New Jersey Geological Survey
Open-File Report OFR 95-1

CHARACTERIZATION OF OFFSHORE SEDIMENTS IN FEDERAL WATERS AS POTENTIAL SOURCES OF BEACH REPLENISHMENT SAND--PHASE I

FINAL REPORT
MINERALS MANAGEMENT SERVICE
COOPERATIVE AGREEMENT #14-35-0001-30666

N.J. Department of Environmental Protection - Division of Science and Research

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Cover illustration: The Round Valley Reservoir in Hunterdon County holds surface water withdrawn from the Raritan River. This water is released back to the Raritan during low-flow periods if needed to meet potable-water demands downstream. No water is withdrawn from the Raritan River for the reservoir if no releases were required the previous year. The reservoir is also a popular recreation spot. Photo courtesy of the DEP's Division of Parks and Forestry.

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CHARACTERIZATION OF OFFSHORE SEDIMENTS IN FEDERAL WATERS AS POTENTIAL SOURCES OF BEACH REPLENISHMENT SAND--PHASE I

Final Report on Phase I, Cooperative Agreement #14-35-0001-30666, to investigate sources of beach replenishment sand in federal waters offshore of New Jersey

by

Jane Uptegrove[1], Lloyd G. Mullikin[1], Jeffrey S. Waldner[1], Gail Ashley[2], Robert E. Sheridan[2], David W. Hall[1], James T. Gilroy[1], and Stewart C. Farrell[3]

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CONVERSION FACTORS

For readers who wish to convert measurements from the inch-pound system of units to the metric system of units, or vice versa, the conversion factors are listed below:

Multiply	By	To obtain
centimeter (cm)	0.3937	inch (in)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
kilometer (km)	0.6214	mile (mi)
kilometer^2 (km^2)	0.3861	mile^2 (mi^2)
meter^3 (m^3)	35.31	foot^3 (ft^3)
meter^3 (m^3)	1.308	yard^3 (yd^3)

Multiply	By	To obtain
inch (in)	2.54	centimeter (cm)
foot (ft)	0.305	meter (m)
yard (yd)	0.914	meter (m)
mile (mi)	1.609	kilometer (km)
mile^2 (mi^2)	2.59	kilometer^2 (km^2)
foot^3 (ft^3)	0.0283	meter^3 (m^3)
yard^3 (yd^3)	0.7645	meter^3 (m^3)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929, a geodetic datum derived from a general adjustment of the first-order nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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CHARACTERIZATION OF OFFSHORE SEDIMENTS IN FEDERAL WATERS AS POTENTIAL SOURCES OF BEACH REPLENISHMENT SAND--PHASE I

Jane Uptegrove[1], Lloyd G. Mullikin[1], Jeffrey S. Waldner[1], Gail Ashley[2], Robert E. Sheridan[2], David W. Hall[1], James T. Gillroy[1], and Stewart C. Farrell[3]

ABSTRACT

In 1992, the Minerals Management Service (MMS) of the U.S. Department of the Interior and the New Jersey Geological Survey (NJGS), New Jersey Department of Environmental Protection (NJDEP) formed a multi- agency task force and began a two-phase study to investigate potential beach-replenishment-sand sources in federal waters offshore of New Jersey.

Phase I consists of the collection of geologic and geophysical data, including the following: 1) a review of previous investigations; 2) identification of shoreline areas with severe erosion problems; 3) identification of potential sources of beach replenishment sands; and 4) acquisition of seismic data and vibracores. Prior work in the federal waters area of the New Jersey offshore were transposed to the Geographic Information System (GIS) at NJGS and an extensive reference list of studies was compiled.

Analysis of beach profile data utilized the Interactive Survey Reduction Program (ISRP) software to estimate volume and shoreline change at 83 beach profile stations along the coast, and derive estimates of replenishment volumes for beach sections between profile stations. Resulting data and cross-sectional profiles were compiled on individual data sheets. Also, a record of recent (1984-1993) replenishment projects for the entire coast was compiled. Reaches 2, 3, 4, 7, 10, 11, 12 and 14 seem most affected by coastal erosion.

NJGS and Rutgers University deployed the combination analog/digital seismic system, to collect more than 150 line miles of data in 1993. Subsequently, twenty vibracores were collected in 1994.

Phase II of the MMS study includes analysis of the seismic data and vibracores, sand volume estimates, economic analysis of onshore vs. offshore sand for replenishment, and related environmental studies.

INTRODUCTION

The fate of New Jersey's coastal areas (and in particular, its beaches) is increasingly the subject of public concern and debate as population and recreation pressures intensify in coastal communities. The state is committed to maintaining beaches, in part with extensive sand-replenishment projects. Concurrently, the federal government is mandated to manage the public waters offshore of New Jersey on the Atlantic Inner Continental Shelf. This mandate includes expansion of knowledge about potential resources of the offshore area. To promote this expansion, the Minerals Management Service (MMS) of the U.S. Dept. of Interior initiated Cooperative Agreement #14-35-0001-30666 with the New Jersey Geological Survey (NJGS), Division of Science and Research, New Jersey Dept. of Environmental Protection (NJDEP) to obtain basic geological, economic and environmental data on sand deposits in federal waters offshore of New Jersey with potential for use in beach-replenishment efforts.

Accordingly, the NJGS established a Task Force with representatives from participating agencies, including Division of Engineering and Construction (DEC) and the Division of Fish, Game and Wildlife at NJDEP, Rutgers University Geosciences Dept., and the Philadelphia District Office of the U.S. Army Corps of Engineers (USACE). Data compilation and acquisition services were contracted to Rutgers Geosciences and the New Jersey Marine Sciences Consortium. Also, to expand the technical background of project staff at NJGS and enhance the research opportunities afforded by the MMS grant, the NJGS established liaisons with the New York District of the USACE, Rutgers University's Institute of Marine and Coastal Sciences, the Coastal Research Center (CRC) at Stockton State College, and the Bureau of Marine Water Classification and Analysis, NJDEP. The technical assistance provided by all these agencies was key to the completion of the project.

Phase I of this study, the collection of geologic and geophysical data started on July 1, 1992, and included the following: 1) a review of previous investigations for background data; 2)identification of shoreline areas with severe erosion problems; 3)identification of offshore sites within federal jurisdiction as potential sources of beach replenishment sands; and 4) acquisition of seismic data and vibracores from these potential source areas. Following is a brief summary of the work performed on these tasks.

1) Review of previous investigations. Gail M. Ashley and Robert E. Sheridan of Rutgers Geosciences appointed Frederick L. Muller to compile references and interview investigators, including the USACE, Philadelphia and New York Districts. He also studied data on vibracores archived by Rutgers, USACE and Alpine Ocean Seismic Survey, Inc. In addition, Rutgers Geosciences graduate students John S. Carey, Matthew C. Goss, and Peter C. Smith compiled summaries of the major New Jersey seismic/vibracore studies and their locations. The map data were transposed onto the Geographic Information System (GIS) at NJGS to produce figures 1 and 2 of this report. Review of the previous studies revealed that there has been prior work in the federal waters area of the New Jersey offshore, specifically 1)Cousins, Dillon, and Oldale (1977), 2)McClennan (1983), 3)Williams and Duane (1974), and 4)Meisburger and Williams (1980). The Meisburger and Williams (1980) Cape May study included seismic and vibracore data from several shoals located in federal waters. Their work provides a firm basis for additional work in this area. Also, Rutgers staff compiled references on coastal processes active on the Atlantic Inner Continental Shelf as well as studies of specific sites in the New Jersey offshore area. Selected references are listed at the end of this report.

2) Identification of eroding shoreline in New Jersey and prioritization of replenishment need. With the cooperation of the USACE, DEC and the CRC, Lloyd G. Mullikin and James T. Gilroy of the NJGS analyzed beach profile data collected by Stewart C. Farrell of Stockton State's Coastal Research Center (CRC) for NJDEP's Division of Engineering and Construction (DEC), utilizing ISRP software to estimate volume and shoreline change at 83 beach profile stations along the New Jersey Coast. These data were combined with the available record of beach restoration projects from the DEC and with anecdotal data from the public to identify beaches subjected to the most severe erosion. Data on the volume and shoreline change and the cross section of the profile were compiled on a data sheet for each profile station. The profile data sheets are grouped by reach segments along the New Jersey Atlantic Coast, together with summary data for each reach. These findings were transferred to map form by ranking the volume gain/loss along the New Jersey Coast (figs. 3A and 3B).

NJGS' analysis of Stockton State's quantitative data is in general agreement with the information from DEC and the public, particularly for beaches with extreme gain or loss of sand.

The DEC and the USACE have derived volume estimates of needed beach sand at sites along the New Jersey coast under evaluation for replenishment projects. Accordingly, NJGS did not attempt to derive summary figures for these quantities. Moreover, beach dynamics differ considerably from one area to another. Thus, accurate estimates of comprehensive replenishment-sand volumes were beyond the capability of this analysis. Alternatively, utilizing the ISRP software, NJGS staff derived estimates of hypothetical replenishment volumes for sections of the coast between profile stations (see tables 2E through 14E). This information can be used on the profile or reach scale by coastal planners and others to delineate specific replenishment sand needs. Also, NJGS staff compiled several data sources to produce the record of recent (1984-1993) replenishment projects for the entire

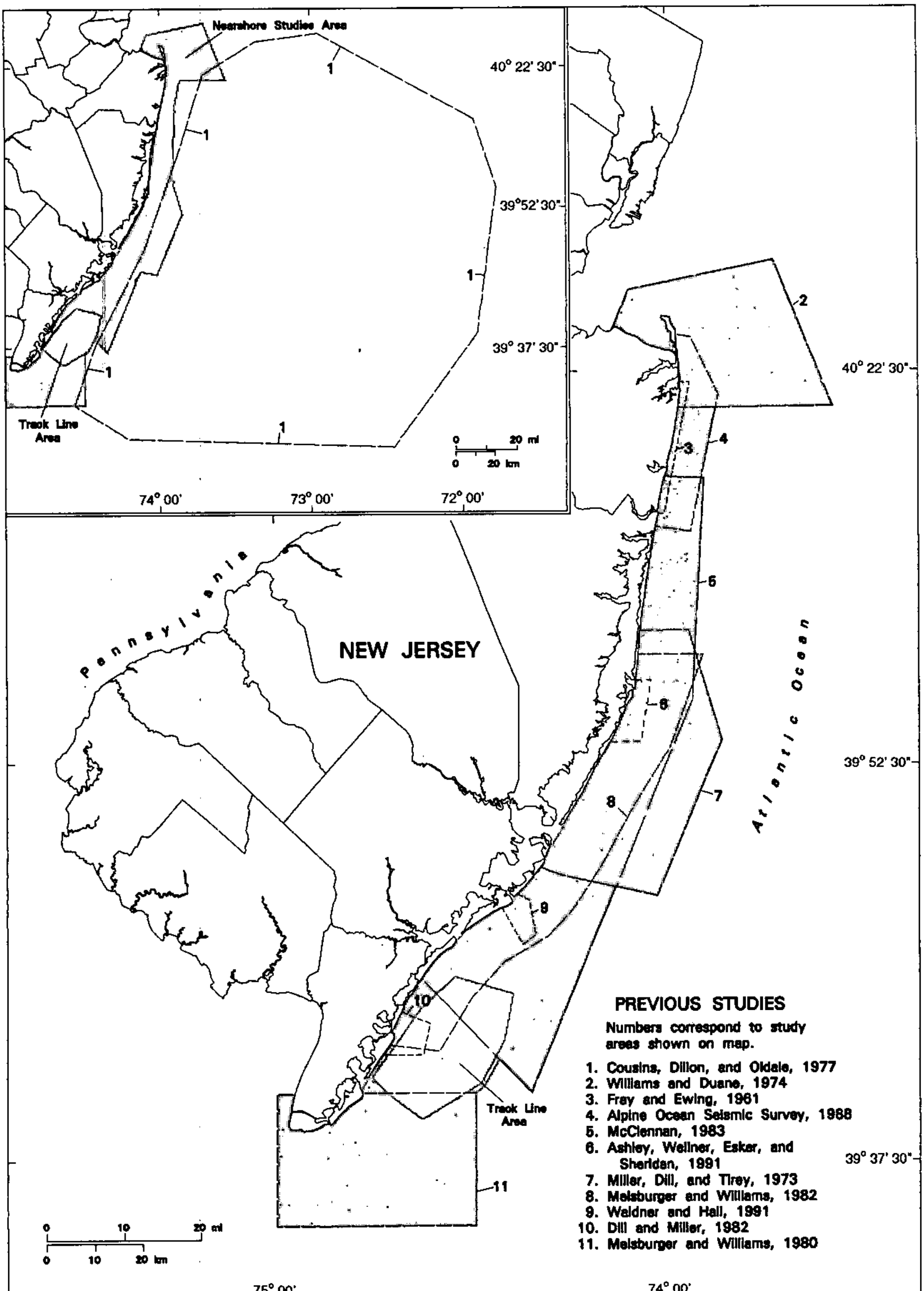


Figure 1.--Location of Task Force seismic survey and previous seismic studies.

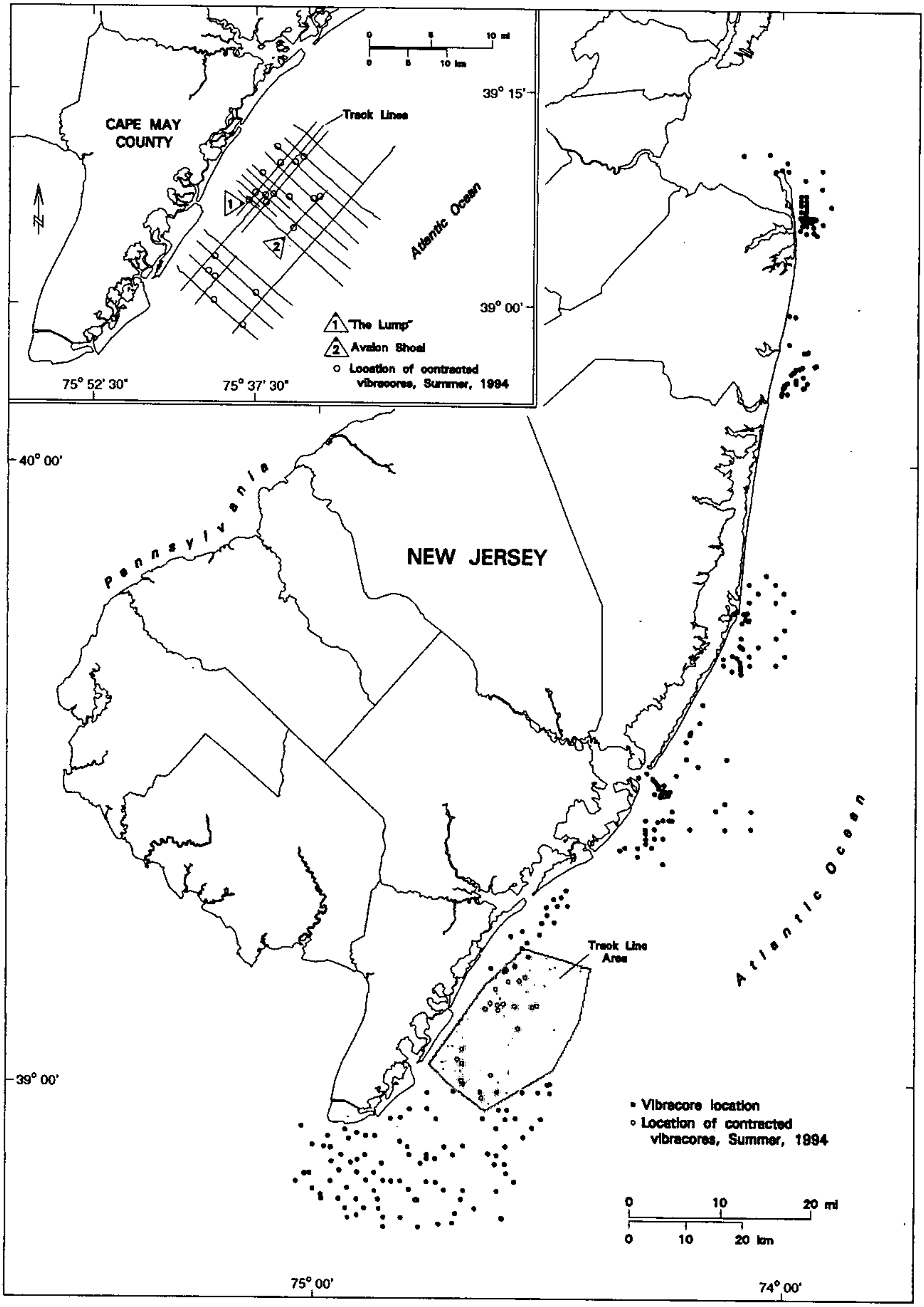


Figure 2.--Location of Task Force vibracores, Task Force seismic survey track lines, and previous vibracorings.

