THE RICHARD STOCKTON COLLEGE OF NEW JERSEY
COASTAL RESEARCH CENTER

In the past 25 years, perhaps the most dramatic shoreline change has occurred at Barnegat Inlet, NJ following the re-alignment of the south jetty starting in 1989. The entire Borough shoreline advanced from its March 1987 (left) position at the lighthouse 2,400 feet along the new jetty declining to 450 feet at 26th Street in Barnegat Light Borough.

New Jersey Beach Profile Network 2011 Annual Report on Shoreline Changes in New Jersey Coastal Reaches One Through Fifteen Raritan Bay to Delaware Bay--Covering 25 Years of Research

Prepared for:
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Coastal Research Center

New Jersey Beach Profile Network
2011 Annual Report

Shoreline Changes In New Jersey
Coastal Reaches One Through Fifteen
Raritan Bay to Delaware Bay
A Review of 25 Years 1986 to 2012

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EXECUTIVE SUMMARY

The New Jersey Beach Profile Network (NJBPN) project was authorized by the New Jersey Department of Environmental Protection (NJDEP) in 1986. This year marks a quarter century of reporting on the conditions observed along the New Jersey shoreline. To mark this milestone the normal format has been expanded to include comparison plots of the 1986 cross section against the fall 2011 survey, comparison photographs covering the 25-year interval, and graphs of the 25 years of annual sand volume change and shoreline position shift for each of the 105 sites. A cumulative value over time is also presented along with a trend line of expected future evolution at the site. The report is divided into four coastal county segments and provides a summary of beach changes for that county. Major beach restoration or hard structure projects are reviewed for performance and effectiveness. A discussion of issues and pending project work in the county is also included. These observations on beach changes along the New Jersey coastline provide a means to determine both rapid seasonal changes as well as follow long-term trends in shoreline position and beach volume. Major shore protection projects resulting in the addition of millions of cubic yards of new sand have given a performance monitoring aspect to the report. The report includes the 105 profile site locations that extend from the lower Raritan Bay, along the four oceanfront county shorelines and into Delaware Bay along the western shore of Cape May Co.

Traditional photographs, cross sections, trend charts, and text focus on the seasonal and year to year changes observed since the previous report. The report is also found on the website at www.stockton.edu/crc. Past reports are linked to the site so comparisons can be made to the most recent observations along the New Jersey coastline. These reports show the following:

- The enormous positive impact of beach nourishment over the past 25 years.
- The enhanced shoreline protection benefits of 25 years of dune growth in height and width.
- The importance of the inlet processes and their impact on changes on adjacent beaches.
- The ability to analyze causes of extreme sand volume gain or loss at specific sites on the coast.
- The pattern of sand distribution along barrier islands as determined by that island's profiles.
- The beneficial results of the low incidence of serious storm events impacting the NJ coast.
- The ability to gage the impact of Declared Disaster events on the NJ coastline.

The recent pattern of storms has followed the pattern of Pacific Ocean equatorial temperature variation termed El Nino and La Nina. The 2009-2010 winter saw two Federal disaster declarations while a third occurred in late December 2010. Hurricane Irene made landfall along the Ocean County shoreline as a strong tropical storm with winds just under hurricane strength. Irene and a late October 2011 northeaster were the only events to occur between June 2011 and June 2012. The entire winter post October 29, 2011 saw very mild weather conditions with no measurable erosion due to northeast storm activity. In fact late April 2012 had worse weather at the ocean front than all of November 2011 through March 2012.

The survey data were analyzed and evaluated to show changes in the four county shorelines and sand volume changes for the 18-month study interval. The three-month seasonal average sand volume changes for each county plus the 18-month summary are shown below.

