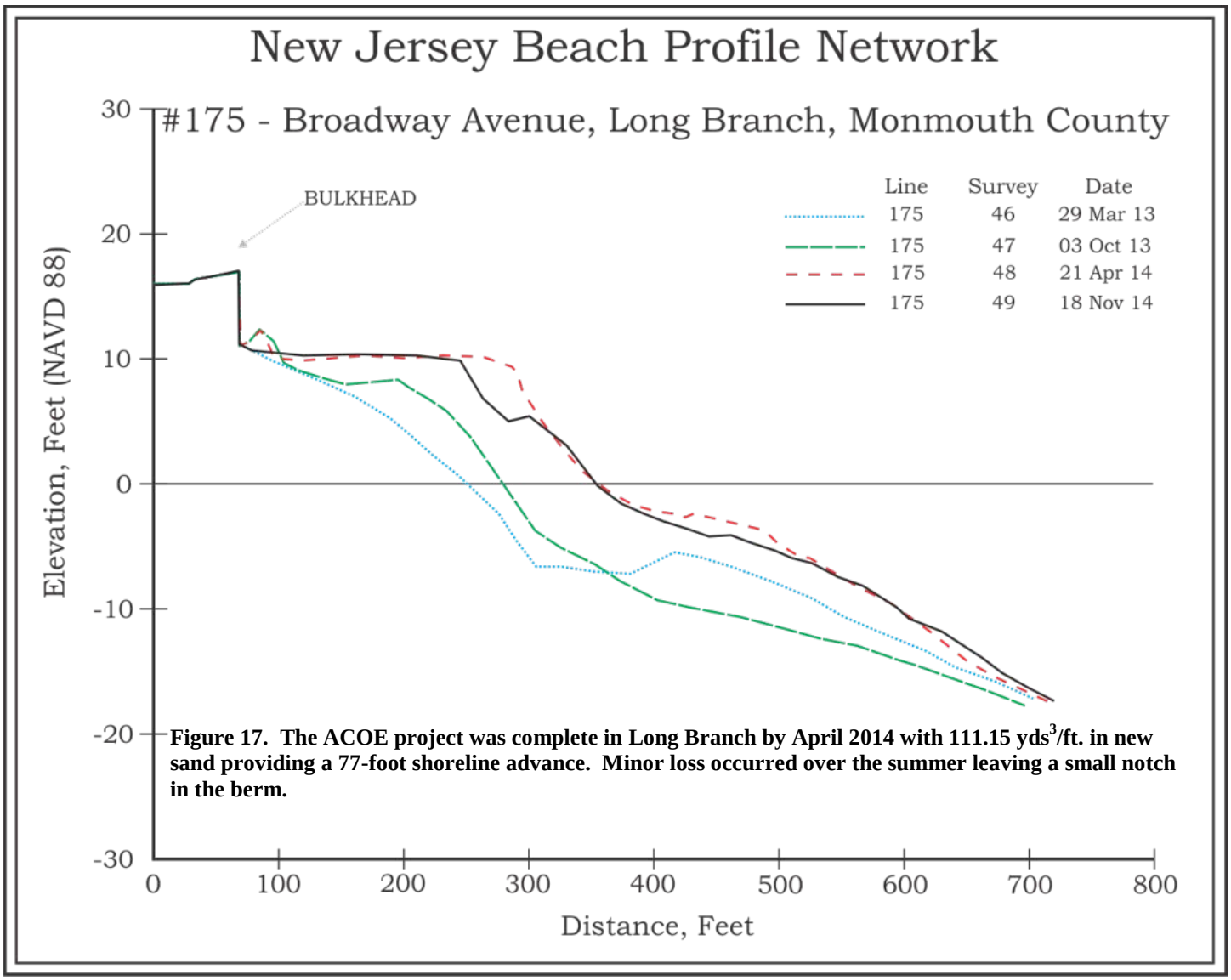


Figure 17. The ACOE project was complete in Long Branch by April 2014 with 111.15 yds^3/ft. in new sand providing a 77-foot shoreline advance. Minor loss occurred over the summer leaving a small notch in the berm.

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 right picture taken December 3, 2014.

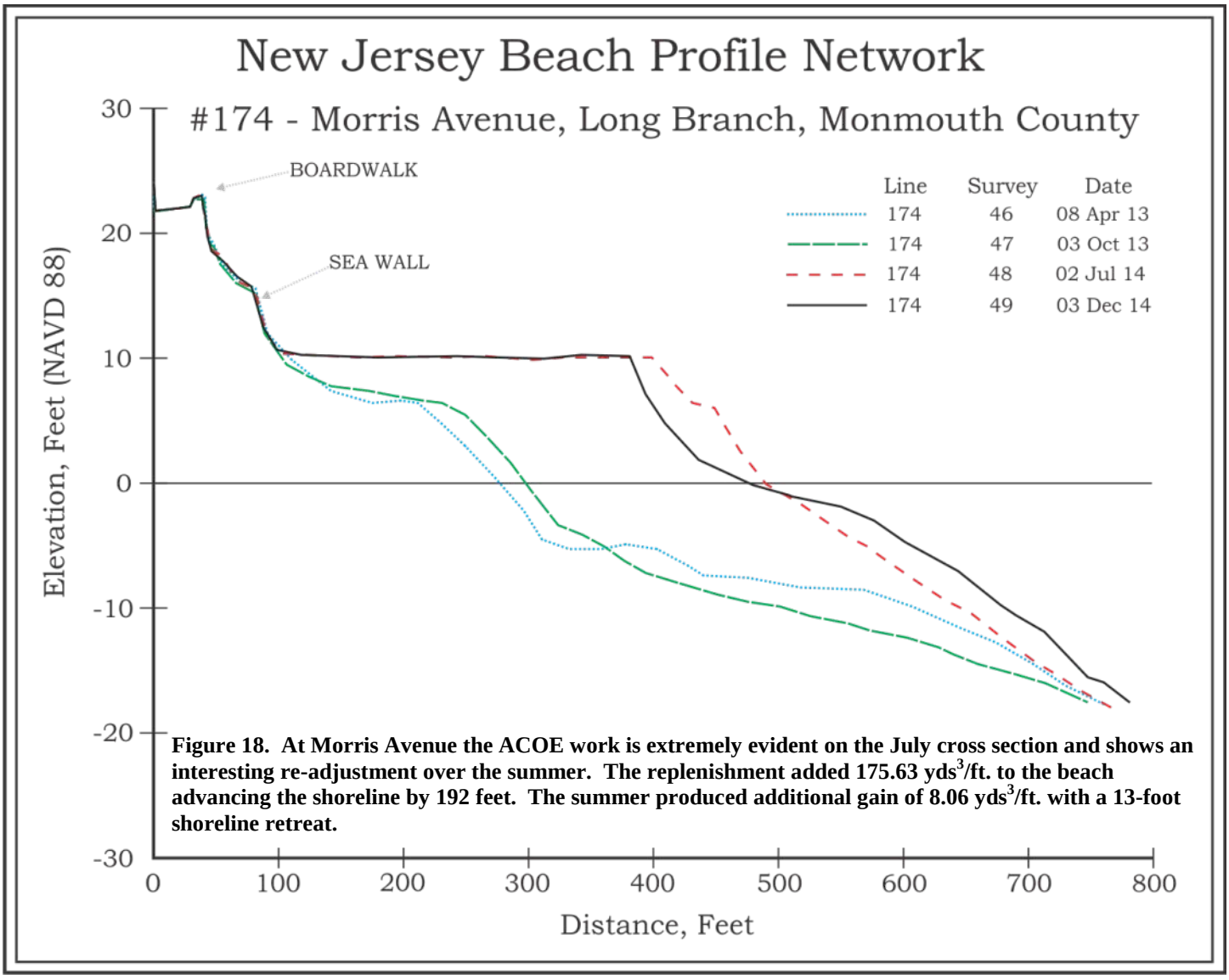


Figure 18. At Morris Avenue the ACOE work is extremely evident on the July cross section and shows an interesting re-adjustment over the summer. The replenishment added 175.63 yds^3/ft. to the beach advancing the shoreline by 192 feet. The summer produced additional gain of 8.06 yds^3/ft. with a 13-foot shoreline retreat.

NJBPN 173 – West End Avenue, Long Branch

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 3rd view shows artwork on one revetment rock re-deposited on the seawall, looking over the new federal beach.

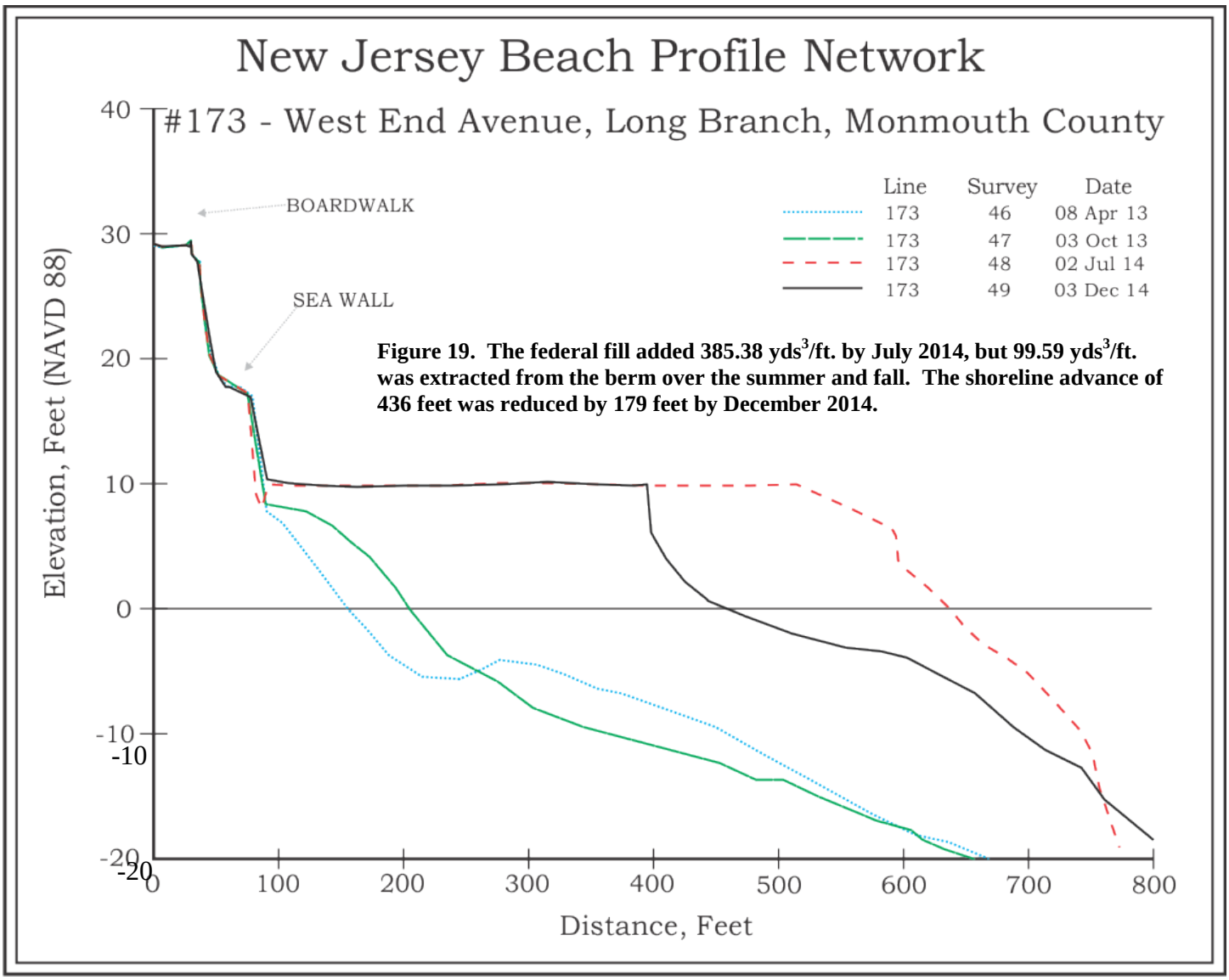


Figure 19. The federal fill added 385.38 yds^3/ft. by July 2014, but 99.59 yds^3/ft. was extracted from the berm over the summer and fall. The shoreline advance of 436 feet was reduced by 179 feet by December 2014.