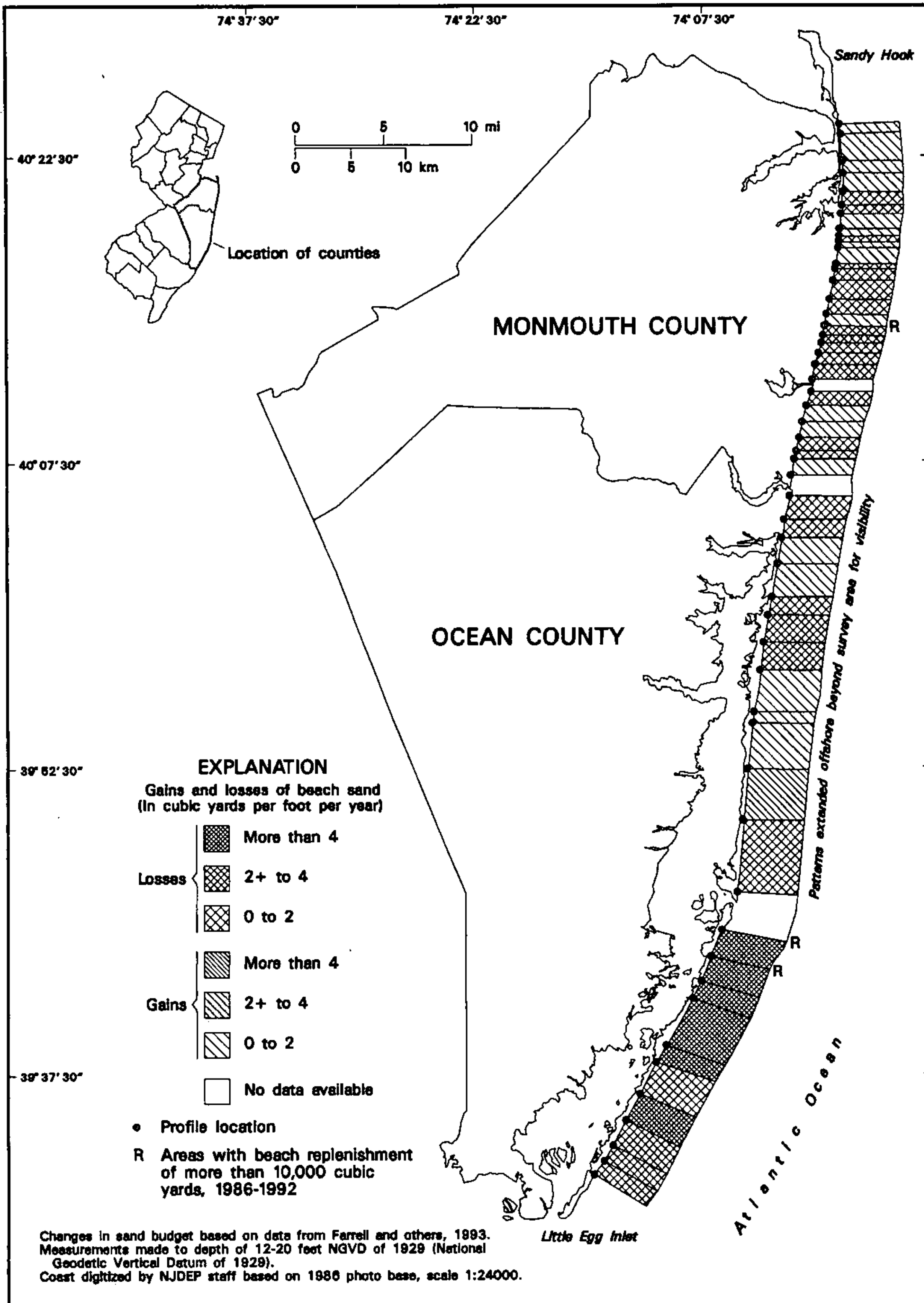


Figure 3A.--Changes in volume of beach sediment and replenished (resupplied) sediment in the Northern Coastal Area (Monmouth and Ocean Counties), 1986-1992.

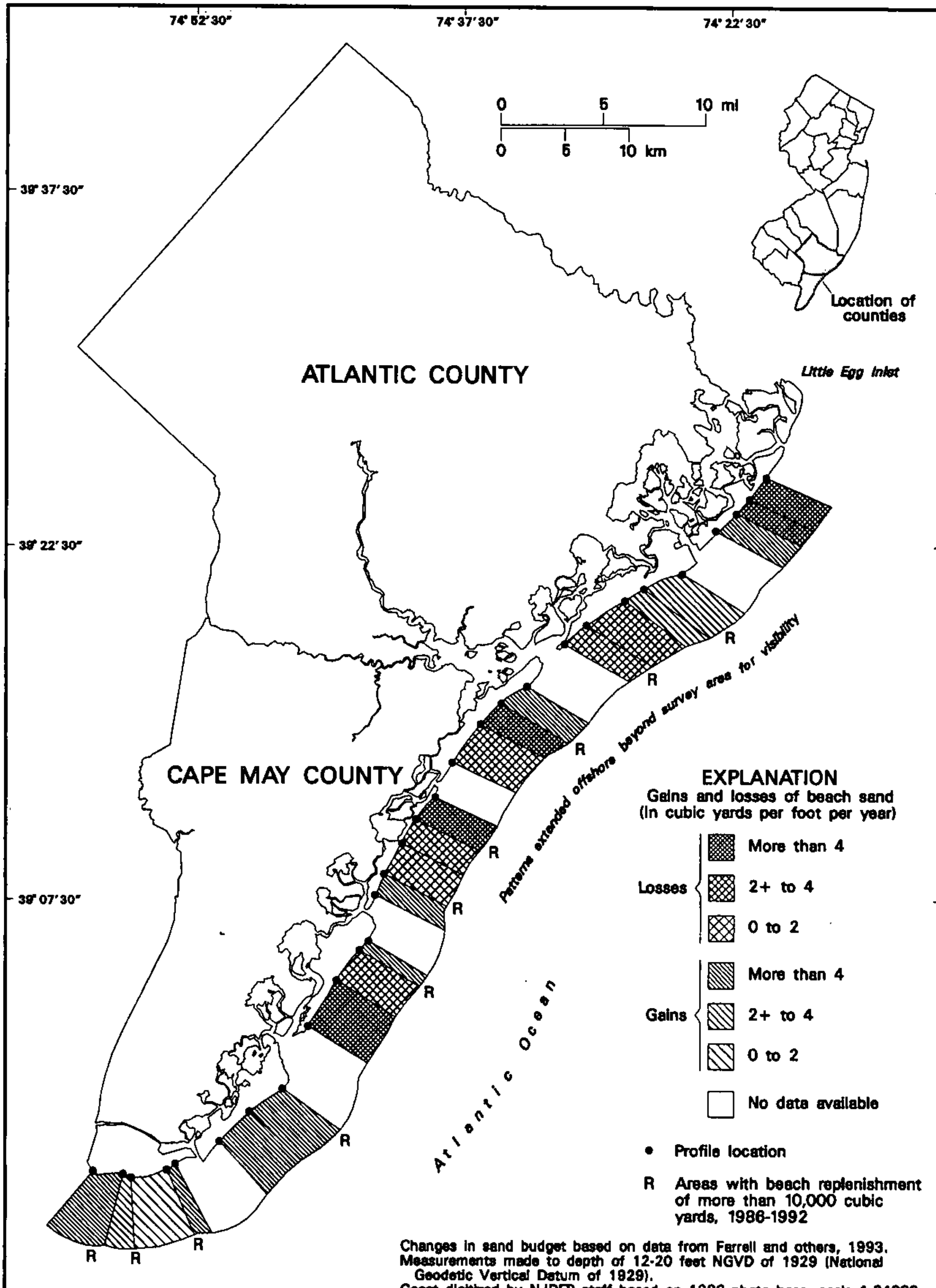


Figure 3B.--Changes in volume of beach sediment and replenished (resupplied) sediment in the Southern Coastal Area (Atlantic and Cape May Counties), 1986-1992.

New Jersey coast (tables 2B through 14B). This information is essential in any analysis of erosion patterns. For instance, profiles located near replenishment projects can provide information about the fate of replenishment sands. Already, this compilation has proved helpful in recommending additional profile stations for expansion of the New Jersey Beach Profile Network.

3) Identification of offshore sand sites within federal jurisdiction as potential source areas for beach replenishment sands. Rutgers Geosciences led this task of the project, reviewing previous studies to avoid duplication and consulting NJDEP staff on areas of significant beach erosion. Of two key areas chosen, economic and logistical constraints restricted detailed investigation to one, situated offshore of Townsends Inlet, New Jersey.

4) Acquisition of seismic data and vibracores from the identified areas. Geophysicists Jeffrey S. Waldner and David W. Hall of NJGS and Robert E. Sheridan and Peter C. Smith of Rutgers University deployed the combination analog/digital seismic system, first developed under the auspices of the MMS' Continental Margins Program (Year 9), to collect more than 150 line miles of data during the summer of 1993 (fig. 2). Sheridan subsequently designated vibracore locations based on initial review of the analog seismic data. The original vibracore contract, arranged to piggyback on a vibracore project of the USACE, encountered unresolved legal issues between the USACE and NJDEP. Eventually, a vibracoring contract was awarded by NJDEP to New Jersey Marine Sciences Consortium in June, 1994. Twenty vibracores were collected during late August and early September, 1994. Analysis of the seismic data and the vibracores is scheduled for Phase II of the MMS study.

PREVIOUS STUDIES

Listed below are brief descriptions of 11 major studies of the New Jersey offshore area, keyed by number, author(s) and date of publication to the locations in figure 1. The studies are of three types:

1.) seismic/stratigraphic,
2.) resource evaluation, and
3.) environmental.

The following descriptions were compiled from the text of the studies and thus may include dated material. For instance, in Meisburger and Williams' Cape May study (1980), some of the shoals identified as promising sources of replenishment sand have already been dredged for the Cape May replenishment projects. Also, because systems of units varied by study, units are reported as found in each study with a conversion to inch-pound or metric, as needed. Review of these studies preceded site selection for the seismic and vibracore work of the current project. Table 1A lists the types of data that were collected and analyzed in these studies. Figure 2 shows the location of vibracores collected as part of these studies. Complete references are included in the reference list.

1. Cousins, Dillon, and Oldale, 1977: A regional seismic study of the continental shelf from Long Island to Chesapeake Bay. Its major objectives were to search for potential environmental hazards such as mobile sand sheets or recent faulting, and tentatively to identify the shallow subsurface sedimentary structure and stratigraphy. The authors cite several significant seismic or bathymetric studies of this region that precede their work, including those of Veatch and Smith (1939), Emery (1965,1966,1968), Stearns (1967, ESSA C&GS series), Uchupi (1968, 1970), Emery and Uchupi (1972), and Schlee and Pratt (1972) (see Cousins, Dillon, and Oldale, (1977) for complete references).

This survey was conducted during April and May of 1975, funded by the Bureau of Land Management and by the U.S. Geological Survey, Office of Marine Geology, Branch of Atlantic-Gulf of Mexico Geology, at Woods Hole, Massachusetts.

The data are presented in three sections: 1) the Long Island shelf; 2) the New Jersey shelf to Delaware Bay (area no. 1 in fig. 1), and 3) the Delaware shelf south to the entrance of Chesapeake Bay and the entire Virginia shelf.

2. Williams and Duane, 1974: A total of 445 miles (716 km) of continuous seismic reflection profiles (50-200 joule sparker) and 61 vibracores were obtained from the Inner New York Bight, an area of about 250 square miles (650 square kilometers) offshore of northern New Jersey and western Long Island. Shrewsbury Rocks, a submarine outcrop of resistant coastal plain sediments, demarcates two distinct geomorphic provinces. The northern province is underlain by coastal plain strata which have been deeply eroded by Pleistocene glacial processes and covered by sand-and-gravel outwash. In the southern province, the coastal plain strata have been evenly truncated and are now covered by a veneer of more recent material. Seismic records reveal three primary types of bedding: 1) Coastal Plain strata which exhibit a gentle, regional, southeastward dip, 2) steeply inclined crossbeds of fluvial origin which are restricted to an elongate basin east of Sandy Hook, and 3) Pleistocene-Holocene stratified fluvial sands and gravels which are regionally discontinuous and dip gently seaward. Cores show that fine to medium sand predominates on the inner shelf. Isolated patches of coarse sand and rounded pea gravel are present offshore of Long Island. Coarse sediment offshore of New Jersey is considered to originate from sea floor outcrops of coastal plain strata. Very fine sand, silt and clay comprise the sea floor materials occupying the head of the Hudson River Channel. Sand suitable for beach nourishment blankets the shallow parts of the Inner New York Bight. An estimated 2 billion cubic yards (1.52 billion cu. meters) of clean sand is recoverable by dredging. Significant parts of the Hudson Channel have been filled by ocean disposal of as much as 1 billion cubic yards (0.76 billion cu. meters) of anthropogenic waste material.

3. Fray and Ewing, 1961: Sparker survey and echosounder data were taken along two transects parallel to the northern New Jersey shoreline. Twenty piston cores taken in the summer and fall of 1960 were drilled to a maximum depth of 220 cm.(approx. 7 feet). Gross core lithology, grain size, mineral content, cementing material and organic content were described for each lithologic unit. Offshore components of the Navesink, Red Bank, Manasquan and Kirkwood formations were tentatively identified using sparker survey, macrofossil and core data.

4. Alpine Ocean Seismic Survey, Inc., 1988: During February and March of 1988 the Sea Bright Borrow Area was further investigated to delineate additional offshore areas of suitable borrow material. This was in response to a revised requirement of 47.2 million cubic yards (36 million cu. meters) of sand for nourishment of Section One project beaches. The entire Sea Bright Borrow was investigated by geophysical lines operated with a UNIBOOM subbottom seismic profiler capable of penetrating and delineating the deeper subbottom strata. Based on the interpretation of the seismic reflections, 30 vibracores were taken at selected locations. Cores and geophysical data of this survey and its predecessors were correlated and analyzed. These activities delineated a total of 54.46 million cubic yards (41.4 million cubic meters) of sand from the Sea Bright Borrow Area suitable for replenishment of nearby beaches.

5. McClennan, 1983: High-resolution seismic profiles and sidescan sonar data were collected offshore of New Jersey in June, 1980. The sidescan sonar images indicated some potentially active megaripples with 2- to 3-meter (6- to 10-foot) crestal spacing within an area of general image darkening. The darkened area may consist of a group of indistinguishable ripples. The megaripples cluster in patches of 10 to 50 sequential ripples in the northern part of the study area. Most are concentrated in water depths of 20 to 22 meters (65 to 72 feet); others are in water as shallow as 12 to 15 meters (39 to 49 feet) and extend laterally as far as 9 to 17 km (5.6 to 10.6 miles) offshore. The seismic reflection profiles recorded subbottom reflectors as deep as 42 meters (138 feet) below seabed. Horizontal reflectors, sediment-filled valleys, buried channels, and multiply-dipping reflectors were recorded. Flat-lying reflectors were observed south of Barnegat Inlet with locally buried valleys or inlets cutting the sediments southeast of Great Egg, Little Egg, and Barnegat Inlets. North of Barnegat Inlet, subbottom reflectors are traceable as far as 4 km (2.5 miles); they are separated by 5 to 12 meters (16 to 40 feet) of sediment. A 2-km (1.24-mile) transition zone separates the northern and southern parts. Surficial sediments in this transition zone typically are less than 1 meter (3.28 feet) thick but may be very active, as indicated by numerous megaripples and linear sand stringers.

