

STOCKTON UNIVERSITY COASTAL RESEARCH CENTER



Hereford Inlet, Cape May County, March 10, 1991, seven years prior to the initial NJ State and municipally funded beach restoration. Bird habitat consisted of four large intertidal shoals situated between the 123rd Street groin in Stone Harbor and the rock revetment protecting North Wildwood. 25 years and 4.8 million cubic yards of beach restoration later, nesting habitat had expanded into a 7,500 foot long spit extending to a point south of the third shoal in the photo.

An Analysis of Thirty Years' Study of Sand Redistribution and Shoreline Changes in New Jersey's Four Coastal Counties Raritan Bay, the Atlantic Ocean Coast, and Delaware Bay Fall 1986 Through Fall 2016

VOLUME 4 of 4 CAPE MAY COUNTY & APPENDIX

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An Analysis of Thirty Years' Study of
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Raritan Bay, the Atlantic Ocean Coast,
and Delaware Bay

VOLUME 4 of 4 CAPE MAY COUNTY & APPENDIX

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New Jersey Beach Profile Network

Cape May County

Great Egg Harbor Inlet
to Stow Creek

NJBPN Profile #'s
225 - 100

New Jersey Beach Profile Network Cape May County Site Locations

There are thirty-one NJBPN survey sites along the beaches of Cape May County, consisting of a combination of barrier islands, coastal headlands and the Delaware Bay shore. Twenty-seven sites are Atlantic Ocean profiles and the remaining four are set along the Delaware Bay shoreline of western Cape May County. The ocean profile sites are located in the following municipalities: the City of Ocean City, Strathmere in Upper Township, the City of Sea Isle City, the Borough of Avalon, the Borough of Stone Harbor, the City of North Wildwood, the City of Wildwood, Lower Township, the City of Cape May, and the Borough of Cape May Point. Profile #111 on South Pointe in Stone Harbor was lost due to erosion and was replaced by profile #212, which is located south of 121st Street in Stone Harbor. Development forced the shifting of three sites over the years to allow an unobstructed survey line. The four Delaware Bay profiles are located in the communities of Reeds Beach in Middle Township, Villas in Lower Township, North Cape May in Lower Township and at the Higbee Beach State Park.

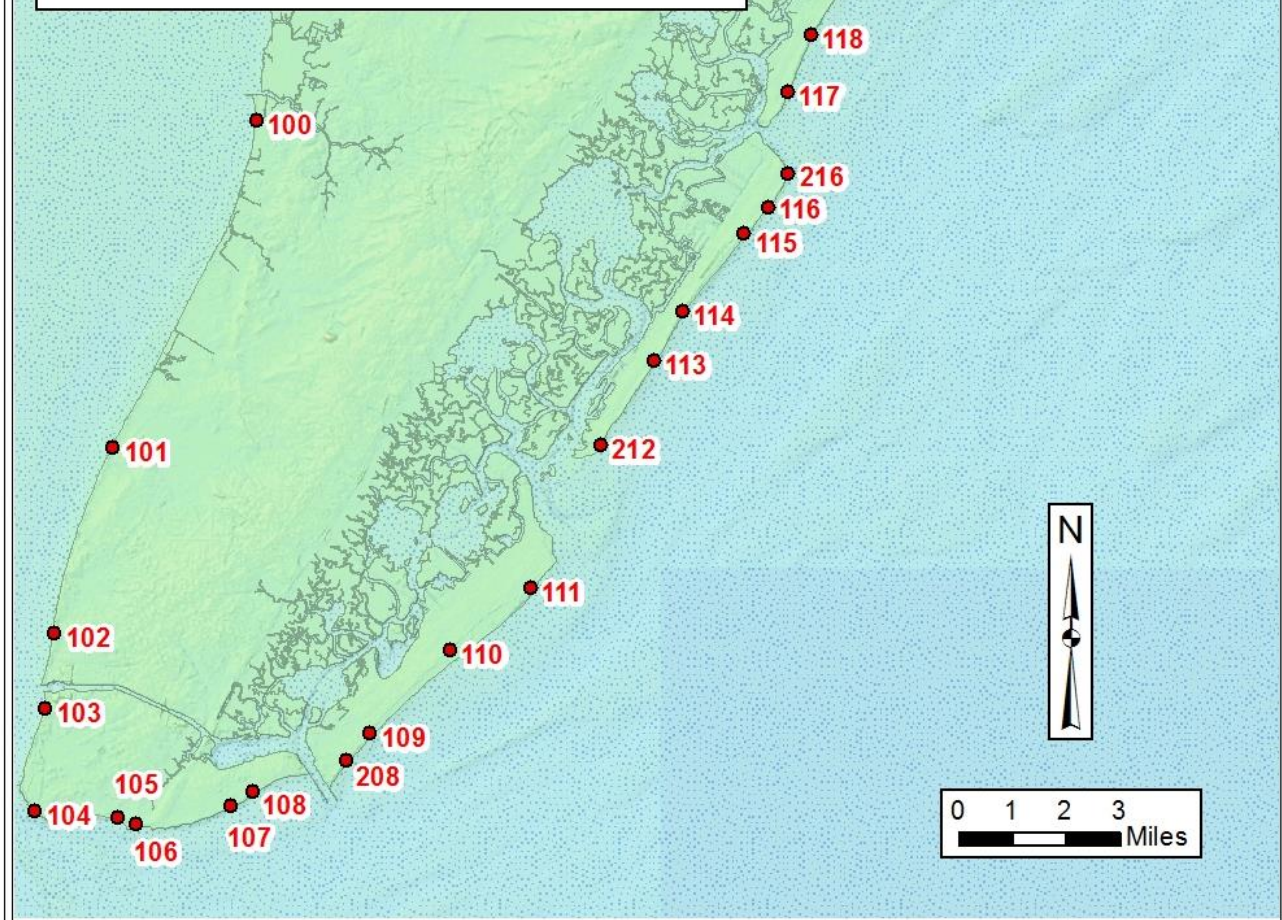


Figure 451. Locations of the 31 NJBPN profile sites in Cape May County, NJ.

Cape May County Summary

Coastal surveys start at Reeds Beach on the western Cape May County shoreline, extend down to Cape May Point, then up the barrier island oceanfront for a total of 31 survey stations. The county has five tidal inlets separating four barrier islands and a complex coastal geomorphic compartment that is the site of Cape May City, a US Coast Guard base and Cape May Point. Each inlet has near identical geomorphic conditions with a narrow, rapidly changing southern spit that curves deep into the inlet opening, a large ebb-tidal delta offshore and a distinct offset in the seaward position of the southern inlet shoreline due to wave refraction around the ebb-tidal delta. This makes the northeast corner of each island vulnerable to northeast wave conditions especially when the main tidal channel lies close to the southern shoreline of the inlet. Each island has at least one profile location where the 30-year surveying history is one of repetitive erosion cycles following each restoration attempt going back to 1983 in Ocean City and 1984 at Strathmere (NJ State/local projects followed later by Federal work). Avalon conducted a State/local project in 1987, followed 22 years later by the State and North Wildwood in 2009. Episodic deposition has occurred in the mid-section of the four barrier islands yielding generous dunes and wide beaches (20th Street in Ocean City, Williams Road in Strathmere, 35th Street in Avalon, and Cresse Avenue in Wildwood Crest). Sand moves eventually to the southern tip of each island creating a rapidly changing environment at the northern side of each tidal inlet (Corson's Inlet state park, Townsend's Inlet, South Point in Stone Harbor, the Cape May Wildlife Refuge now occupying the former US Coast Guard site on what was once called Two-Mile Island and the Cape May Nature Conservancy). Up until 1922, Two-Mile Island was separated from Anglesea (Wildwood & North Wildwood) by Turtle Gut Inlet, which closed largely due to human activities related to building a causeway and bridge from Anglesea to Two-Mile Island for pending development. Turtle Gut Inlet had been mapped as early as 1756 (published by Mr. Franklin of Philadelphia), so was a viable inlet continuously for over 160 years of history. The inlet was the site of a Revolutionary War naval incident in 1776 as two British warships pursued the "Brigantine Nancy" into the inlet. The Nancy was a blockade runner carrying gunpowder for the revolutionary army. The warships could not enter due to shallow depths and sent longboats with marines to capture the Nancy. The crew, aided by another vessel under the command of Captain John Barry, later the "Father of the US Navy", kept them a bay while they off-loaded most of the gunpowder and then set the Nancy on fire and abandoned her. The British marines boarded and took the prize, but then the remaining powder blew up eliminating the Nancy and the victorious marines.

Individual Profile Site Descriptions

Ocean City (Sites 225, 125, 124, 123, 122, 222, & 221):

The USACE 2015/2016 Great Egg Harbor Inlet to Townsends Inlet, NJ storm damage reduction project for Ludlam island also included 1.5 million cubic yards of sand for the southern shoreline of Ocean City that suffered damage during Hurricane Sandy due to low, narrow dunes. This project covers from 42nd Street to 59th Street in Ocean City. The Corson's Inlet State Park shoreline south of development in Ocean City suffered dune loss of considerable magnitude during Hurricane Sandy. Since sand naturally moves south under wave dominance from the northeast, this shoreline should benefit from any sand losses in Ocean City's part of the new project. The seventh periodic USACE nourishment cycle was completed by December 2015 with placement of approximately 1 million cubic yards of sand to maintain the federal beach design in Ocean City from Surf Road to 34th Street. Completion of these projects now places all of Ocean City's developed shoreline under a federal project providing similar storm protection to the entire community. The Cape May County shoreline from Great Egg Inlet in Ocean City to Hereford Inlet in Stone Harbor is now under USACE project jurisdiction with a 3 to 5 year maintenance cycle to restore these beaches to the design specifications.

Sea Isle City & Strathmere (Sites 121, 120, 119, 118, & 117):

In 2009 a NJ State and locally sponsored shore protection project expanded the beach berm width and built up a continuous dune system in Strathmere to Sea Isle City. The project protected these two communities from substantial damage during Hurricane Sandy when about 230,000 cubic yards of sand were lost. This eroded shoreline was restored by the USACE project that commenced in April, 2015 that included southern Ocean City

and all of Ludlam Island to 93rd Street in Sea Isle City using sand from offshore borrow sites previously defined. Sand was added first in Ocean City, then starting in Strathmere and worked south finishing at 93rd Street in Sea Isle City. Over 3.4 million cubic yards of new sand was pumped onto this island from offshore. Extra work was done following extensive erosion during Northeast Storm Jonas in late January 2016, to restore the design template. Dune fencing will encourage aeolian accumulation on the seaward dune slope from the wider beaches. The position of the main tidal channel in Corson's Inlet continues to be monitored because it's position in terms of the Strathmere inlet shoreline is critical to the rates of erosion seen on the southern inlet and adjacent oceanfront shoreline.

Avalon & Stone Harbor (Sites 216, 116, 115, 114, 113, & 212):

These two communities have been leaders in shore protection by having successfully managed to have Federal shore protection projects constructed and have for years, promoted wider, higher dunes with coordinated development of pedestrian access pathways that lessen the possibility for a breach at street end public access points. The US Army Corps of Engineers (USACE) completed a project restoration from the 8th Street jetty to 31st Street in Avalon and from 70th Street in Avalon south to the terminal groin south of 123rd Street in Stone Harbor. This work was completed under PL 113-2 Emergency Restoration funds for Hurricane Sandy damage to USACE project. Since that was completed in early 2013, erosion claimed the sand to the revetment rocks at 12th Street in Avalon. The Borough conducted a municipal beach project in 2015, adding 740,000 cubic yards of sand between 9th and 25th Streets. A sand back-passing operation was completed to move sand from the mid-island borrow zone beaches to the erosional part of the island. Stone Harbor's southern oceanfront suffered severe loss rates due to the increased frequency of storm events culminating in storm damage suffered during winter storm Jonas in early 2016, leading to substantial dune erosion. An effort to utilize sand extracted from lagoon dredging along the bayshore as beach augmentation was cancelled due to problems with the geo-textile storage in the municipal marina parking lot. Currently, the USACE is working with the NJ Division of Coastal Engineering to complete a beach maintenance effort on both communities for 2017.

The Wildwoods (Sites 111, 110, 109, & 208):

The City of North Wildwood has adopted the Army Corps project design and concept for the Wildwoods federal project by using heavy trucks to haul sand back from Wildwood City where it accumulates to replace losses occurring between 2nd and 8th Avenues on their oceanfront. Wave refraction and channel configuration at Hereford Inlet near the North Wildwood shoreline continue to allow sand to move south into Wildwood and northwesterly into Hereford Inlet maintaining the inlet sand beach. This beach has been utilized by shorebirds for nesting, which has and resulted in adjusting the beachfill template to eliminate any work on the inlet side of the 2nd Avenue jetty. The back-passing plan has resulted in transporting 151,000 cubic yards of sand from seaward of the Wildwood storm water discharge lines on the city beaches in the spring of 2016. This was followed by a similar effort in early 2017 (200,000 cubic yards moved). With little in mobilization costs, this effort has benefitted both cities greatly. Wildwood gets a better stormwater drainage rate and North Wildwood regains lost sand at a cost of around \$5.75 per cubic yard.

Work by the Philadelphia District USACE continues toward an approved design document for the Wildwoods that include sand harvesting from Wildwood and Wildwood Crest beaches and passing it back north to the erosion zone in North Wildwood, as opposed to pumping in new sand from offshore or Hereford Inlet tidal shoals. This program gained additional interest following the US Fish & Wildlife Service determination that henceforth, the Coastal Barrier Resource Act (CBRA) zone in Hereford Inlet precluded the federal government from spending federal dollars to dredge sand from Hereford Inlet to benefit either the Wildwoods or Stone Harbor to the north. North Wildwood, Stone Harbor and Avalon are seeking congressional assistance in modifying the CBRA language to allow the federal agencies to fund beach nourishment projects using CBRA zone sand supplies. At present, the three Wildwood municipalities plus the private beaches within the Township of Lower remain the only Atlantic Coastal communities without a current federal beach and shore protection project under direction of either the New York or Philadelphia district Corps of Engineers. Those three towns are on the board for a project that is still in development at the District and Headquarters level.

Cape May City (Sites 108, 107, 106, 105, & 104):

On the Atlantic Ocean side of the county, the large scale federal shore protection projects are guaranteed to accelerate the two processes of inlet modification. Evidence of these processes are illustrated on the cover and in Figure 1, which shows the spectacular growth in South Point on Seven-Mile Island since 1991. This growth resulted from an increase in sand supply due to beach nourishment in Stone Harbor derived from the sand in the ebb-tidal shoals of Hereford Inlet. Similarly, the expansion of the Nature Conservancy beach south of Cape May City since 1989 beach nourishment commencement in Cape May City is also due to sand migration via longshore transport.

Cape May City beaches all added sand to the berm as a wedge during the summer of 2014. This material was stable until a series of days in early October 2015 that transported about 35,000 cubic yards of sand around the 3rd Avenue groin into “The Cove” on the conservancy beach. This was repeated by a factor of two January 23, 2016 (NE Storm Jonas) and again exactly a year later January, 2017 with another northeaster. The summer berm in Cape May City appears stable with a seaward slope of 1:10 to the low tide line, then gentler further seaward. An attempt to grade out a gentler beach berm slope failed to stabilize at the 1:15 value, rapidly returning to the steeper 1:10 slope. The combination of sand grain size and wave climate seems to define the natural slope condition at the city’s beaches. Added studies were approved by the City for 2016 to better understand the beach configuration and seaward slope data following a number of injury complaints alleged to be the result of a beach that was “too steep” and enhanced wave breaking at the shoreline as a result of the steep slope. Unfortunately, an administrative change during the 2016 elections caused the additional studies to be terminated.

Western Delaware Bay Shoreline of Cape May County (Sites 103, 102, 101, & 100):

During 2013, habitat restoration work commenced under an umbrella of wildlife oriented groups funded with National Fish & Wildlife Sandy recovery money. Attention was focused on the western shoreline of Cape May County over the past three years largely due to the loss of horseshoe crab egg laying habitat at the marsh edge beaches. These thin veneers of coarse sandy beaches have been the choice area for the largest population of horseshoe crabs in the world to lay millions of eggs each May. These same beaches are critical forage areas for Red Knots and other shorebirds that consume the eggs as fuel for their long breeding flight from south to north each spring. Sand was supplied from quarries in Cape May County and the beaches were engineered to have a sloping berm and an elevation just above normal mean higher high water. Work expanded during 2015 westward along the Delaware Bay shoreline into Cumberland County (Fortescue and Money Island) providing additional locations where the marshes at the water’s edge received quantities of suitable sand to replace horseshoe crab egg-laying sites wiped out by Hurricane Sandy. Other efforts have focused on sediment distribution budgets and documentation of wave energy flux (heights, periods and direction of travel) along the lower Delaware Bay NJ shoreline.

Sandy ripped up the sand veneer and washed it inland among the marsh grasses leaving bare sod and mud in place of sand. Work included habitat restoration using quarry sand and building oyster reef sites along the bayshore in relatively shallow water. Marsh restoration is being incorporated into the Maurice River delta area to convert extensive mud flats back into viable marsh habitat. In addition, a federal project long on the sidelines, is being re-examined for implementation on the western Cape May County bayshore using Delaware Bay dredge sand derived from routing Delaware Bay shipping channel maintenance. Another sand source could come from material that has been discharged at what is called “buoy 10” at the mouth of the bay. This project has evolved into a USACE flood mitigation effort for Lower and Middle Township shoreline areas on the western coast. The project’s local governmental goal is to provide a beach berm and sufficient elevation dune to allow the Federal Emergency Management Agency (FEMA) to re-evaluate the new preliminary flood hazard maps and move the V-zone designation, presently assigned to most of the Lower Township Delaware Bay shoreline, landward to the crest of a newly constructed dune. A landward movement of the V-zone such as this would save the bayshore homeowners from mandatory V-zone flood insurance premiums if they also have federally backed mortgages. Under the current adopted mapping for flood hazards, there is no western Delaware bayfront V-zone designation.

**INSTRUCTIONS FOR USING THE GRAPHICAL ILLUSTRATIONS PROVIDING INFORMATION
ON EACH OF THE 107 NEW JERSEY COASTAL SITES DEVELOPED SINCE 1986
(OR A MORE RECENT ESTABLISHMENT DATE)**

1. The initial page for each survey location is a full page photograph showing the beach condition as it existed during the fall survey season of 2016.
2. The second page is a pair of beach photographs showing the comparison from the fall survey season of 2015 with the corresponding view taken during the survey season completed in the fall of 2016 with descriptive comments below the two photographs.
3. The third page is the cross section plot for the site showing the most recent four surveys dating from spring 2015, fall 2015, spring 2016 and fall 2016 accompanied with a text description of pertinent changes to the dune, beach or offshore segment.
4. The fourth page is a shoreline position and sand volume trend analysis showing each fall survey since the profile was established in 1986 or a later date for some sites. The bars represent annual shoreline position changes and sand volume gain or loss combined with a pair of lines showing the cumulative effect of the annual change data. Major projects always appear the year they are constructed and subsequent years of change that follow.
5. The fifth page is a presentation of all profile surveys at the specific site color-coded by date of survey. Initial surveys are plotted in blue, shifting green, then yellow, finally to orange and red colors for the most recent years. The plots show the evolution of the profiles over the complete 30-years of measured data, with the ability to see the dramatic impact of major beach restoration efforts as a significant alteration to the pattern. Colors progressing from blue to red in the seaward direction indicate an accretional pattern and colors progressing from blue to red in the landward direction indicate an erosional pattern. The thick black line displays the mean profile shape, which is calculated by taking the average of all measured profiles from each site.
6. The sixth and final page shows a pair of aerial photographs paired with a cross-section plot of the site. The aerial photographs are composed of a historical aerial from around the year 1995 and a more recent aerial from around the year 2015 (exact years are indicated on the plot). The cross-section plot displays the profile view of the site from the same years as displayed in the aerial photographs and both the plots and aerials are set to the same distance scale. This figure shows the change over time at each profile site as presented by an aerial image comparison and a cross-sectional comparison. Combining these two different means of data presentation allows for changes in topographic features, vertical elevations, and shoreline positions to be displayed simultaneously in the same figure.

NJBPN 225 – Gardens Road, Ocean City (September 20, 2016)

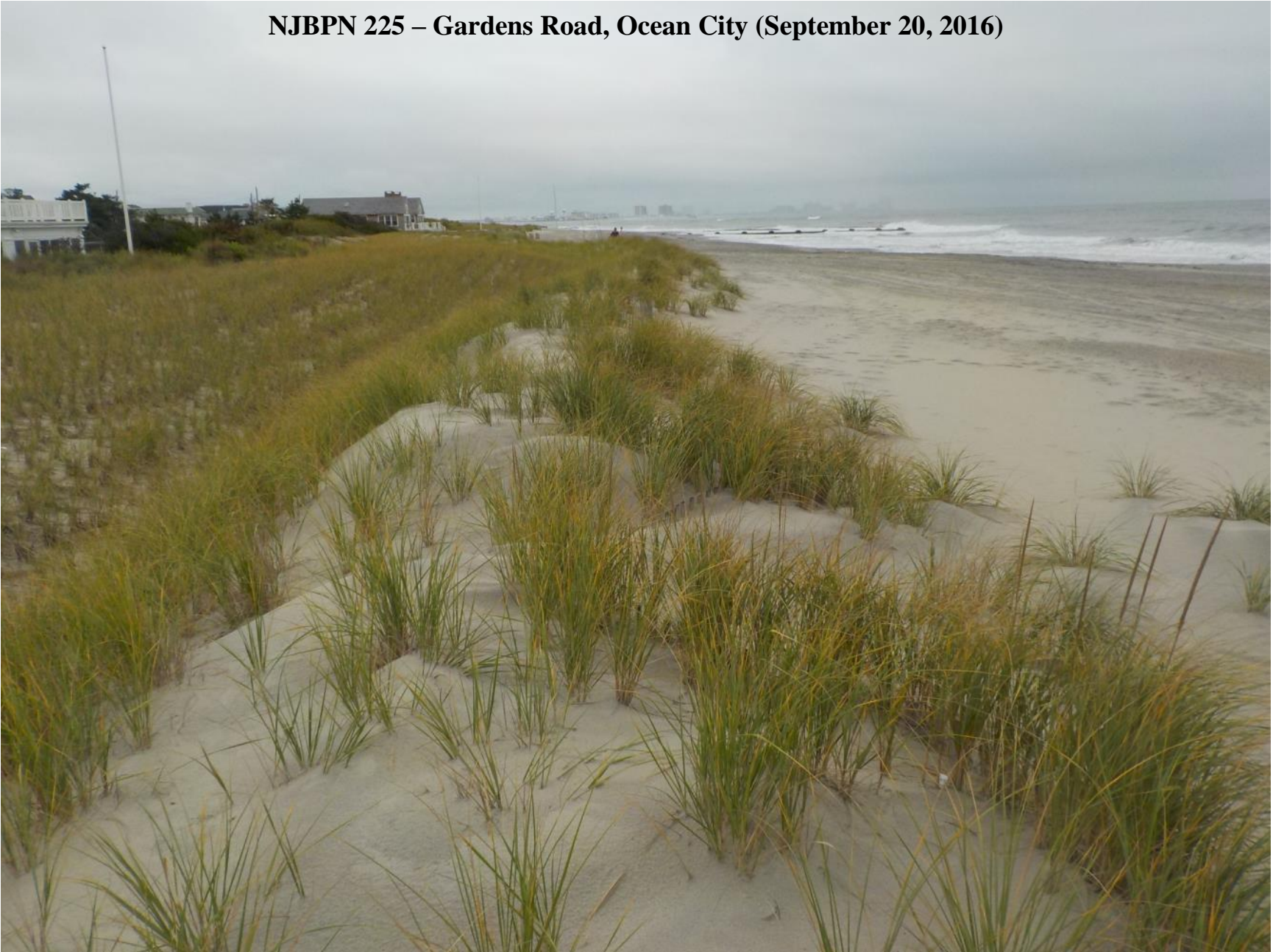


Figure 452. A September 2016 view of the beach toward Little Egg Inlet showing the dunes seaward of development plus the beach maintained by the USACE's Peck's Beach project.

NJBPN 225 – Gardens Road, Ocean City



Figure 453a & 453b. The Gardens Road site is the northernmost profile in Ocean City and located in proximity Great Egg Inlet. (Left photo is from September 1, 2015. Right photo is from September 20, 2016). The dune and some of the berm that was created by the 2013 Federal emergency beach fill remained throughout 2015 and 2016. Seasonal berm elevation changes occurred, but the shoreline position was relatively constant. Over the 18-month study interval the site saw 25.21 yds³/ft in sand volume gains combined with a 28 ft shoreline advance.

New Jersey Beach Profile Network

#225 - Gardens Road, Ocean City, Cape May County

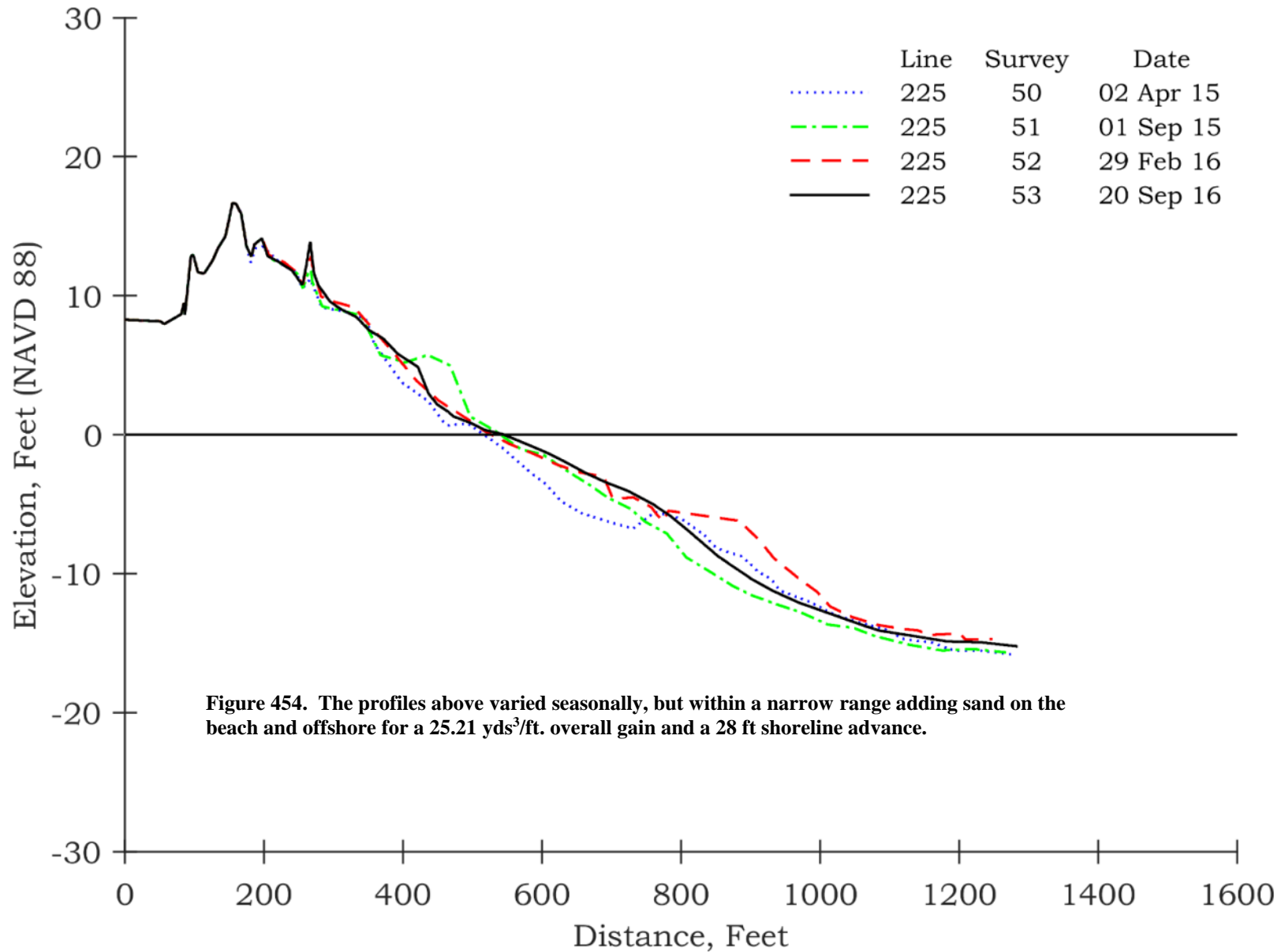


Figure 454. The profiles above varied seasonally, but within a narrow range adding sand on the beach and offshore for a 25.21 yds³/ft. overall gain and a 28 ft shoreline advance.

22-Year Coastal Changes at Site 225, Gardens Road, Ocean City, Cape May Co.

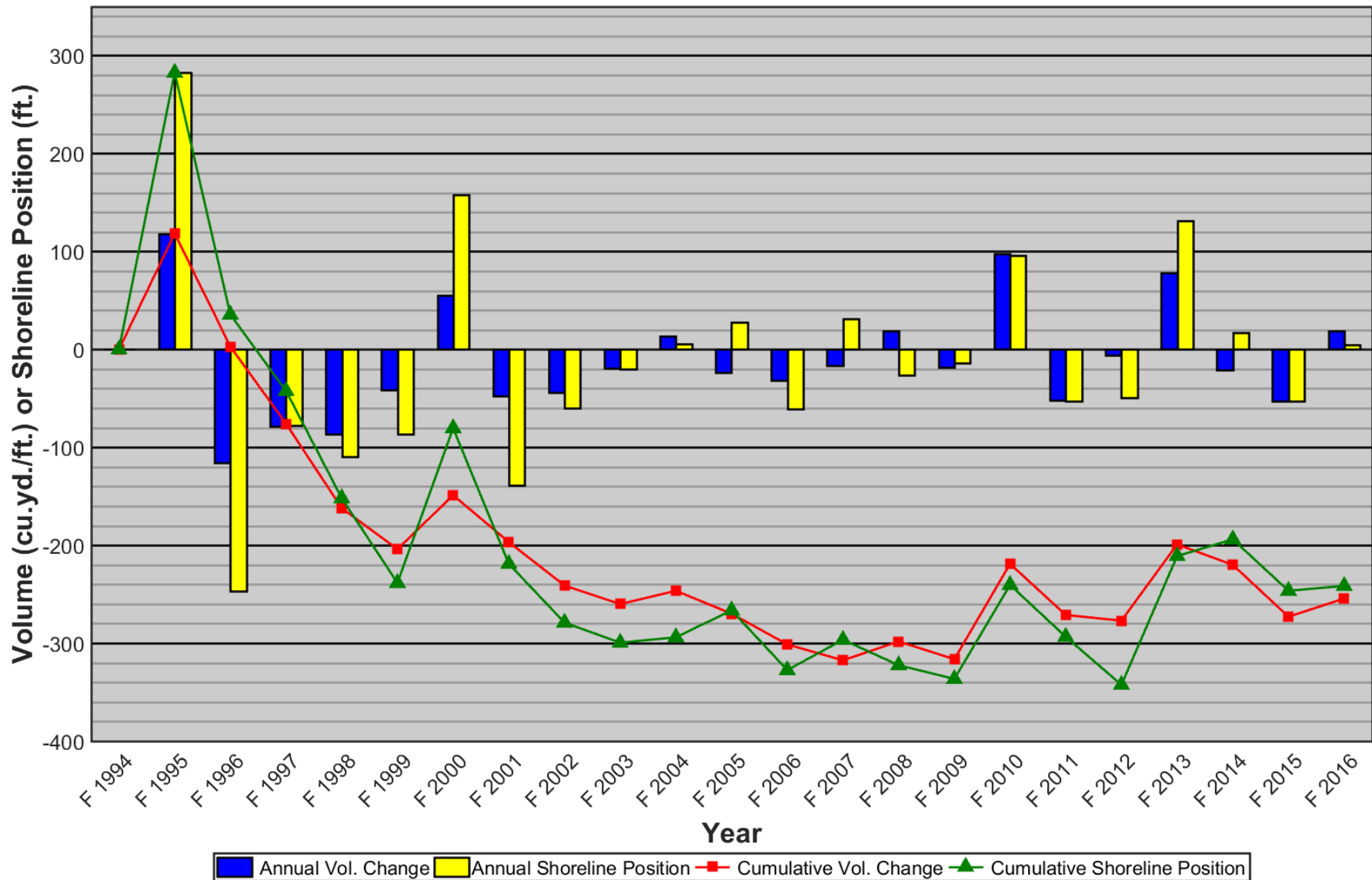


Figure 455. Established at Great Egg Inlet in Ocean City in 1994, the initial beach restoration effort in 1991 was missed, but the repair following the 1992 northeast storm followed in 1995 as a major enhancement. However, the long term trend was both a shoreline retreat of 240 ft and a sand volume loss of 250 yds³/ft. from the 1994 starting point. Minor additions of sand took place in 2000, 2010 and in 2013 following Hurricane Sandy.

22-Year Ensemble Mean Profile at Site 225, Gardens Road, Ocean City, Cape May Co.

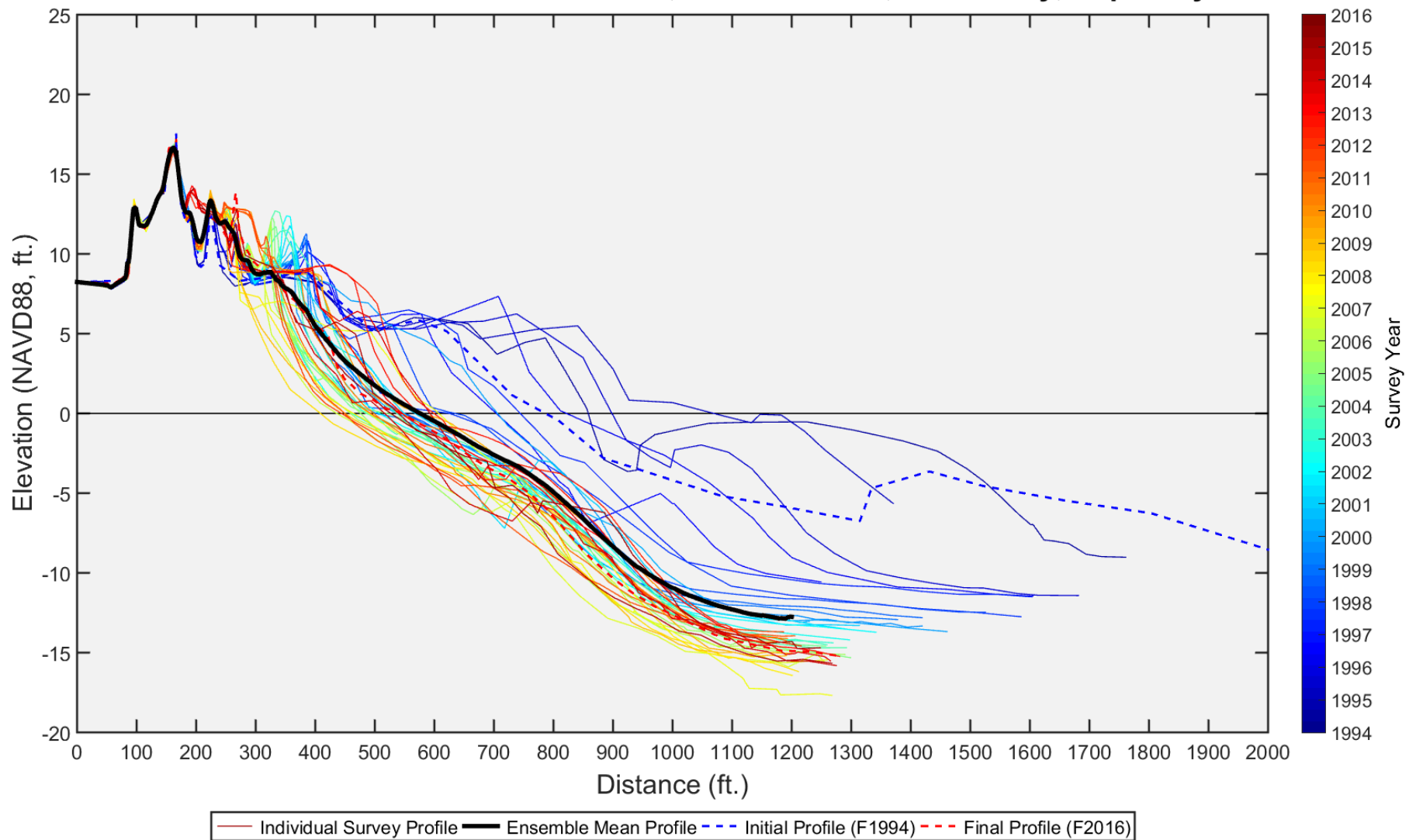


Figure 456. The progression of profiles over time for Gardens Road shows that the shoreline positions early in this series were well seaward of the current positions. The past 15 years have seen variation around the mean position with no extensive sand volume or shoreline advances since 1995. The original 1994 survey (blue dashed line) was significantly more robust than the most recent survey (red dashed line). The initial survey followed the first modern beach restoration by 2 years.

#225 - Gardens Road, Ocean City, Cape May County
Comparison of 1995 to 2015

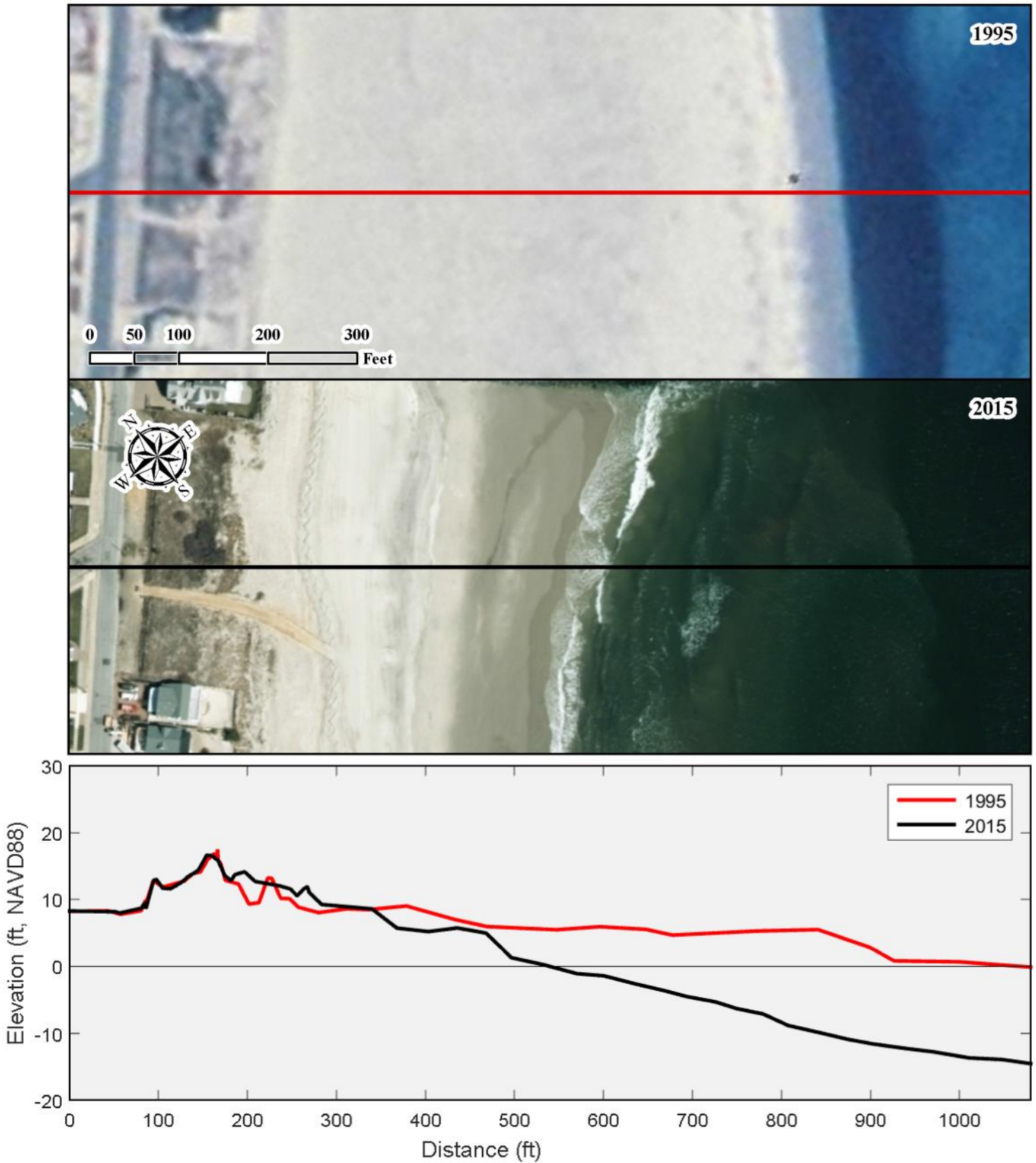


Figure 457. The Gardens Road site had been nourished twice previously, initially in 1992, then restored following the December 1992 northeast storm, so the beach was considerably wider in 1995 than it was in 2015

NJBPN 125 – 6th Street, Ocean City (September 20, 2016)



Figure 458. Sixth Avenue in Ocean City is subject to rapid rates of erosion. This view to the south shows the dune toe near the boardwalk and the existing berm at the beach. The pedestrian access path is at the end of 6th Ave.

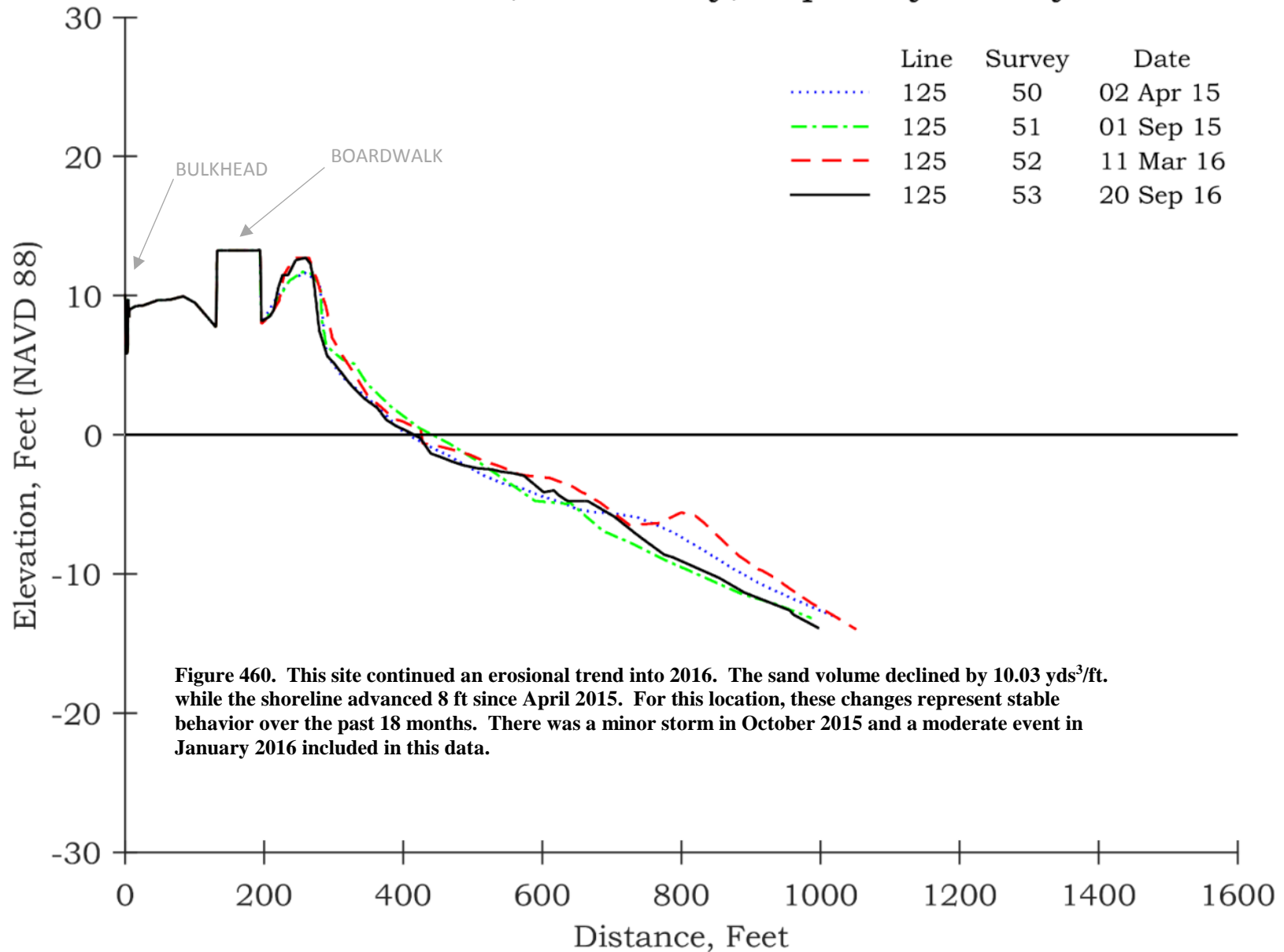
NJBPN 125 – 6th Street, Ocean City



Figure 459a & 459b. The left photo (taken September 1, 2015) shows a modest berm still present from the USAACE (2013) beach fill. The right photo (taken September 20, 2016) shows approximately the same berm width with slightly more sand at the fencing.

New Jersey Beach Profile Network

#125 - 6th Street, Ocean City, Cape May County



30-Year Coastal Changes at Site 125, 6th Street, Ocean City, Cape May Co.

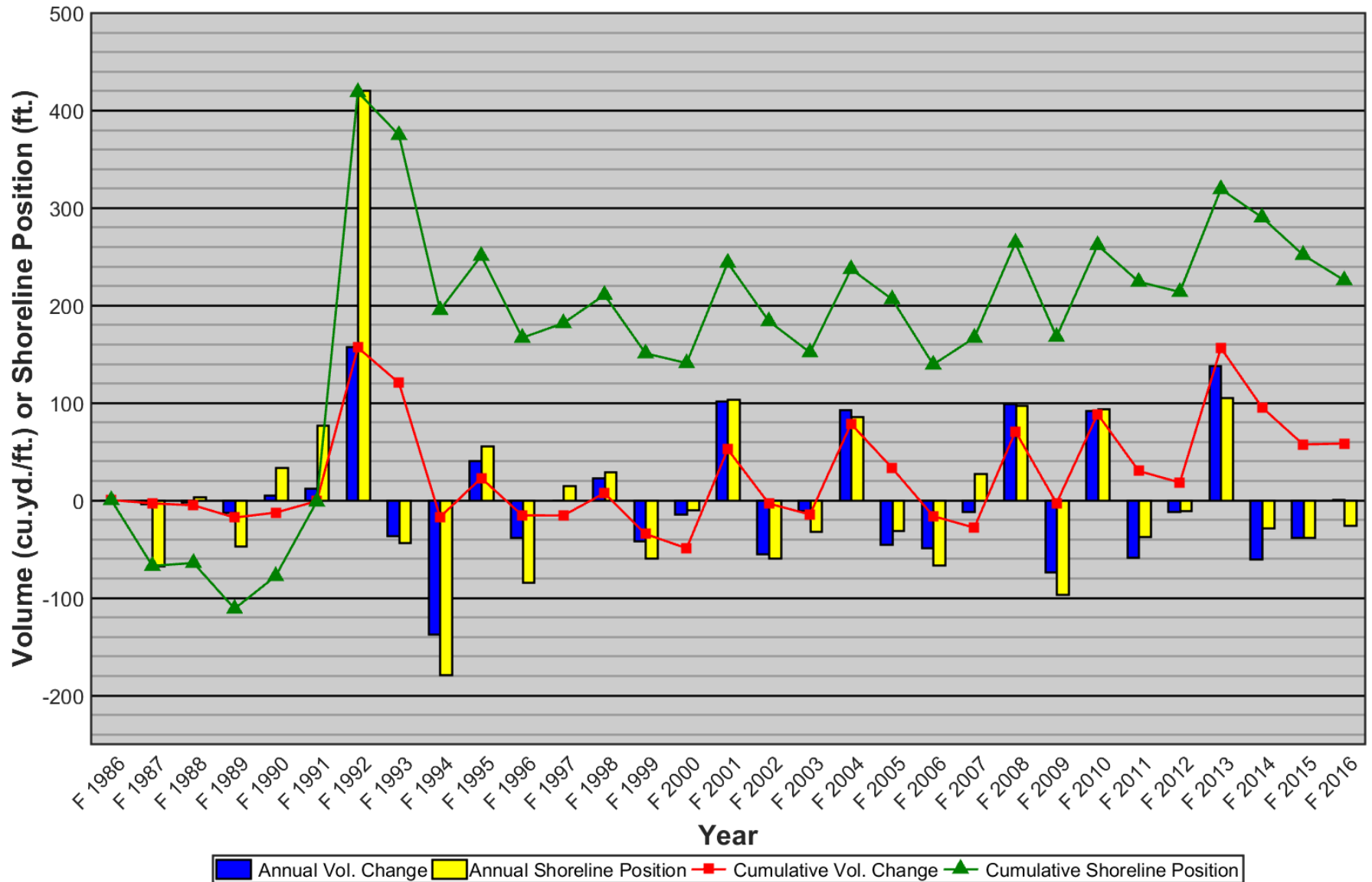


Figure 461. Ocean City saw its first episode of the recent beach nourishment actions in 1992, just prior to a major northeast storm. Multiple maintenance efforts have kept this site above the conditions present between 1986 and 1991 with a more impressive shoreline advance than sand volume gain. Initial beach nourishment efforts occurred in 1952 as 2.54 million cubic yards of sand were pumped onto the municipal beaches. During the 1960's and 1970's, the City owned a dredge that pumped dredged material from the bayside lagoons across the island to the beaches every winter until either the dredge wore out or the operator retired. The shoreline ended the 30-year time period 223 ft seaward of the 1986 position with 60 yds³/ft. in added sand volume.

30-Year Ensemble Mean Profile at Site 125, 6th Street, Ocean City, Cape May Co.

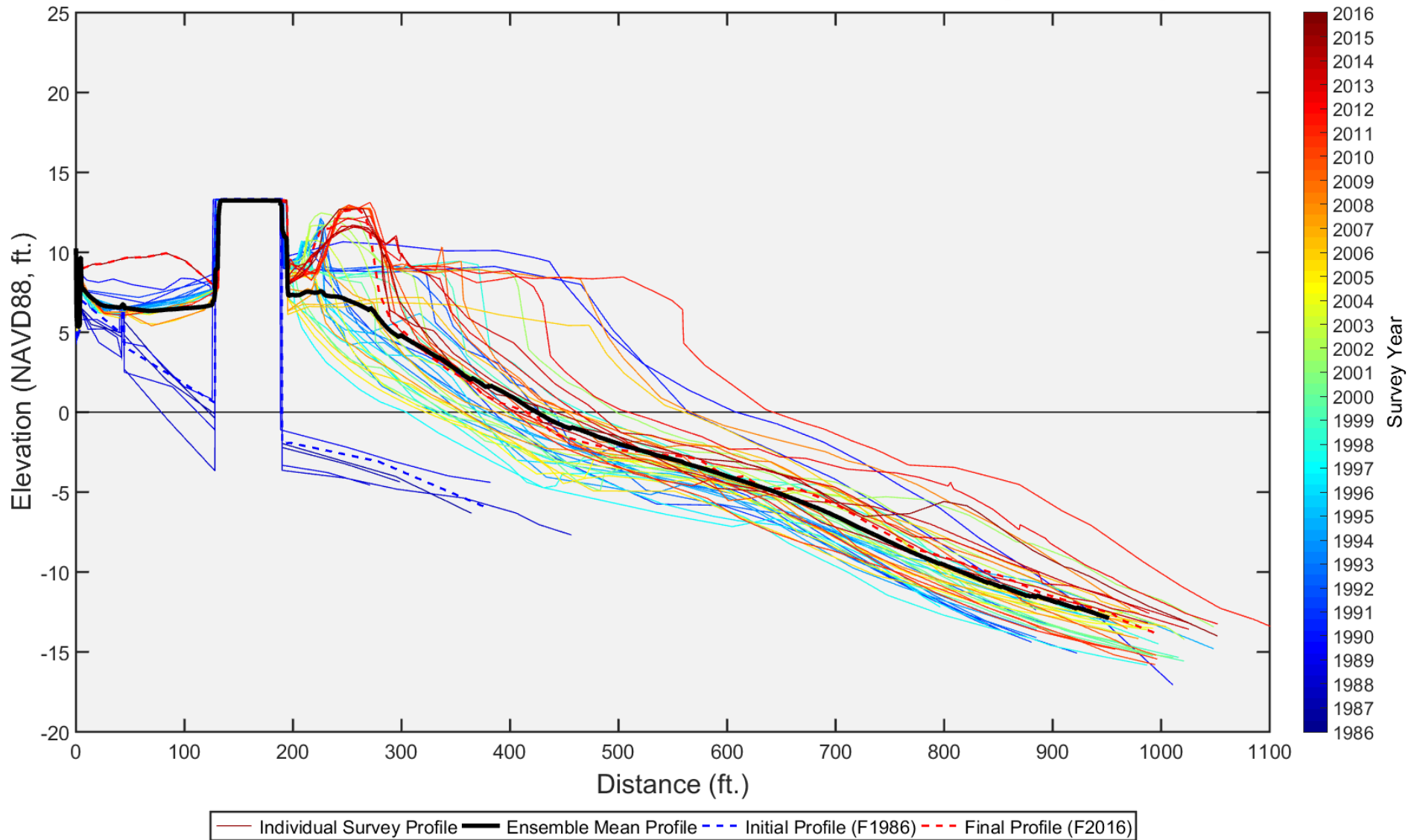


Figure 462. The earliest surveys showed low tide reached under the boardwalk to a street end revetment with clear urgency for additional shore protection. The initial fill was a pronounced addition compared to the early surveys, but shoreline retreat pushed the beach back to the boardwalk several times before maintenance occurred. Recent work has kept the dune in place with a reasonable beach width seaward protecting the boardwalk, properties and infrastructure, once exposed to direct wave attack.

#125 - 6th Street, Ocean City, Cape May County
Comparison of 1986 to 2015

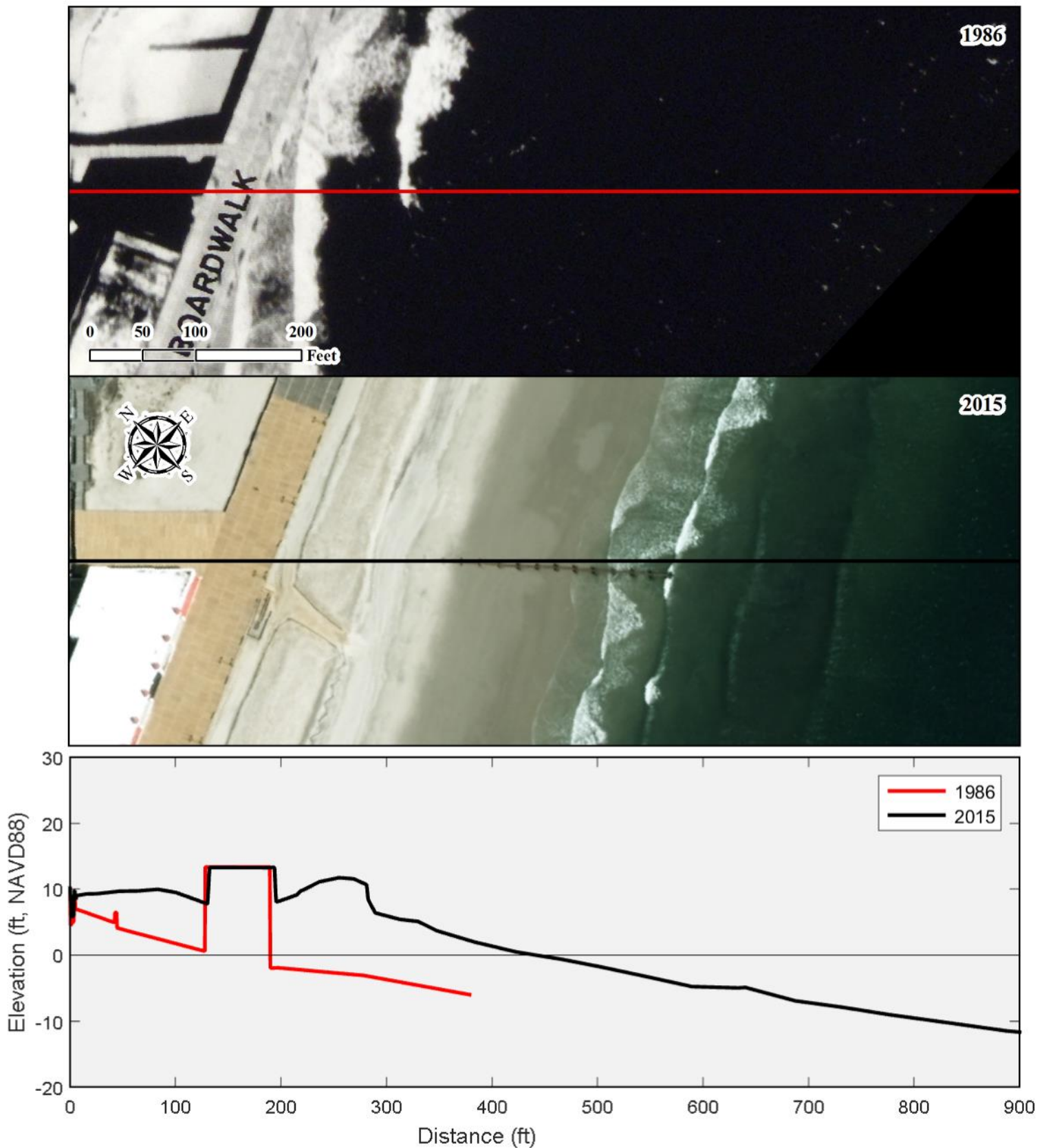


Figure 463. The 1986 air photograph shows that high tide was at or under the boardwalk. The starting point for this survey was adjacent to the landward bulkhead protecting the street pavement end. This region in Ocean City has been volatile in terms of erosion, forcing repetitive maintenance to keep a dune and beach in place.

NJBPN 124 – 20th Street, Ocean City (September 16, 2016)



Figure 464. This northerly view at the water's edge is in contrast with the two pictures below taken at the dunes that have developed on the 1991 beach restoration and augmented by repetitive fill work to the north. No added sand was directly placed here since 1991, it all arrived naturally over the time interval.

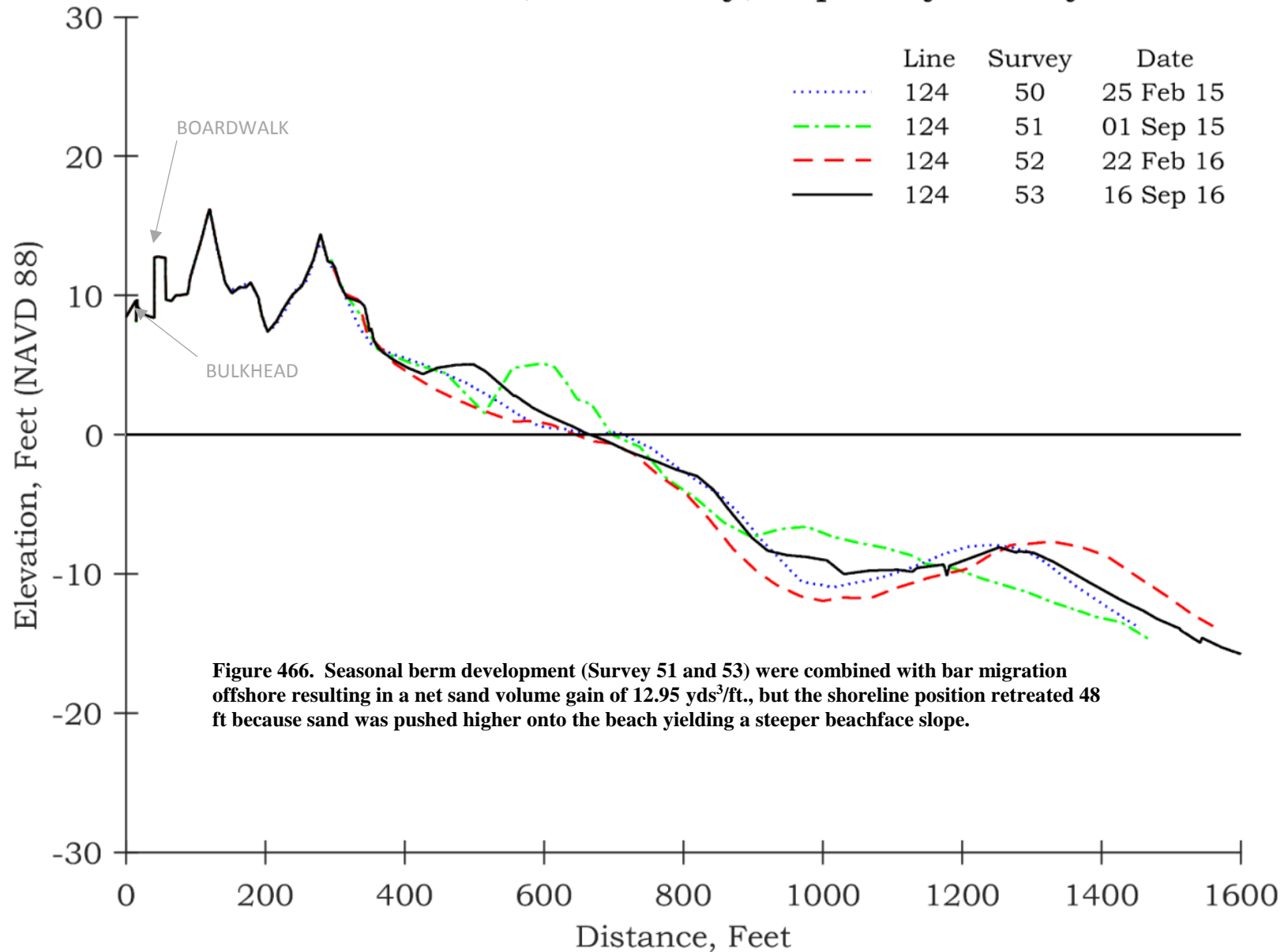
NJBPN 124 – 20th Street, Ocean City



Figure 465a & 465b. The 20th Street profile is located near the center of the island and hosts an extensive dune and wide berm. The area has been accretional since the initial beach restoration in 1992. Photo on the left was taken September 1, 2015. Right photo was taken September 16, 2016. The dune continued to move slightly seaward and there were volumetric gains over the course of 2016.

New Jersey Beach Profile Network

#124 - 20th Street, Ocean City, Cape May County



30-Year Coastal Changes at Site 124, 20th Street, Ocean City, Cape May Co.

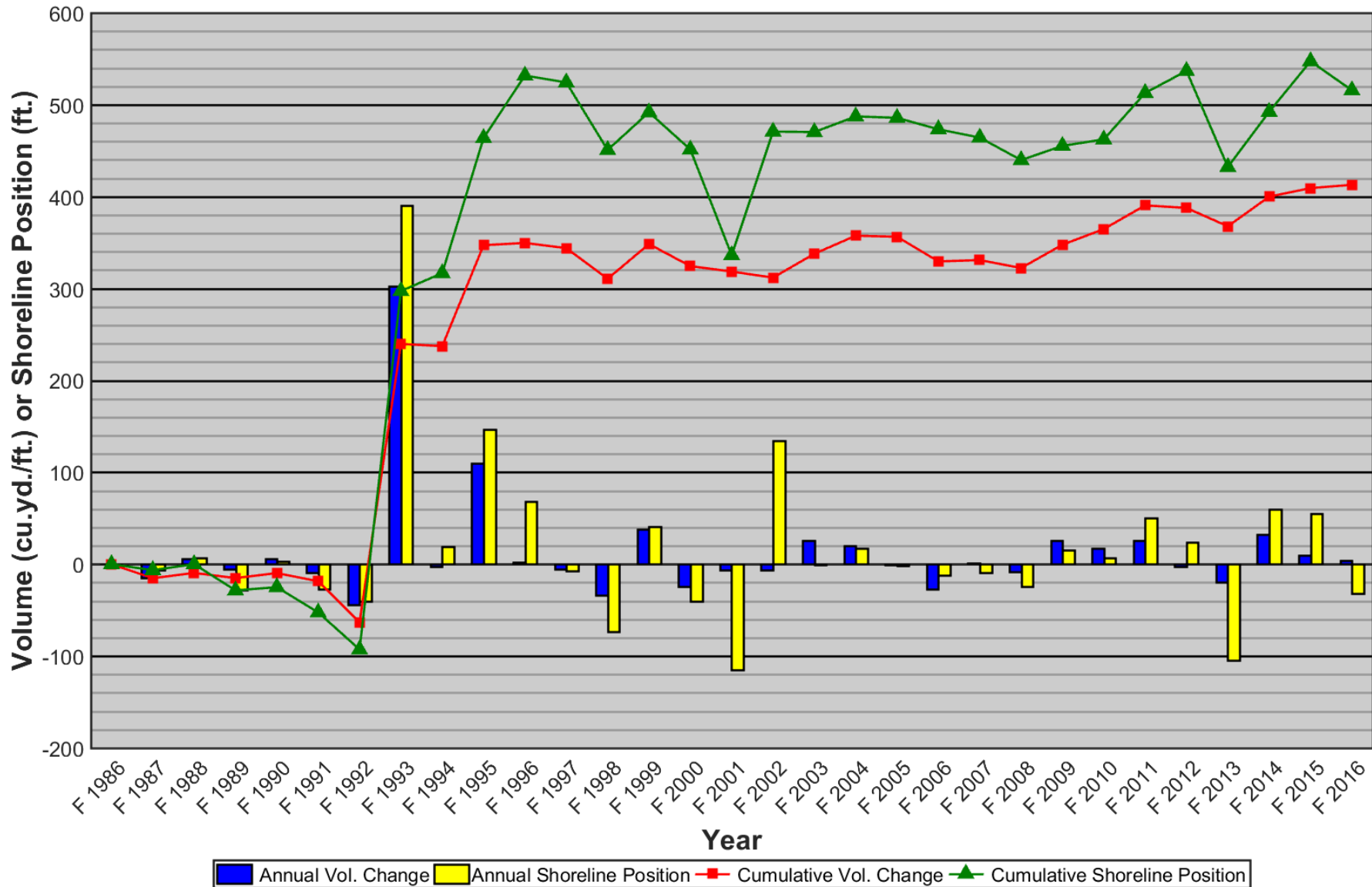


Figure 467. In the center of the island the long term trend has been dramatically positive. The initial sand deposit in 1992 was the only time that sand was placed here. All other changes were naturally achieved as sand left the northern beaches and moved south. Today the shoreline site is 520 feet seaward of the initial shoreline position, as almost 410 yds³/ft. of sand were added to the site over the 30-year measurement period. This profile defines one of several examples of a beach segment with outstanding results from the USACE project programs.

30-Year Ensemble Mean Profile at Site 124, 20th Street, Ocean City, Cape May Co.

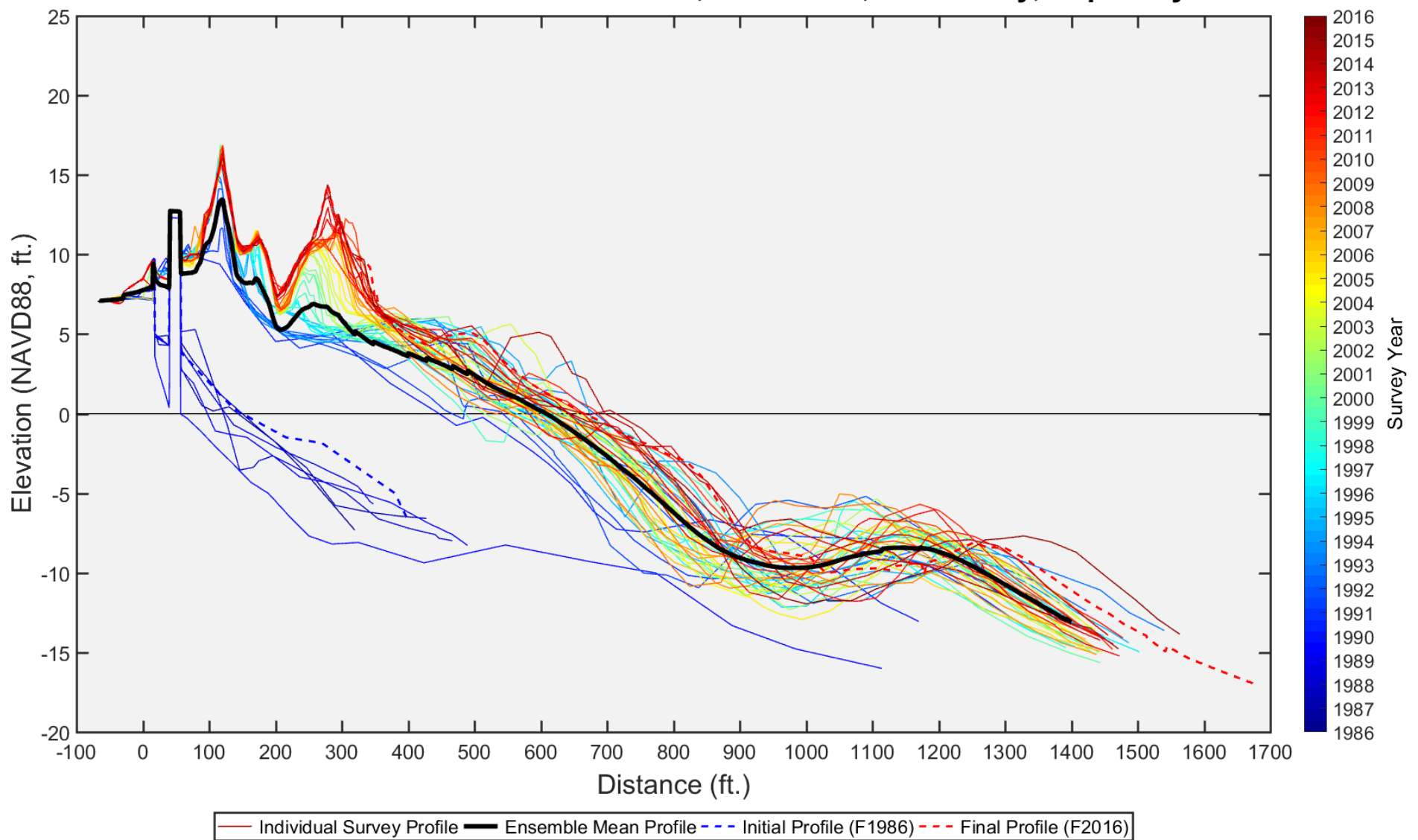


Figure 468. The contrast between the pre-1992 project and all surveys afterwards is remarkable and demonstrates a dramatic effect from the sand placement. The general trend in the post-project envelope has been one where the dunes have grown massively large and the beach generally moved seaward in cycles of change. Given that this site saw zero maintenance since the original fill placement, the effect is all the more impressive. Hurricane Sandy was of little impact, but if Sandy had occurred in October 1991, the boardwalk and property damage would have been catastrophic. Evidence for this was seen in the \$4 million in boardwalk damage between 19th and 12th Streets suffered during the “Perfect Storm” of Halloween 1991. The December 1992 NE Storm eroded the beach but without any damage to the boardwalk or homes along this oceanfront section between the Gardens and 34th Street.

#124 - 20th Street, Ocean City, Cape May County
Comparison of 1986 to 2015

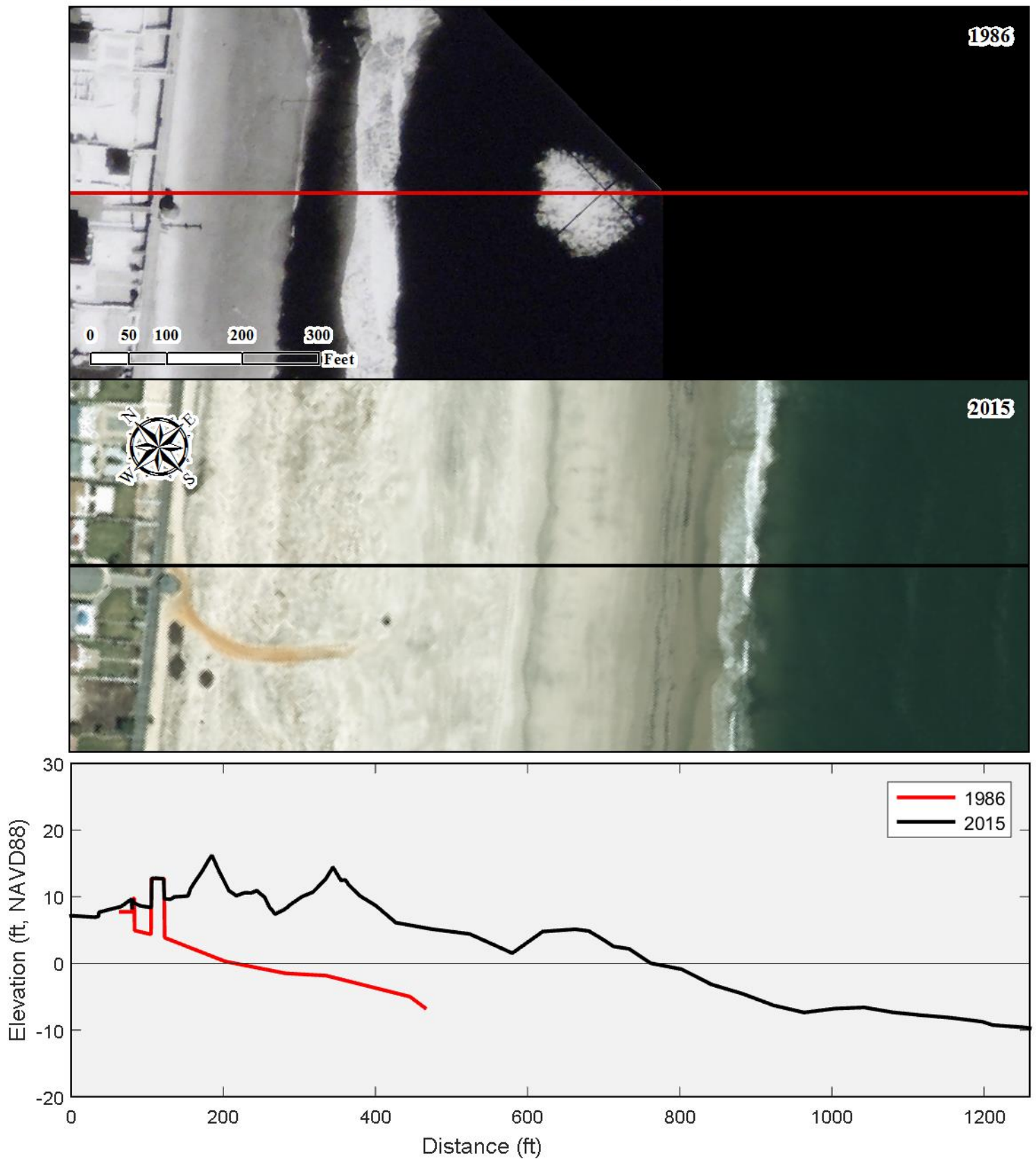


Figure 469. By 1986, high tide was at the timber bulkhead at 20th Street and early in the NJBPN surveying prior to the 1992 beach fill, low tide was under the boardwalk. At this location the sand volume was never subject to chronic erosion, instead conditions were a result of diminished material within the local sand budget. Conditions were enhanced over the next 25 years by adding material to the local budget moved south by littoral processes derived from the 6th to 12th Street project area.