	S 10 – F 10 Cu. yds/ft.	F 10 – S 11 Cu. yds/ft.	S 11 – F 11 Cu. yds/ft.	S 10 – F 11 Cu. yds/ft.
Monmouth County	-2.91	2.05	-0.66	-1.24
Ocean County	4.71	0.57	2.54	9.41
Atlantic County	7.69	1.82	33.81	43.17
Cape May County	2.59	5.78	15.46	24.24

Beach nourishment occurred in the southern three counties between the spring 2010 and fall 2011. The 2009 Long Branch project had been redistributed by early 2010 and had minimal impact on the averages. Strong shoreline advances were seen at the 14 northern Ocean County sites as sand migrated onto the beach profile in substantial quantities. This proved beneficial during Hurricane Irene because many beaches were wider than in many previous summer seasons. Sand was added to Long Beach Island, Absecon Island, Ocean City, Ludlam Island, 7-Mile Island and Cape May City during this time interval. A restoration project was conducted in the City of North Wildwood to repair cumulated damages from November 2009 through December 2010. Hurricane Irene and the October 29, 2011 storm were restored using recycled sand trucked in from the berm in the Borough of Wildwood Crest in the late winter of 2012.

The shoreline change values reflect low storm frequency combined with long, quiet periods where sand could migrate landward from water depths near 20 feet to the offshore bars where it could progress up the foreshore slope to the berm. The beach nourishment activity within the southern three counties produced three-times the advance seen in Monmouth County, which has a steeper beachface slope because the sand is coarser in size.

	S 10 – F 10 Feet	F 10 – S 11 Feet	S 11 – F 11 Feet	S 10 – F 11 Feet
Monmouth County	1.44	3.51	8.39	13.33
Ocean County	19.88	2.24	17.16	39.28
Atlantic County	7.68	13.28	17.29	38.26
Cape May County	5.86	0.35	30.90	41.28

State wide, the sand volume change at all 105 sites was a gain of 10.32 $yds^3/ft.$ The State-wide shoreline change was an advance of 29.36 feet.

Since 1986 approximately $601,577,500 has been spent to place 80,735,735 cubic yards of sand on 53.75 of the 97.09 miles of developed New Jersey shoreline (Sandy Hook to Cape May Point is 126.45 miles). Of the 97-mile developed shoreline 55.36% has been nourished since 1985 by either the ACOE (84.67%) or the NJ State/local partnership (15.33%). The impact over 25 years has been an average coast-wide sand volume gain of 3.022 $yds^3/ft.$ and a shoreline advance seaward of 4.029 feet. Dividing the 25-year beach nourishment volume by 25, then by the number of feet along the NJ coastline equals 4.816 $yds^3/ft.$ in sand volume placed on each foot of beachfront. The average price per cubic yard placed appears to be a significantly impressive investment in maintaining a $36,600,000,000 ANNUAL economy generated by NJ coastal tourism.

ACKNOWLEDGEMENTS

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INTRODUCTION:

It has been a quarter century since the Division of Coastal Resources within the New Jersey Department of Environmental Protection (NJDEP) requested an initial quantitative survey of the entire State ocean coastline be undertaken. This project remains one of just a few where coastal states conduct repetitive surveys of their beach/dune systems to determine the annual magnitude and rate of change in the sand volume or shoreline position for the entire State's ocean coast. The New Jersey program is the only one where the project has been conducted in the same format, with the same methodology, and with the same leadership guiding the process for its duration thus far.