6. Ashley, Wellner, Esker, and Sheridan, 1991: Analysis of 100 km (62 miles) of seismic reflection (GEOPULSE) profiles from a 47-km^2 (18-square-mile) grid on the low-mesotidal inner continental shelf near Barnegat Inlet revealed that the upper 30 meters (100 feet) is composed of three unconformity-bounded units. Vibracores 1 to 6 meters (3 to 20 feet) long recovered from 12 sites contain several lithofacies, reflecting a variety of depositional environments that existed during late Quaternary glacio-eustatic sea-level fluctuations on this slowly subsiding passive margin with low sediment supply. Environments include 1) rivers active during glacial and stadial lowstands of the sea, 2) a barrier island- lagoon complex, 3) pro-barrier ebb-tidal delta, 4) shore-attached and shore-detached ridges, and 5) below-storm-wavebase shelf dating to interglacial or interstadial highstands.

Table 1A. Title, author(s) and types of data collected and analyzed in the 11 previous offshore studies

Ref No.	Author(s) Date	Title	Agency	Description of Data: Seismic Study Area Corner Points	Description of Data: Vibracores Amt.	Description of Data: Vibracores Data	Biblio.	Maps	Tables	Comments
1	Cousins, P. Dillon, W.P. Oldale, R.N., 1977	Shallow Structure of Sediments of the U.S. Atlantic Shelf, Long Island, N.Y. to Norfolk, Va.	U.S. Geological Survey	40° 39' 25.6"N 73° 11' 55.9"W 40° 13' 50.2"N 72° 12' 36.0"W 39° 54' 06.4"N 72° 04' 36.3"W 38° 53' 33.8"N 74° 45' 44.3"W 40° 28' 13.8"N 73° 56' 15.9"W 40° 37' 19.3"N 73° 35' 52.1"W	0	not available	yes	yes	unknown	
2	Williams, S.J. Duane, D.B., 1974	Geomorphology and Sediments of the Inner New York Bight Continental Shelf	U.S. Army Corps of Engineers	40° 35'N 73° 44'W 40° 32'N 74° 06'W 40° 18'N 73° 58'W 40° 18'N 73° 35'W	61	log, grain size	yes	yes	yes	Icons Program, maximum penetration 300 ft.
3	Fray, C.T. Ewing, J., 1961	Project 555 - Monmouth County Offshore Borings Cu - Report No. 1	N.J. Dept. of Conservation and Economic Development	40° 21'N 73° 58'W 40° 21'N 73° 57'W 40° 06'N 74° 01'W 40° 06'N 74° 02'W	20	log, grain size	no	yes	yes	echo soundings core desciptions
4	Alpine Ocean Seismic Survey, 1988	Identification and Delineation of Potential Borrow Areas for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Final Report, Vol 1, 4	Alpine Ocean Seismic Survey for the U.S. Army Corps of Engineers	38° 40'N 74° 40'W 38° 40'N 71° 50'W 40° 30'N 71° 50'W 40° 30'N 74° 00'W	70	log, grain size	no	yes	yes	summary of at least five borrow sites
5	McClennan, C.E., 1983	Middle Atlantic Near Shore Seismic Survey and Side Scan Sonar Survey of Potential Geologic Hazards off the New Jersey Coastline, in Environmental Geologic Studies on the U.S. Mid - and North Atlantic Outer Continental Shelf Area, v. ii, Mid - Atlantic Region	U.S. Geological Survey, B.A. McGregor, ed.	39°12'N 74° 37'W 39° 00'N 74° 22'W 40° 10'N 74° 01'W 40° 10'N 73° 55'W	20	unknown	yes	yes	no	side scan sonar geohazard analysis, 3.5 khz uniboom system
6	Ashley, G.M. Wellner, R.W. Esker, Dominic Sheridan, R.E., 1991a	Clastic Sequences Developed During Late Quaternary Glacio-eustatic Sea-level Fluctuations on a Passing Margin: Example from the Inner Continental Shelf near Barnegat Inlet, N.J.	Sea Grant Program, New Jersey Marine Consortium, NA 89AA-D-S6057 (Project No. RS-14)	39° 40' 00"N 74° 07' 30"W 39° 40' 00"N 74° 00' 00"W 39° 47' 00"N 74° 05' 00"W 39° 47' 00"N 74° 06' 00"W	12	core logs, grain size	yes	yes	no	
7	Miller, H.J. Dill, C. Tirey, G.B., 1973	Final Report: Geophysical Investigation of Atlantic Generating Station Site and Offshore Region	Alpine Geophysical, Inc.	39° 25'N 74° 17' 30"W 39° 22' 30"N 74° 02' 30"W 39° 40' 00"N 73° 52' 30"W 38° 00' 00"N 73° 59' 30"W 39° 52' 30"N 74° 05' 00"W	47	log	yes	yes	no	3.5 khz sparker profiles, uniboom system also used, max depth 500 ft.
8	Meisburger, E.P. Williams, S.J., 1982	Sand Resources on the Inner Continental Shelf Off the Central N.J. Coast	U.S. Army Corps of Engineers	39° 05'N 74° 40'W 39° 50'N 74° 05'W 39 °50'N 73 °55'W 39° 05'N 74° 36'W	97	log, grain size	yes	no	yes	Icons Program limited side scan sonar
9	Waldner, J.S. Hall, D.W., 1991	A Marine Seismic Survey to Delineate Tertiary and Quaternary Stratigraphy of Coastal Plain Sediments Offshore of Atlantic City, N.J.	New Jersey Department of Environmental Protection, New Jersey Geological Survey	39 °17'N 74° 23'W 39° 18'N 74° 21'W 39° 21'N 74° 26'W 39° 22'N 74° 22'W	0	not available	yes	no	no	geohazard analysis, offshore hydrostratigraphy, geopulse system uniboom, max. depth 1100 ft.
10	Dill, C.E. Miller, H.J., 1982	Bathymetric and Geologic Study of the Proposed Outfall at Avalon, N.J. in Wastewater Handling Facilities, Cape May County, N.J.	Converse Consultants Inc., by Alpine Geophysical, Inc.	39° 04'N 74° 38'W 39° 05'N 74° 40'W 39° 07'N 74° 34'W 39° 05'N 74° 37'W	12	log, grain size	no	no	no	max. penetration 100 ft., 3.5 khz profile
11	Meisburger, E.P. Williams, S.J., 1980	Sand Resources on the Continental Shelf of the Cape May Region, N.J.	U.S. Army Corps of Engineers	39° 00'N 75° 00'W 38° 45'N 75° 00'W 38° 45'N 74° 30'W 39° 00'N 74° 30'W	104	log, grain size	yes	no	yes	Icons Program misc. report, no equipment specified

Following the last major interglacial (approx. 125 ka), sea level fell and riverine erosion produced a planar, seaward-dipping surface (R1) by early Wisconsinan time (approx. 70 ka). As sea level rose during the mid-Wisconsinan (approx. 55 ka), a barrier island system migrated shoreward to within 0.2-1.7 km (0.1 to 1.1 miles) of the modern barrier shoreline, leaving a 4- to 6-meter (13- to 20-foot)-thick record (Depositional Sequence I). Maximum highstand of the mid-Wisconsinan sea was 20 meters (66 feet) below present sea level. Sea level fell again during the late Wisconsinan (approx. 20 ka) and rivers again flowed across the exposed shelf, creating an unconformity (R2). Subsequently, a barrier/lagoonal system developed following rising sea level at least by early mid-Holocene time, based on peat (8,800 ± 130 BP) cored from a depth of 12 meters (39 feet). The mid-Wisconsinan (approx. 55 ka) barrier system was preserved under these early Holocene transgressive sediments (Lower Unit of Depositional Sequence II, lower transgressive tract). The modern barrier and inner continental shelf deposits (Upper Unit of Depositional Sequence II, upper transgressive tract) are thin (typically 3 to 4 meters, or 10 to 13 feet) pebbly sands overlying a prominent unconformity (a transgressive surface, R3) formed by marine erosion during the Holocene sea-level rise. The ebb tidal delta and shore-attached linear sand ridges both act as partial shields against wave and tidal current erosion of the muddy substrate directly beneath R3. In the nearshore area, this shielding produces a transgressive surface (marine unconformity) of relatively high relief (3 to 7 meters, or 10 to 23 feet).

7. Miller, Dill, and Tirey, 1973: High-resolution seismic data (3.5 kHz Sparker and UNIBOOM) disclosed the sand thickness of the Beach Haven Ridge, site of the proposed Atlantic Generating Station. It is only 5 ft. (1.5 meters) thick on the northern end of the ridge but thickens to 20 ft. (6 meters) on the southern end. The ridge is underlain by a north-south trending valley at depths of more than 60 ft. (18 meters) that is filled with Holocene (7,000-8,000 years before present) mud. The valley is incised into clay units of Pleistocene age, probably deposited during the ^{18}O isotope stage- 5 highstand of sea level. The sparker seismic signal penetrated more deeply into the Tertiary and Pleistocene formations which dip southeastward as deep as 500 ft (152 meters) below the sediment surface. Also, the Tertiary formations are at a very shallow depth north of Barnegat Inlet where they crop out on the sea floor.

8. Meisburger and Williams, 1982: About 1800 km^2 (700 sq. miles) of the central New Jersey Inner Continental Shelf between Avalon and a line 7.5 km (4.7 miles) north of Barnegat Inlet was surveyed to assess and quantify marine sand and gravel resources as deep as 6 meters (20 ft.) below the sea floor. A total of 1133 km (704 miles) of high-resolution seismic reflection profiles and limited sidescan-sonar coverage were combined with analysis of 97 vibracores to quantify the offshore sand resources. Study results show that many linear and arcuate shoals appear to be Holocene in age and overlie pre-Holocene deposits. The pre-Holocene deposits contain shells, shell fragments, and other calcareous material and commonly are yellowish-brown, suggesting deposition in a subaerial setting or exposure to leaching processes. The heterogeneous character, extremely poor sorting, oxidation-type color of the coarser material, and the coincidence with channel-like subbottom reflectors on seismic records suggest a fluvial origin. An estimated 172 million cubic meters (225 million cu. yards) of suitable sand, in 15 areas, is available, but requires further evaluation.

9. Waldner and Hall, 1991: Deeper penetrating seismic reflection data revealed the Miocene "800-ft. aquifer" dipping southeastward. Correlation to the U.S.G.S. offshore monitoring well yields reliable identification of the seismic reflection horizons. The higher-resolution GEOPULSE seismic data revealed an incised valley higher in the stratigraphic section with a southeast trend . The age of incision and subsequent filling are unknown.

10. Dill and Miller, 1982: Geophysical survey data were collected off Avalon, NJ in the area proposed for installation of an outfall pipe. Using a DE 719-B Echo Sounder, detailed bathymetry of the adjacent coastal waters was surveyed. The bathymetric data showed that the ocean bottom descends to the 40-foot (12-meter) contour within 5000 feet (1524 meters) of the beach and remains relatively flat seaward from that line to the boundary of the survey area. An ORE 3.5 kHz subbottom profiler was used along 20 transects parallel to the shoreline and 13 transects perpendicular to the shoreline. The profiling penetrated to a maximum depth of 60 feet (18 meters) below the sea floor and disclosed a series of flat lying reflectors; the uppermost reflectors are truncated by the sloping ocean bottom on their seaward edge. Eleven vibracores taken to a depth of 30 feet (9 meters) show that the sediments corresponding to the prominent reflectors consist primarily of sand and gravel with some layers of silt. An upper unit of dense, medium-to-fine sand extends from the beach and thins rapidly seaward. An intermediate unit consists of organic silt mixed with gravel, interpreted as Late Pleistocene-Holocene material. The underlying third unit is much older and contains abundant clean sand and fine gravel.

11. Meisburger and Williams, 1980: A geologic study of the Inner Continental Shelf region off of Cape May, NJ was conducted in order to find and delineate sand and gravel for beach restoration and maintenance. This study included analysis of 1258 kilometers (782 miles) of seismic reflection profiles and 104 sedimentary cores as much as 3.7 meters (12.14 feet) in length. Results of the study indicated that 18 sites, identified on isopach maps, contain nearly 1.09 billion cubic meters (1.43 billion cu. yds.)of sand. All but two of the sites are linear and arcuate shoals of Holocene age consisting of clean, quartz sand of marine origin. The shoals are about 6 meters (20 feet) thick and appear to rest on a pre-Holocene fluvial surface composed of dense silty sand and gravel. The six shoals closest to the Cape May beaches contain about 216 million cubic meters (283 million cu. yds.) of sand, making them the most promising southern sites for future consideration.

IDENTIFICATION OF ERODING SHORELINE

The New Jersey Beach Profile Network

The concept for a New Jersey Beach Profile Network (NJBPN) developed in March 1986 at the New Jersey Dept. of Environmental Protection's Division of Engineering and Construction (DEC), formerly the Division of Coastal Resources. The DEC contracted with the Stockton State College Coastal Research Center (CRC) to assist in the planning and implementation of the program. The CRC staff began data collection at the NJBPN survey stations in 1986.

The NJBPN developed in response to coastal damage caused by a March 1984 northeast storm and Hurricane Gloria in 1985. This damage occurred at a time when the state had scant quantifiable survey data to substantiate the amount or severity of sediment loss on the state's beaches. Municipalities with damaged beaches could only estimate losses as "low", "moderate", or "severe". Also, there was no way to document whether losses had been chronic or related to a particular storm event. After the March, 1984 storm, Federal Emergency Management Agency's (FEMA) Interagency Hazard Mitigation Report (FEMA-701-DR-NJ) recommended an updated mapping program every five years or after the next severe storm, complemented by annual beach-dune profiling surveys. The proposal pointed out the need for beach volume data to determine both short- and long-term trends in beach stability. The short term events, such as storm recovery and beach nourishment activity, would be reflected in the long term history of shoreline advance or retreat at each of the project sites.

In 1985, documentation of beach condition was necessary to satisfy the Damage Survey Report (DSR) requirements of FEMA for losses to municipally engineered and funded beaches and dunes. In the aftermath of Hurricane Gloria, FEMA strongly recommended that the state initiate a monitoring program so that the documentation would be available in the future.

The beach and dune profiling program involves annual monitoring of general shoreline and beach face conditions, including erosional and depositional trends. These data permit determination of potential erosion problems and areas in need of beach and dune protection programs. The profiling program has the potential to help reduce development risks in high hazard areas and to aid in the coordination of federal assistance through FEMA following major coastal storms.

Methodology

During the summer of 1986, scientists from the DEC and CRC visited each New Jersey municipality along the Atlantic Coast, and parts of Raritan and Delaware Bay. Beach survey sites were selected based on the following criteria:

1. Location represents typical community beach condition.

2. Each shoreline community has at least one site.

3. Existing survey data are used to determine the site.

4. Surveys are to be conducted annually in the Fall.

5. No federal property is included in the program.

6. Control points for profile stations are sited on State or County property.

In the Fall of 1986, the survey team collected the first set of measurements. A team from the CRC has collected follow-up measurements every year through 1993. The 1992 survey was completed three weeks prior to the December 1992 northeast storm, the damage from which resulted in the New Jersey shore being declared a Federal disaster area. The analysis in this report is based on the data collected annually from 1986 to 1992.

There are 90 beach profile stations, 83 along the Atlantic Coast, 3 on Raritan Bay, and 4 on Delaware Bay. The beach profiles are surveyed each autumn.

The profile lines are surveyed with a Lietz Set-4 Total Station Electronic Transit which feeds data to a SDR-22 survey data logger. The unit is activated over the first known point, the Instrument Station (IS), with data entered concerning survey location, benchmark elevation and position for two known points as well as several environmental variables (such as temperature), collimation, transit height, and prism height. The survey points are obtained using a reflecting prism. A back shot is taken at the second known point, (called the Back Shot (BS)). Then a line of points is shot across the dunes, back beach, shore face and into the water to a minimum water depth of 12.0 feet below NGVD (National Geodetic Vertical Datum of 1929), formerly called mean sea level. A typical beach profile consists of 35 to 50 individual data points. The prism pole height can be changed between data points to reflect shot conditions so that entry into the ocean only requires added pole height to overcome water depth.