NJBPN 272 – 805 Ocean Ave, Long Branch

This site, established in 2010, is located on the northeastern edge of Lake Takanassee and within a groin compartment. On the left (Oct. 17, 2013) the swash zone and beach extends to the north. The ACOE restoration effort extended to the south into Elberon during 2014.

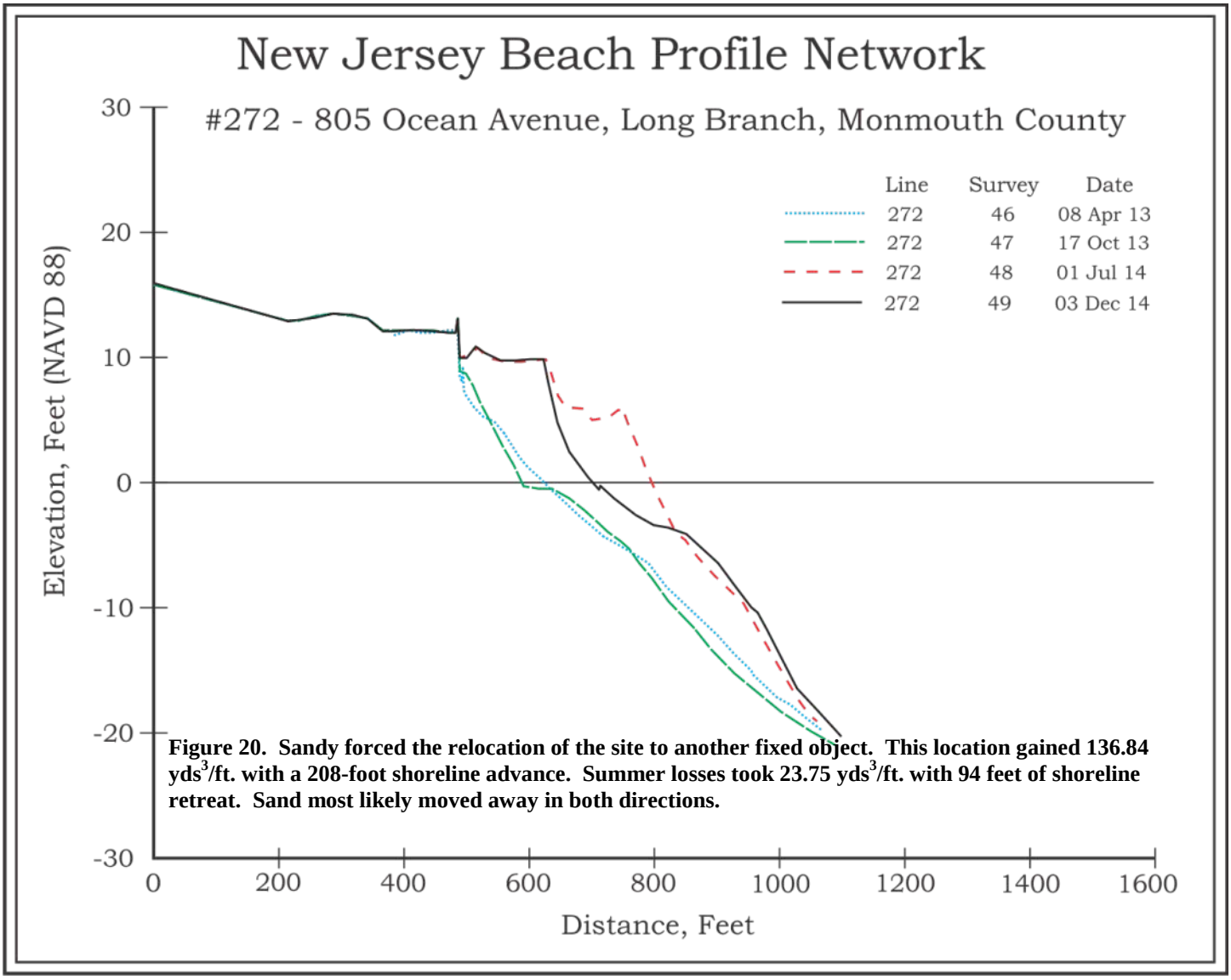


Figure 20. Sandy forced the relocation of the site to another fixed object. This location gained 136.84 yds^3/ft. with a 208-foot shoreline advance. Summer losses took 23.75 yds^3/ft. with 94 feet of shoreline retreat. Sand most likely moved away in both directions.

NJBPN 171 – Pullman Avenue, Elberon

This site is located on the highest point along the bluff shoreline and erosion of the bluff generated the first dry beach ever seen October 2, 2013. Over a year later the beach is narrower, but still present.

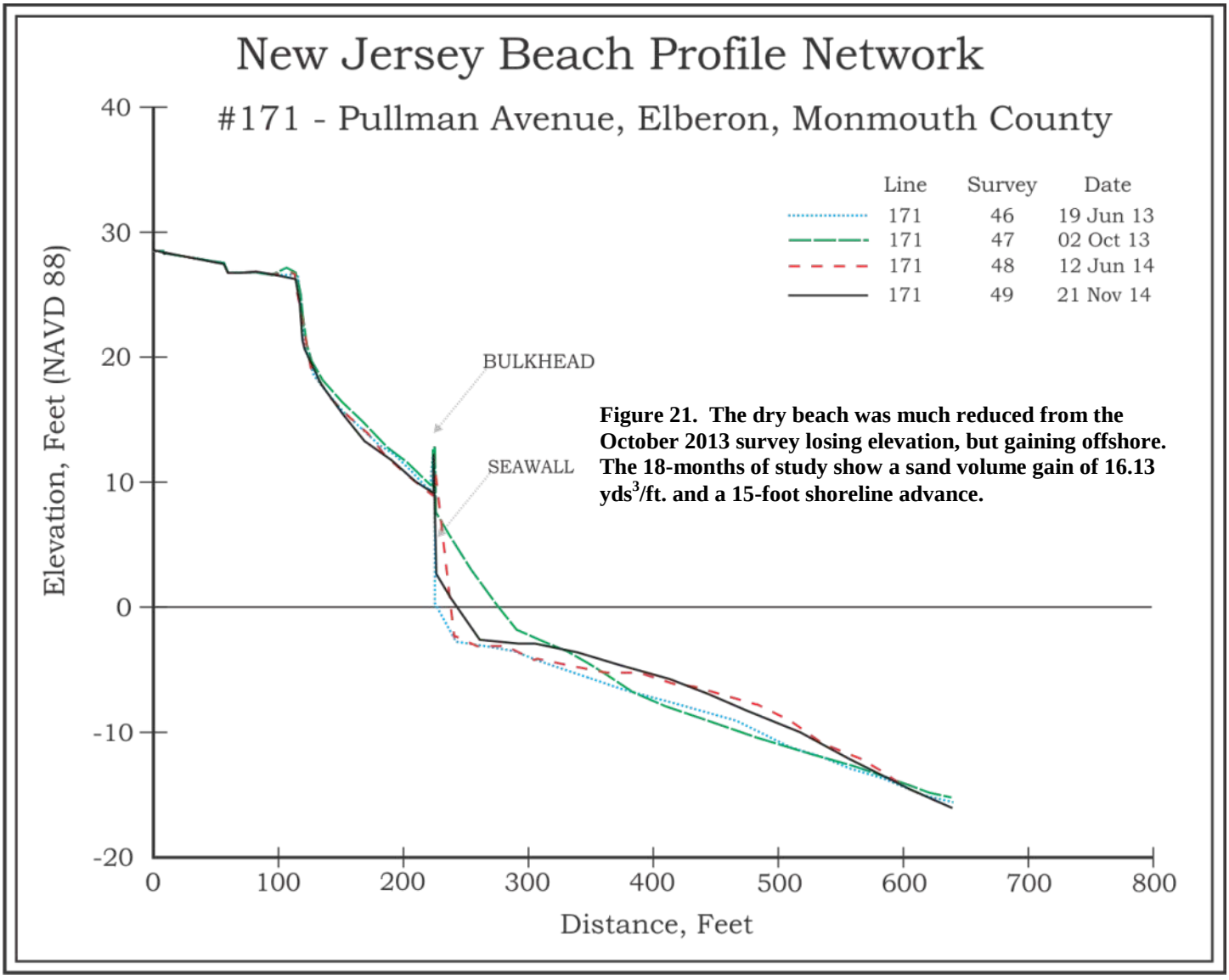


Figure 21. The dry beach was much reduced from the October 2013 survey losing elevation, but gaining offshore. The 18-months of study show a sand volume gain of 16.13 yds^3/ft. and a 15-foot shoreline advance.

NJBPN 170 – Roosevelt Avenue, Deal

This profile is located between two rock groins that limit sediment movement. This area has never received sand from direct beach nourishment and has never benefited from the addition of sand from the littoral system derived from the Federal beach fills. The photo on the left (taken October 2, 2013) shows the deposit of sand derived from the storm erosion of the bluff. By November 21, 2014 sand moved offshore and adjusted lower at the rocks.