NJBPN 123 – 34th Street, Ocean City (September 16, 2016)



Figure 470. View to the south along the beach at 34th Street in Ocean City. The 2015 fill commenced several blocks to the south and continued to 59th Street.

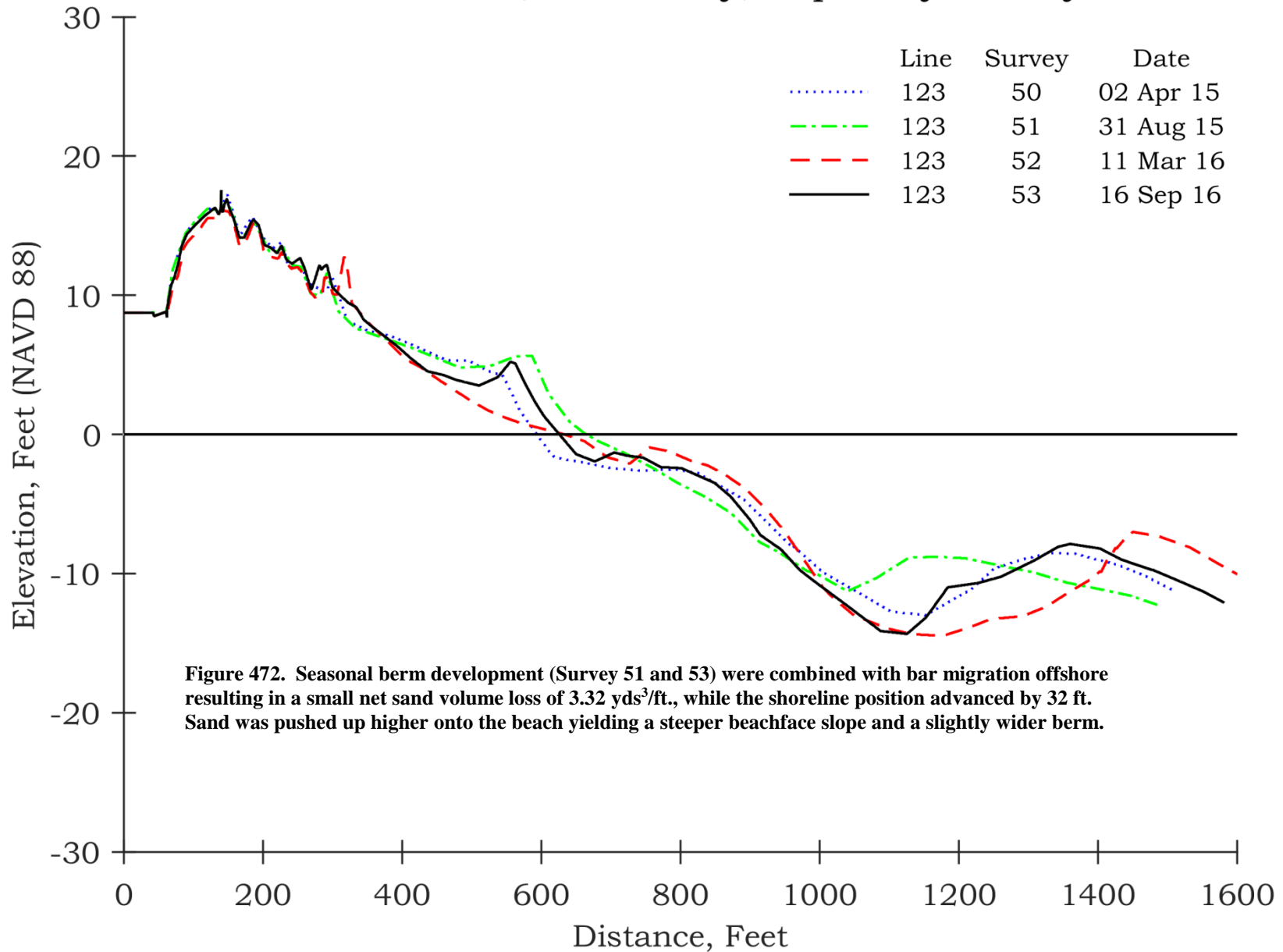
NJBPN 123 – 34th Street, Ocean City



Figure 471a & 471b. The comparison photos show a view to the south (left taken August 31, 2015 and right photo taken September 16, 2016) and the extent of the beach at 34th Street. The dune fencing has become almost buried from Aeolian transport and a large bar can be seen offshore in the photograph to the right.

New Jersey Beach Profile Network

#123 - 34th Street, Ocean City, Cape May County



30-Year Coastal Changes at Site 223, 34th Street, Ocean City, Cape May Co.

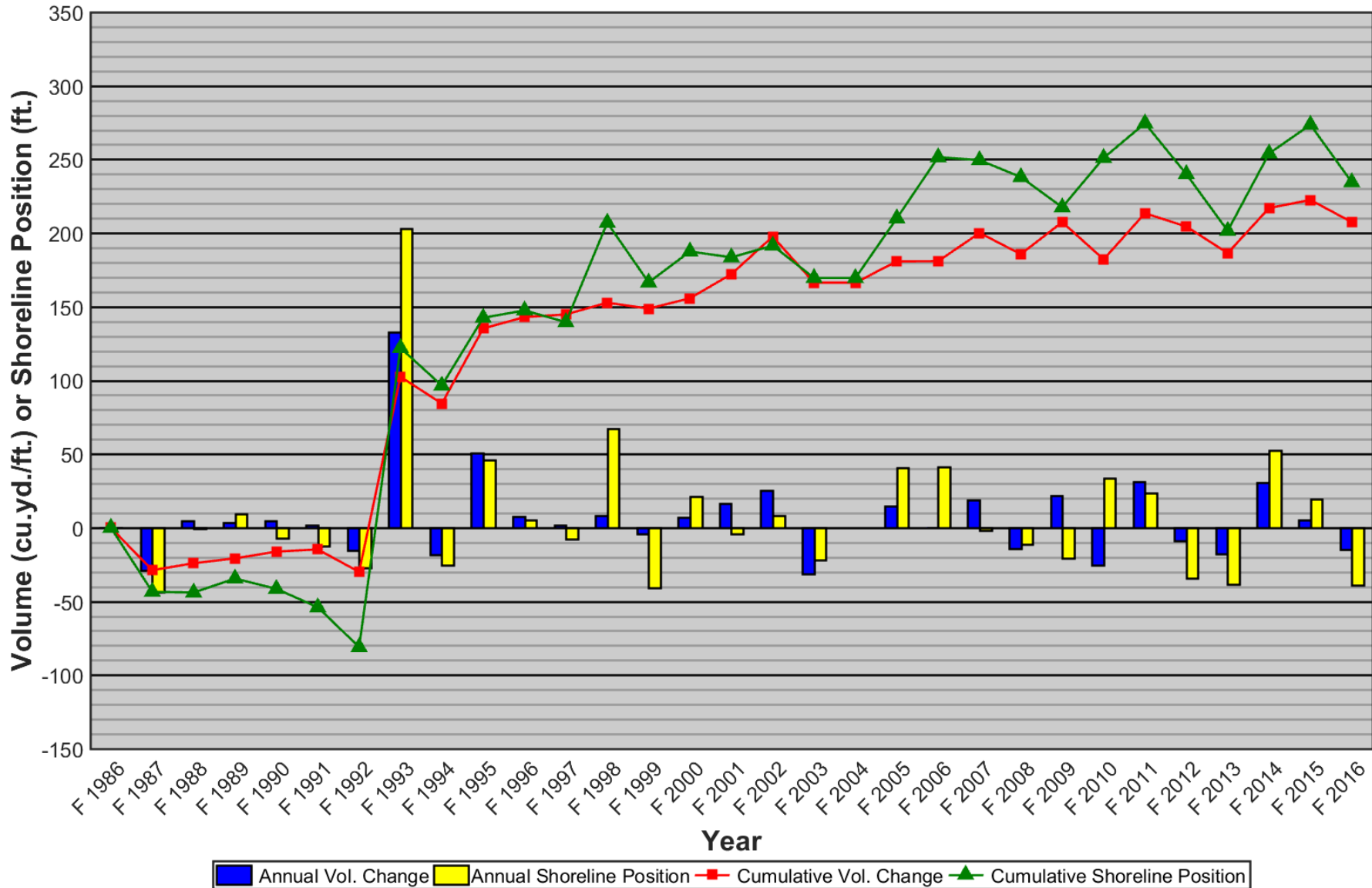


Figure 473. Since the initial fill placement in 1992, this site has seen steady increases in sand volumes and by 2016, the added sand was twice the initial placement volume, without any additional volume being introduced directly. The shoreline cycled within a 75-ft variation four times and was not always associated with a sand volume increase. This is another site where stability was fostered by an initial beach nourishment (shoreline advance of 200 feet) that was enhanced over the years through the longshore transport of sand from the northern project beaches. The cross section line was shifted south to include the new, enhanced dune in 2004.

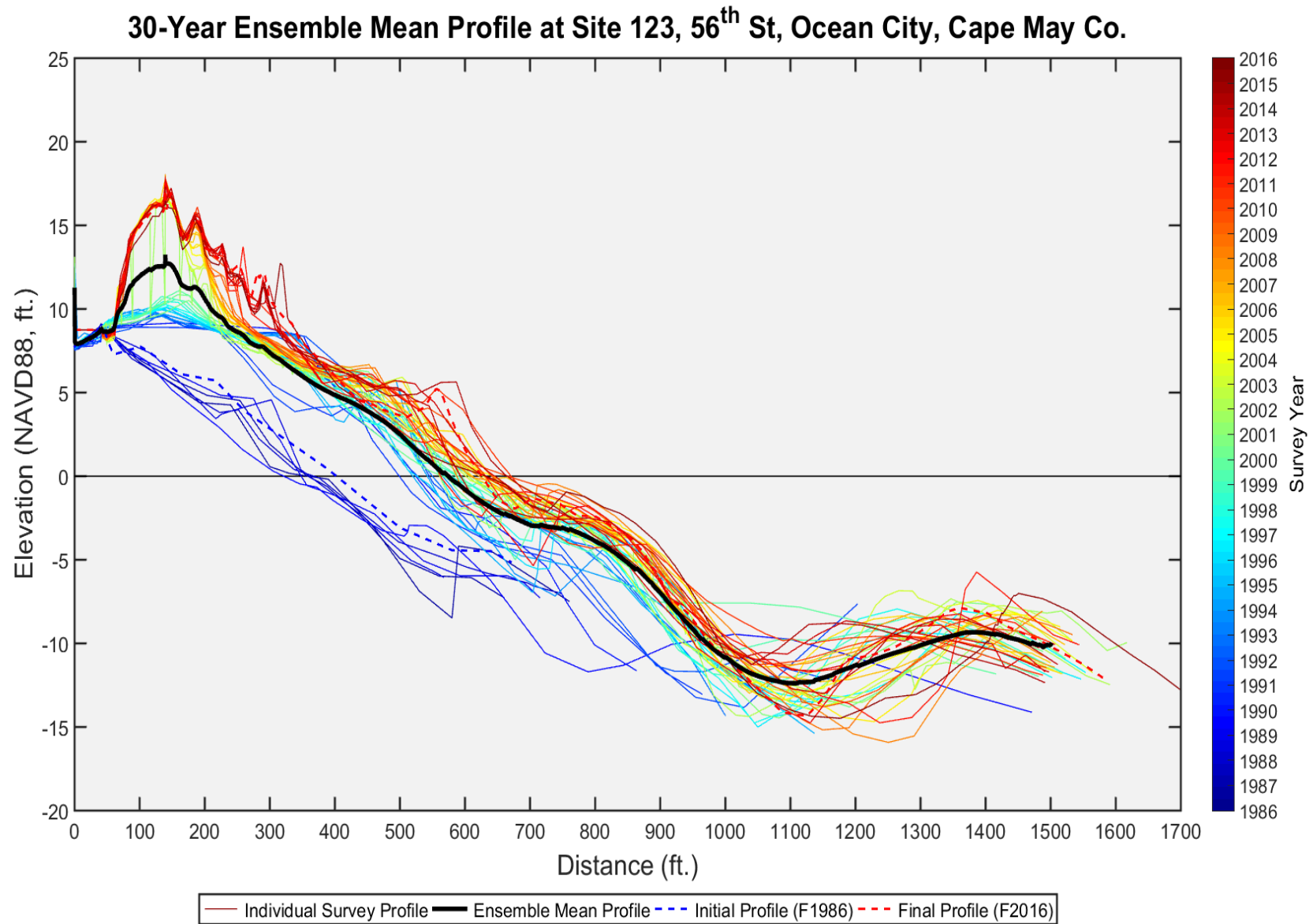


Figure 474. This site was moved away from the vehicle and pedestrian access pathway 12 years ago to monitor the dune and the beach as a unit. Previously, there was no dune at the 34th Street access and the site was shifted south approximately sixty feet to include the dunes. The 12-year profile envelope is fairly tight with the early plots generally landward of the latest surveys. This agrees with the data since 2004 in the figure above.

#123 - 34th Street, Ocean City, Cape May County
Comparison of 1995 to 2016

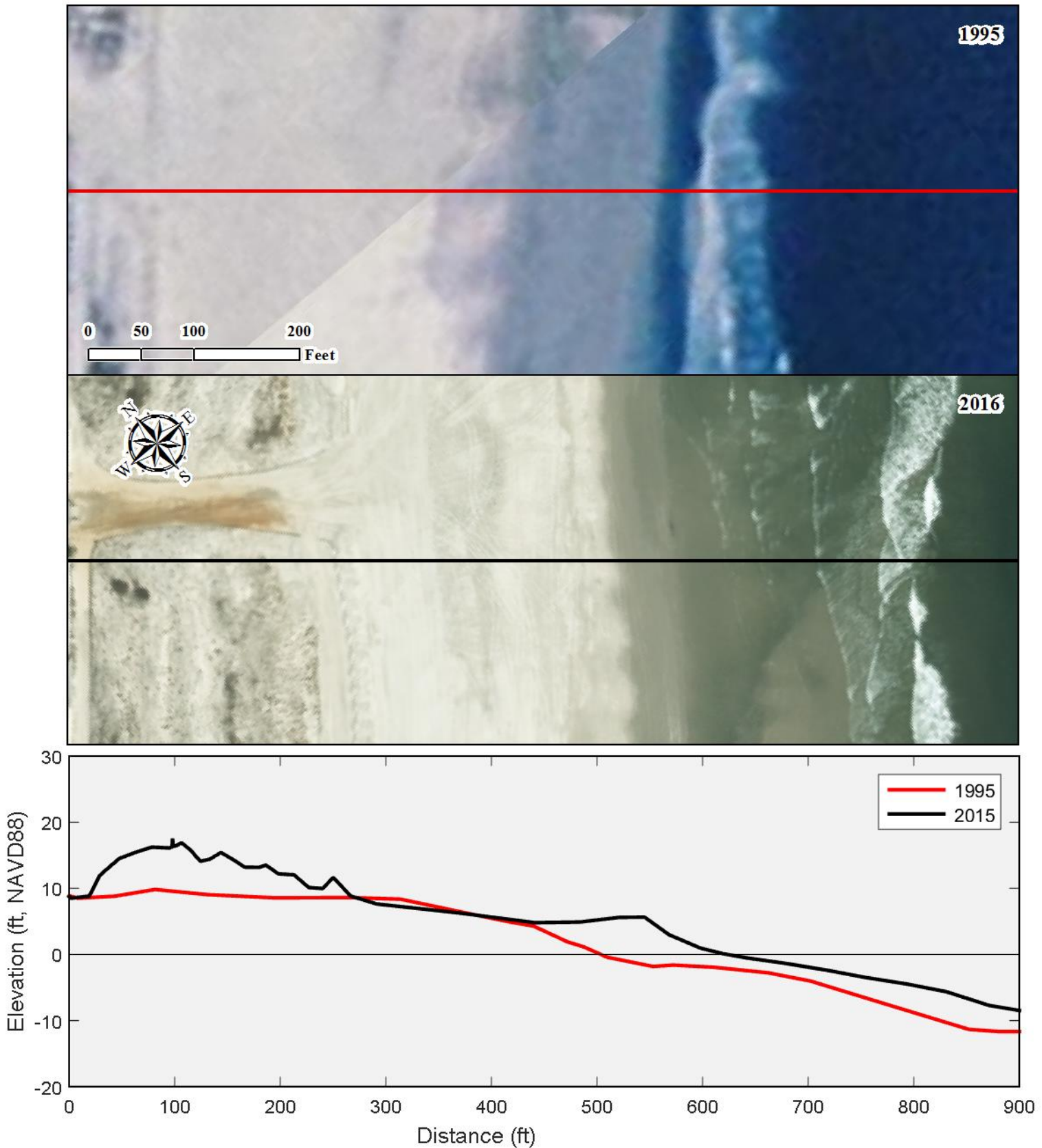


Figure 475. This site was relocated 61 feet south because a vehicle access path to the beach prevented establishment of a dune on the original site selected. The beach received sand during the State of NJ nourishment project in 1995. The comparison above shows the subsequent influx of sand from the north end USACE project over the last decade.

NJBPN 122 – 56th Street, Ocean City (September 15, 2016)



Figure 476. A view of the new federal beachfill looking north, with the dune grass in place and thriving. The width of dry beach is outstanding.

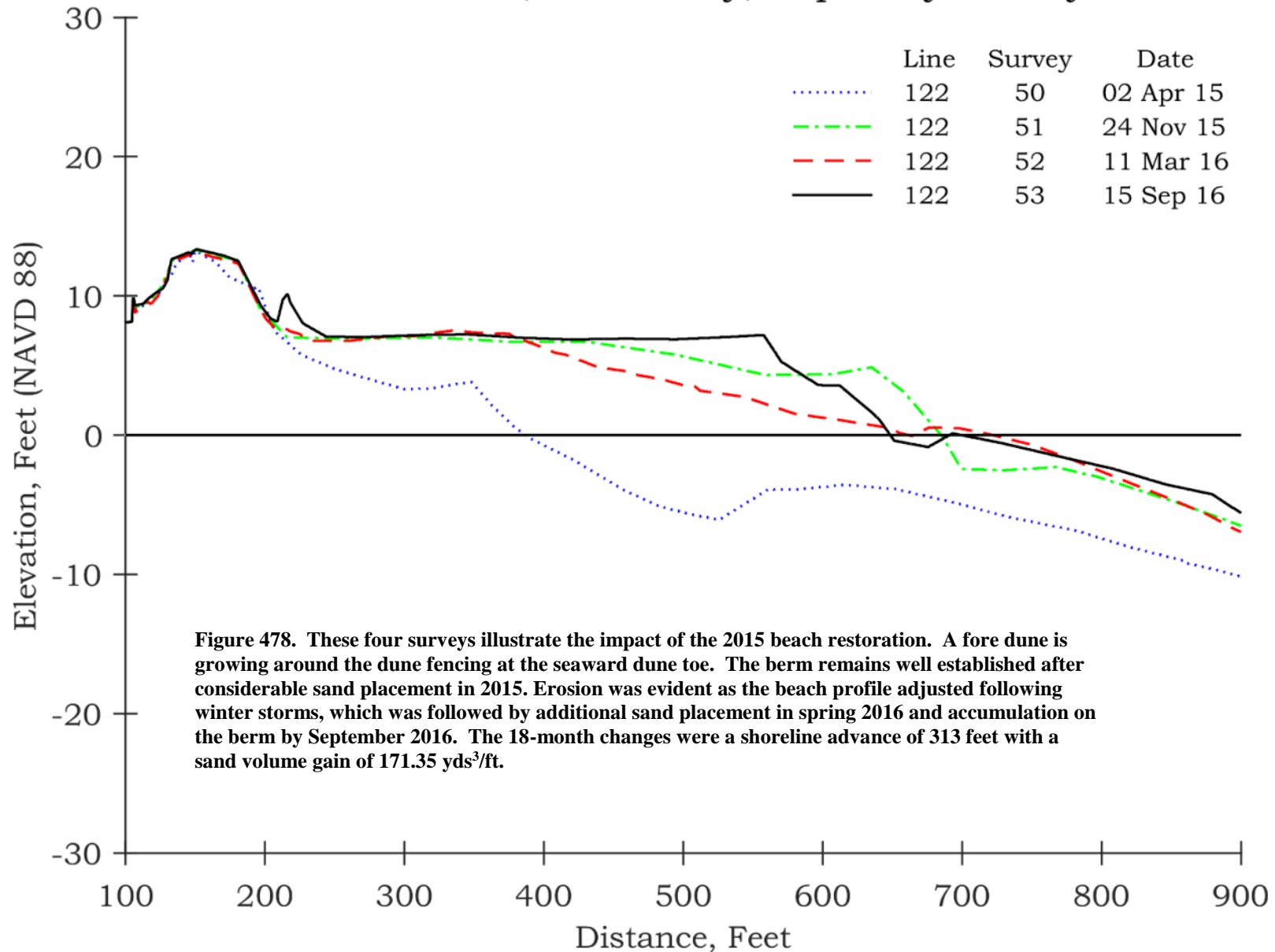
NJBPN 122 – 56th Street, Ocean City



Figure 477a & 477b. In 2015, the 56th Street site received its first sand replenishment since the 1995 state beach fill. The site is now included in the federally authorized project. The November 24, 2015 (left) photo shows the immediate post-project dune and berm. On the right (photo taken September 15, 2016) after a year of growth the grass appears healthy and vigorous. The wider beaches provide sand and space for continued natural dune development.

New Jersey Beach Profile Network

#122 - 56th Street, Ocean City, Cape May County



30-Year Coastal Changes at Site 122, 56th Street, Ocean City, Cape May Co.

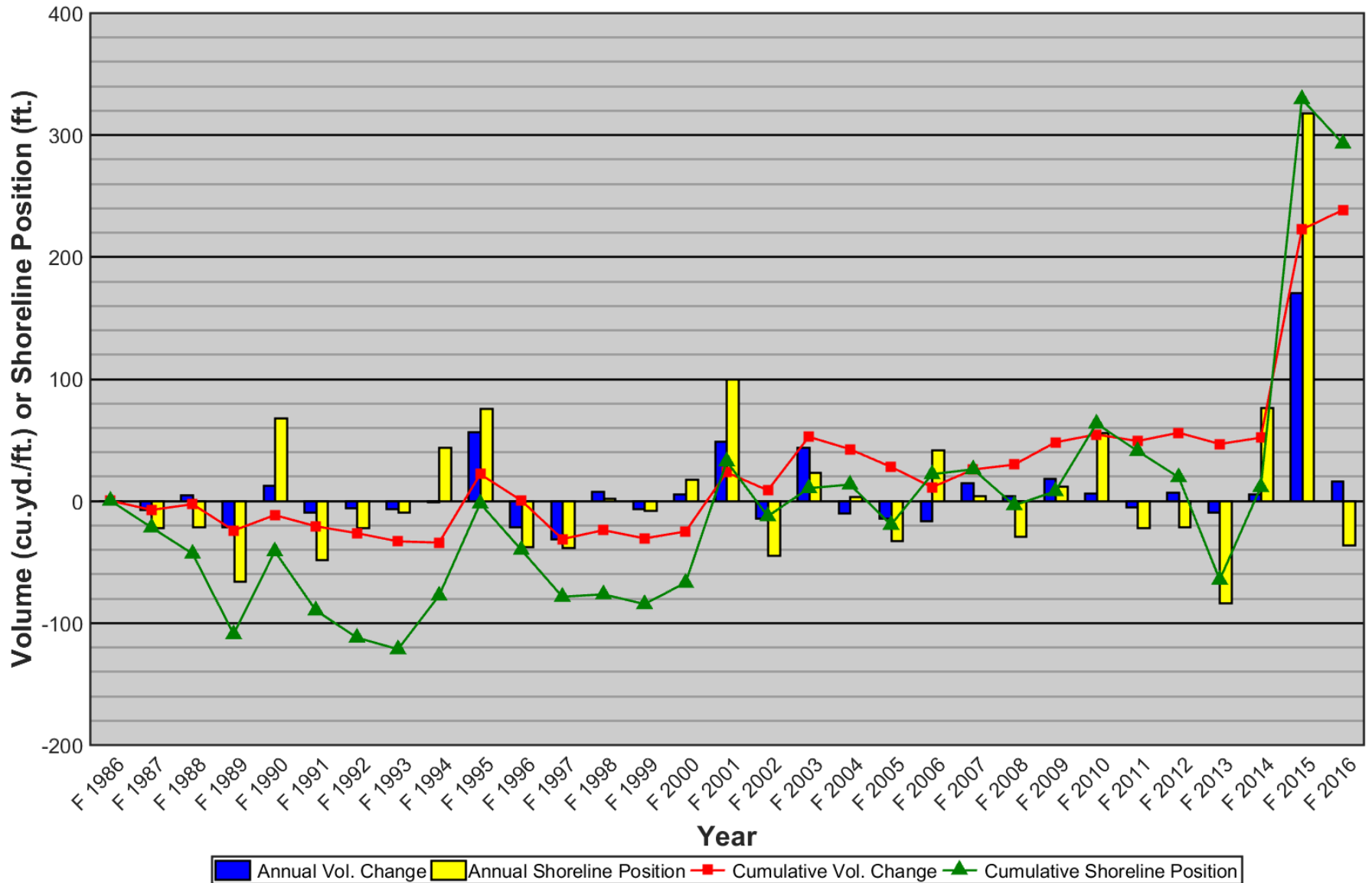


Figure 479. 56th Street received some sand in 1995 as a result of a NJ State sponsored project, but that material rapidly dispersed to the south. A non-federal re-nourishment effort in November 2000 added 303,000 cubic yards of sand to the south end of Ocean City. By 2001, littoral transport from surpluses to the north and the 2000 project augmented the site's sand volume, raising it above the initial 1986 value by 50 yds³/ft. In 2015, the USACE took charge of this section of beach and added 170 yds³/ft. of sand, greatly enhancing shore protection at this site.

30-Year Ensemble Mean Profile at Site 122, 56th Street, Ocean City, Cape May Co.

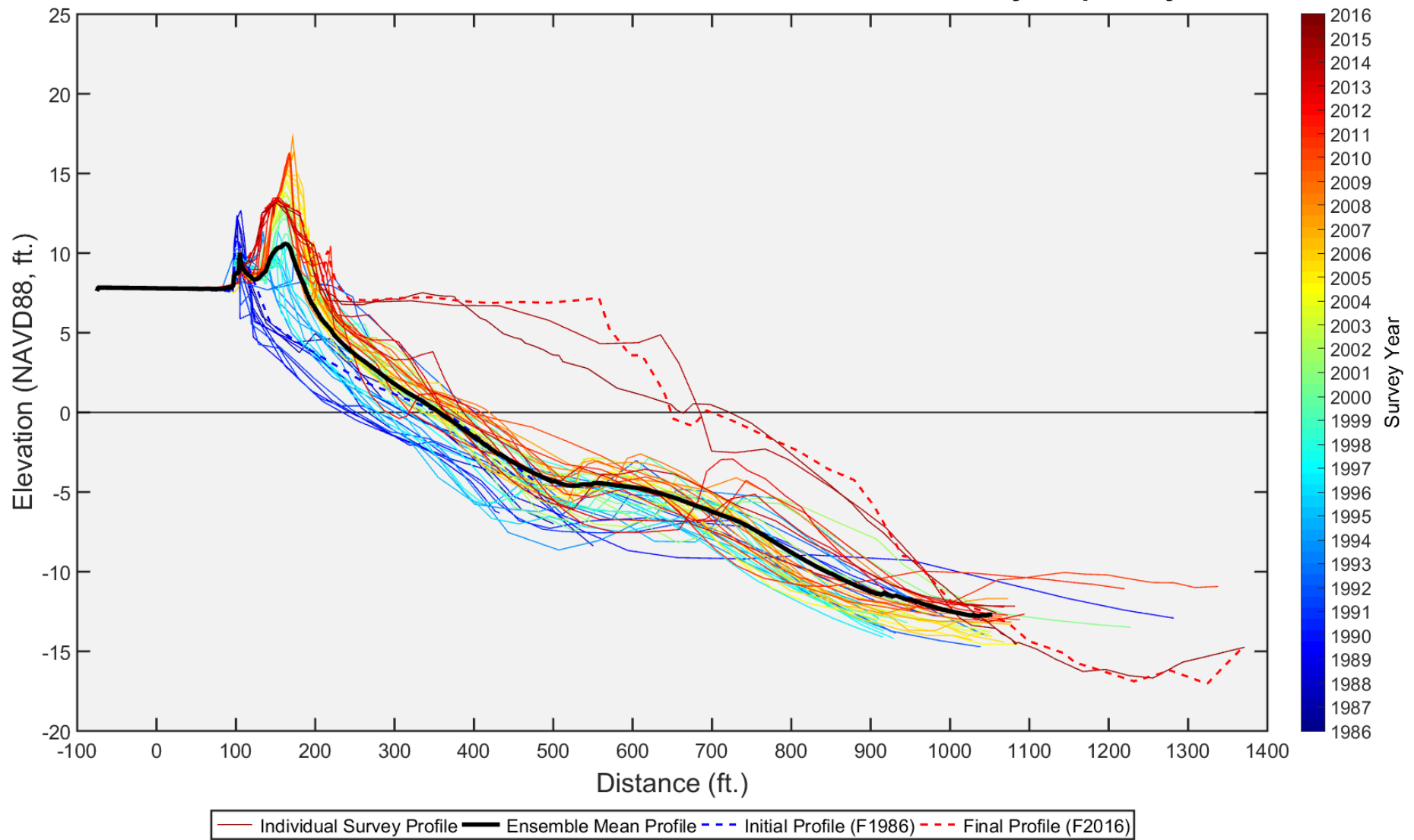


Figure 480. This figure displays the slow accretion of sand as evident by the progression of colored profile lines from blue to red within a tight envelope. The USACE beach fill shows in the red profile lines since 2015 and the overall seaward progression of the site from the initial to the most recent profile lines (blue and red dashed lines) is very dramatic.

#122 - 56th Street, Ocean City, Cape May County
Comparison of 1995 to 2016

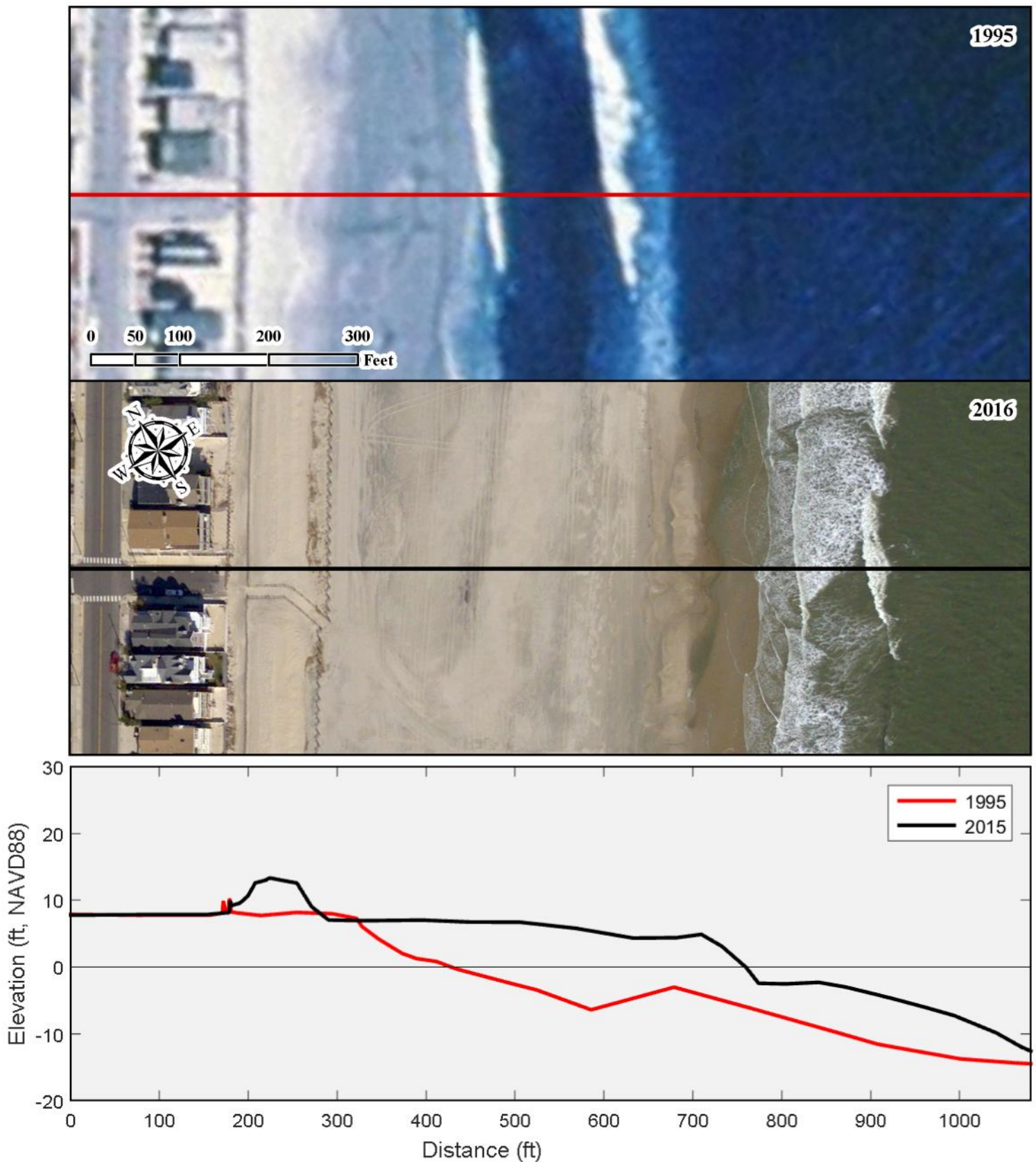


Figure 481. The USACE very recent work here has made a significant difference in beach width and dune development. Hurricane Sandy breached this section due to a lack of either sufficient beach width or dune system formation to provide ample shore protection. The USACE project beach will support further dune development and enhanced shore protection.

NJBPN 222 – 59th Street, Ocean City (September 15, 2016)



Figure 482. The new beach at 59th Street is much wider than prior to the 2015 fill effort. The early 2015 survey demonstrates the comparison prior to and subsequent to the fill project.

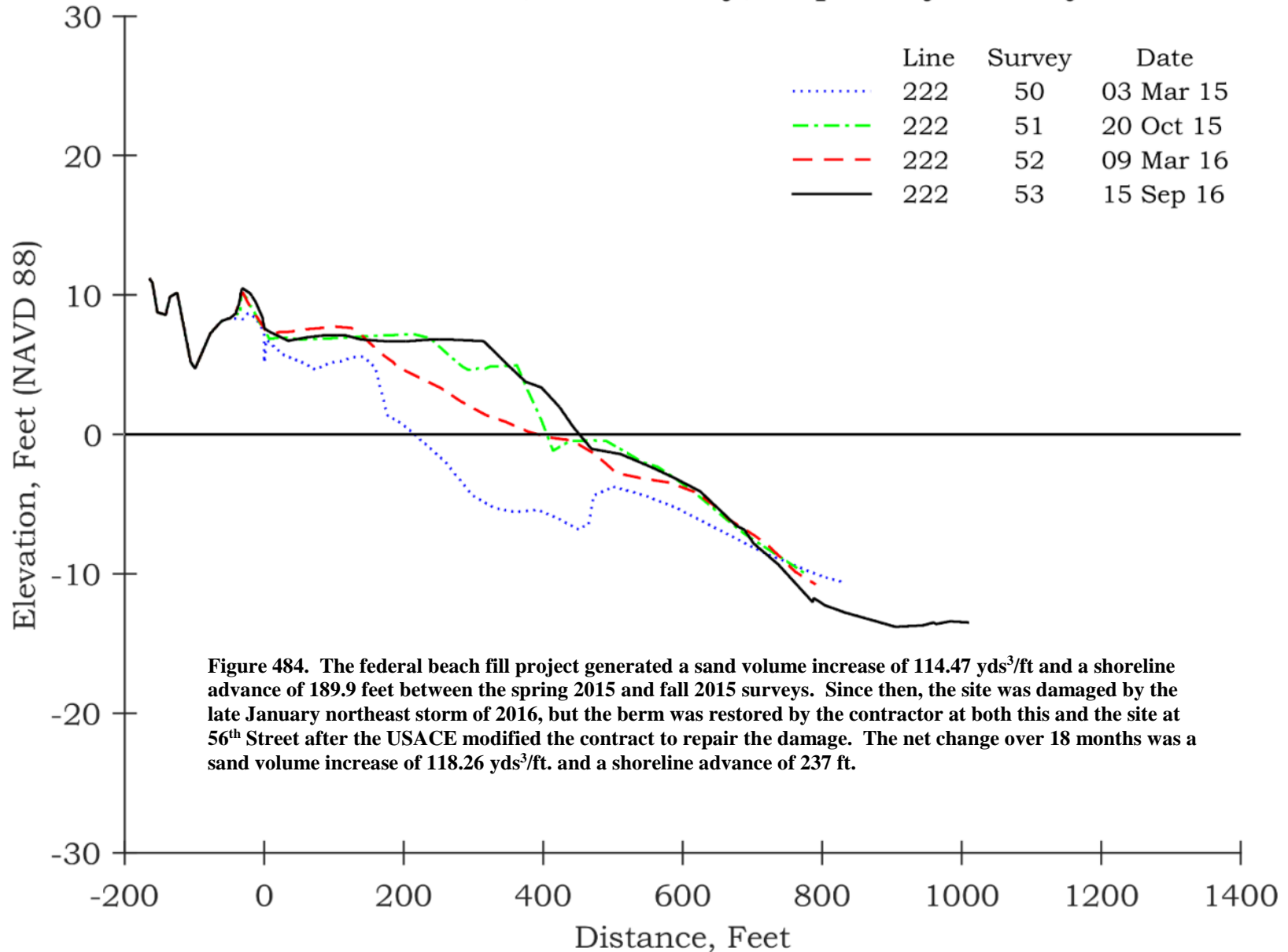
NJBPN 222 – 59th Street, Ocean City



Figure 483a & 483b. The 59th Street site is located at the southern end of Ocean City's developed shoreline, just within the Corson's Inlet State Park. This site is also within the 2015 federal beach fill project area. The equipment was still present in the left photograph taken October 20, 2015, while the open beach was the view in the September 15, 2016 photograph on the right.

New Jersey Beach Profile Network

#222 - 59th Street, Ocean City, Cape May County



7-Year Coastal Changes at Site 222, 59th Street, Ocean City, Cape May Co.

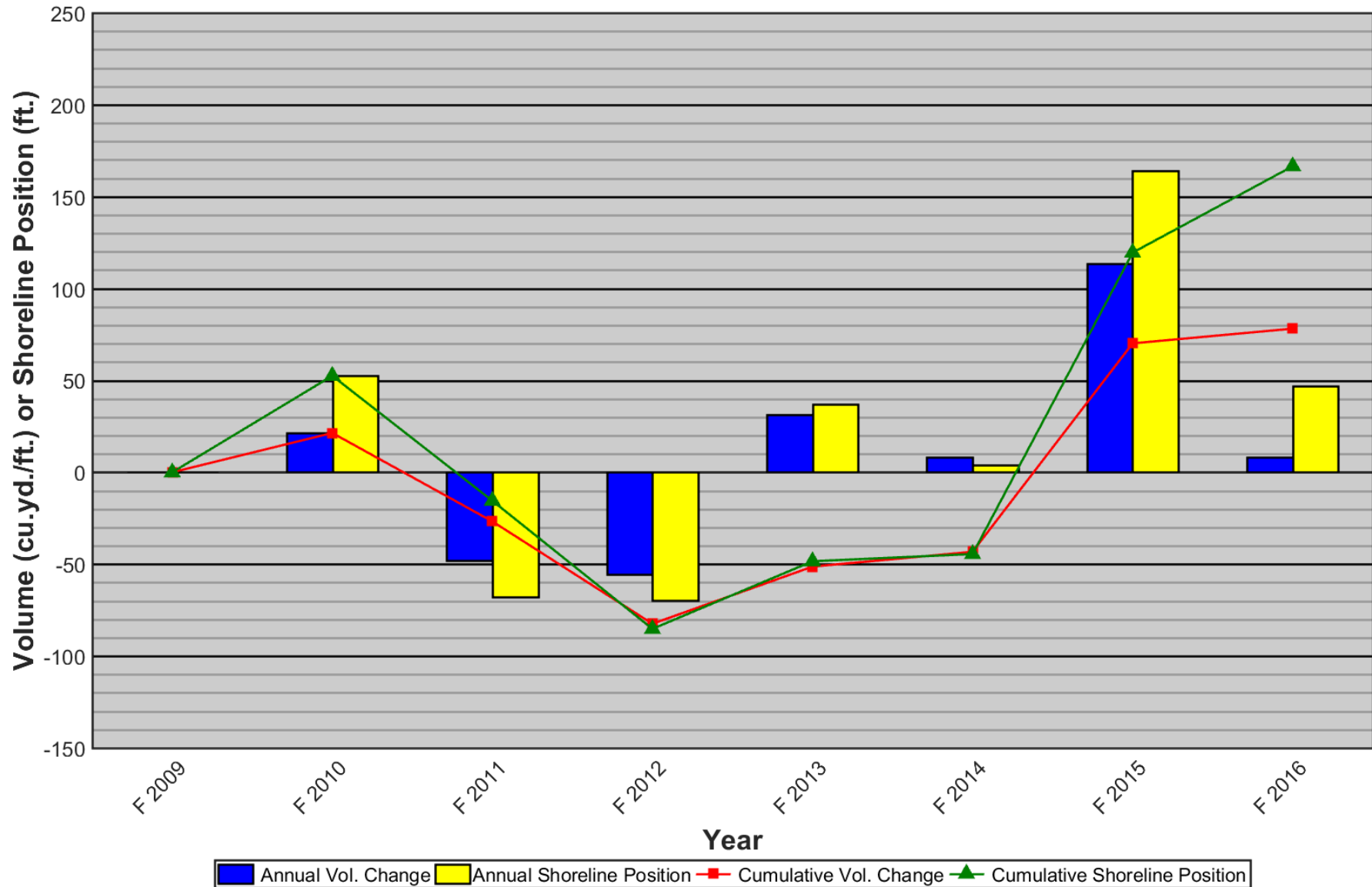


Figure 485. 59th Street was established prior to Hurricane Sandy as it became clear that the south end of the barrier island was subject to high volume sand changes in the beachfront. A 2009 NJ State sponsored beach nourishment project for Strathmere added interest in how sand moved in and around Corson’s Inlet. The USACE project in southern Ocean City was constructed in 2015 as shown in the figure above. No sand was directly placed here, but proximity allowed littoral transport to move material to the site rapidly.

7-Year Ensemble Mean Profile at Site 222, 59th Street, Ocean City, Cape May Co.

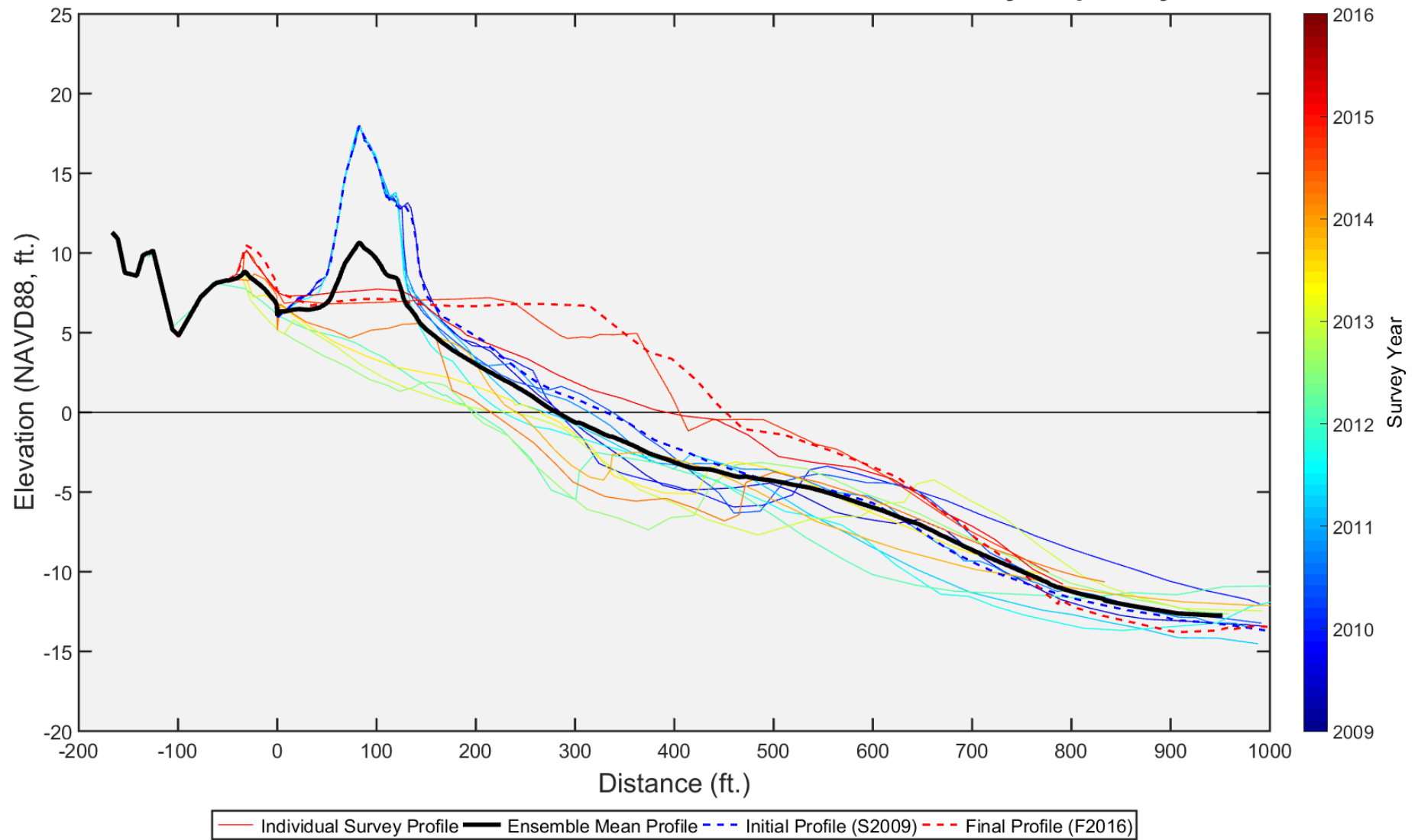


Figure 486. The USACE beach fill changes shows in the red profile lines on the graph above. The new wider beach will supply aeolian sand to the dune field over time. The site's dune is growing naturally at a location landward of the previous feature flattened during Hurricane Sandy.

#222 - 59th Street, Ocean City, Cape May County
Comparison of 2010 to 2016

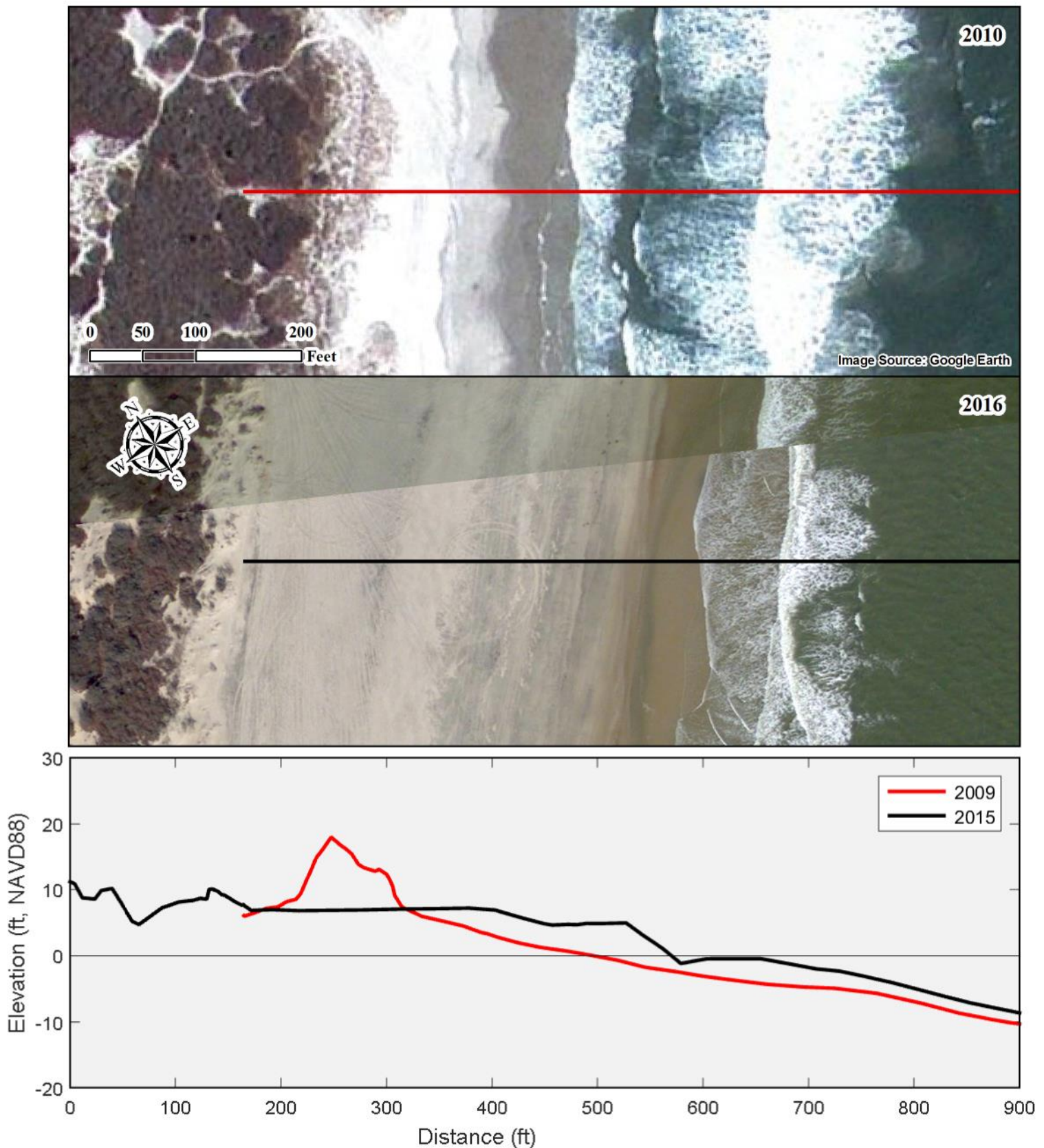


Figure 487. Hurricane Sandy washed the dune inland at this relatively new location, with recent addition of sand beginning to re-establish the feature. Sand shed from the recent fill between 34th and 59th Streets in Ocean City is providing the source material.

NJBPN 221 – Corson’s Inlet State Park, Ocean City (September 16, 2016)



Figure 488. View to the south a year following sand placement in Ocean City. Littoral transport has added material to the park shoreline widening the beach.

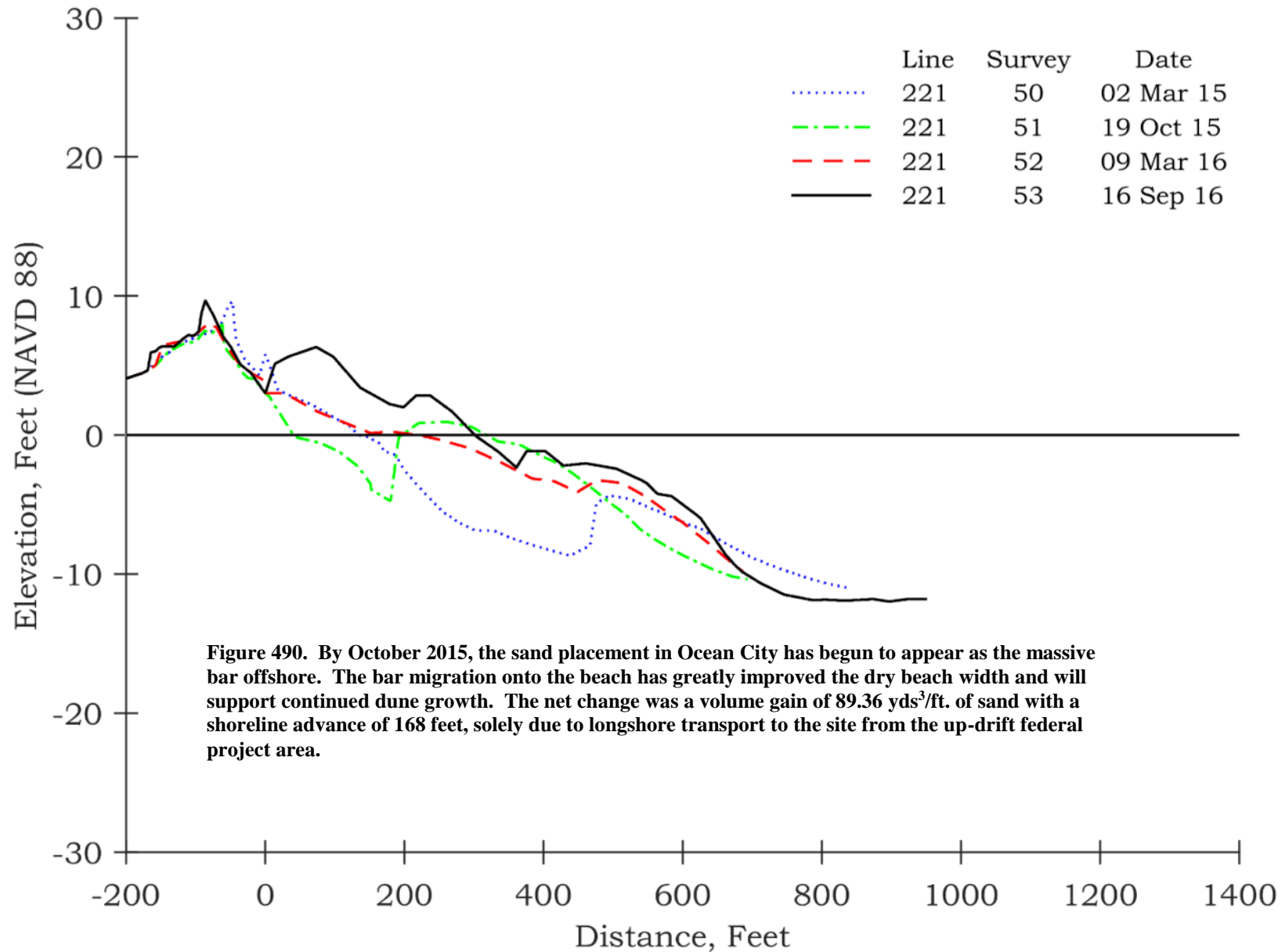
NJBPN 221 – Corson’s Inlet State Park, Ocean City



Figure 489a & 489b. The left view was taken as the Ocean City beach project was completed on October 19, 2015. The right photograph shows the beach and dune a year later following some sand migration into the area. Plants have colonized the upper beach starting the natural process of dune growth.

New Jersey Beach Profile Network

#221 - Corson's Inlet Park, Ocean City, Cape May County



7-Year Coastal Changes at Site 221, Corson's Inlet Park, Ocean City, Cape May Co.

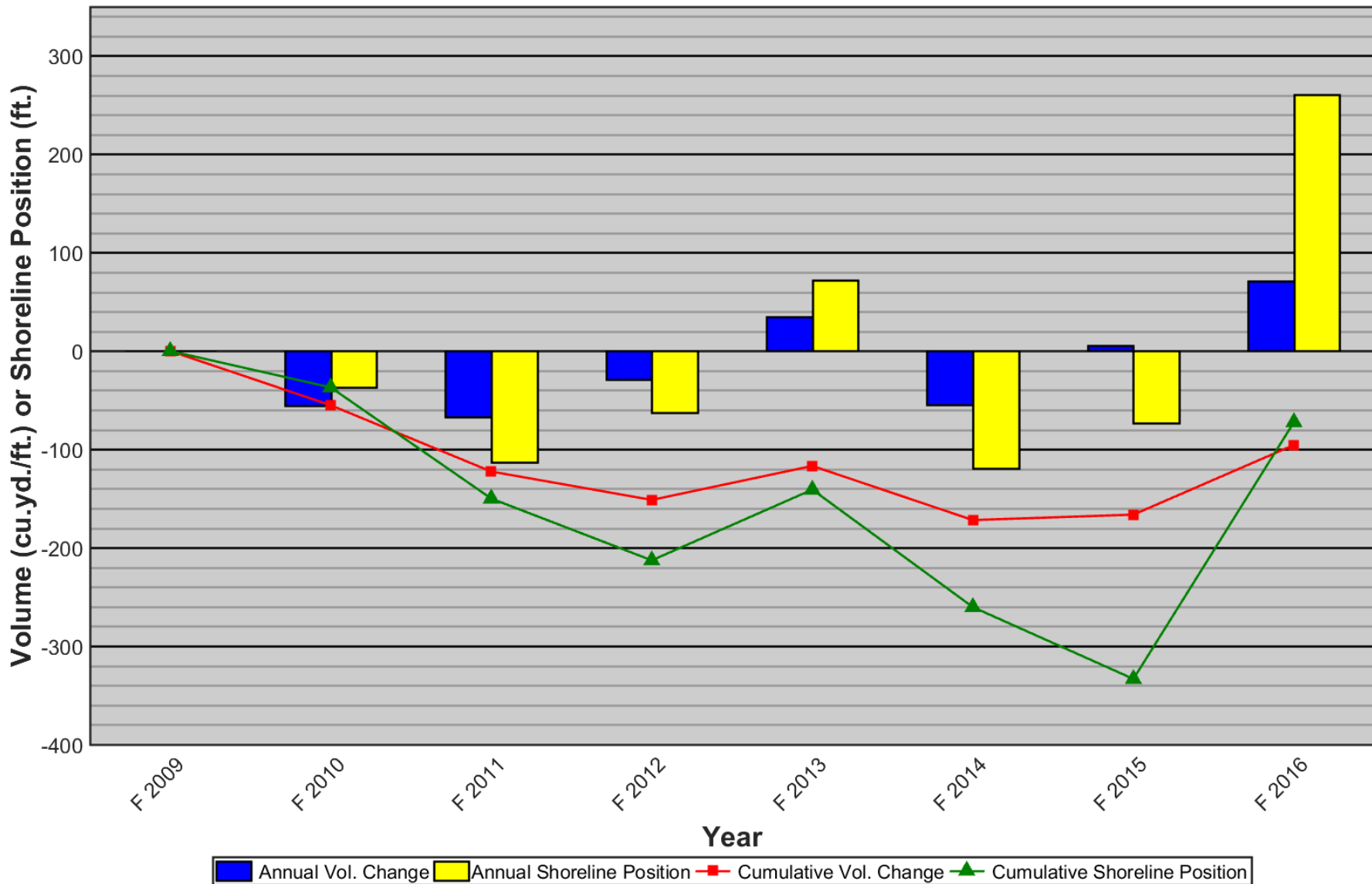


Figure 491. Two new sites were added as a result of a 2009 NJ State beach project in Strathmere to monitor inlet related changes to the park beach south of 59th Street in Ocean City. Annual sand volume changes at this site are subsequent to the USACE project in Ocean City. Significant sand volume gains appear in 2016 as sand moved south along this undeveloped shoreline.

7-Year Ensemble Mean Profile at Site 221, Corson's Inlet Park, Ocean City, Cape May Co.

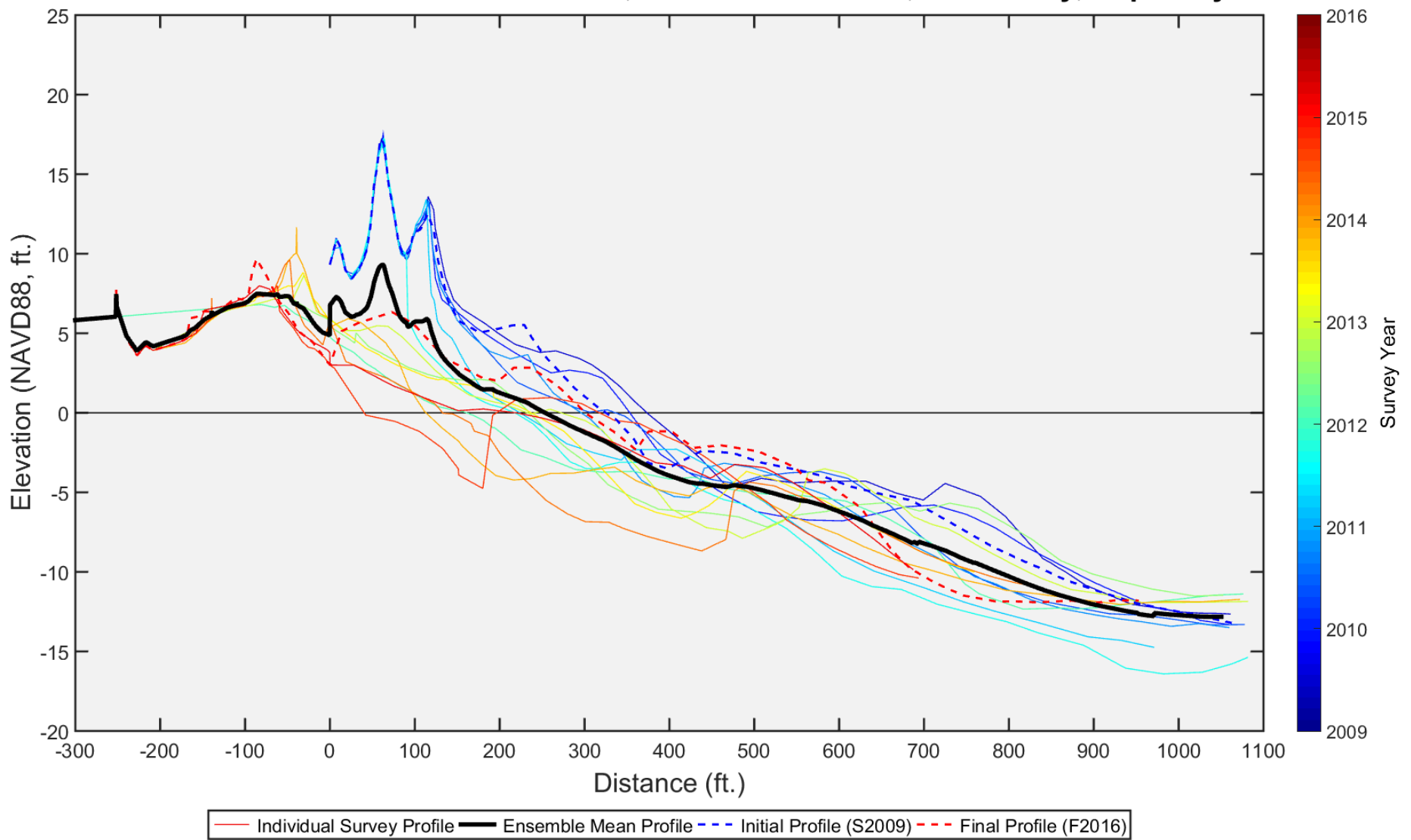


Figure 492. The Park dunes were destroyed by Hurricane Sandy as overwash moved material landward. The new dune is growing in a landward location as the shoreline advances seaward due to an influx of beach nourishment sand from Ocean City.

#221 - Corson's Inlet Park, Ocean City, Cape May County
Comparison of 2010 to 2016

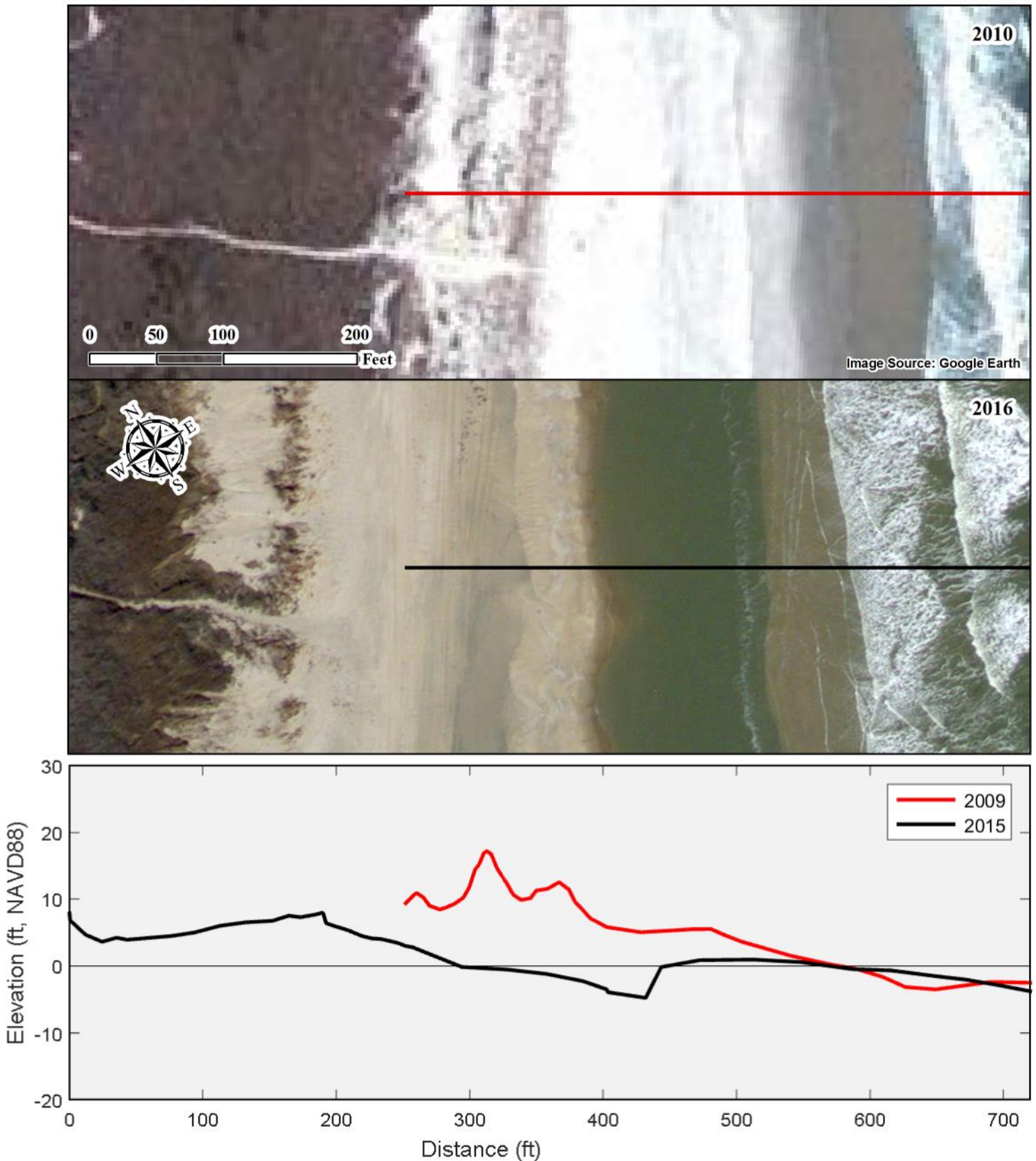


Figure 493. This site is in the Corson's Inlet State Park and is a natural environment location where Hurricane Sandy eroded the beach and dune, pushing sand into the heavily vegetated back dune area. Sand is arriving from the recent Ocean City USACE work in 2015 supplying a source of sand for natural beach recovery

NJBPN 121 – Williams Road, Strathmere (September 12, 2016)



Figure 494. View to the south along the seaward dune toe from the vehicle access pathway to the beach. The plants are doing well and a small foredune is developing at the fence line.

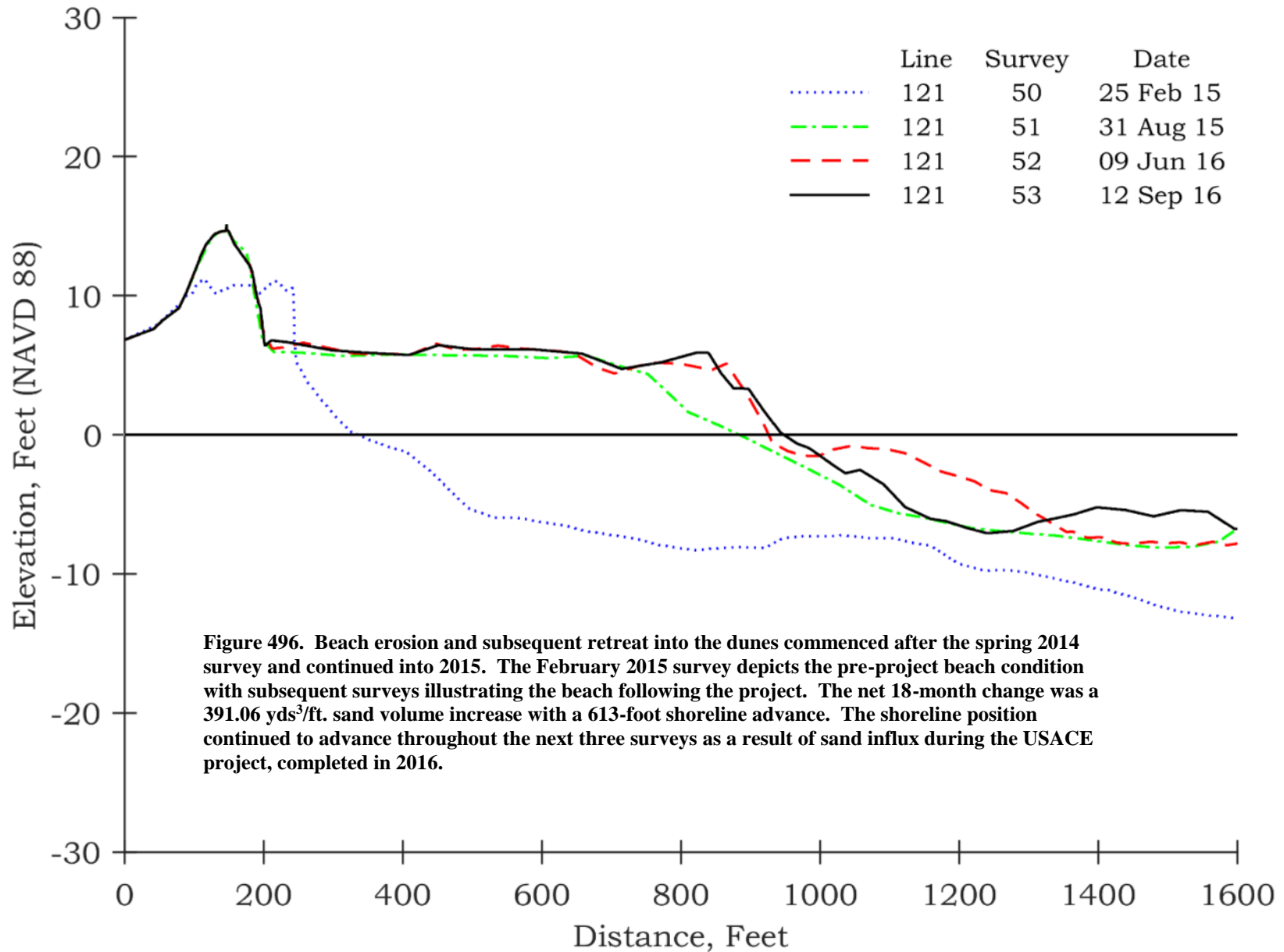
NJBPN 121 – Williams Road, Strathmere



Figure 495a & 495b. The Williams Road site is strongly influenced by the ebb-tidal delta at Corson's Inlet. The left photograph was taken August 31, 2015 following the Ludlam Island US Army Corps of Engineers project was completed. The right photograph was taken September 12, 2016 as a panorama across the wide beach deposited seaward of the dune.

New Jersey Beach Profile Network

#121 - Williams Road, Strathmere, Cape May County



30-Year Coastal Changes at Site 121, Williams Road, Strathmere, Cape May Co.