The New Jersey Beach Profile Network (NJBPN) project provides local and regional information on coastal zone changes and is designed to document seasonal and storm-related damage assessments of the New Jersey shoreline. This report includes long-term trends at all 105 sites to develop statistically meaningful information for use by State and local coastal zone managers. The database covers 25 years at 105 locations between Raritan Bay (three sites in the lower bay), the Atlantic Ocean coastline, and Delaware Bay (four sites on the western shoreline of Cape May County). Each site has been visited annually in the fall since 1986. Semiannual visits, each spring and fall, began in 1994 following the passage of Public Law 155. The program was expanded to take surveys every spring following the winter northeasters and in the fall following the summer beach accretion. In addition, new sites were established in the gaps of coverage and adjacent to tidal inlet shorelines. This means that about 10 sites have been followed for less than the 25-year history of the program, but their addition significantly benefited the data coverage. The information collected consists of photographs of the beach/dune system at each site, a topographic profile of the dune, beach and seafloor to a minimum depth of 14-16 feet, and field notes on significant geologic changes. Also, any construction activity is noted and necessary information regarding quantity and duration of such activity is gathered. The field data are used to generate graphical cross section plots, which can be used for comparison across the width of the active coastal zone. The cross section is also used to calculate sand volume and shoreline position changes. The 2011 report is the latest in a series of annual reports prepared for the New Jersey Department of Environmental Protection (NJDEP) that began in 1987. The information is arranged by county and sequential profile site location, and includes the survey cross sections, site photographs, a graph of the 25-year trend in sand volume and shoreline position, and the description of significant changes. The tables of the beach volume and shoreline change data for this contract period are found after the county site descriptions for Cape May County. A summary of each county's coastal zone activities follows the county profile site location diagram.

SIGNIFICANCE OF THE PROJECT TO NEW JERSEY COASTAL MANAGERS:

The NJBPN program came into being following northeast storm damage in 1984 that was followed the following summer with the passage of Hurricane Gloria. At that time there were no systematic evaluations of beach width, dune heights, sand supply changes or shoreline positions relative to valuable infrastructure assets on the shoreline. The NJ Coastal program was run through the NJDEP's Division of Coastal Resources under the leadership of John Weingart. All NJ-sponsored construction projects were handled by the Division of Coastal Engineering and Construction under the direction of Bernard Moore (Bernie to all those involved). US Army Corps District projects were handled separately by the Corps with minimal to moderate NJ State cooperation. Since the State has two separate Corps Districts with jurisdiction along the NJ shoreline, the cooperation was further diluted. The New York District is responsible for Raritan Bay and the ocean coast

south to the north jetty of Manasquan Inlet. The Philadelphia District has responsibility for the Manasquan Inlet, south into the Delaware Bay. The Philadelphia District is also responsible for the NJ Inter-coastal Waterway within the barrier island lagoons to Bay Head in Ocean County.

The modern era started slowly, but it could be said that the beginning was cooperation among New Jersey's Congressional delegation, the Army Corps, and the Division of Coastal Engineering that commenced following Hurricane Gloria in 1985. The stimulus was a Congressional Authorization for $6,000,000 to offset storm damage losses and provide incentive to establish a better means of dealing with coastal storm damages. Former Senator William Bradley and his cohorts in Congress guided the funds to the Division of Coastal Resources, who involved the NJ Coastal Engineering operation. At the same time Congress was considering using Federal funds to allow the US Army Corps of Engineers to undertake shore protection projects at a 65% federal share of project cost. Congressman William Hughes (R-Cape/Atlantic County) was a strong proponent of this means of shore protection and found a willing State partner in Mr. Bernie Moore. NJ coastal legislators also realized that 100% State funding using bond authorization legislation was not the long term solution to the problems facing the state's coastline were eager to combine Federal and State with local contributions as large scale project affecting entire barrier islands.

The inception of New Jersey Federal projects commenced at both Corps Districts with by far the most comprehensive work designed around the restoration of the entire Monmouth County (non-federal) ocean coastline. The Philadelphia District commenced work on the Ocean City and Cape May City beaches in the late 1980's. The Army Corps procedure developed around a 100% federally funded reconnaissance study on the validity of shore protection within the affected zone being considered and an evaluation of the benefits versus the costs incurred. With positive outcomes favoring the project from the reconnaissance study, the Corps continued into the next phase called the Feasibility Study that was 50% federally funded and 50% State funded. This was a comprehensive evaluation of the erosion and damage situation, the environmental issues, the economic assessment of the public and private assets needing protection and an evaluation of several methodologies designed to rectify the erosion problems. Following positive outcomes from the Feasibility Study, the project design work was given the go-ahead and a NJ State and local partnership was created to be part of the Federal State-Aid agreement that would authorize the project to proceed given US Congressional authorization of the funding for the 65% Federal share.