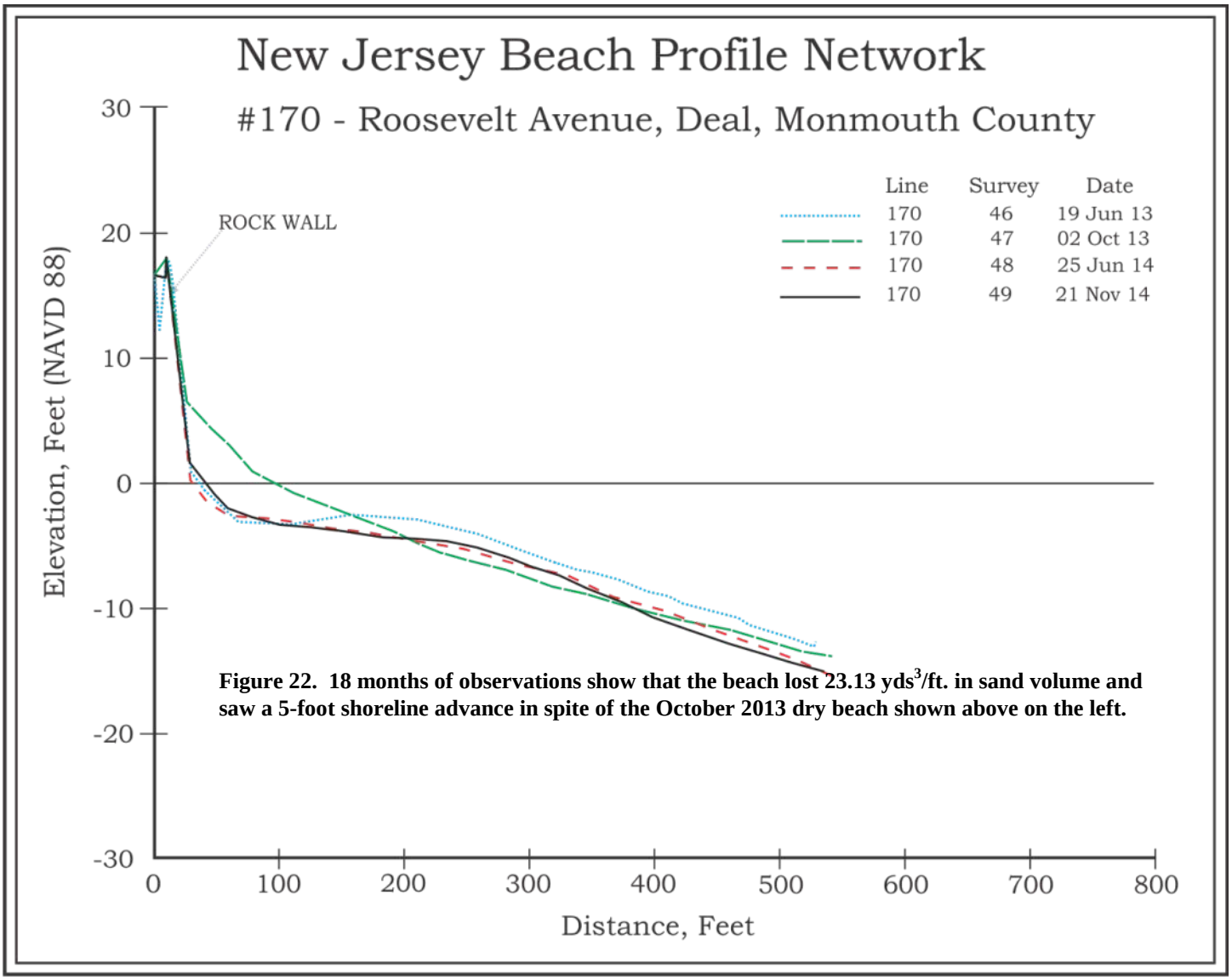


Figure 22. 18 months of observations show that the beach lost 23.13 yds^3/ft. in sand volume and saw a 5-foot shoreline advance in spite of the October 2013 dry beach shown above on the left.

NJBPN 169 – Darlington Avenue, Deal

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 October 2, 2013 (left) natural recovery added 21.60 yds^3/ft. back to the beach with some reconstruction of bluff protection structures. A year later the beach gained 4.72 yds^3/ft. with a 5-foot shoreline advance.

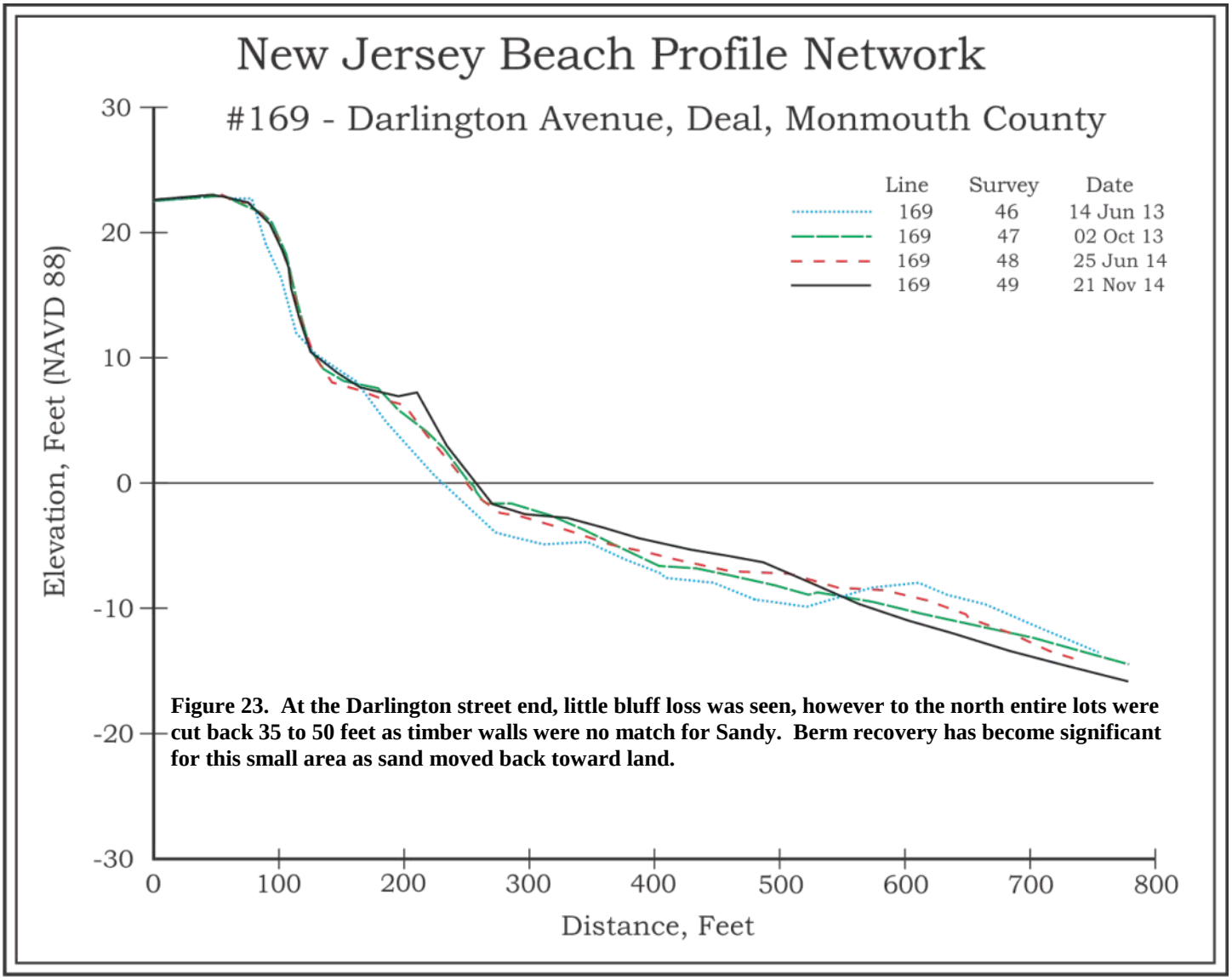


Figure 23. At the Darlington street end, little bluff loss was seen, however to the north entire lots were cut back 35 to 50 feet as timber walls were no match for Sandy. Berm recovery has become significant for this small area as sand moved back toward land.

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 October 1, 2013 when a fairly significant wedge of sand was on the berm. Reduced during the following year, the deposit is still better than it was April 2013.

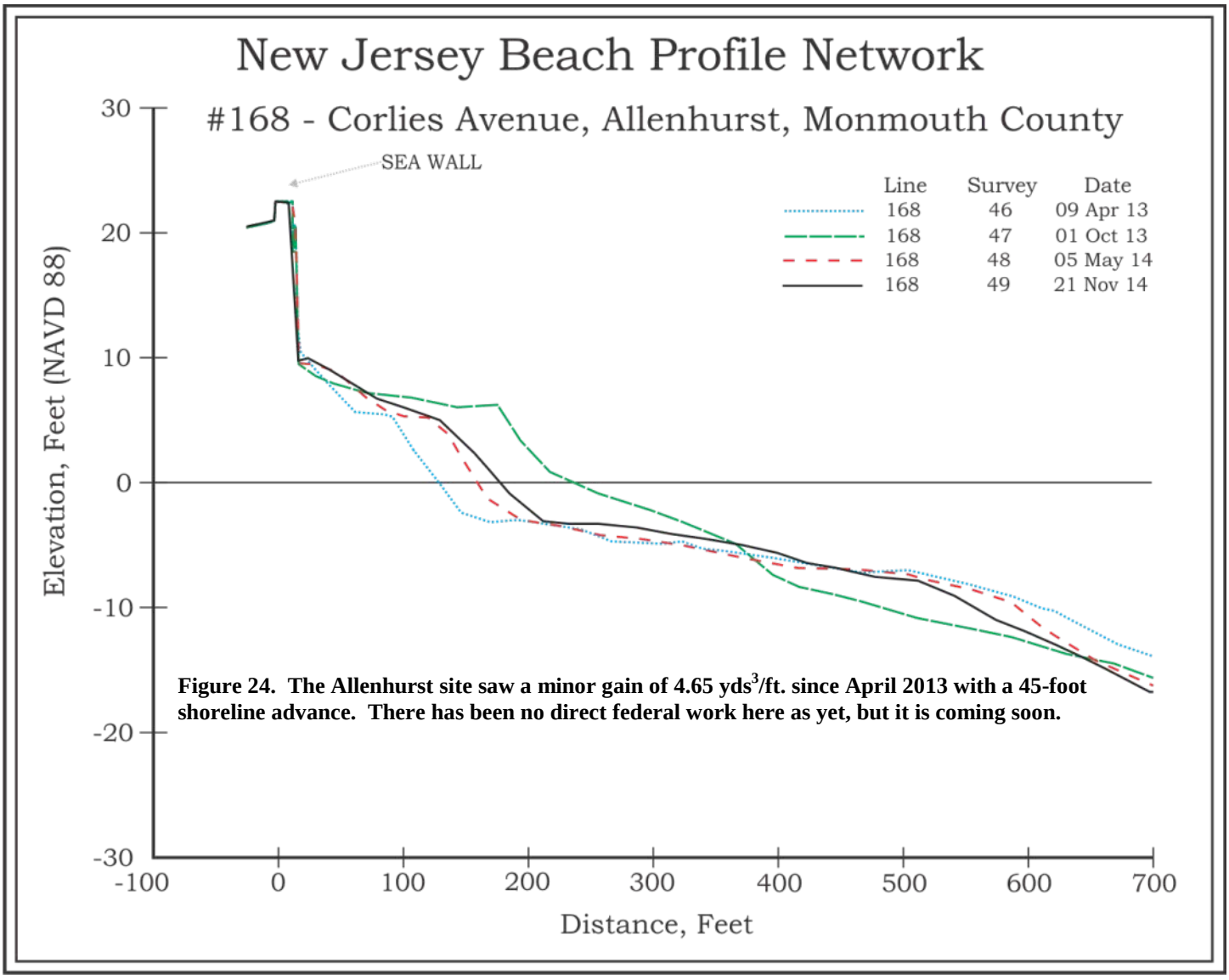


Figure 24. The Allenhurst site saw a minor gain of 4.65 yds^3/ft. since April 2013 with a 45-foot shoreline advance. There has been no direct federal work here as yet, but it is coming soon.

This site is the northernmost site included in the Federal shore protection southern project segment. The left photo (taken on October 1, 2013) showed natural sand recovery. Natural recovery permitted 17.79 yds^3/ft. in offshore deposition to return to the beach. The federal project added 92.68 yds^3/ft. and produced a 100-foot shoreline advance.