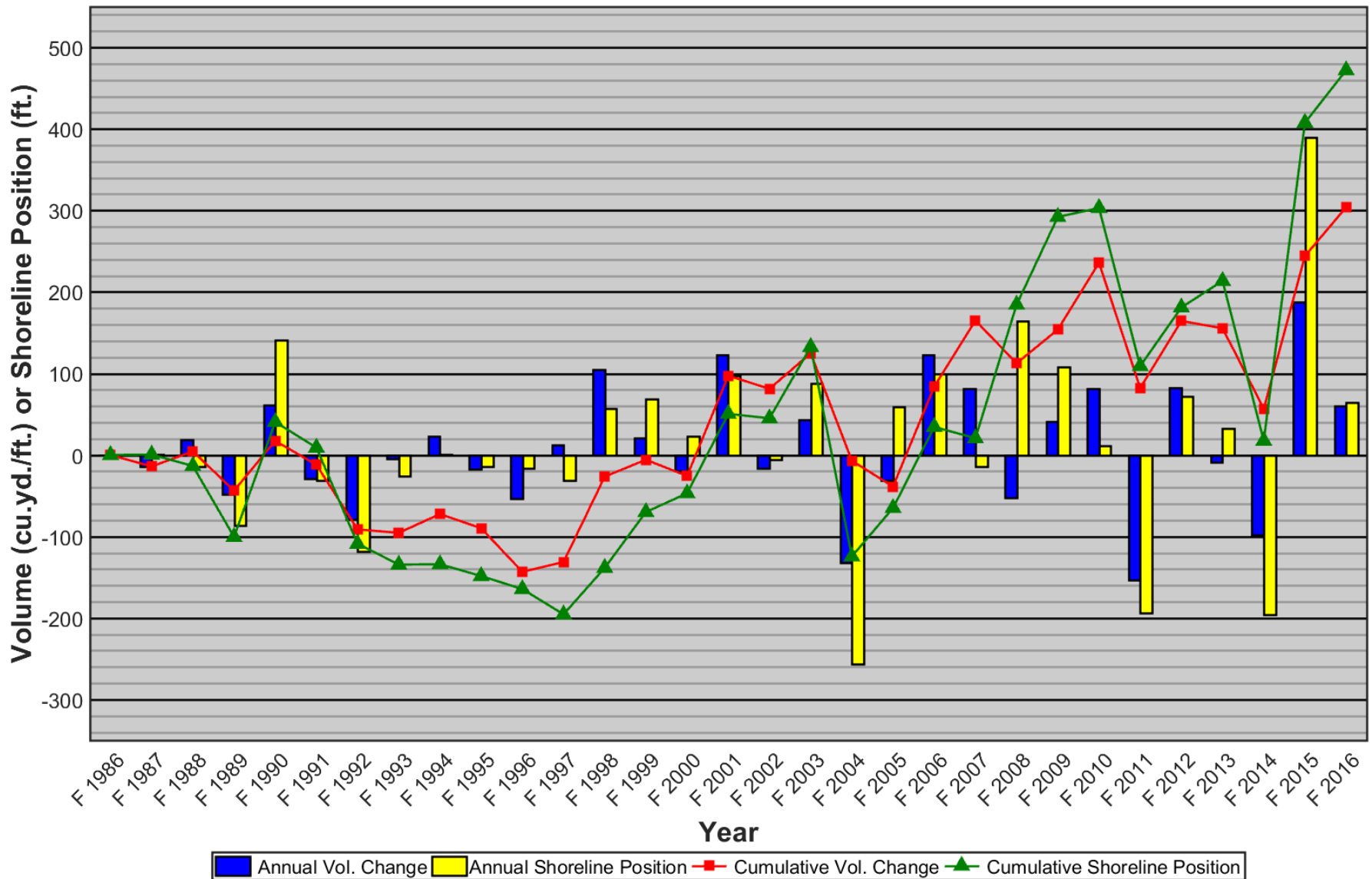


Figure 497. Williams Road is located in proximity to the south side of Corson’s Inlet. The early survey profiles show considerable retreat leading to a 2001 NJ State co-sponsored beach restoration project. The State returned in 2009 with a much larger project generating a substantial improvement at this location. By 2014, storm erosion had reduced the beach close to the 1986 conditions, so the 2015/2016 USACE project was a most welcome influx of new sand to the system.

30-Year Ensemble Mean Profile at Site 121, Williams Road, Strathmere, Cape May Co.

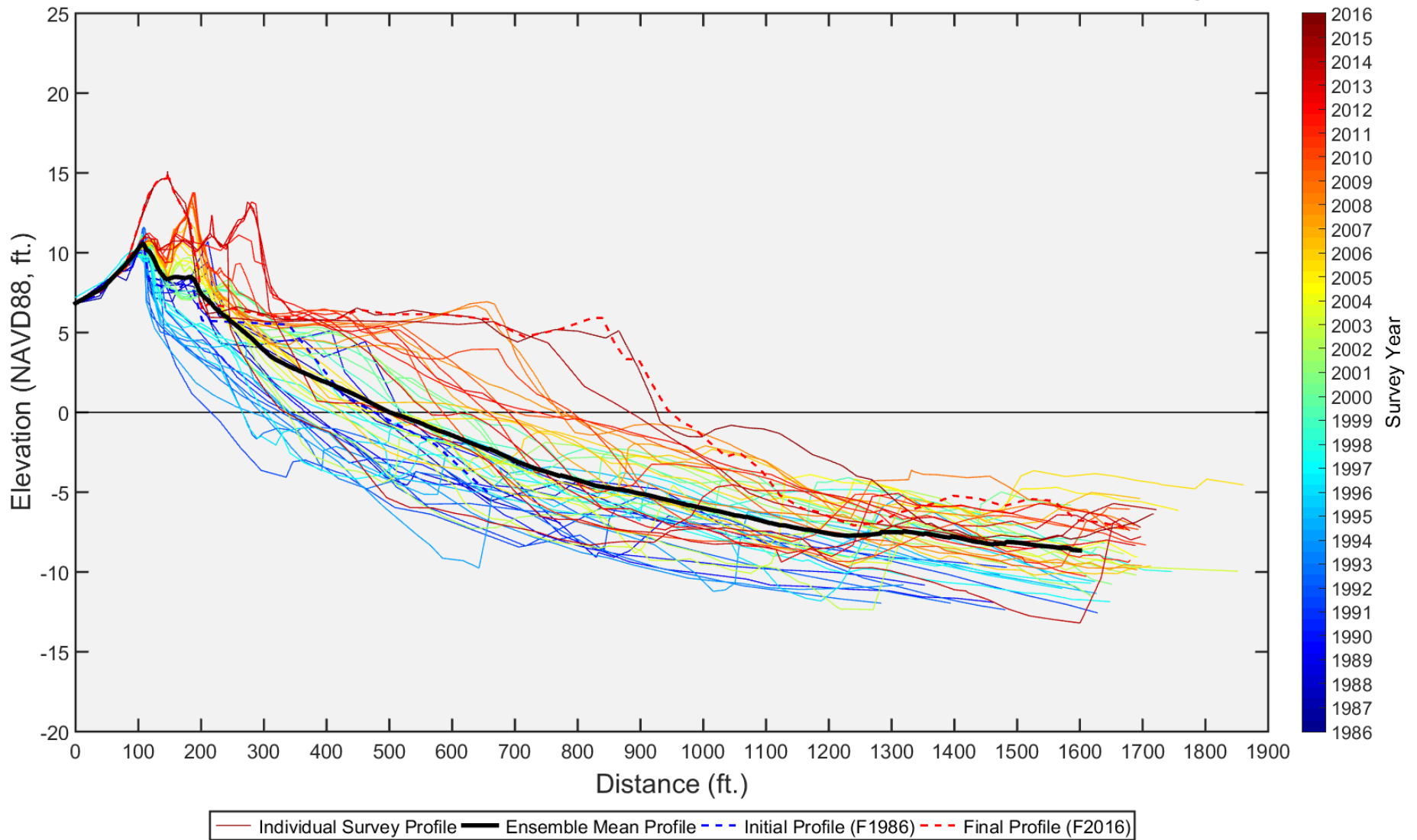


Figure 498. This display shows the trend toward a wider beach with a much larger dune system by 2016. Sand was added here in 1984, 2001, and 2009 by the State of New Jersey and in 2015 by the USACE. More extreme changes occur closer to the inlet (Seaspray Avenue), but this site is still close enough to the inlet to display large excursions from the mean profile (bold black line) position as shown. Greater stability exists farther south from this site and the inlet.

#121 - Williams Road, Strathmere, Cape May County
Comparison of 1995 to 2016

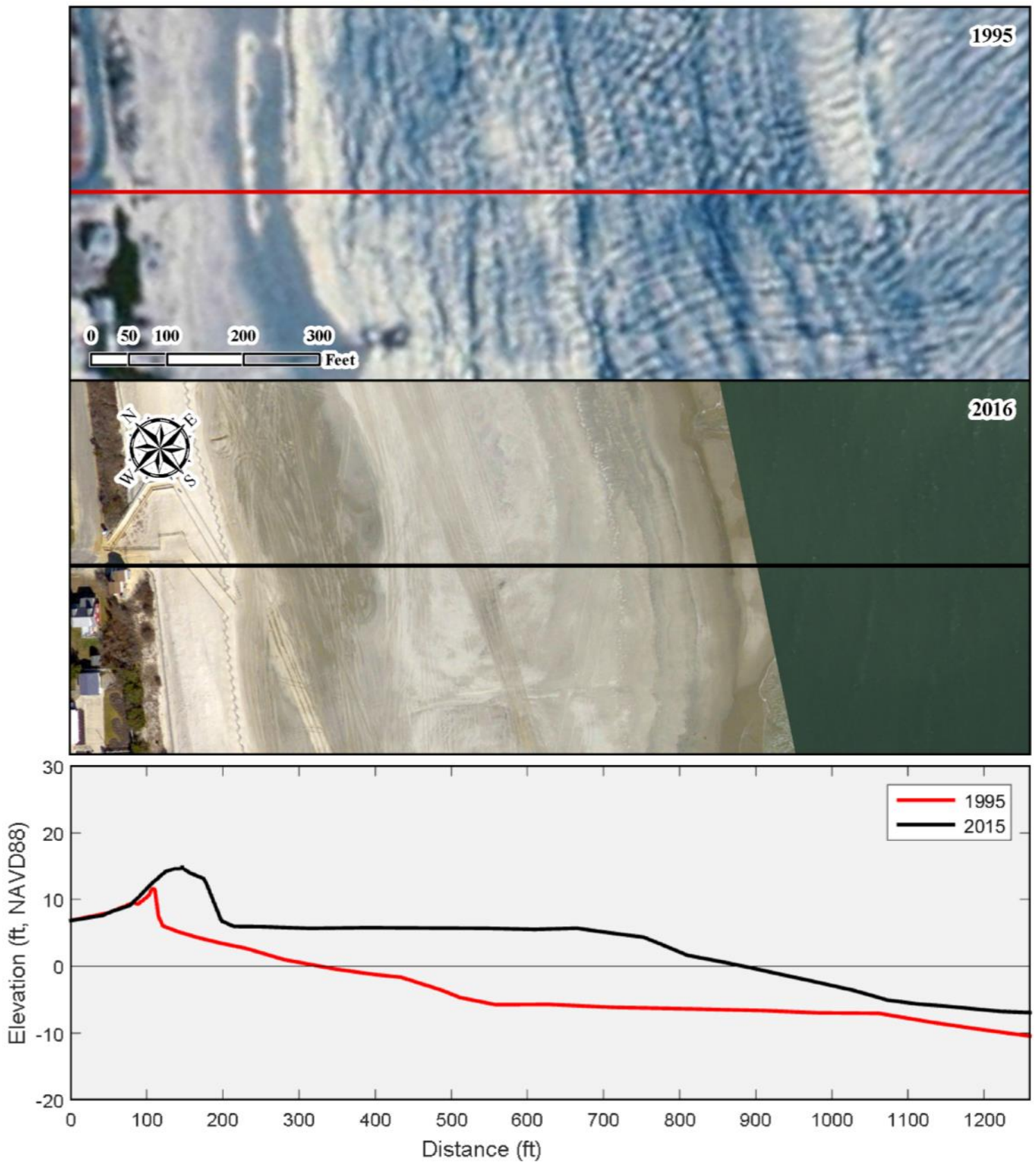


Figure 499. Inlet variations have had a pronounced impact on the width of this beach. Development along the inlet coastline has been threatened by the shifting shoreline and would continue to be threatened if nothing had been done to combat the erosion. Beach fill work was completed here in 1984, 2001, 2009 and 2015, and has had a pronounced impact on the beach configuration, with the shoreline advancing almost 600 feet from 1995 to 2015.

NJBPN 120 – 1st Street, Sea Isle City (September 13, 2016)



Figure 500. View to the south in the fall of 2016 showing sand accumulation at the fence line and the width of the dry beach.

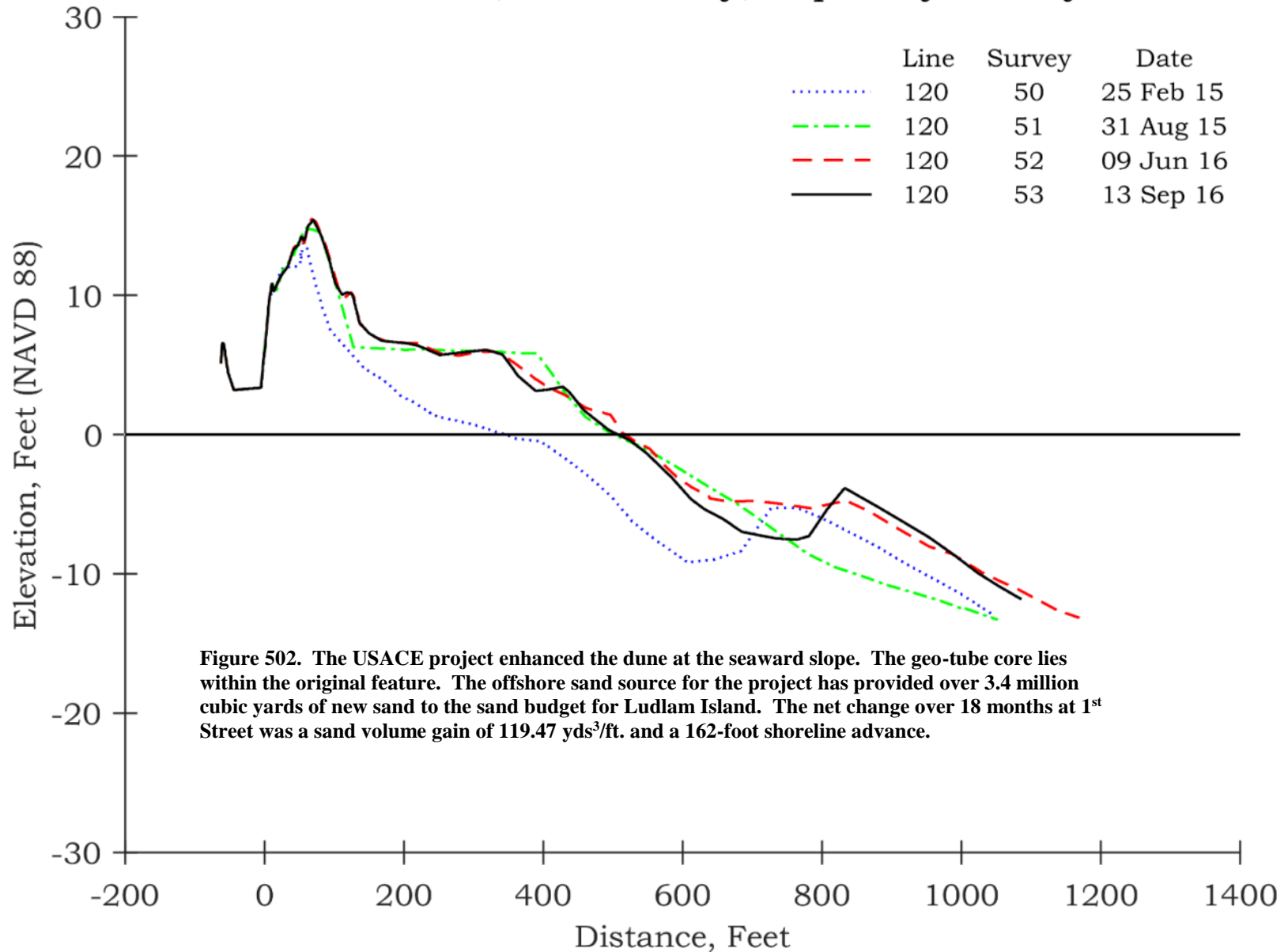
NJBPN 120 – 1st Street, Sea Isle City



Figure 501a & 501b. Photo on the left was taken August 31, 2015 at the toe of the new foredune and the original dune that is located landward of the new fence was constructed in 1998 with a geo-tube core. The photo on the right was taken September 13, 2016, which was a year after the federal project. The dry beach width was increased and aeolian transport resulted in sand accumulating on the seaward dune slope.

New Jersey Beach Profile Network

#120 - 1st Street, Sea Isle City, Cape May County



30-Year Coastal Changes at Site 120, 1st Street, Sea Isle City, Cape May Co.

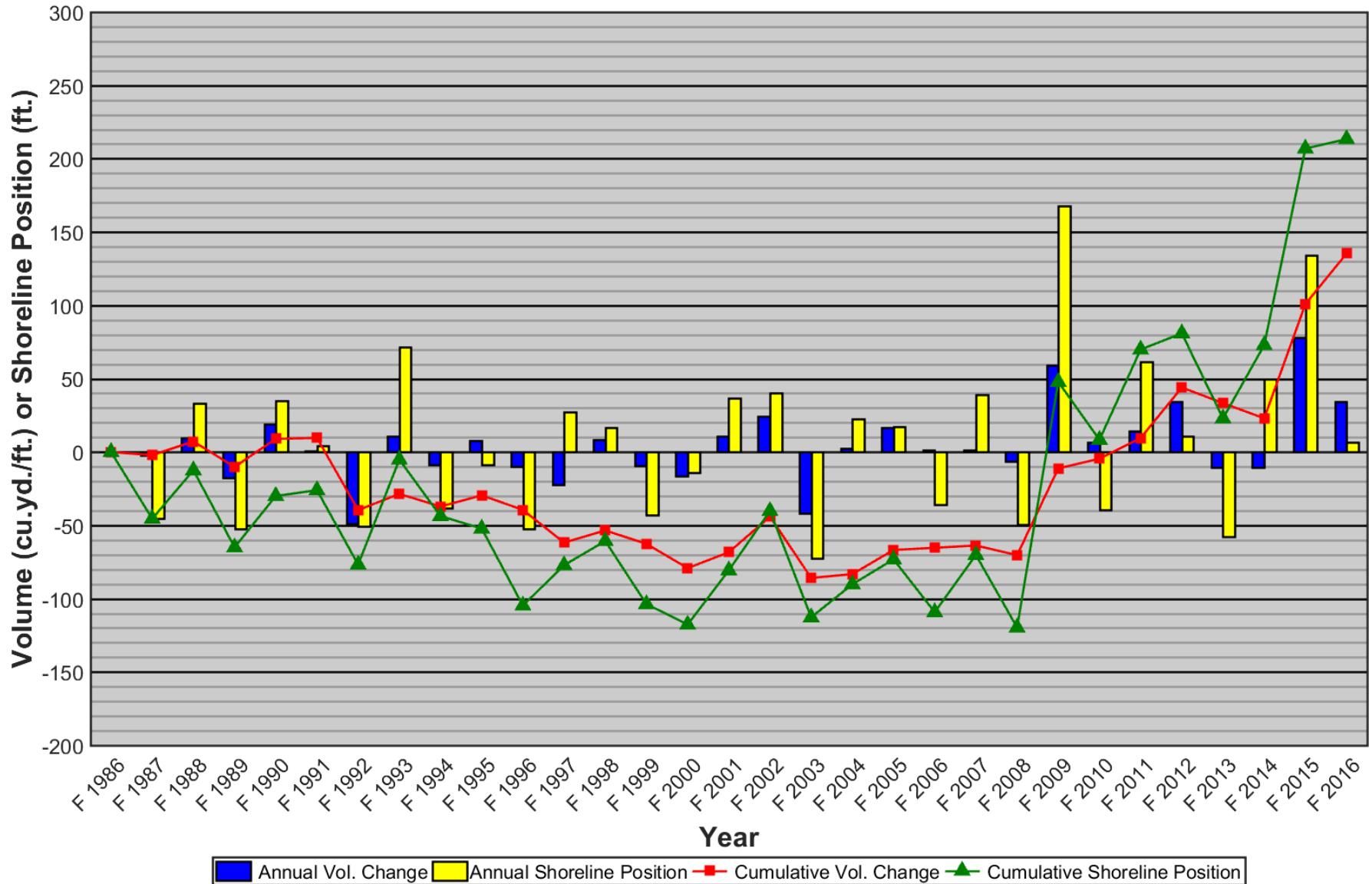


Figure 503. Usually mid-island profile locations are fairly stable or accretional in terms of sand supplies. Whale Beach is an exception. Marginally more than a city block wide, there is one row of homes along the western side of Commonwealth Avenue. This region has been subject to episodes of storm overwash resulting in the county's installation of a geo-tube core in the dune to protect the road. Sand was placed here in 1984, but did not last long. The 2001 project appears as an increase in sand volume and a spike in seaward shoreline advance. Real improvement occurred in 2009 with the NJ State project and was followed in 2015 by the USACE effort.

30-Year Ensemble Mean Profile at Site 120, 1st Street, Sea Isle City, Cape May Co.

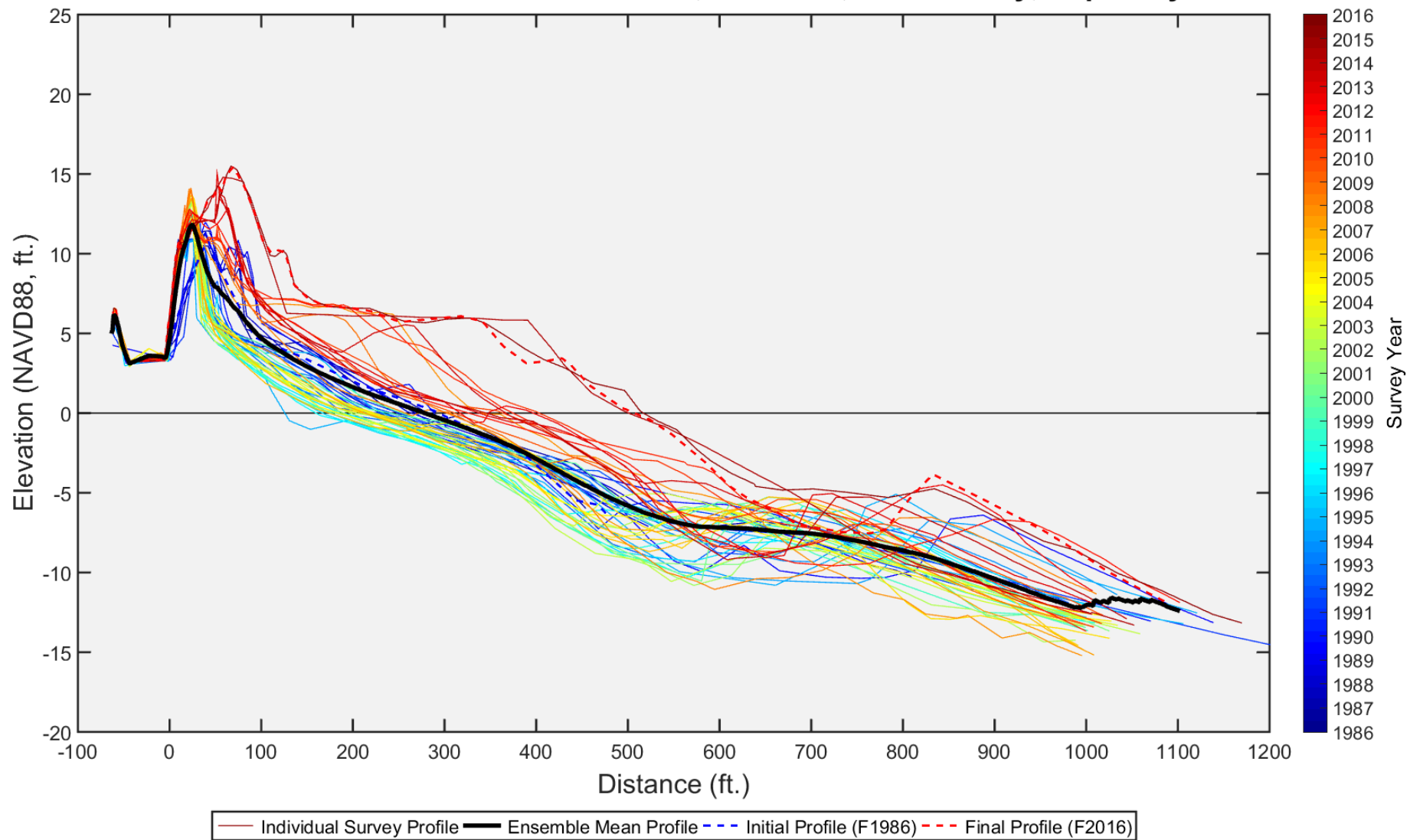


Figure 504. This site demonstrates the recent beach restoration activity since 2009 with the most recent profile cross section showing as a red dashed line, representing the USACE project at this location.

#120 - 1st Avenue, Sea Isle City, Cape May County
Comparison of 1995 to 2016

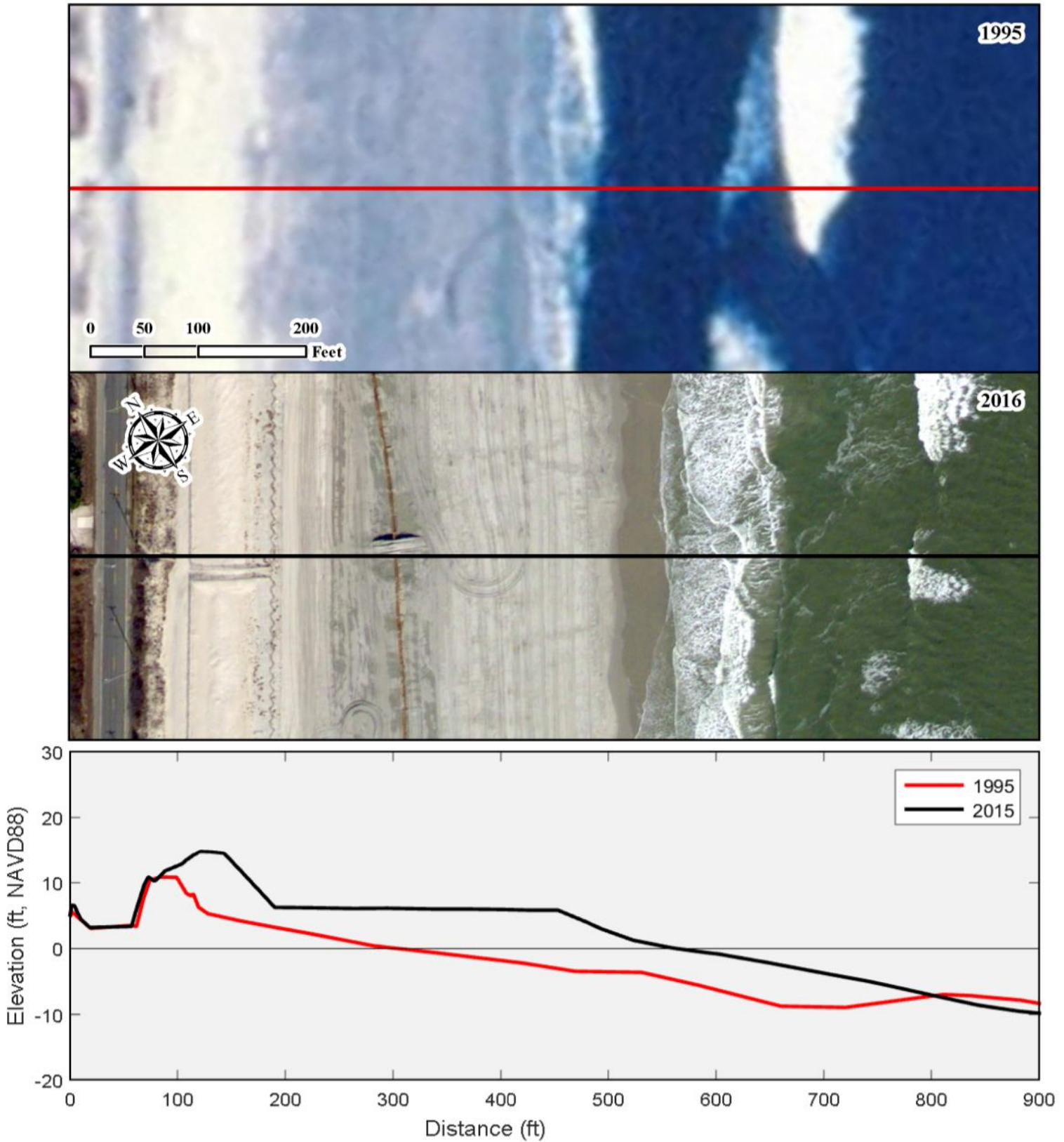


Figure 505. Recent USACE beach restoration work has made a difference in the dune and beach width. The original dune contains a 10 ft diameter geo-textile sand-filled tube that extends 2,400 feet south into Sea Isle City.

NJBPN 119 – 25th Street, Sea Isle City (September 12, 2016)



Figure 506. View to the north from 25th Street in Sea Isle City at the public access pathway. The dune grass has developed and the 2016 beach is much improved.

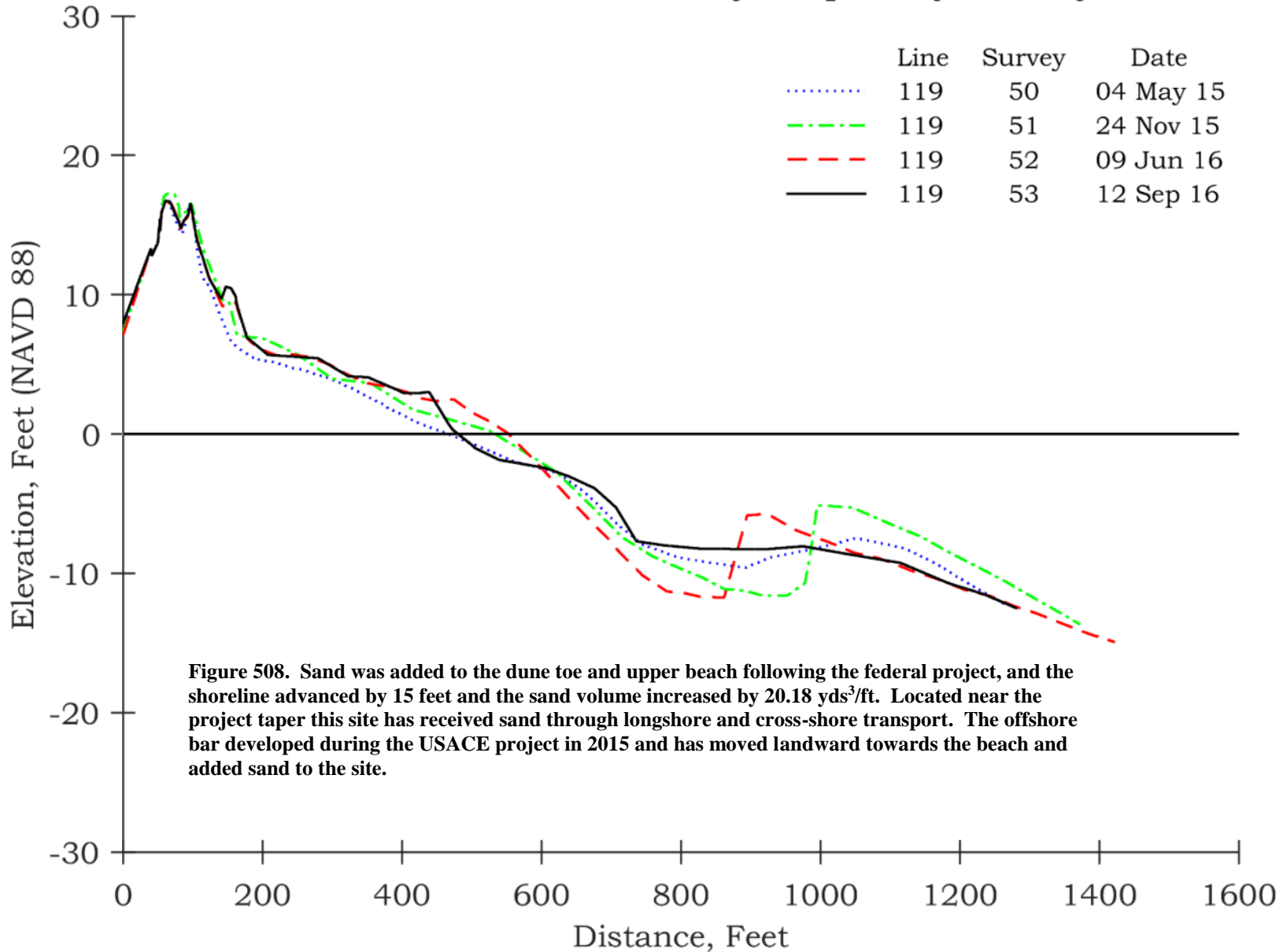
NJBPN 119 – 25th Street, Sea Isle City



Figure 507a & 507b. The 25th Street site is positioned near the northern limit of development east of Commonwealth Avenue. The site is reasonably stable and was enhanced in 2009 under the NJ State project. The left photo taken on November 24, 2015 shows the fenced dune zone and new pedestrian access path. The right photo taken on September 16, 2016, shows sand accumulation around the fencing and vegetation growth on the seaward dune slope a year later.

New Jersey Beach Profile Network

#119 - 25th Street, Sea Isle City, Cape May County



30-Year Coastal Changes at Site 119, 25th Street, Sea Isle City, Cape May Co.

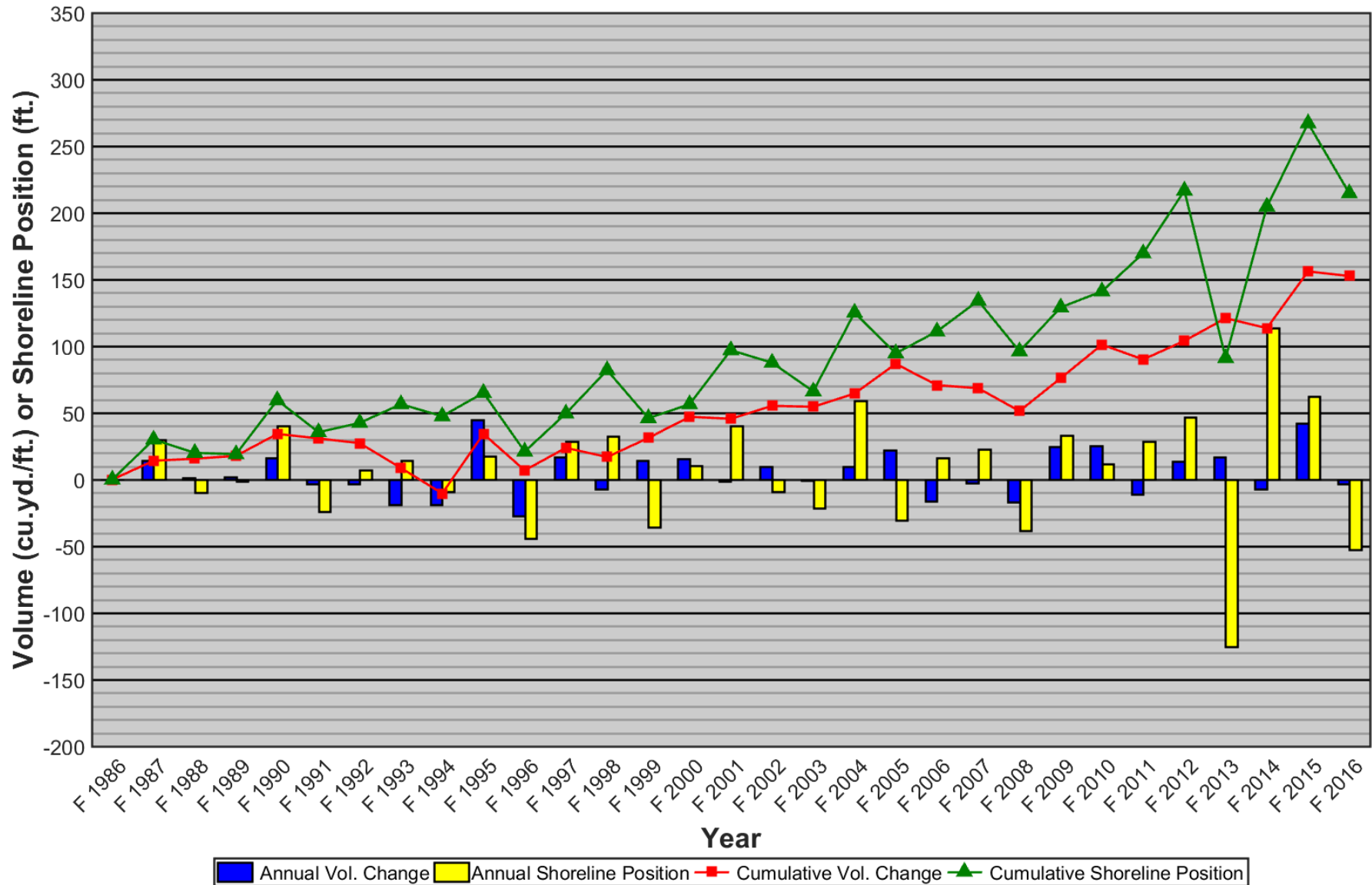


Figure 509. Sand seems to have slowly drifted south to the 25th Street location with the 2015 addition of material by the USACE. Some sand from 2009 has likely moved to this site over the following several years, but no direct placement occurred. Sand volume changes have been modest but increasing over time with larger variation in the shoreline position.

30-Year Ensemble Mean Profile at Site 119, 25th Street, Sea Isle City, Cape May Co.

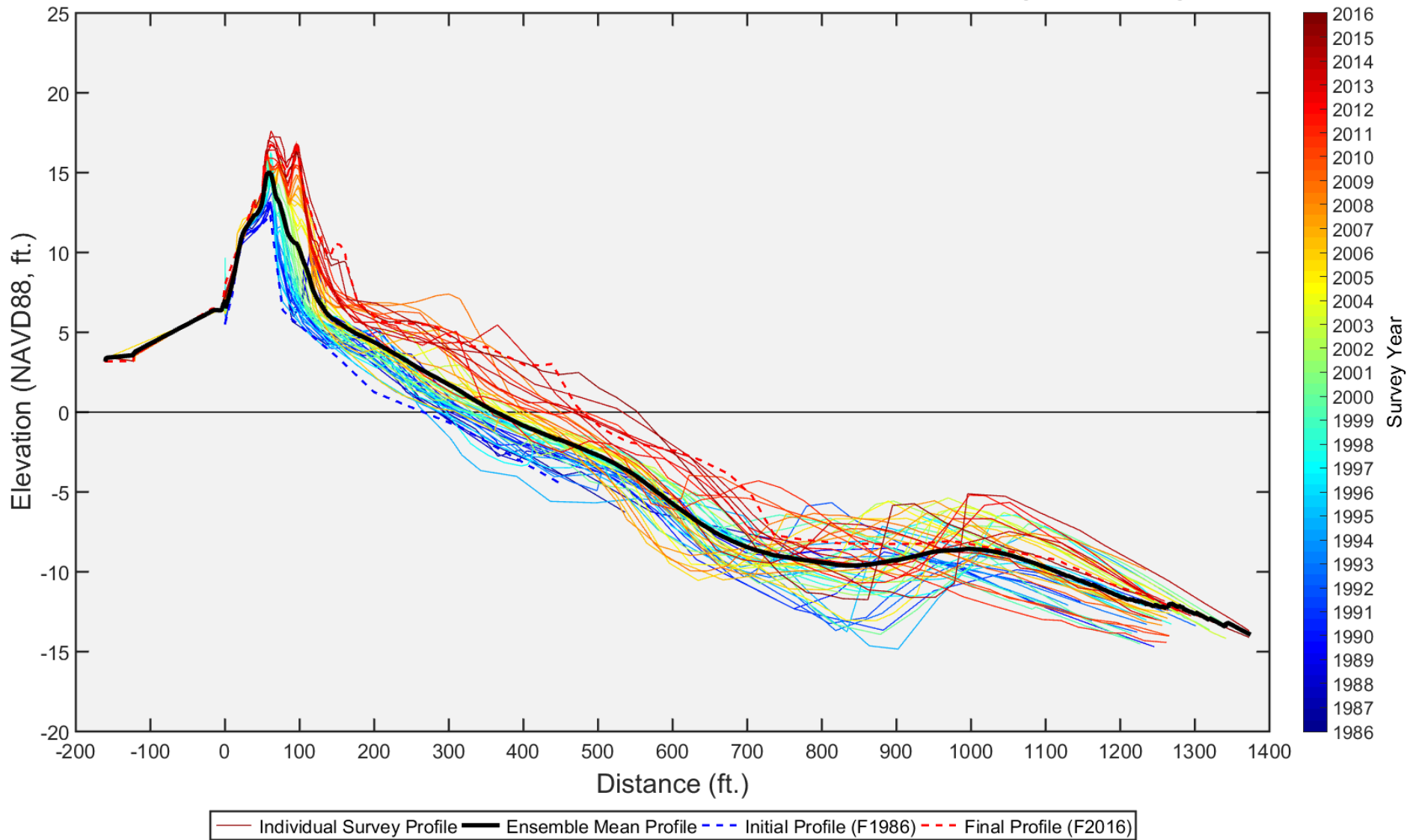


Figure 510. The general positive trend in beach conditions shows up well at this location where the colors progress uniformly from blue (early surveys) to red most recent surveys). The dune is wider and higher in elevation and the shoreline has progressed seaward with a steady increase in beach width and elevation as a result of offshore bar formation and landward migration.

#119 - 25th Street, Sea Isle City, Cape May County
Comparison of 1995 to 2016

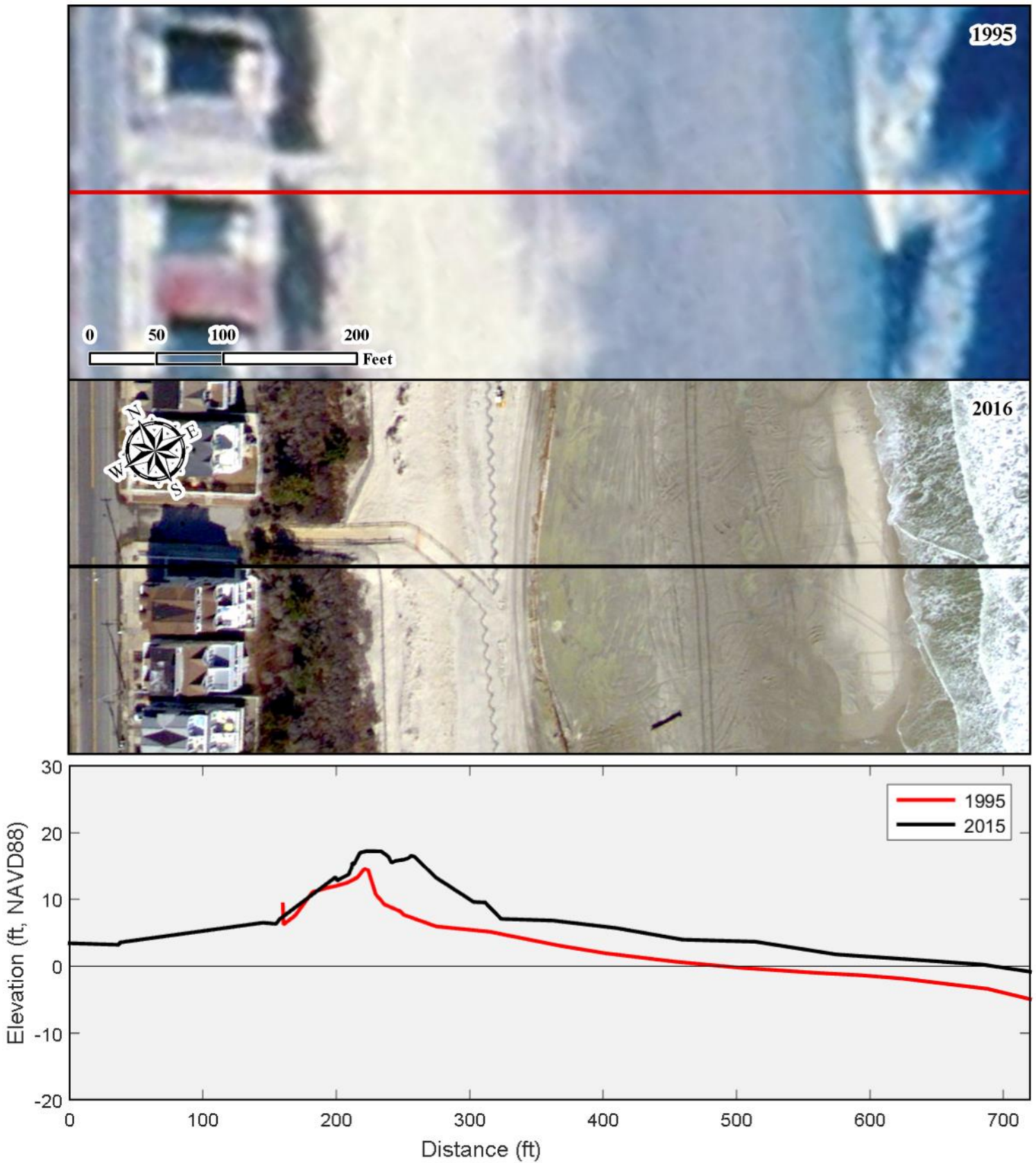


Figure 511. Recent beach restoration efforts on Ludlam Island have enhanced the dune and generated a higher and wider beach.

NJBPN 118 – 57th Street, Sea Isle City (September 12, 2016)



Figure 512. Looking south at the beach berm at 57th Street in Sea Isle City. The wider beach developed a high elevation berm in 2016 with a swale to the landward side.

NJBPN 118 – 57th Street, Sea Isle City

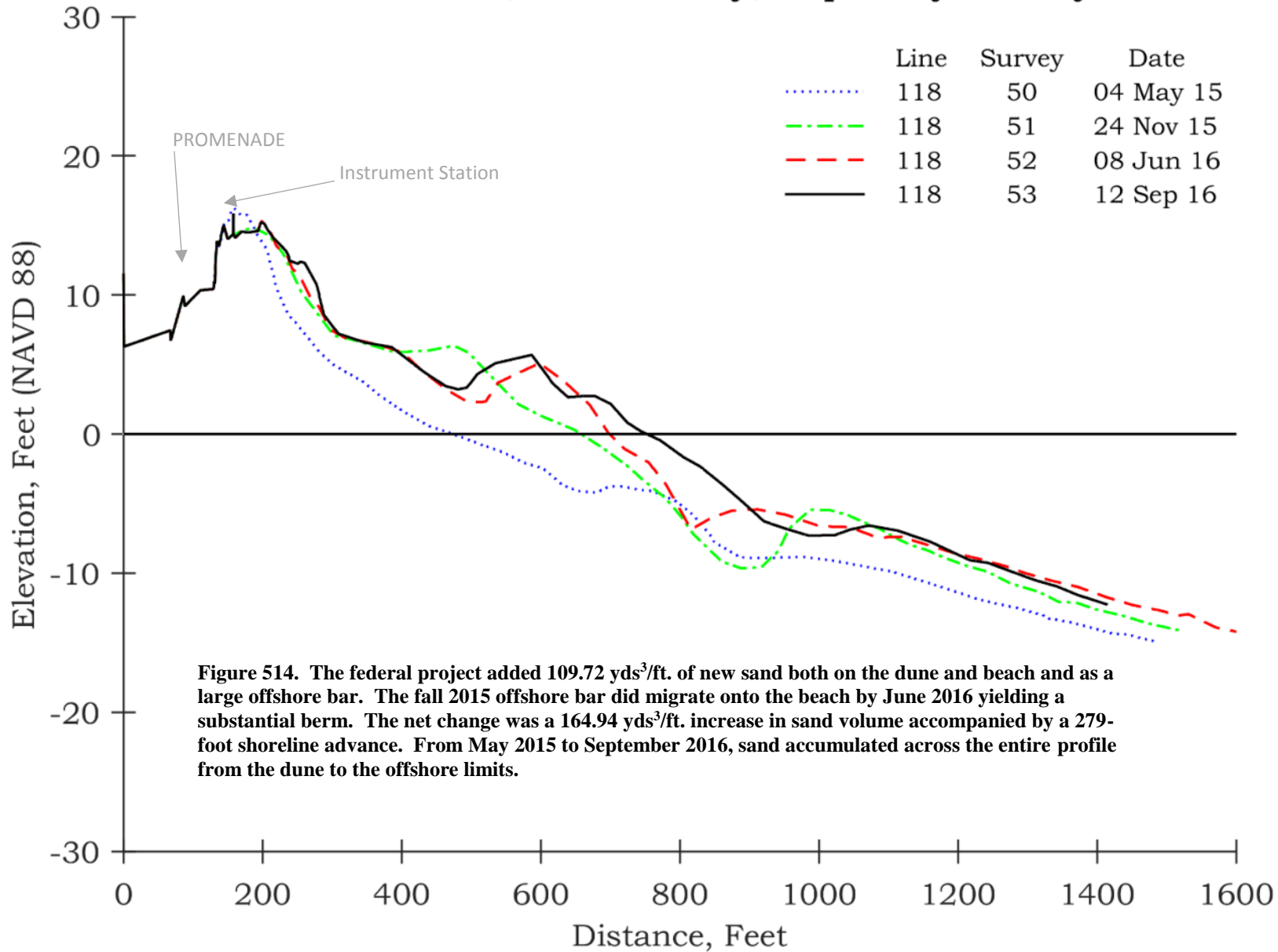


3

Figure 513a & 513b. The left photo was taken on November 24, 2015 and shows work in progress for the federal project as it moved south toward Townsend's Inlet. The right photo taken on September 12, 2016, shows a graded and raked sand beach late in the bathing season.

New Jersey Beach Profile Network

#118 - 57th Street, Sea Isle City, Cape May County



30-Year Coastal Changes at Site 118, 57th Street, Sea Isle City, Cape May Co.

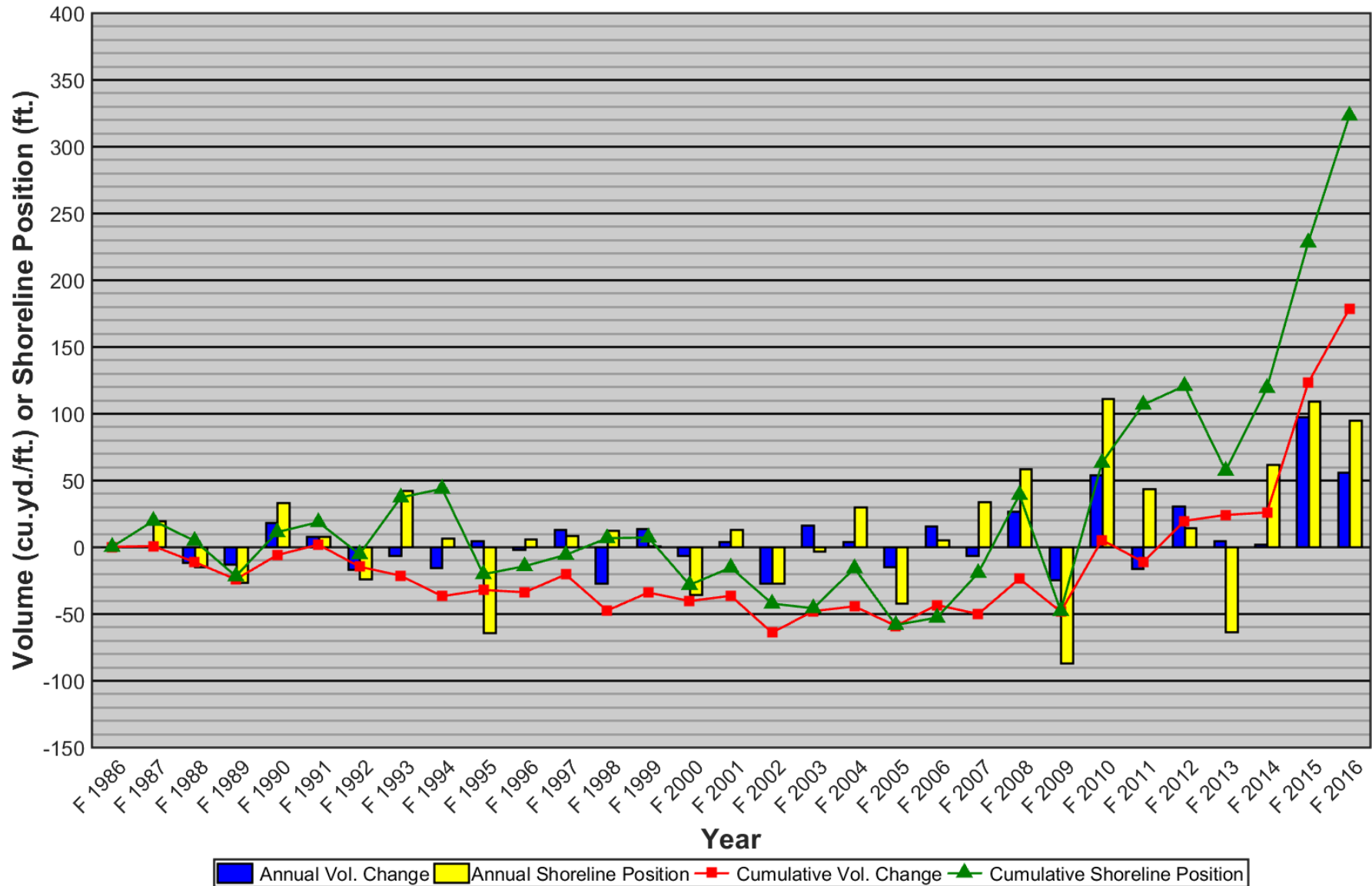


Figure 515. In the middle of Sea Isle, the beach lies seaward of a promenade, which rests on a double timber bulkhead with a rock revetment seaward of the front bulkhead. Installed after the 1962 northeast storm, this feature has been buried in dune sand such that its presence is all but forgotten. The beach here retreated somewhat between 1986 and 2010. The recovery back above the starting conditions in 1986 is likely due to the 2009 NJ State project sand arriving at the site by 2010. Rapid advance commenced in 2015 with the USACE project, with additional material placed following NE Storm Jonas in 2016.

30-Year Ensemble Mean Profile at Site 118, 57th Street, Sea Isle City, Cape May Co.

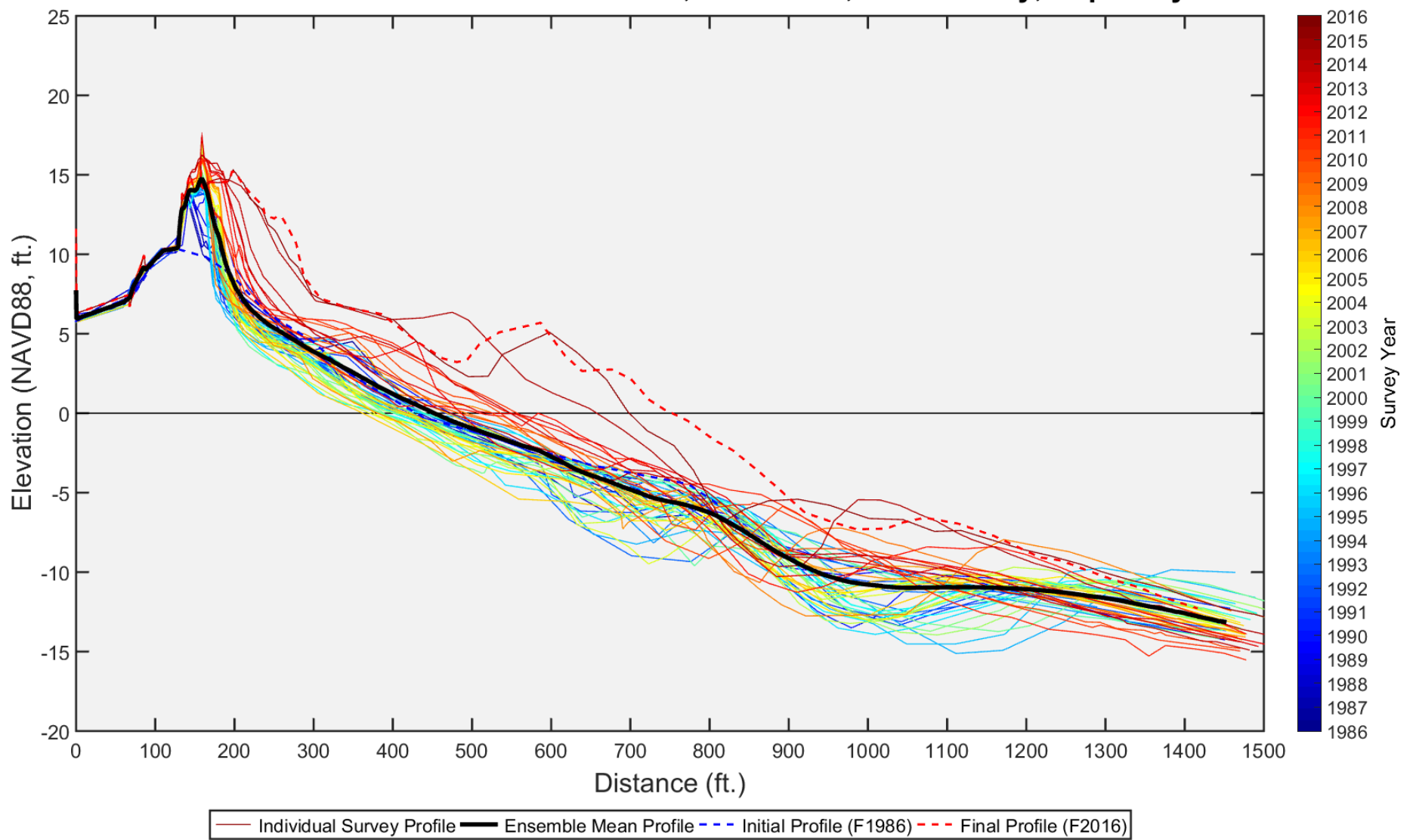


Figure 516. The profile envelope is fairly tight at this location indicating a generally stable to slightly accretional beach. The 2015 USACE post-project profiles are shown in red as the widest beach with added material in the dunes.

#118 - 57th Street, Sea Isle City, Cape May County
Comparison of 1995 to 2016

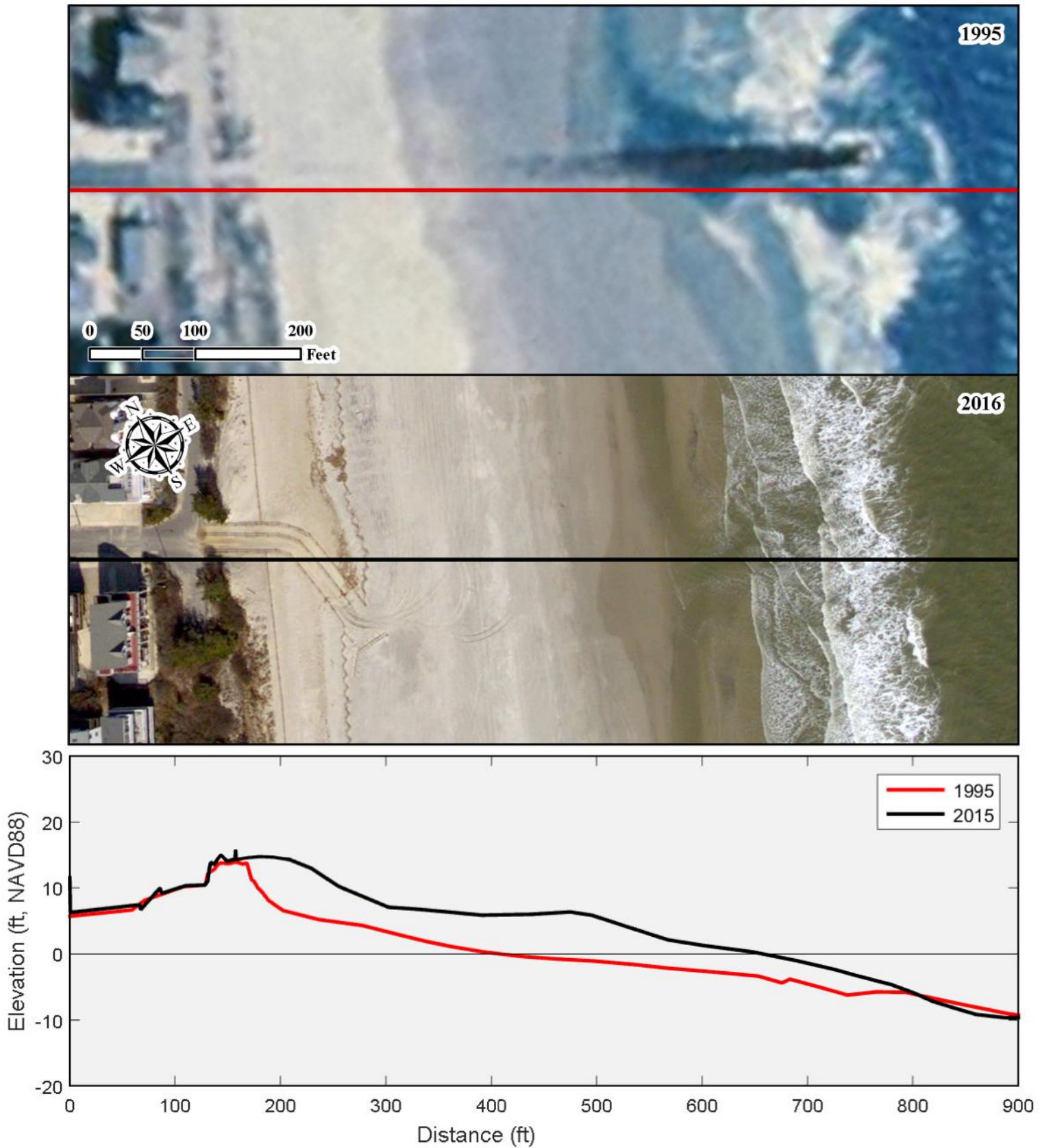


Figure 517. There is a promenade built on top of twin timber bulkheads, with a rock revetment in front of the seaward bulkhead. This was done following the 1962 northeast storm. The 2016 beach restoration under federal authority has dramatically enhanced the dune and beach seaward of the promenade, resulting in a shoreline advance of about 350 feet.

NJBPN 117 – 80th Street, Sea Isle City (September 12, 2016)



Figure 518. View to the north along the dune toe at the south end of Ludlam Island. The fencing was all but buried within a year of its installation.

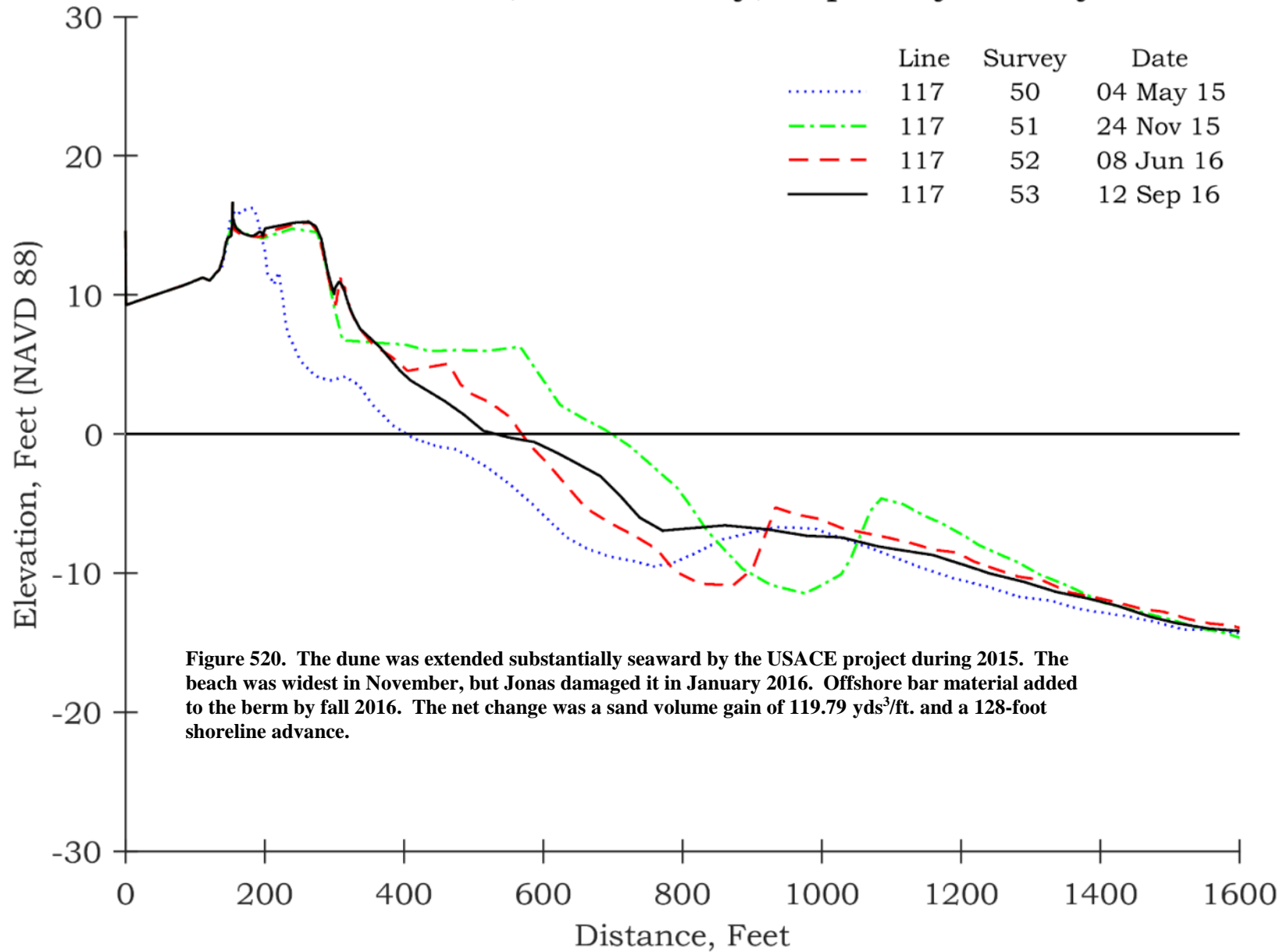
NJBPN 117 – 80th Street, Sea Isle City



Figure 519a & 519b. The left photo was taken November 24, 2015 and shows the new fence line on the dune feature being installed during the federal project. The right photo, taken on September 12, 2016, shows the significant amount of wind-transported sand that was deposited around the newly installed, 4-foot high fence over a period of one year.

New Jersey Beach Profile Network

#117 - 80th Street, Sea Isle City, Cape May County



30-Year Coastal Changes at Site 117, 80th Street, Sea Isle City, Cape May Co.

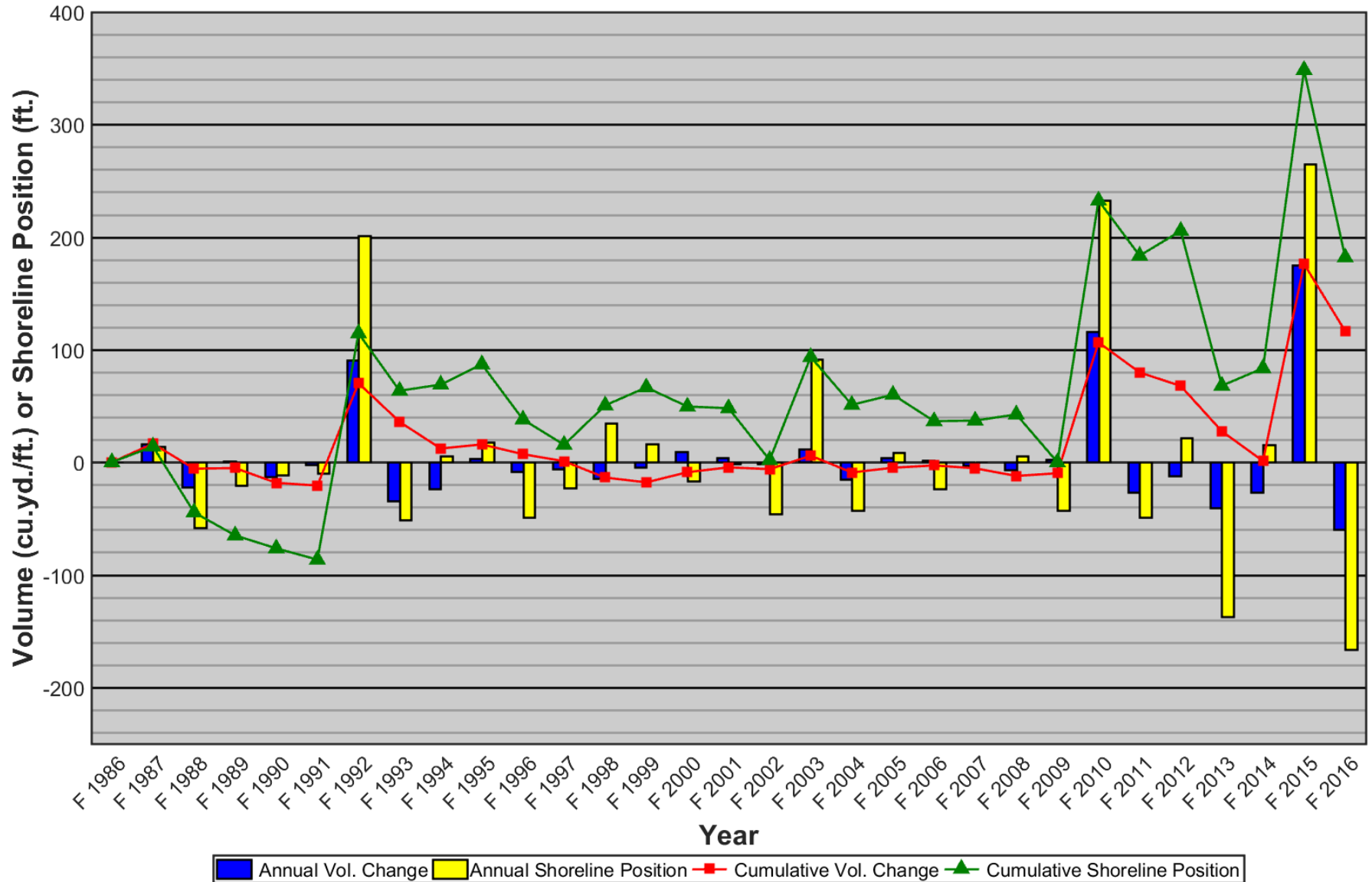


Figure 521. The southernmost site in Sea Isle saw several jumps in sand volume and shoreline positions over time. The 1992 spike accompanied an Avalon maintenance effort that extended to Sea Isle. This was followed in 2003 by another small placement effort during the initial USACE Avalon work. Sand arrived in 2010 likely derived from the 2009 Strathmere/Sea Isle City project, while the 2015 USACE Ludlam Island project was the final episode in this record.

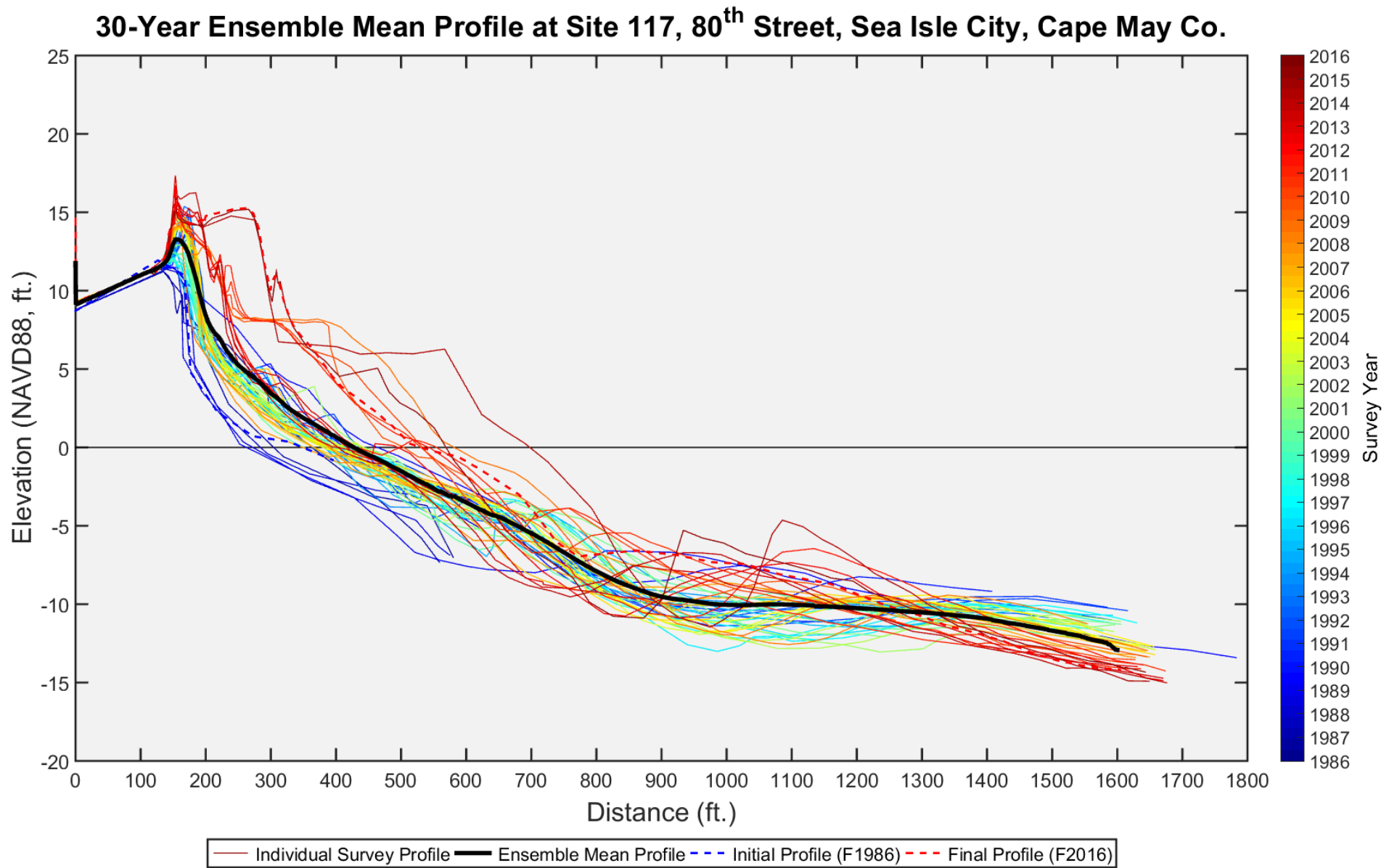


Figure 522. The random beach nourishment efforts over the years and the site’s proximity to Townsends Inlet have randomized the color positions as a trend at this site between episodes of erosion and sand placement. The dune and beach has grown larger as the 2015 USACE project was completed.