Next, the stored data are transferred to a personal computer *via* Lietz SDR software. The survey team checks the data against field data before transferring to database storage. The profile plots (as seen on the profile data sheets) and some of the volume calculations are computed with the Interactive Survey Reduction Program (ISRP) of Birkemeier and Leffler (1992). With this software, one can plot as many as five surveys of a single profile site and compute the unit volume change between any two of the surveys. The unit volumes are measured in cubic yards of sand per linear foot of shoreline. Typically, the calculated volume estimates generated with the software can provide approximate volume change values for the beach area within 1000 feet of the profile site (or to any groin/jetty structure--the structures invalidate the calculation because of their sand-collecting or sand-starving effect). Because some of the survey sites are over 6000 feet apart, one cannot compute volume change for an entire beach or total volume gain/loss between sites without understanding that such estimates are a gross approximation of the complex, variable and dynamic sand-supply systems that characterize the New Jersey coast.

The New Jersey Coastline

The New Jersey Coast is 130 miles in length. Its beaches are composed primarily of unconsolidated sand, silt and gravel reworked from Cretaceous, Tertiary, and Quaternary Coastal Plain sediments (McMaster, 1954). The unconsolidated material is eroded either from onshore Coastal Plain Formations in the northern section of the coast or from submerged coastal plain sediments redistributed along the Coast by wave action and longshore transport. The New Jersey Coast is the landward boundary of the Atlantic Continental Shelf, a slowly subsiding passive margin with low sediment supply that has undergone several glacially- controlled sea-level fluctuations (Ashley and others, 1991a). Sea level has risen along the New Jersey Coast, and the nearshore zone is being inundated at a rate of about 8.7 inches per century, with accompanying shoreline retreat landward of as much as 12 feet per year (Psuty, 1986, Nordstrom and others, 1977).

The Northern Coast

Cretaceous, Tertiary and Quaternary Coastal Plain sediments are directly exposed to wave action from Long Branch south to Point Pleasant Beach (see figs. 4-7). In this part of the coast, called the Headlands by Fisher (1965) and by Nordstrom and others (1977), the modern beach lies directly seaward of a bluff which rises as much as 26 feet above the beach. Prior to extensive human development in the last half of the 19th century, narrow dunes had covered the bluff and migrated over it a short distance inland. Nowadays, major storms erode the beach/dune cover and the bluff itself. The eroded material is reworked by wave action and is thus incorporated into the present-day sediment supply. Longshore currents may carry the sand northward or southward along the coast to be deposited at a spit, on another beach, or at an inlet. In the northern coastal area, a barrier island stretches from Monmouth Beach to Sea Bright (see fig. 4). The spit at Sandy Hook marks the temporary northern endpoint of sand deposition by longshore transport on the New Jersey coast.

As development expanded toward and along the edge of the bluff in the northern coastal area, property owners asked for help to protect their property. The engineering solution to the landward erosion of the Monmouth County bluffs took the form of bulkheads, steel pilings and rock revetments (reinforcement of shoreline with large quarry stones, some emplaced to protect a bulkhead). The armoring of the shoreline cut off the supply of sand to the beach and longshore transport system, with the long term result that the beaches are nearly nonexistent in much of northern Monmouth County.

The Southern Coast

By contrast, there are no exposed Cretaceous and Tertiary Coastal Plain sediments along the southern New Jersey coast (from Mantoloking to Cape May Point, see figs. 7-16). Here, the sands reworked from submerged Coastal Plain sediments mingled with eroded onshore sediments transported from the northern bluffs by longshore currents to form a series of barrier islands ranging in length from 5 miles (the Wildwoods, fig. 15) to 18 miles (Long Beach Island, fig. 9). Along the coast from Point Pleasant southward (fig. 7), the beaches consist of progressively less material derived from the bluffs in Monmouth County (McMaster, 1954). South of Long Beach Island (Reach 7), the average diameter of sand grains is half that of those on the northern beaches; moreover, the suite of trace minerals interspersed with the predominantly quartz sand differs from that found in the northern sands. This suggests either that the sand on the southern coast barrier islands has been derived from sources other than the northern bluffs or that it has been reworked after deposition and later sea-level rise.

Inlets

From Mantoloking to Cape May, large lagoonal systems of open bay and salt marshes lie between the barrier islands and the mainland. Tidal inlets divide the barrier islands from each other (see figs. 8-16). These inlets interrupt the longshore transport of beach sand, restricting sediment transport to cells that extend from inlet to inlet along the barrier islands. Some material is transferred to neighboring barrier islands by the complex tidal currents that occur at the inlets and by migration of the inlets (Ashley, 1987; Halsey and others, 1982).

Of New Jersey's 11 inlets, 5 are confined between rock jetties (at Shark River, Manasquan, Barnegat, Absecon and Cold Springs), and no longer shift position. Three inlets (Beach Haven/Little Egg, Brigantine and Corsons) are still "natural" in that no engineered structures modify their natural equilibrium. Three inlets (Great Egg, Townsends and Hereford) have one jetty or one shoreline armored with rock to control inlet channel migration.

In many undeveloped coastal areas, tidal inlets have a greater impact on beach erosion or accretion on individual barrier islands than does longshore transport. For Cape May Point and Cape May City, if sediment transport by longshore currents were the dominant factor shaping the barrier islands, these two communities at the southern endpoint of longshore transport on the New Jersey Coast would be buried in beach sand. Instead, both southernmost communities are sand starved. In addition, changes resulting from coastal development and shoreline construction have affected shoreline stability.

Along the New Jersey coast, several beach replenishment projects have been completed, and others are planned. These projects are an attempt to restore balance between sediment loss and sediment supply on both bluff shoreline and the barrier island environments. Monitoring of these replenishment projects will provide quantitative data on beach sand requirements and loss rates, and may enable State and municipal planners to establish nourishment schedules for maintaining coastal beaches.

Data Analysis

Staff at The New Jersey Geological Survey examined beach profile data collected by Stockton State's CRC, 1986-1992, from all 83 Atlantic Coast profile stations (Reaches 2-14). Using ISRP, this information was analyzed and organized into data sets, one for each profile line. Each profile data set includes the following:

1) A cross section of the 1986 and 1992 profiles to show change in the profile between these years.

2) A graph and table showing approximate sand volume change from 1986 to 1992.

3) A graph and table showing shoreline change from 1986 to 1992.

The profile is based on the 35 to 50 measurements logged in the field.

Volume Change

The volume of sand in cubic yards per linear foot of shoreline is calculated, factoring in both that part of the beach above and below the water line to a water depth of 3.7 meters (12 feet). The annual total is the combined value of the above- and below-sea-level values. The approximate 6-year volume change is the combined value of all 6 annual totals. The mean annual volume change is the average value of the annual totals. The standard deviation indicates the range of values around the mean. Negative values indicate loss of sand. Each additional year of data extends the time series for each profile, thus improving the reliability of the values.

For profiles located within or near areas of recent beach replenishment projects, the data may reflect the added sand volume. However, not all profiles at replenishment sites show this increase. In some instances, the beach appears to lose the replenished sand, as indicated by a sharp decrease in the following year (for example, profile 126, Longport Borough, where 129,000 cubic yards of sand were added in 1990). Likewise, a more subtle increase in volume for neighboring profiles may be evident as the replenished sand is redistributed by longshore transport. Or, the replenished sand may have been transported by longshore currents to an area between profiles and thus not be evident in this analysis. Information on replenishment projects is listed in tables 2B-14B. Also, the location of the profiles with respect to the municipalities is shown in figs. 4-16 and tables 2A-14A.

As noted above, in the northern coast area (Reaches 2-4), the beaches are armored with jetties and a sea wall. The apparent small volume change shown for these areas reflects initial lack of sand. Likewise, accumulation of sand is limited because the high tide laps up along the sea wall at many of the northern coast beaches. Also, the mean slope of the beach (including its extension under water) in the north is approximately twice as steep as it is in the south. In addition, there is a less extensive system of offshore shoals to break the force of incoming waves. These factors combine to inhibit sand deposition on the northern beaches.

Profiles in natural areas (for example profile 247, located in Island Beach State Park) may show a more stable volume change pattern. Many of the profiles for Reach 6, including those in Island Beach State Park, are stable compared to other profiles on the coast. However nearby jetties and structured inlets affect these areas also. Given these influences, the profile data are most effectively used to monitor local beach dynamics. In some instances, a trend in neighboring profiles may reflect a broader beach dynamic, but one cannot define such a trend solely on the basis of the profile data.

Shoreline Change

On all shoreline change data herein reported, the changes are based on the distance of the shoreline from a known reference marker on land in 1986, the first year of the survey. Migration of the shoreline seaward or landward is represented as a positive or negative value, respectively, in relation to the 1986 shoreline. Although the volume change data are calculated based on a line constructed from 35-50 measurements, the shoreline data are direct measurements.

Shoreline change may reflect an actual increase in beach size or only a shift of sand along the profile. If the shoreline has retreated significantly, the sand may have moved directly offshore within the range of the profile measurement (to a water depth of 12 feet). In such instances, the shift in sand volume to the underwater area would be evident in the cross section or in the volume change graph. The 1992 measurements for profile 145 illustrate this. The planned expansion of the survey program to collect data semi-annually instead of annually may reveal seasonal erosion and accretion patterns such as short-range shifting of sediments offshore and onshore.

In other cases, the shoreline change data closely parallel the volume change data (for example, profiles 126 and 134). Refer to both graphs and the cross sections to compare trends.

In the shoreline change table for each profile, the net shoreline change value is the combined value of the increase/decrease of the shoreline from 1986 through 1992. A high positive value reflects significant natural or engineered seaward migration of the shoreline; for example, profiles 105 and 108, both of which are in an area of replenishment.

By contrast, on Long Beach Island, though replenishment sand was emplaced in Barnegat Light Borough and Long Beach Township, Section I, this replenishment does not show up in the net change value (see profiles 144 and 145). This could be due to: 1)location of the profiles outside the area of the replenishment, 2)shift of sand offshore, or 3)longshore transport of sand beyond the profile area.

Grouping by Reach

The New Jersey Atlantic Coast profile data are organized into 13 segments called reaches. Most reach boundaries are along natural breaks, typically at coastal river mouths in the north and at inlets in the south. The few exceptions are those between Reaches 2 and 3, 5 and 6, and 14 and 15, which are at municipal boundaries.

The 13 reach maps (at the beginning of each reach section) include information on the municipalities, profiles and calculated volume change between profiles (assuming no engineered structures and uniform beach dynamics between profiles). Facing each reach map are tables summarizing reach data for the years 1986- 1992. Tables 2B-14B list the dates of previous beach replenishment projects by municipality, based on information provided by DEC, New Jersey Dept. of Environmental Protection (NJDEP). The shoreline change and volume change data for profiles located within the reach are summarized in tables 2C-14C and 2D-14D, respectively. Tables 2E-14E list values for approximate sand gain or loss based on the calculated average volume change of two neighboring profiles for an entire reach. As stated above, such a calculation assumes that erosion/accretion conditions in the area of a profile extend uniformly as far as the midpoint of the distance to the next profile and that no engineered structures are situated between the profiles. This is, in many cases, farther than the 1000-foot distance indicated by Farrell (1993) as the valid limit of the data on each side of a profile. This table provides an approximation of volume change between profiles and thus along the length of a reach rather than actual measured values. A detailed analysis of local volume change (between profiles within a reach) would require more profiles (1 per 1000 feet) to more accurately characterize the volume change. No data are shown for inlet areas owing to the complexity of their sediment transport dynamics.

The volume change calculations were compared to estimates made by 1) the U.S. Army Corps of Engineers (USACE) 2) DEC and 3) some anecdotal information from the public. The calculated average values generally supported all three, particularly for areas of extreme gain or loss.

The calculated-volume-change data were entered into the Geographic Information System at New Jersey Geological Survey to produce the volume-change maps for the New Jersey Atlantic Coast (figs. 3A and 3B). On these maps, locations of completed beach replenishment projects are indicated just offshore of the replenishment sites by the letter "R".

Results

Data shown in the various reach and profile tables demonstrate the complex nature of the New Jersey Atlantic Coast. Longshore drift, hurricanes, winter storms and rising sea level maintain a constant state of coastal flux. Some areas were stable during the 7-year period of beach profiling, 1986-1992 (for example, profile 161, Spring Lake Borough, Reach 4). Others, however, were very volatile (for example, profile 168, Allenhurst Borough, Reach 3).

Apparent increase in sand volume and/or seaward shoreline migration in these data may indicate little or no major storm activity, or may reflect beach replenishment or other engineering activity. For example, a groin may cause sand buildup on one beach while starving the beach downdrift of the groin. An explanation of the causes of prevailing beach conditions is beyond the scope of this report. Accordingly, the reader is urged to check the table of beach replenishment projects against the profile data in order to distinguish natural from artificial changes.

Beach Replenishment Project Design--USACE and DEC, NJDEP

All beach restoration or construction activity funded by the state or federal government is preceded by a series of site evaluations performed by DEC and USACE respectively. On many projects the agencies work cooperatively. The first investigative step, called reconnaissance, includes a data search for documentation of previous projects, a review of air photos, recent and historic, and identification of potential funding sources. The second step, called the feasibility study, includes the collection of new data, such as marine seismic surveying, and analysis of vibracores, to evaluate potential sand excavation sites. Also, securing funding commitments and developing preliminary design criteria are part of the feasibility phase. The final step is project implementation, during which contracts are negotiated and finalized and the contractor completes the replenishment. All shore protection projects administered by the USACE include a 50-year schedule of restoration and beach maintenance involving channel dredging, beach sand replenishment, and/or construction/maintenance of engineered structures such as jetties, groins or bulkheads.

Summary of shoreline conditions and USACE/DEC replenishment activity grouped by reach

The beaches in Reaches 2, 3 and 4 are the most intensely developed and heavily armored in New Jersey, with groins, jetties and miles of sea wall. The stable appearance of these beaches from 1986 through 1992 is misleading. The ocean laps up against the sea wall between profile stations 183 and 184. There are very narrow beaches between profile stations 178 and 179. The steep seaward slope of the beach and seabed here adds to the area's lack of sand stability. A shore protection project for the area from Sea Bright to Monmouth Beach (the shoreline section encompassing profiles 182-178) initiated by USACE in cooperation with NJDEPE includes beach replenishment which started in the spring of 1994.

Reaches 5 and 6 comprise some of the most stable sections of the New Jersey Atlantic Coast. The beaches are somewhat steep, but seabed slope is more gradual than it is to the north, and hardened shoreline structures are few. No sand replenishment or construction activity has occurred from 1985 through 1994. The USACE is planning a reconnaissance study here for engineered beach stabilization or replenishment to begin in 1995.

Reach 7 (Long Beach Island) is a low-lying barrier island with gently sloping beaches and few hardened shoreline structures. It sustained substantial erosional damage during several recent coastal storms (Eugene Keller, oral commun., 1993). Except for sand dredged from Barnegat Inlet in 1992 and pumped to a few northern beaches, this Reach has had little shore protection activity from 1985 through 1994. USACE started a reconnaissance study of this area in March, 1994.

Reach 8 includes Pullen and Brigantine Islands. Pullen Island and the northern 2 miles of Brigantine Island are undeveloped natural areas (profile 134 is within this area). Brigantine City occupies the rest of Brigantine Island. Both islands are low-lying, gently sloping, and both have very changeable shorelines, particularly in the northern natural areas. USACE and DEC started a feasibility study of this reach in 1994.

Reach 9 (Absecon Island) has undergone replenishment activity in Atlantic City and Longport Borough, and sand redistribution in Margate City. Profiles 130, 129, and 128, on the northeastern end of Absecon Inlet at Atlantic City and Ventnor, show positive net volume change, whereas profiles 127 and 126 show negative net volume change. As with Reach 8, USACE and DEC began a feasibility study in Reach 9 in 1994.

Reach 10 (Peck Beach, the barrier island occupied by Ocean City) received a major replenishment in 1992, and a smaller one at its northeastern end in 1989. These replenishments, along with periodic maintenance work (emplacement of additional smaller volumes of sand) by the USACE, are designed to maintain sand volume on these beaches.

Reach 11 (Ludlam Beach) is a low-lying shoreline under intense erosional pressure. Several replenishments were completed from 1984 through 1992. The USACE plans to start a reconnaissance study following a groin-construction project at Whale Beach, Upper Township by DEC, scheduled for completion in 1996.