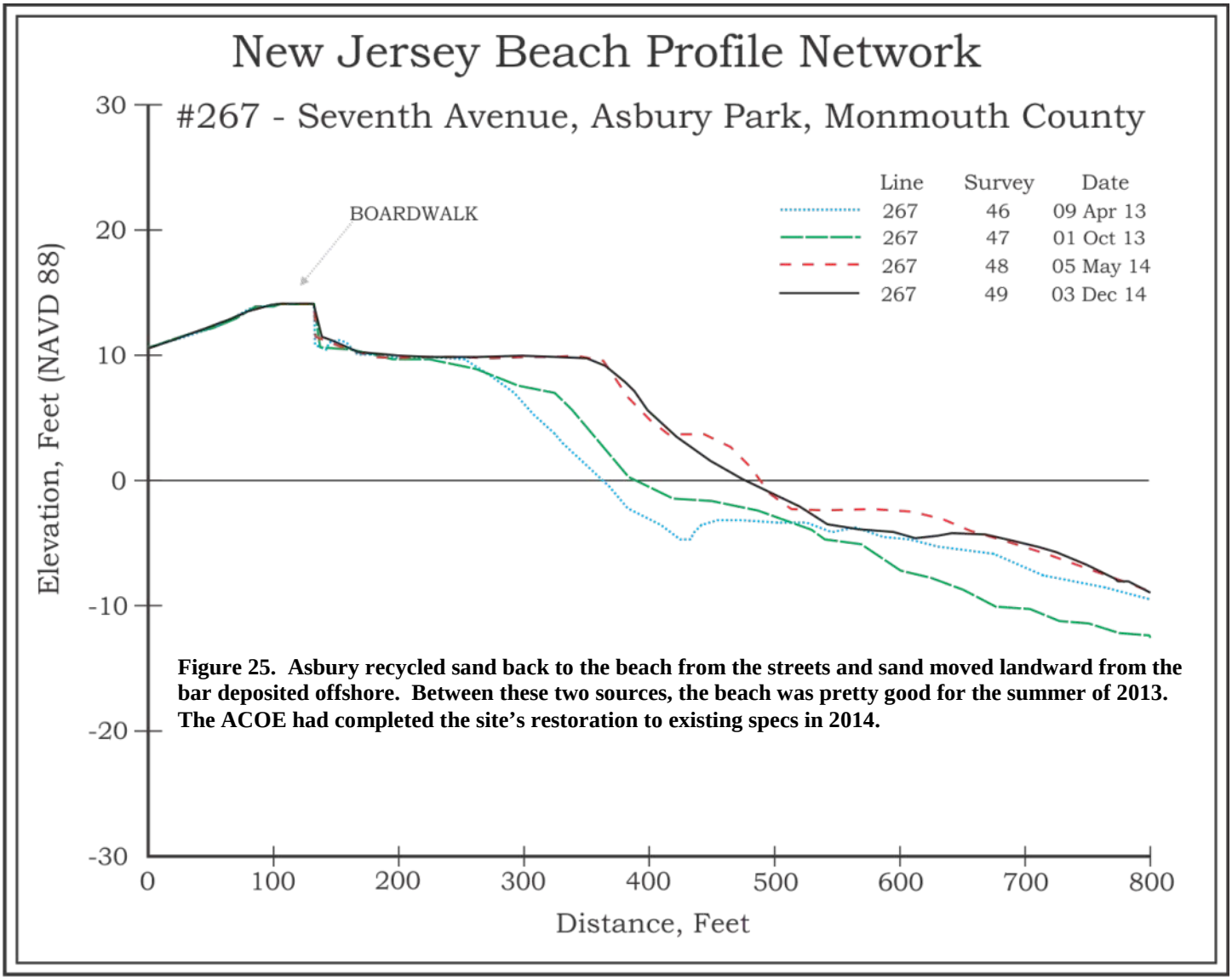


Figure 25. Asbury recycled sand back to the beach from the streets and sand moved landward from the bar deposited offshore. Between these two sources, the beach was pretty good for the summer of 2013. The ACOE had completed the site's restoration to existing specs in 2014.

NJBPN 167 – 3rd Avenue, Asbury Park

By October 1, 2013 natural recovery had restored 26.98 yds^3/ft. to the beach prior to the ACOE completing this southern section's project restoration. The ACOE work added the berm as more sand accumulated offshore.

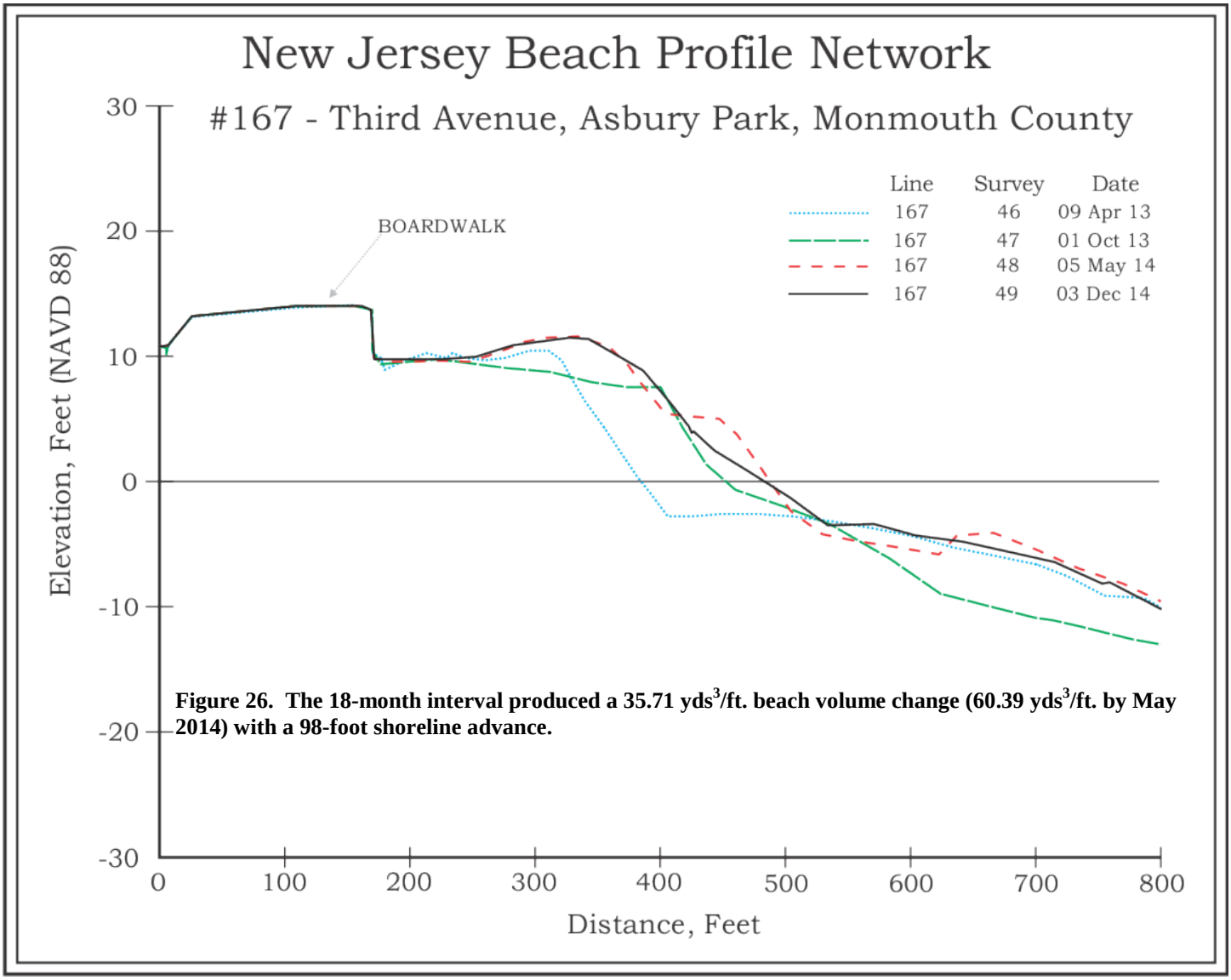


Figure 26. The 18-month interval produced a 35.71 yds^3/ft. beach volume change (60.39 yds^3/ft. by May 2014) with a 98-foot shoreline advance.

NJBPN 166 – Ocean Pathway, Ocean Grove

By September 29, 2013 the beach had recovered 22.65 yds^3/ft. prior to the ACOE commencing restoration work. The sand volume added over the next year amounted to 35.79 yds^3/ft. with a 12-foot shoreline advance (12/11/2014).

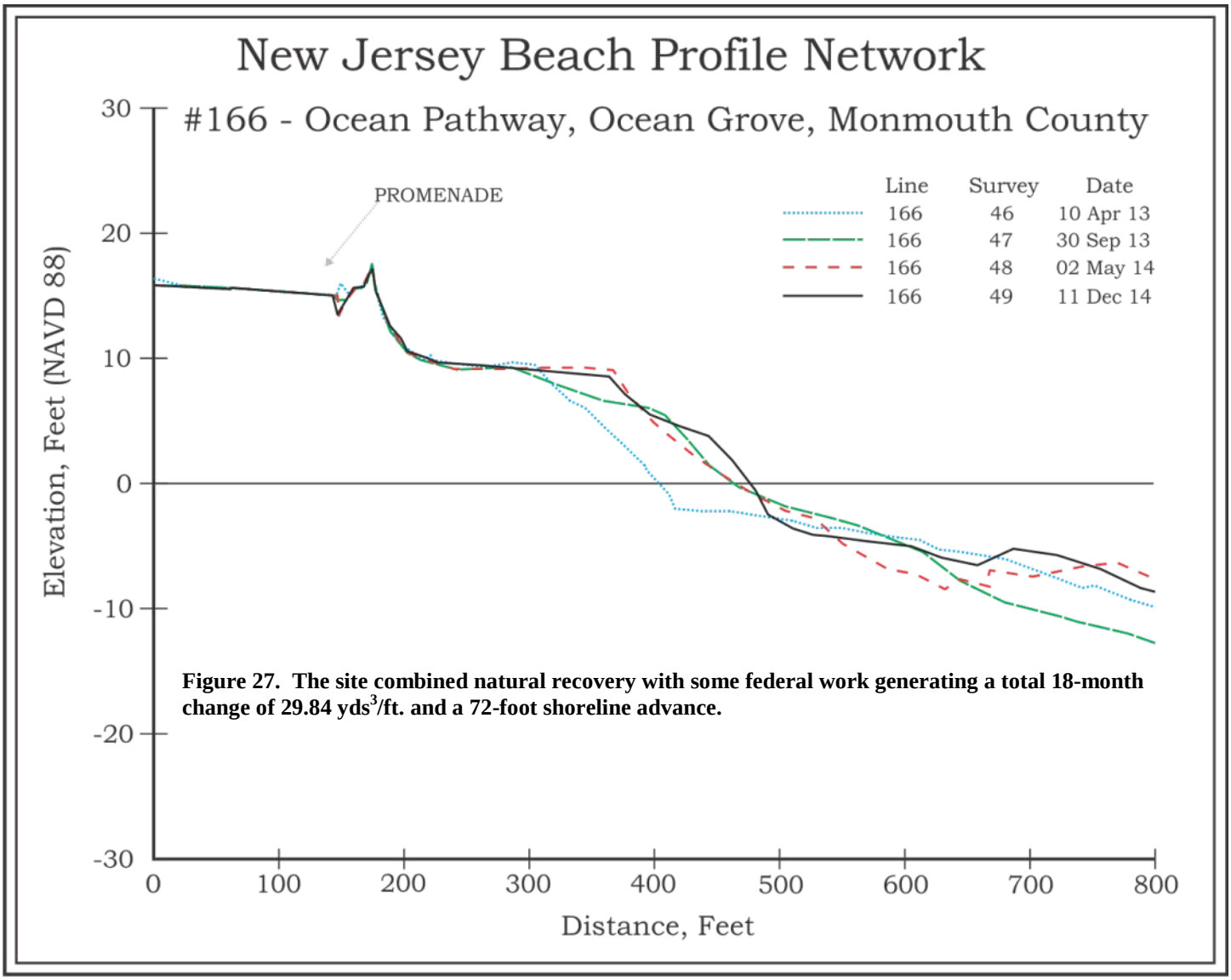


Figure 27. The site combined natural recovery with some federal work generating a total 18-month change of 29.84 yds^3/ft. and a 72-foot shoreline advance.