#117 - 80th Street, Sea Isle City, Cape May County
Comparison of 1995 to 2016

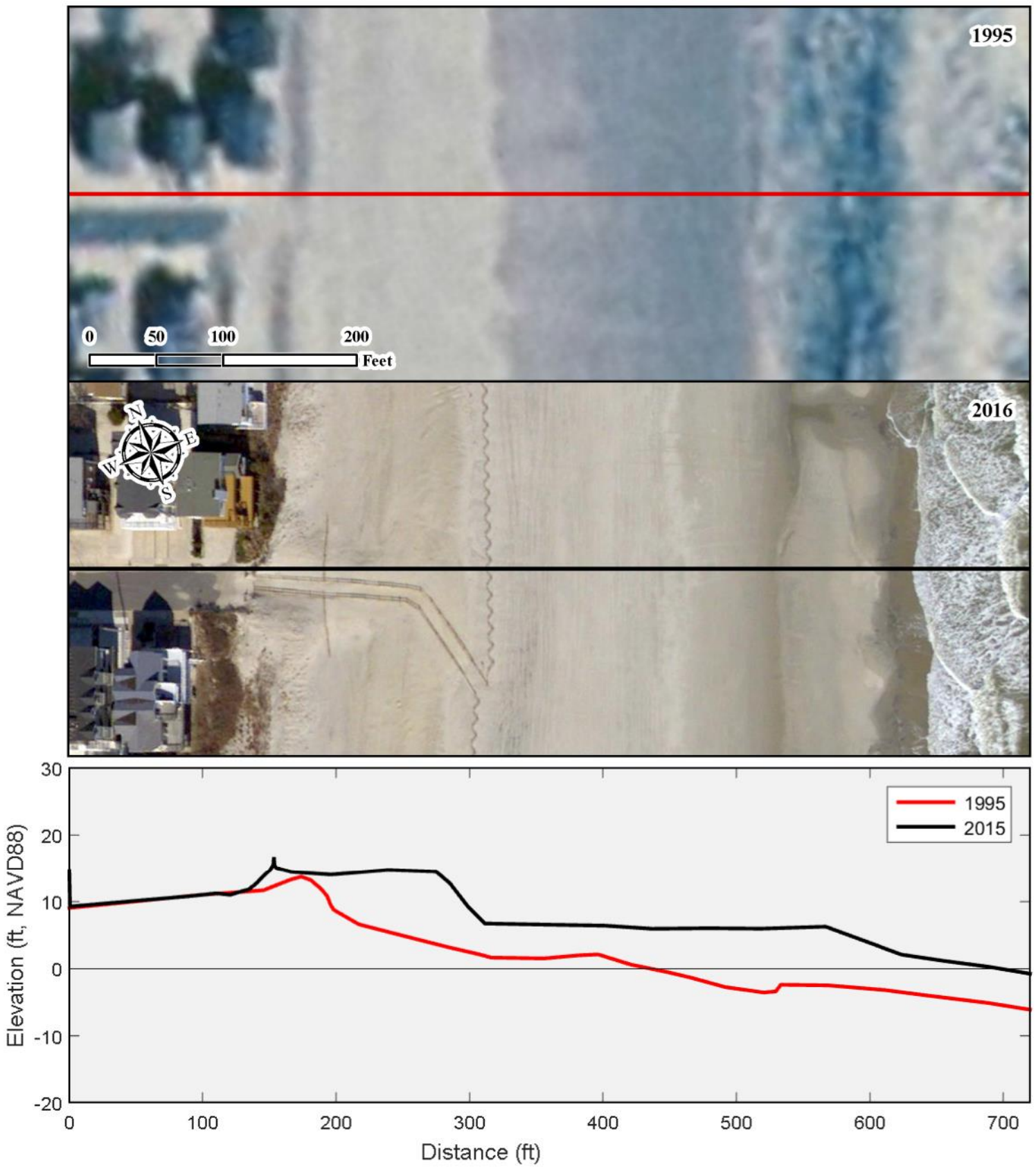


Figure 523. Periodic beach nourishment and the federal project in 2015 enhanced this beach in Sea Isle City with a much wider dune, a higher beach, and a shoreline increase of almost 300 feet.

NJBPN 216 – 9th Street, Avalon (September 8, 2016)



Figure 524. Two rows of sand fencing lie buried in sand placed by the Borough, yet beach erosion still reached the rock revetment at 12th Street.

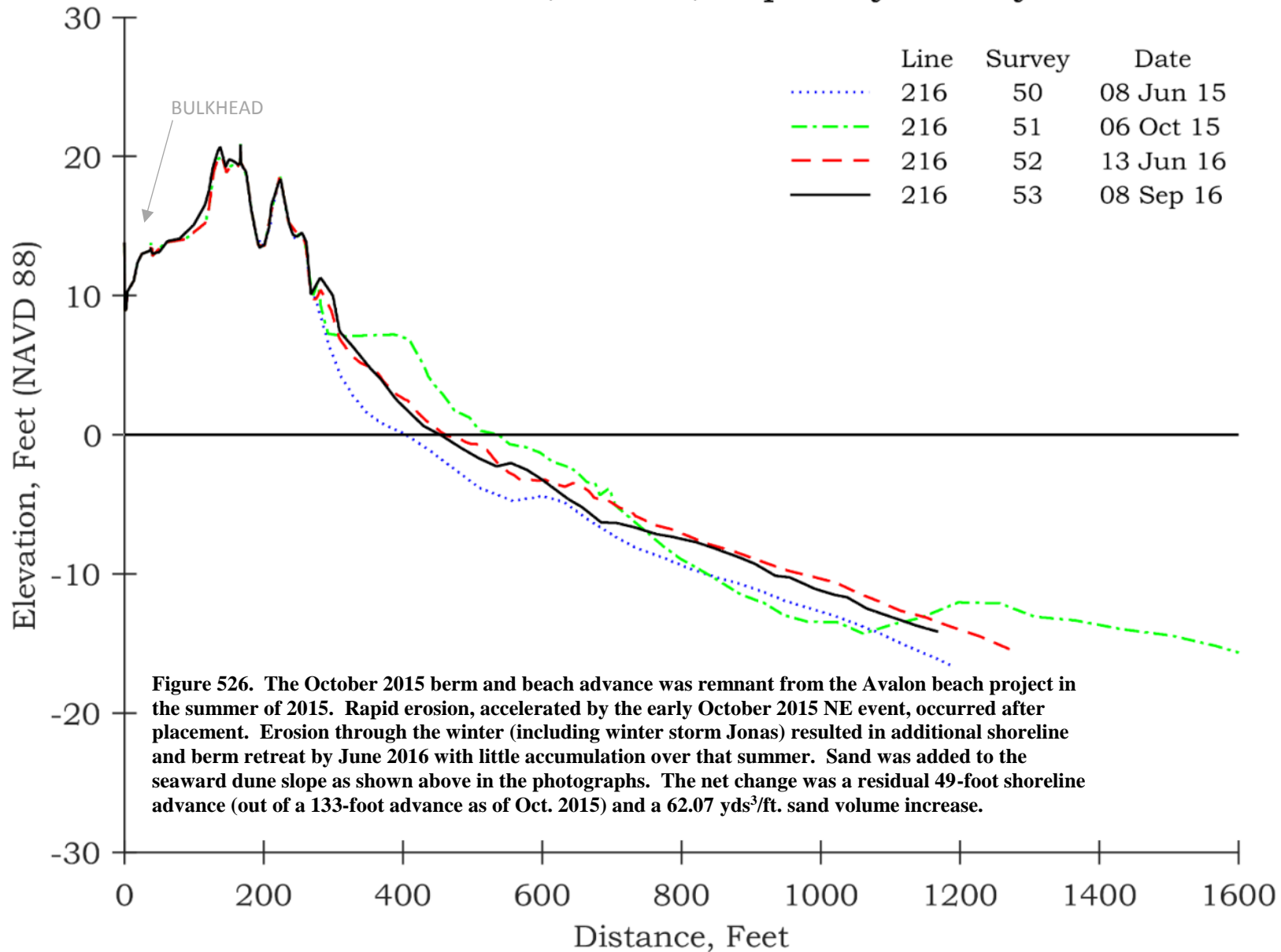
NJBPN 216 – 9th Street, Avalon



Figure 525a & 525b. The 9th Street site is located near the Townsend's Inlet south jetty. The left photo taken, on October 7, 2015, followed an Avalon-funded beach restoration in 2015 augmenting the post-Sandy federal work in 2013. Sand filled in the fencing nearly to the top of the 4-foot fence, but shoreline retreat due to several storms and frequent onshore wind and wave conditions was so extensive, that by September 8, 2016, the beach was at the 12th Street revetment rocks three blocks south of the site.

New Jersey Beach Profile Network

#216 - 9th Street, Avalon, Cape May County



22-Year Coastal Changes at Site 216, 9th Street, Avalon, Cape May Co.

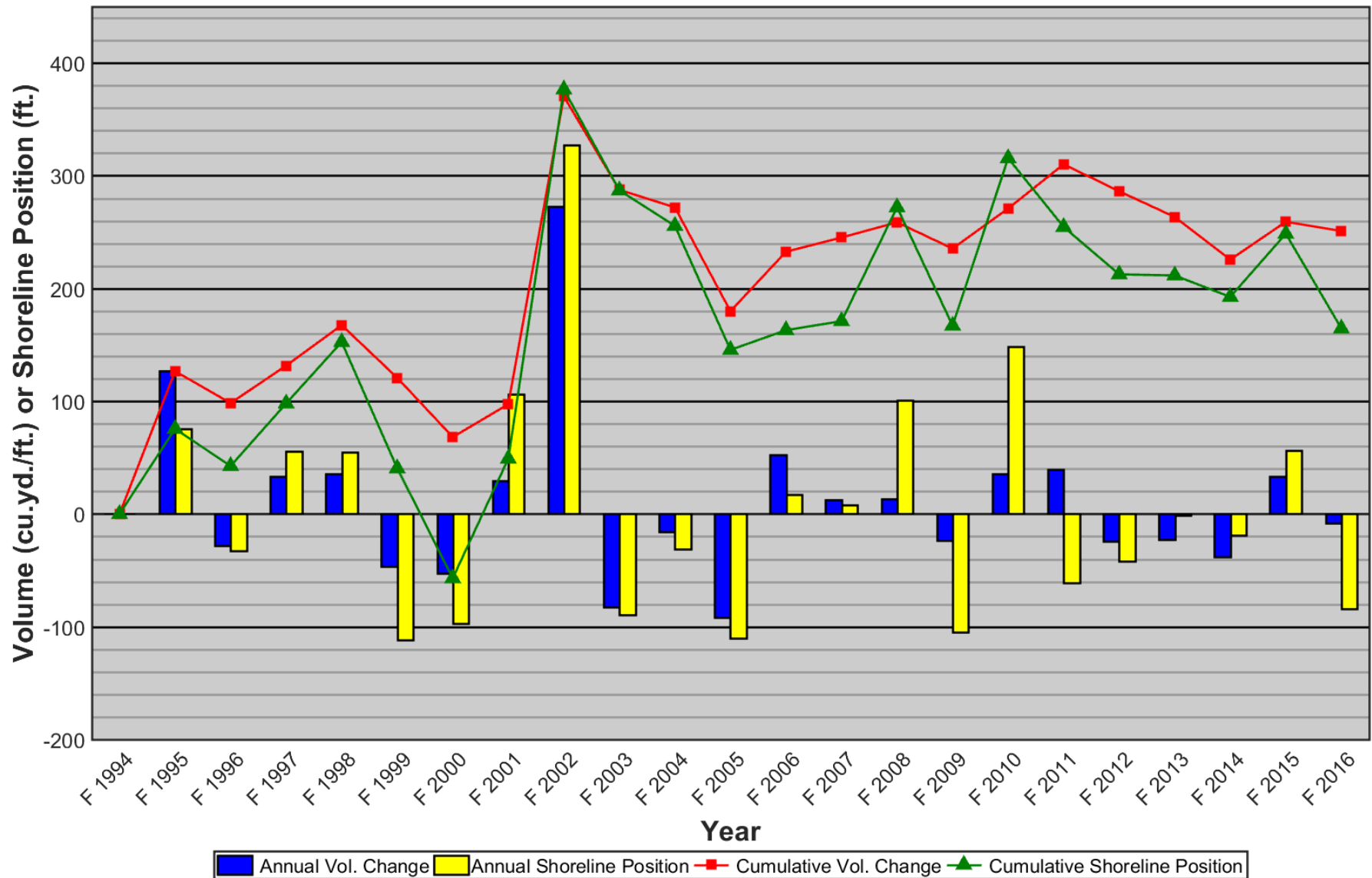


Figure 527. There have been multiple efforts to add sand to this site since 1987, however, the site was not established until 1994 as a more proximal site to Townsends Inlet to balance the site 117 in Sea Isle City on the other side of the inlet and track changes in this highly erosional zone. The USACE initial work shows as the largest spike in sand placement in 2002. Subsequent placement volumes were smaller or not directly put in place at 9th Street. The trends have been more stable since the USCAE project in 2002 initiated a balance between episodes of erosion and periodic nourishment.

22-Year Ensemble Mean Profile at Site 216, 9th Street, Avalon, Cape May Co.

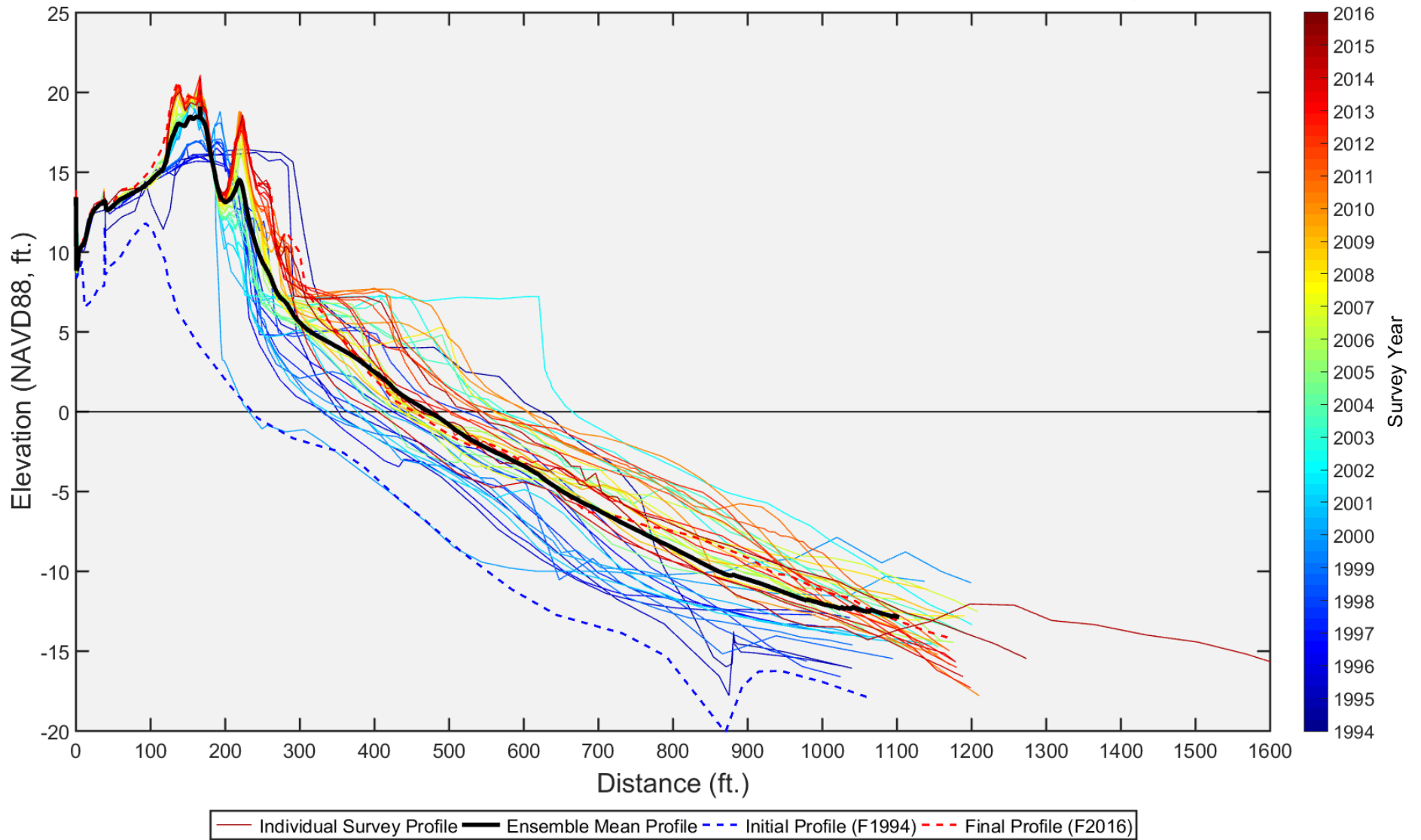


Figure 528. The 1994 survey shows a depleted beach and small dune that was successively enhanced over 22 years. The most extensive beach width was seen in 2002.

#216 - 9th Street, Avalon Borough, Cape May County
Comparison of 1995 to 2015

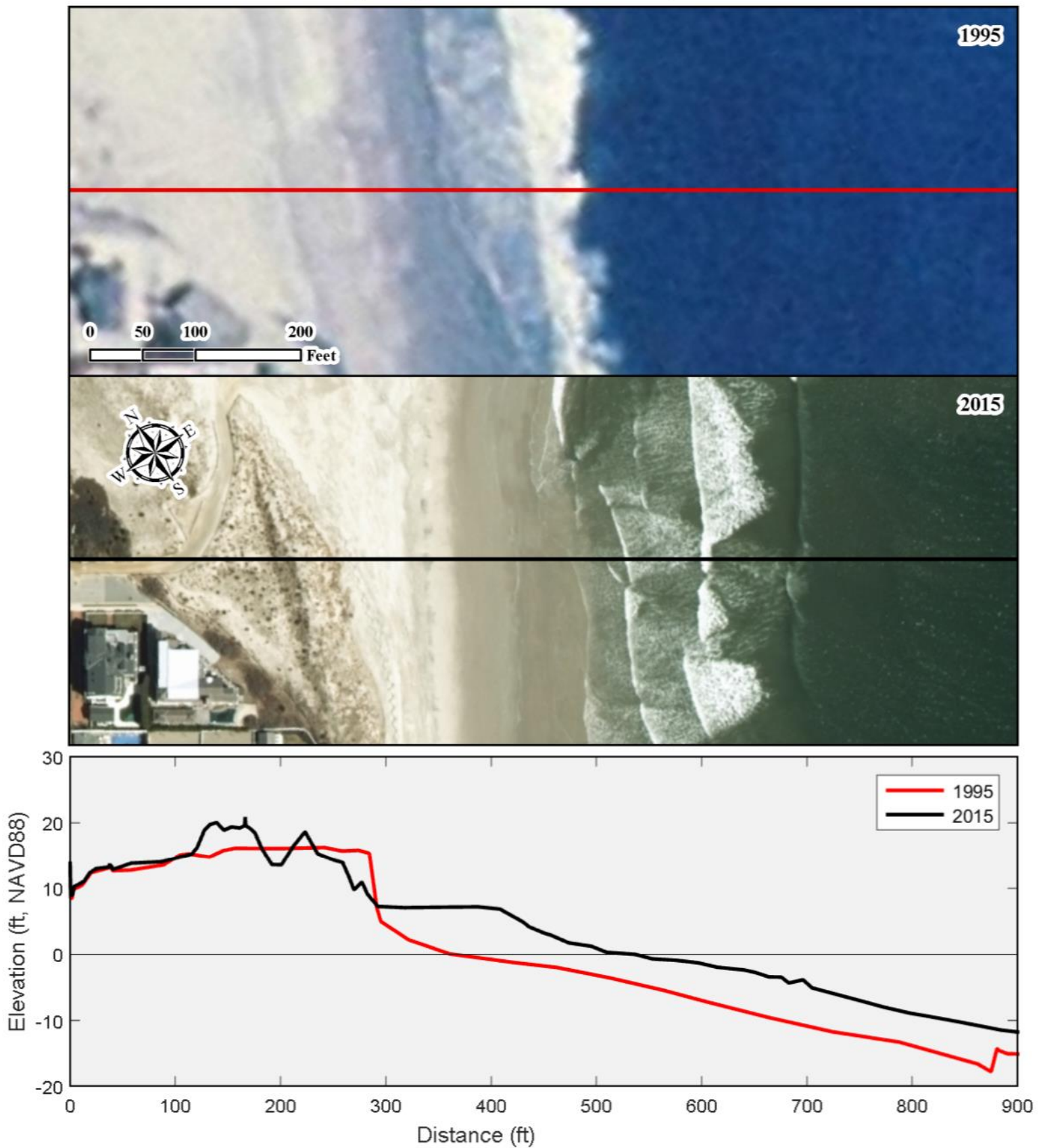


Figure 529. Added in 1994 to provide better inlet beach coverage, this site has benefitted from beach restoration since 1987, when Avalon produced its initial effort. Now part of the federal shore protection program, the site continues to be periodically nourished in order to maintain the dune and beach configuration.

NJBPN 116 – 23rd Street, Avalon (September 8, 2016)



Figure 530. By September 2016, the beach was in fair condition with the storm water discharge line still buried at the dune toe, but not out on the berm. Wind deposition had added sand to the dune and its seaward slope.

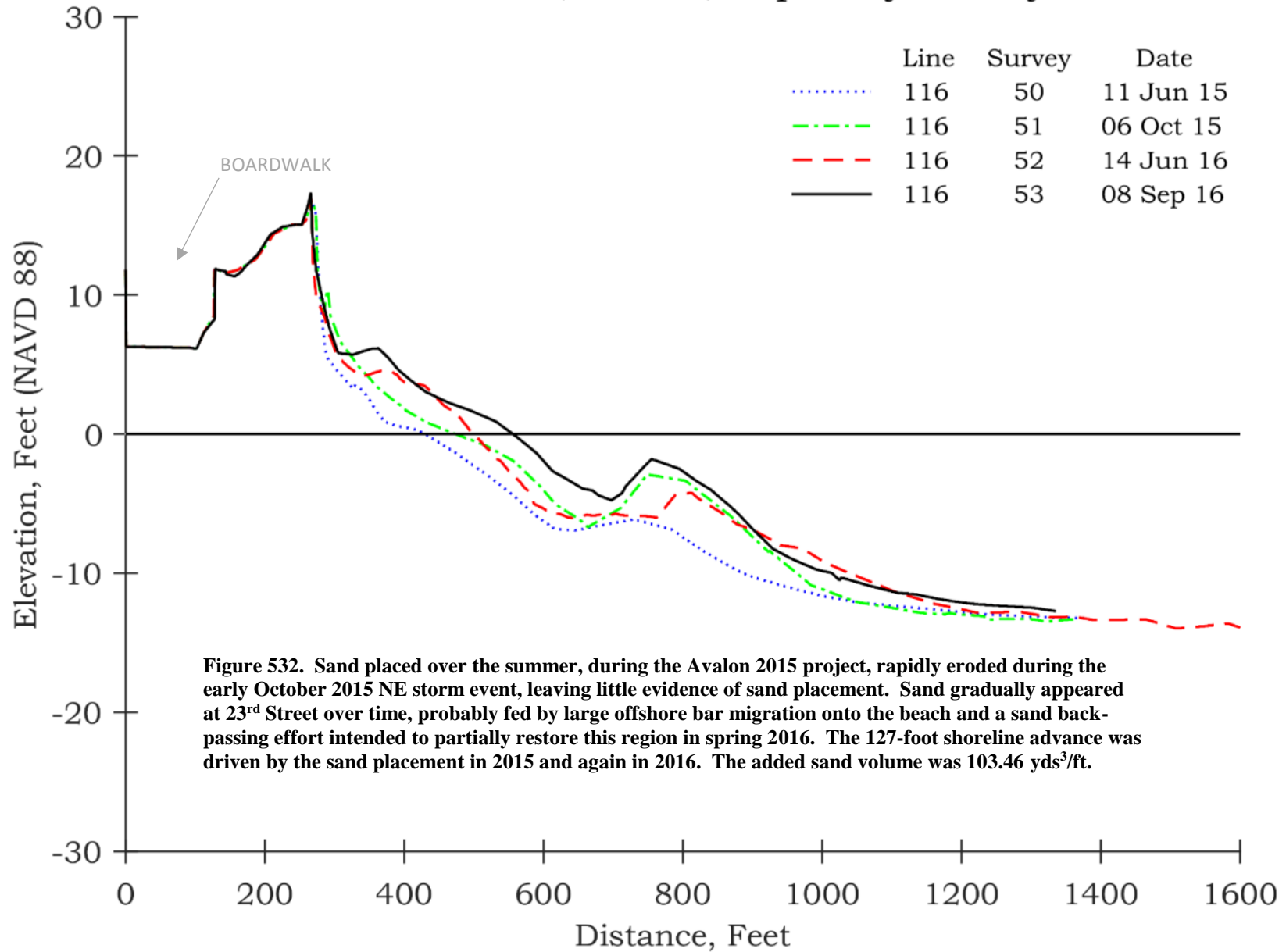
NJBPN 116 – 23rd Street, Avalon



Figure 531a & 531b. The left picture was taken from the dune crest on October 15, 2015 following the Borough beach project. By September 8, 2016 (right picture) the beach was slightly wider and sand had deposited at the dune toe.

New Jersey Beach Profile Network

#116 - 23rd Street, Avalon, Cape May County



30-Year Coastal Changes at Site 116, 23rd Street, Avalon, Cape May Co.

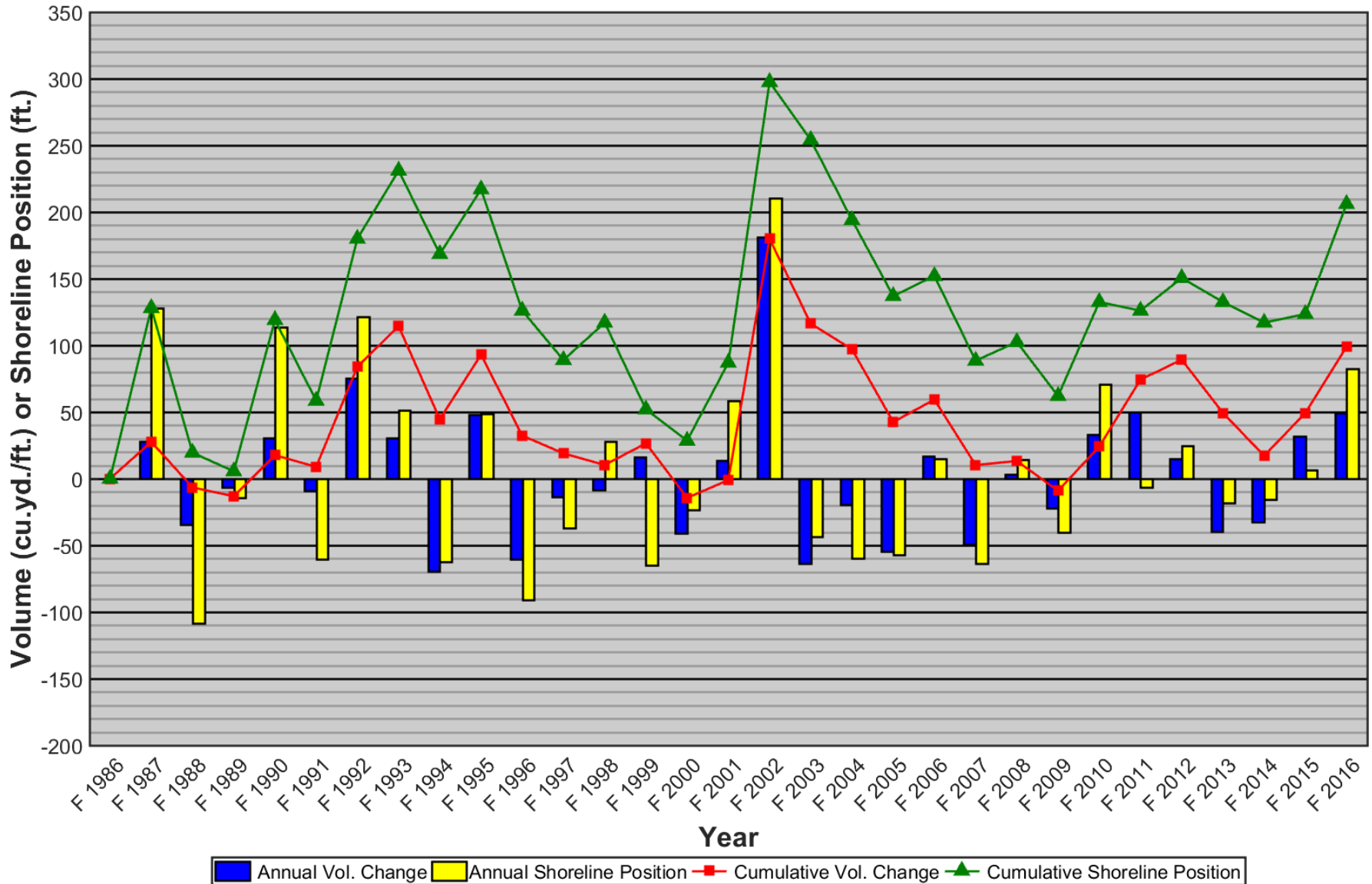


Figure 533. The 1987 initial Avalon Borough and NJ State beach restoration shows as a spike in shoreline position of only an added 30 yds³/ft. in sand volume. There were multiple other projects in the 1990's done by the Borough and state until the 2002 USACE initial project. Subsequent periodic nourishments have maintained a credible sand volume and a 206-foot shoreline advance since 1986.

30-Year Ensemble Mean Profile at Site 116, 23rd Street, Avalon, Cape May Co.

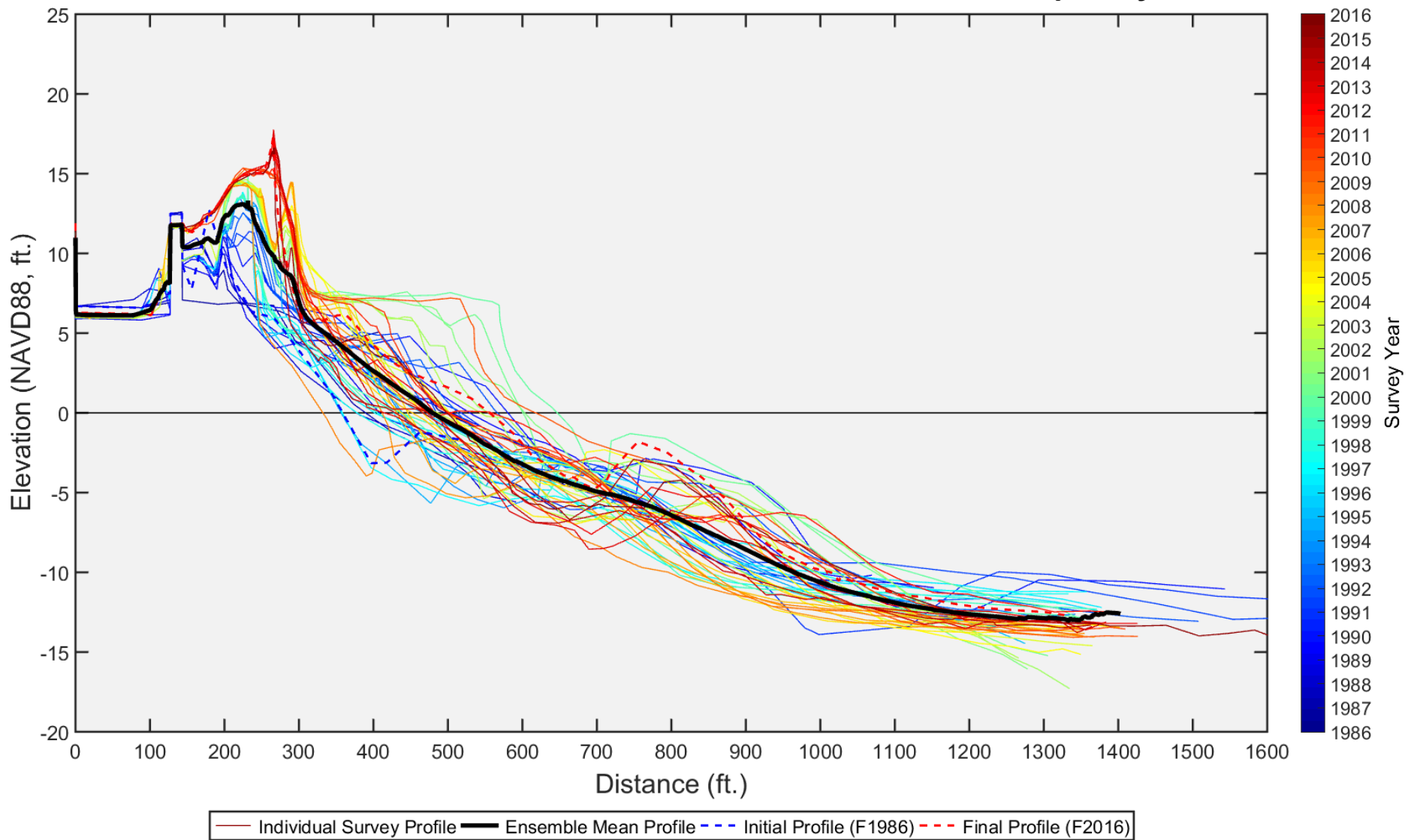


Figure 534. The envelope of change has varied greatly over time, with no obvious accretional or erosional trend. However, a distinct trend in dune growth is apparent and has been responsible for creating a much more effective dune barrier to storm waves. The variations of berm projections shown in the figure represent each successive beach restoration and the following episodes of erosion.

#116 - 23rd Street, Avalon Borough, Cape May County
Comparison of 1986 to 2015

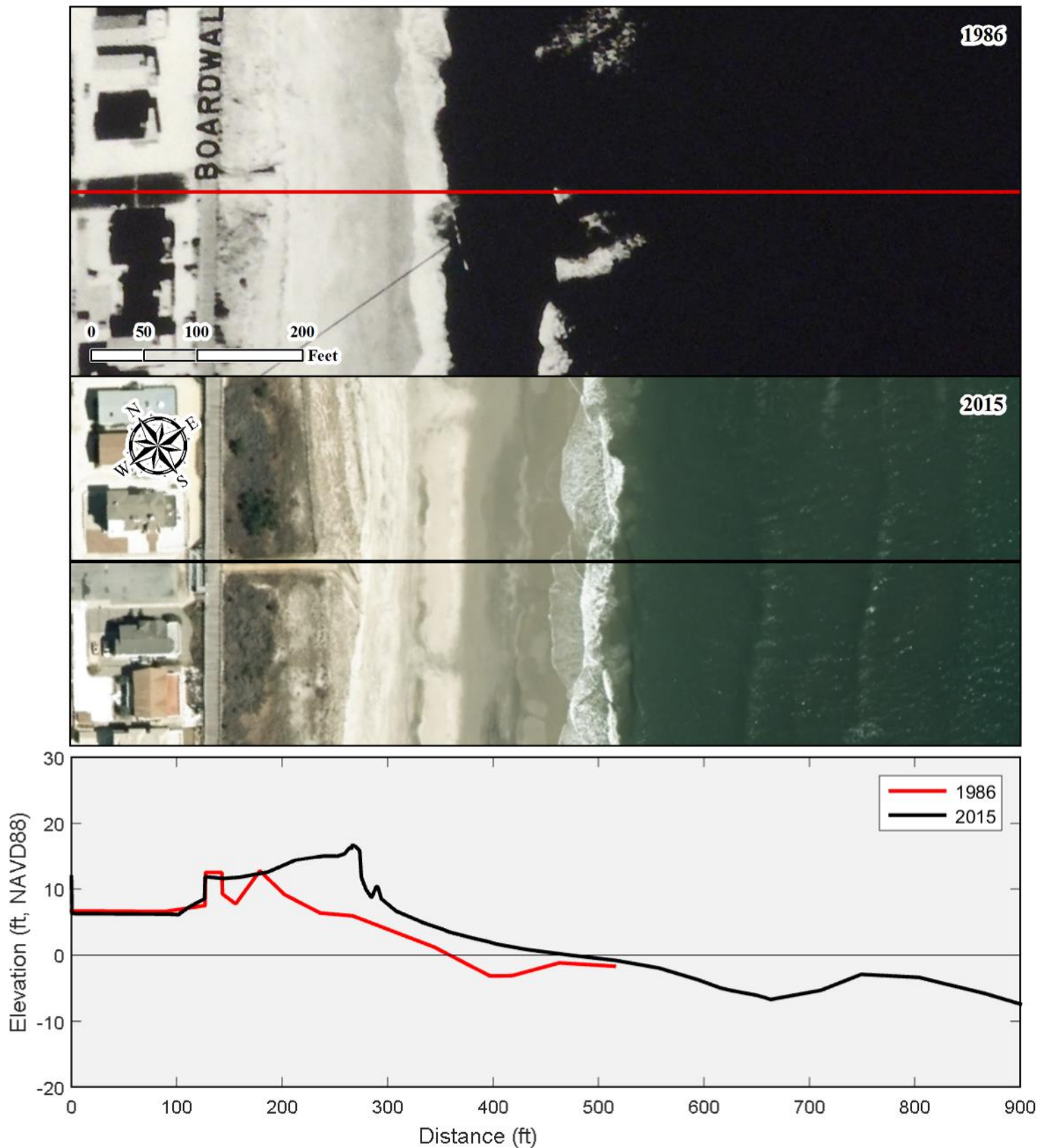


Figure 535. This Avalon site was repeatedly supplied with sand from Townsend’s Inlet ebb-tidal delta since 1987, so the 1986 photograph depicts a pre-nourished narrow beach and low dune that became dramatically worse by April 1987 (the high water line was landward of the boardwalk). This dramatic shoreline retreat triggered the initial beach restoration during that year. The beach has grown slightly from 1986 to 2015 and the dune has become much more robust.

NJBPN 115 – 35th Street, Avalon (September 9, 2016)



Figure 536. Looking north from the dune toe at 35th Street in Avalon, the newly extended pier at 32nd Street now reaches the ocean again. Sand was transported north from this site in 2016 by the Borough in a back-passing operation. Wind deposition has added to the dunes, while the harvest zone (for the back-passing operation) was completely filled back by June.

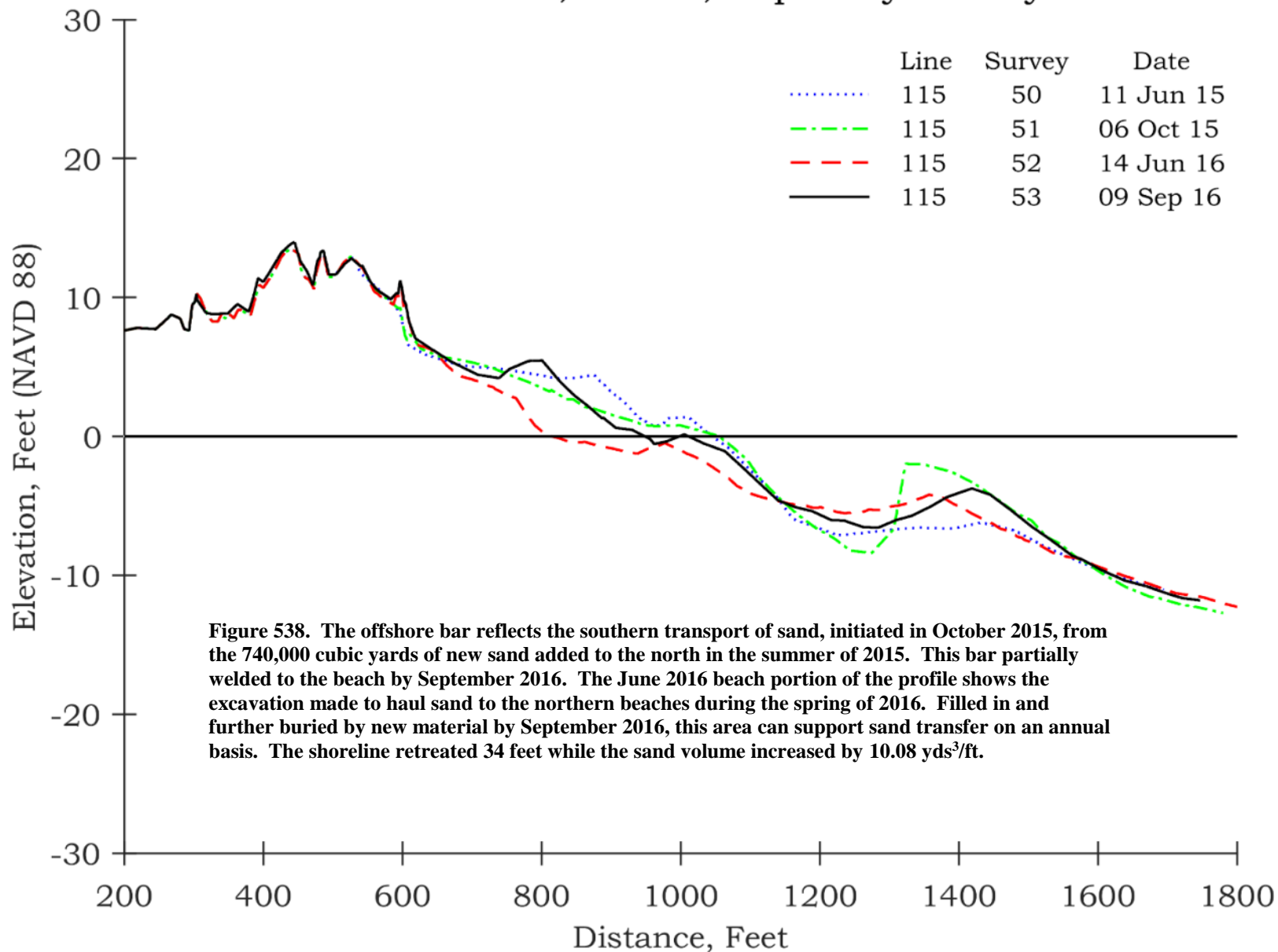
NJBPN 115 – 35th Street, Avalon



Figure 537a & 537b. Photo on the left is 35th Street as of October 6, 2015 and shows a wide beach, with aeolian sand deposition along the dune fence that has seen sand blown into the dunes yet again. The photo on the right was taken from the berm on September 9, 2016 and shows the new, extended pier and the general beach width at this site several months following sand harvesting for the back-passing project. Sand volume has already naturally recovered and restored the beach width and berm elevation to pre-project conditions.

New Jersey Beach Profile Network

#115 - 35th Street, Avalon, Cape May County



30-Year Coastal Changes at Site 115, 35th Street, Avalon, Cape May Co.

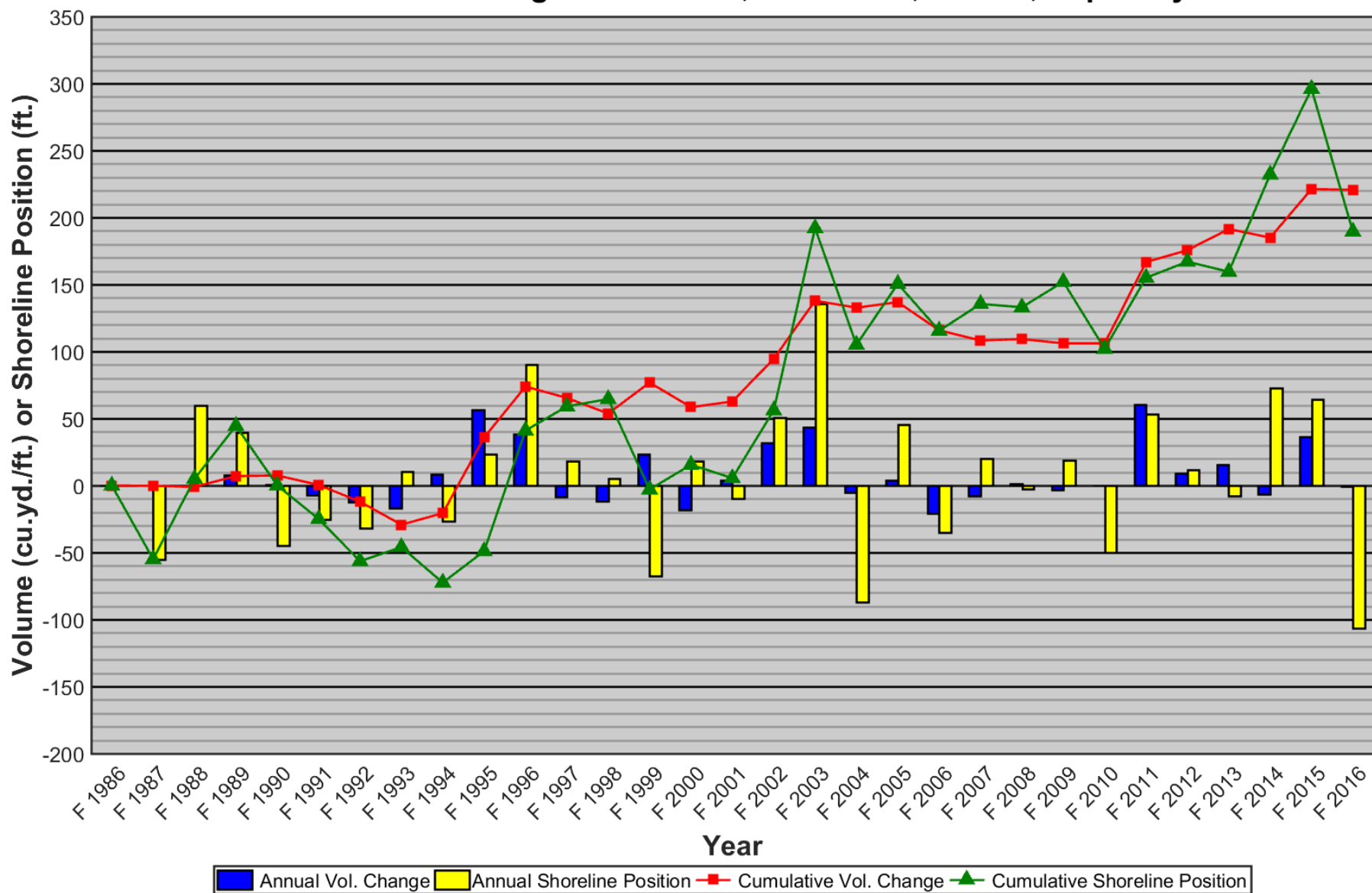


Figure 539. The 35th Street site represents a significant trend in beach enhancement without a direct placement of sand ever occurring. The 1987 fill had a minor impact by 1990 that faded badly by 1994. Recovery due to the influx of new sand followed by a drop in sand volume reached another low point by 2001 as sand cycled through on longshore currents. The USAACE project occurred, but sand was not placed this far south. Longshore currents, however, carried sand south from the fill area and caused material to accumulate at this site fairly rapidly. The next 8 years saw relative stability with subsequent advances in 2013 and 2015, resulting in a net gain in volume of 220 yds³/ft. and a 190-foot shoreline advance.

30-Year Ensemble Mean Profile at Site 115, 35th Street, Avalon, Cape May Co.

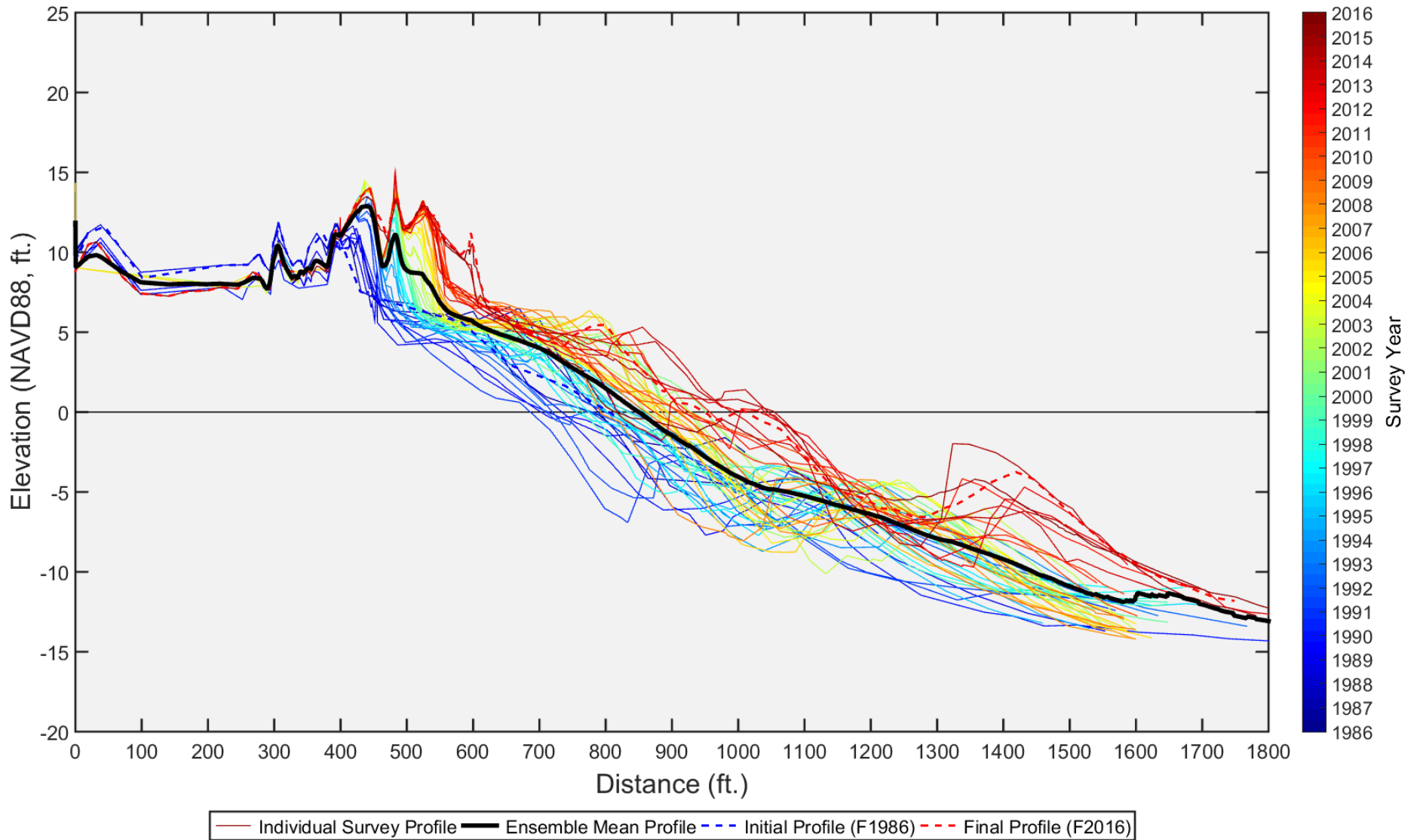


Figure 540. The general trend of beach enhancement can be seen in the progression of colors over time from blue to red with the later cross sections being higher in elevation and having shoreline positions farther seaward. The dune has also doubled in width from the early surveys.

#115 - 35th Street, Avalon Borough, Cape May County
Comparison of 1995 to 2015

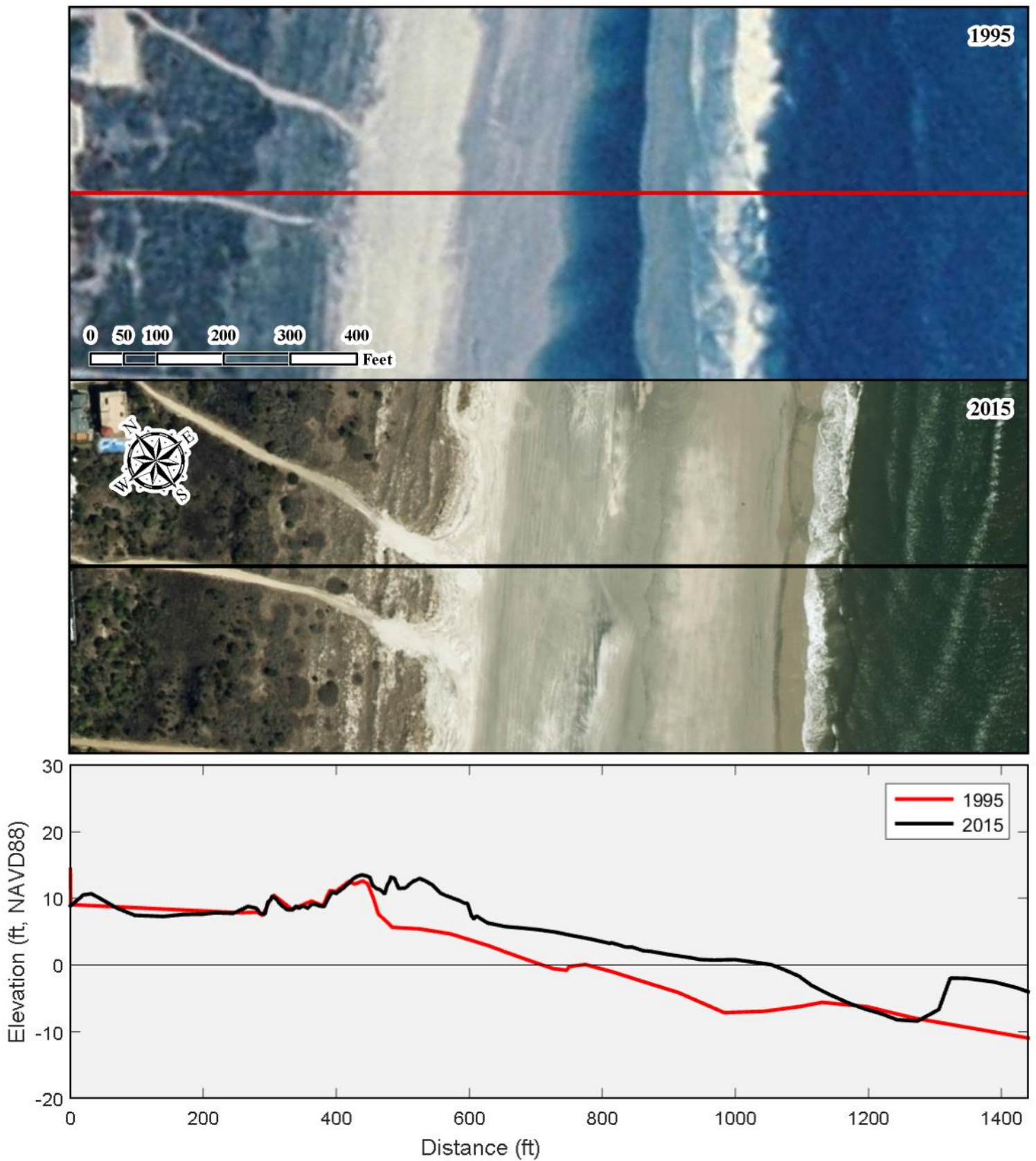


Figure 541. The sand shed from the engineered beach north of 31st Street resides in part at this location and to the south of 35th Street. The introduction of this material has acted to double the width of the dune and greatly increase the beach width.

NJBPN 114 – 70th Street, Avalon (September 9, 2016)



Figure 542. Looking south along the dune toe at 70th Street in Avalon. This site is very stable, with the dune and beach accreting large amounts of sand. The accretional nature of this site is due to it being located at the northern taper of the federal project with sand only placed here once in 2003.

NJBPN 114 – 70th Street, Avalon



Figure 543a & 543b. The 70th Street location has been a stable area for decades and lies at the very north limit of the Stone Harbor segment of the Seven Mile Island USACE shore protection project that has a break between 31st Street and 70th Street, due to long term shoreline stability in that section. The left photo was taken October 8, 2015, and shows fencing added in 2014 being partially buried by constant wind transport of sand into the dune area. The right photograph was taken September 9, 2016 out on the berm midway between the dune toe and the swash.

New Jersey Beach Profile Network

#114 - 70th Street, Avalon, Cape May County

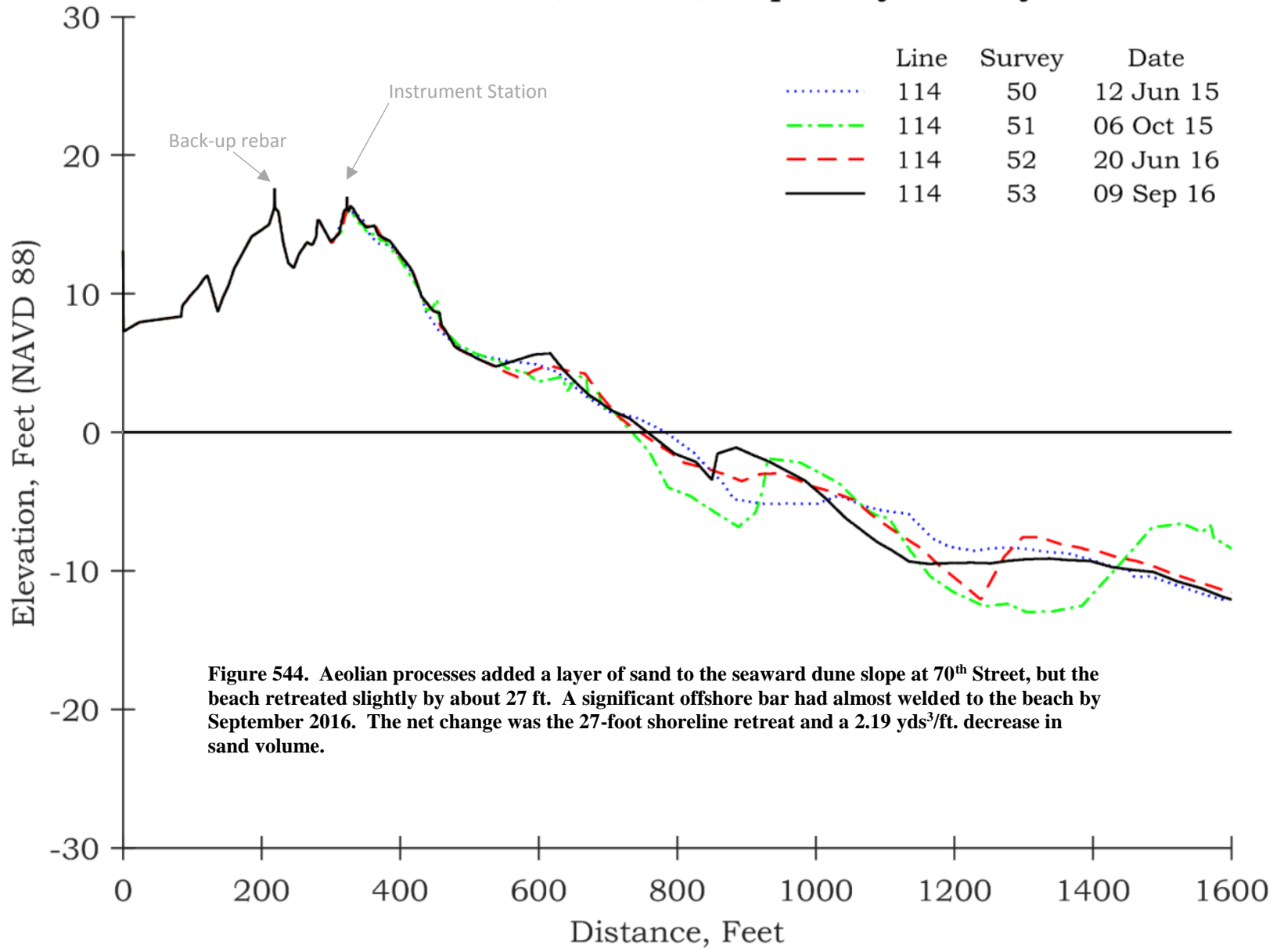


Figure 544. Aeolian processes added a layer of sand to the seaward dune slope at 70th Street, but the beach retreated slightly by about 27 ft. A significant offshore bar had almost welded to the beach by September 2016. The net change was the 27-foot shoreline retreat and a 2.19 yds³/ft. decrease in sand volume.

30-Year Coastal Changes at Site 114, 70th Street, Avalon, Cape May Co.

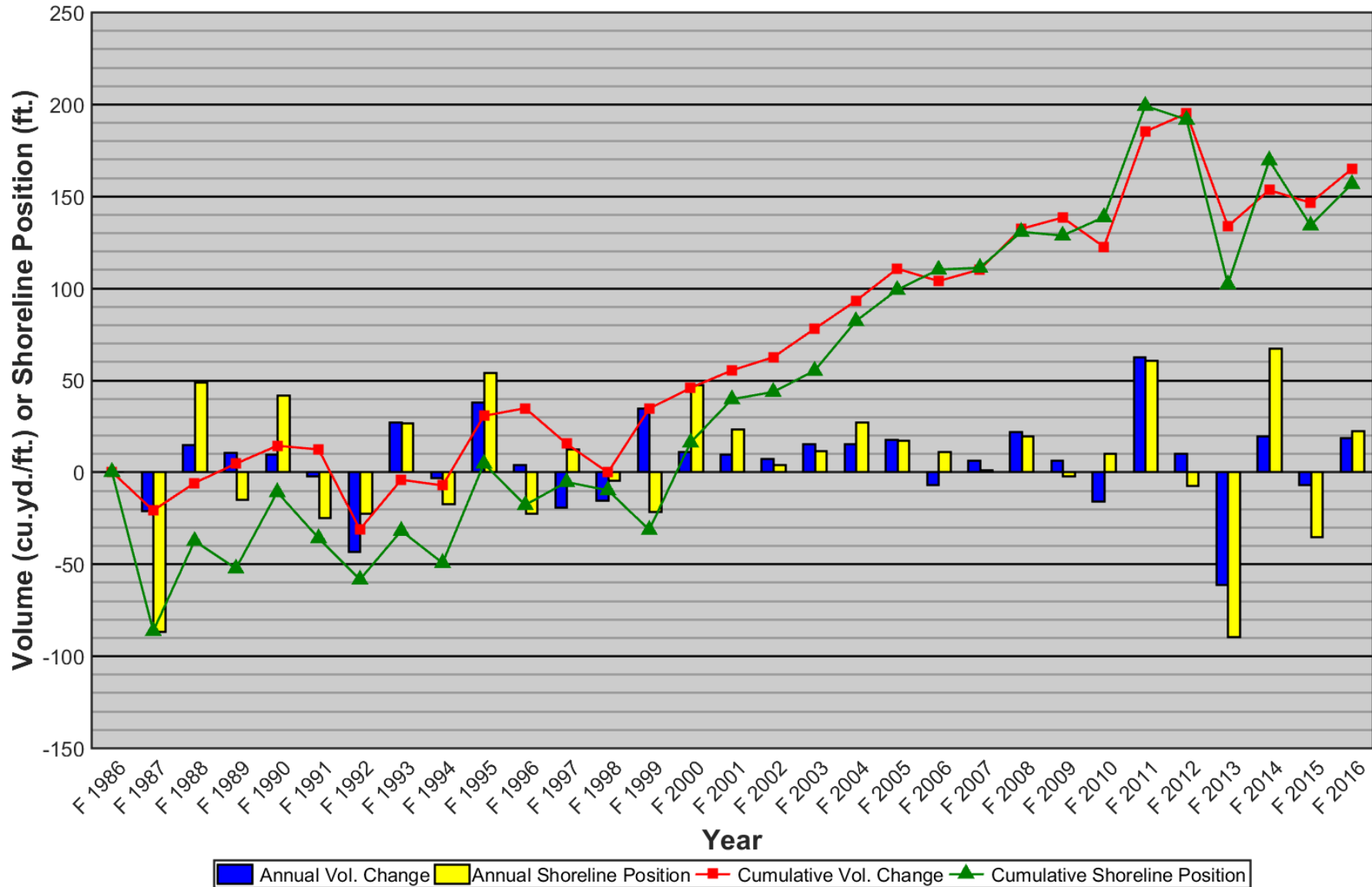


Figure 545. This site behaves as a true mid-island profile benefiting from sand volume accumulation and resulting shoreline advance seaward. In 2003, the USACE did deposit some sand within a few blocks to the south as they commenced building the Stone Harbor portion of the Seven-Mile-Island project. Since 1986 the shoreline has advanced by 157 feet and has accumulated 165 yds³/ft. in sand volume.

30-Year Ensemble Mean Profile at Site 114, 70th Street, Avalon, Cape May Co.

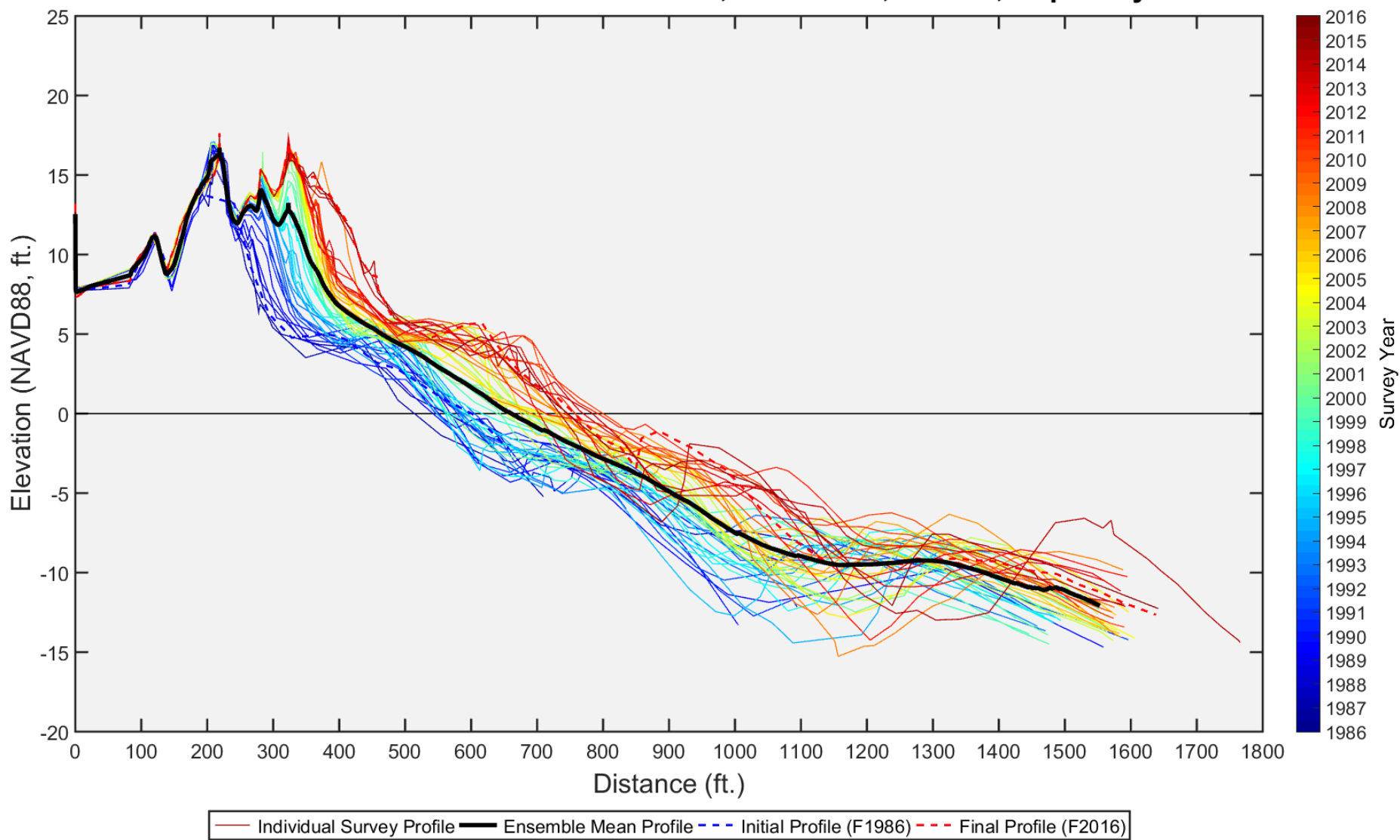


Figure 546. The progression of beach profiles over time shows the general advance in beach width, dune growth, and the increase in overall elevation of the profile at this site.

#114 - 70th Street, Avalon Borough, Cape May County
Comparison of 1995 to 2015

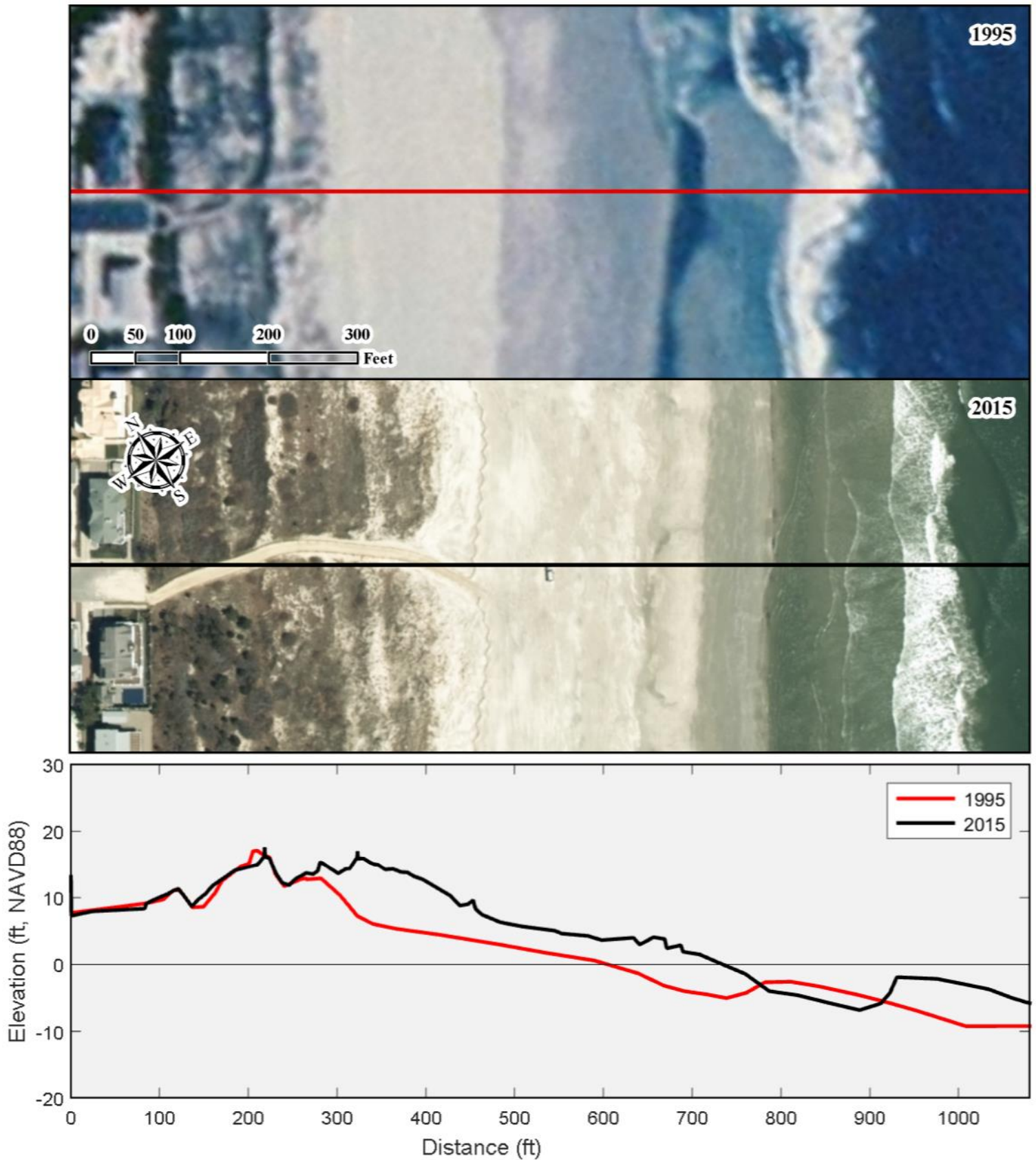


Figure 547. Minimal beach enhancement occurred at this site (initial federal project 2003), but sand has accumulated naturally over time generating a massive dune and a wider beach.

NJBPN 113 – 90th Street, Avalon (September 14, 2016)



Figure 548. View north along the dune toe showing sand accumulation in the dunes and at the fence line. USACE work is anticipated here in spring 2017.

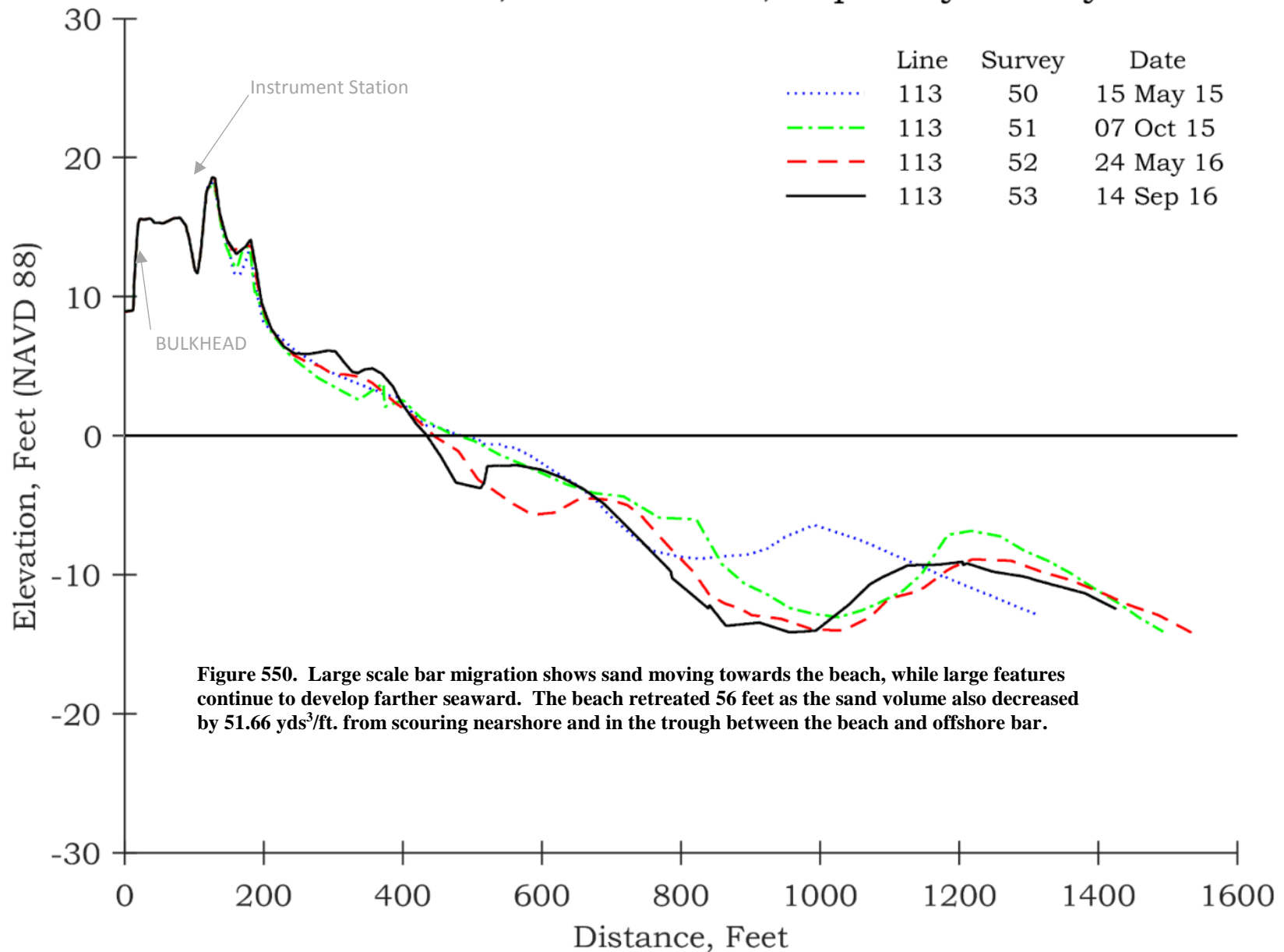
NJBPN 113 – 90th Street, Avalon



Figure 549a & 549b. The 90th Street location has been quite stable and has not required maintenance as frequently as sites farther south. The left photo, taken on October 12, 2015, shows a narrower beach with sand accumulation around the fencing. The right photograph was taken September 14, 2016 on the mid-berm looking north showing the wide relatively stable recreational beach.