The NJ State Congressional and Senatorial Delegations were extremely important to this effort advancing, but cooperation among the NJ Senate and Assembly was critical as well because the remaining 35% of project cost was to come from the "local" partners. In 1994 the State passed what has been called the NJ Shore Protection Act that created a perpetual fund to provide the majority (75%) of the non-Federal project share and stop relying on repetitive legislative bond authorizations (that needed voter approval) and have funds available to leverage the Federal project funding rate of 65% of project costs. The New Jersey Shore Partnership was founded to promote this cooperation between State and Federal agencies, lobby the Congressional team and coordinate the State work with the Federal designs through Mr. Moore's offices.

By 1988 this effort resulted in two projects starting up in Ocean City and Cape May City in Cape May County. Both were federally authorized to restore the shore protection to entire communities comprising most of or all of an entire barrier island. Design evaluation by the Corps of Engineers determined that beach nourishment on a very large scale gave the best return on investment in terms of storm damage avoided and economic benefit to the region. Sand would be derived from the ebb-tidal delta deposits at the inlets or derived from seabed deposits offshore that contained suitable material for use as beach fill sand. Hard structures were analyzed, but found to be too expensive for large scale utilization and did not provide the means to allow traditional recreational and public access uses of the shoreline after installation.
As all the design and planning work proceeded, the Division of Coastal Resources requested that Dr. Stewart Farrell at Stockton State College determine a means to monitor beach, dune and offshore changes along the entire shoreline to have a quantitative database available should major storm damage occur in the future. A

team of Coastal Resources personnel, Dr. Farrell and an outside consultant (Dr. Steven Leatherman) undertook a week-long tour of the entire ocean shoreline and selected 100 potential sites for surveys of the beach/dune system. While the beach survey research process was not unique having been developed decades previously, applying it to an entire State's coastline in a consistent and repetitive manner was brand new in the nation. The initial program was to visit each site one yearly in the fall to capture the maximum sand deposit on the beach following the summer's accretional interval. In 1994 the program was increased to twice a year adding a spring survey to collect data on what usually is a minimal beach width following multiple winter northeast storms. At that time eight new survey locations were added and two were abandoned. Over the next 18 years a few more sites were added to provide coverage of gaps in the data and cover the New Jersey State Park shoreline on Pecks Beach in Cape May County. The seven sites on the Raritan Bay and Delaware Bay shoreline have provided corresponding data on the performance of bay beaches were sand is the dominant sediment type. Today, 25 years later, this is the only program where the same procedures, consistent application and the same entity has been responsible for the data and its presentation to the State has been operating in the US.

THE NEW JERSEY COASTAL ZONE:

The northern coast in Monmouth County is considered a headland beach (carved into older geologic sedimentary units that created a sandy beach backed by a bluff of the older sediments) which erode during serious storm events. The erosion provided new sand supplies and some gravel to the beach system, but the repeated bluff retreat produced by storms quickly became a serious problem following extensive human development during the last third of the 19th Century. Coastal protection structures multiplied and intensified between 1880 and 1950. Centuries of erosion had created two major sand spits, one to the north from Long Branch (Sandy Hook), and the other to the south from Bay Head (Mantoloking to Barnegat Inlet). To the south of Barnegat Inlet, barrier islands compose the remainder of the NJ coastline where individual islands are separated from the mainland by a series of bays and tidal lagoons. These islands provide no local sand supply to the beach and as a result the shoreline moves landward with rising sea level. All areas of the New Jersey coastline continue to strive for equilibrium in response to storms, waves, sea level and tidal currents in spite of all human efforts to establish stability and protect man-made development.