NJBPN 165 – McCabe Avenue, Bradley Beach

No dune was restored by September 30, 2013, but 9.77 yds^3/ft. in offshore sand deposits had returned to the beach prior to the ACOE work on this shoreline. The beach and fencing was restored as of December 11. 2014 adding elevation to the beach if not much width.

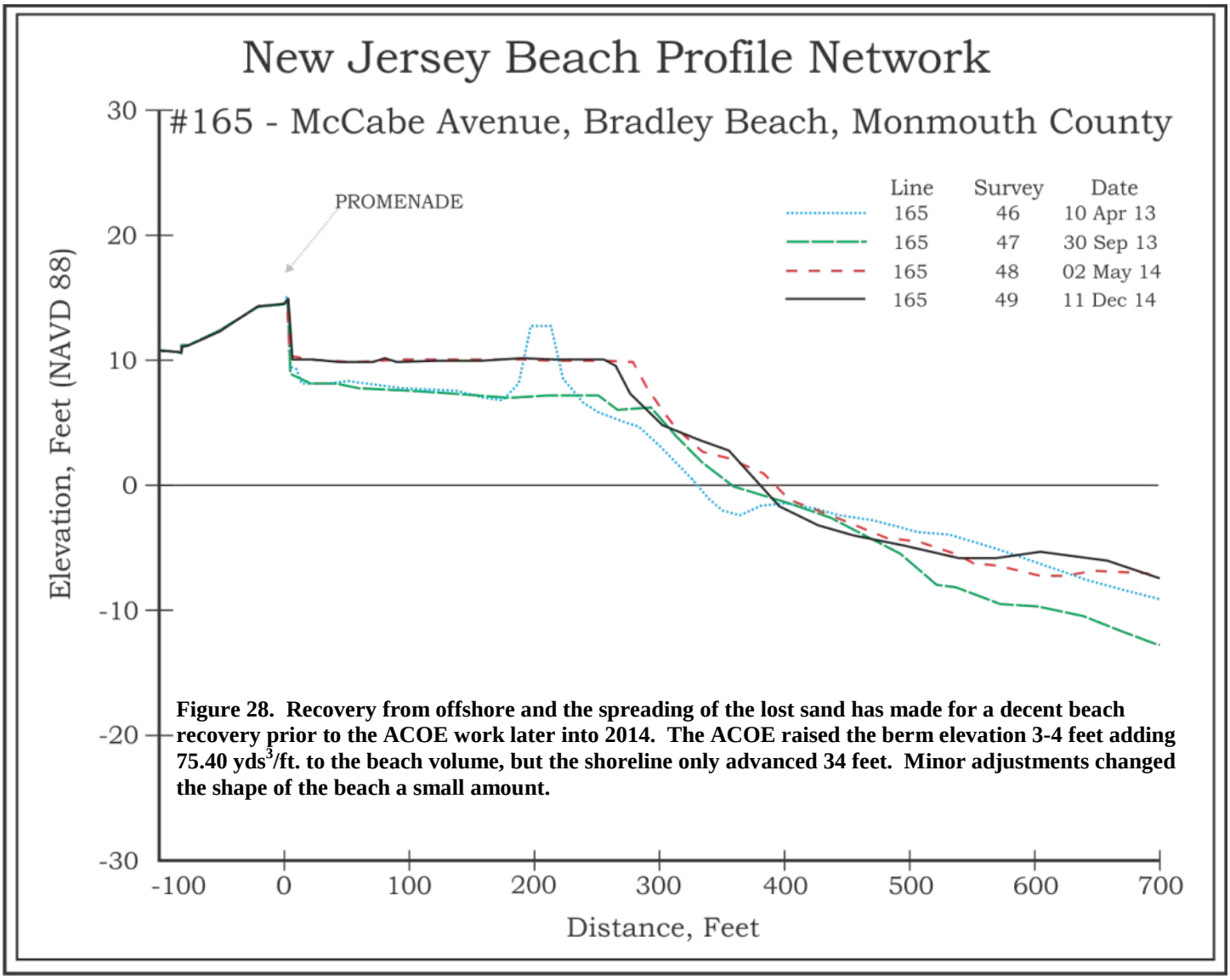


Figure 28. Recovery from offshore and the spreading of the lost sand has made for a decent beach recovery prior to the ACOE work later into 2014. The ACOE raised the berm elevation 3-4 feet adding 75.40 yds^3/ft. to the beach volume, but the shoreline only advanced 34 feet. Minor adjustments changed the shape of the beach a small amount.

NJBPN 164 – Sylvania Avenue, Avon-by-the Sea

This site is located north of the Shark River inlet and was nourished in the 1999 Federal shore protection project. 10.48 yds^3/ft. in natural recovery was added to the beach by Sept 27, 2013 prior to the ACOE restoring the beach to their design specifications. Sand was added across the berm to raise the beach elevation and increase width.

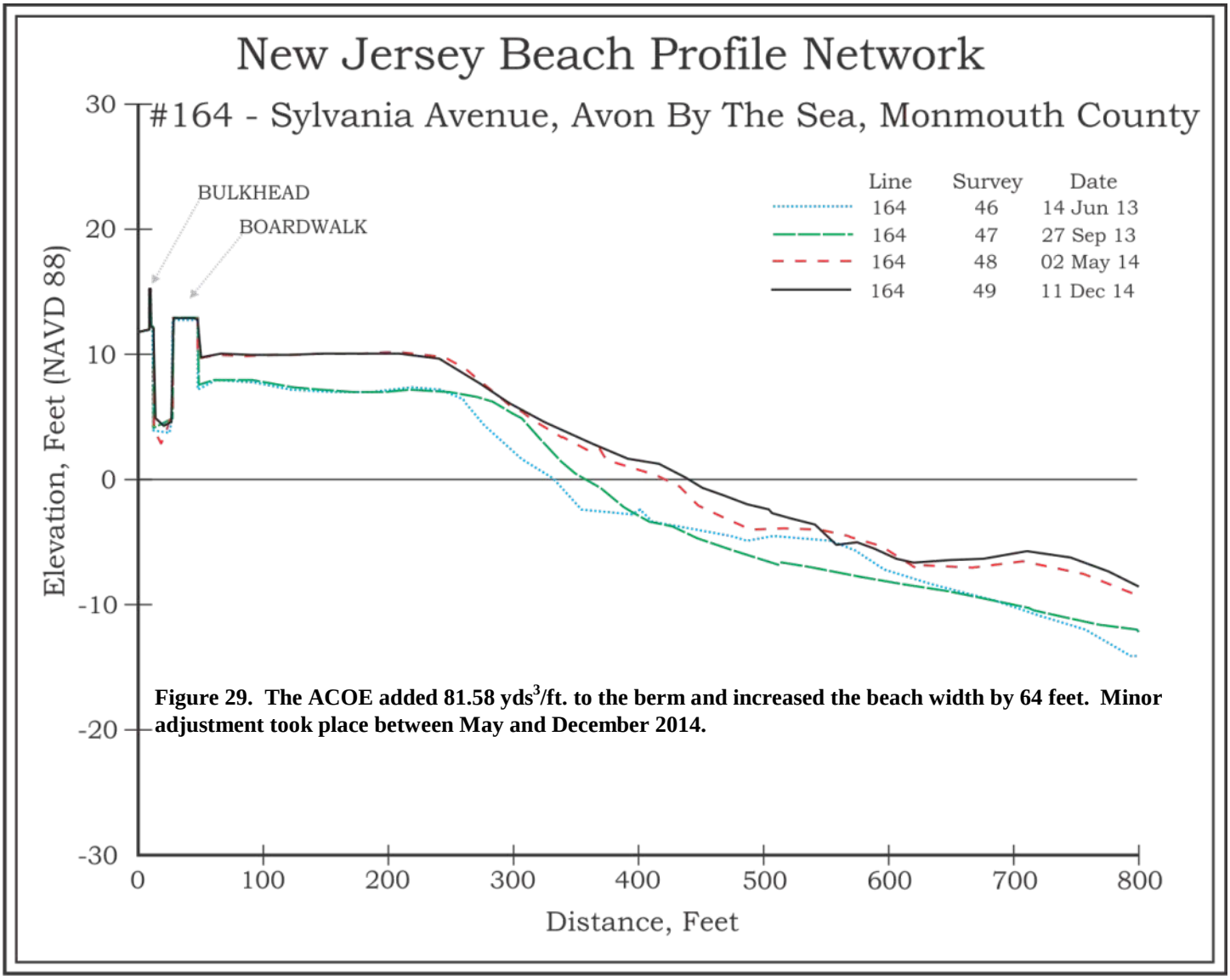


Figure 29. The ACOE added 81.58 yds^3/ft. to the berm and increased the beach width by 64 feet. Minor adjustment took place between May and December 2014.

NJBPN 163 – 5th Avenue, Belmar

This site did not have a dune prior to Sandy but had a wide, dry beach. Natural recovery brought 31.76 yds^3/ft. of sand back to the beach leaving little additional sand placement by the ACOE later into 2014.