Reach 12 (Seven Mile Beach) has had several replenishments and some construction activity in the Avalon Borough part of the island (profiles 116, 115, and 114). Graph 1 for profile 116 shows the volume change resulting from the large replenishments. Farther down the island (profiles #115-113) the evidence is less clear. The Stone Harbor Borough part of the island (profile 113) has had no replenishment projects. The spit at the southwestern end of the island is eroding rapidly, Hereford Inlet is widening, and the downdrift barrier island (Reach 13) is receiving abundant sediment (see Ashley, 1987). USACE and DEC are cooperating on a feasibility study for the island as a whole (Eugene Keller, oral commun., 1993).

Reach 13 (Five Mile Beach, the Wildwoods) has some of the widest, high-sand-volume beaches on the New Jersey Coast. As noted above, it lies downdrift of Hereford Inlet and it accumulates sediments moved downshore from the inlet by longshore transport. However, water has inundated the lower-lying landward side of the protective coastal dunes. Hereford Inlet is wide and shallow, except for the navigation channel on its southwestern side (directly along the northeastern end of Reach 13). Inlet dynamics are active in a cycle of spit growth, spit erosion and spit breaching (Ashley, 1987). As a result, frequent dredging is required to maintain the navigation channel. As documented in table 13B, there have been several replenishments of dredge material at North Wildwood City (area including profile 111) since 1985. Also, some of the dredged sand is used to build up the lower-elevation back dune area. The southern 1.2 miles of the island is part of a U.S. Coast Guard Station. With the exception of the ongoing redistribution of the dredged sand from Hereford Inlet, this reach is not part of a USACE or DEC shore protection project.

Reach 14 is another section of low lying shoreline vulnerable to erosion. The developed parts of this reach contain numerous groins and other engineered structures. The U.S. Coast Guard Station, situated on both sides of Cape May Inlet, comprises the eastern 1 mile of the island. In 1990, the USACE initiated a 50-year replenishment project for the Reach. As part of this project, Cape May City is already (1994) receiving sand; Lower Township is the subject of a USACE feasibility study; Cape May Point Borough, located at the mouth of Delaware Bay is next in line as the subject of a USACE reconnaissance study.

As seen in table 14B, there are documented replenishment projects in Cape May City, Lower Township and Cape May Point Borough from 1986 through 1992. The volume change data for profiles 104-108 reflect the replenishment activity. This reach, with its complex wave-current interaction, has displayed some of New Jersey's most severe shoreline losses.

New Jersey's intensely developed Atlantic Coast is susceptible to the natural changes affecting many Atlantic Coastal areas, including landward migration of barrier islands, rising sea level, and inlet migration. Reaches 2, 3, 4, 7, 10, 11, 12, and 14 appear to be more strongly affected by these changes. Fixed engineered structures to maintain channels or to protect real estate have both positive and negative effects on nearby beaches, and affect natural longshore sediment transport processes.

Given the state's commitment to shore protection, the USACE and DEC have planned cooperative studies for Reaches 5, 6, 7, 11 (these are at reconnaissance stage) and 8, 9, and 12 (these are at feasibility stage) (Eugene Keller, oral commun., 1994).

Reach 13, with its accreting shoreline, is not part of any shore protection project, except for the maintenance dredging of Hereford Inlet.

As previously noted, the profile surveys of volume change and shoreline change provide only discrete snapshots of beach dynamics along the New Jersey Coast. The analysis is an effort to quantify the complex and varied dynamics at work. In particular, calculations of volume change between profiles assume constant beach conditions and no engineered structures between profiles. The shoreline and volume change data provide baseline data for monitoring the fate of replenishment sands. As the duration of the study lengthens each year, the validity of the profile data is correspondingly enhanced (Farrell, 1993). In light of New Jersey's commitment to shore protection, such data will be increasingly valuable to federal, state, and local officials, home buyers, coastal planners and engineers, insurance companies, the scientific community and the coastal community at large.

SELECTION OF HIGH PRIORITY SURVEY AREAS

Compilation of available geologic and geophysical information, together with the beach replenishment critical areas assessment disclosed areas lacking necessary seismic and sedimentological information. The area off Townsends Inlet, between the 3-mile state and 12-mile federal limit was chosen for collection of additional seismic and core data. The additional data were needed to:

1) enable assessment of the quality and volume of sand in federal waters as much as 3 to 12 miles offshore;

2) address a lack of seismic and coring data in the target area at these depths;

3) collect new data directly offshore of a known "problem area", where coastal erosion is significant and where replenishment projects are imminent;

4) possibly connect and extend the active seismic and coring operations of other agencies, such as the U.S. Army Corps of Engineers or state agencies; and

5) possibly arrange a "piggyback" contract on Corps of Engineers vibracoring contracts, thus saving on mobilization costs.

The data compilation disclosed information gaps at two locations: 1) off Townsends Inlet (figs. 13 and 14), and 2) off Loveladies (near Harvey Cedars, north end of Long Beach Island, fig. 9). These are both areas of continuing beach erosion problems and may be supplied by artificial beach replenishment in the near future. Both areas have prominent submarine features in the federal waters area (3 to 12 miles offshore). These are northeast-trending elongate linear topographic ridges 10 to 30 feet high. In addition, both are locations where new seismic and coring data could greatly extend knowledge of the Holocene and Late Pleistocene stratigraphy of the New Jersey Continental Shelf.

The Townsends Inlet area was selected because, within the time and funding available, the survey could adequately evaluate the sand resources. In addition, the current seismic and coring studies of the Corps of Engineers off Townsends Inlet provide good coverage in the adjacent area within state waters, 0 to 3 miles offshore (Brian Murtaugh, oral commun., 1993). An adequate grid and coring density could be obtained in either the Townsends Inlet or the Loveladies area, but not in both. The potential for cooperation on the vibracoring contract with the Corps of Engineers (scheduled for the Fall of 1993) prompted selection of the Townsends Inlet area for the 1993 survey.

ACQUISITION OF NEW DATA

Seismic survey

The seismic data acquisition for the MMS study, which took place during the summer of 1993 (hereafter referred to as "the survey") was based on investigating beyond the 3-mile state limit the offshore extension of some features found in the nearshore area of the USACE study, as well as other features farther offshore. The linking of the two studies by integration of the data sets should result in enhanced analytical capacity for both studies.

The survey focuses on sand ridges--linear features 10-30 feet high, trending northeast roughly parallel to the coast along the inner continental shelf offshore of New Jersey (Ferland, M. A., 1990; Stubblefield and others 1983; Field and Duane, 1976; Stubblefield and Swift 1976; McKinney, and others, 1975; Stahl and others, 1974; and Duane and others 1972). These ridges are large accumulations of sand, the upper parts of which have been reworked by currents. Active reworking of sediments of the inner shelf is important as a source of beach and backbarrier sediment and in onshore transport. (Ferland, 1990). Typically, sand ridges are among the most suitable and economical sources of sand for beach replenishment (Meisburger and Williams, 1980).

The survey grid consists of a series of intersecting lines, roughly parallel and perpendicular to the predominant northeast trend of the ridges (see fig. 2). Real-time cursory interpretation of the analog data paper records made it possible to collect additional seismic data over areas of interest.

Development of data acquisition methods

For the past two years (1992-1994), the New Jersey Geological Survey and Rutgers University, Department of Geological Sciences, have developed a digital high-resolution single-channel marine seismic system. Initially funded under the Minerals Management Service Continental Margins Program (Year 9), this system combines conventional analog equipment with a land-based engineering seismograph (Waldner and others, 1993;1994). The system capitalizes on the processing and archival capabilities of digital data.

Data acquisition system

The analog equipment is an ORE Geopulse™ system in which a towed catamaran with a magnetorestrictive diaphragm having a peak frequency of about 1.0 kilohertz is the seismic source. The power supply (Model

5420A) provides energy levels of 105, 175, 280, 350 and 455 joules. A Geopulse™ receiver (Model 5210A) and EPC graphic data recorder control the firing rate, frequency filtering, and gain scaling, before plotting the data on electrosensitive paper. A digitizing dual trace oscilloscope (Hewlett Packard Model 54200A/D) monitors the incoming raw and filtered signal.

Digital system components

The digital system receiver is a Bison Instruments 9024™ 24-channel engineering seismograph. Analog-to-digital conversion is 16-bit with digital instantaneous floating point. Wave noise (a low-frequency, high-energy signal) is attenuated by analog-receiver low-cut frequency filters before entering the first channel of the digital seismograph. Digital filters on the digital seismograph are, therefore, selected with due regard to the analog filters to minimize signal aliasing. The seismograph is equipped with an auto-save feature which routes to internal storage after a pre-set number of enhancements. In the marine surveys, each shotpoint is saved without signal enhancement. Internal data storage is on an 80-megabyte hard disk.

Digital data storage restrictions

The digital operating system limits downloading to 999 files or fewer, although more can be saved by the seismograph. In addition, download time for hundreds of small files to a microcomputer increases geometrically to unfeasible limits. For most survey situations, at 12 traces per file, the 80-megabyte hard disk can hold nearly 12,000 recorded traces. This is enough for a single day of data collection, permitting downloading overnight. For example, with an analog firing rate of three shots per second and a trigger-divider (detailed in the next section) ratio of 10:1, approximately 11 hours of continuous digital recording is possible.

Digital system enhancements added in Townsends Inlet survey

A trigger-divider and automatic roll-along switch overcomes digital recording and storage problems. A trigger-divider sends a slower trigger rate to the digital seismograph while maintaining the fast firing-rate for analog records. The slower digital trigger-rate serves three purposes. First, it adapts the firing rate normally used by analog units that is too fast (often 2-5 triggers per second) for the cycle time of the engineering seismograph; second, it maintains output of an analog paper copy for cursory interpretation and general quality control; and third, it reduces the digital data collected to a manageable but representative size. An automatic roll-along switch (developed by Bison Instruments) overcomes limitations of the seismograph's mass- storage device and the micro computer by grouping adjacent traces to files. The 12-channel roll-along switches the single channel input to the next trace after each trace-sampling cycle. With the auto-save feature set to 12 enhancements per SAVE, the roll-along groups 12 sequential traces to a single file. The system is limited to 12 instead of 24 channel-files so that the auto-save cycle time is shorter than the digital firing-rate.

Survey positioning

Survey positioning *via* the Global Positioning System (GPS) enables one to plot real-time position and to obtain navigation accuracy to within 10 meters following processing. The seismic data are correlated to the GPS data by synchronization of the seismograph clock to the GPS clock, thereby matching seismic data file-header time-tags to geodetic coordinates. This reduces the rubber-sheeting error of analog data caused by interpolation of data points between manual time marks on the analog paper record. Vibracores and bottom grab-samples that are similarly surveyed with GPS can be projected accurately onto the seismic section.

Table 1B compares GPS positioning accuracy with other methods employed in water covered areas for various survey classes. For the offshore New Jersey survey, real-time positioning conformed to absolute point positioning with selective availability (SA). Using a stable GPS base station (maintained at the Department of Environmental Protection building, 401 E. State Street, Trenton, New Jersey) post-processing accuracy conformed to differential pseudo ranging standards. Discussion of GPS positioning including processing can be found in Hoffman-Wellenhof and others (1993) and Puterski and others (1992).

Townsends Inlet Seismic Survey

More than 150 line-miles of data were collected at the Townsends Inlet site in both analog and digital format. The analog data were used for optimum placement of vibracores, collected as part of Phase I of the MMS grant.

The file format of the engineering seismograph is SEG-2, a standard magnetic tape format recognized by the Society of Exploration Geophysicists (SEG). In preparation for processing, the data are converted to SEG-Y format (SEG Technical Standards Committee, 1980). As a part of Phase II of the MMS study, the data were processed using EAVESDROPPER™, a common-midpoint (CMP) processing software developed by the Kansas Geological Survey (Kansas Geological Survey, 1993; Bennett and Chung, 1986; Somanas and others, 1987). The digital data will be processed with conventional seismic processing routines such as: trace sorting, removal of defective data traces, residual static corrections, source receiver offset corrections, deconvolution, horizontal stacking, digital frequency filtering, muting and gain scaling. Seismic processing theory is thoroughly reviewed by Robinson and Treitel (1980); Robinson (1983); Waters (1978); Yilmaz (1988); Sheriff and Geldart (1982-83).

Seismic Interpretation

After processing, the seismic data will be correlated with the vibracores and with data from previous studies to identify sand deposits and estimate their volumes by seismic stratigraphy. Seismic stratigraphy as applied to marine unconsolidated sediments is a method of determining the nature and geologic history of the sediments and their depositional environment from seismic evidence (Sheriff, 1984). Its basic assumption is that a reflection alignment corresponds to a time-stratigraphic horizon, a representation of the surface of the solid earth at a particular geologic time (Anstey, 1977) rather than a record of the time- transgressive lithostratigraphy (rock stratigraphy). Seismic stratigraphic methods are discussed in: Berg and Woolverton (1985) Sheriff (1980); Brown and Fischer (1980); Sangree and Widmer (1979); Anstey (1977); and Payton, (1977).

Using the premise of seismic stratigraphy, Vail and others (1977) identified seven-types of stratigraphic interpretations besides post depositional structural deformation based on the geometry of seismic reflection correlation patterns: (1) geologic time correlations, (2) definition of genetic depositional units, (3) thickness and depositional environment of genetic units, (4) paleobathymetry, (5) burial history, (6) relief and topography on unconformities and (7) paleogeography and geologic history when combined with geologic data. However, a limiting factor is that lithofacies and rock type cannot be determined directly from geometry of reflection correlation patterns.

Seismic Sequence Analysis

Seismic sequence analysis defines separate, genetically related strata, termed depositional sequences, by locating their boundaries, usually by evidence of unconformities. The time interval represented by strata of a given sequence may differ from place to place, but the range is confined to synchronous limits marked by ages of the sequence boundaries where they become conformities. Depositional sequence boundaries are recognized on seismic data by identifying reflection patterns caused by lateral terminations due to sediment or eustatic change.

For the study area off New Jersey, the glacial mechanisms that influenced sea-level cycles in the Holocene/Wisconsinan are very useful for seismic sequence analysis because amplitudes of the eustatic sea-level changes vary for the different components of the Milankovitch cycles (Ashley and others, 1991a). The deep-sea oxygen isotope records (Ruddiman 1977; Sancetta and others, 1973) indicate that the last two major glaciations in the late Wisconsinan (approximately seventy thousand years ago) (Stage 4) would be of a magnitude to cause major sea-level falls across New Jersey. These sea-level falls would create the exposures of the shelf that correspond to the type 1 sequence boundaries of Vail and others (1977) and Haq and others (1987).

Seismic Facies Analysis

Seismic facies analysis delves further into the character of a group of reflections by investigating the general amplitude, frequency, interval velocity, abundance, continuity and configuration of the reflections (Sheriff, 1980). Where the seismic facies are described and mapped, an interpretation of the environmental setting and sedimentary processes enables the interpreter to predict the lithology of seismic facies (Vail and others, 1977).