The greatest human influence on growth in the coastal counties was from the establishment of the rail system from the metropolitan centers to the shore. Businessmen in New York City created the New York & Long Branch Railroad in the 1870's following the Camden & Atlantic City Railroad's construction to Atlantic City on Absecon Island in the late 1850's. This growth accelerated during the last 20 years of the 19th Century. Previously, visitors had been coming to the NJ shore by boat or overland to small "resorts" in Cape May, or Tucker's Beach and points along the Monmouth County shoreline. Every major conflict and/or financial crisis curtailed the rate of development. World War I halted growth, but after the peace major new hotels were built at all the, then developed sites. The Great Depression followed by World War II eliminated growth until the late 1940's. Between 1950 and 2000 the rush to the shore was on. Multi-lane highways replaced the railroads to give the public access and the purchase of a second home became the way to vacation at the beach. Today visitors generate $27.7 billion in tourism revenue; create 350,000 jobs at local businesses, which pay $5.0 billion in taxes to the NJ treasury making the Jersey shore and its tourism the second largest state industry.

Naturally, defending this investment against storms, tidal currents, and sea level rise has also become a highly advanced industry. Early efforts relied on local products primarily the Eastern White Cedar to create bulkheads, jetties and groins along the coast. Big errors made during the early years were:

1) Not reserving the dry beach and dune system as publicly held real estate.
2) In many cases plowing large dune systems flat to make more room for development.
3) Building on tidal inlet channel margins and failing to recognize the rapid rates of channel migration.

The arrival of the railroad meant that other products could be brought in to hold back the sea. Concrete, stone and steel made their impact as all structures facing the ocean got higher, longer, and tougher. Better roads and

trucks brought all these commodities directly to any coastal site in crisis. As a result many segments of the coast have continuous bulkheads, closely spaced groins and all but 3 of the 11 inlets are confined by jetties.

The earliest attempt at sand supplies came in the form of trucking sand from Belmar beaches across the Shark River Inlet and dumping it on the Avon side to effectively "by-pass" the inlet. In 1952 the ACOE conducted a 2.54 million cubic yard beach fill in Ocean City in Cape May County. Beach restoration followed the devastating March 1962 northeast storm as many sources of sand were employed to replace the beaches torn away by the event. Beach nourishment got a boost in the 1970's as the State passed two multi-million dollar bond issues to finance projects at a variety of places. Congressman William Hughes guided an initial Federal project in Ocean City at the same time the restoration was advancing to construction in Cape May City. These successes generated interest in undertaking the restoration of the entire Monmouth County oceanfront shoreline. Five years, 25 million cubic yards of sand and $250 million dollars later, the largest beach restoration project ever in Monmouth County was completed by 2000. Additional Federal beach projects were approved and constructed in Surf City, Brigantine, Atlantic City, Ventnor City, Ocean City, Avalon, Stone Harbor, Cape May City and Cape May Point. Federal projects are pending for the Northern Ocean County shoreline (hampered by real estate issues), Ludlam Island and North Wildwood, but lack sufficient funding to go to construction. State and local sponsorship have carried this effort to non-Federal sites. This effort has moved the State of New Jersey to number one in the nation in terms of the percentage of the shoreline under nourishment contracts and in terms of obtaining Federal dollars for beach restoration.

The legacy of having private ownership of the beach has proved to be a thorn in the side of future beach nourishment in areas pending because private ownership frequently extends to the Mean High Tide Line in New Jersey. The original private developers held thousands of feet of coastal property, but with subdivisions to create 50 to 100-foot wide lots for individual homes, the number of properties within a prospective beach restoration project makes obtaining signed easement documents nearly impossible. Owner resistance varies from reluctant to militantly against allowing the project to proceed on their piece of the beach. Experience has shown that a few antagonistic property owners can sabotage a major project in spite of the enormous economic benefit to the municipality as a whole. Litigation takes time and money and the Federal agency (ACOE) insists that real estate problems are the responsibility of the local sponsor of a project. A Court decision has forced the NJDEP to re-evaluate their public access goals especially in sections of the NJ coast primarily devoted to private single family homes at the shoreline. Public funding for shore protection has many public benefits beyond saving expensive private homes at the beach. The health of the NJ beach economy depends on making investments in all of it over time if the State desires to maximize the benefits to, utilization by, and revenue stream this part of the State's environment provides to its citizens.