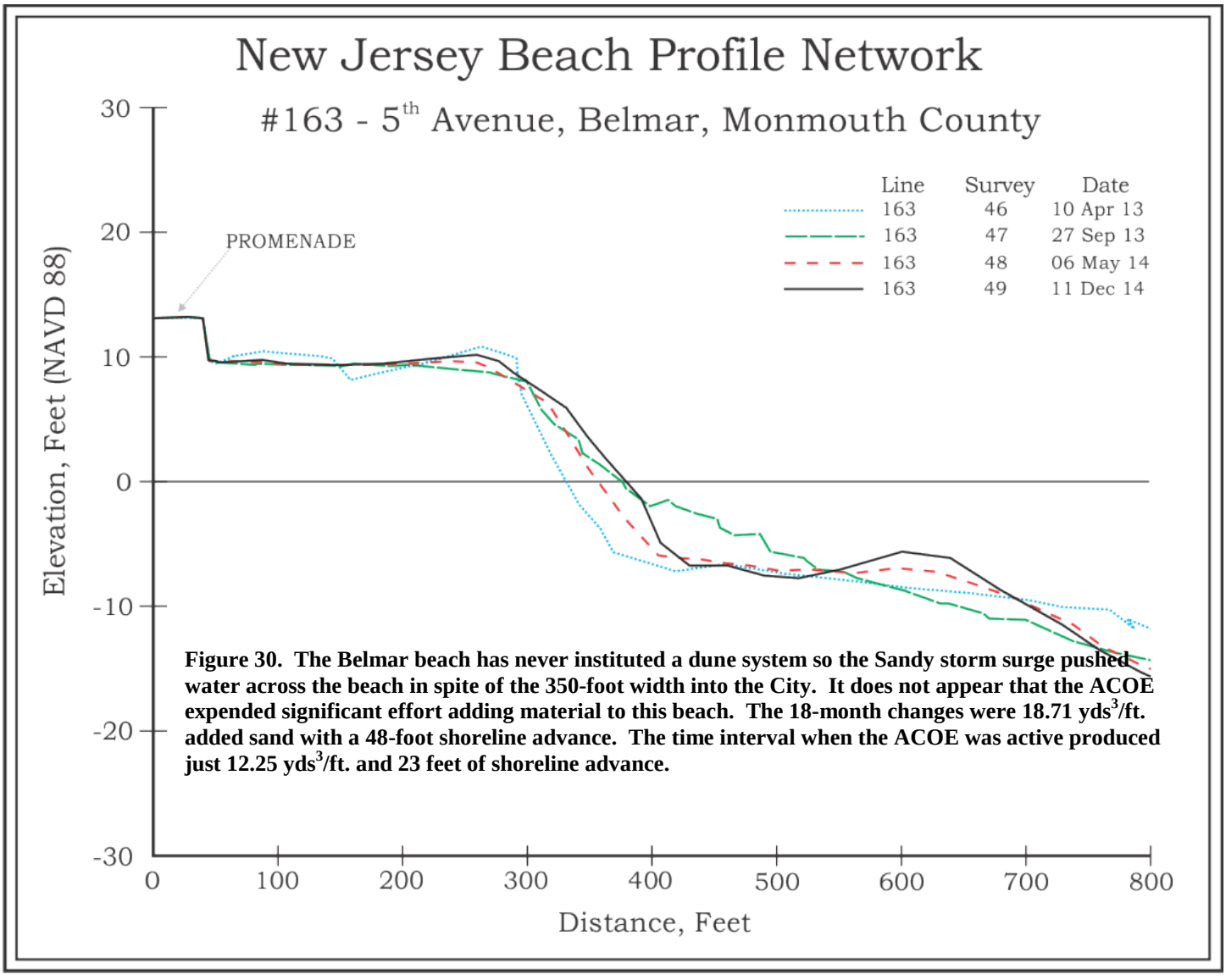


Figure 30. The Belmar beach has never instituted a dune system so the Sandy storm surge pushed water across the beach in spite of the 350-foot width into the City. It does not appear that the ACOE expended significant effort adding material to this beach. The 18-month changes were 18.71 yds^3/ft. added sand with a 48-foot shoreline advance. The time interval when the ACOE was active produced just 12.25 yds^3/ft. and 23 feet of shoreline advance.

The southern Belmar shoreline saw 11.23 yds^3/ft. recovered on the beach naturally by 9/27/2013. ACOE work was in progress on December 12, 2014 to widen the beach and add sand.

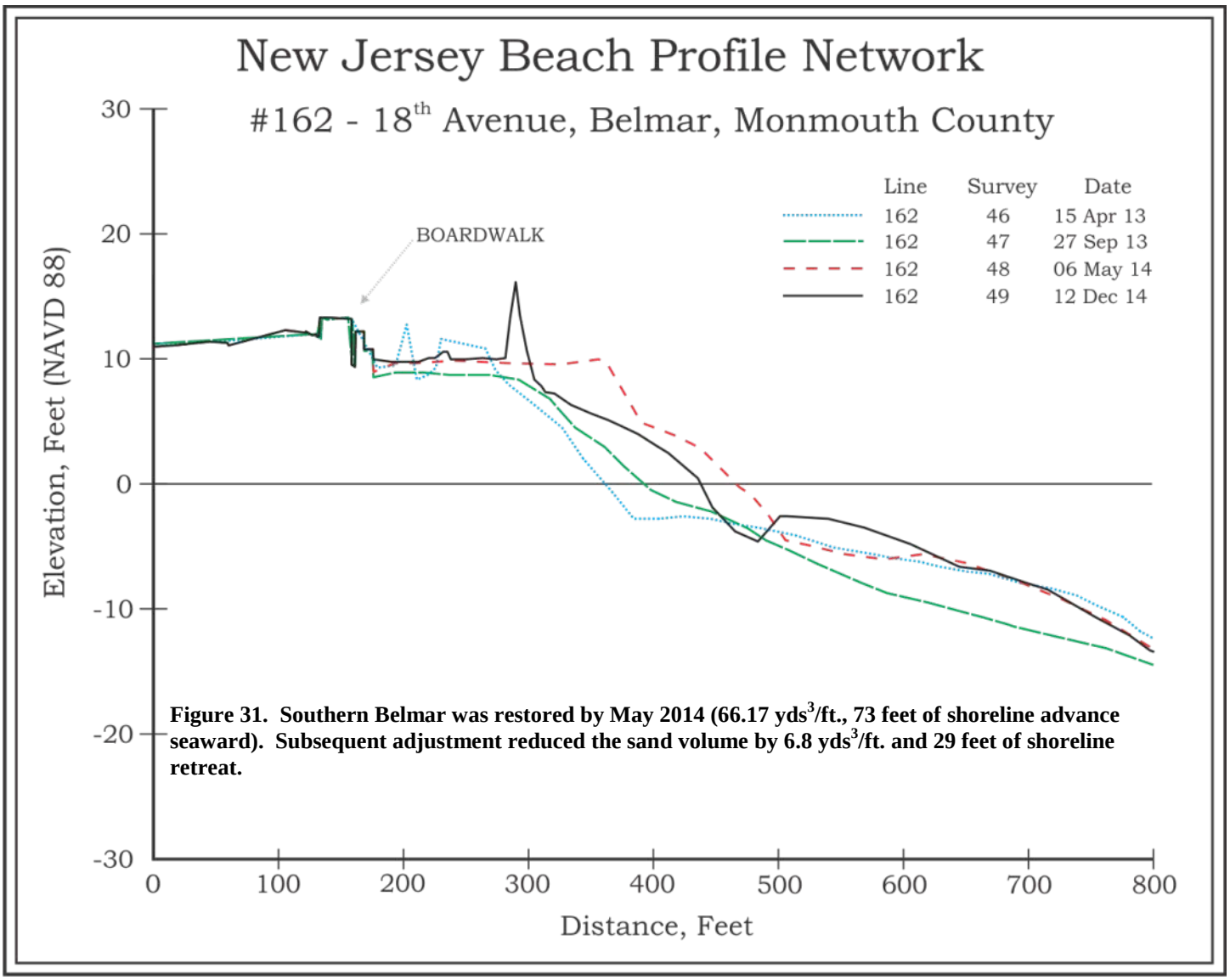


Figure 31. Southern Belmar was restored by May 2014 (66.17 yds^3/ft., 73 feet of shoreline advance seaward). Subsequent adjustment reduced the sand volume by 6.8 yds^3/ft. and 29 feet of shoreline retreat.

NJBPN 161 – Brighton Avenue, Spring Lake

A massive effort restored the boardwalk by Sept 26, 2013 and 31.40 yds^3/ft. in eroded beach/dune sand returned to the beach naturally. By December 11, 2014 (right) the ACOE had added 40.47 yds^3/ft. in new sand advancing the shoreline by 13 feet.

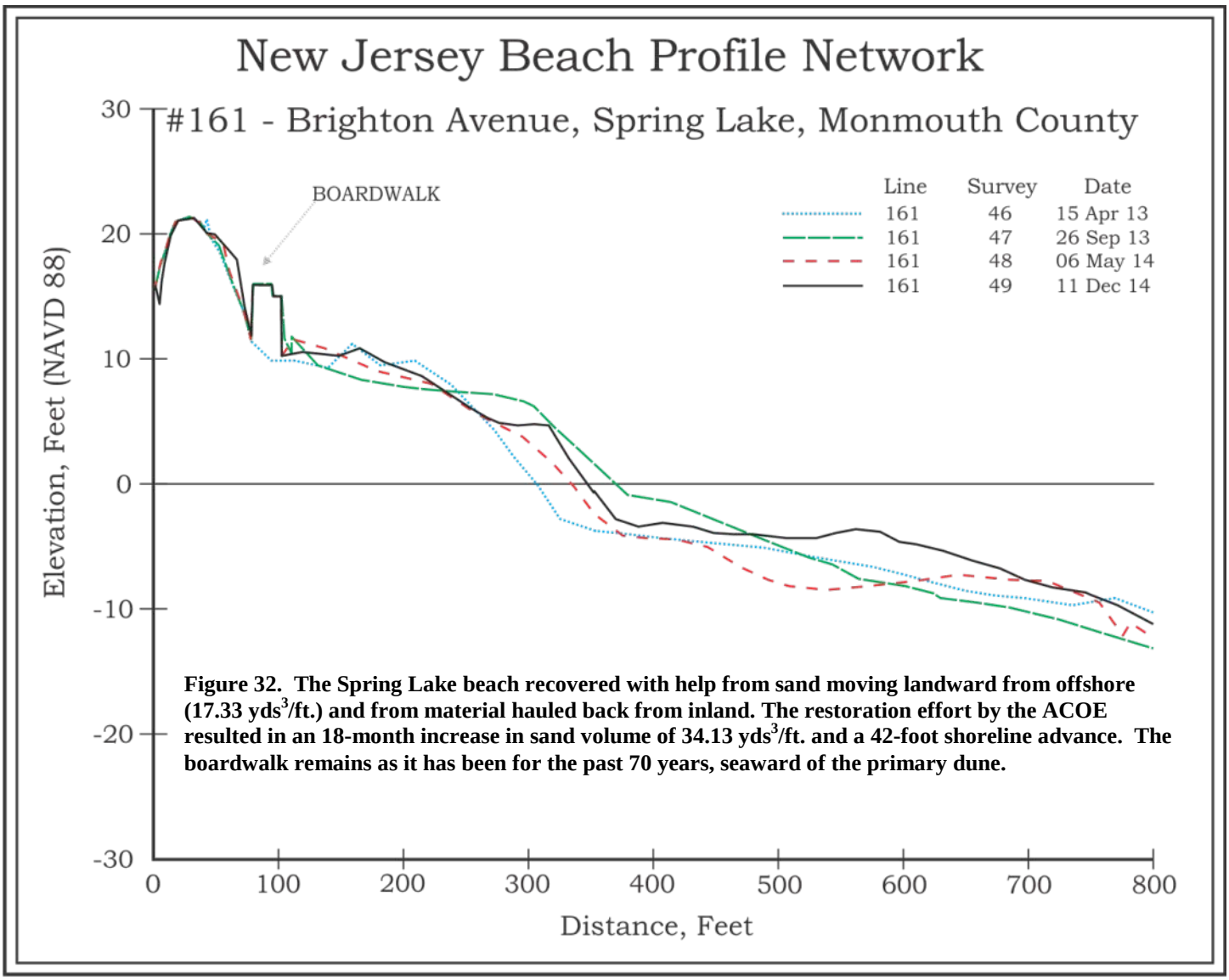


Figure 32. The Spring Lake beach recovered with help from sand moving landward from offshore (17.33 yds^3/ft.) and from material hauled back from inland. The restoration effort by the ACOE resulted in an 18-month increase in sand volume of 34.13 yds^3/ft. and a 42-foot shoreline advance. The boardwalk remains as it has been for the past 70 years, seaward of the primary dune.

NJBPN 160 – Salem Avenue, Spring Lake

By the end of September 2013 the boardwalk was replaced with a modest recovery in beach sand from offshore sources. The ACOE completed restoration in 2014 adding 32.29 yds^3/ft. This site did not have a dramatic post-construction outcome.