New Jersey Beach Profile Network

#113 - 90th Street, Stone Harbor, Cape May County



30-Year Coastal Changes at Site 113, 90th Street, Stone Harbor, Cape May Co.

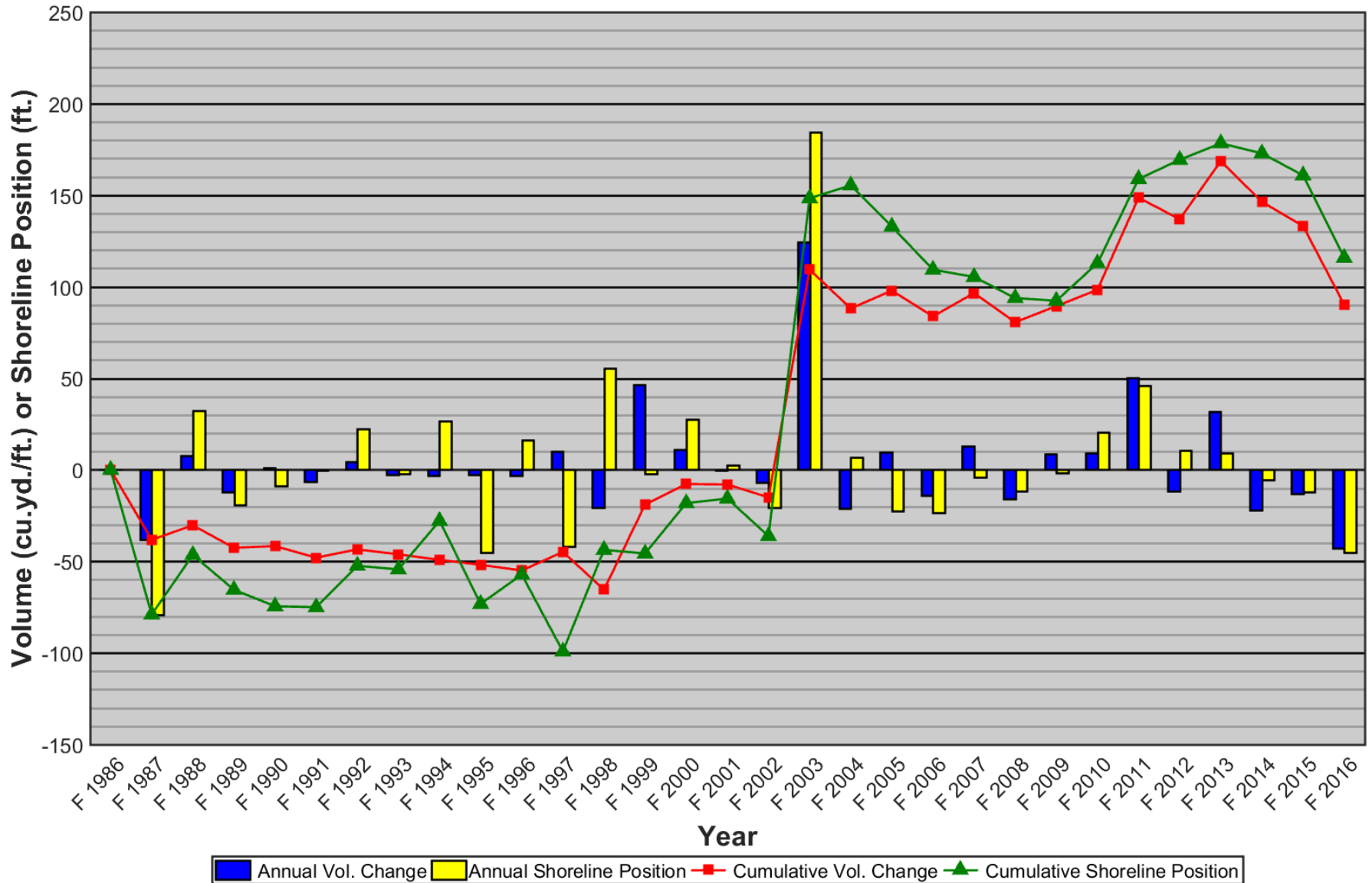


Figure 551. 90th Street lost substantially in 1987 and did not recover until 2003 when the USACE constructed its initial sand fill. In 1998, the State and the Borough completed a beachfill that shows as a minor improvement in sand volume between 1998 and 2002. Since 2003, there have been three additional fill efforts, following Hurricane Irene, then Sandy in 2013 and a maintenance project in spring 2017 (not shown).

30-Year Ensemble Mean Profile at Site 113, 90th Street, Stone Harbor, Cape May Co.

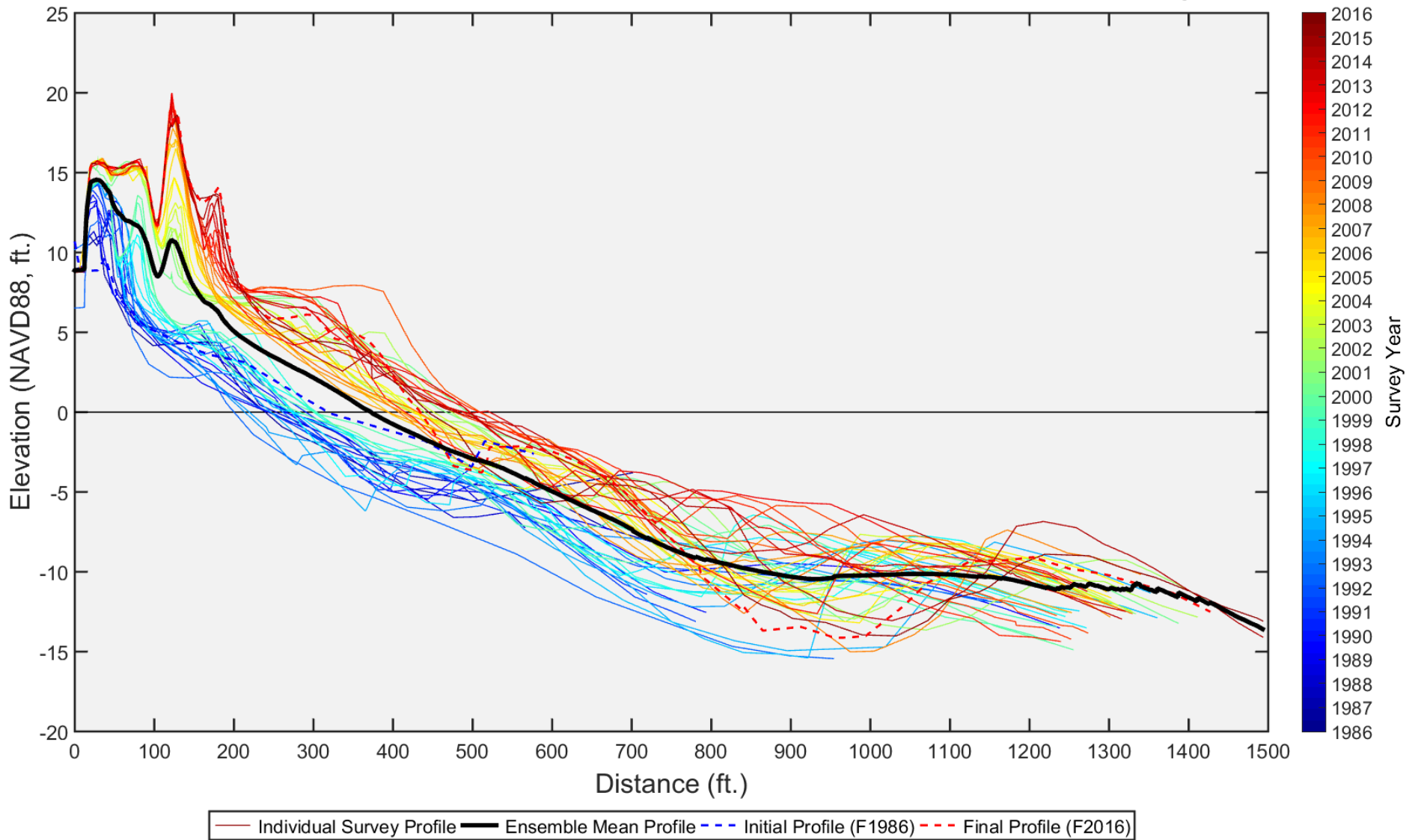


Figure 552. There is a distinct separation between the pre-USACE cross -sections and the cross-sections that follow the 2003 initial fill date. Both groups, however, show small variations in terms of envelope distribution for the individual profiles. The offshore varies the most with deep troughs and large offshore bar formation and migration.

#113 - 90th Street, Stone Harbor Borough, Cape May County
Comparison of 1995 to 2015

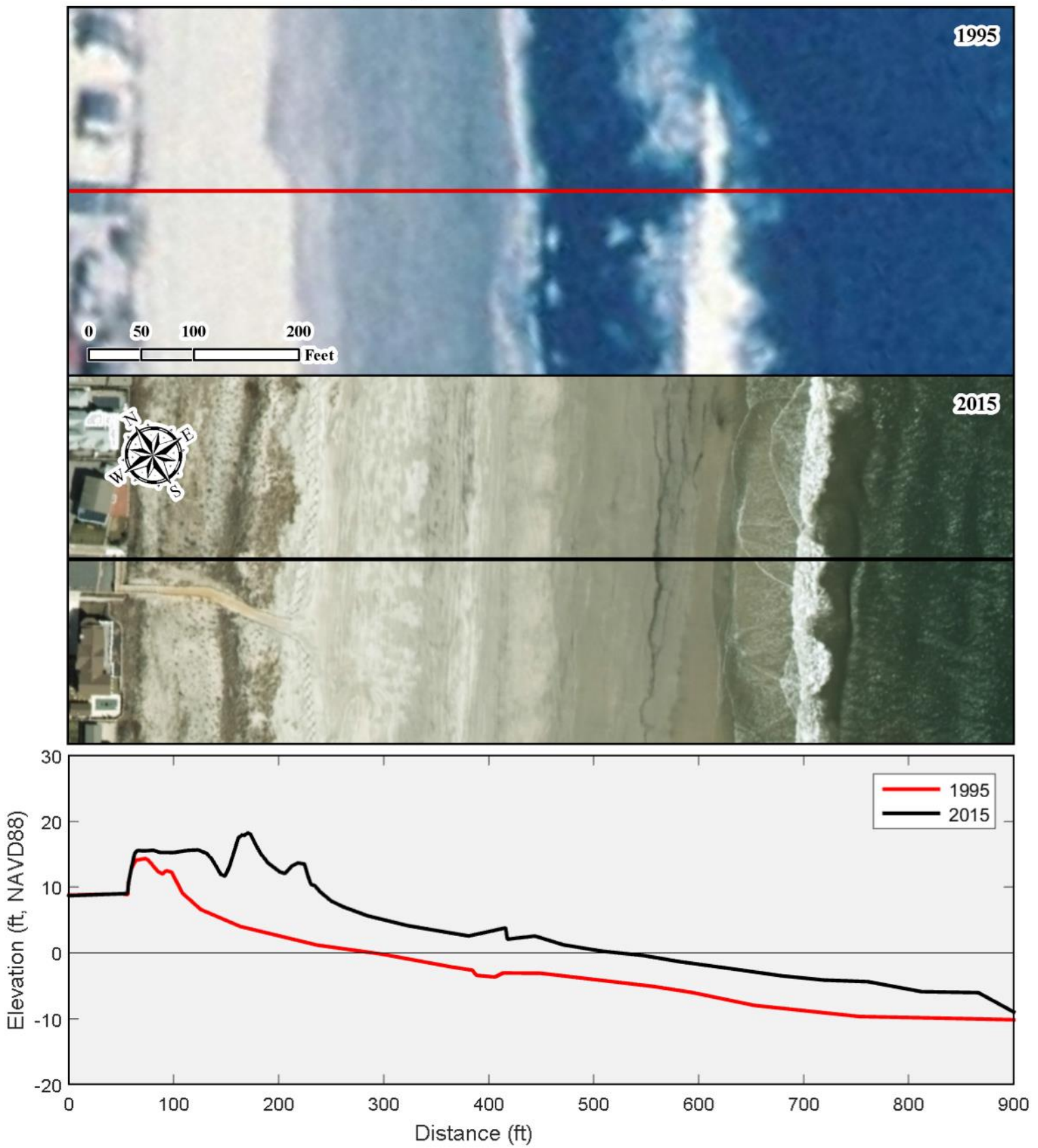


Figure 553. The first beach restoration in Stone Harbor took place in 1997 with a state and local project. This figure shows the comparison between pre-project beach conditions and post-USACE project inception in 2003. Conditions were substantially improved, as evident by the approximate 200-foot shoreline advance

NJBPN 212 – 121st Street, Stone Harbor (September 14, 2016)



Figure 554. This is a particularly great view to the south along the very southern Stone Harbor dune crest showing the terminal groin and the offset between it and the beach at South Point. Beach nourishment here has had a pronounced benefit to the bird habitat creation since 1998 as sand lost from Stone Harbor moves to the point.

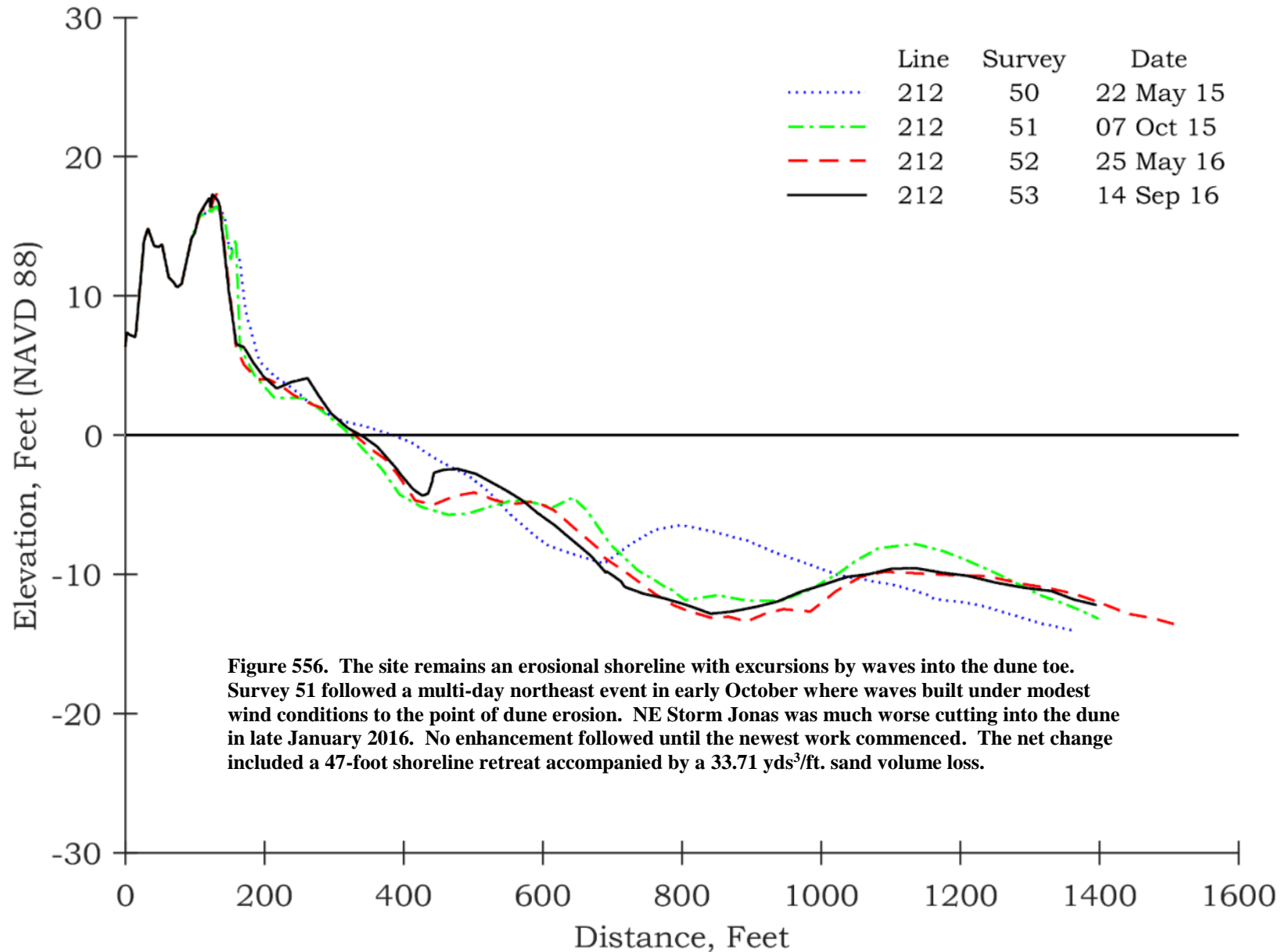
NJBPN 212 – 121st Street, Stone Harbor



Figure 555a & 555b. The south end Stone Harbor site has shown a long-term erosional trend that may be influenced by changes surrounding Hereford Inlet. The site has been the recipient of numerous beach nourishment projects including municipal and Federal efforts. Most recent was spring 2013 as a post-Sandy restoration. The State of NJ is currently funding a maintenance effort into spring 2017. The left photo, taken on October 13, 2015, shows a wet beach nearly to the dune toe. By September 14, 2016 (right photo), the raked section of the beach was still subject to high tide wave run-up.

New Jersey Beach Profile Network

#212 - South End, Stone Harbor, Cape May County



22-Year Coastal Changes at Site 212, South End, Stone Harbor, Cape May Co.

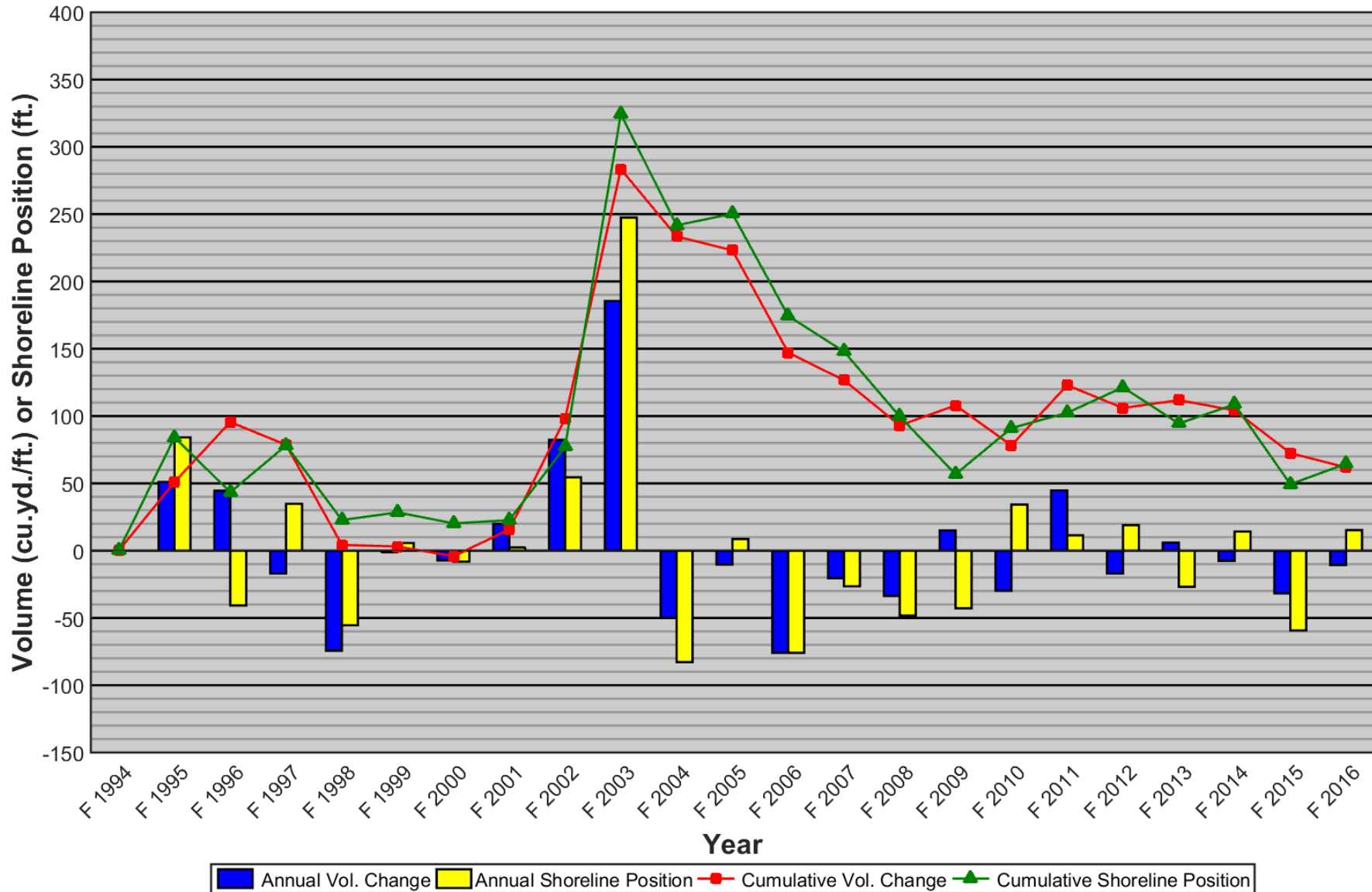


Figure 557. This was another site established in order to measure changes associated with a tidal inlet. In 1994, the terminal groin at 123rd Street was also the beginning of the Hereford Inlet shoal system. The 1998 State and local fill was a start, but the 2003 federal project really enhanced the regeneration of South Point as a trailing spit on this barrier island. Since 1994 South Point has grown almost 8,000 ft south from its 1991 position when the original inlet site 112 was abandoned due to severe chronic erosion at the point resulting in the loss of all upland areas south of the terminal groin.

22-Year Ensemble Mean Profile at Site 212, South End, Stone Harbor, Cape May Co.

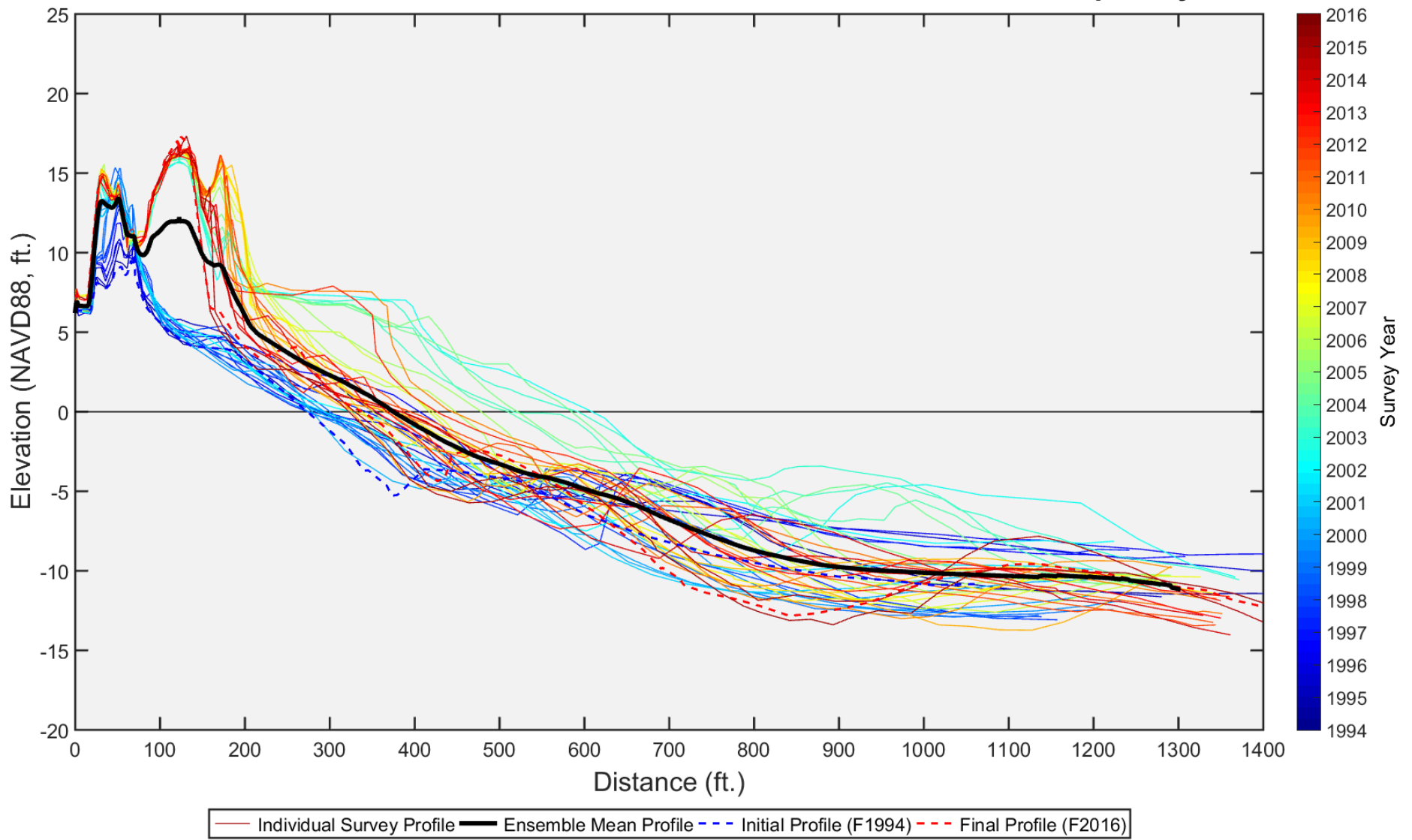


Figure 558. The USACE fill project substantially enhanced the dune and developed a wider beach, but the extensive profiles from the early 2000's (light green lines) failed to maintain their seaward positions for any length of time.

#212 - South End, Stone Harbor Borough, Cape May County
Comparison of 1995 to 2015

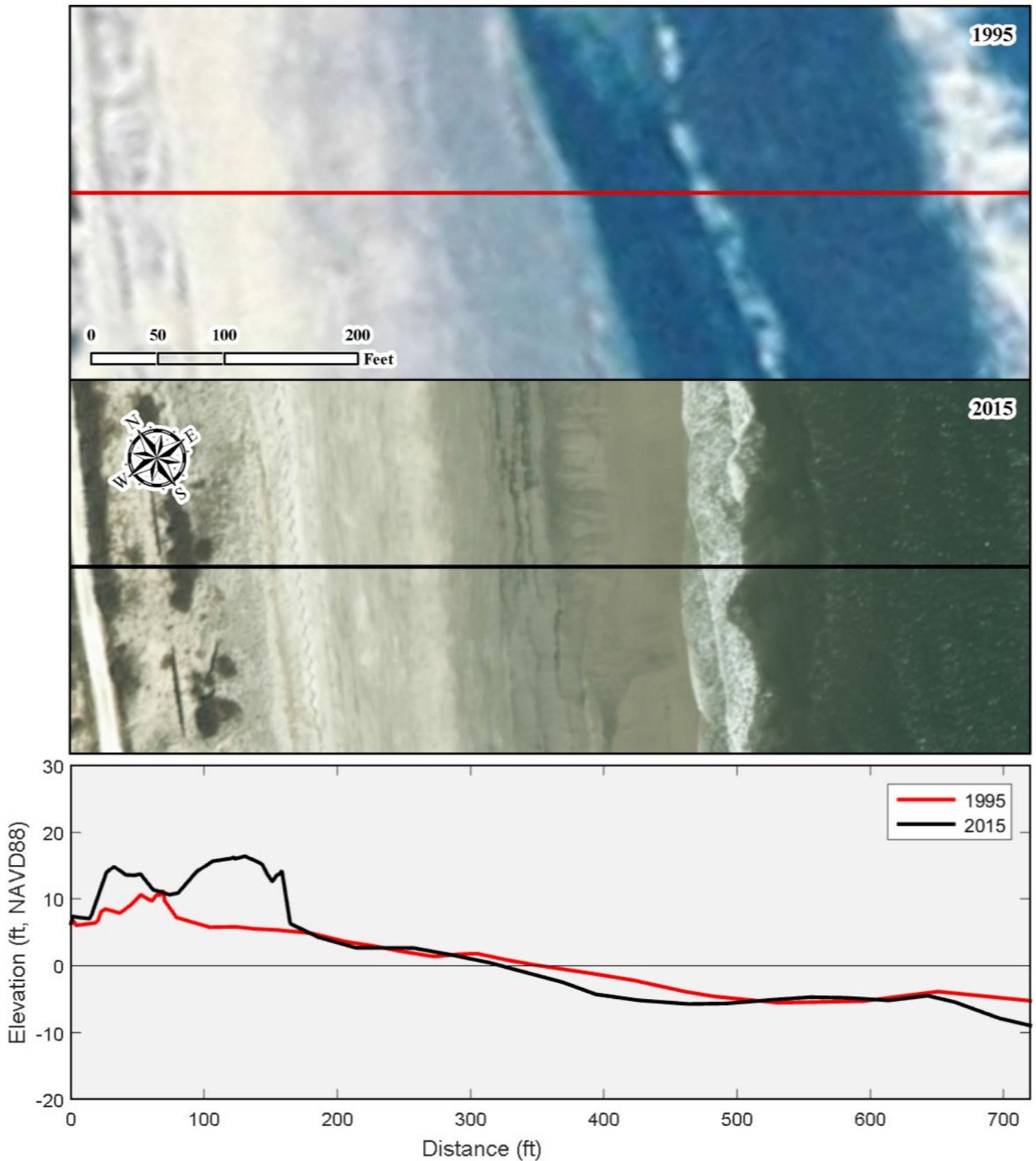


Figure 559. Initially, this site was south of the terminal groin on the natural area called South Point. By 1990, South Point had been lost as dry upland beach and had become intertidal shoals and shallow water. Sand added to Stone Harbor from 1997 on has brought back over 7,500 ft of South Point as a new sand spit. The original profile was moved north of the terminal groin and shows that dune development has been the key improvement since beach work commenced.

NJBPN 111 – 15th Avenue, North Wildwood (September 14, 2016)



Figure 560. The North Wildwood beach is narrow from here north and subject to rapid erosion due to its proximity to Hereford Inlet and its orientation. North Wildwood has benefited from the largest sand backpass effort to date in New Jersey, which has moved sand from the Wildwood beaches back to the northern beaches.

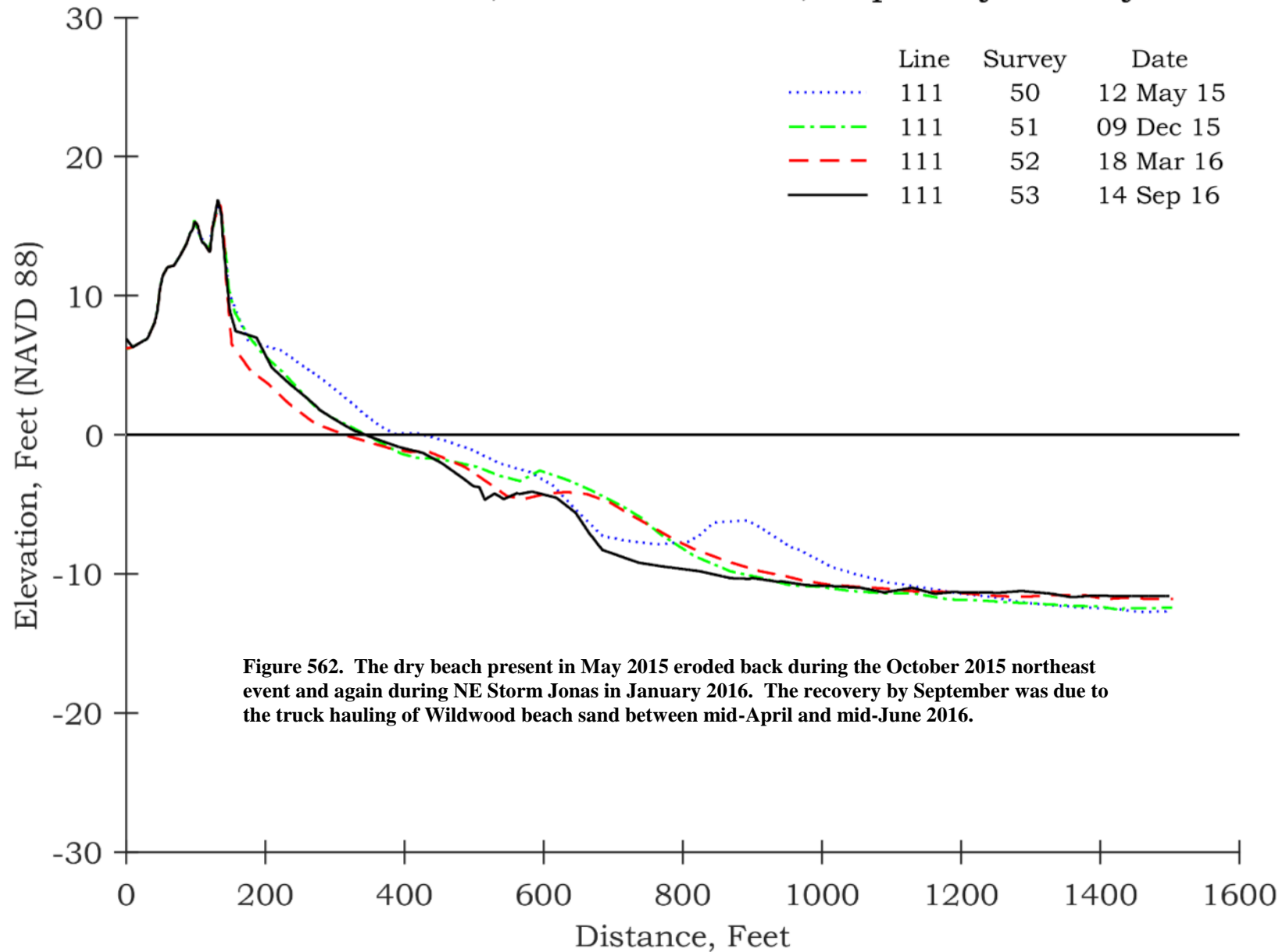
NJBPN 111 – 15th Avenue, North Wildwood



Figure 561a & 561b. The 15th Avenue site is influenced by the dynamics associated with Hereford Inlet. A NJ State sponsored 2009 beach fill temporarily interrupted a decade of erosion here. Photo on the left was taken December 9, 2015 at the limit of wave run-up. The right photo, taken on September 14, 2016, shows a narrower beach as a result of several northeast storms. During the spring of 2016, 151,000 cubic yards of sand were hauled north from the stormwater discharge lines on the beach in Wildwood to augment the beach to the north. Sand back-passing efforts resumed in late winter into the spring of 2017 with 200,000 cubic yards transported.

New Jersey Beach Profile Network

#111 - 15th Avenue, North Wildwood, Cape May County



30-Year Coastal Changes at Site 111, 15th Avenue, North Wildwood, Cape May Co.

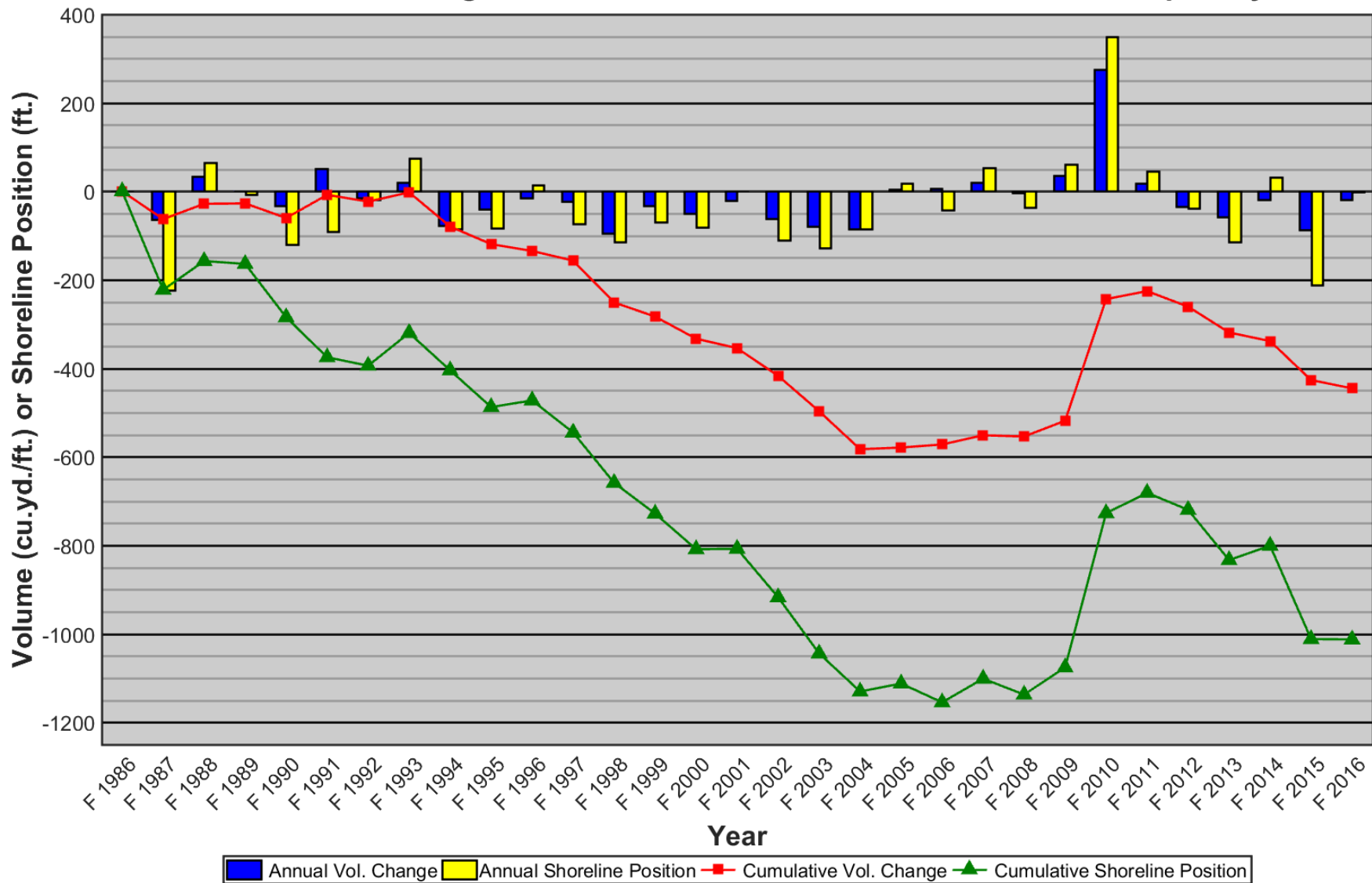


Figure 563. 15th Avenue in North Wildwood represents the most erosional site in New Jersey. Losing almost 600 yds³/ft. by 2006 accompanied by a 1,150 ft. shoreline retreat, this site retreated over a city block from the 1986 position. In 2009 the State and North Wildwood conducted a major beach restoration adding 450 feet of beach width. Since then the width has been reduced by 320 ft. The sand volume also declined from the restored volume by 220 yds³/ft. All of these losses are divided between sediment accumulation along the North Wildwood Hereford Inlet shoreline and south into Wildwood City (see next site south).

30-Year Ensemble Mean Profile at Site 111, 15th Avenue, North Wildwood, Cape May Co.

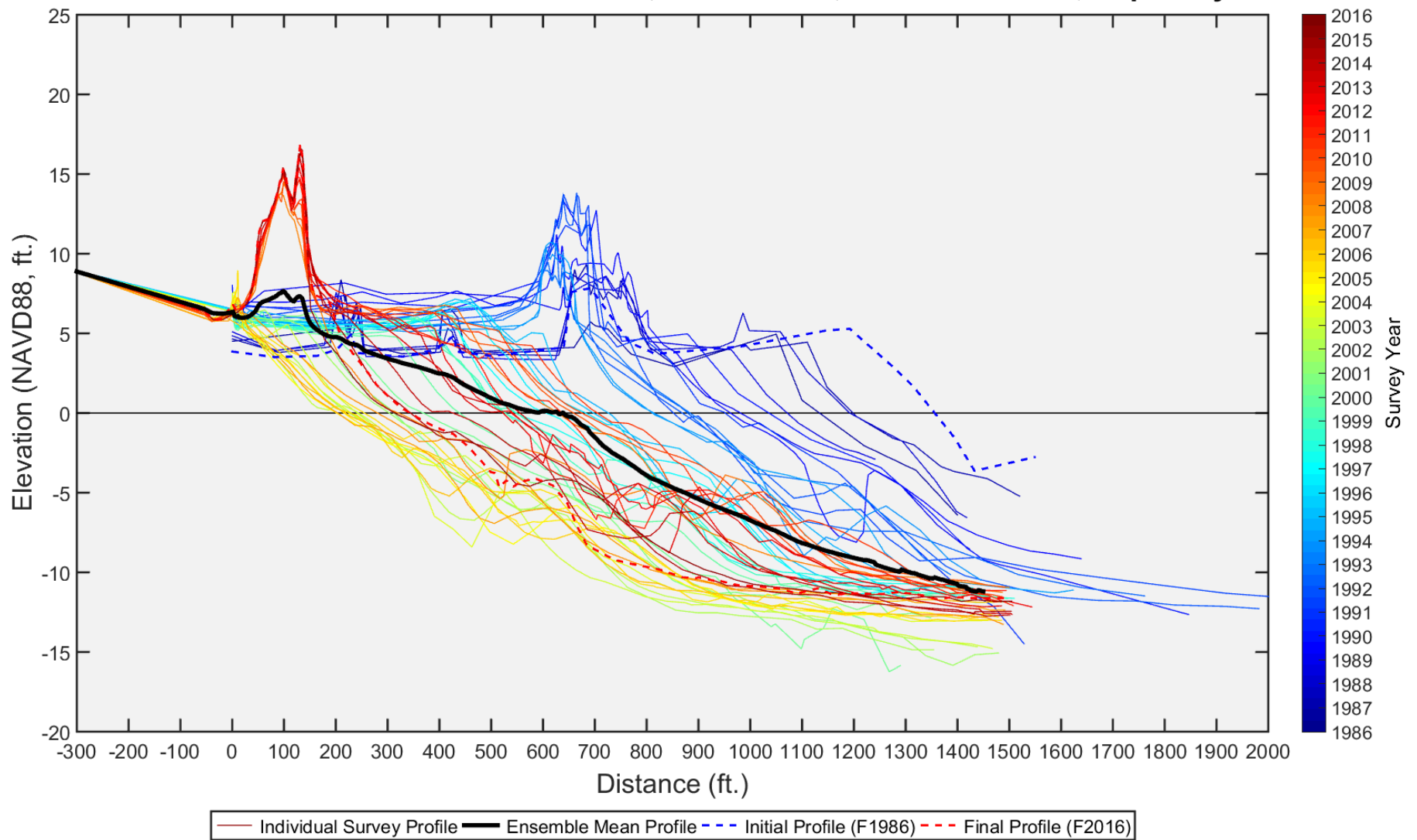


Figure 564. The original profile included a large “island” dune near the water’s edge that eroded as the shoreline retreated. The new dune established during the 2009 project has remained in place. This is one of only a few NJ sites where the initial profile (blue dashed line) lies well seaward of the most recent survey (red dashed line). Major changes to the tidal current circulation into and out of Hereford Inlet are responsible for this dramatic shift in shoreline position.

#111 - 15th Avenue, North Wildwood, Cape May County
Comparison of 1986 to 2015

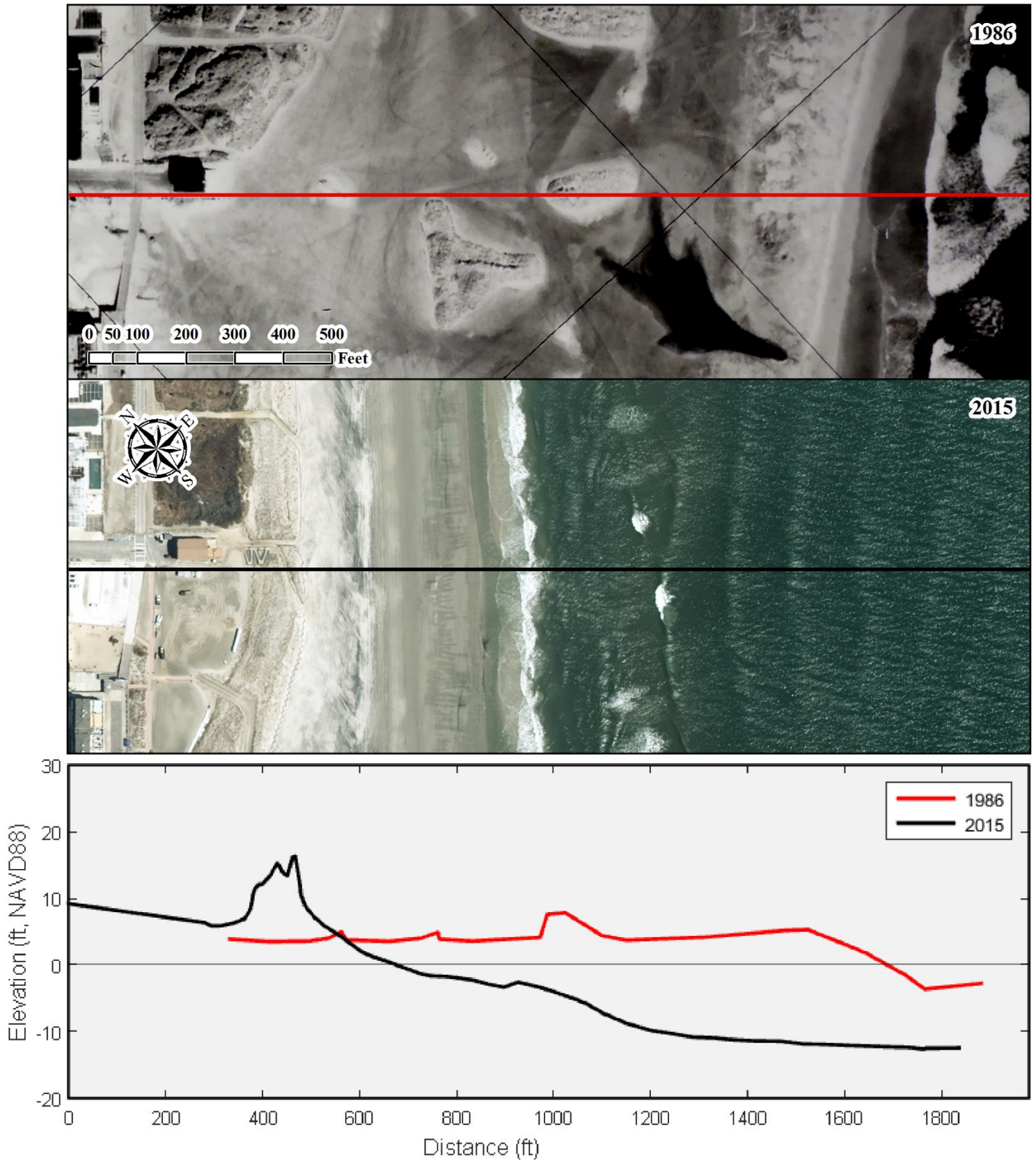


Figure 565. This location has suffered New Jersey’s worst shoreline retreat during the monitoring interval with 1,057 ft of shoreline loss since 1986. Even though the NJ State intercession in 2009 provided 1.45 million cubic yards of restoration sand to the North Wildwood beachfront, this site was never able to rebound. One of the “island dunes” can be seen in the 1986 aerial photograph and on the 1986 profile line, beginning near the 1000 foot Distance location

NJBPN 110 – Cresse Avenue, Wildwood (November 22, 2016)



Figure 566. View to the north along the eastern edge of the Wildwood Boardwalk at Cresse Avenue. The wide beach, notorious in Wildwood, shows as a vast gray plain with the amusement piers in the distance along with the new convention center.

NJBPN 110 – Cresse Avenue, Wildwood



Figure 567a & 567b. The Cresse Avenue site has been accumulating sand volume since 1992. Sand lost from North Wildwood migrates south adding to the beach width each year. The left photo, taken on December 9, 2015, shows the expansive view, an additional 43 ft wider than in 2014. The right photo taken November 22, 2016 repeats the expansive view of the beach, this time 16 ft wider than in 2015.

New Jersey Beach Profile Network

#110 - Cresse Avenue, Wildwood, Cape May County

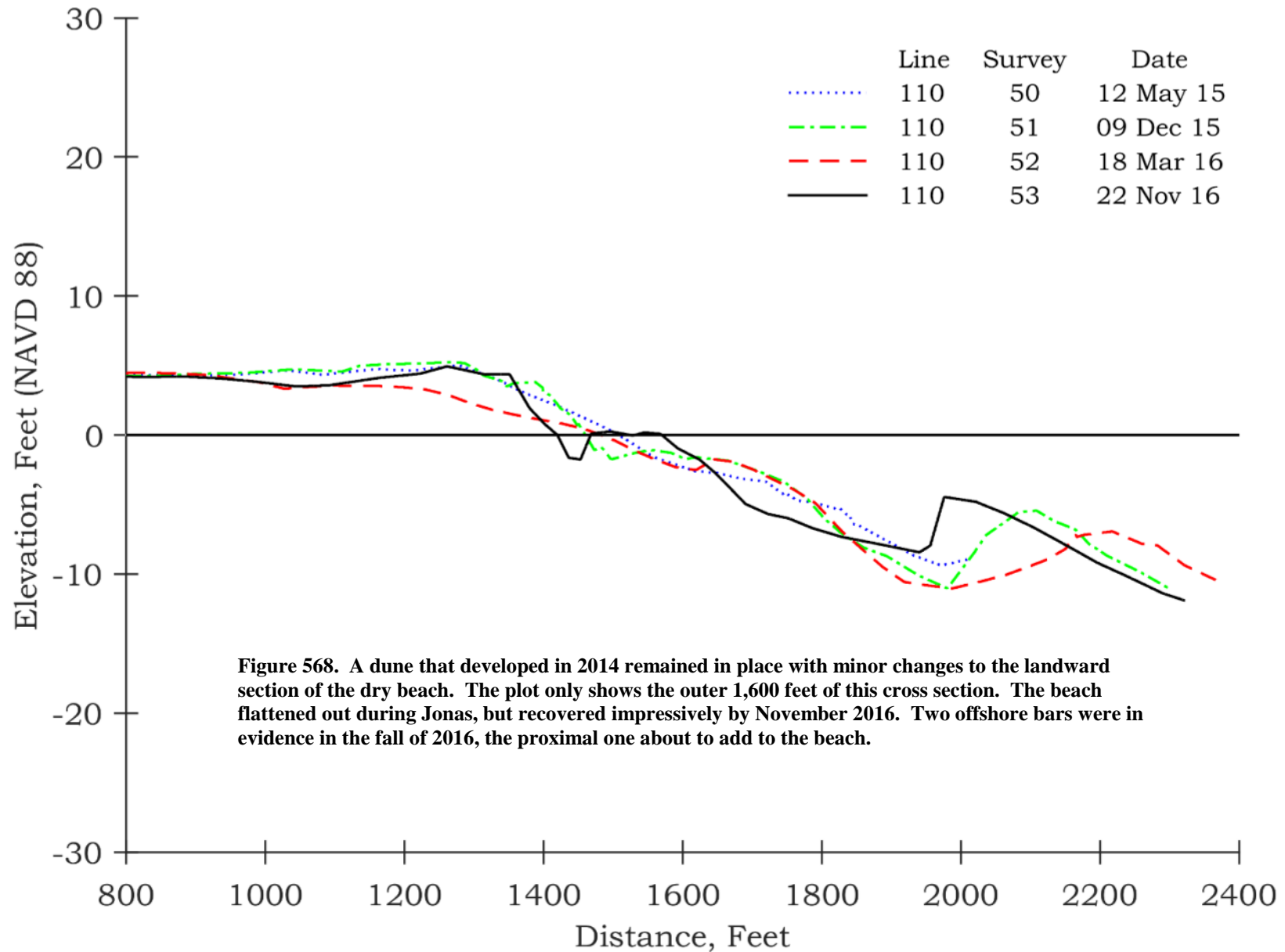


Figure 568. A dune that developed in 2014 remained in place with minor changes to the landward section of the dry beach. The plot only shows the outer 1,600 feet of this cross section. The beach flattened out during Jonas, but recovered impressively by November 2016. Two offshore bars were in evidence in the fall of 2016, the proximal one about to add to the beach.

30-Year Coastal Changes at Site 110, Cresse Avenue, Wildwood, Cape May Co.

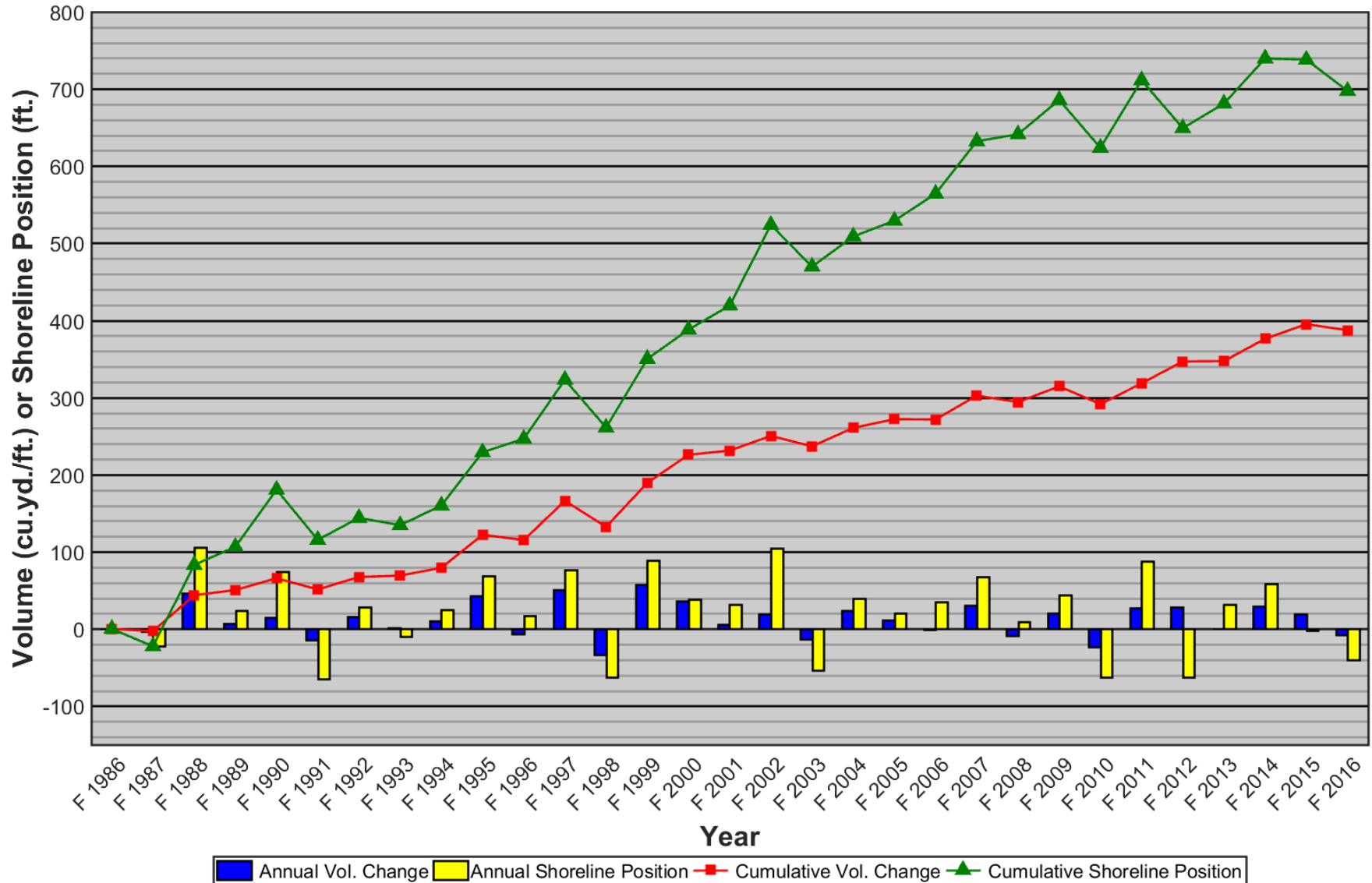


Figure 569. A partial answer to where all the North Wildwood sand went is found at the Cresse Avenue site at the border between Wildwood and Wildwood Crest. Only the series of northeast storms produced negative sand volume and shoreline change data. Minor losses did occur in the future, but the trend was strongly positive. The beach sand volume increased by 383 yds³/ft. and the shoreline advanced by 700 feet, which is one of the largest, naturally occurring shoreline adjustments at all NJ sites.

30-Year Ensemble Mean Profile at Site 110, Cresse Avenue, Wildwood, Cape May Co.

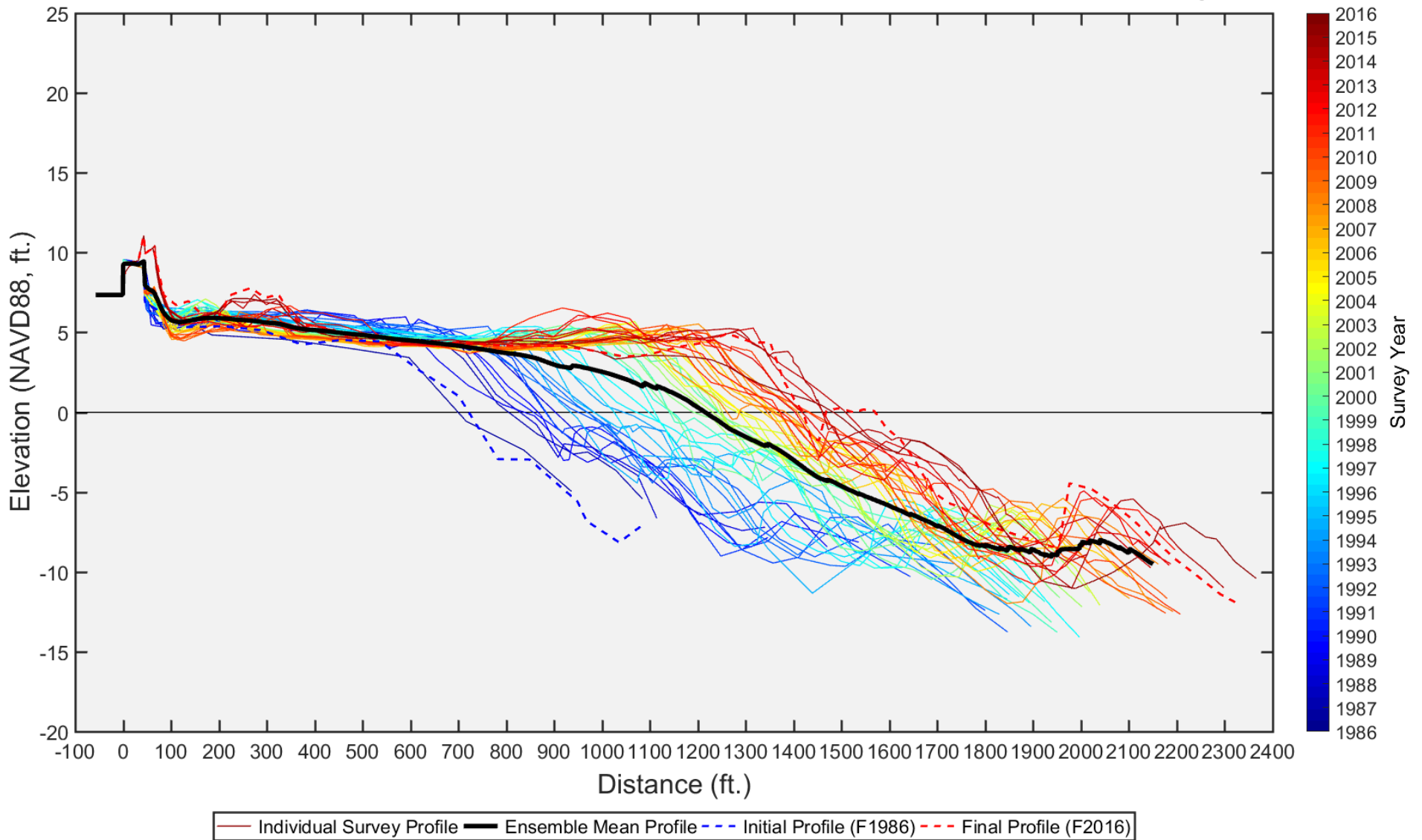


Figure 570. The gain in beach width with time is reflected in the progressive color change from blue to red in the seaward direction at this site. The contrast between the initial survey in 1986 (blue dashed line) and the 2016 survey (red dashed line) is clear evidence that sand moves south from North Wildwood depositing along the Wildwood City beach.

#110 - Cresse Avenue, Wildwood, Cape May County
Comparison of 1995 to 2015

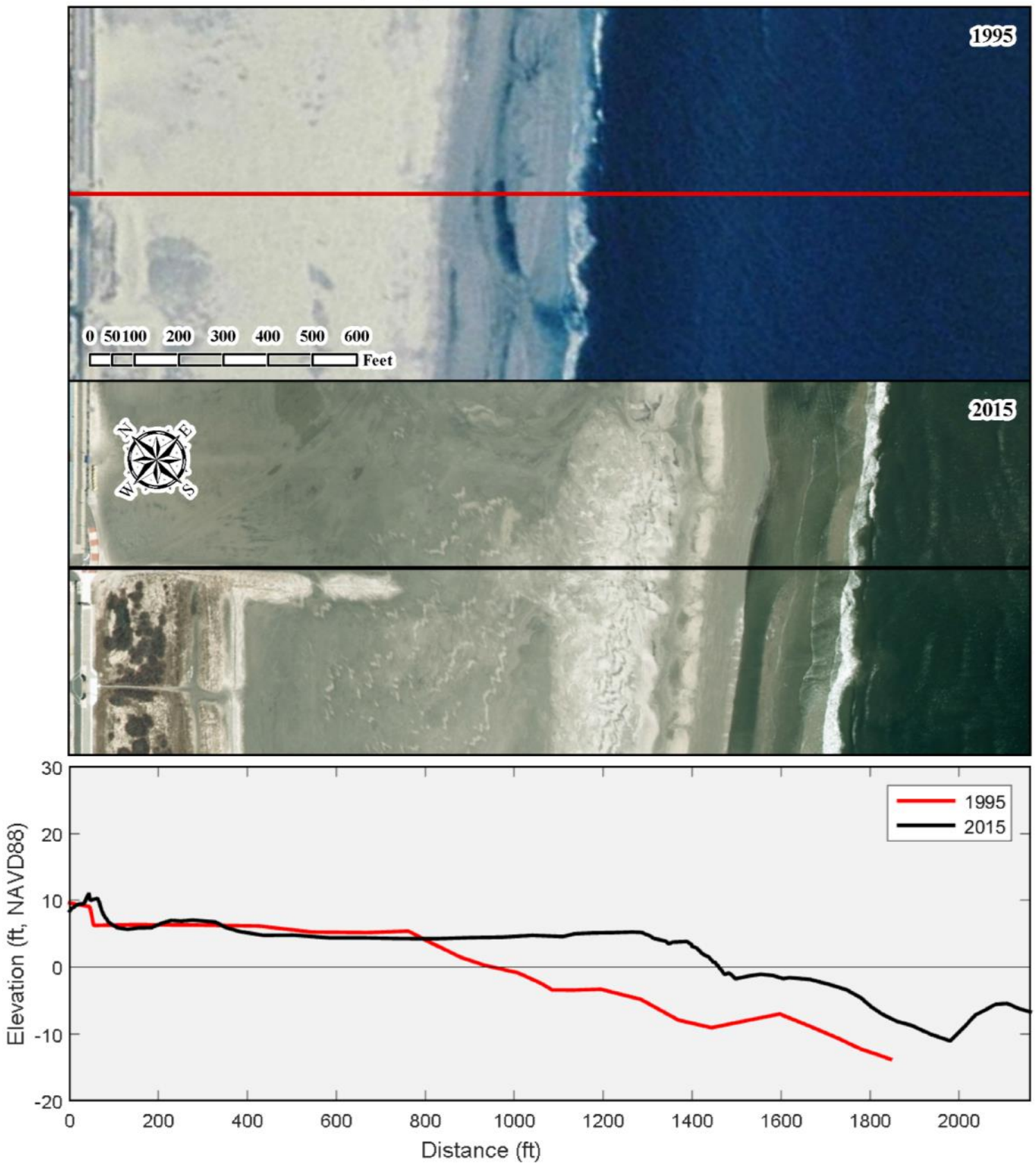


Figure 571. The vast amount of sand lost from site 111 seems to have appeared at this location, resulting in a 5502 ft increase in beach width since 1995. There has been no sediment added by human effort to the Wildwood shoreline, in fact almost 200,000 cubic yards have been recently trucked back to North Wildwood in order to assist with storm water drainage problems on the municipal beach.

NJBPN 109 – Raleigh Avenue, Lower Township (November 22, 2016)



Figure 572. As evident from this mid-beach view looking north from Raleigh Avenue in Lower Township, the wider beaches continue north through Wildwood Crest. This site is located adjacent to the beginning of the Two Mile Beach Unit Wildlife Refuge lands. This is the southern limit of the proposed USACE back passing project sand source.

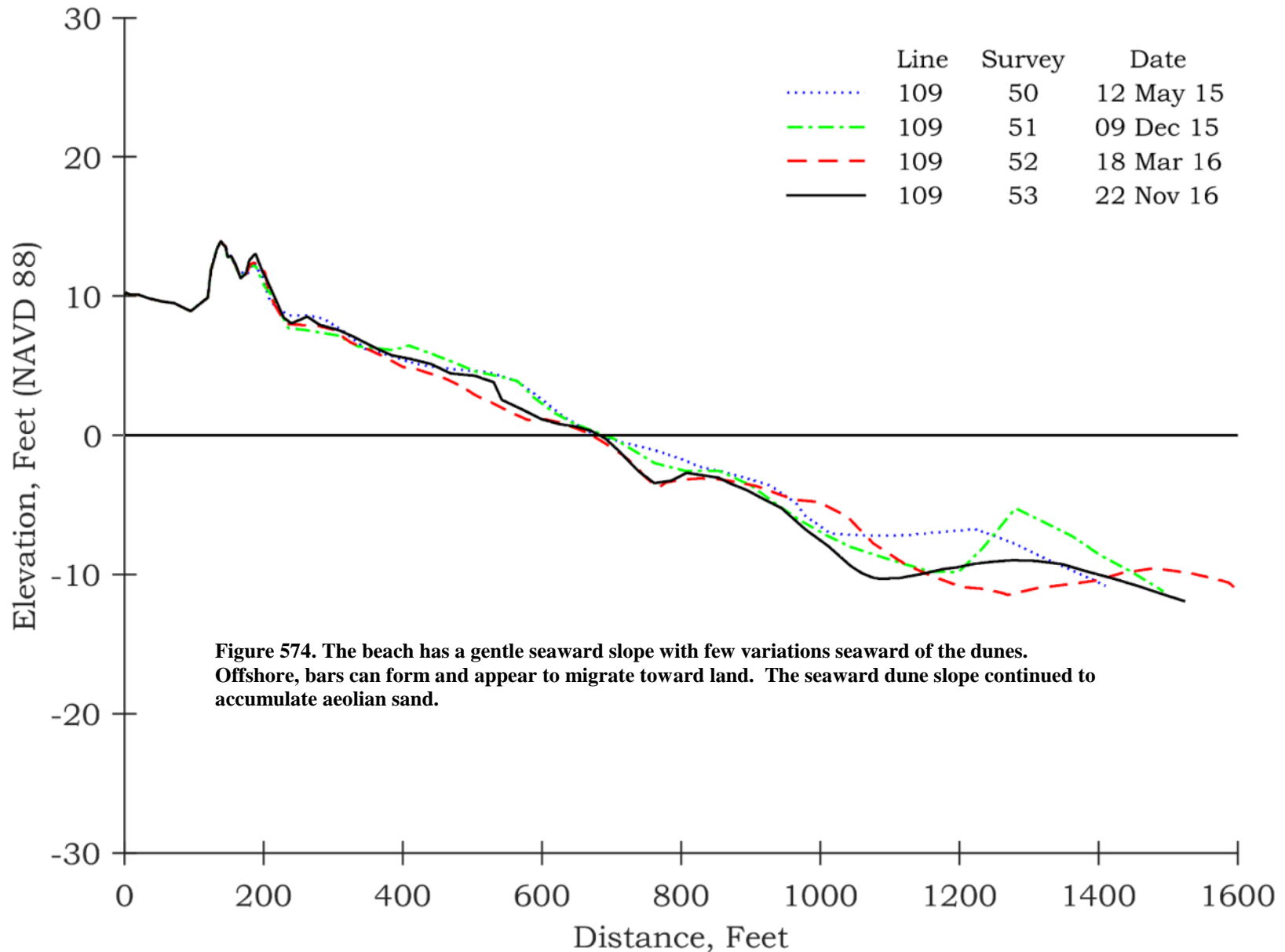
NJBPN 109 – Raleigh Avenue, Lower Township



Figure 573a & 573b. The left photo, taken on December 9, 2015, shows the central zone of the beach and gives a good view of the width. A similar view on November 22, 2016 shows little change, especially in terms of the large scale presented here.

New Jersey Beach Profile Network

#109 - Raleigh Ave., Lower Township, Cape May County



30-Year Coastal Changes at Site 109, Raleigh Ave., Lower Township, Cape May Co.

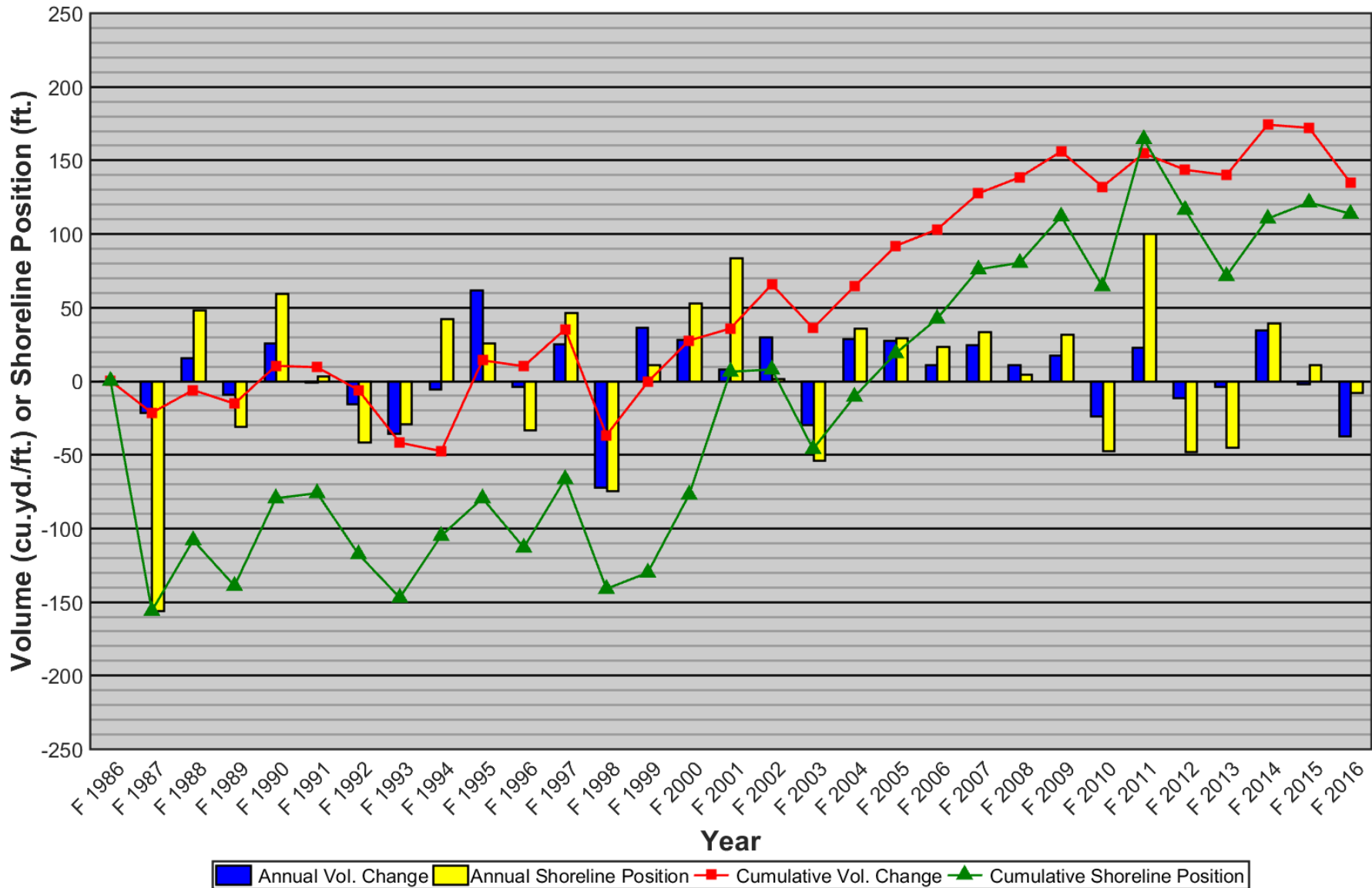


Figure 575. Raleigh Avenue showed a shoreline retreat of over 150 ft by 1989, but with minimal sand volume loss. The shoreline position remained negative and retreat values varied from 80 ft to 150 ft landward of the original position, with volume change oscillating above and below zero, for the majority of the 1990's. Shoreline and volume experienced positive gains from 1999 to 2002 and shoreline position retreated past the original position for the final time in 2003. From 2005 onward, both shoreline position and volume remained above the original values, with a final shoreline advance of about 115 ft and a final volume change of 135 yds³/ft.