STORM EVENTS IN 2010-2011:

The 2009-2010 winter storm season was the most intense in the new century, but this past winter was one of the most benign. A northeaster October 29, 2011 was followed by the mildest winter in decades without a single storm until April 29, 2012. Beach erosion was minimal, even at local "hot spots". The October storm event did receive a limited storm disaster declaration.

The hurricane season produced the first tropical system to cross the NJ coastal oceanfront shoreline since 1903. Hurricane Irene began in the latter part of August developed into a category 4 storm by August 26th and was feared to possess the energy and intensity to be a major threat to the Carolinas and the Mid-Atlantic coastline. The hurricane made its initial US landfall on the southern North Carolina shoreline as a category 1 storm, moved back out to sea off Virginia Beach, VA, passed seaward of the Eastern Shore, Maryland and Delaware before crossing the NJ shoreline in Atlantic County on August 29th. Irene went back to sea in Ocean County and continued to make its third landfall on Long Island. It crossed Long Island, Long Island Sound and died in New England producing disastrous flooding as the tropical moisture was dumped on the hilly landscape.

Irene was declared a Federal Disaster by the President and became DR-NJ 4021. Most beaches had become narrower from the offshore movement of sand during the numerous 2009-2010 storm events. The storm-generated littoral currents moved material south and eroded the beaches on the south side of each tidal inlet. Dunes lost sand with some scarps reaching the crest of the existing dune. Several homes on Long Beach Island were left standing on the wet beach at low tide requiring emergency authorization of funding replacement sand supplies. Quarry sand was hauled to the Borough of Avalon to restore the dune between 17th and 21st Streets. Two large NJ State/local beach projects suffered multi-hundred thousand cubic yard sand losses in The Township of Upper and North Wildwood. Both of these projects were completed in 2009, with the contractor forced off the site prior to finishing the last 40,000 cy of the contract in the City of North Wildwood.

TWENTY-FIVE YEAR ANALYSIS OF SHORELINE CHANGE:

In addition to the annual 2010 to 2011 review, this report provides a 25-year shoreline change analysis of each of the 105 monitoring sites and a discussion of the overall trend for each county. Four figures are provided for each site: a full-page photograph of the 2011 shore condition, 2010-2011 cross sections for the dunes, beach and offshore, 25-year cross section comparison between 1986 and 2011 with comparison photographs, and a 25-year trend in shoreline location and sand volume changes. Note that in the 25-year cross section comparison figure, the dashed red line (1986 inferred) represents an inferred extension of the 1986 profile. This line is extended to the final point on the 2011 survey to allow the calculation of estimated sand volume changes offshore. The inferred line could have been extended in a straight line from the final two points in the 1986 survey or extended horizontally, but neither method would provide reasonable estimates of sand volume change for the region of the cross section not covered back when an optical theodolite and a traditional survey stadia was used. The laser transit and prism allowed the swimmer freedom to go much further out to sea and reach the 16-foot depths done since 1991. The in-water part of the early profiles was done with 80 pounds of lead around one's waist and the hope that the depth was never over your head in the wave trough. Drawing a straight line to the 2011 final elevation point provides the best estimate of the sand volume change for the zone between the ending point of the 1986 profile and the ones done after the laser was adopted. There are several new sites added since 2009 where it made no sense to do a trend analysis on three years of data, so no trend graph exists for those sites.