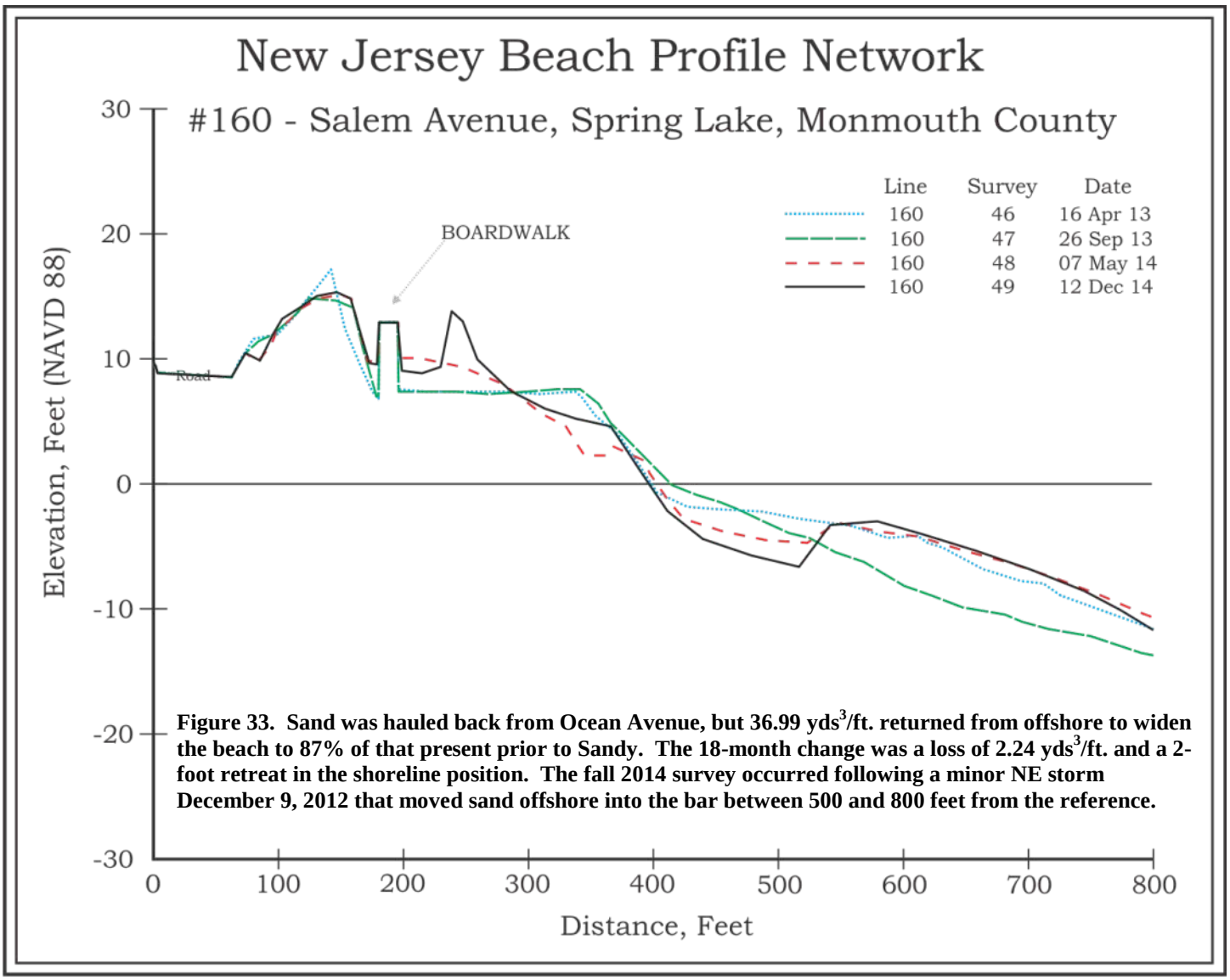


Figure 33. Sand was hauled back from Ocean Avenue, but 36.99 yds^3/ft. returned from offshore to widen the beach to 87% of that present prior to Sandy. The 18-month change was a loss of 2.24 yds^3/ft. and a 2-foot retreat in the shoreline position. The fall 2014 survey occurred following a minor NE storm December 9, 2012 that moved sand offshore into the bar between 500 and 800 feet from the reference.

NJBPN 159 – New York Avenue, Sea Girt

Boardwalk damage was restored and 39.16 yds^3/ft. in lost sand returned by Sept 26, 2013 from deposits formed offshore. Modest additions were made by the ACOE during 2014 (23.81 yds^3/ft.) and the beach was wider.

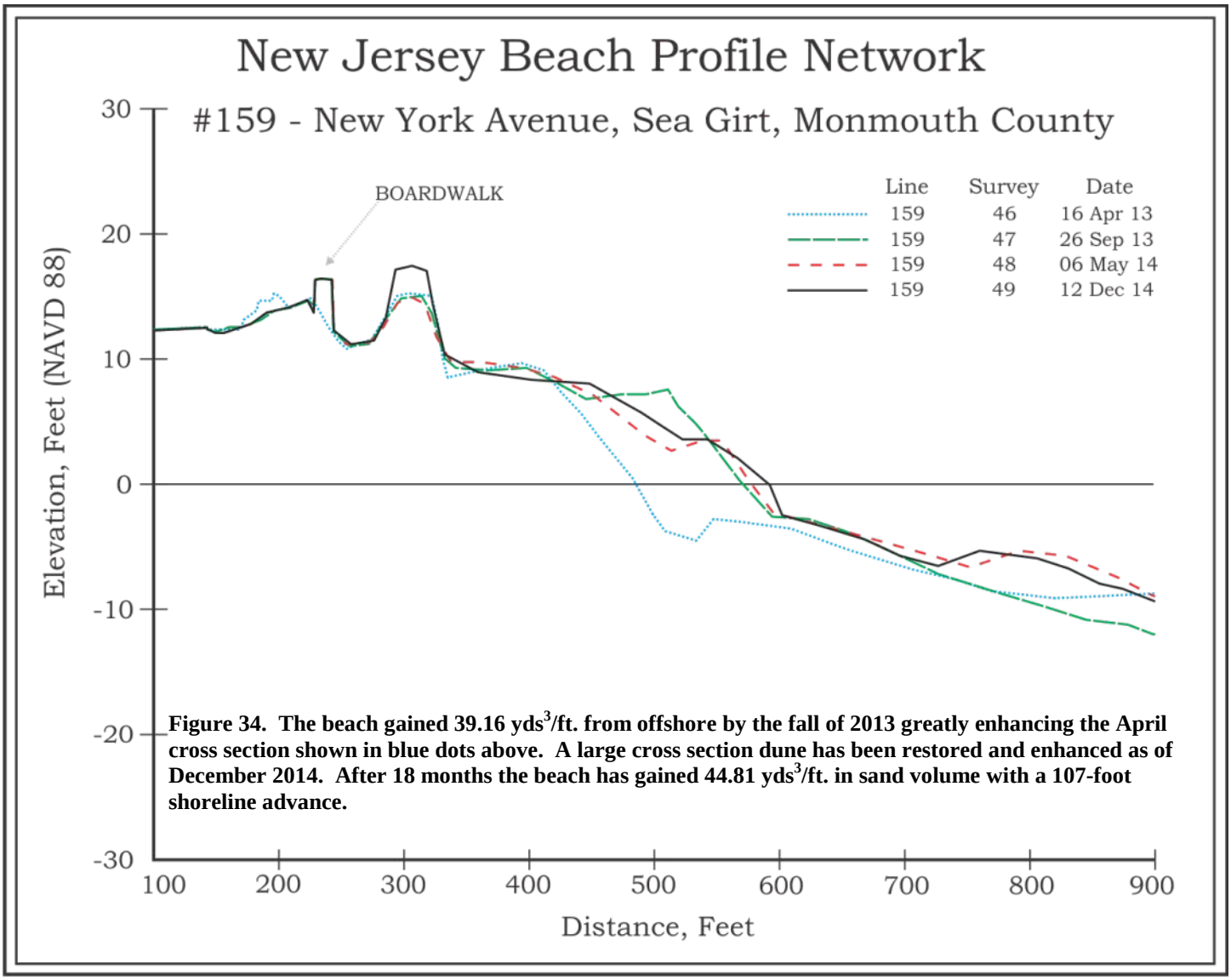


Figure 34. The beach gained 39.16 yds^3/ft. from offshore by the fall of 2013 greatly enhancing the April cross section shown in blue dots above. A large cross section dune has been restored and enhanced as of December 2014. After 18 months the beach has gained 44.81 yds^3/ft. in sand volume with a 107-foot shoreline advance.

NJBPN 158 – Trenton Avenue, Sea Girt

The ridge of recovered sand remains along this segment of the Borough beach and was augmented by 35.07 yds^3/ft. in sand returned to the beach from offshore. Sand was added by the ACOE in early 2014 and the recovered sand was molded into a dune ridge at the toe of the primary dune.

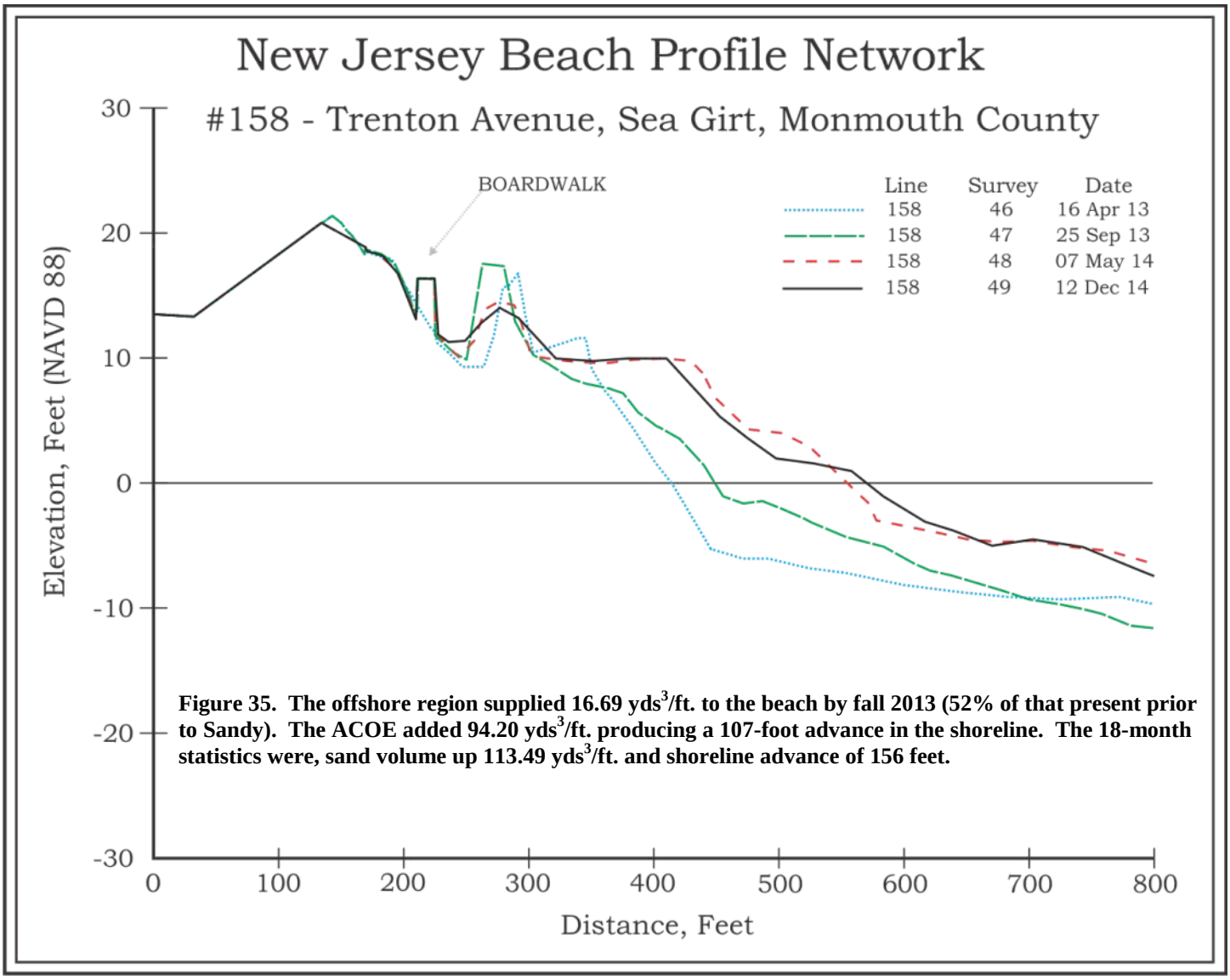


Figure 35. The offshore region supplied 16.69 yds^3/ft. to the beach by fall 2013 (52% of that present prior to Sandy). The ACOE added 94.20 yds^3/ft. producing a 107-foot advance in the shoreline. The 18-month statistics were, sand volume up 113.49 yds^3/ft. and shoreline advance of 156 feet.