Seismic facies units are mappable, three-dimensional seismic units composed of groups of reflections whose parameters differ from those of adjacent units. Where the internal reflection parameters, the external form, and the three-dimensional associations of those seismic facies units are delineated, the units can then be interpreted in

Table 1B. Allowable horizontal positioning system criteria[1]

Positioning system	Estimated Positional Accuracy (Meters RMS)[2]	Allowable for Survey Class		
		1	2	3
Visual Range Intersection	3 to 20	No	No	Yes
Sextant Angle Resection	2 to 10	No	Yes	Yes
Transit/ Theodolite Angle Intersection	1 to 5	Yes	Yes	Yes
Range Azimuth Intersection	0.5 to 3	Yes	Yes	Yes
Tag Line (Static Measurements from Bank)				
<1500 ft from baseline	0.3 to 1	Yes	Yes	Yes
>1500 ft but <2000 ft	1 to 5	No	Yes	Yes
>3000 ft from baseline	5 to 50+	No	No	Yes
Tag Line (Dynamic)				
<1000 ft from baseline	1 to 3	Yes	Yes	Yes
>1000 ft but <2000 ft	3 to 6	No	Yes	Yes
>2000 ft from baseline	6 to 50+	No	No	Yes
Tag Line (Baseline Boat)	5 to 50+	No	No	Yes
High Frequency EPS (Microwave or UHF)	1 to 4	Yes	Yes	Yes
Medium Frequency EPS	3 to 10	No	Yes	Yes
Low Frequency EPS (LORAN)	50 to 2000	No	No	Yes
Satellite Positioning:				
Doppler	100 to 300	No	No	No
Starfix	5	No	Yes	Yes
NAVSTAR GPS:				
Absolute Point Positioning (no SA)[3]	15	No	No	Yes
Absolute Point Positioning (with SA)	50 to 100	No	No	Yes
Differential Pseudo Ranging	2 to 5	Yes	Yes	Yes
Differential Kinematic (future)	0.1 to 1.0	Yes	Yes	Yes

[1] from U.S. Army Corps of Engineers, 1991
[2] RMS: root mean square
[3] SA: selective availability, a U.S. Department of Defense accuracy limitation

Table 1C. Latitude/longitude locations for the 20 vibracores collected during the summer, 1994

Site	Latitude	Longitude	Site	Latitude	Longitude
1	39° 07' 15.9" N	74° 38' 10.4" W	11	39° 11' 02.1" N	74° 35' 31.6" W
2	39° 07' 49.0" N	74o 37' 32.9" W	12	39° 09' 57.9" N	74° 33' 52.2" W
3	39° 07' 43.6" N	74° 35' 54.4" W	13	39° 09' 53.9" N	74° 35' 15.1" W
4	39° 07' 09.4" N	74° 36' 33.2" W	14	39° 09' 10.5" N	74° 36' 52.1" W
5	39° 10' 18.6" N	74° 33' 05.6" W	15	39° 07' 31.8" N	74° 34' 27.5" W
6	39° 07' 39.0" N	74° 36' 37.5" W	16	39° 02' 21.4" N	74° 41' 47.5" W
7	39° 05' 21.8" N	74° 34' 04.2" W	17	39° 01' 57.0" N	74° 41' 11.2" W
8	39° 07' 34.0" N	74° 31' 36.7" W	18	39° 00' 18.2" N	74° 41' 17.2" W
9	39° 03' 22.1" N	74° 41' 12.5" W	19	38° 58' 34.6" N	74° 38' 39.4" W
10	39° 07' 26.0" N	74° 32' 11.7" W	20	39° 00' 50.0" N	74° 37' 26.5" W

terms of environmental setting, depositional processes and lithology.

Sand deposit identification and volumetric estimates

The resulting interpretation will be used to identify sand deposits suitable for beach sand (part of the Phase II study). It is planned to contour these deposits so that their volumes can be calculated. Thus, the volumetric estimates would only include the area covered by the seismic traverses.

Vibracoring

In June, 1994, the New Jersey Geological Survey finalized a contract with New Jersey Marine Sciences Consortium to collect 20 vibracores in the area of the Townsends Inlet seismic survey (summer, 1993). Core locations were selected by NJGS and Rutgers University Geosciences Department, based on initial findings of the 1993 seismic survey. The drilling was completed in early September, 1994. The 20 vibracore sites are listed by latitude/longitude in table 1C. Prominent shoals from which cores were collected include "The Lump" and Avalon Shoal (fig. 2). The cores will be logged, photographed and undergo additional preparation for analysis after transport to Rutgers University. Subsequently, Rutgers Geosciences Dept. will perform the textural and mineralogic analysis as part of Phase II of the cooperative study.

FUTURE WORK

In Phase II of the cooperative study, NJGS will continue to obtain basic geologic, economic and environmental data on offshore sand deposits in federal waters. More specifically, the tasks will include the following: 1) analysis of the seismic data and vibracores collected in Phase I; 2) a comparison of sediment needs vs. availability of the selected offshore deposits; 3) a cost comparison of onshore vs. offshore sand resources and dredging in state vs. federal waters; and 4) investigation of environmental effects of extracting offshore sand resources.

ACKNOWLEDGEMENTS

The authors would like to thank the following people for their contributions to this report: Roger Amato of the Minerals Management Service, who provided technical and administrative guidance for the study; Karl Muessig of the New Jersey Geological Survey, who initiated and then managed the study during the first 16 months of the cooperative agreement; Peter C. Smith of Rutgers University who collected seismic data during the '93 survey and monitoried the drilling operation for quality control of the vibracores, summer, '94; Lynn Bocamazo, Douglas Gaffney, and Brian Murtaugh of the U.S. Army Corps of Engineers, who provided extensive technical background and references; Bernard Moore and Eugene Keller of NJDEP's Division of Engineering and Construction provided technical assistance and replenishment data and arranged for additional funding for the '94 vibracoring; William Eisele and Joseph Rommell of NJDEP's Bureau of Marine Water Classification and Analysis, who made available and piloted the James J. Howard research vessel for the seismic survey. Richard Henne of NJGS provided technical assistance to the seismic team; Zehdreh Allen-Lafayette and Maryann Scott of NJGS produced the 17 digital maps; Doreen Hogan of NJGS computer-formatted the 96 pages of profile/reach tables and the text of the final report; Jo Valencia of NJGS typed sections of the report; William Graff, I.G. Grossman, Richard Dalton, David Harper, and Thomas Seckler of NJGS edited the manuscript and/or offered helpful criticism during the compilation of the report. MMS' Year-9 funding under agreement #14-35-0001-30643 provided critical support for the development of the combination digital/analog seismic system. The beach replenishment-sand study was funded under Cooperative Agreement #14-35-0001-30666 by the Minerals Management Service, U.S. Department of the Interior.

REACH AND PROFILE DATA SHEETS

Pages 24 through 140 contain the profile data sheets, reach tables, and reach maps as described in the Data Analysis section of the text.

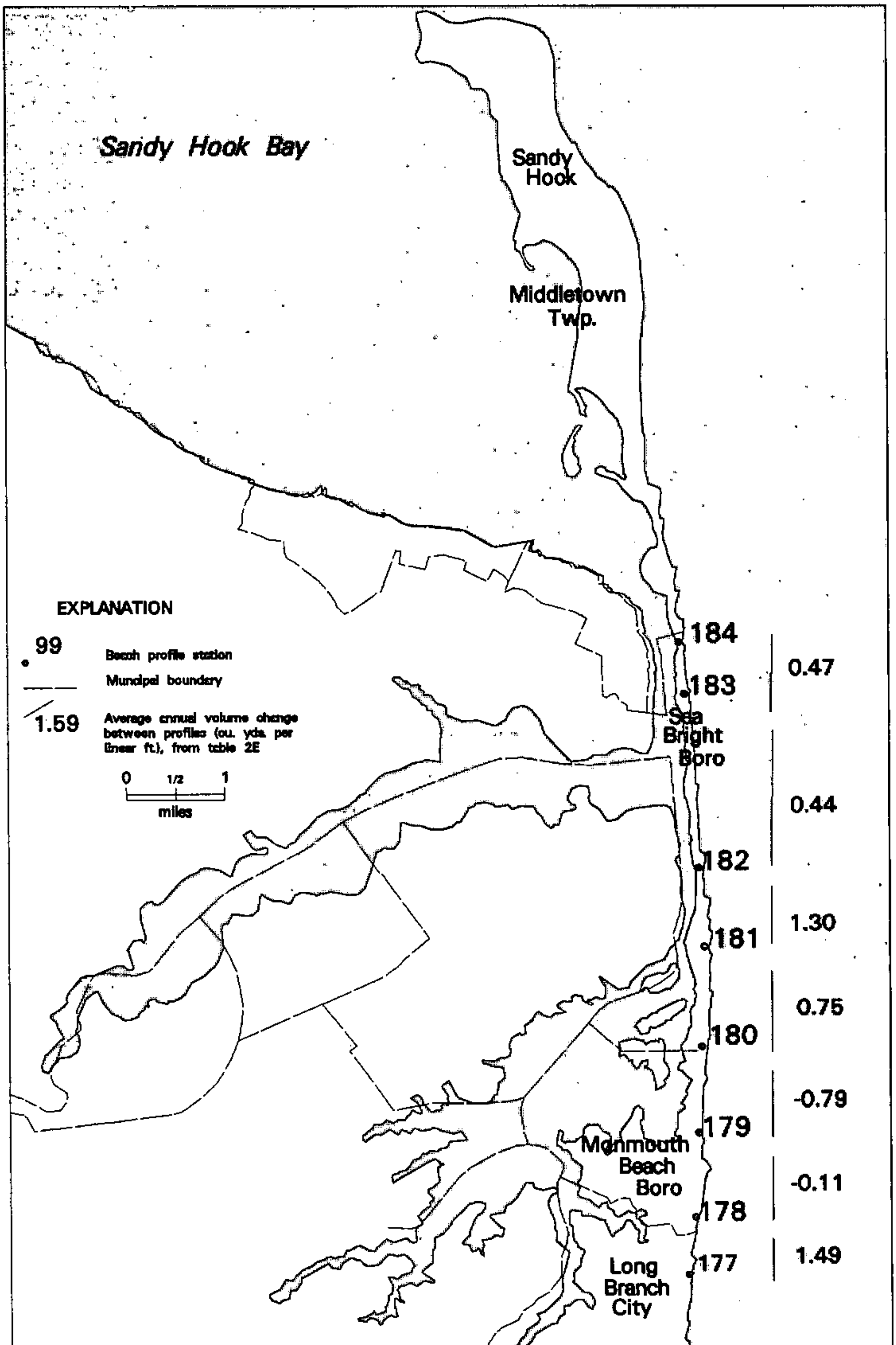


Figure 4. Map of Reach 2, Sandy Hook to Long Branch, showing municipalities, profile locations, and calculated volume change between profiles.

Table 2A. Profile stations - Sandy Hook to Long Branch, Monmouth County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
184	735835W	402400N	10 (est.)[4]	Entrance to Gateway National Recreation Area, Sea Bright Borough
183	735830W	402331N	10 (est.)[4]	Via Ripa St., Sea Bright Borough
182	735825W	402213N	12.64	Route 36 (Ocean Ave.), Sea Bright Borough
181	735824W	402138N	6.57	Municipal parking lot, Sea Bright Borough
180	735827W	402047N	8.17	Opposite Ocean Reef Condominiums, Sea Bright Borough
179	735828W	402013N	11.39	Cottage Rd., Monmouth Beach Borough
178	735832W	401937N	14.97	Monmouth Beach Club, Monmouth Beach Borough

1 In degrees, minutes, seconds.
2 Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
3 Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.
4 Estimated, not measured.

Table 2B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
Middletown Twp.		Replenishment of unknown amount documented by National Park Service at Sandy Hook natural area, 1985-1992.	NA	NA
Sea Bright Borough		Army Corps replenishment project under evaluation, with 1994 planned start. Profile stations 183 and 184 are at sites with no dry beach.		
Monmouth Beach Borough	1985	Replenishment	3,230	325
		Army Corps replenishment project under evaluation, with 1994 planned start. Profile stations 178 and 179 are at sites with very narrow beaches that are typically submerged at high tide.		

1 Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
2 NA, data not available.

Table 2C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
178	87.39	36.73	64.99	17.31	11.37
179	161.86	134.34	146.89	11.85	24.33
180	212.32	154.47	181.94	18.01	-29.29
181	241.18	189.82	212.13	17.59	25.29
182	271.22	238.09	260.44	10.97	-9.79
183	91.71	83.94	87.08	2.86	6.93
184	146.73	143.89	145.61	1.10	0.94

1 Data summarized from table 2 of Profiles 178-184.
2 The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
3 Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 178-184.

Table 2D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
177[3]	10.15	-7.22	2.84	6.32	17.05
178	14.83	-19.24	0.14	12.43	0.85
179	7.19	-4.14	-0.36	6.40	-2.13
180	5.40	-8.67	-1.23	4.91	-7.35
181	9.52	-9.94	2.74	11.77	16.44
182	9.34	-9.47	-0.14	7.41	-0.81
183	5.76	-3.77	1.03	3.53	6.16
184	4.16	-6.41	-0.09	3.67	-0.62

1 Data summarized from table 1 of Profiles 177-184.
2 Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 177-184.
3 Profile 177 included from Reach 3 to calculate volume change between profiles 177 and 178, although it is outside Reach 2.

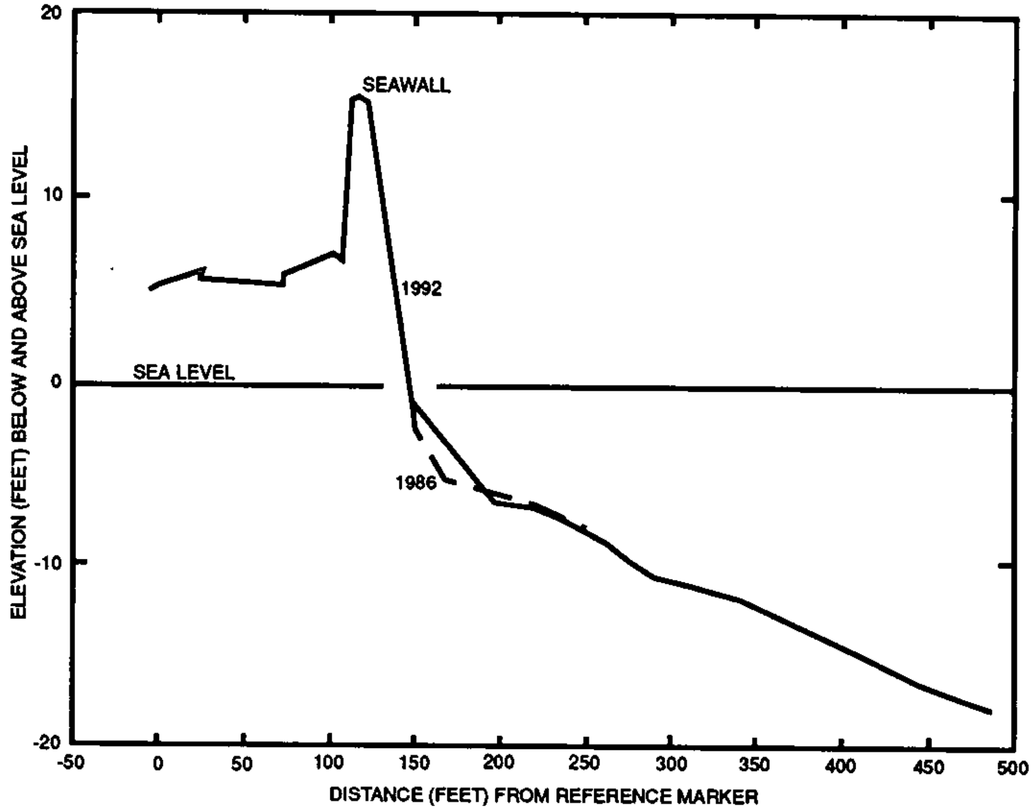
Table 2E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
177-178	3,300	1.49	4,917	2,200
178-179	3,700	-0.11	-407	2,507
179-180	3,350	-0.79	-2,646	2,127
180-181	5,350	0.75	4,012	3,162
181-182	3,500	1.30	4,550	2,206
182-183	7,900	0.44	3,476	5,515
183-184	2,900	0.47	1,363	2,256

1 Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
2 Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
3 Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
4 Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 2, Profile 184
Entrance to Gateway National Recreation Area, Sea Bright Borough

Change in profile of sand surface, 1986 to 1992



Graph 1

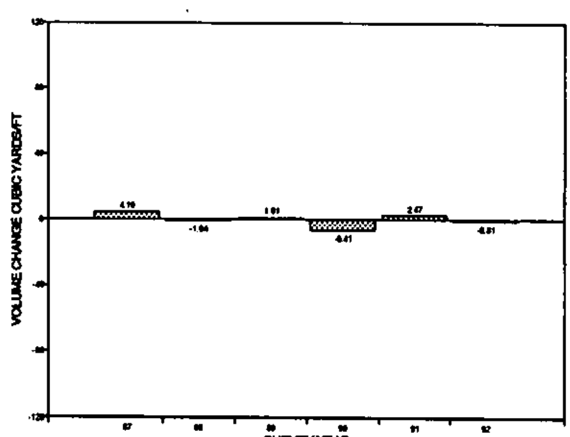


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-0.07	4.23	4.16
1988	-0.07	-0.97	-1.04
1989	1.05	-0.04	1.01
1990	-1.29	-5.12	-6.41
1991	-0.18	2.65	2.47
1992	0.73	-1.54	-0.81
Approximate 6-yr. volume change			-0.62
Mean annual volume change			-0.09
Standard deviation			3.67