30-Year Ensemble Mean Profile at Site 109, Raleigh Ave., Lower Township, Cape May Co.

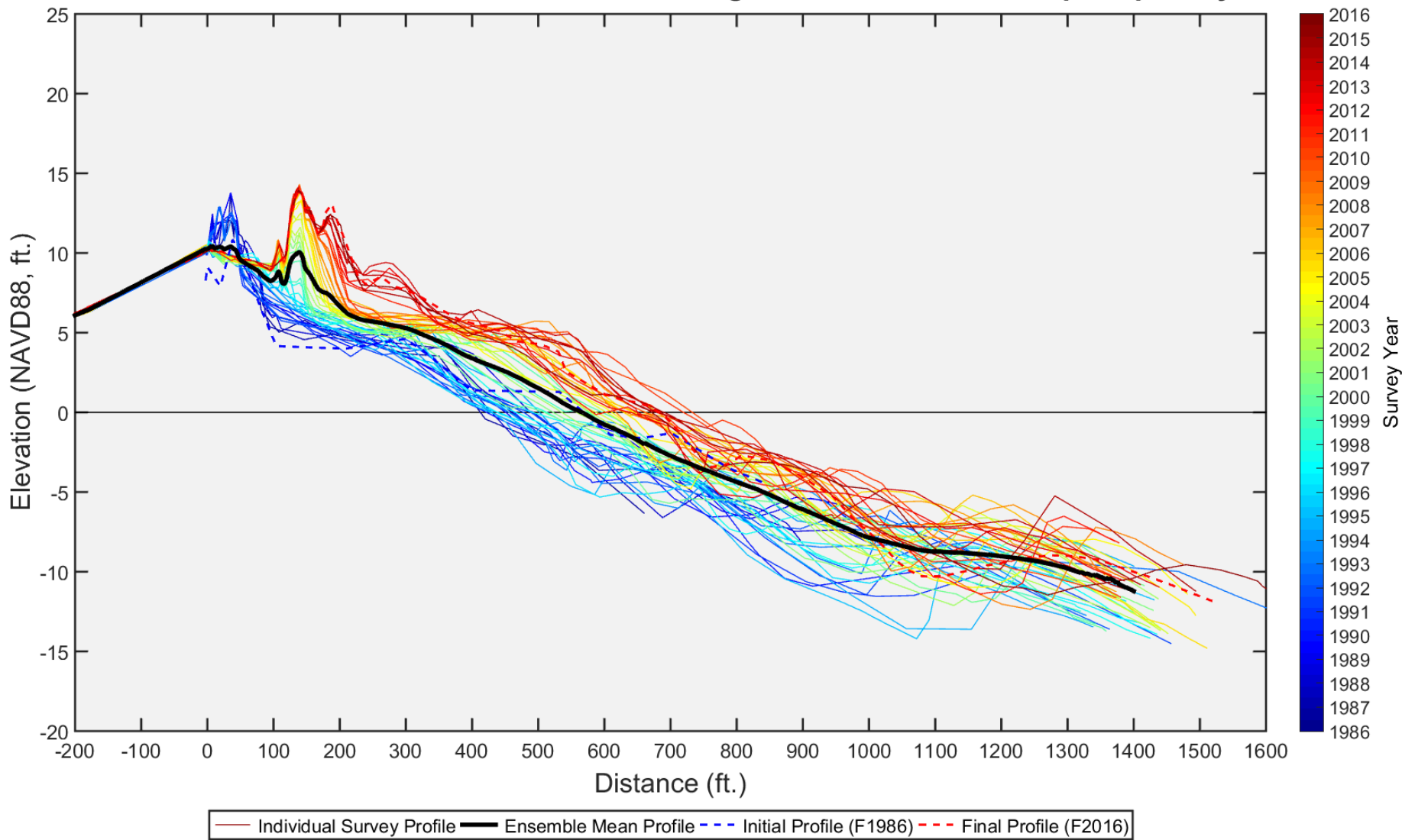


Figure 576. Dune growth is very apparent at this site and was accompanied by a significant seaward advance in the shoreline over time. This pattern is consistent with sediment captured by the Cold Springs Inlet jetties at the south end of the island.

#109 - Raleigh Avenue, Lower Township, Cape May County
Comparison of 1995 to 2015

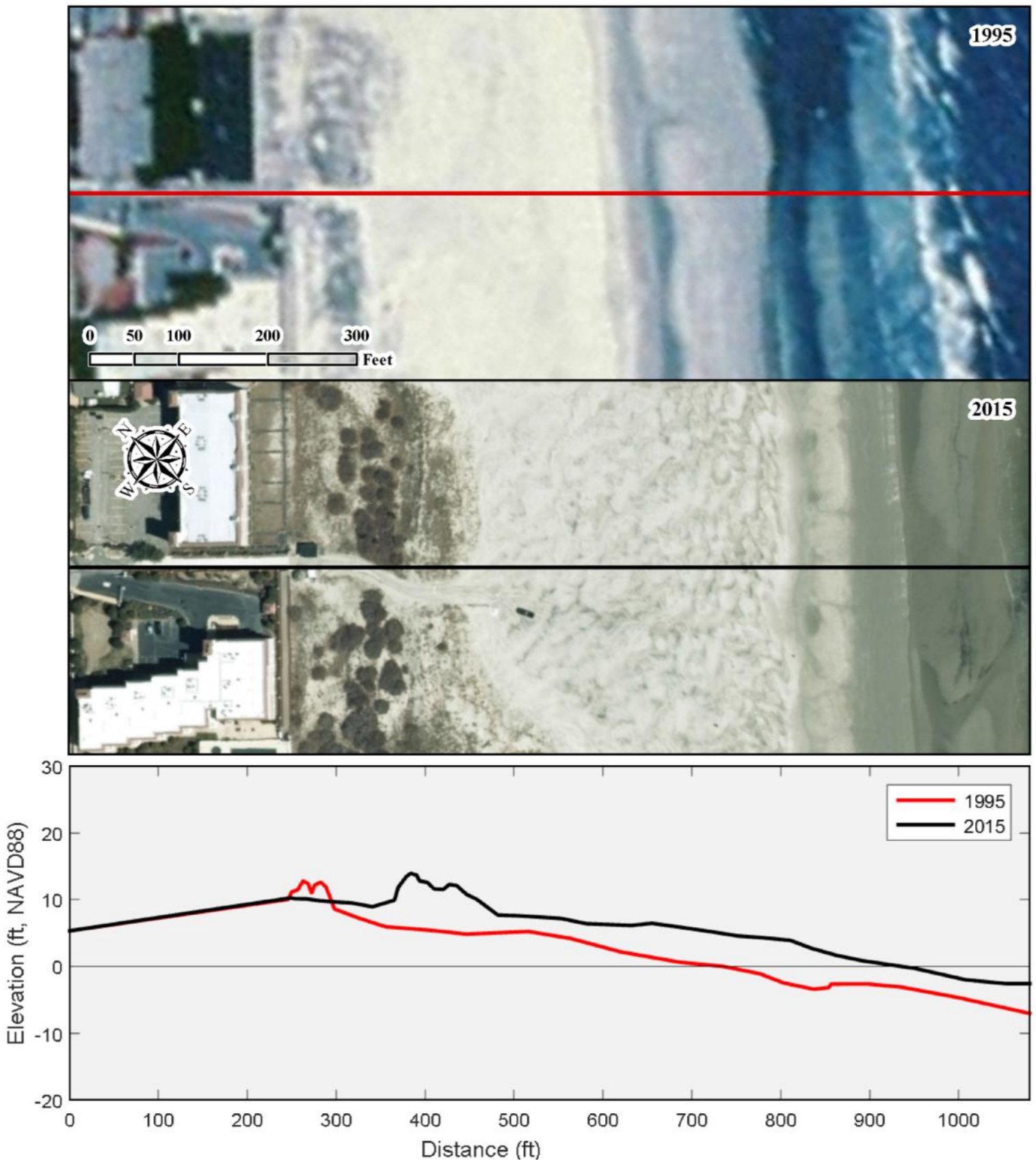


Figure 577. The southern directed transport of sand along the Wildwoods has benefitted this site as well. No human effort has been involved and the shoreline has advanced by almost 200 ft over the past 20 years.

NJBPN 208 – Cape May National Wildlife Refuge (NWR), Lower Township (November 23, 2016)



Figure 578. View is looking north along the wildlife refuge beach near the dune toe toward Lower Township. The beach width is retained by the Cold Springs Inlet jetty built in 1908 to 1911 for the US Navy site now used by the US Coast Guard.

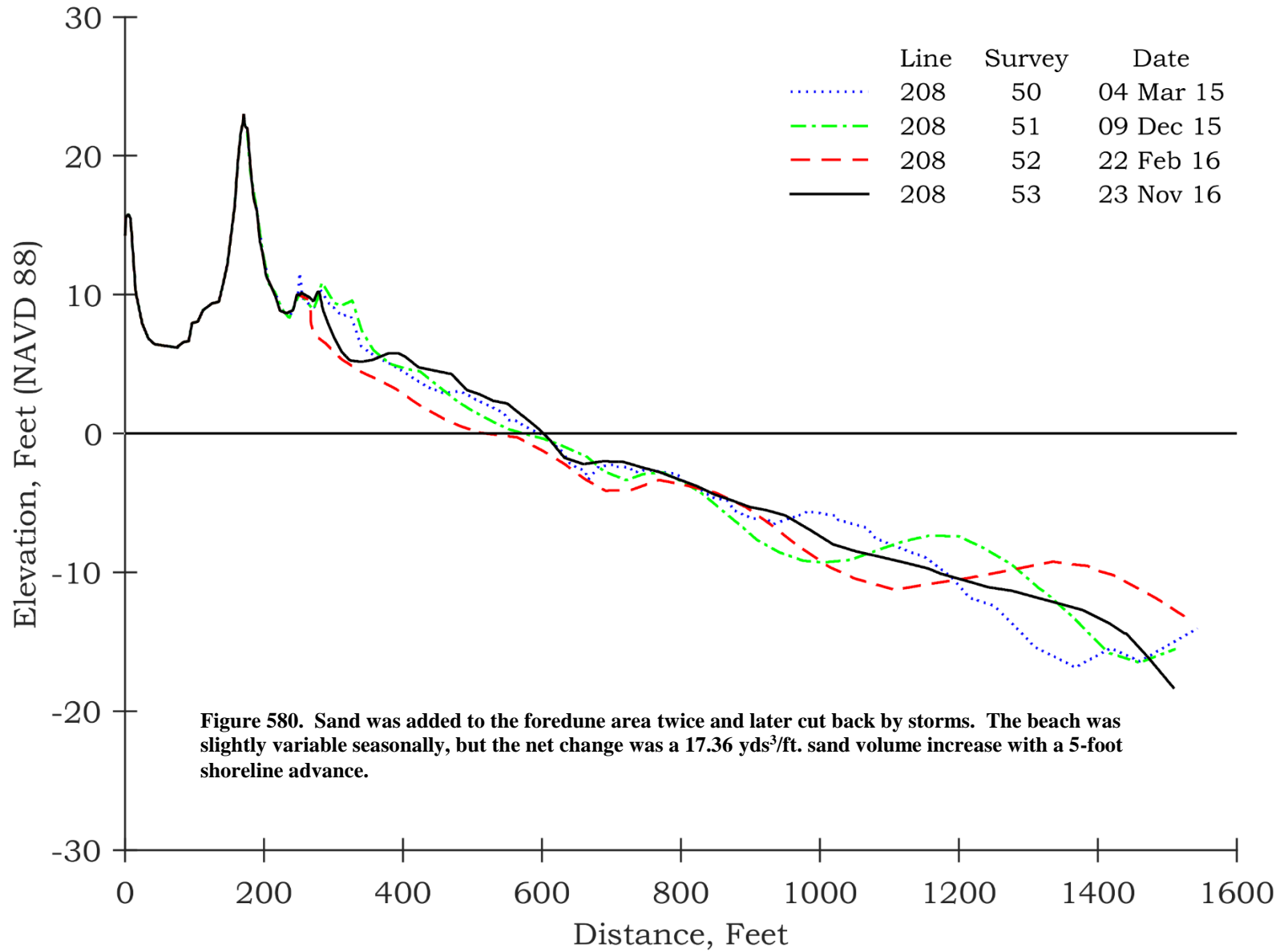
NJBPN 114 – Cape May NWR, Lower Township



Figure 579a & 579b. The left photo was taken December 9, 2015 and is a view across the dunes and gentle shoreward gradient developed on the wide beach. The right photo was taken on November 23, 2016 and shows continued sand accumulation.

New Jersey Beach Profile Network

#208 - Cape May NWR, Lower Township, Cape May County



22-Year Coastal Changes at Site 208, Cape May NWR, Lower Township, Cape May Co.

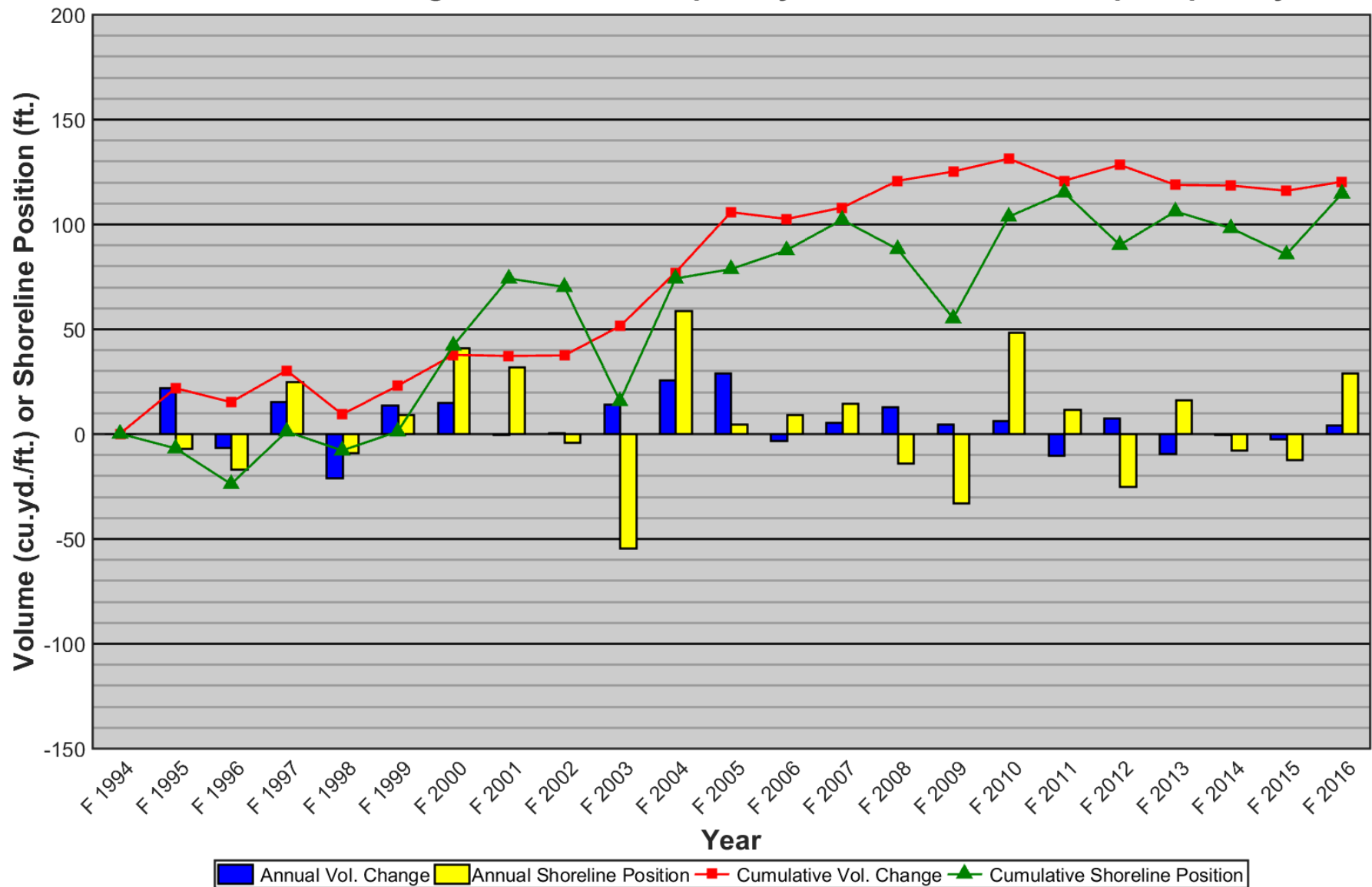


Figure 581. The Cold Springs Inlet stone jetties effectively impound sand on the north side producing the shoreline advance trend with major oscillations, but with a stable volume change remaining very close to 120 yds³/ft from 2008 to 2016, indicating an overall stable beach in terms of volume. Both shoreline position and volume change remained above the initial values since the year 2000, with the shoreline advancing by 115 ft and the volume increasing by 120 yds³/ft by 2016.

22-Year Ensemble Mean Profile at Site 208, Cape May NWR, Lower Township, Cape May Co.

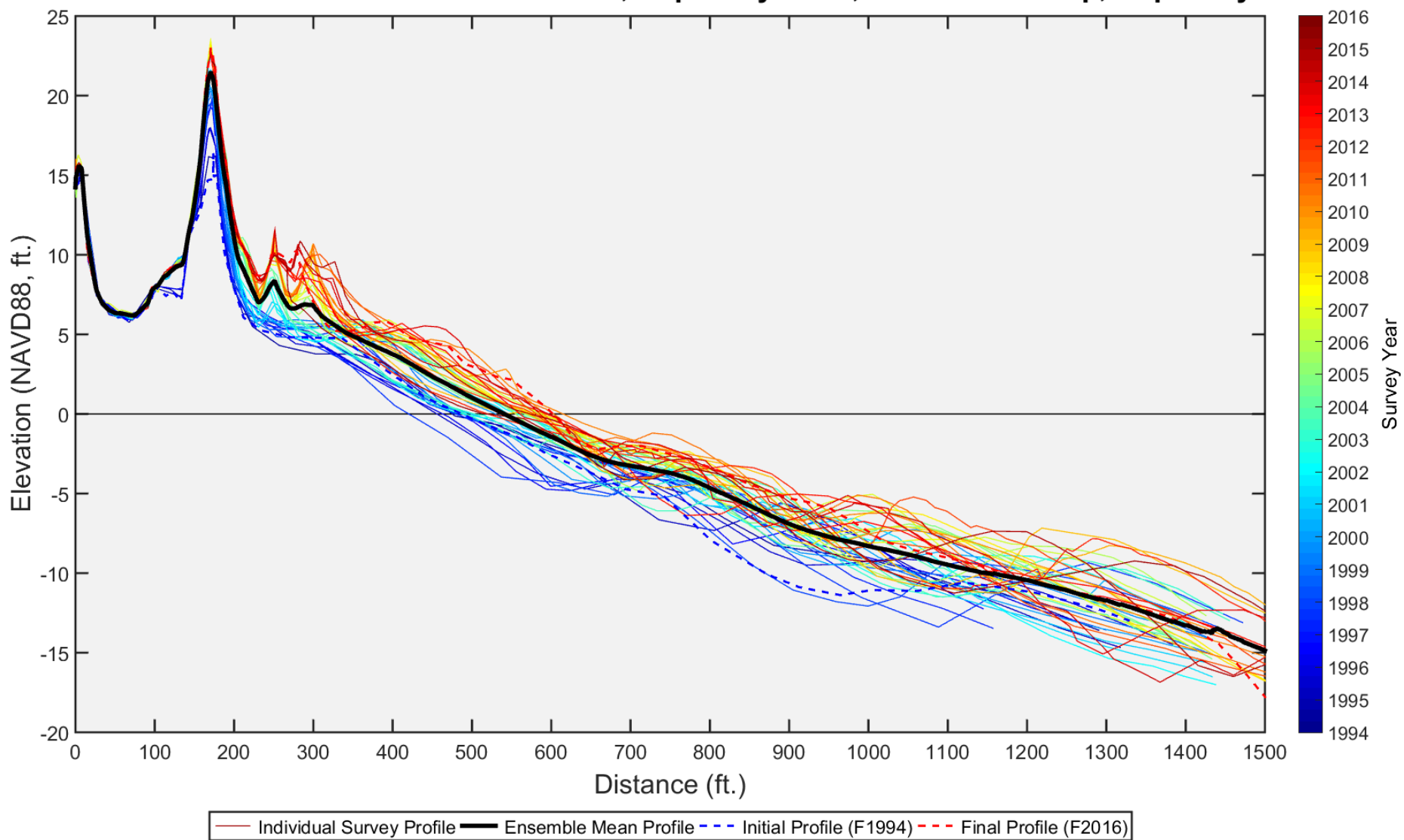


Figure 582. The Cape May Wildlife Refuge saw sand volume and shoreline gains with steady dune and beach growth over a 22 year interval. This is another site added in 1994 to be proximal to tidal inlets.

#208 - Cape May NWR, Lower Township, Cape May County
Comparison of 1995 to 2015

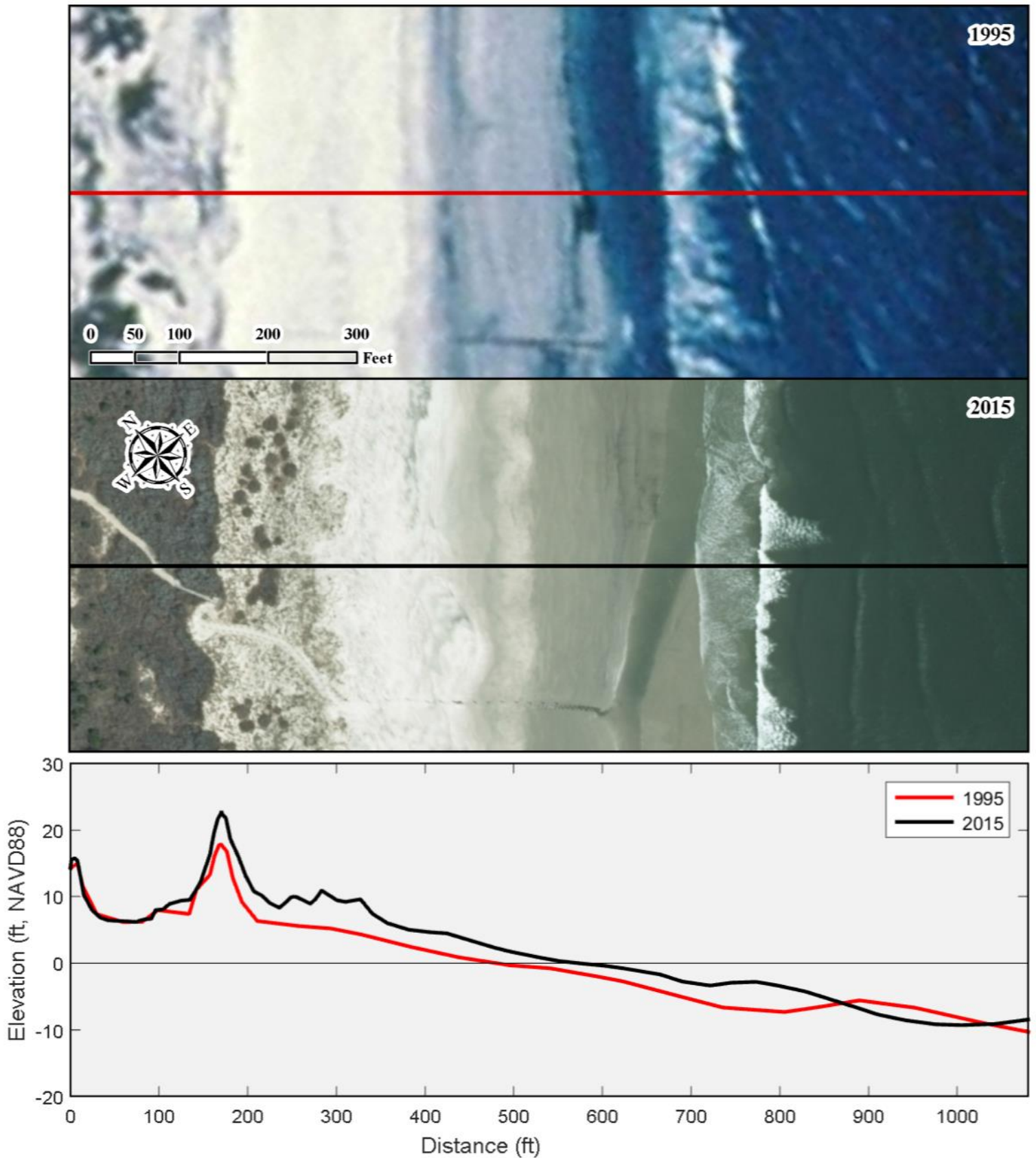


Figure 583. The Cold Springs Inlet jetty impounds sand as part of the process enhancing this islands southern shoreline. Here the dune has grown larger along with the beach getting wider and higher since this site was established in 1994.

NJBPN 108 – Cape May Beach Club, Cape May City (October 5, 2016)



Figure 584. The Cape May Beach Club property lies between the City of Cape May and the US Coast Guard beach to the south of the Cold Springs Inlet. This site has a steep beach slope with minimal dunes because the club wants direct, level access from the facility to the shoreline.

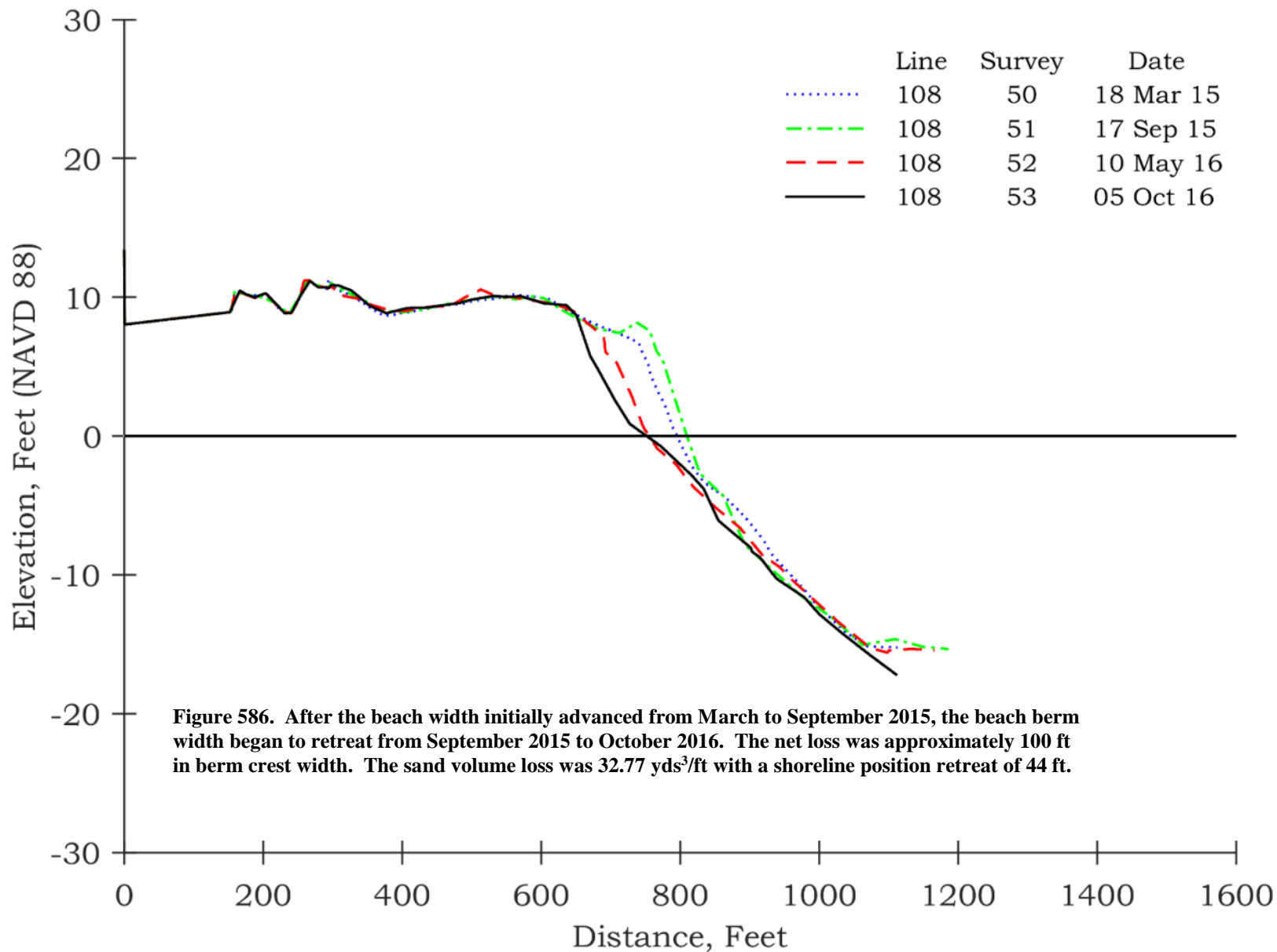
NJBPN 108 – Cape May Beach Club, Cape May City



Figure 585a & 585b. The left photo was taken September 17, 2015. The right photo was taken on October 5, 2016. The two photos show relative consistency in beach configuration and elevation with modest variation in width.

New Jersey Beach Profile Network

#108 - Cape May Beach Club, Cape May County



30-Year Coastal Changes at Site 108, Cape May Beach Club, Cape May Co.

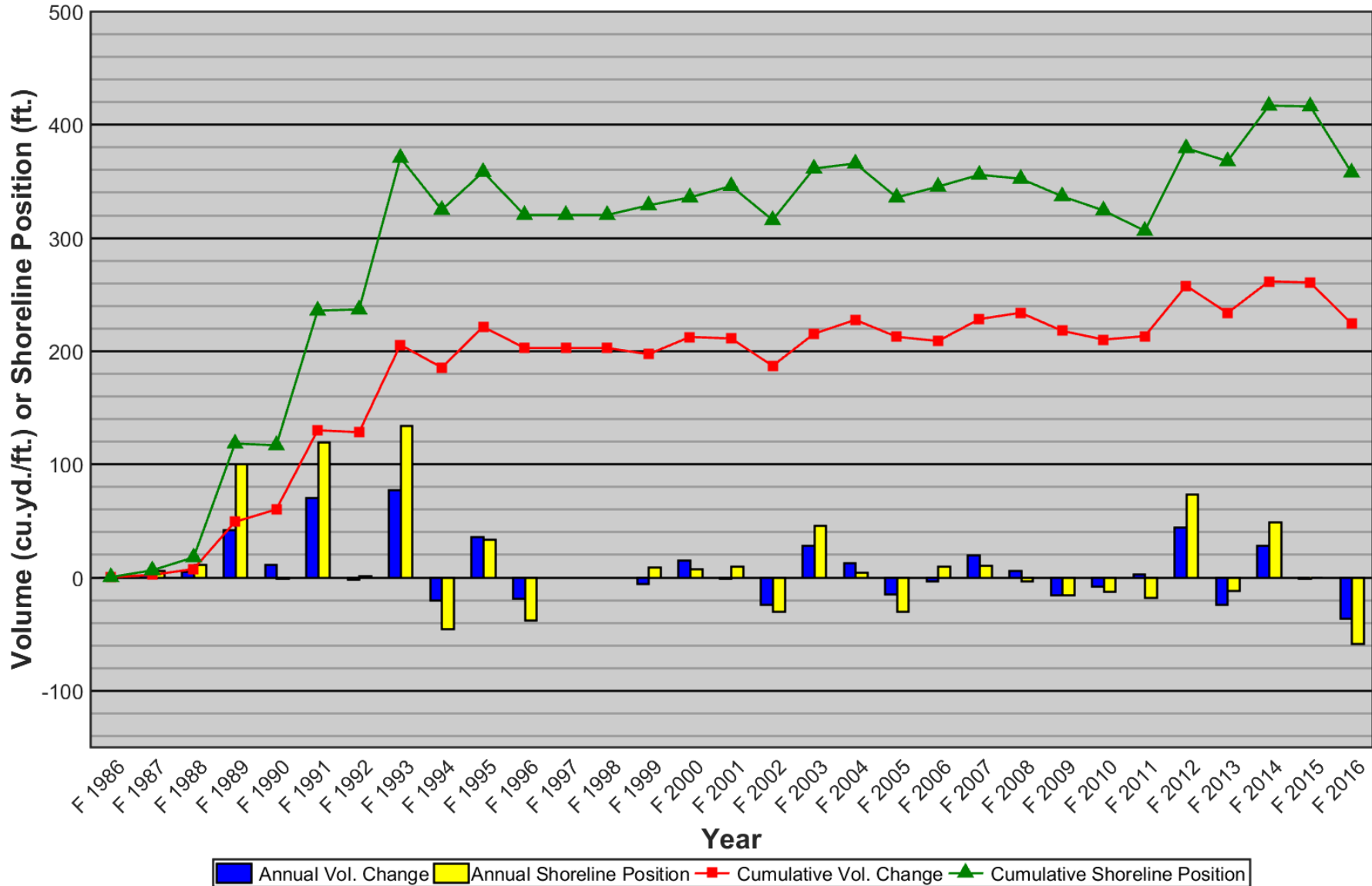


Figure 587. Cape May City was the first community along the NJ coastline to receive US Army Corps of Engineers sand nourishment in the modern era. Authorized by a 1986 Water Resources Act from Congress, this project utterly changed the beach access, water use ability, and economic outlook for this iconic tourism city. Both shoreline position and beach volume have maintained a consistent pattern from the early 1990's onward, assisted by seven maintenance efforts, not all of which actually placed sand directly at this site but all added to the regional sediment budget.

30-Year Ensemble Mean Profile at Site 108, Cape May Beach Club, Cape May Co.

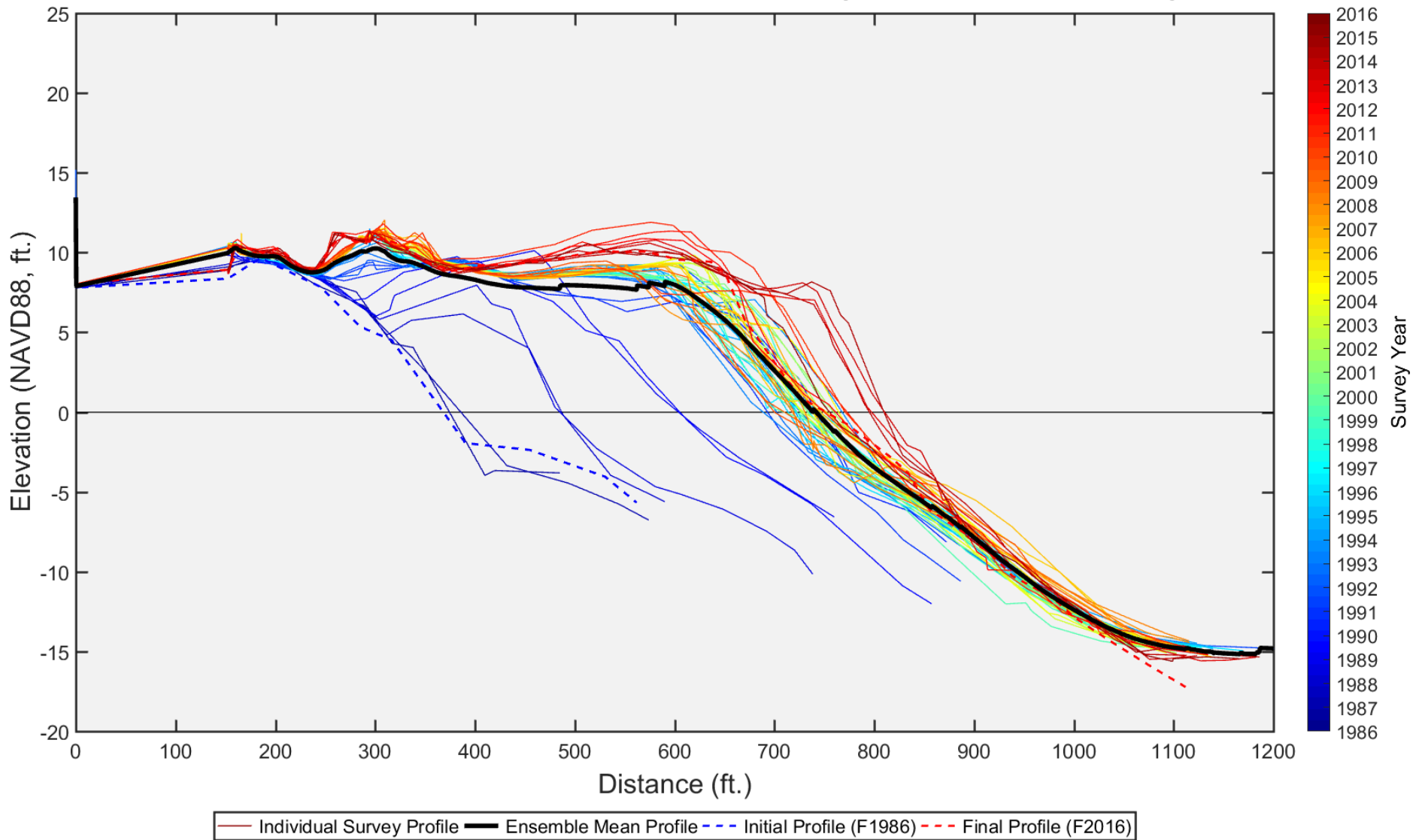


Figure 588. The enhancement is clearly observed in this figure, which shows progressive beach fills moving the beach berm and shoreline seaward while increasing the sand volume. Profiles from the early 1990's onward cluster around a shoreline position of 750 ft with a relatively small envelope of change over time. The more recent profiles show an increase in berm elevation from the mean profile, but very small variation from the mean in the offshore region.

#108 - Cape May Beach Club, Cape May, Cape May County
Comparison of 1986 to 2015

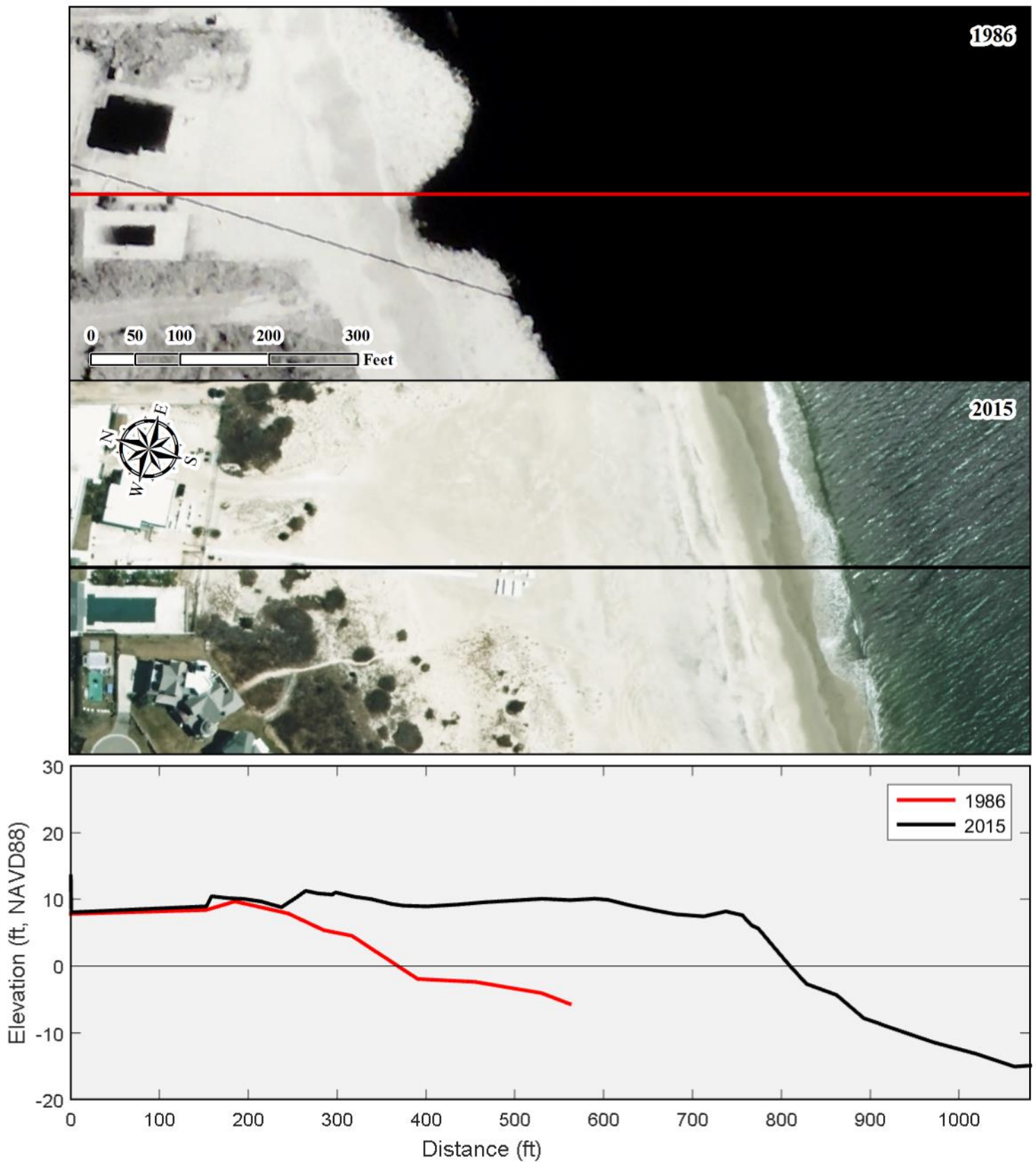


Figure 589. The 1986 aerial photo shows conditions at the northern extent of the Cape May City beaches three years prior to the initial beach restoration effort by the USACE. By 2015, a much wider beach existed, but without significant dune development on this private section of beach. This site experienced a shoreline advance of almost 400 ft from 1986 to 2015.



Figure 590. At Baltimore Avenue, the earliest of surveys went into the water at the base of the rocks, now located far to the left of the grass and adjacent to the road in the picture above. Sand nourishment projects have restored an excellent beach that provides abundant recreational space for beach patrons. The wide beach and dune system has also enhanced shore protection for oceanfront development and infrastructure.

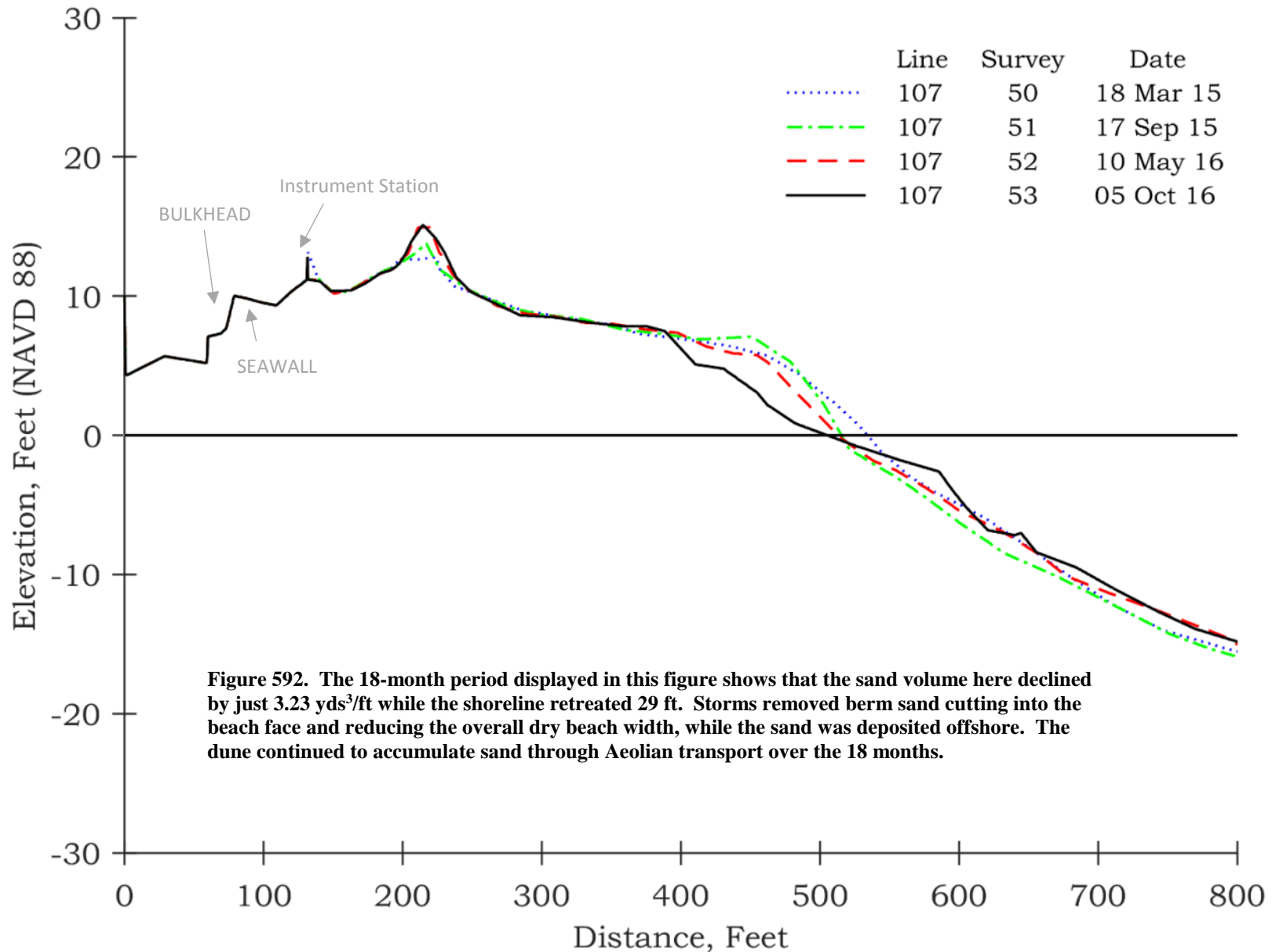
NJBPN 107 – Baltimore Avenue, Cape May City



Figure 591a & 591b. The left photo was taken on September 17, 2015. The right photograph was taken October 5, 2016 with substantial surf scouring the beach face. Prior to 1989, the spot the photographer was standing at would have been 300 ft from the shoreline in about 15 ft of water.

New Jersey Beach Profile Network

#107 - Baltimore Ave., Cape May, Cape May County



30-Year Coastal Changes at Site 107, Baltimore Ave., Cape May, Cape May Co.

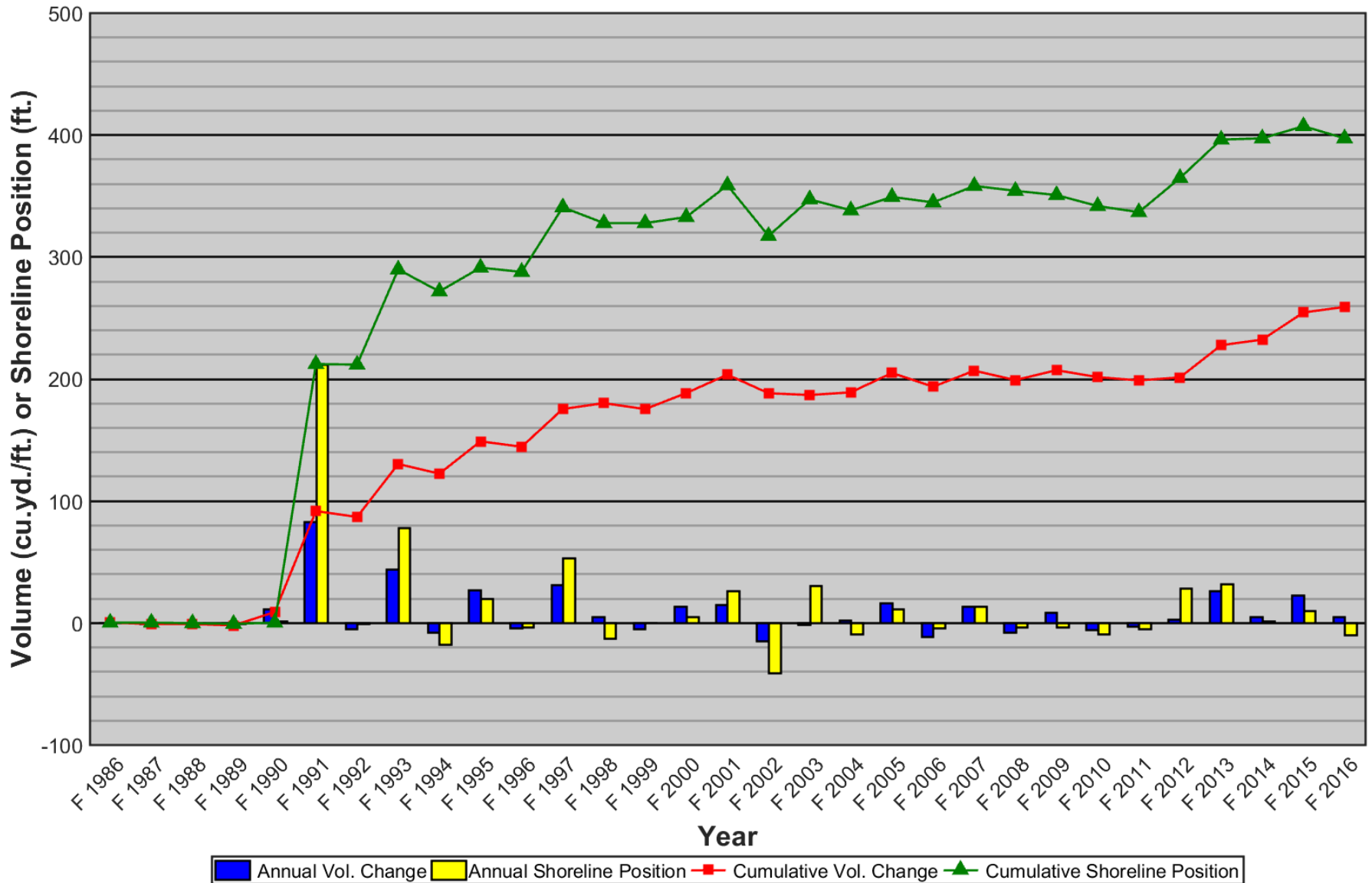


Figure 593. The Baltimore Avenue site had no sand beach seaward of the rock revetment in the first years that measurements were taken, with the revetment acting as the only shore protection for the city at this location. Initial sand placement occurred in 1990, with construction completed in 1991. Subsequent maintenance and the mid-project location of this profile has resulted in relative stability with increasing sand volume (+260 yds³/ft) and shoreline position advance (+400 ft) over the years.

30-Year Ensemble Mean Profile at Site 107, Baltimore Ave., Cape May, Cape May Co.

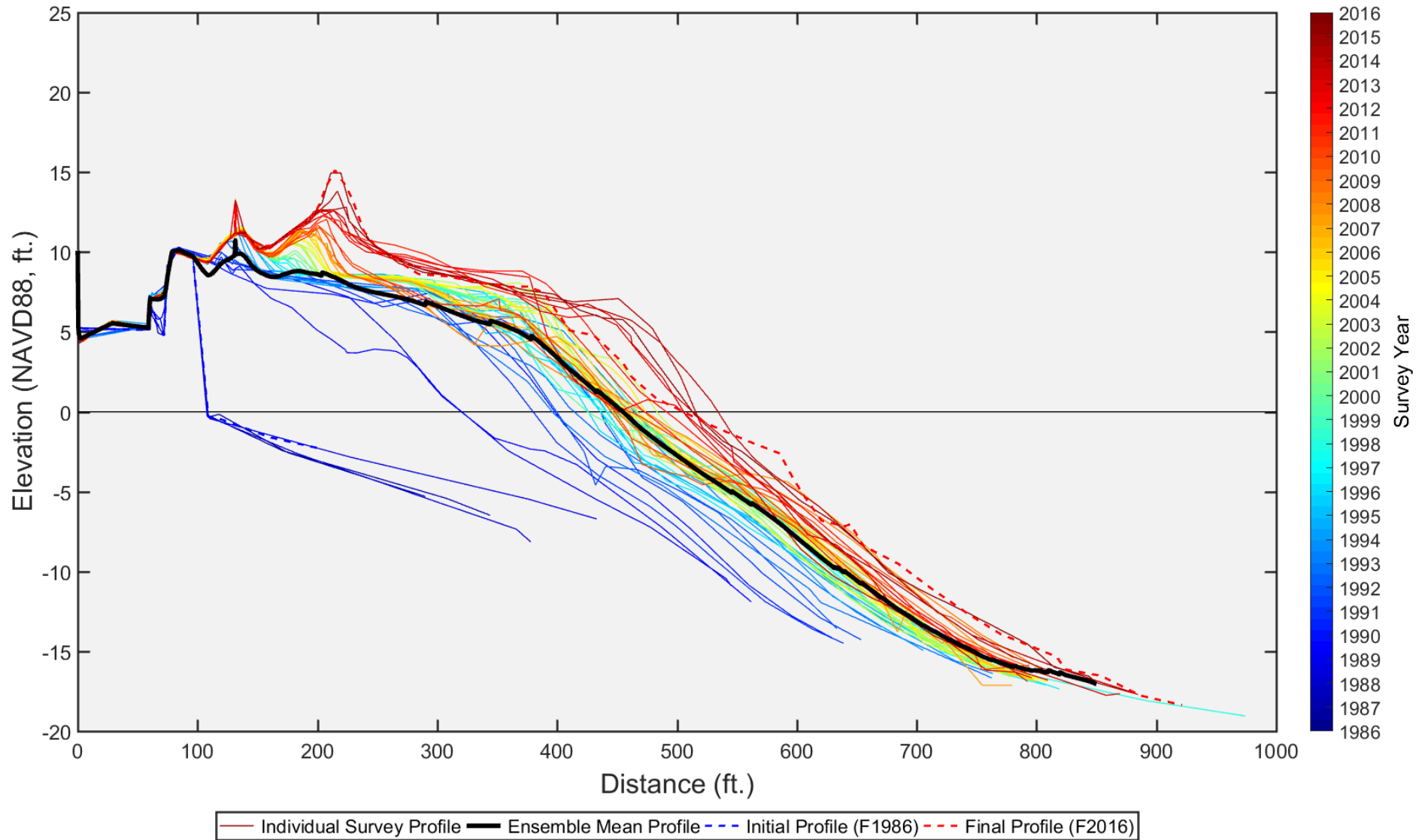


Figure 594. The initial survey involved sliding off the algae covered rocks between breaking waves into the water and trusting there was a sand bottom there somewhere. Three surveys later, the federal beach was in place and advances continued, along with dune development, up to conditions present as of 2016. The economic benefits of this new beach for Cape May City was unsurpassed for all of the variety of tourist destination enterprises in operation within city limits.

#107 - Baltimore Avenue, Cape May, Cape May County
Comparison of 1986 to 2015

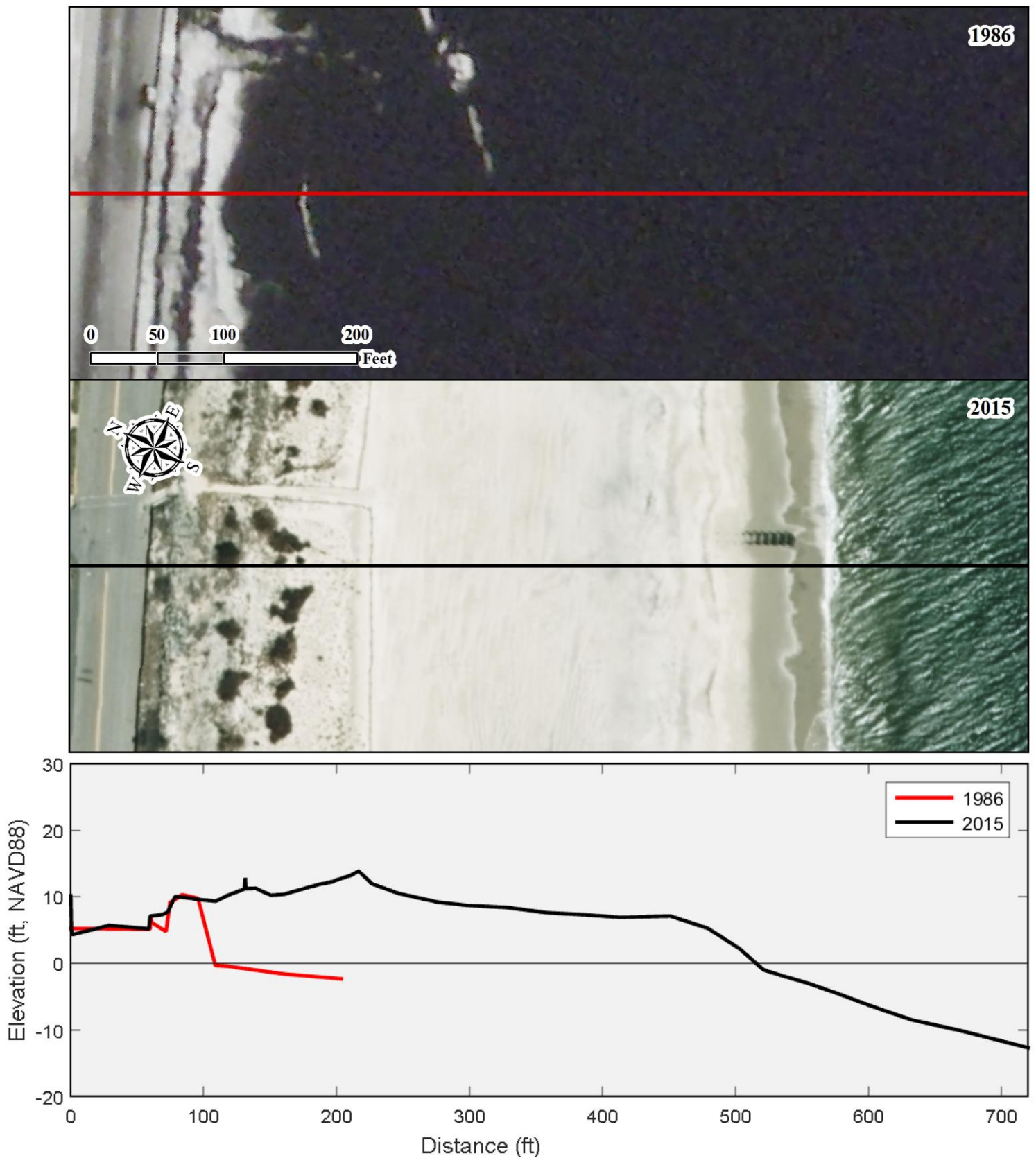


Figure 595. Sand was initially placed at this site in 1990, with more added in 1993. The beach has remained very stable with periodic nourishment up drift of this site but with little additional direct sand placement. The 1986 profile went into the water directly at the rock revetment and the new shoreline in 2015 was almost 400 ft farther seaward

NJBPN 106 – Broadway Avenue, Cape May City (October 4, 2016)



Figure 596. Broadway beach in Cape May City is one of the busiest recreational areas in the municipality. This beach lies at the southern extent of sand nourishment with a terminal groin holding the majority of fill from leaving into the Nature Conservancy to the south. Prevailing currents and waves also transfer sand around the groin, enhancing the shoreline south into Cape May Point.

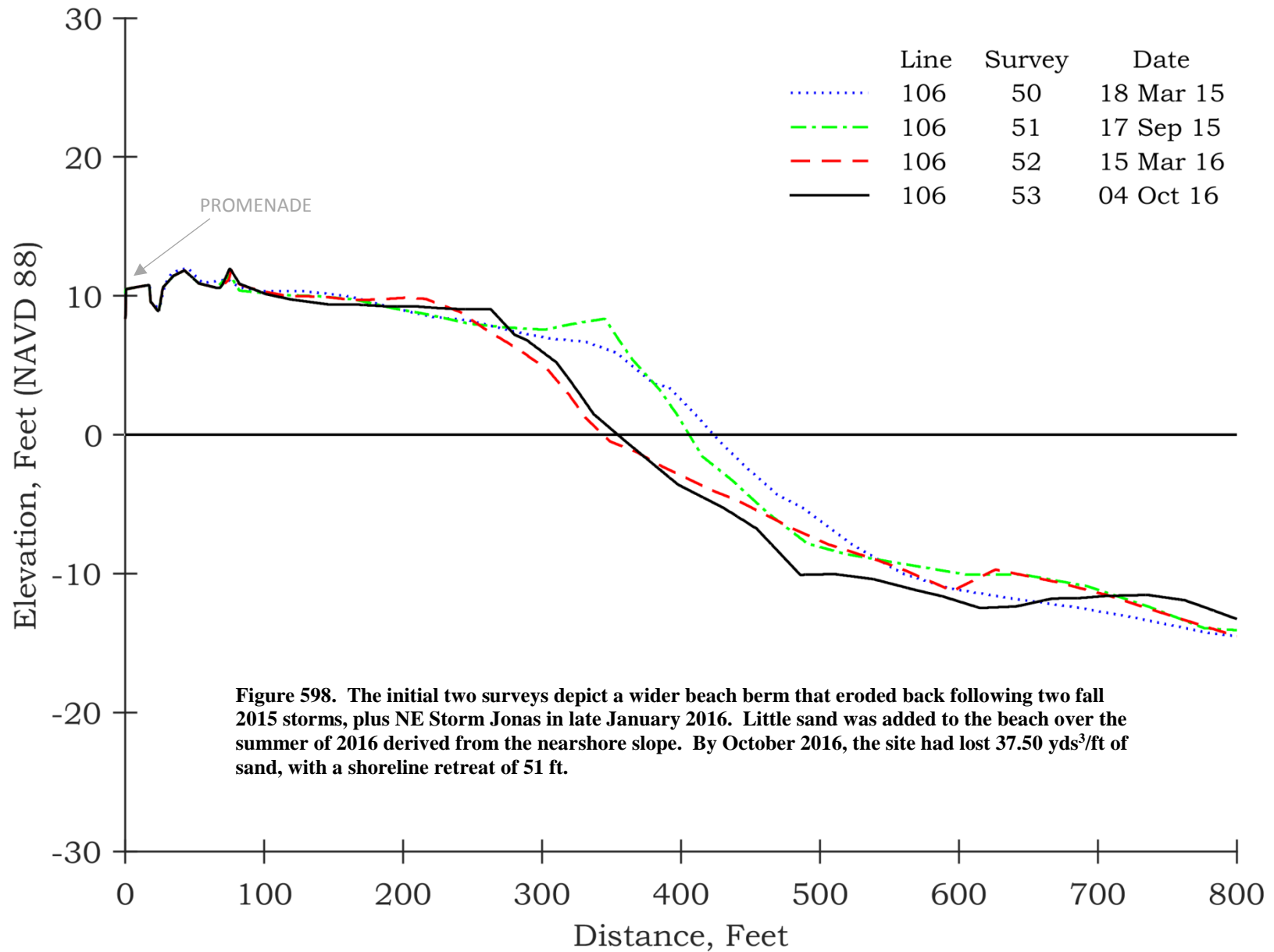
NJBPN 106 – Broadway Avenue, Cape May City



Figure 597a & 597b. The left photo was taken on September 17, 2015. The right photo was taken on October 4, 2016 and shows a stable beach relative to the rock groin in the distance.

New Jersey Beach Profile Network

#106 - Broadway Ave., Cape May, Cape May County



30-Year Coastal Changes at Site 106, Broadway Ave., Cape May, Cape May Co.

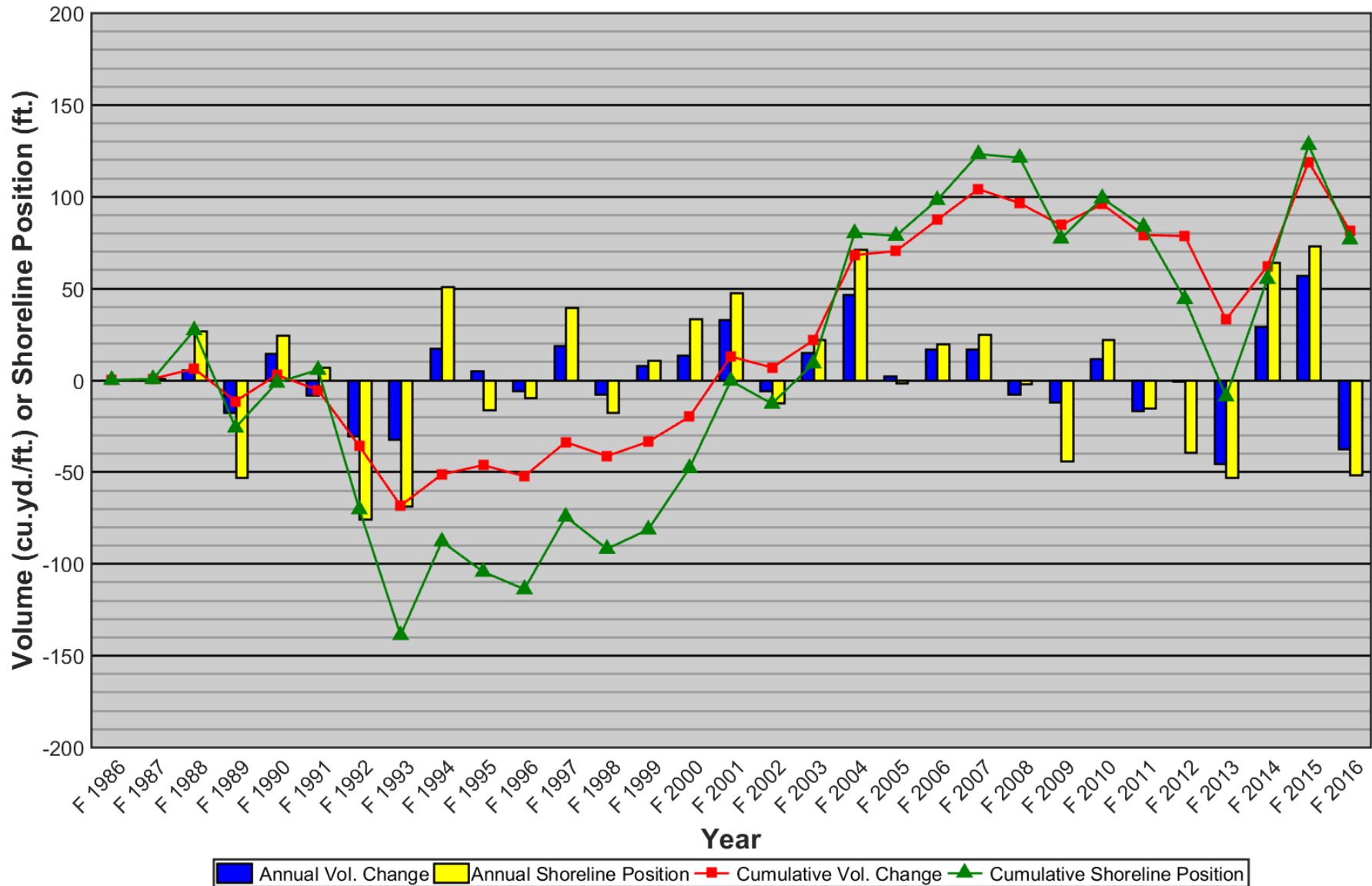


Figure 599. Broadway is located at the southern end of the Cape May City project with a terminal groin to the southwest. Sand placement occurred here, but sediment transfer across the groin or around it seemed to produce both shoreline retreat and sand volume losses until 2002. There have been seven maintenance efforts over the years since 1989, placing additional sand into the system, most recently in 2014. The site experienced severe losses in shoreline and volume in 2013, with the shoreline retreating behind the initial shoreline position for the first time since 2003. Final shoreline position was about 80 ft seaward of the intimal and the final volume change was about 80 yds³/ft greater than the initial.

30-Year Ensemble Mean Profile at Site 106, Broadway Ave., Cape May, Cape May Co.

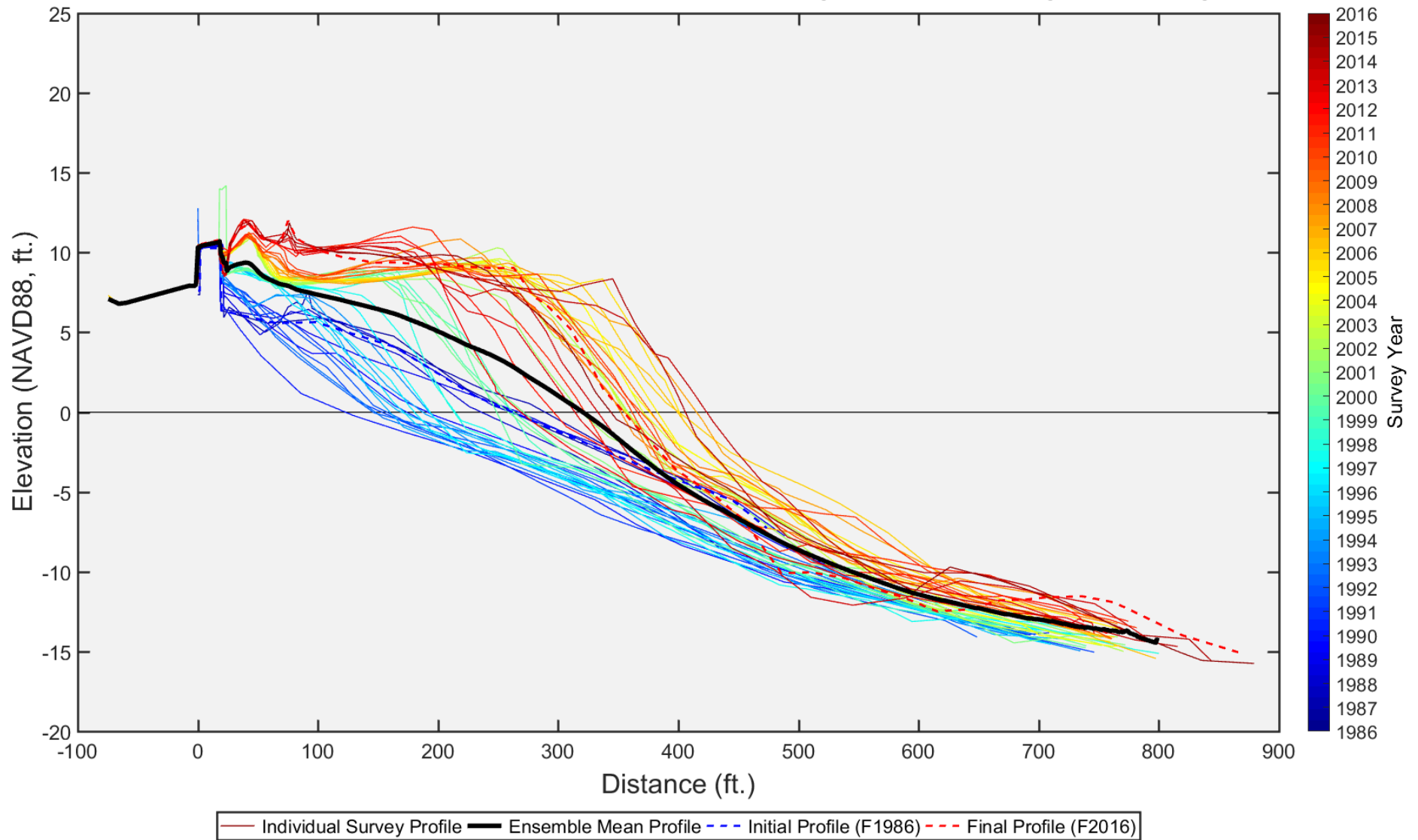


Figure 600. The initial data, from 1986 to the late 1990's, shows an erosional beach and shoreline with the majority of profiles residing landward of the initial profile (dashed blue line). Beach fills in the early 2000's raised the elevation of the dry beach and berm, developed a dune system that has grown over time, and greatly shifted the shoreline seaward. The beach and shoreline have remained at the seaward location since the early 2000's except for a major loss in 2013 where the shoreline retreated back to the initial shoreline from 1986 (dashed blue line). The mean profile appears to fall in between and divide the two envelopes of change before and after the early 2000's.