NJBPN 157 – Riddle Way, Manasquan

At Riddle Way, material was recovered and spread with little help from offshore migration (1.20 yds^3/ft. 9/25/2013). By May 2014 the ACOE 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.

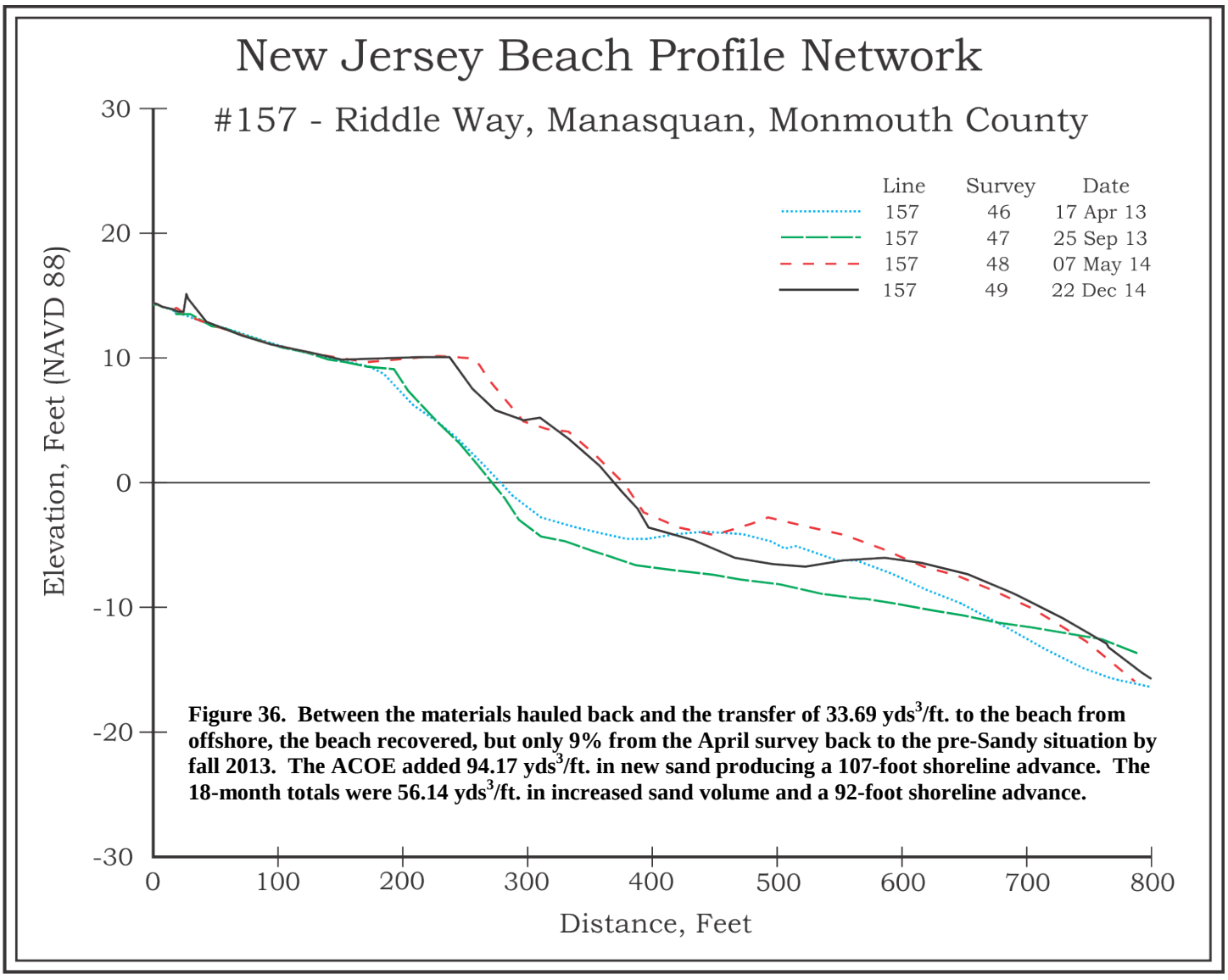


Figure 36. Between the materials hauled back and the transfer of 33.69 yds^3/ft. to the beach from offshore, the beach recovered, but only 9% from the April survey back to the pre-Sandy situation by fall 2013. The ACOE added 94.17 yds^3/ft. in new sand producing a 107-foot shoreline advance. The 18-month totals were 56.14 yds^3/ft. in increased sand volume and a 92-foot shoreline advance.

NJBPN 256 – Pompano Avenue, Manasquan

This site is located just north of the Manasquan Inlet. By 9/25/2013 the structural damage was restored, no dune replaced the loss and just 12.80 yds^3/ft. was recovered naturally by the beach from offshore. By May of 2014 the beach had 82.26 yds^3/ft. in new sand added by the ACOE resulting in a 113-foot shoreline advance.

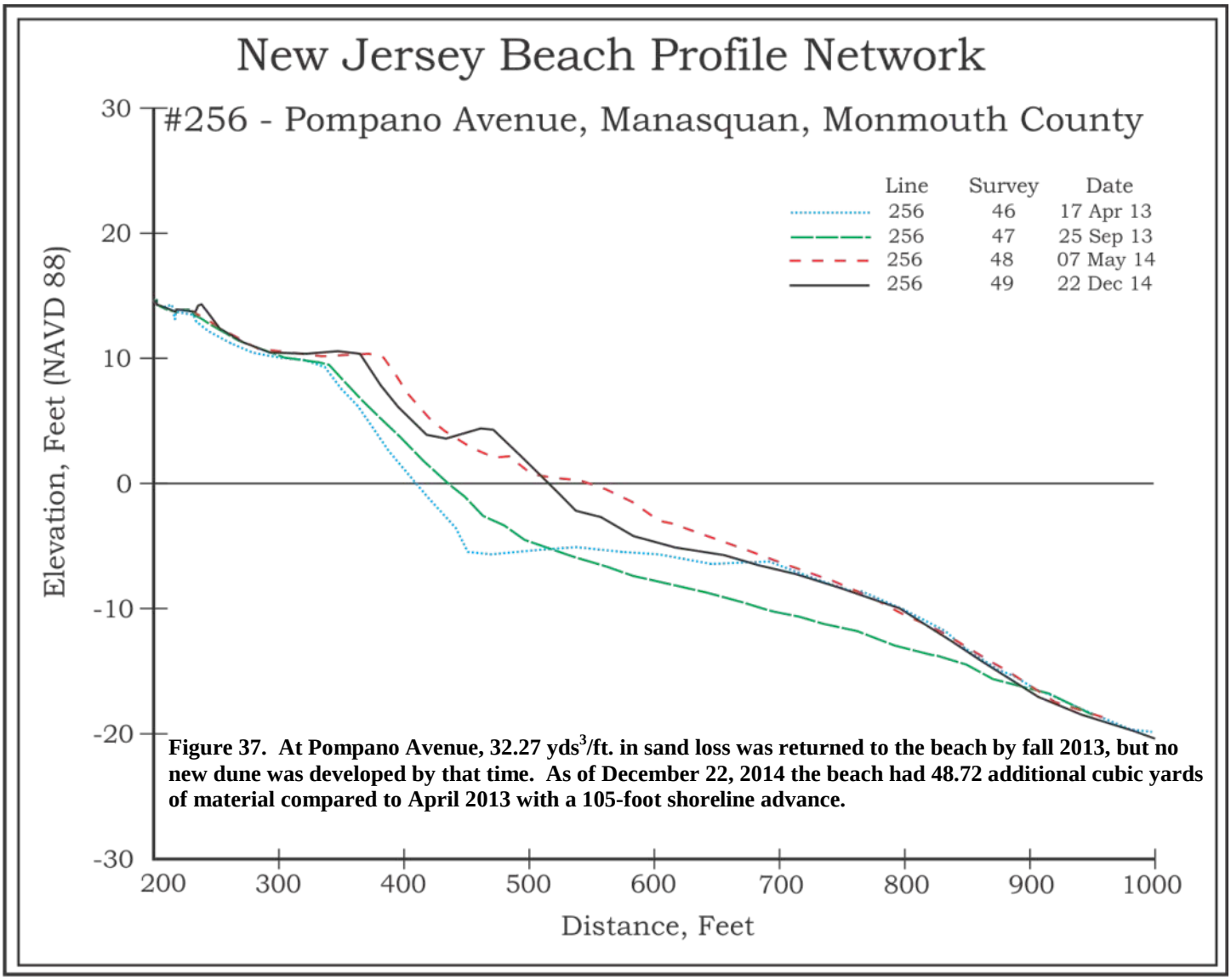


Figure 37. At Pompano Avenue, 32.27 yds^3/ft. in sand loss was returned to the beach by fall 2013, but no new dune was developed by that time. As of December 22, 2014 the beach had 48.72 additional cubic yards of material compared to April 2013 with a 105-foot shoreline advance.

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. Minor storm impacts have re-adjusted the sand volume placed and moved some material north toward Sandy Hook. Most changes are localized thus far at the end of 2014 two years after Hurricane Sandy. Over the next year work continues to contract for the center segment between Elberon and Loch Arbor including Deal and Allenhurst. If that work goes to construction, then the entire Monmouth County oceanfront will be under federal management for beach nourishment.

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 17th 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.

Reviewing the data collected for this report on Monmouth County the surprise was in the relatively high sand volumes that returned to the beach naturally prior to the ACOE work south of Monmouth Beach. The average sand volume that migrated back to the shoreline since Sandy was 21.80 yds^3/ft. and represents 60.1% of the sand lost due to Sandy. 101.4% of the offshore deposits documented by the CRC survey crews was taken from the fall of 2012 to the fall of 2013 meaning that the process was pretty efficient, but the probability is that some material also made its way back from further seaward than the CRC crew normally survey offshore.

Monmouth County saw an average of 64.13 yds^3/ft. in new sand added to the 36 cross sections producing a 92-foot average shoreline advance between April 2013 and December 2014. The 8 Sea Bright sites averaged a gain of 74.73 yds^3/ft., the 6 Long Branch sites averaged a gain of 128.76 yds^3/ft., and the 13 sites between Asbury Park and Manasquan averaged a gain of 46.20 yds^3/ft.

The benefits to the State of New Jersey, its Monmouth County municipalities and coastal citizens from the funding provided by Public Law 113-2 passed January 29, 2013 by Congress is extraordinary and should have greater appreciation in the media from State and local officials.