[1] Negative value denotes loss of sand

Graph 2

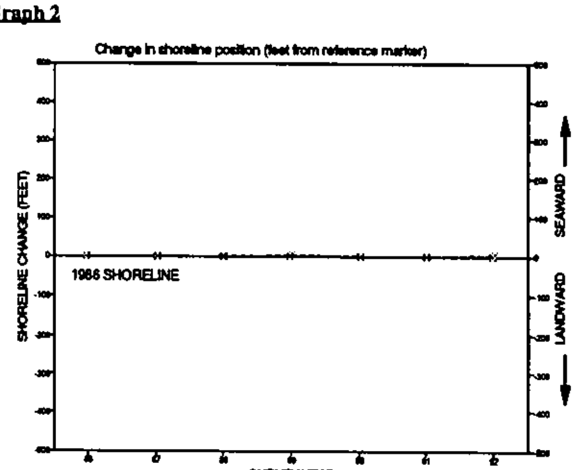


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/10	145.77	
1987	10/05	145.46	-0.31
1988	10/11	146.24	0.47
1989	10/11	146.73	0.96
1990	10/15	144.44	-1.33
1991	10/21	143.89	-1.88
1992	10/26	146.71	0.94
Net shoreline change, 1986-1992 [3]			0.94
Mean annual distance from ref. mkr., 1986-1992 [3]			145.61
Standard deviation			1.10

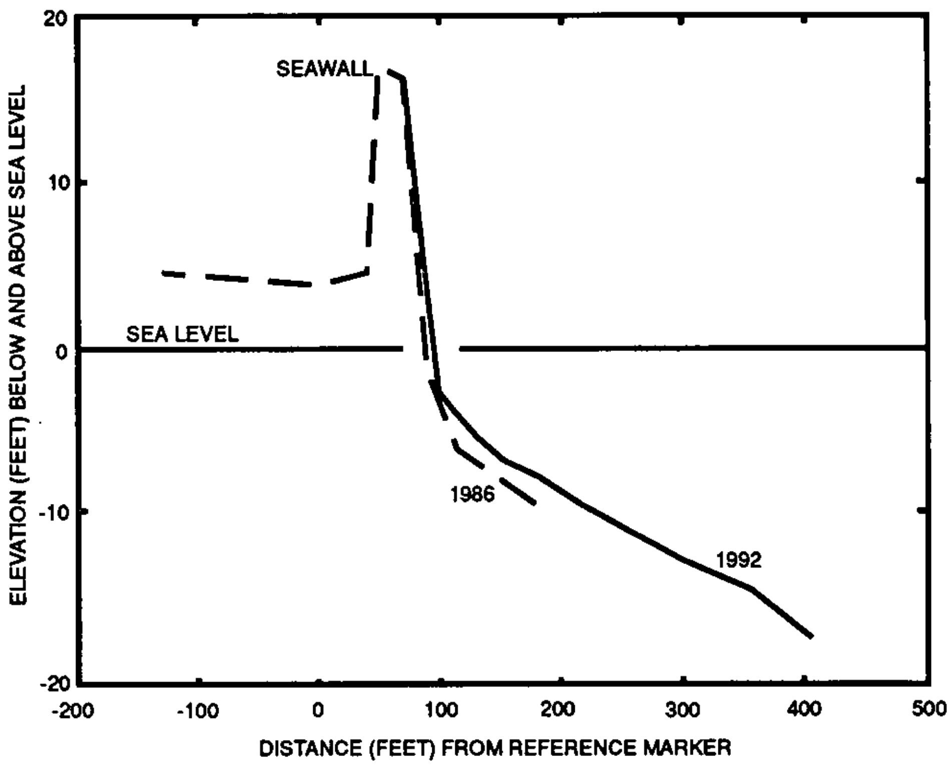
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 2, Profile 183
Via Ripa Street, Sea Bright Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

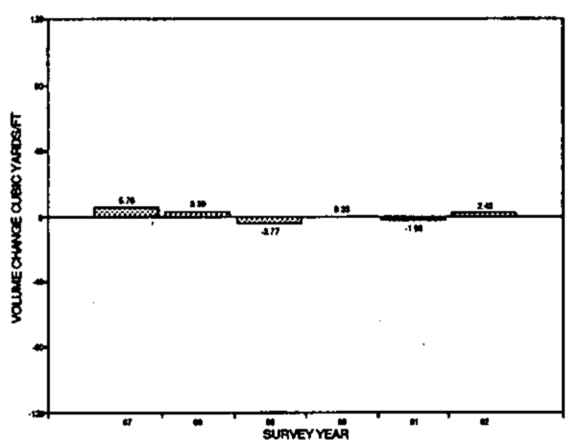


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	0.00	5.76	5.76
1988	-0.21	3.60	3.39
1989	0.94	-4.71	-3.77
1990	-0.16	0.49	0.33
1991	0.70	-2.68	-1.98
1992	0.91	1.52	2.43
Approximate 6-yr. volume change			6.16
Mean annual volime change			1.03
Standard deviation			3.53

[1] Negative value denotes loss of sand

Graph 2

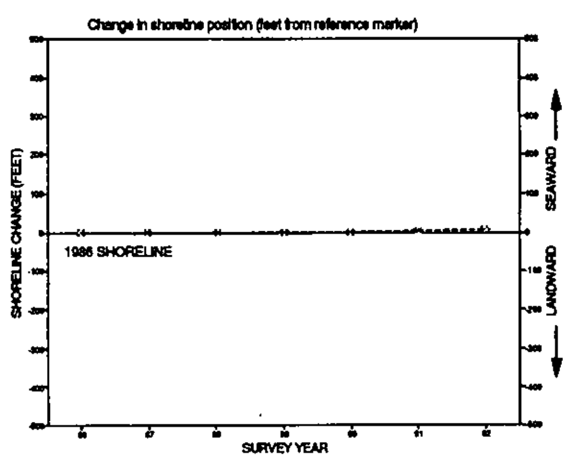


Table 2

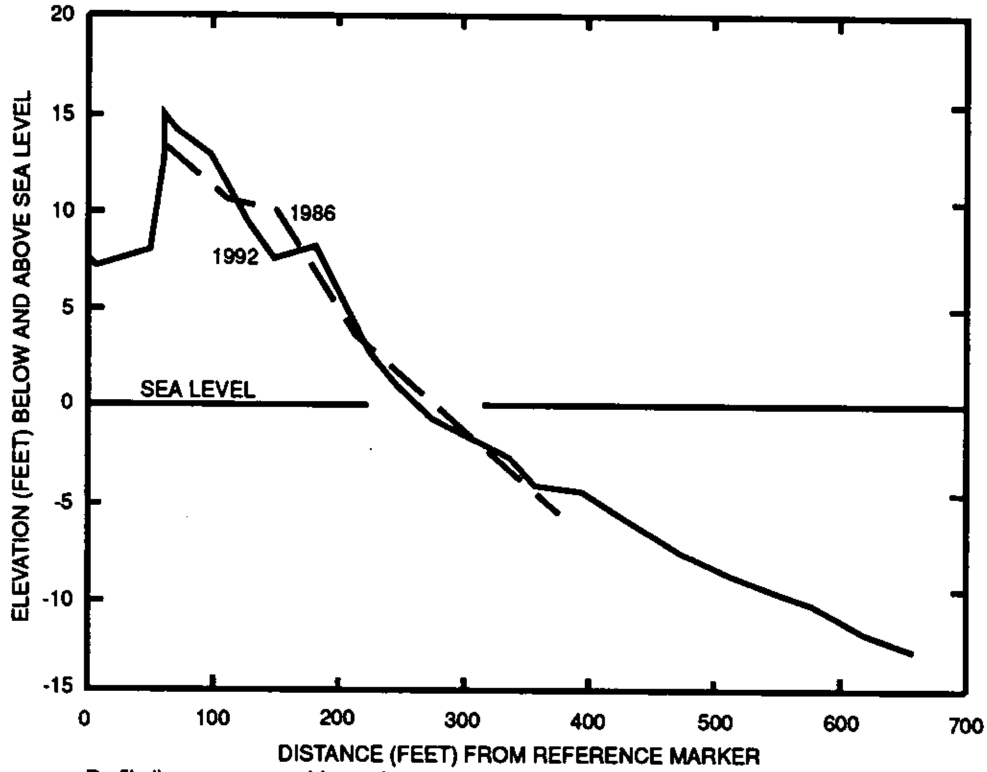
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/10	84.78	
1987	10/05	84.78	
1988	10/11	83.94	-0.84
1989	10/11	87.57	2.79
1990	10/15	87.00	2.22
1991	10/21	89.75	4.97
1992	10/26	91.75	6.93
Net shoreline change, 1986-1992 [3]			6.93
Mean annual distance from ref. mkr., 1986-1992 [3]			87.08
Standard deviation			2.86

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 2, Profile 182
Route 36 (Ocean Avenue), Sea Bright Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

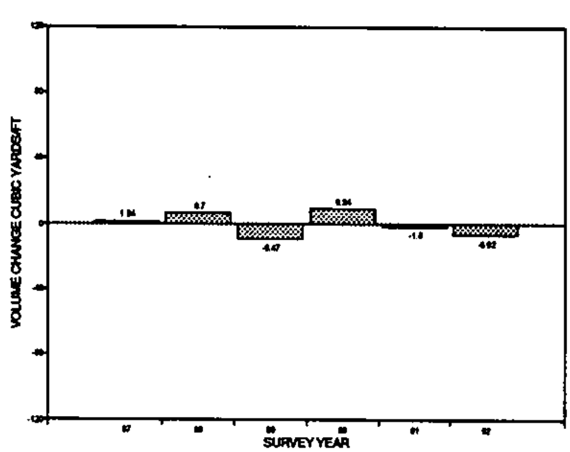


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	4.64	-3.30	1.34
1988	-1.07	7.77	6.70
1989	-1.38	-8.09	-9.47
1990	2.81	6.53	9.34
1991	0.45	-2.25	-1.80
1992	-4.43	-2.49	-6.92
Approximate 6-yr. volume change			-0.81
Mean annual volume change			-0.14
Standard deviation			7.41

[1] Negative value denotes loss of sand

Graph 2

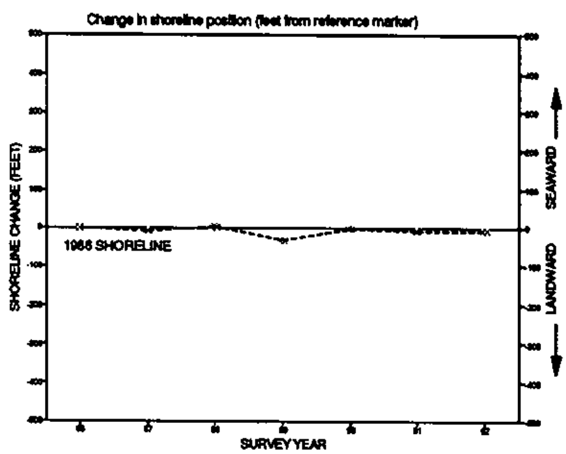


Table 2

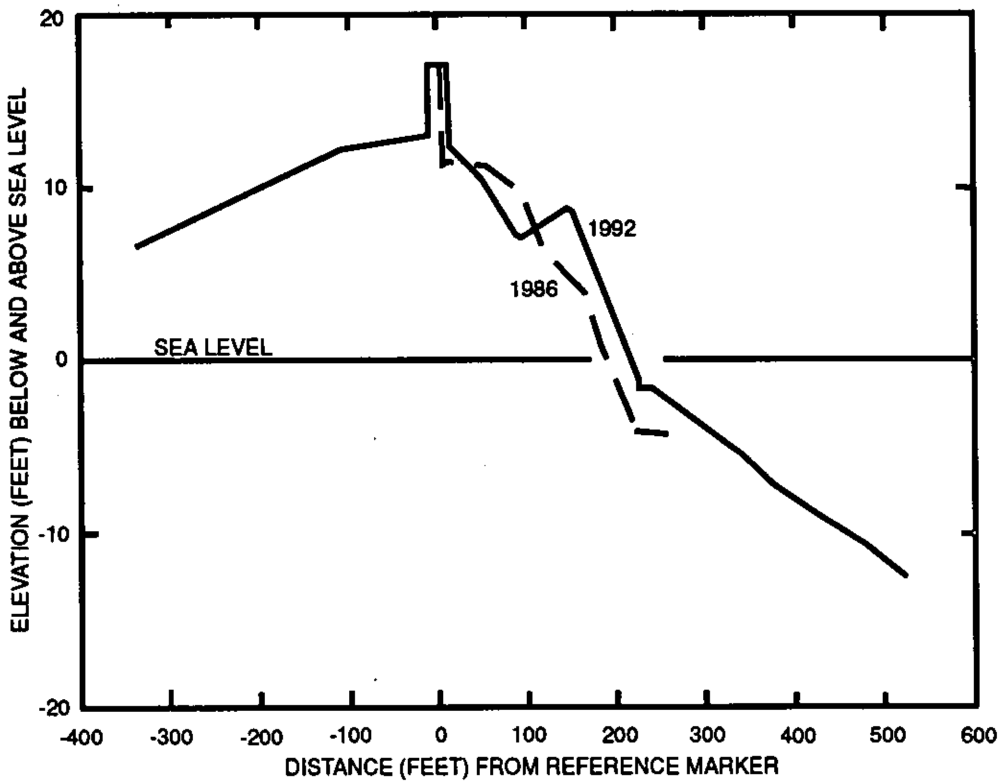
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/10	269.64	
1987	10/05	259.48	-10.16
1988	10/11	271.22	1.58
1989	10/11	238.09	-31.55
1990	10/15	264.96	-4.68
1991	10/21	259.84	-9.80
1992	10/26	259.85	-9.79
Net shoreline change, 1986-1992 [3]			-9.79
Mean annual distance from ref. mkr., 1986-1992 [3]			260.44
Standard deviation			10.97

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 2, Profile 181
Municipal Beach, Sea Bright Borough

Change in profile of sand surface, 1986 to 1992



Graph 1

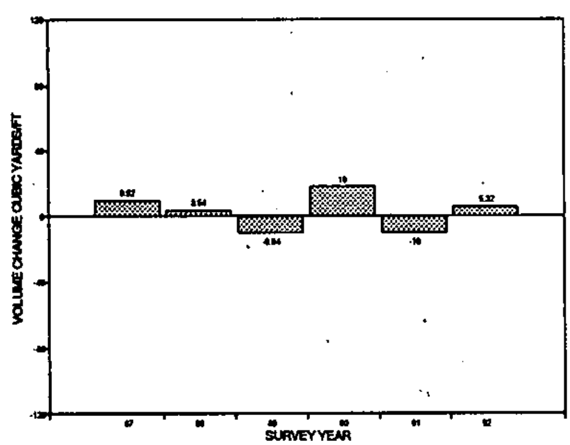


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	5.28	4.24	9.52
1988	-3.02	6.56	3.54
1989	1.32	-11.26	-9.94
1990	5.45	12.55	18.00
1991	-4.17	-5.83	-10.00
1992	5.60	-0.28	5.32
Approximate 6-yr. volume change			16.44
Mean annual volume change			2.74
Standard deviation			11.77