#106 - Broadway Avenue, Cape May, Cape May County
Comparison of 1986 to 2015

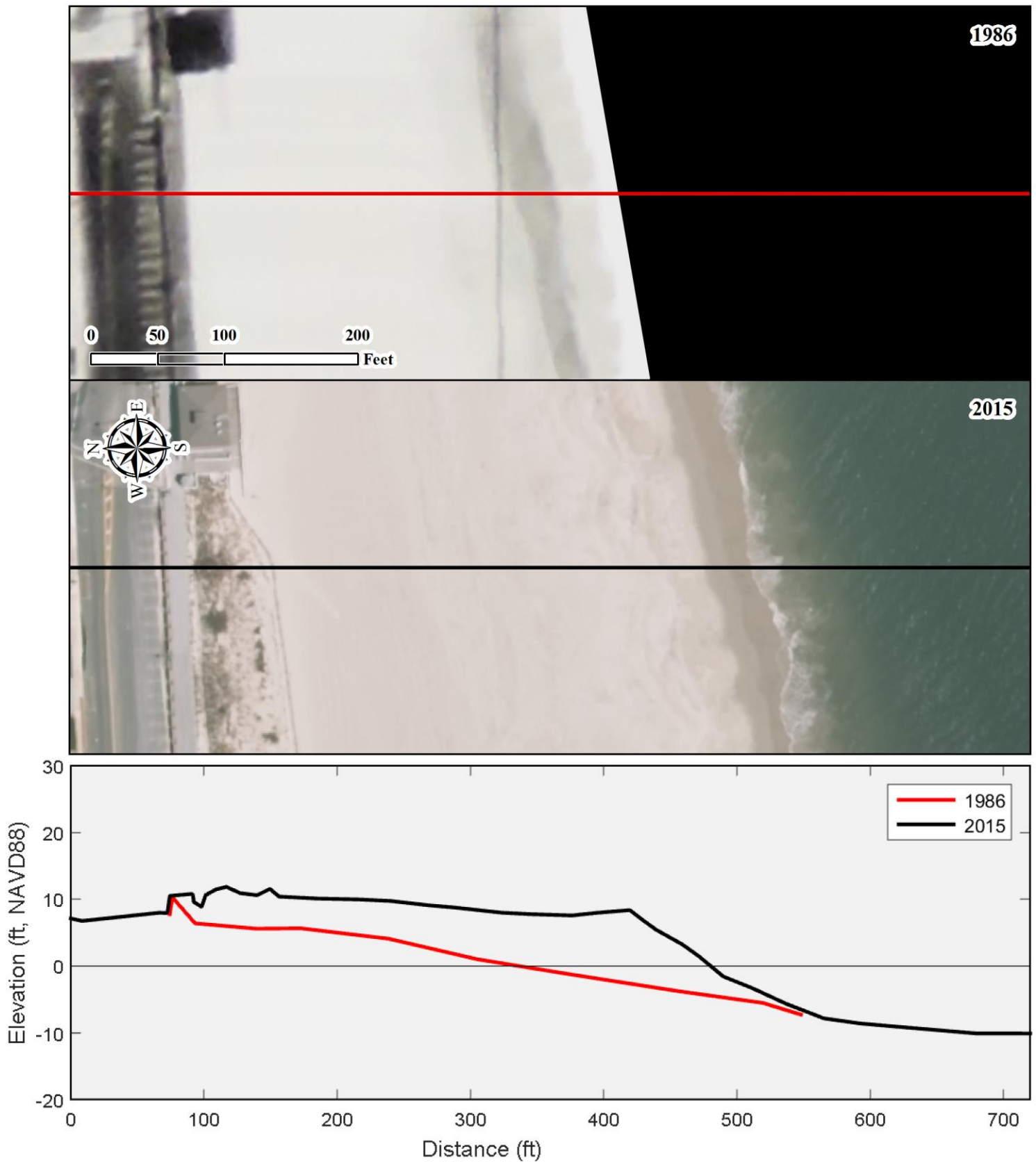


Figure 601. Beach nourishment has enhanced this site dramatically in terms of overall beach sand volume, elevation, width of the recreational berm, and shoreline advance.

NJBPN 105 – Nature Conservancy, Cape May (October 4, 2016)



Figure 602. The berm with a small scarp cut at the level of the high tide shows a curved beach leading back to the Cape May City terminal groin. The dune at the far left was once the shoreline in 1986 and all of the added width shown here is due to natural sand transfer from the Cape May project around the terminal groin.

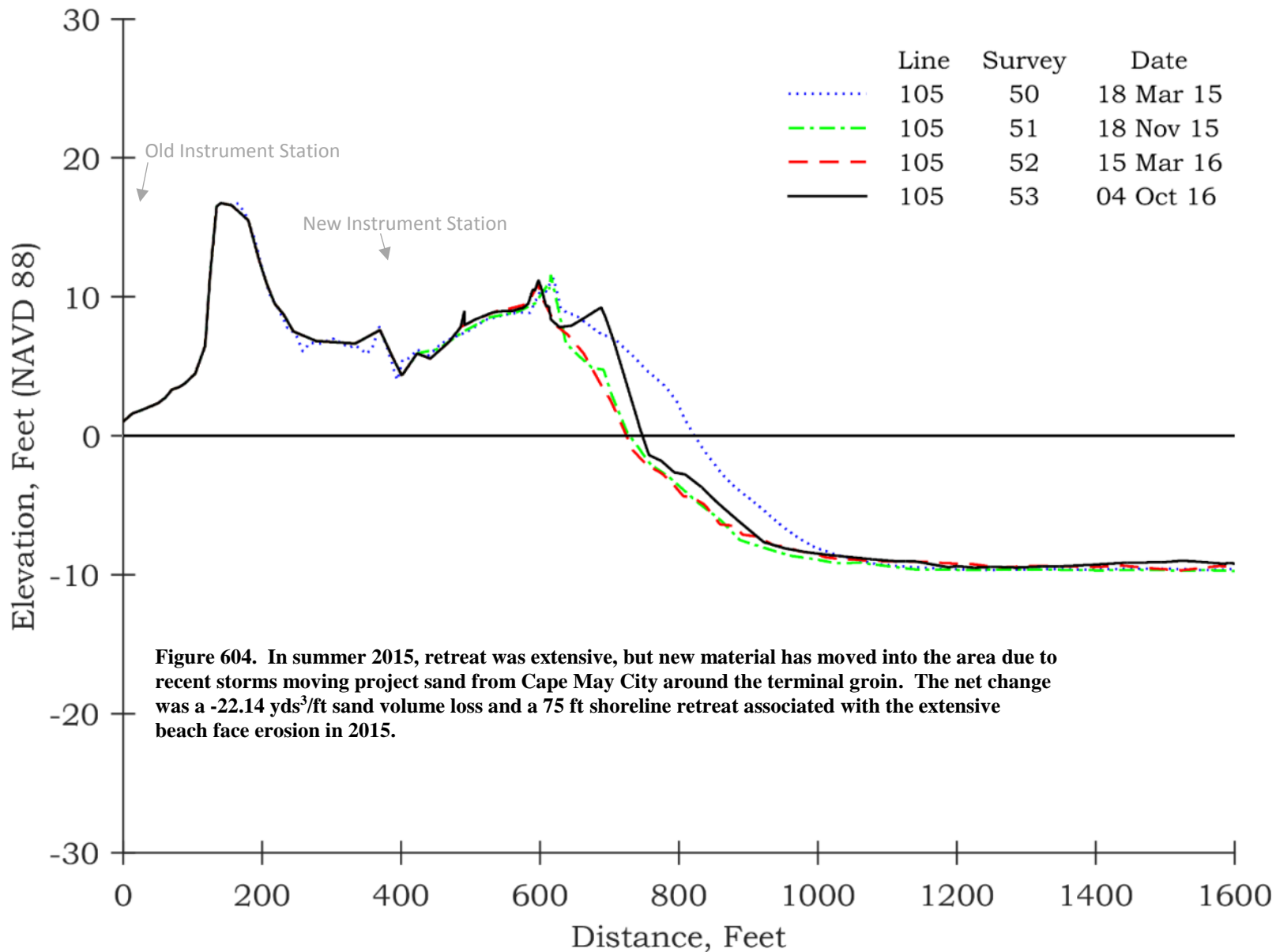
NJBPN 105 – Nature Conservancy, Cape May



Figure 603a & 603b. The left photo was taken November 18, 2015. The right photo was taken on October 4, 2016 and shows a steeper beach face and the deposition of new sand at the base of the groin bordering the development in the distance.

New Jersey Beach Profile Network

#105 - Nature Conservancy, Cape May, Cape May County



30-Year Coastal Changes at Site 105, Nature Conservancy, Cape May, Cape May Co.

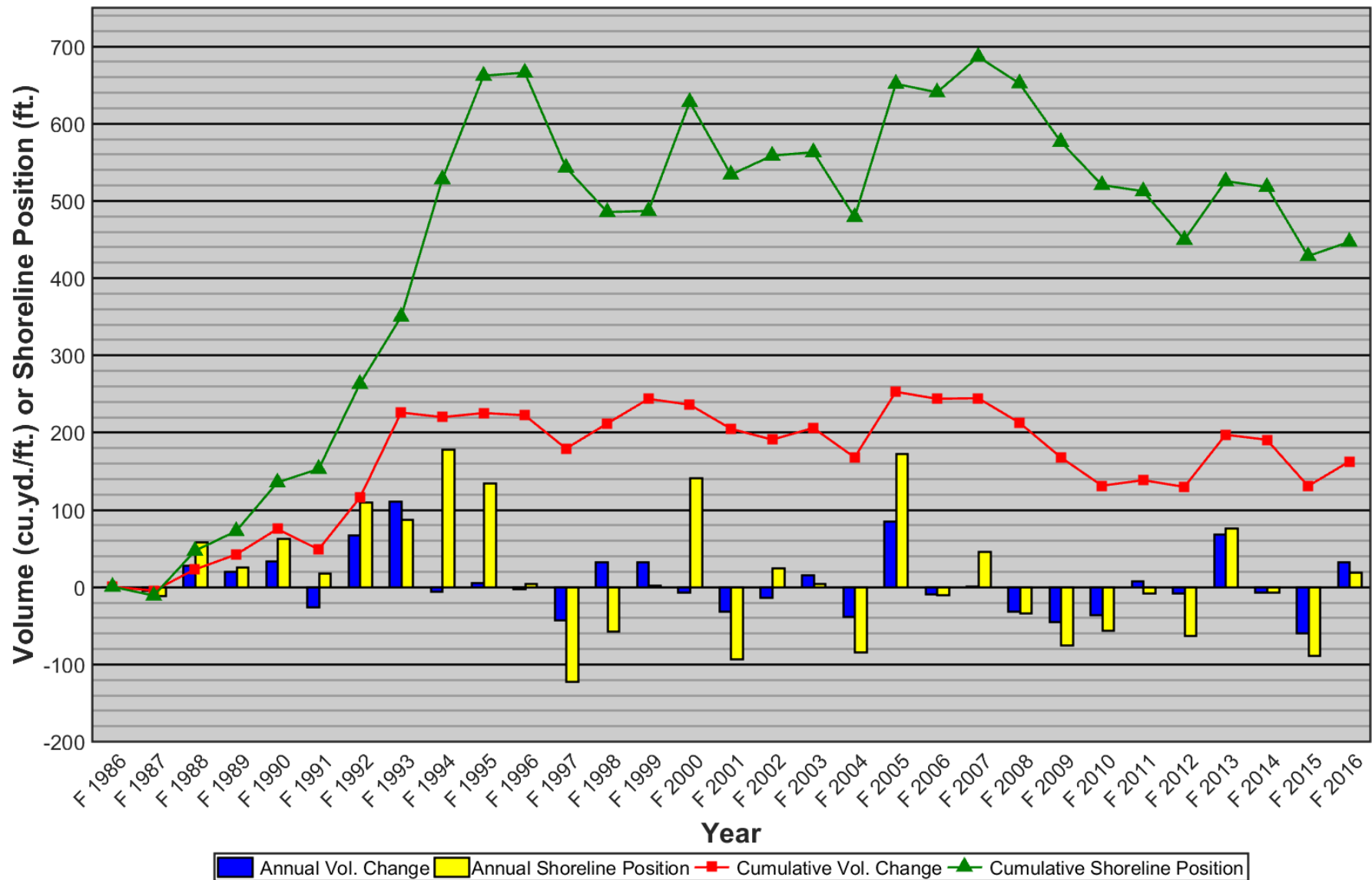


Figure 605. Site 105 is south of the Cape May City terminal groin in a natural area, formerly known as “South Cape May” in the early 20th Century. Sand immediately flooded into the location following the 1989 federal project introduction of sediment onto Cape May City beaches. The shoreline experienced a very large seaward shoreline advance of 660 feet in only 8 years. Over the past 25 years, there have been five seasonal episodes with rapid advances in shoreline positions from 110 ft to 180 ft. Recently the trend has moved towards modest retreat.

30-Year Ensemble Mean Profile at Site 105, Nature Conservancy, Cape May, Cape May Co.

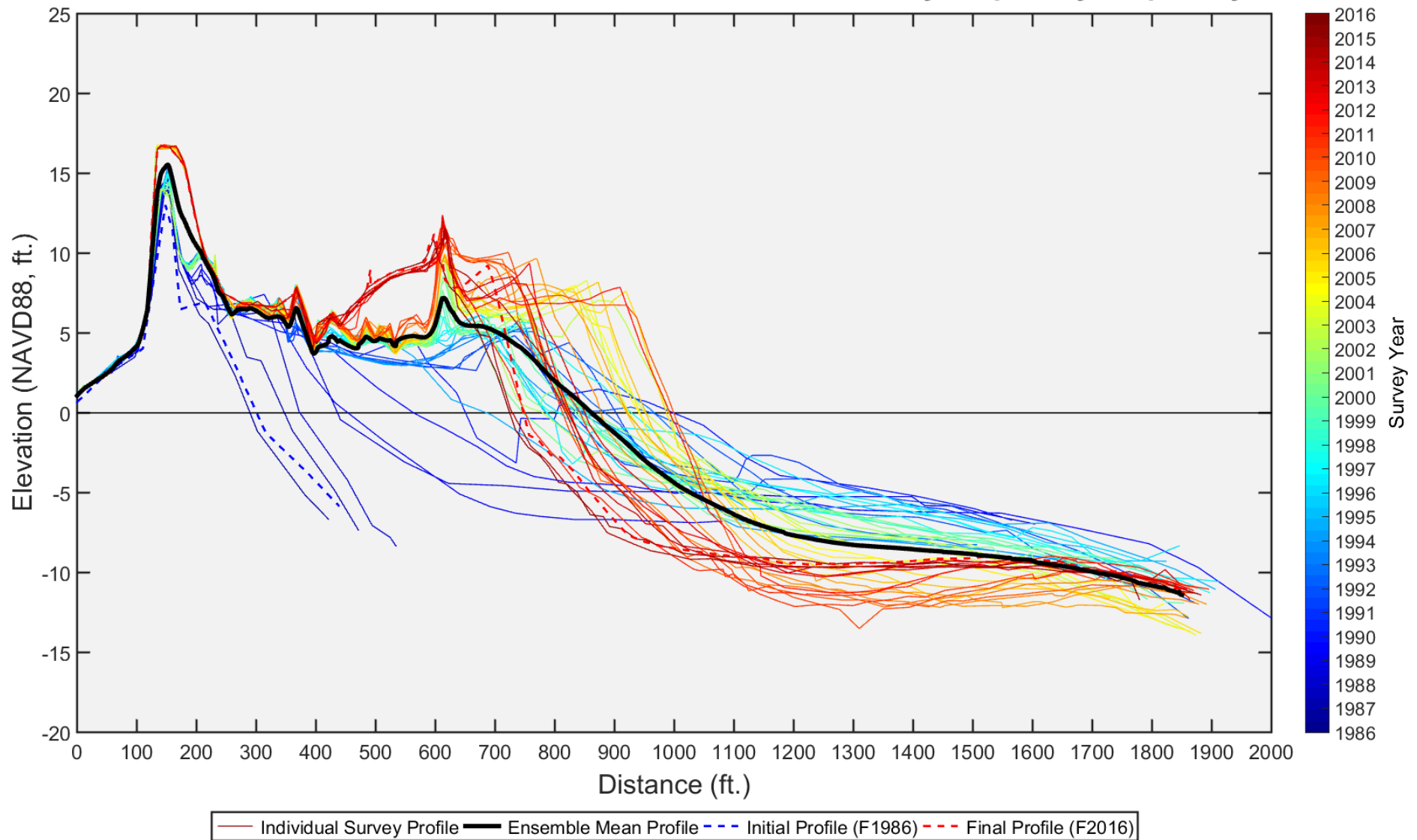


Figure 606. The commencement of beach restoration in 1989 provided a periodic supply of sand leaving the Cape May City project. This influx of sand resulted in a 600 ft advance in the shoreline. Natural deposition has created a variety of profile configurations between a wide beach with a shallow offshore region early in the study period to a higher berm, steeper beach face slope, a deeper trough in the offshore region, and a new developing dune system during the recent surveys. The original dune consisted of an I-5 gravel core constructed because the shoreline was in recession threatening to breach into the interior. The immediate response and influx of sand from the beach fill activity in Cape May City eliminated this concern going forward as sand was deposited seaward of the dune expanding the beach.

#105 - Nature Conservancy, Cape May, Cape May County
Comparison of 1986 to 2015

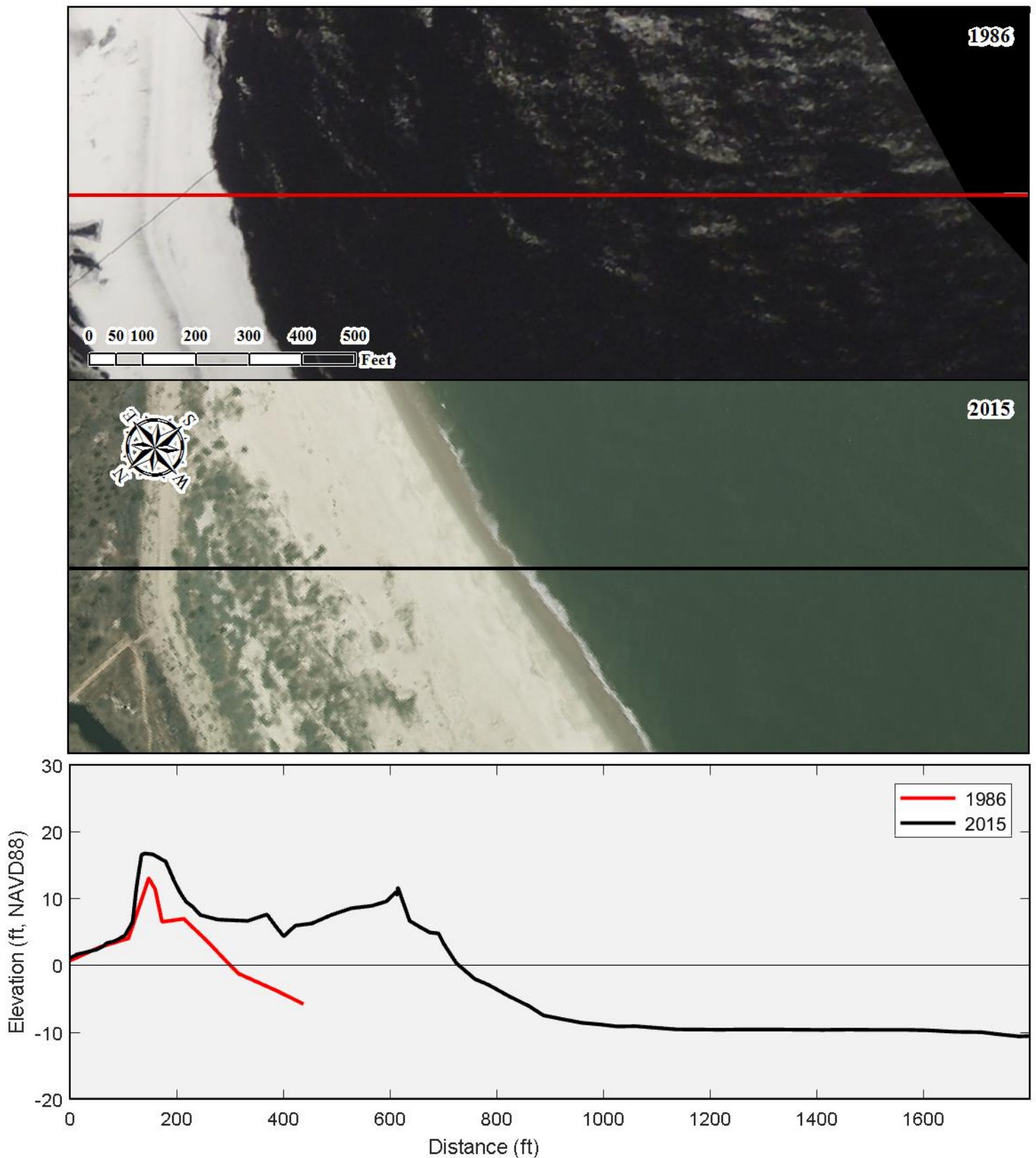


Figure 607. This site was not directly nourished, but has received much of the sand lost from Cape May City's project. The beach is in much better shape in 2015 as compared to 1986. The dune was manmade in 1986 in order to help prevent repetitive storm overwash into Cape May City, but a natural dune has developed since the beach fills began, as evident in the 2015 aerial photograph

NJBPN 104 – Lake Drive, Cape May Point (November 22, 2016)



Figure 608. The Cape May Point beach at Lake Drive was the last segment between Cape May City and Cape May Point to receive sand from a USACE project in 2005. Retreat rates have been slower than in the past as a direct result of the sand influx into this system.

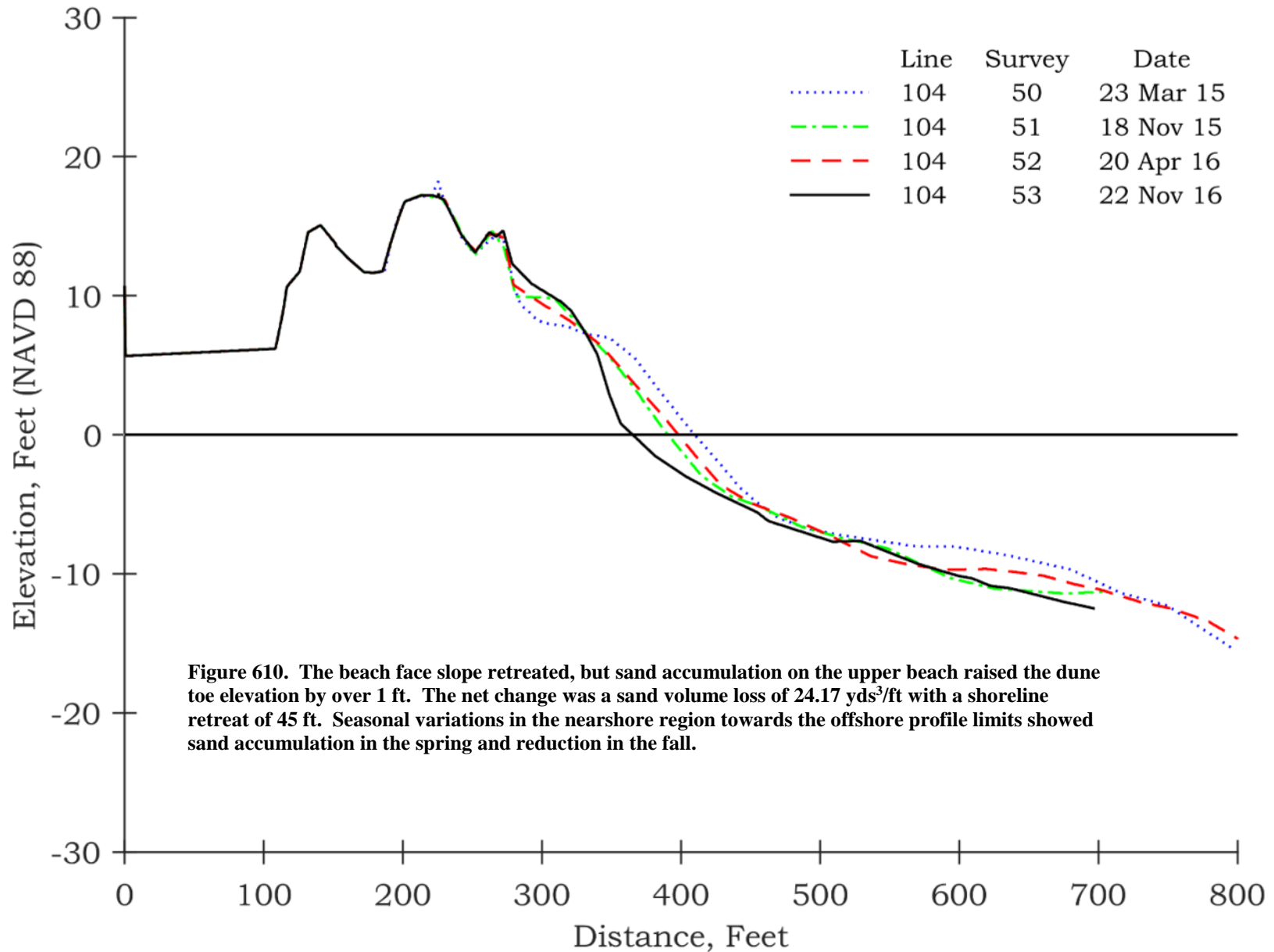
NJBPN 104 – Lake Drive, Cape May Point



Figure 609a & 609b. The left photo was taken on November 18, 2015. The right photo was taken on November 22, 2016, one year later. Sand accumulated on the upper beach but the beach face slope had eroded and retreated by 2016.

New Jersey Beach Profile Network

#104 - Lake Drive, Cape May Point, Cape May County



30-Year Coastal Changes at Site 104, Lake Drive, Cape May Point, Cape May Co.

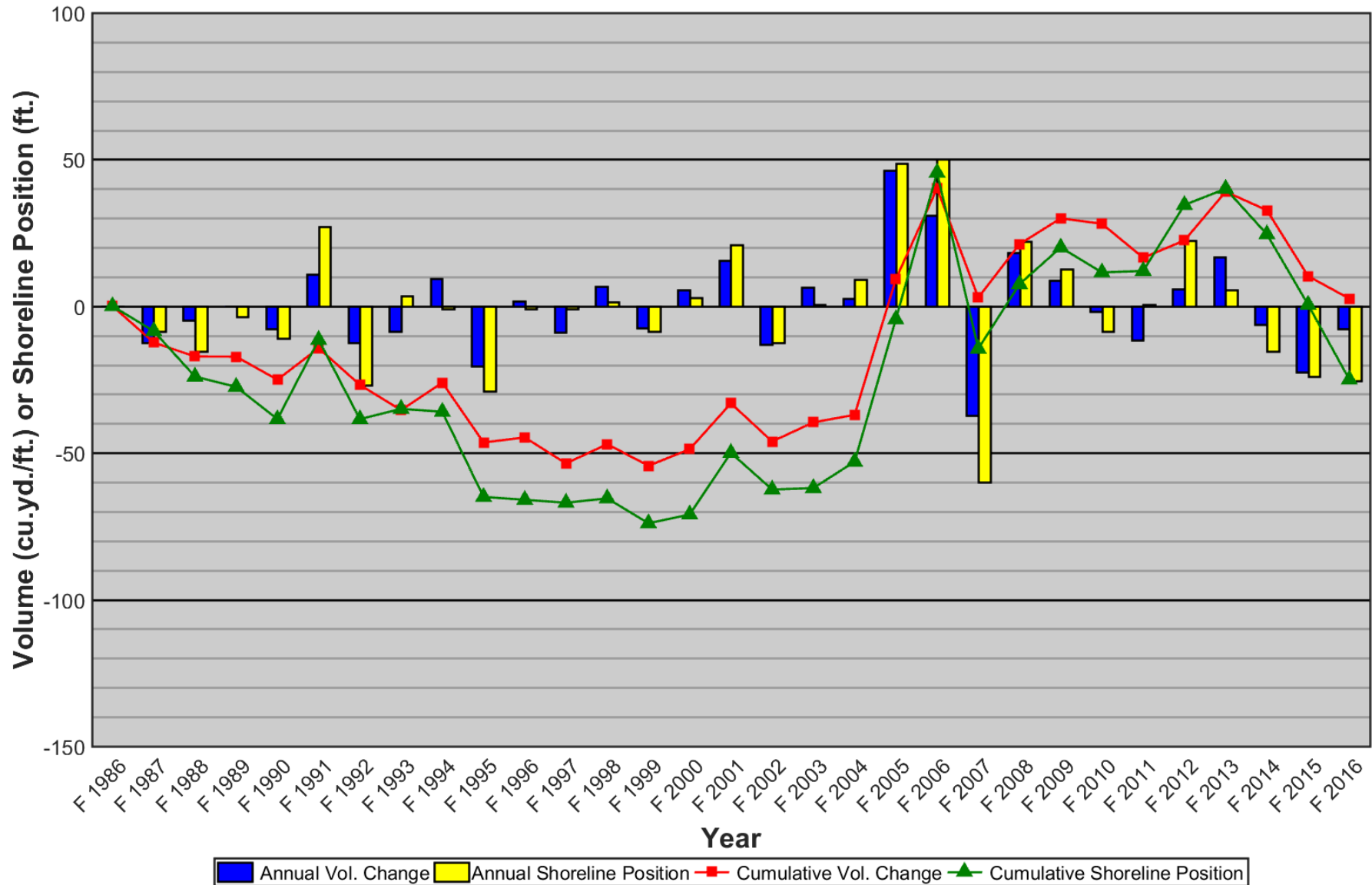


Figure 611. The Lake Drive site faces south, southwest and does not experience severe northeast wave events. Strong tidal currents into and out of Delaware Bay, however, contribute to sand loss to the tidal bars in the bay called “The Rips” by locals. Between 1986 and 2005, sand volume loss was the norm, with corresponding shoreline retreat reaching almost 75 ft. The USACE intervened in 2005 with a beach nourishment project that added sand to the Borough’s beaches except at the western two groin cells in Cape May Point. The 2005 project brought the beach volume and shoreline position above the 1986 values for the first time. Since then, the beach has been fluctuating around the initial values, with positive values from 2008 to 2014, but the 30-year numbers show a beach volume change of about 2 yds³/ft. and a shoreline retreat of about 25 ft.

30-Year Ensemble Mean Profile at Site 104, Lake Drive, Cape May Point, Cape May Co.

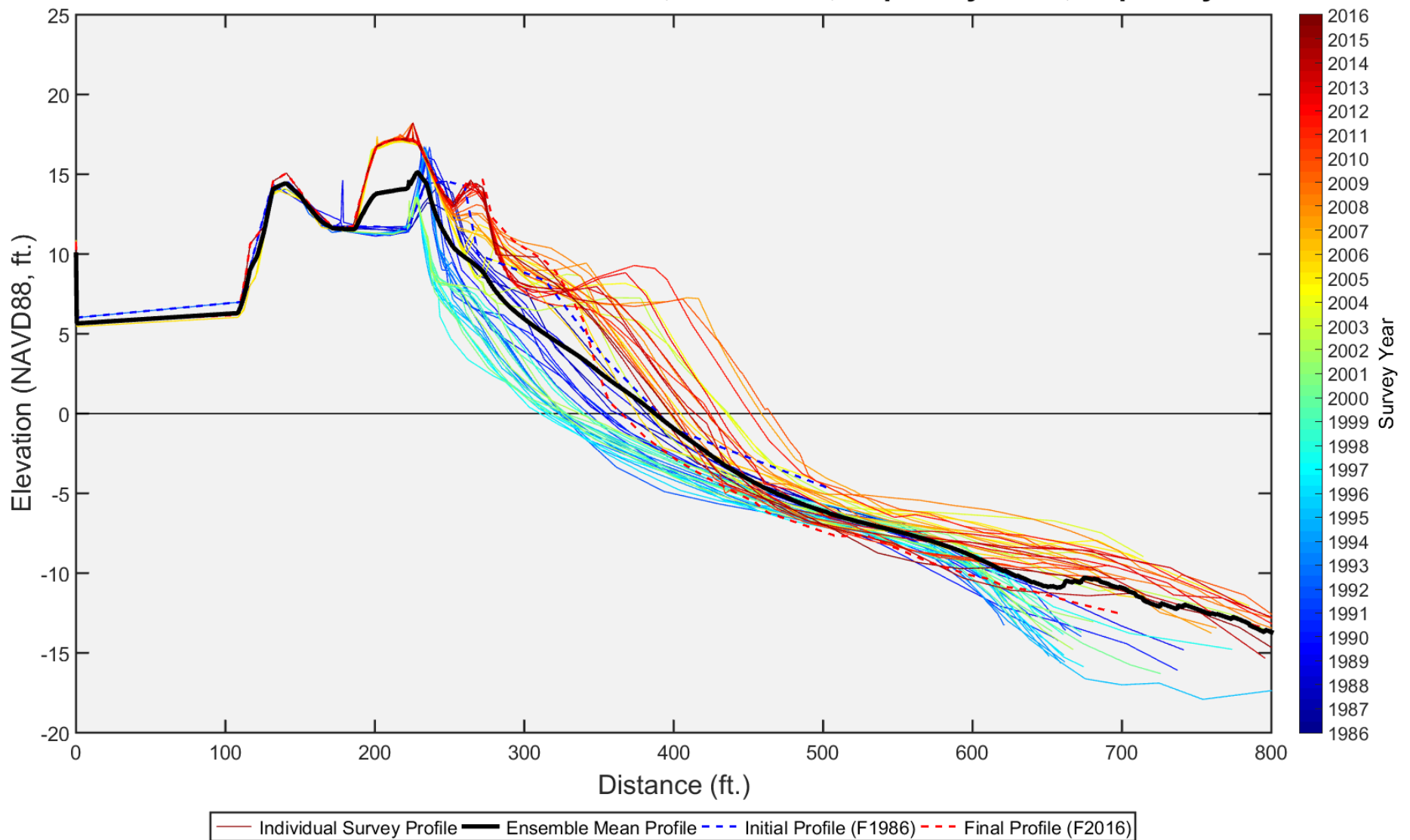


Figure 612. The two distinct color groupings of profiles plots represent pre-federal (blue/green lines) and post-federal project (yellow/red lines) conditions. Dune development has always been encouraged by the borough and they have been successful. The USACE project established a larger primary dune with subsequent fencing adding foredune growth through aeolian processes. The project enhanced the beach berm width and height feeding the nearshore with additional sand. By 2016 conditions had begun to regress as the shoreline retreated landward and the nearshore slope deepened.

#104 - Lake Drive, Cape May Point Borough, Cape May County
Comparison of 1995 to 2015

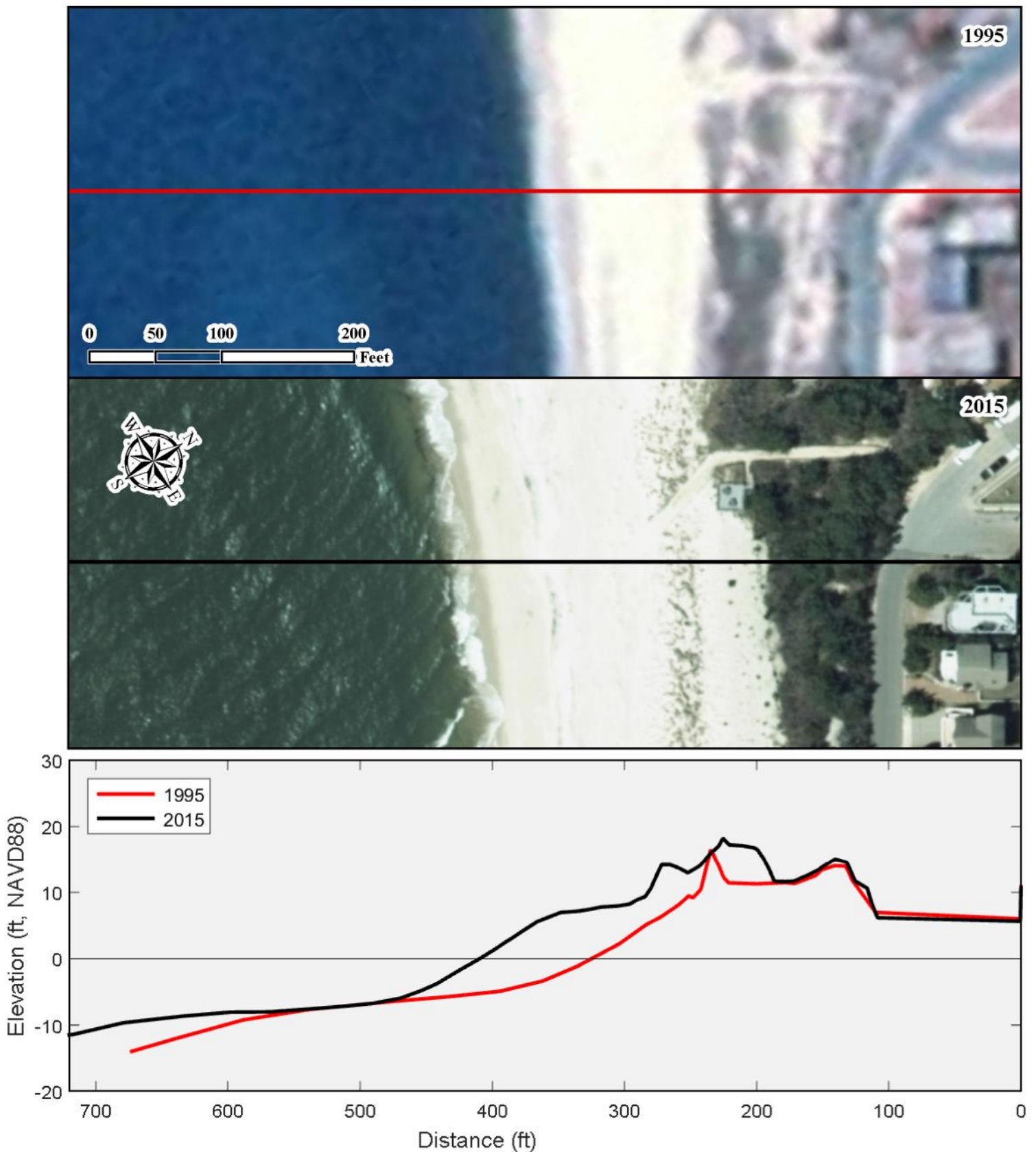


Figure 613. Beach nourishment came to Cape May Point in 2005 with two subsequent cycles of project maintenance conducted. The change to the shoreline position is project related, while the growth in the dunes is partially due to natural processes enhanced by fence installation as well as the USACE project (note the orientation change here as the shoreline curves to face the west).

NJBPN 103 – Higbee Beach State Park, Lower Township (November 23, 2016)



Figure 614. Higbee beach is a wildlife/recreation area under the NJ Park Service with an extensive uplands dune field, which was once the site of a magnesite ($MgCl$) smelting operation and a sand mining effort. The beach is narrower in this region as the shoreline transitions into Delaware Bay. This site has been retreating slowly as the bluff erodes feeding some sand into the beach. The Cape May Canal jetty is in the distance.

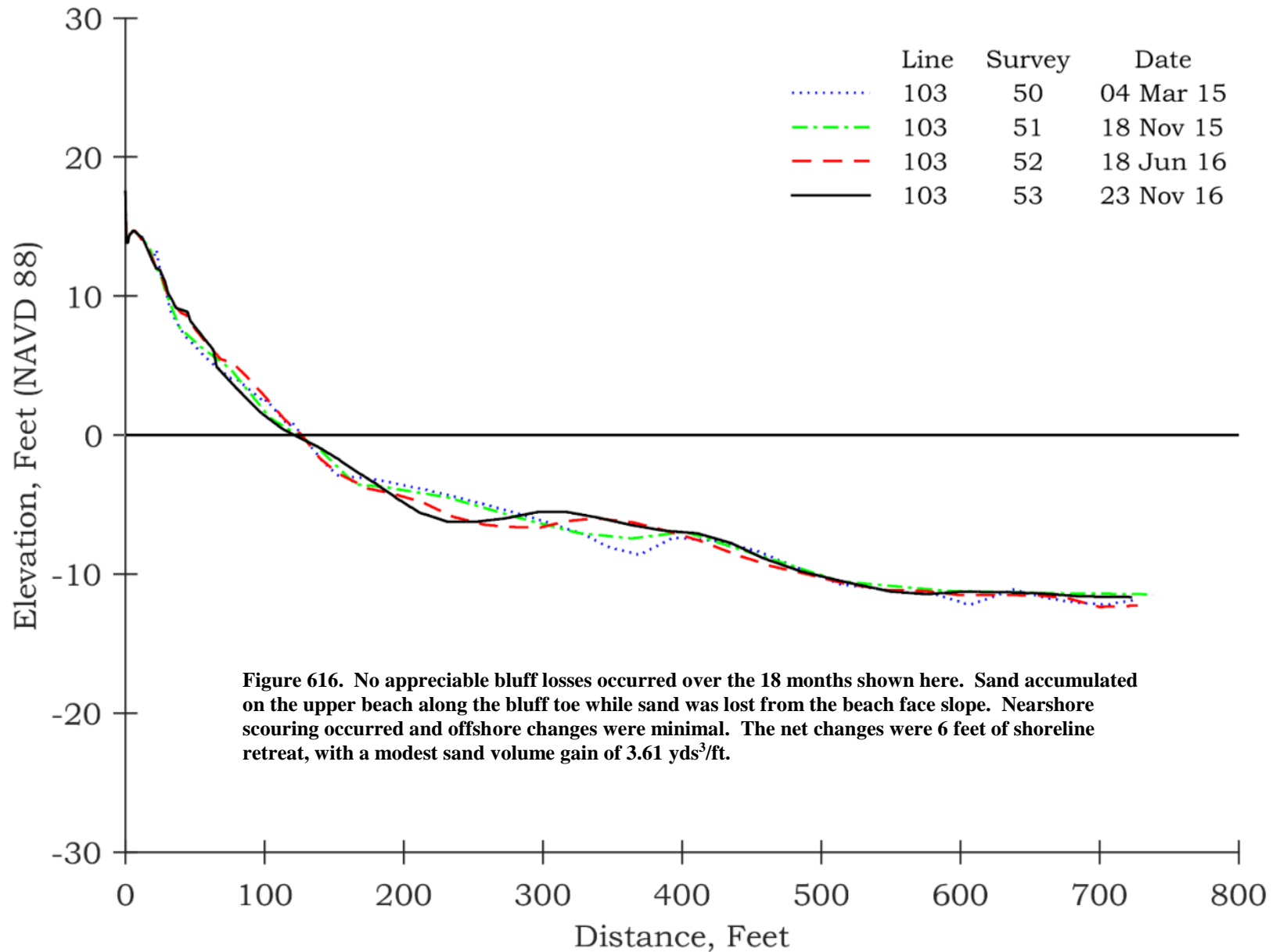
NJBPN 104 – Higbee Beach State Park, Lower Township



Figure 615a & 615b. The left photo was taken November 18, 2015. The right photo, taken November 23, 2016, shows the bluff vegetation at the edge of the scarp and a look up the beach toward the Cape May Canal.

New Jersey Beach Profile Network

#103 - Higbee Beach, Cape May County



30-Year Coastal Changes at Site 103, Higbee Beach, Cape May Co.

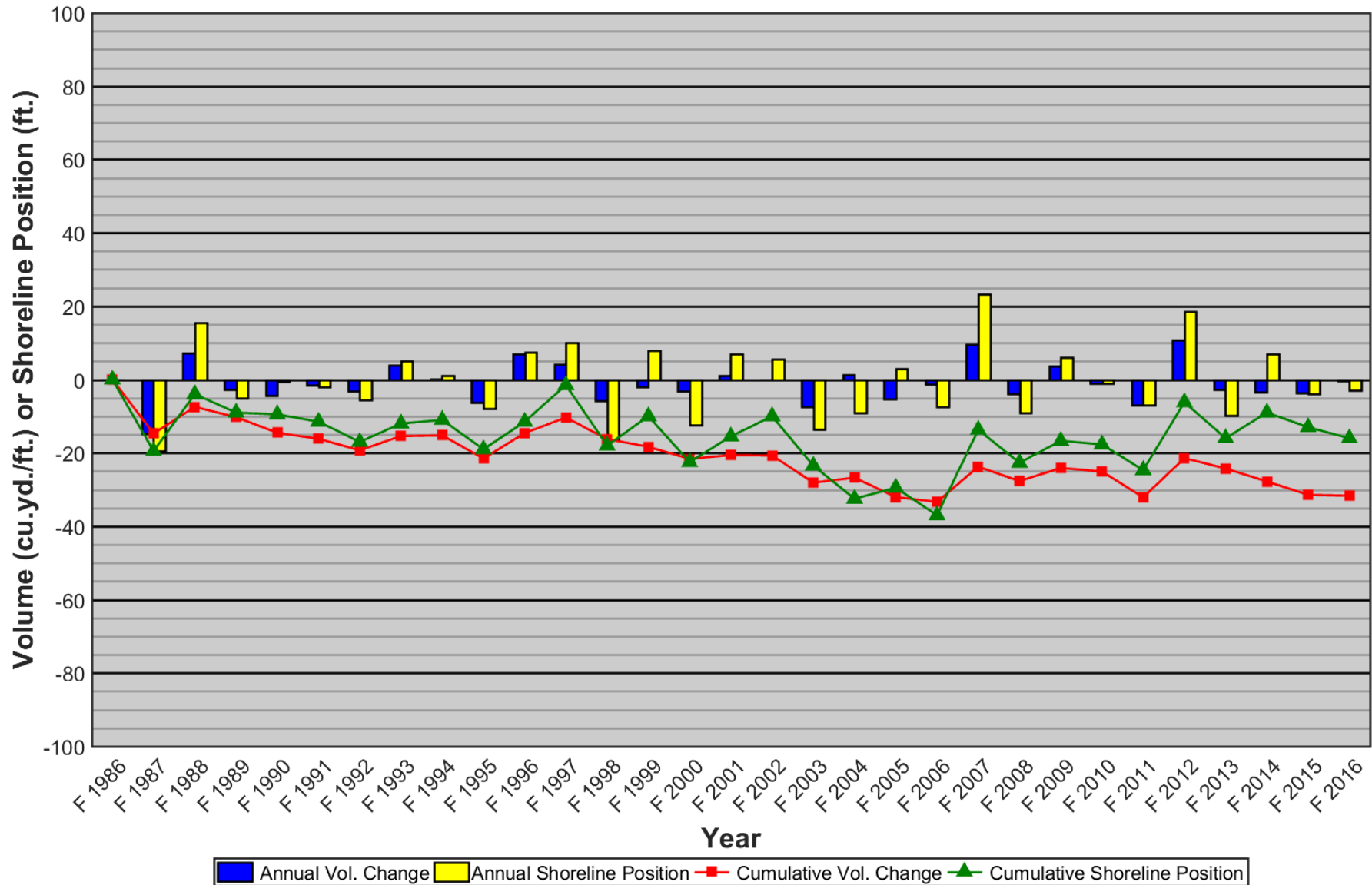


Figure 617. Located between the final groin in Cape May Point and the jetties guarding the Cape May Canal, the site has been slowly retreating in both shoreline and bluff position while the sand volume present within the profile envelope diminished. Since the sand is largely derived from bluff erosion and redistribution by waves on the beach, this process is not likely to change.

30-Year Ensemble Mean Profile at Site 103, Higbee Beach, Cape May Co.

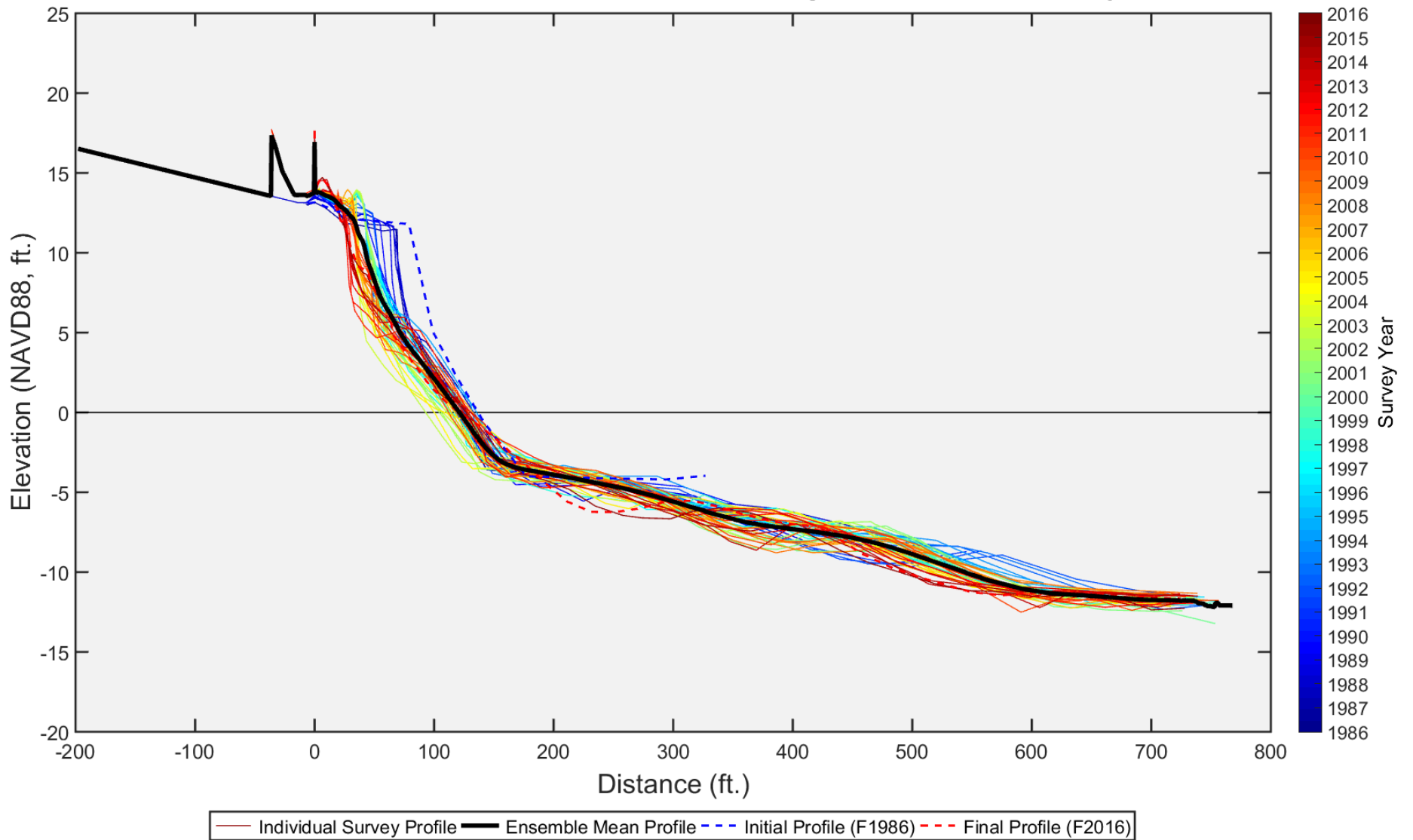


Figure 618. The bluff retreat is clear from the entire profile envelope plotted above. On the beach and offshore in the bay, change is less dramatic and more variable.

#103 - Higbee Beach, Lower Township, Cape May County
Comparison of 1995 to 2015

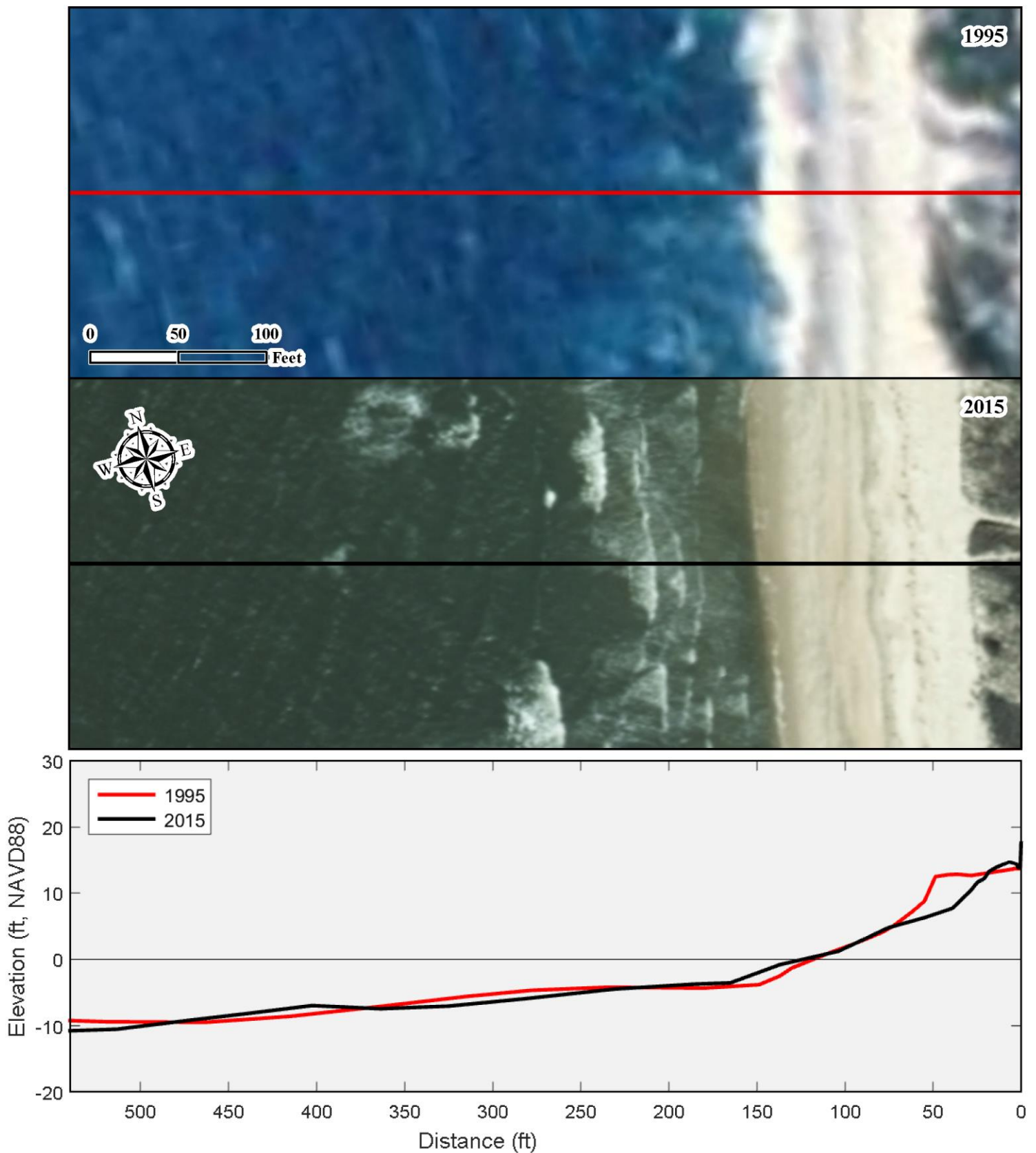


Figure 619. Located in a natural area, site 103 does suffer storm-related bluff erosion with the sand supplied to the beach. Change has been modest at this site but clearly trending towards shoreline retreat and a slowly declining sand volume.

NJBPN 102 – Whittier Avenue, North Cape May (September 28, 2016)



Figure 620. This view to the north along the Delaware Bay shoreline shows the massive dune developed above the seaward edge of the Cape May bluff at this site, along with the smaller hard structures (groins) put in to slow sand transport. The dune and beach system is substantial for the bayshore and remains relatively stable.

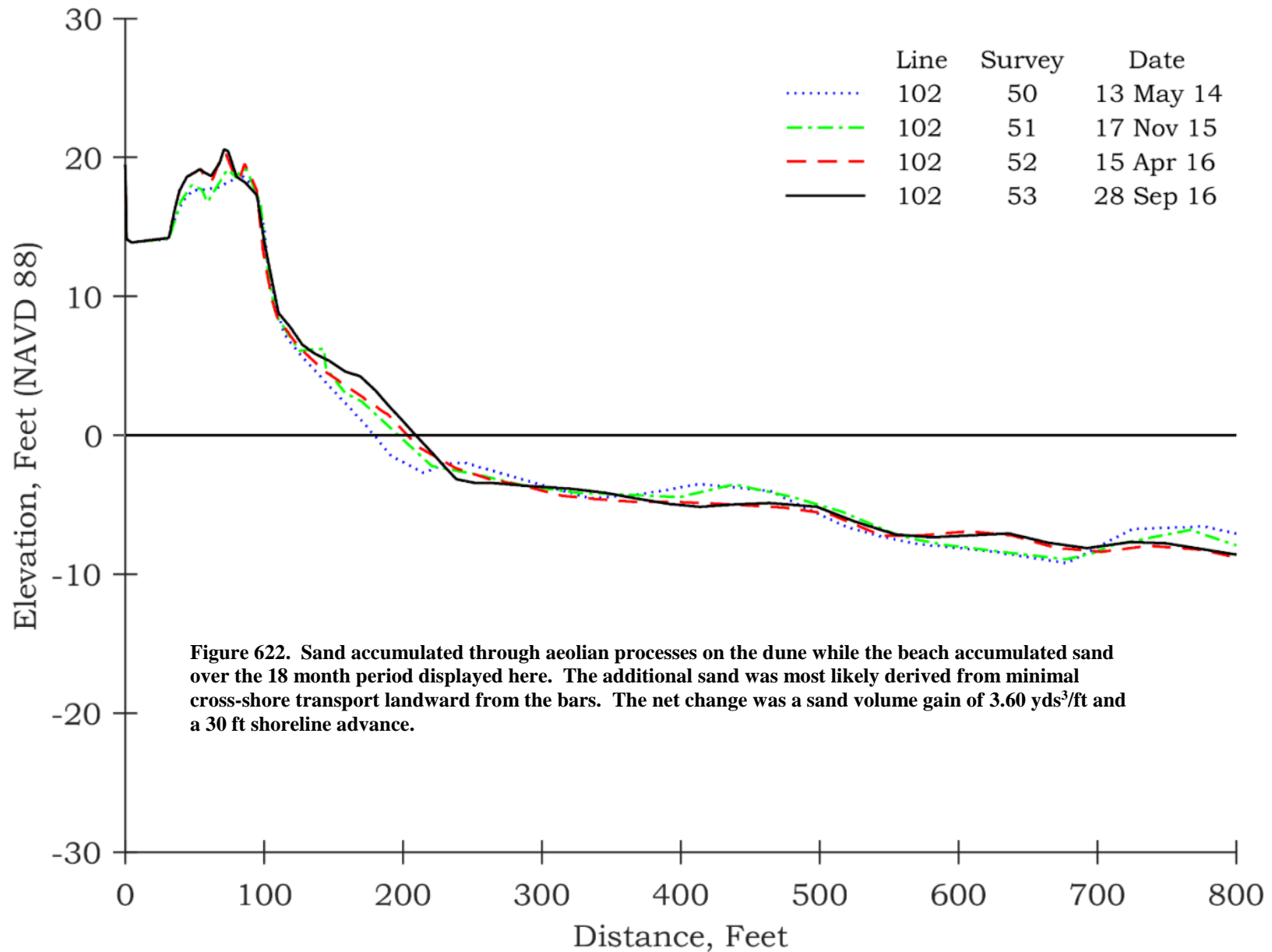
NJBPN 102 – Whittier Avenue, North Cape May



Figure 621a & 621b. The left photo was taken on November 17, 2015. The right photo, taken on September 28, 2016, shows a slightly wider beach in comparison to the timber groin.

New Jersey Beach Profile Network

#102 - Whittier Ave., North Cape May, Cape May County



30-Year Coastal Changes at Site 102, Whittier Ave., North Cape May, Cape May Co.

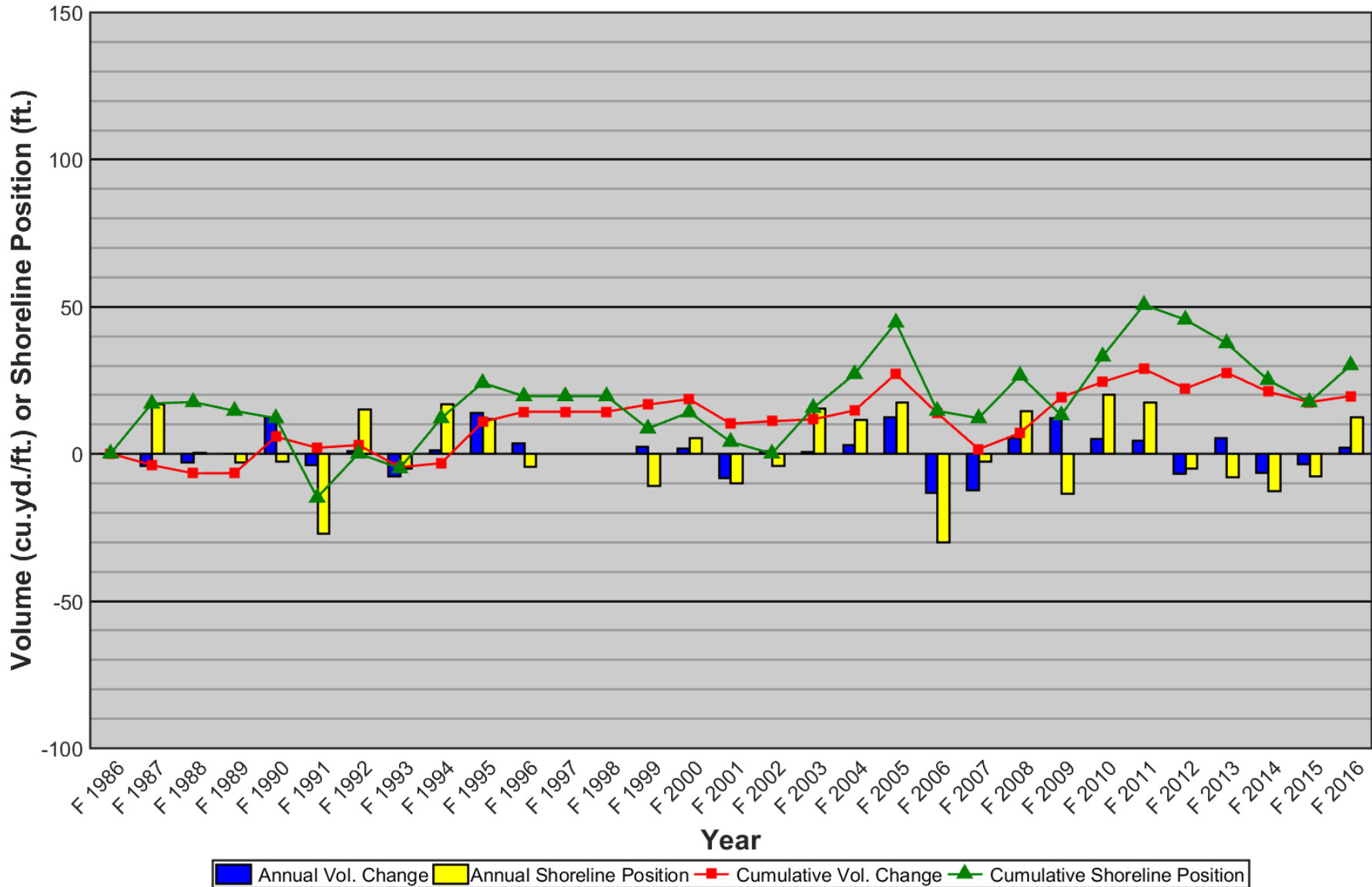


Figure 623. This Delaware Bay site has seen moderate sand volume gains that could be termed a trend with some larger fluctuations from the early 2000's on. Sand supplies are natural, quite limited and essentially derived from bluff erosion over long term intervals. The construction of the Cape May Canal effectively cut the site off from sand sources coming around the Cape May Point region.

30-Year Ensemble Mean Profile at Site 102, Whittier Ave., North Cape May, Cape May Co.

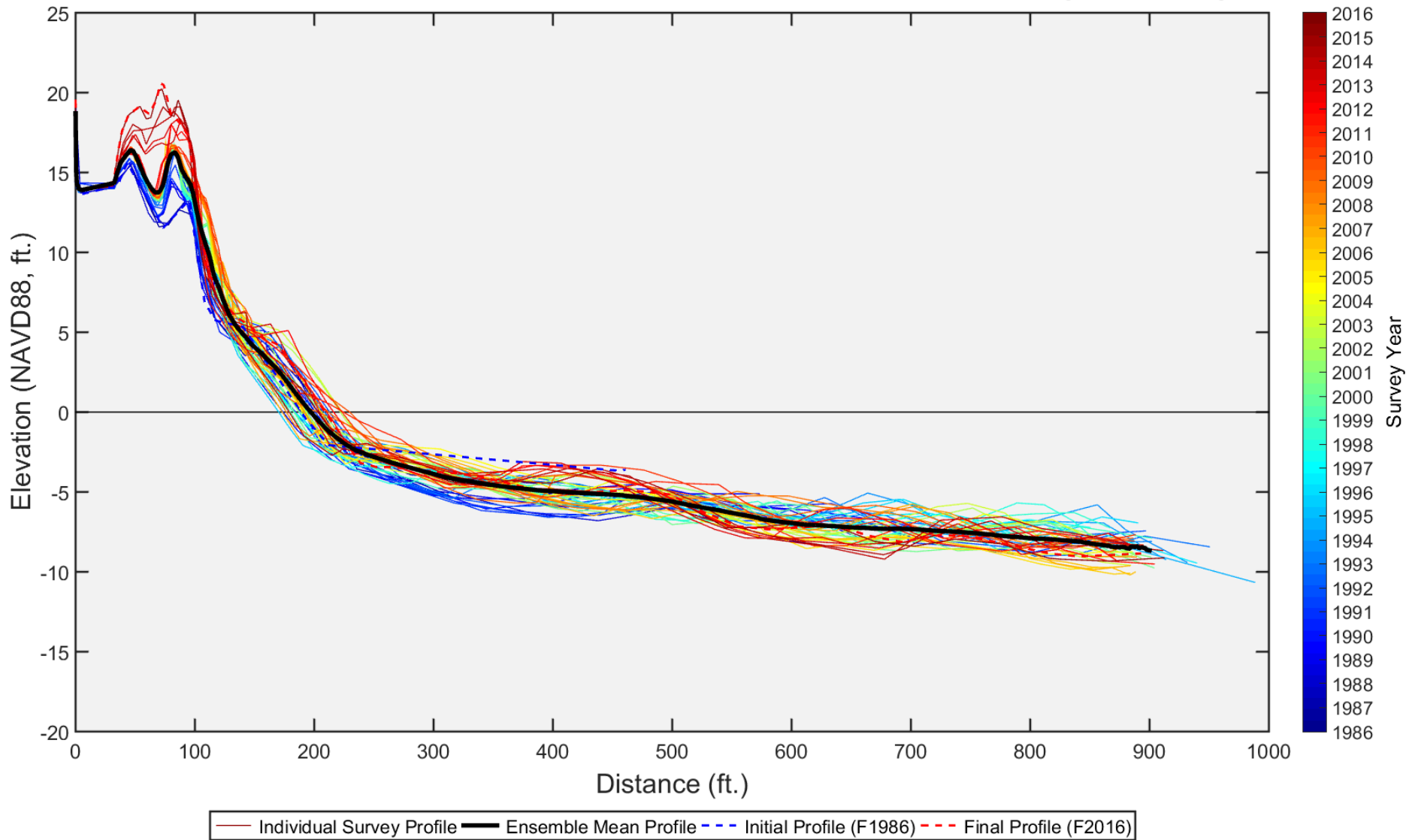


Figure 624. The profile envelope shows how the dune has dramatically grown over time with modest beach accumulation that supports the continued dune development. Offshore is a wide, shallow erosional surface produced over long term intervals of bay waves cutting into the coastal bluff. The envelope of change is small and does not vary far from the mean profile, as is typical of all bay Delaware Bay sites.

#102 - Whittier Ave, North Cape May, Cape May County
Comparison of 1995 to 2015

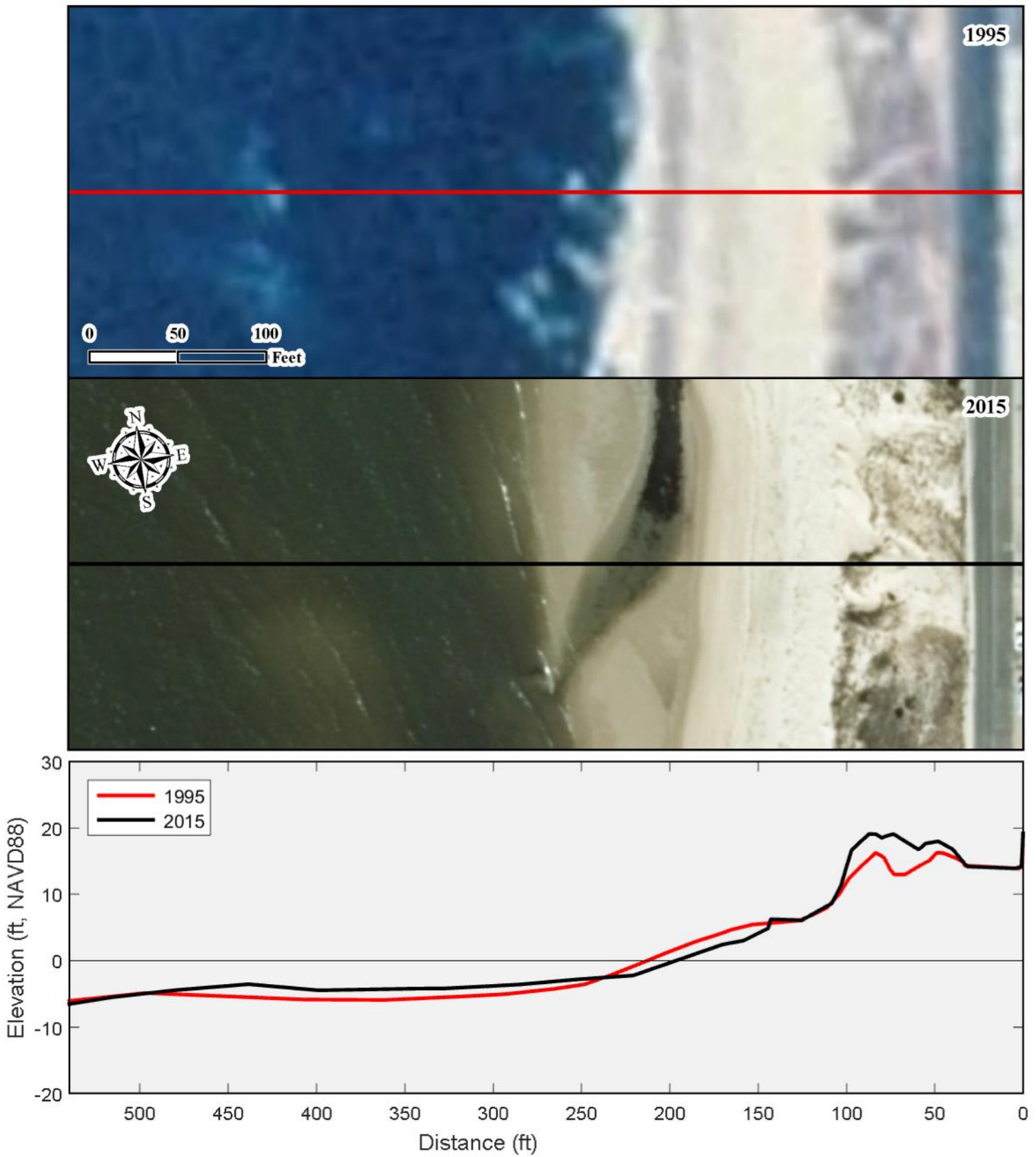


Figure 625. Aeolian processes have produced significant natural dune growth over the years while beach and shoreline changes have been modest and variable supporting the continued dune development.

NJBPN 101 – Pacific Avenue, Villas (September 28, 2016)



Figure 626. Farther north along the Delaware Bay shore, the beach narrows and the dune is lower in elevation. Offshore a vast low tide terrace exists due to long-term shoreline retreat.

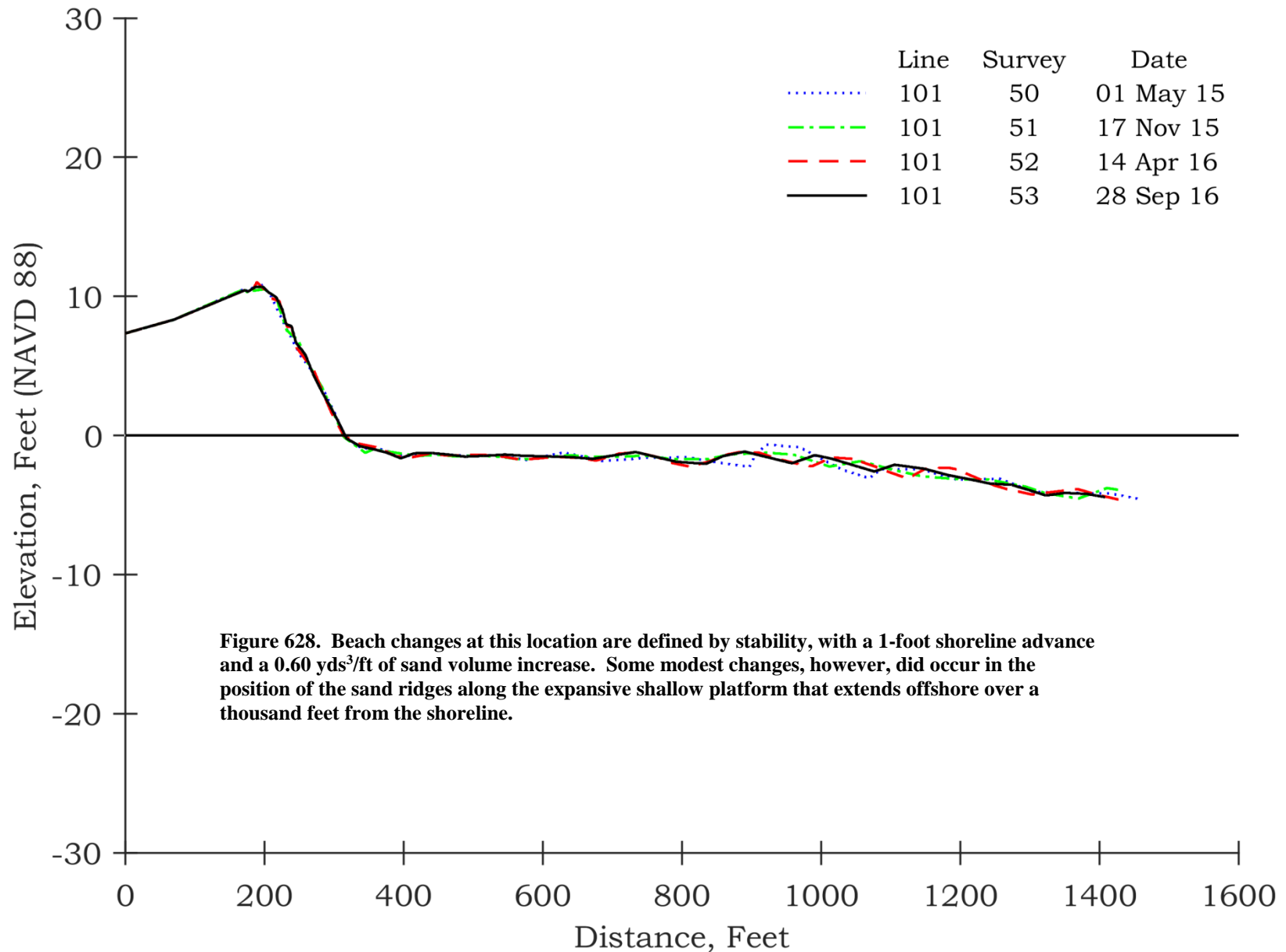
NJBPN 101 – Pacific Avenue, Villas



Figure 627a & 627b. The left view was taken November 17, 2015. The photo on the right was taken on September 28, 2016. Minimal change occurred at Pacific Avenue with some dune grass growth toward the bay. The sediments on the low tide terrace appear to alternate between mud flats and thin sand ridges, as can be seen to the left of the orange cone in the right hand photo.

New Jersey Beach Profile Network

#101 - Pacific Avenue, Lower Township, Cape May County



30-Year Coastal Changes at Site 101, Pacific Avenue, Villas, Cape May Co.

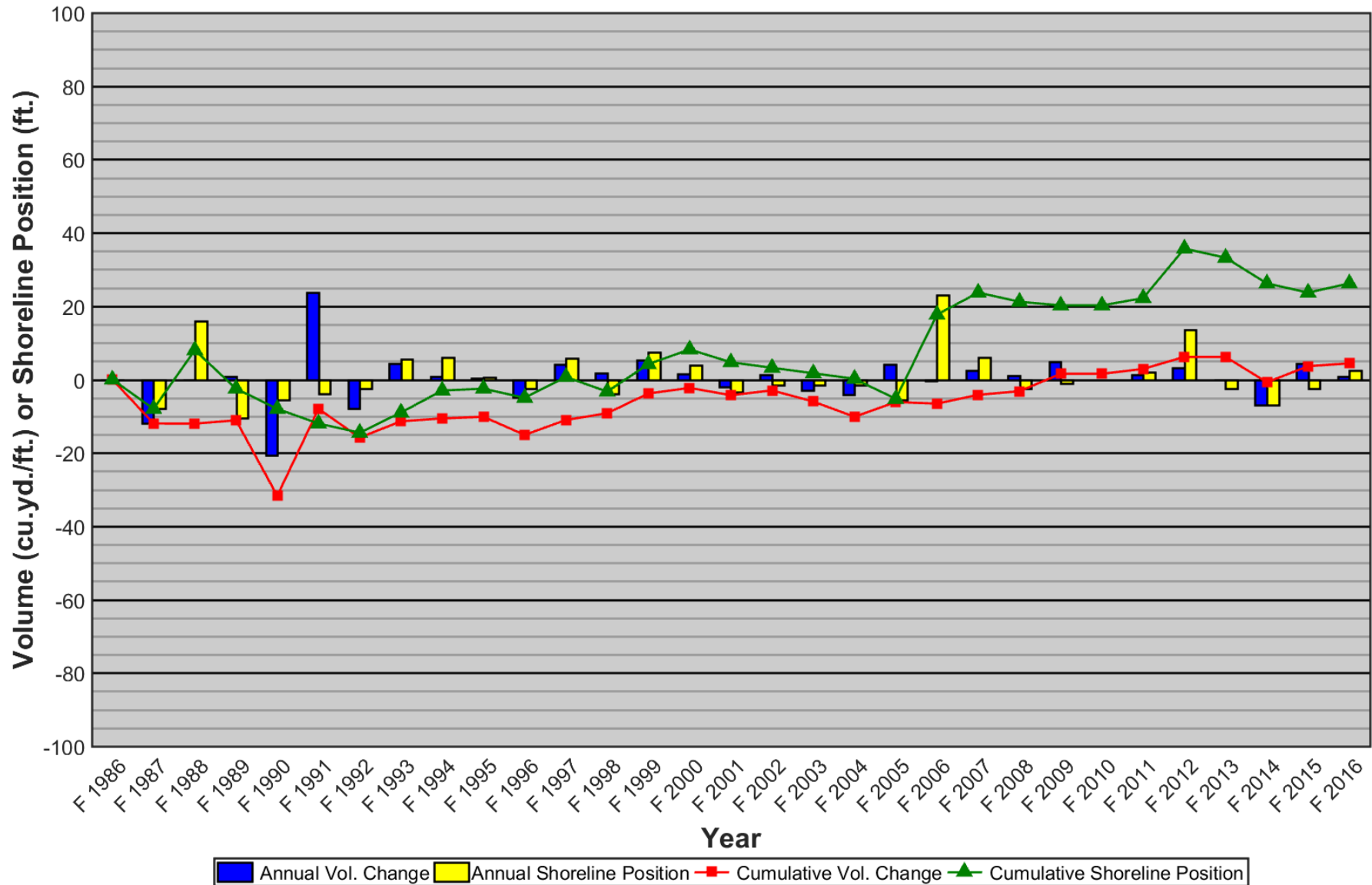


Figure 629. The sand volume remains relatively constant with a small influx or loss of material over the period of measurements, but remained negative for the majority of the time period. Sand volume finally turned positive in 2009, but dropped below the original value again in 2014, and turned positive again in 2015. Shoreline positioned varied more so than volume and oscillated above and below zero for quite some time. Shoreline position turned positive in 2006 and remained at least 20 ft seaward of the original shoreline position from then on.

30-Year Ensemble Mean Profile at Site 101, Pacific Avenue, Villas, Cape May Co.

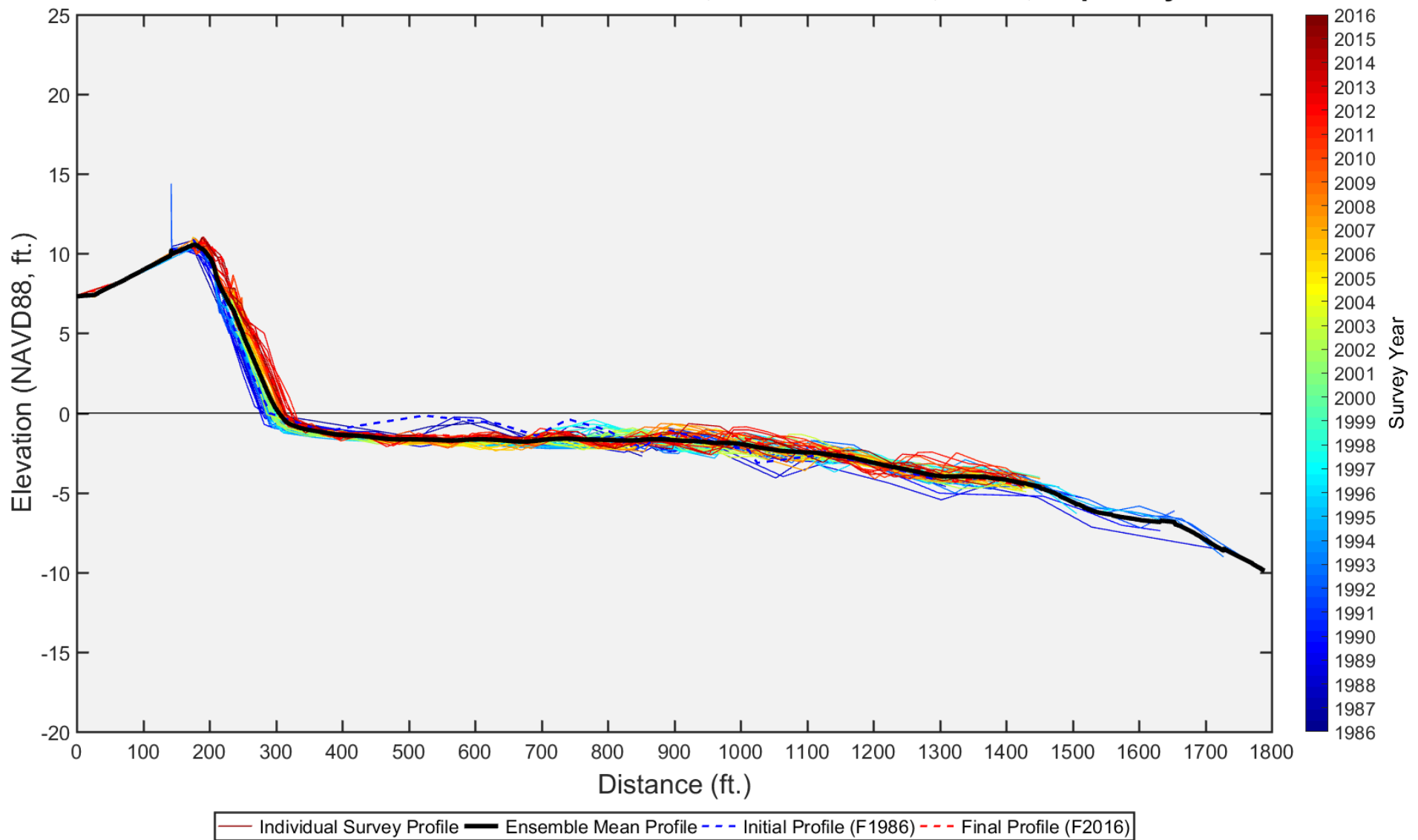


Figure 630. The profile plot ensembles indicates beach erosion has been minimal with consistent shore features and a long term modest expansion of the beach width. Offshore the sand ridge positions on the terrace changes with seasons, but the overall terrace elevation is fairly consistent with small variation about the mean profile.

#101 - Pacific Avenue, Villas, Cape May County
Comparison of 1995 to 2015

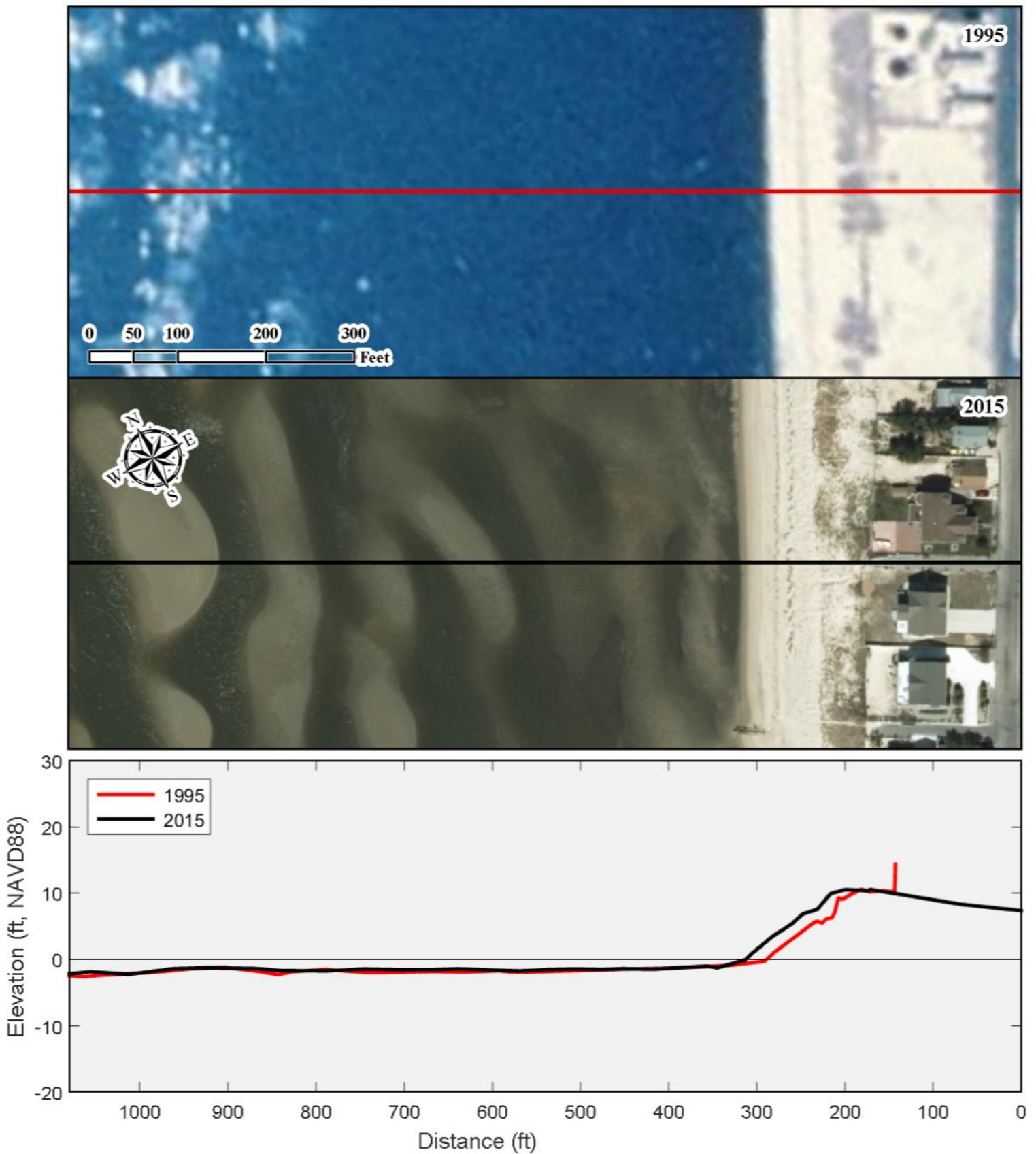


Figure 631. Site 101 shows modest beach expansion with very little difference offshore on the low tide terrace between 1995 and 2015.

NJBPN 100 – Reeds Beach, Middle Township (September 28, 2016)



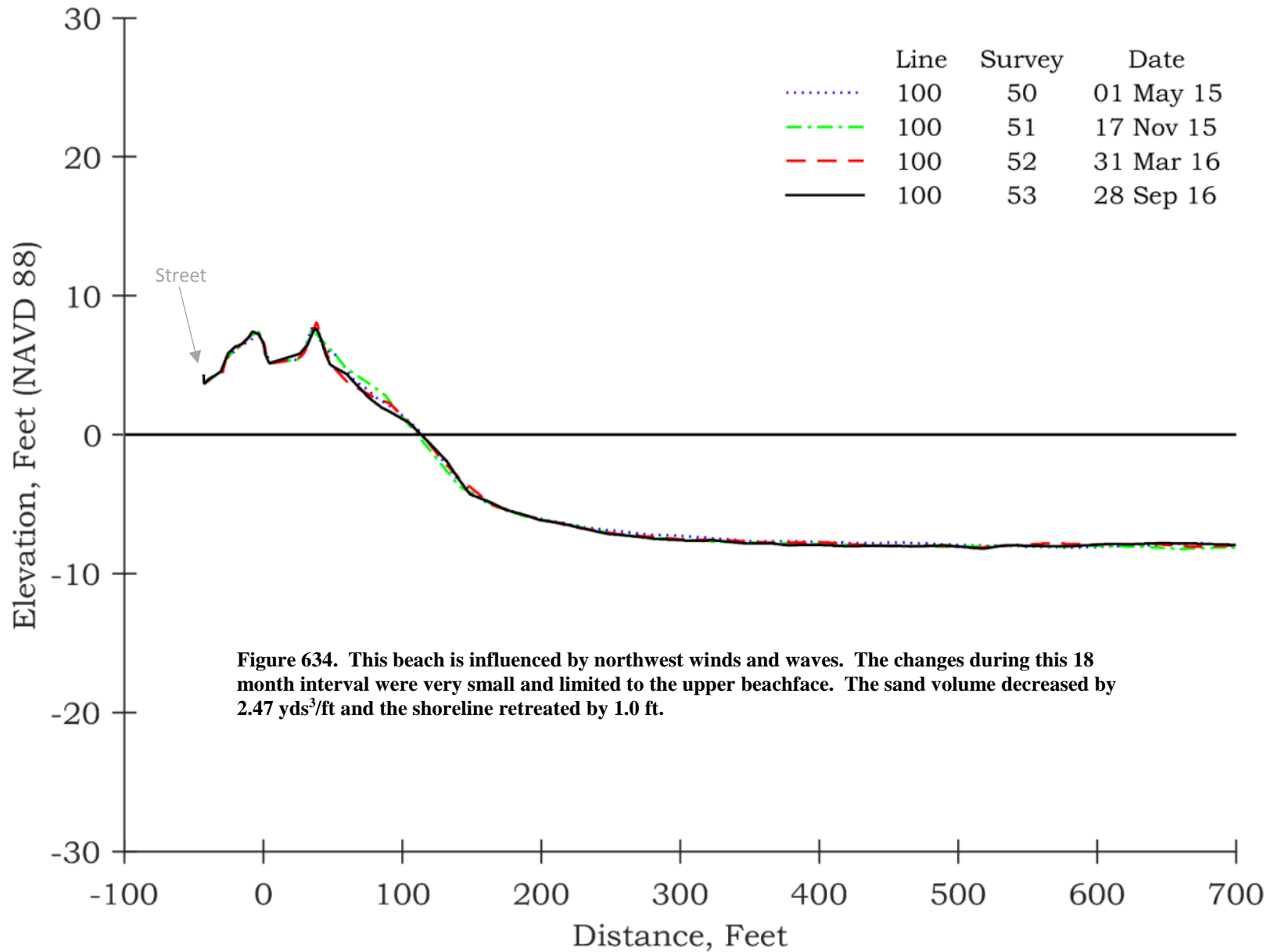
Figure 632. Reeds Beach is located on the northwest shoreline of Cape May County. The dune is small and maintained by removing sand from the road, while the beach is narrow and easily flooded in storms. Westerly wind-generated waves on Delaware Bay are particularly troublesome for this part of the county shoreline.



Figure 633a & 633b. The left photograph was taken on November 17, 2015. The right photo was taken on September 28, 2016. The left view shows the road and dune landward of the road and the new ridge of sand placed on the upper beach to hold back minor wave/storm events. The right view shows the beach slope to the low tide terrace with the recent swash line on the sand.

New Jersey Beach Profile Network

#100 - Reeds Beach, Cape May County



30-Year Coastal Changes at Site 100, Reeds Beach, Cape May Co.

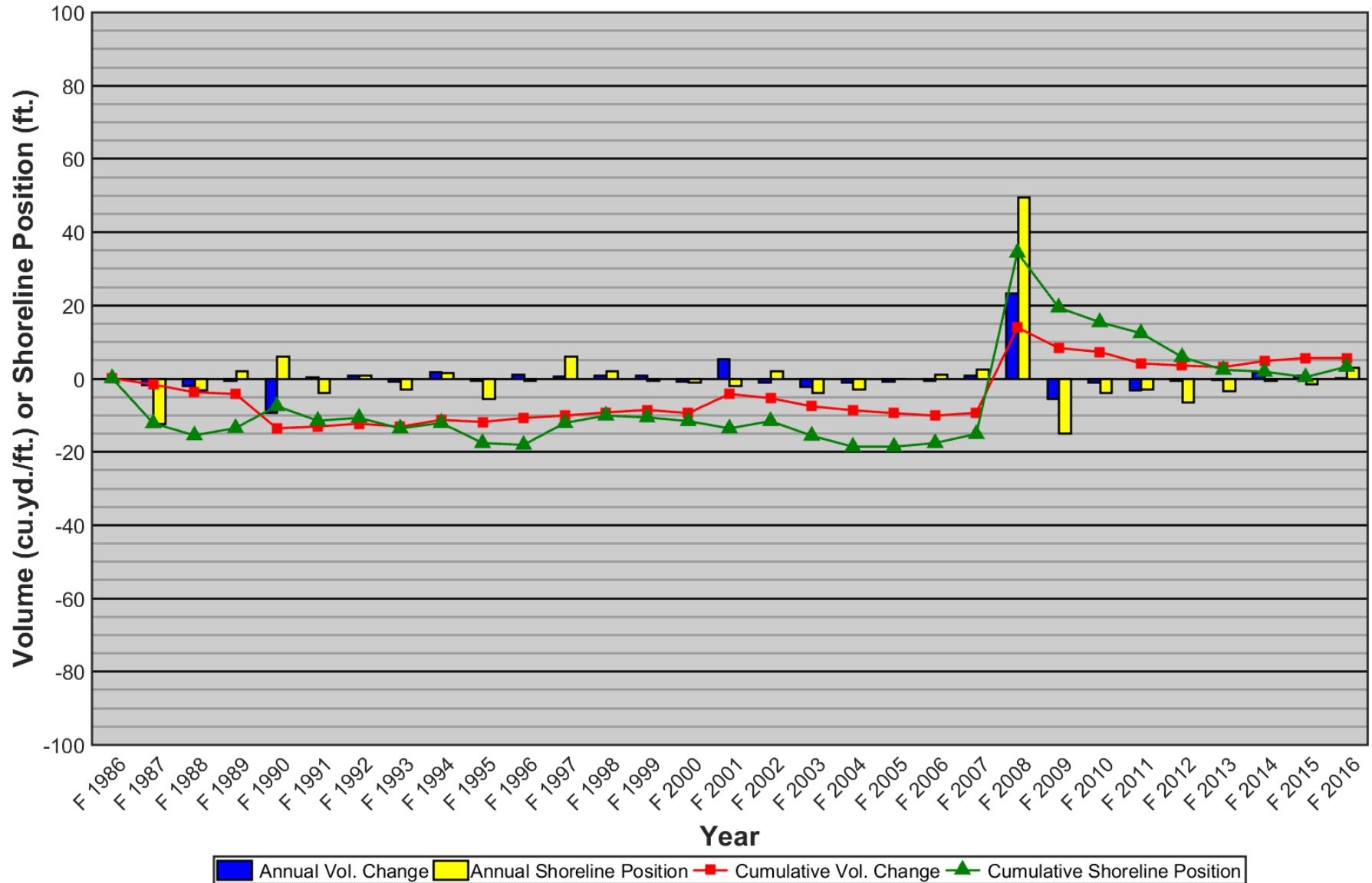


Figure 635. The early trends were modest beach and shoreline losses. In 2008, a beach nourishment effort by the State of New Jersey, using sand dredged from Bidwell Creek, was completed. This nourishment was fairly effective in pushing the shoreline and sand volume above the 1986 values, but both shoreline position and beach volume have decreased to values slightly above the original values from 2008 to 2016, showing that it is difficult to keep added material on this beach.

30-Year Ensemble Mean Profile at Site 100, Reeds Beach, Cape May Co.

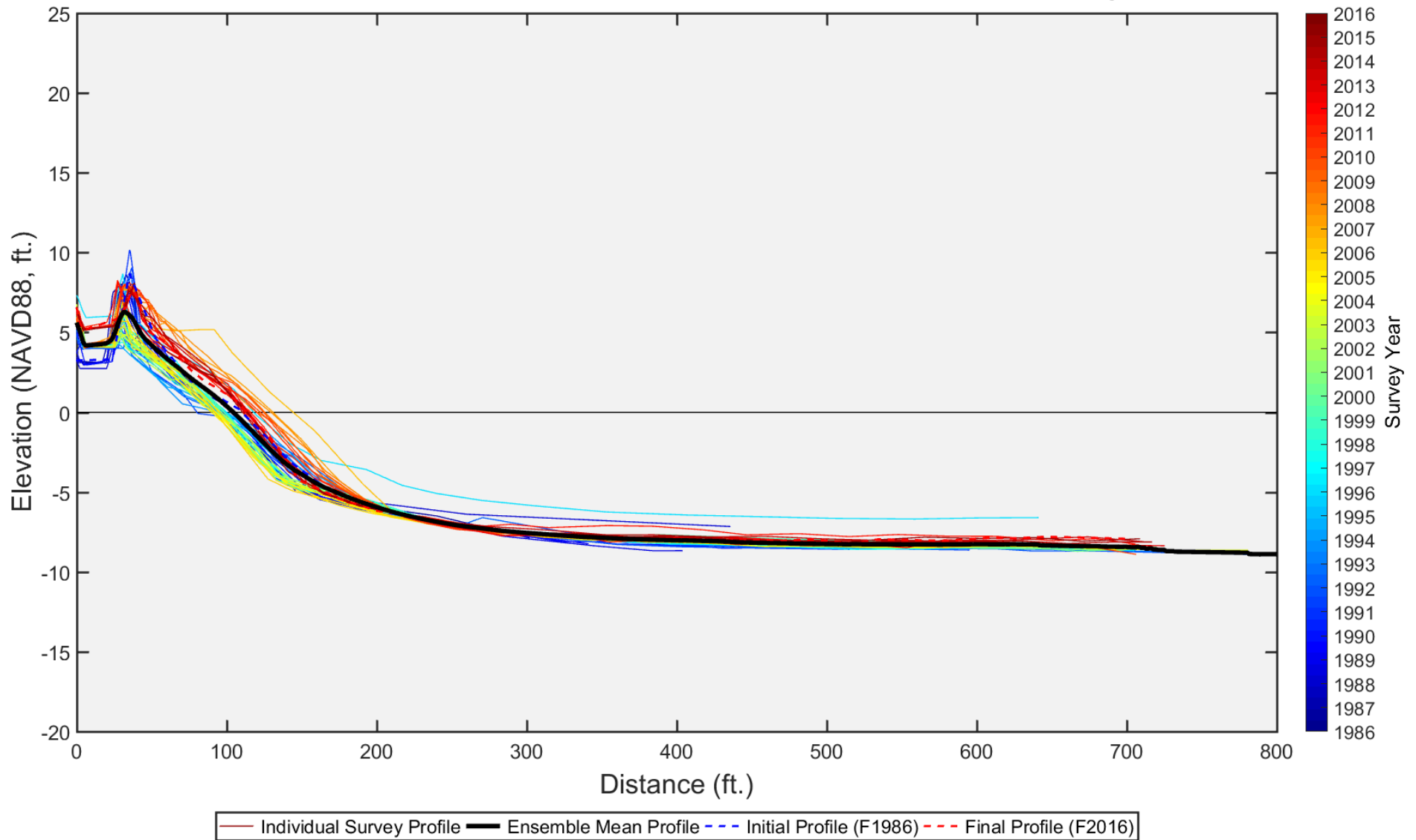


Figure 636. The sand placed in 2008 shows as higher elevation profiles, but offshore the profile consistency remains uniform. Unlike site 101 in the Villas, there are fewer bars to move about on the terrace and migrate landward and exposure usually reveals muddy sediment below a thin veneer of sand.

#100 - Reeds Beach, Middle Township, Cape May County
Comparison of 1995 to 2015

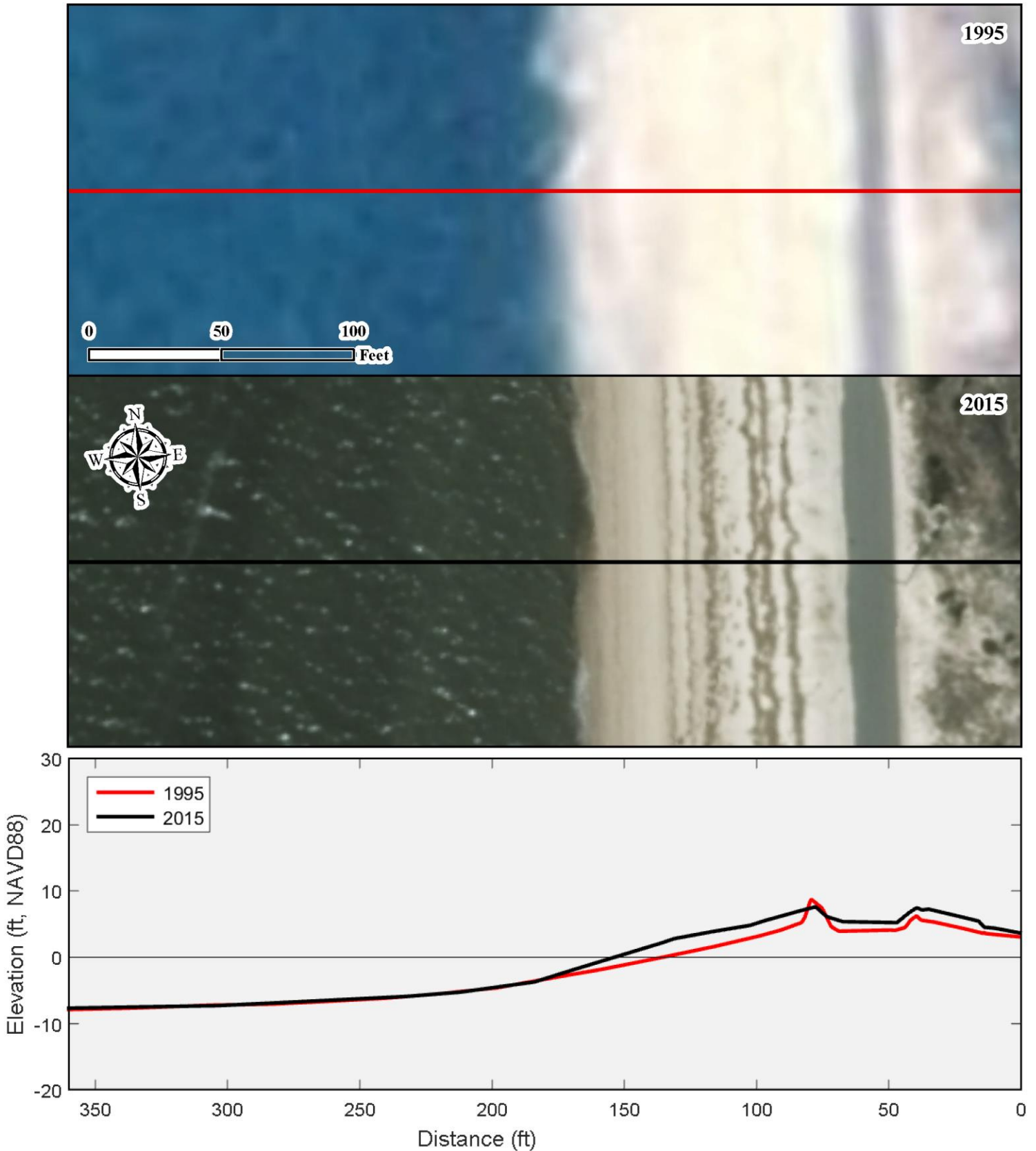


Figure 637. A modest amount of sand was introduced on Reeds Beach in 2008, derived from dredging of Bidwell Creek. North of this site naturally existing sandy beach shorelines diminish transitioning to exposed marsh on the western shoreline of Cape May County. The sand introduced in 2008 is barely noticeable by 2015 and the overall shoreline change is minimal.

Summary & Conclusions

There were few major storm events following Hurricane Sandy that struck the Jersey shore from 2013 to 2016. The worst being NE Storm Jonas on January 23, 2016 that produced beach erosion and significant tidal flooding equal in southern Cape May County to that from Sandy. A limited disaster declaration resulted in DR-NJ-4264 for the snow removal and coastal damage by the federal government, March 14, 2016. The USACE responded by requesting the dredging contractors working the area to return to touch up the damage done to the ongoing federal project in southern Ocean City and on Ludlam Island.

Erosion continues to plague the northeast segment of Ocean City, Strathmere, Avalon and North Wildwood. Each site required additional maintenance in 2014 and into 2015. Ocean City appears in satisfactory condition, with the 2015 Army Corps project covering its southern shoreline to Corson’s Inlet State Park, and south along all of Ludlam Island.

Avalon continued to rapidly lose sand from the 10th to 21st Street segment and see it accumulate it between 35th and 70th Street beaches. As a result, the Borough executed a 740,000 cubic yard restoration by May 2015. The USACE intends to return during the spring of 2017 to perform maintenance on their project. In North Wildwood, back-passing was used to provide minor sand volumes (38,000 cubic yards) in 2012 to enhance the northern 5 city oceanfront beach blocks. An additional 37,000 cubic yards was made available in the fall of 2015 from sand dredged by the NJDOT from the Beach Creek NJ State navigation channel entrance from Hereford Inlet. In 2016 a joint effort between Wildwood and North Wildwood cleared the Wildwood storm drains and provide that excavated sand to North Wildwood placed between 3rd and 26th Streets to repair dune damage and beach loss caused by NE Storm Jonas. Another similar cooperative effort is scheduled for early spring 2017.

Cape May County, Beach Volume & Shoreline Position Changes Over 30 Years

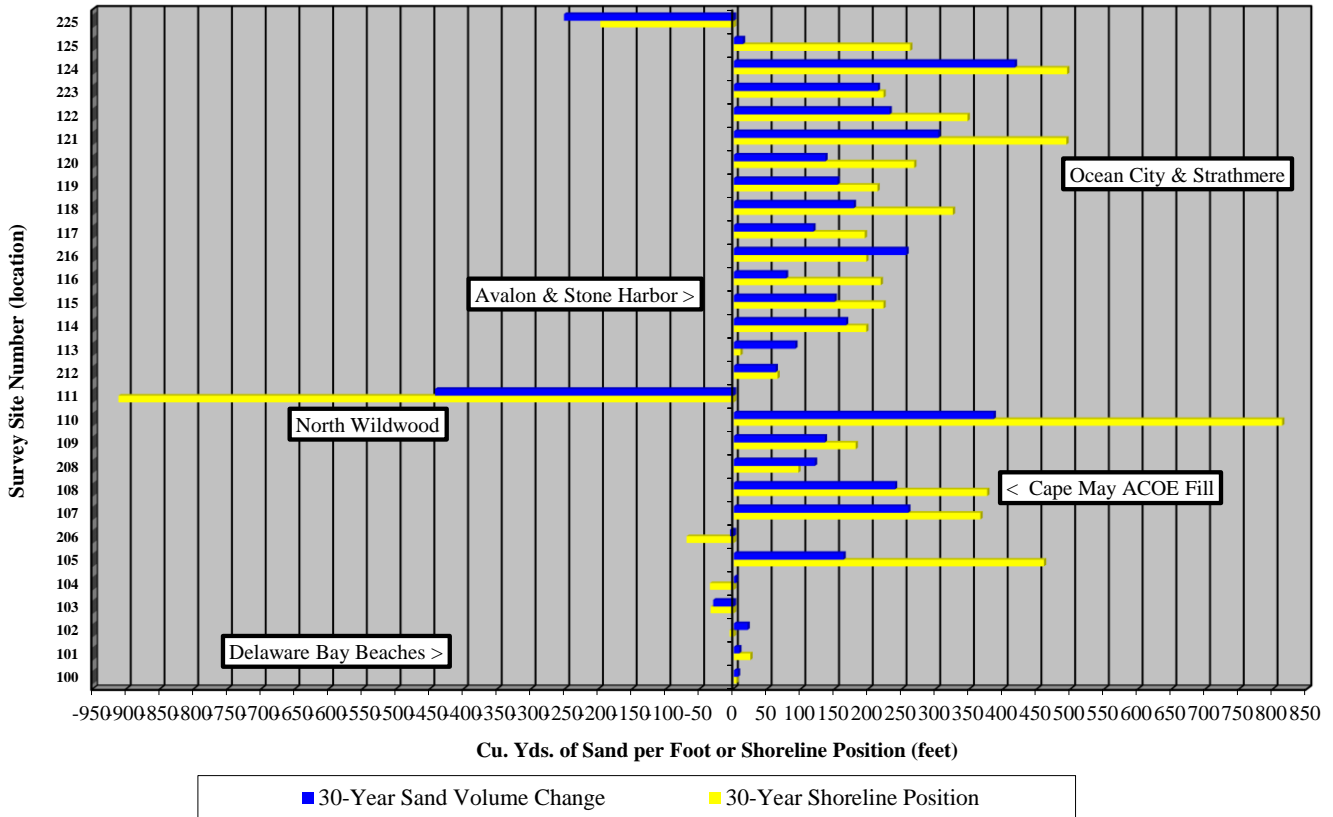


Figure 638. After 30 years of surveying in Cape May County, the net shoreline and sand volume change is positive. The minimal change along Delaware Bay is related to limited wave fetch and sand supplies. Two sites (111 and 110) represent the worst erosion combined with the transfer of over half that loss to the next site to the south in Wildwood. Communities from Ocean City to Stone Harbor all were beneficiaries of the USACE’s coastal projects as was the Cape May City shoreline.

Since Sandy, work by the Philadelphia District USACE has restored all authorized and constructed projects back to individual project design specifications (the Table below courtesy of Jeffery Gebert, USACE).

Table 2. Cape May County USACE Project Sand Volumes due to Sandy

SITE LOCATION	CONTRACTOR	SAND VOLUME (cy)	
Ocean City (berm)	Great Lakes Dredge and Dock	1,746,206	
Ocean City (dune betterment)	Great Lakes Dredge and Dock	56,110	
TCM - Avalon	Norfolk Dredging Company	336,359	
TCM - Stone Harbor	Norfolk Dredging Company	674,224	
CM Inlet to Lower Township	Weeks Marine Inc	585,328	
Lower Cape May Meadows - CM Pt	Weeks Marine Inc	345,000	Scheduled periodic nourishment (not post-Sandy FCCE work)

The 2015 Ludlam Island and Ocean City project resulted in placing 3.4 million cubic yards of sand at a cost of \$82.3 million between 34th Street to 59th Street in Ocean City, then between Seaspray Road in Strathmere and 93rd Street on Ludlam Island. Completed under PL 113-2 passed by Congress in early 2013, this project required NJ as the non-federal sponsor for initial construction, but was done at 100% federal expense. The Ocean City portion planned for 1.603 million cubic yards of which 403,000 cubic yards represented advance fill. Strathmere to Sea Isle City was planned to require 5.146 million cubic yards. of which 1.82 million cubic yards would be advanced nourishment (USACE, 2001). The 2001 feasibility report also discussed the usual 65% federal share supported by the 35% non-federal sponsor share, a fact altered by PL 113-2 to 100% federal cost for this project’s initial construction.

Work continues on the final design for the project for North Wildwood to Wildwood Crest utilizing some form of sand harvesting from the excesses seen in Wildwood and Wildwood Crest beaches to produce a sand “recycling” program, termed “Back Passing”. The scale and exact methodology is still in the final planning stages.

The final element in the future is the revitalization with a one-time effort project to provide environmental enhancement to the Delaware Bay shoreline of western Cape May County. This project is not part of the Hurricane Sandy PL 113-2 work, so must be funded separately. Back in the 1990’s it was proposed as an environmental restoration for the western county coast, but never received Congressional appropriations to proceed to construction. Recently the Philadelphia District is re-assessing this project as a flood hazard mitigation effort utilizing Delaware shipping channel maintenance dredge material. Other USACE projects have been completed along Delaware Bay in Oakwood Beach, Salem County (354,000 cubic yards) of sand, costing \$12 million.

A Delaware Bayshore, Downe Township, NJ feasibility study under Section 103 of the River and Harbor Act of 1962 (PL 87-874), to design and construct small beach erosion and flood damage reduction projects is in progress. Signed in May 2015, the project’s estimated cost is \$740,000 at a 65% – 35% federal, non-federal sponsor share. The objective is to design projects to mitigate against future damages similar to Hurricane Sandy’s damages seen to impact the region (Fortescue and Gandy’s Beach within Downe Township).

Appendix
Tabulated Volume & Shoreline Change Data by County

TABLE 3						
MOMOUTH COUNTY						
SEASONAL; OVERALL; ANNUAL SPRING & FALL BEACH VOLUME CHANGES						
	Survey & Time Period					
	Seasonal			Overall	Annual Spring & Fall	
	50 - 51	51 - 52	52 - 53	50 - 53	50 - 52	51 - 53
PROFILE SITE LOCATION	S15-F15	F15-S16	S16-F16	S15-F16	S15-S16	F15-F16
	Volume Change (cubic yards per foot)					
187: Cliffwood Beach, Beach Park	-0.18	-2.13	1.3	-1.07	-2.36	-0.91
286: Union Beach, Beach Street	-4.5	-0.29	-0.81	-5.63	-4.83	-1.11
185: Port Monmouth, Spy House	-16.65	11.94	0.23	-4.15	-4.24	12.52
385: Sandy Hook, North Beach	N/A	N/A	N/A	N/A	N/A	N/A
285: Sandy Hook, Gunnison Beach	6.15	15.76	4.27	25.28	21.17	19.98
284: Sandy Hook, Parking Lot E	-10.18	1.65	28.57	10.56	-18.66	30.21
184: Sandy Hook, Highlands Beach	-35.09	-13.11	32.61	-13.46	-49.24	21.61
183: Sea Bright, Via Ripa Street	19.94	-28.43	52.21	50.34	-8.09	26.81
282: Sea Bright, Shrewsbury Way	-7.51	5.83	13.37	11.12	-2.01	18.69
182: Sea Bright, Public Beach Lot	-0.04	-16.2	15.36	-1.78	-16.27	-1.77
181: Sea Bright, Municipal Lot	-13.87	-13.51	-1.62	-29.18	-27.42	-15.09
180: Sea Bright, Sunset Court	-13.73	-12.01	4.01	-22.1	-25.89	-8.32
179: Monmouth Beach, Cottage Road	-11.3	-26.16	-18.41	-55.89	-37.66	-44.34
178: Monmouth Beach Club	-4.46	-11.6	-15.29	-31.72	-16.07	-27.32
177: Long Branch, Ocean Avenue	-0.54	0.08	5.61	6.17	-1.03	6.83
176: Seven Presidents Park	6.8	2.2	3.92	14.26	10.45	5.94
175: Long Branch, Broadway Avenue	-30.35	1.42	-19.05	-48.29	-28.62	-17.71
174: Long Branch, Morris Avenue	-10.78	-23.44	-12.9	-47.09	-34.19	-36.27
173: Long Branch, West End Avenue	-23.16	-28.71	5.04	-46.87	-51.85	-23.72
272: Long Branch, 805 Ocean Avenue	-11.46	-15.91	217.1	210.34	-30.17	215.47
171: Elberon, Pullman Avenue	9.85	-1.67	272.08	258.6	7.79	269.94
170: Deal, Roosevelt Avenue	7.51	0.09	189.95	191.59	7.49	189.99
169: Deal, Darlington Avenue	241.33	-17.21	-9.2	218.01	225.43	-26.56
168: Allenhurst, Corlies Avenue	11.79	-26.88	11.65	-1.53	-12.93	-12.95
267: Asbury Park, Seventh Avenue	9.66	-10.69	-6.41	-8.31	-1.04	-17.21
167: Asbury Park, Third Avenue	5.2	-12.58	-2.48	-9.91	-7.38	-15.06
166: Ocean Grove, Ocean Pathway	6.02	-14.1	4.93	-5.13	-10.03	-9.14
165: Bradley Beach, McCabe Avenue	7.92	-20.4	5.45	-5.79	-11.34	-14.85
164: Avon By The Sea, Sylvania Avenue	14.3	-26.79	6.35	-4.2	-10.46	-21.13
163: Belmar, 5 th Avenue	3.41	-5.48	-7.59	-9.61	-2.02	-12.69
162: Belmar, 18 th Avenue	10.71	-17.66	0.01	-7.6	-7.37	-16.18
161: Spring Lake, Brighton Avenue	10.96	-13.3	7.47	4.64	-2.75	-6.33
160: Spring Lake, Salem Avenue	27.73	-30.6	17.81	15.18	-2.38	-11.87
159: Sea Girt, New York Avenue	-12.34	8.15	-8.99	-12.73	-2.97	-0.62
158: Sea Girt, Trenton Avenue	-13.44	-22.67	10.15	-25.82	-36.08	-12.48
157: Manasquan, Riddle Way	15.95	-40.36	-0.28	-22.28	-21.86	-37.38
256: Manasquan, Pompano Avenue	20.45	10.01	18.11	47.3	31.25	27.38
AVERAGE for EACH SURVEY	6.00	-10.97	22.90	17.87	-5.10	12.62

TABLE 4						
MOMOUTH COUNTY						
SEASONAL; OVERALL; ANNUAL SPRING & FALL SHORELINE CHANGES						
	Survey & Time Period					
	Seasonal			Overall	Annual Spring & Fall	
	50 - 51	51 - 52	52 - 53	50 - 53	50 - 52	51 - 53
PROFILE SITE LOCATION	S15-F15	F15-S16	S16-F16	S15-F16	S15-S16	F15-F16
	Shoreline Change (feet)					
187: Cliffwood Beach, Beach Park	5.2	-11.17	-0.3	-6.27	-5.97	-11.47
286: Union Beach, Beach Street	-5.4	-2.6	-3.2	-11.2	-8	-5.8
185: Port Monmouth, Spy House	-3.7	6.2	-3.7	-1.2	2.5	2.5
385: Sandy Hook, North Beach	N/A	N/A	N/A	N/A	N/A	N/A
285: Sandy Hook, Gunnison Beach	-15.2	-18.6	31.3	-2.5	-33.8	12.7
284: Sandy Hook, Parking Lot E	-49.4	-38.7	36.7	-51.4	-88.1	-2
184: Sandy Hook, Highlands Beach	-82.7	-1.6	29.4	-54.9	-84.3	27.8
183: Sea Bright, Via Ripa Street	160.2	-183.8	158.7	135.1	-23.6	-25.1
282: Sea Bright, Shrewsbury Way	2.1	-86.9	29.5	-55.3	-84.8	-57.4
182: Sea Bright, Public Beach Lot	9	-101.74	74.2	-18.54	-92.74	-27.54
181: Sea Bright, Municipal Lot	-61.8	10.3	11.6	-39.9	-51.5	21.9
180: Sea Bright, Sunset Court	-64	15.01	21.5	-27.49	-48.99	36.51
179: Monmouth Beach, Cottage Road	-3	-14.4	-11.7	-29.1	-17.4	-26.1
178: Monmouth Beach Club	-15.8	-38.2	6.04	-47.96	-54	-32.16
177: Long Branch, Ocean Avenue	-16.1	-20.8	10.4	-26.5	-36.9	-10.4
176: Seven Presidents Park	25.9	-28.8	18.4	15.5	-2.9	-10.4
175: Long Branch, Broadway Avenue	-80.9	56.3	-81.5	-106.1	-24.6	-25.2
174: Long Branch, Morris Avenue	-20.2	-9	-52.4	-81.6	-29.2	-61.4
173: Long Branch, West End Avenue	-66.2	-25.5	17.6	-74.1	-91.7	-7.9
272: Long Branch, 805 Ocean Avenue	-66	-10.2	321.9	245.7	-76.2	311.7
171: Elberon, Pullman Avenue	8.8	-39.7	418.5	387.6	-30.9	378.8
170: Deal, Roosevelt Avenue	-1.3	-0.27	310.9	309.33	-1.57	310.63
169: Deal, Darlington Avenue	353.1	-42.9	-14.1	296.1	310.2	-57
168: Allenhurst, Corlies Avenue	-13.8	-8.7	7.1	-15.4	-22.5	-1.6
267: Asbury Park, Seventh Avenue	-25.5	7.26	-18.2	-36.44	-18.24	-10.94
167: Asbury Park, Third Avenue	1.8	-18	7.5	-8.7	-16.2	-10.5
166: Ocean Grove, Ocean Pathway	-27.1	-2.08	25.5	-3.68	-29.18	23.42
165: Bradley Beach, McCabe Avenue	-6.6	-29.76	3.5	-32.86	-36.36	-26.26
164: Avon By The Sea, Sylvania Avenue	-16	-0.9	3	-13.9	-16.9	2.1
163: Belmar, 5 th Avenue	1.8	-18.9	13.2	-3.9	-17.1	-5.7
162: Belmar, 18 th Avenue	-7.7	-16.6	5	-19.3	-24.3	-11.6
161: Spring Lake, Brighton Avenue	-25.9	-11.3	6.1	-31.1	-37.2	-5.2
160: Spring Lake, Salem Avenue	-24.2	-11.2	24.1	-11.3	-35.4	12.9
159: Sea Girt, New York Avenue	-68.6	21.3	3.8	-43.5	-47.3	25.1
158: Sea Girt, Trenton Avenue	-25.9	-29.3	25.4	-29.8	-55.2	-3.9
157: Manasquan, Riddle Way	-28.5	-20.3	-3.7	-52.5	-48.8	-24
256: Manasquan, Pompano Avenue	-12.3	-12.8	81.5	56.4	-25.1	68.7
AVERAGE for EACH SURVEY	-7.39	-20.51	42.04	14.15	-27.90	21.53

TABLE 5						
OCEAN COUNTY						
SEASONAL; OVERALL; ANNUAL SPRING & FALL BEACH VOLUME CHANGES						
	Survey & Time Period					
	Seasonal			Overall	Annual Spring & Fall	
	50 - 51	51 - 52	52 - 53	50 - 53	50 - 52	51 - 53
PROFILE SITE LOCATION	S15-F15	F15-S16	S16-F16	S15-F16	S15-S16	F15-F16
	Volume Change (cubic yards per foot)					
156: Point Pleasant, Water Street	-4.72	18.73	-12.68	1.59	14.26	6.3
155: Point Pleasant, Maryland Avenue	2.28	10.34	-0.53	9.89	12.68	10.06
154: Bay Head, Johnson Avenue	-5.78	-7.81	-6.68	-20.13	-13.59	-14.49
153: Mantoloking, 1117 Ocean Avenue	3.32	-4.79	5.39	3.56	-1.83	0.71
152: Brick Township, Public Beach #3	-1.86	13.12	-8.35	1.25	9.89	3.25
151: Normandy Beach, 1 st Avenue	26.11	-39.43	11.53	-1.39	-12.96	-27.65
150: Lavallette, White Avenue	-12.66	20.16	-5.45	0.62	6.99	13.85
149: Ortley Beach, 8 th Avenue	16.52	-27.26	-0.57	-10.5	-10.9	-27.97
248: Seaside Heights, Franklin Avenue	-1.56	-23.03	6.23	-18.55	-24.65	-17.25
148: Seaside Park, 4 th Avenue	-8.65	13.82	11.83	16.71	5.16	25.55
347: Midway Beach, 6 th Lane	40.58	-23.03	12.81	29.42	17.14	-11.1
247: Island Beach State Park, North End	-25.12	26.23	4.38	4.83	1.06	30.7
246: Island Beach State Park,	0.7	-20.58	-17.27	-34.46	-17.88	-36.63
146: Island Beach State Park, South End	10.82	-44.46	-24.41	-57.55	-33.44	-67.92
245: Barnegat Light, 10 th Street	14.7	-77.97	-11.18	-74.81	-63.51	-89.07
145: Barnegat Light, 26 th Street	25.46	13.6	45.49	80.44	38.21	59.09
144: Loveladies, La Baia Street	-0.07	7.35	125.64	131.95	6.53	132.87
143: Harvey Cedars, 73 rd Street	20.73	-25.97	16.59	11.58	-5.32	-9.68
142: Harvey Cedars, Tranquility Drive	-9.14	-88.18	123.33	28.7	-95.35	36.75
241: Surf City, 20 th Street	-10.66	3.74	19	12.01	-7.21	22.9
141: Ship Bottom, 8 th Street	-71.21	14.72	25.63	-24.1	-44.95	39.57
140: Long Beach Township, 32 nd Street	44.38	-11.06	-8.7	24.53	30.05	-18.76
139: Long Beach Township, 81 st Street	202.88	10.68	68.8	266.94	203.78	75.01
138: Long Beach Township, Old Whaling F	100.88	-5.63	37.18	134.32	95.69	33.25
137: Beach Haven, Taylor Avenue	29.23	112.64	-4.86	136.92	141.67	108.26
136: Beach Haven, Dolphin Avenue	-5.72	78.94	96.5	168.03	72.19	175.37
135: Long Beach Township, Webster Ave.	28.17	-3.22	179.02	203.22	25.52	175.88
234: Long Beach Township, Natural Area	9	13.68	110.07	133.64	23.1	123.74
AVERAGE for EACH SURVEY	14.95	-1.60	28.53	41.38	13.30	26.88

TABLE 6						
OCEAN COUNTY						
SEASONAL; OVERALL; ANNUAL SPRING & FALL SHORELINE CHANGES						
	Survey & Time Period					
	Seasonal			Overall	Annual Spring & Fall	
	50 - 51	51 - 52	52 - 53	50 - 53	50 - 52	51 - 53
PROFILE SITE LOCATION	S15-F15	F15-S16	S16-F16	S15-F16	S15-S16	F15-F16
	Shoreline Change (feet)					
156: Point Pleasant, Water Street	-13.2	33.1	-39.6	-19.7	19.9	-6.5
155: Point Pleasant, Maryland Avenue	3.7	-4.2	4	3.5	-0.5	-0.2
154: Bay Head, Johnson Avenue	-27.9	9.1	-9.8	-28.6	-18.8	-0.7
153: Mantoloking, 1117 Ocean Avenue	-5.1	-8.82	-3.8	-17.72	-13.92	-12.62
152: Brick Township, Public Beach #3	-10.6	-9.1	16.5	-3.2	-19.7	7.4
151: Normandy Beach, 1 st Avenue	-9	-8.78	14.2	-3.58	-17.78	5.42
150: Lavallette, White Avenue	-39.1	25.9	-2.5	-15.7	-13.2	23.4
149: Ortley Beach, 8 th Avenue	-12.3	-4.77	7.4	-9.67	-17.07	2.63
248: Seaside Heights, Franklin Avenue	5.8	-44.5	36.8	-1.9	-38.7	-7.7
148: Seaside Park, 4 th Avenue	-12.7	-21.3	36.4	2.4	-34	15.1
347: Midway Beach, 6 th Lane	31.2	-26.5	14	18.7	4.7	-12.5
247: Island Beach State Park, North End	-43.8	15.5	26.9	-1.4	-28.3	42.4
246: Island Beach State Park,	-51.9	-2.95	-16	-70.85	-54.85	-18.95
146: Island Beach State Park, South End	24.8	-26.34	-36.6	-38.14	-1.54	-62.94
245: Barnegat Light, 10 th Street	13.4	-90.3	-49.4	-126.3	-76.9	-139.7
145: Barnegat Light, 26 th Street	78.7	-3.4	53.3	128.6	75.3	49.9
144: Loveladies, La Baia Street	31.1	-53.1	186.5	164.5	-22	133.4
143: Harvey Cedars, 73 rd Street	56.3	-109.3	35.2	-17.8	-53	-74.1
142: Harvey Cedars, Tranquility Drive	39.7	-173	168.2	34.9	-133.3	-4.8
241: Surf City, 20 th Street	22.6	-61.7	29.1	-10	-39.1	-32.6
141: Ship Bottom, 8 th Street	-89.3	-29.4	52.4	-66.3	-118.7	23
140: Long Beach Township, 32 nd Street	67.5	-62.8	18.8	23.5	4.7	-44
139: Long Beach Township, 81 st Street	276.1	-105.88	149.1	319.32	170.22	43.22
138: Long Beach Township, Old Whaling F	167.8	-26.8	60.6	201.6	141	33.8
137: Beach Haven, Taylor Avenue	26.5	175.5	-52.3	149.7	202	123.2
136: Beach Haven, Dolphin Avenue	-19	198.9	-7.8	172.1	179.9	191.1
135: Long Beach Township, Webster Ave.	25	-1.8	190.6	213.8	23.2	188.8
234: Long Beach Township, Natural Area	-2	-21.9	198.6	174.7	-23.9	176.7
AVERAGE for EACH SURVEY	19.08	-15.67	38.60	42.02	3.42	22.93

TABLE 7						
ATLANTIC COUNTY						
SEASONAL; OVERALL; ANNUAL SPRING & FALL BEACH VOLUME CHANGES						
	Survey & Time Period					
	Seasonal			Overall	Annual Spring & Fall	
	50 - 51	51 - 52	52 - 53	50 - 53	50 - 52	51 - 53
PROFILE SITE LOCATION	S15-F15	F15-S16	S16-F16	S15-F16	S15-S16	F15-F16
	Volume Change (cubic yards per foot)					
134: Brigantine, Green Acres Area	-19.87	15.35	-18.27	-21.99	-4.93	-2.34
133: Brigantine, 4 th Street North	-23.24	-17.98	5.74	-39.84	-43.92	-12.65
132: Brigantine, 15 th Street South	11.95	-34.43	16.59	-4.91	-21.77	-19.98
131: Brigantine, 43 rd Street	0.37	3.58	6.91	10.41	3.5	12.56
230: Atlantic City, Rhode Island Ave.	-22.81	-32.55	-7.74	-57.55	-57.08	-39.55
130: Atlantic City, North Carolina Ave.	-12	-30.16	-13.23	-54.32	-41.98	-42.91
129: Atlantic City, Raleigh Avenue	2.89	-11.04	25.19	17.85	-8.1	15.11
128: Ventnor, Dorset Avenue	-18.27	-13.62	3.25	-29.52	-32.89	-9.56
127: Margate, Benson Avenue	-0.06	-32.82	30.39	2.53	-38.33	17.88
126: Longport, 17 th Street	-60.34	16.01	-4.59	-44.24	-40.5	12.48

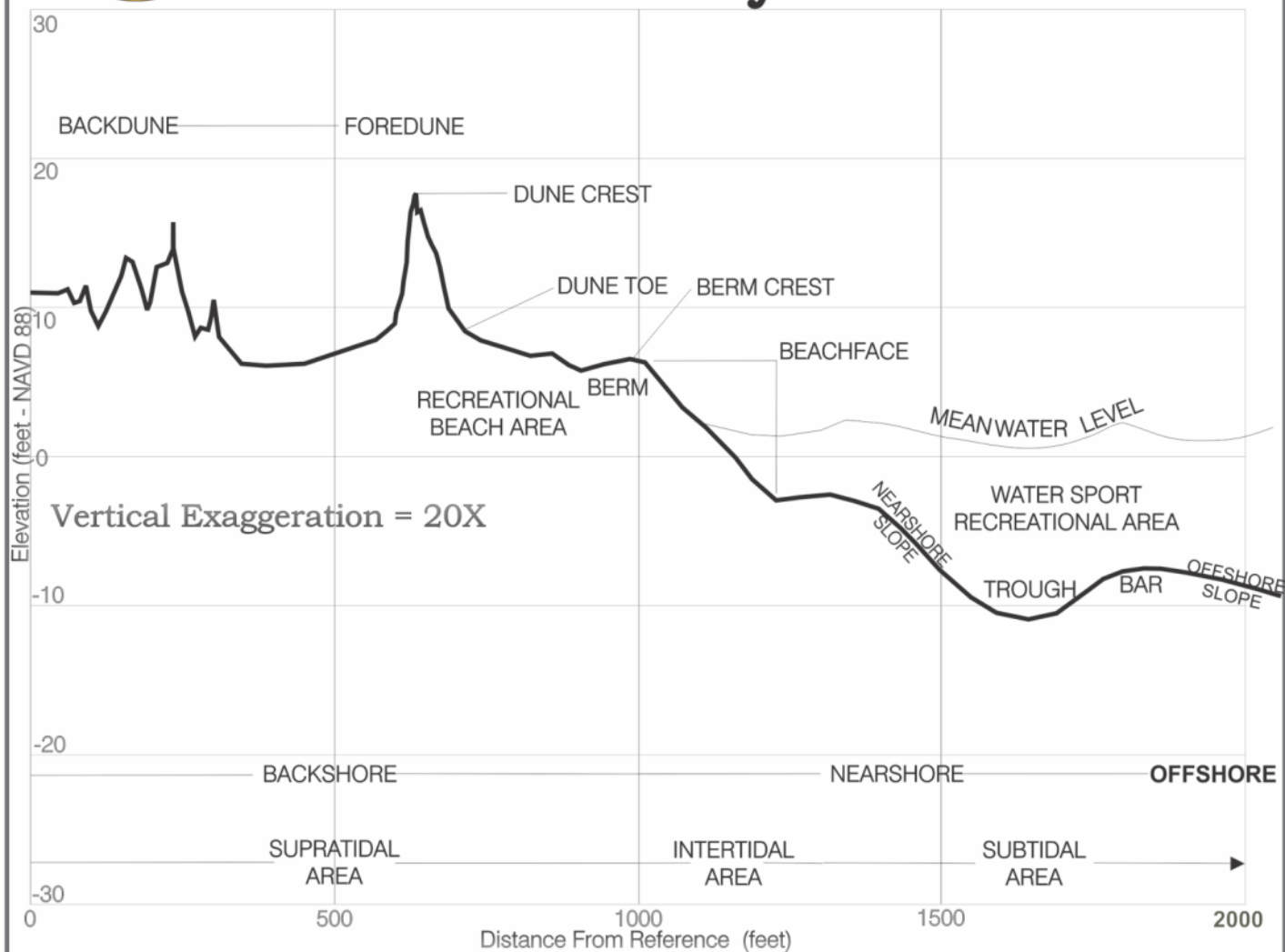
TABLE 8						
ATLANTIC COUNTY						
SEASONAL; OVERALL; ANNUAL SPRING & FALL SHORELINE CHANGES						
	Survey & Time Period					
	Seasonal			Overall	Annual Spring & Fall	
	50 - 51	51 - 52	52 - 53	50 - 53	50 - 52	51 - 53
PROFILE SITE LOCATION	S15-F15	F15-S16	S16-F16	S15-F16	S15-S16	F15-F16
	Shoreline Change (feet)					
134: Brigantine, Green Acres Area	26.9	-29.66	7.1	4.34	-2.76	-22.56
133: Brigantine, 4 th Street North	-117	52.04	-67.9	-132.86	-64.96	-15.86
132: Brigantine, 15 th Street South	12.5	11.1	-49.6	-26	23.6	-38.5
131: Brigantine, 43 rd Street	-78.6	84.7	-50.9	-44.8	6.1	33.8
230: Atlantic City, Rhode Island Ave.	-14.2	-13.5	-14.2	-41.9	-27.7	-27.7
130: Atlantic City, North Carolina Ave.	-10.4	-30.2	-33	-73.6	-40.6	-63.2
129: Atlantic City, Raleigh Avenue	43.7	-83.33	59.3	19.67	-39.63	-24.03
128: Ventnor, Dorset Avenue	-71.9	14.3	7.7	-49.9	-57.6	22
127: Margate, Benson Avenue	6.2	-85.87	40.7	-38.97	-79.67	-45.17
126: Longport, 17 th Street	-73.5	62.73	-49.6	-60.37	-10.77	13.13
SAND VOLUME AVERAGES	-14.14	-13.77	4.42	-22.16	-28.60	-6.90
SHORELINE AVERAGES	-27.63	-1.77	-15.04	-44.44	-29.40	-16.81

TABLE 9						
CAPE MAY COUNTY						
SEASONAL; OVERALL; ANNUAL SPRING & FALL SAND VOLUME CHANGES						
	Survey & Time Period					
	Seasonal			Overall	Annual Spring & Fall	
	50 - 51	51 - 52	52 - 53	50 - 53	50 - 52	51 - 53
PROFILE SITE LOCATION	S15-F15	F15-S16	S16-F16	S15-F16	S15-S16	F15-F16
	Volume Change (cubic yards per foot)					
225: Ocean City, Gardens Road	6.38	36.54	-18.26	25.21	42.85	18.67
125: Ocean City, 6 th Street	-10.46	35.48	-35.14	-10.03	25.21	0.91
124: Ocean City, 20 th Street	10.38	-29.6	27.31	12.95	-21.45	3.58
223: Ocean City, 34 th Street	11.11	-42.4	18.43	-3.32	-28.79	-15.01
122: Ocean City, 56 th Street	156.06	-13.92	28.12	171.35	142.17	16.1
222: Ocean City, 59 th Street	114.37	-27.28	34.64	118.26	86.81	8
221: Ocean City, Corson's Inlet Park	26.11	22.38	48.62	89.36	48.93	71.09
121: Strathmere, Williams Road	332.35	63.48	-5.23	391.06	396.25	59.78
120: Sea Isle City, 1 st Street	85.71	48.42	-14.58	119.47	133.3	34.48
119: Sea Isle City, 25 th Street	22.75	-16.83	10.46	20.18	9.67	-3.48
118: Sea Isle City, 57 th Street	112.47	36.04	23.55	164.94	147.06	55.63
117: Sea Isle City, 80 th Street	178.86	-66.16	7.61	119.79	112.73	-59.59
216: Avalon, 9 th Street	73.12	-4.02	-12.84	62.07	76.88	-8.22
116: Avalon, 23 rd Street	53.64	11.47	38.41	103.46	65.12	49.66
115: Avalon, 35 th Street	11.67	-34.79	35.1	10.08	-25.5	-0.63
114: Avalon, 70 th Street	-26.46	23.52	-5.56	-2.19	2.58	18.43
113: Stone Harbor, 90 th Street	-13	-47.41	6.06	-51.66	-60.38	-42.92
212: Stone Harbor, South End	-22.12	-23	12.49	-33.71	-46.65	-10.62
111: North Wildwood, 15 th Avenue	-35.72	-5.2	-13.49	-54.54	-40.98	-18.8
110: Wildwood, Cresse Avenue	-6.66	-40.53	30.14	-10.79	-38.26	-7.92
109: Lower Township, Raleigh Ave.	-8.96	-40.85	1.3	-43.84	-50.36	-37.31
208: Lower Township, Cape May NWR	13.01	-15.5	20.01	17.36	-1.64	4.31
108: Cape May Beach Club	3.64	-23.85	-13.27	-32.77	-19.51	-36.39
107: Cape May, Baltimore Ave.	-7.78	6.85	-2.7	-3.23	-0.83	4.56
206: Cape May, Broadway Ave.	3.55	-28.17	-8.61	-34.44	-23.94	-37.5
105: Cape May, Nature Conservancy	-54	6.94	24.97	-22.14	-46.48	31.82
104: Cape May Point, Lake Drive	-16.65	4.95	-12.61	-24.17	-11.18	-7.69
103: Higbee Beach	3.9	-3.19	2.81	3.61	0.77	-0.25
102: North Cape May, Whittier Ave.	1.53	-5.2	6.84	3.6	-3.34	2.05
201: Lower Township, Pacific Avenue	0.5	-0.77	1.06	0.96	-0.31	0.78
100: Reeds Beach	-2.5	0.89	-0.82	-2.47	-1.61	0.01
AVERAGE for EACH SURVEY	32.80	-5.54	7.57	35.63	28.04	3.02

TABLE 10						
CAPE MAY COUNTY						
SEASONAL; OVERALL; ANNUAL SPRING & FALL SHORELINE CHANGES						
	Survey & Time Period					
	Seasonal			Overall	Annual Spring & Fall	
	50 - 51	51 - 52	52 - 53	50 - 53	50 - 52	51 - 53
PROFILE SITE LOCATION	S15-F15	F15-S16	S16-F16	S15-F16	S15-S16	F15-F16
	Shoreline Change (feet)					
225: Ocean City, Gardens Road	23.5	-12.8	17.7	28.4	10.7	4.9
125: Ocean City, 6 th Street	34.6	-15.3	-11	8.3	19.3	-26.3
124: Ocean City, 20 th Street	-16.3	-52.6	20.8	-48.1	-68.9	-31.8
223: Ocean City, 34 th Street	71.3	-32.3	-6.7	32.3	39	-39
122: Ocean City, 56 th Street	298.2	36.9	-22.3	312.8	335.1	14.6
222: Ocean City, 59 th Street	189.9	-12.5	59.2	236.6	177.4	46.7
221: Ocean City, Corson's Inlet Park	184.8	-98.7	82.2	168.3	86.1	-16.5
121: Strathmere, Williams Road	548.7	42.5	21.7	612.9	591.2	64.2
120: Sea Isle City, 1 st Street	155.3	16.24	-9.7	161.84	171.54	6.54
119: Sea Isle City, 25 th Street	67.2	20	-72.6	14.6	87.2	-52.6
118: Sea Isle City, 57 th Street	184.2	41.1	53.8	279.1	225.3	94.9
117: Sea Isle City, 80 th Street	294.4	-128.7	-37.8	127.9	165.7	-166.5
216: Avalon, 9 th Street	133	-75.7	-8.1	49.2	57.3	-83.8
116: Avalon, 23 rd Street	43.9	25.4	57.3	126.6	69.3	82.7
115: Avalon, 35 th Street	9.6	-240.5	196.7	-34.2	-230.9	-43.8
114: Avalon, 70 th Street	-49.2	11.9	10.4	-26.9	-37.3	22.3
113: Stone Harbor, 90 th Street	-11.2	-34.52	-10.3	-56.02	-45.72	-44.82
212: Stone Harbor, South End	-61.9	6.9	8.3	-46.7	-55	15.2
111: North Wildwood, 15 th Avenue	-81.7	-30.44	29.5	-82.64	-112.14	-0.94
110: Wildwood, Cresse Avenue	-48.3	22.7	41.7	16.1	-25.6	64.4
109: Lower Township, Raleigh Ave.	7.7	-18.53	11.1	0.27	-10.83	-7.43
208: Lower Township, Cape May NWR	-23.4	-54.4	83.1	5.3	-77.8	28.7
108: Cape May Beach Club	14.6	-54.5	-3.6	-43.5	-39.9	-58.1
107: Cape May, Baltimore Ave.	-18.7	-2.6	-7.6	-28.9	-21.3	-10.2
206: Cape May, Broadway Ave.	-17.7	-62	10.6	-69.1	-79.7	-51.4
105: Cape May, Nature Conservancy	-93.5	-4.7	23.2	-75	-98.2	18.5
104: Cape May Point, Lake Drive	-19.1	7.4	-33	-44.7	-11.7	-25.6
103: Higbee Beach	-2.8	2.6	-5.4	-5.6	-0.2	-2.8
102: North Cape May, Whittier Ave.	17.6	6.5	5.9	30	24.1	12.4
201: Lower Township, Pacific Avenue	-2.3	1	1.9	0.6	-1.3	2.9
100: Reeds Beach	-3.7	2.75	0.1	-0.85	-0.95	2.85
AVERAGE for EACH SURVEY	58.99	-22.16	16.36	53.19	36.83	-5.80

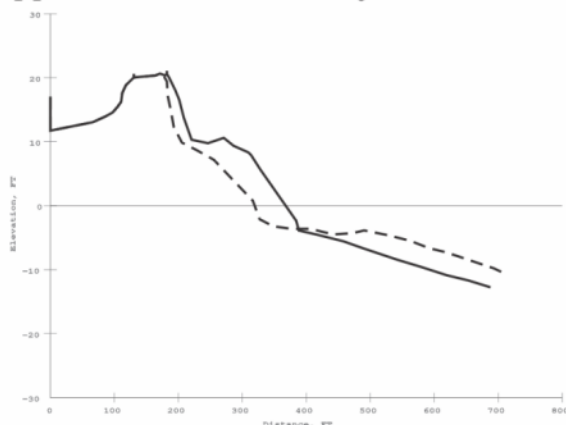


Typical Beach Profiles in New Jersey



Above is a typical beach profile with major features and zones labeled. No beach will show every aspect of this diagram at all times, but it illustrates all important features that appear on the New Jersey shoreline..

Seasonal Variations



The pair of profiles to the left show typical seasonal beach profile changes. The dashed line profile develops during a winter season, where wave conditions move material offshore. The solid line profile is generated during a summer season, where wave conditions move sand onshore, building a well developed berm and wider beach and adding to the dune. The winter wave conditions shift this beach material to the offshore region of the profile.



Coastal Research Center

Glossary of Coastal Terms

Accretion - The addition of material to the beach by natural processes.

Aeolian Accretion - The accretion that results from wind transport of sand landward of the water line.

Backshore - The area of the beach profile landward of the berm and seaward of upland dunes or bluffs. Also termed the "backbeach".

Beachface - Also known as foreshore. The area of the beach exposed to regular wave action.

Berm - The nearly horizontal portion of the beach formed at the high water line as waves deposit material. A beach may have no berm or multiple berms depending on tidal ranges.

Bulkhead - A structure that is built to retain or prevent the slumping of land at the influence of water and wave action. Bulkheads are typically made of wood, steel, plastic or aluminum.

Cross-shore Transport - The transfer of sand perpendicular to the shoreline, or along the profile. A bar migrating onto the beach is an example of cross-shore transport.

Current - The rate of flow of water.

Downdrift - The dominant direction of movement of littoral sediments.

Datum - A reference level from which elevations are measured.

Dry Beach - The area of beach between the water and dune toe that is commonly used for recreation. Also referred to as the recreational beach.

Dune - Unconsolidated hills or mounds of sand. Dunes are the result of aeolian processes and may have vegetation ranging from sparse to dense. Vegetation greatly stabilizes a dune.

Eddy - A current that rotates over a relatively small area as a result of confluence of streams or excess turbulence.

Erosion - The removal of sediment by natural processes, such as wind water or ice movement.

Foredune - The most seaward dune ridge along the profile.

Geotube - A geo-textile fabric tube filled with sand, typically used to retain material or to dissipate wave energy at a point where erosion is a substantial problem.

Groin - A shore-perpendicular erosion control structure, usually made of wood or rock. This structure acts to slow the process of littoral transport of the sand along the shoreline.

Hurricane - A tropical cyclone in the Northern Hemisphere, with sustained winds over 74 mph.

Jetty - A shore-perpendicular erosion control structure similar to a groin, however it is used to control the position of an inlet or channel.

Littoral Current - Current that moves parallel to the shoreline, that results from the approach of waves at some angle to the shoreline not equal to a parallel-to-the-beach approach direction.

Littoral Drift - Also known as longshore transport. Movement of material in the longshore direction, resulting from currents generated by waves (above).



Longshore Transport - Also known as littoral drift. Movement of sand in the longshore direction, resulting from the littoral currents.

NGVD - (the datum of 1929) An elevation reference developed from a specific model of the Earth's surface.

NAVD - (the datum of 1988) A revised reference elevation derived from leveling observation adjustments.

Onshore - In the direction of the shoreline; landward.

Offshore - In the direction away from the shoreline; seaward from the shoreline.

Neap Tide - A tide having significantly reduced variations from mean tide levels. Neap tides occur near quarter moon stages.

Nearshore - Region of beach profile extending from the berm seaward to moderate depths.

Northeaster - Dominant type of coastal winter storm event experienced in New Jersey, with winds from the northeast that exceed 30 mph.

Revetment - Cover of stone placed on or along a shoreline to protect a slope or shore structure.

Ridge - A low relief, shoreline-parallel continuous ridge of sand, built and pushed landward by wave action.

Riprap - Line of smaller rocks placed as a mass along a slope or structure for protection.

Runnel - An area of lower elevation than, but parallel to and usually landward of a ridge(s).

Scarp - A near vertical feature created through the erosion of sand from the lower portion of a slope or bluff.

Scour - Underwater removal of material through currents and wave action.

Seawall - A hard structure that separates the land and water.

Shoreline - The narrow area of land in contact with the water. When referring to a profile plot, the point where the profile crosses the line representing the datum (zero elevation usually).

Spring Tide - Tide with the most extreme variations from mean tide levels. Spring tides occur at new or full moon stages.

Swale - A long, narrow, generally shallow depression between ridges.

Swash - The area of beachface exposed to breaking wave energy as they come ashore.

Storm Surge - The abnormal rise in local sea level that accompanies a hurricane or other major storm event due to the lower barometric pressure in the storm and wind shear on the water's surface.

Updrift - In the direction opposite of the dominant movement of littoral materials.

Wrack - Debris deposited on the beach by wave action.

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