[1] Negative value denotes loss of sand

Graph 2

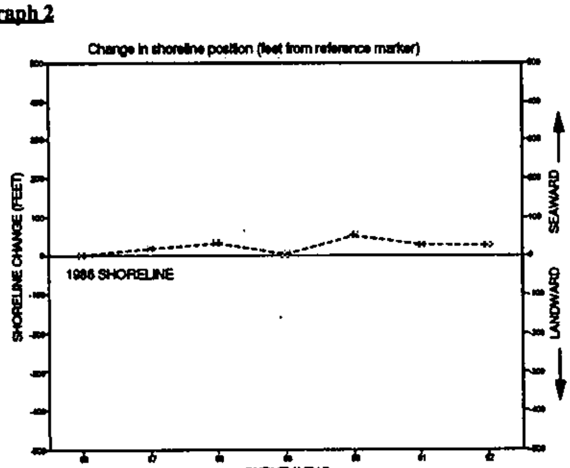


Table 2

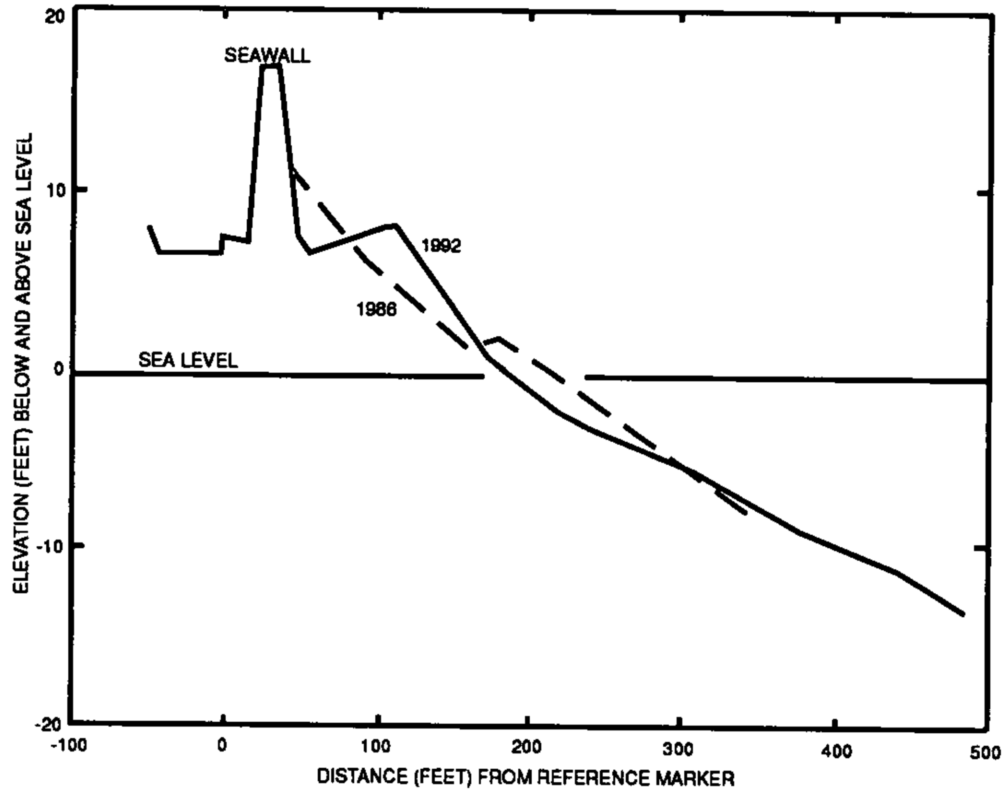
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/10	189.82	
1987	10/05	205.86	16.04
1988	10/12	220.7	30.88
1989	10/11	193.46	3.64
1990	10/15	241.18	51.36
1991	10/21	218.75	28.93
1992	10/26	215.11	25.29
Net shoreline change, 1986-1992 [3]			25.29
Mean annual distance from ref. mkr., 1986-1992 [3]			212.13
Standard deviation			17.59

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 2, Profile 180
Opposite Ocean Reef Condominiums, Sea Bright Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

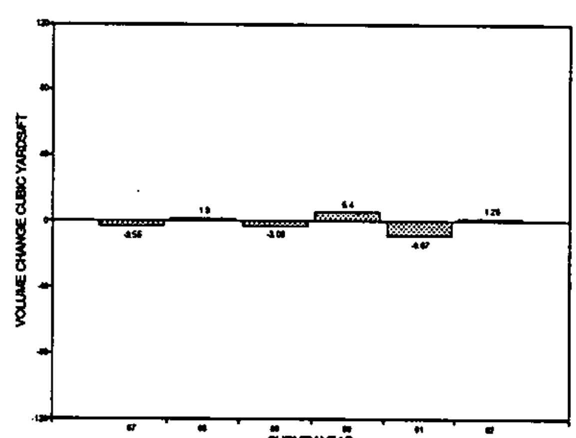


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR[1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-0.15	-3.40	-3.55
1988	-3.98	5.28	1.30
1989	3.62	-6.70	-3.08
1990	0.40	5.00	5.40
1991	-4.80	-3.87	-8.67
1992	2.84	-1.59	1.25
Approximate 6-yr. volume change			-7.35
Mean annual volume change			-1.23
Standard deviation			4.91

[1] Negative value denotes loss of sand

Graph 2

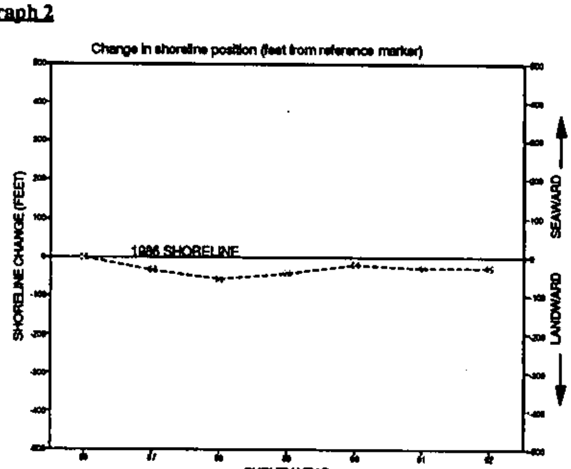


Table 2

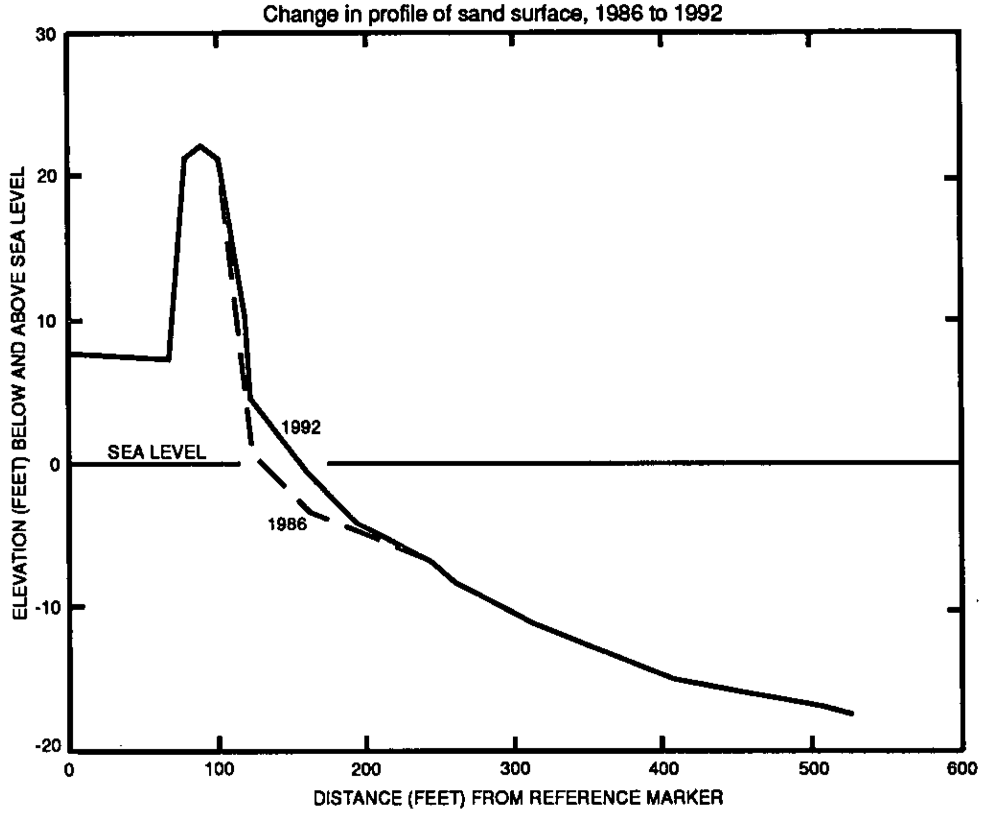
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker[1]	Change from 1986 shoreline[2]
1986	11/11	212.32	
1987	10/07	179.19	-33.13
1988	10/12	154.47	-57.85
1989	10/11	169.58	-42.74
1990	10/16	192.28	-20.04
1991	10/22	182.69	-29.63
1992	10/27	183.03	-29.29
Net shoreline change, 1986-1992[3]			-29.29
Mean annual distance from ref. mkr., 1986-1992[3]			181.94
Standard deviation			18.01

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 2, Profile 179
Cottage Road, Monmouth Beach Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

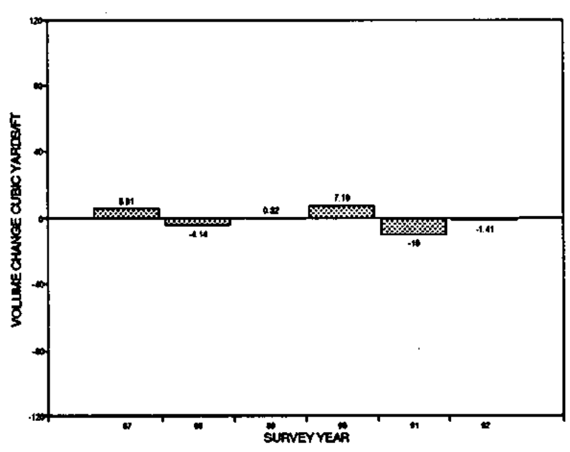


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	4.30	1.61	5.91
1988	-3.65	-0.49	-4.14
1989	0.68	-0.36	0.32
1990	4.13	3.06	7.19
1991	-4.17	-5.83	-10.00
1992	2.09	-3.50	-1.41
Approximate 6-yr. volume change			-2.13
Mean annual volume change			-0.36
Standard deviation			6.40

[1] Negative value denotes loss of sand

Graph 2

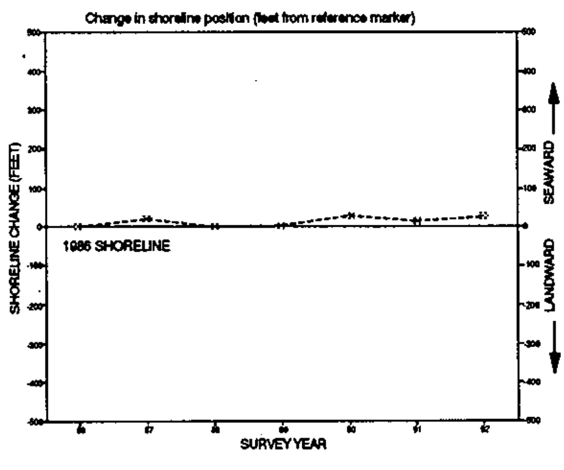


Table 2

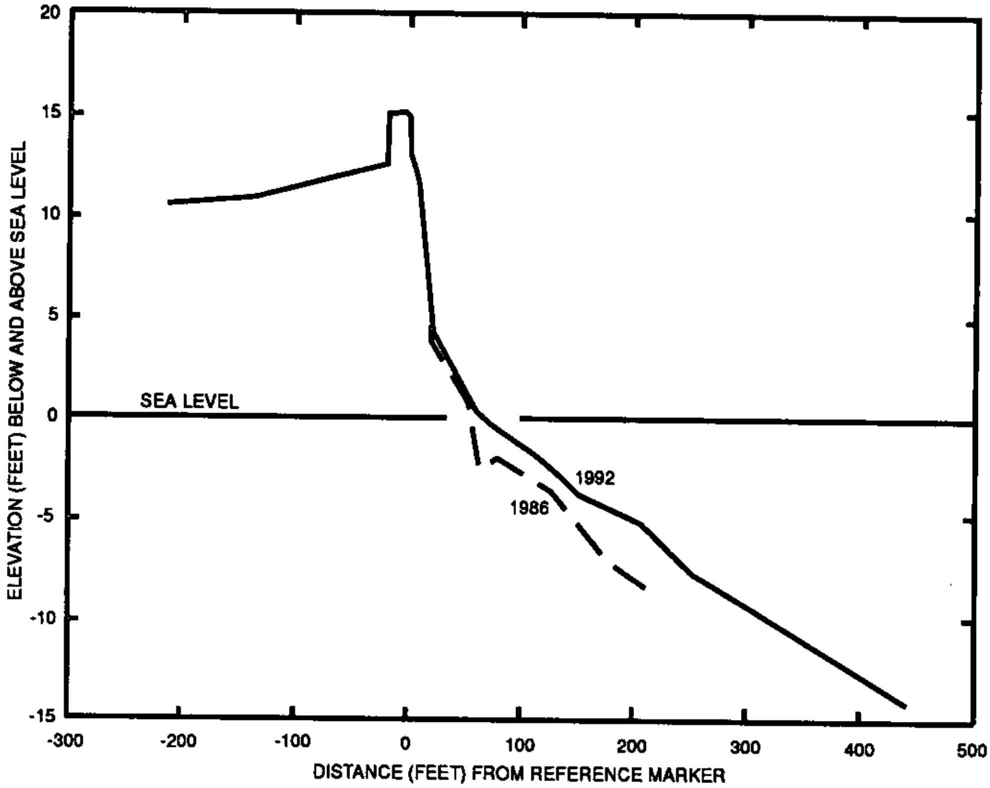
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/11	134.34	
1987	10/07	153.41	19.07
1988	10/12	134.44	0.10
1989	10/11	136.04	1.70
1990	06/11/91	161.86	27.52
1991	10/22	149.48	15.14
1992	10/26	158.67	24.33
Net shoreline change, 1986-1992 [3]			24.33
Mean annual distance from ref. mkr., 1986-1992 [3]			146.89
Standard deviation			11.85

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 2, Profile 178
Monmouth Beach Club, Monmouth Beach Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

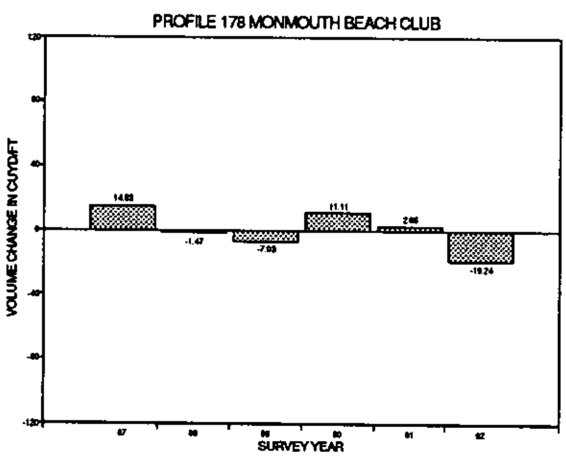


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	1.16	13.67	14.83
1988	-2.55	1.08	-1.47
1989	-1.07	-5.96	-7.03
1990	3.54	7.57	11.11
1991	3.27	-0.62	2.65
1992	-3.07	-16.17	-19.24
Approximate 6-yr. volume change			0.85
Mean annual volume change			0.14
Standard deviation			12.43

[1] Negative value denotes loss of sand

Graph 2

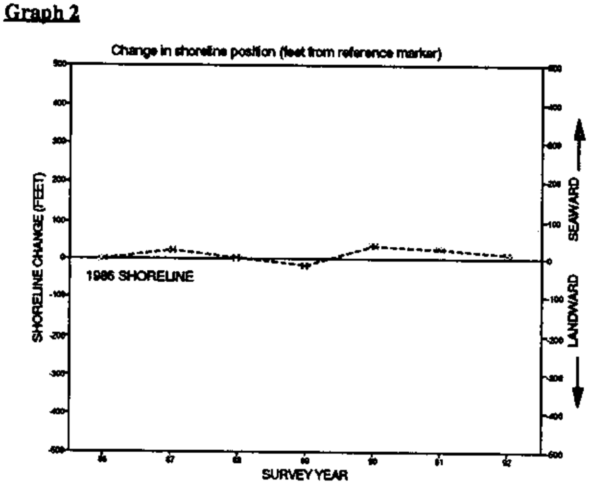


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/11	53.84	
1987	10/07	74.28	20.44
1988	10/12	57.38	3.54
1989	10/12	36.73	-17.11
1990	10/16	87.39	33.55
1991	10/22	80.10	26.26
1992	10/27	65.21	11.37
Net shoreline change, 1986-1992 [3]			11.37
Mean annual distance from ref. mkr., 1986-1992 [3]			64.99
Standard deviation			17.31

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

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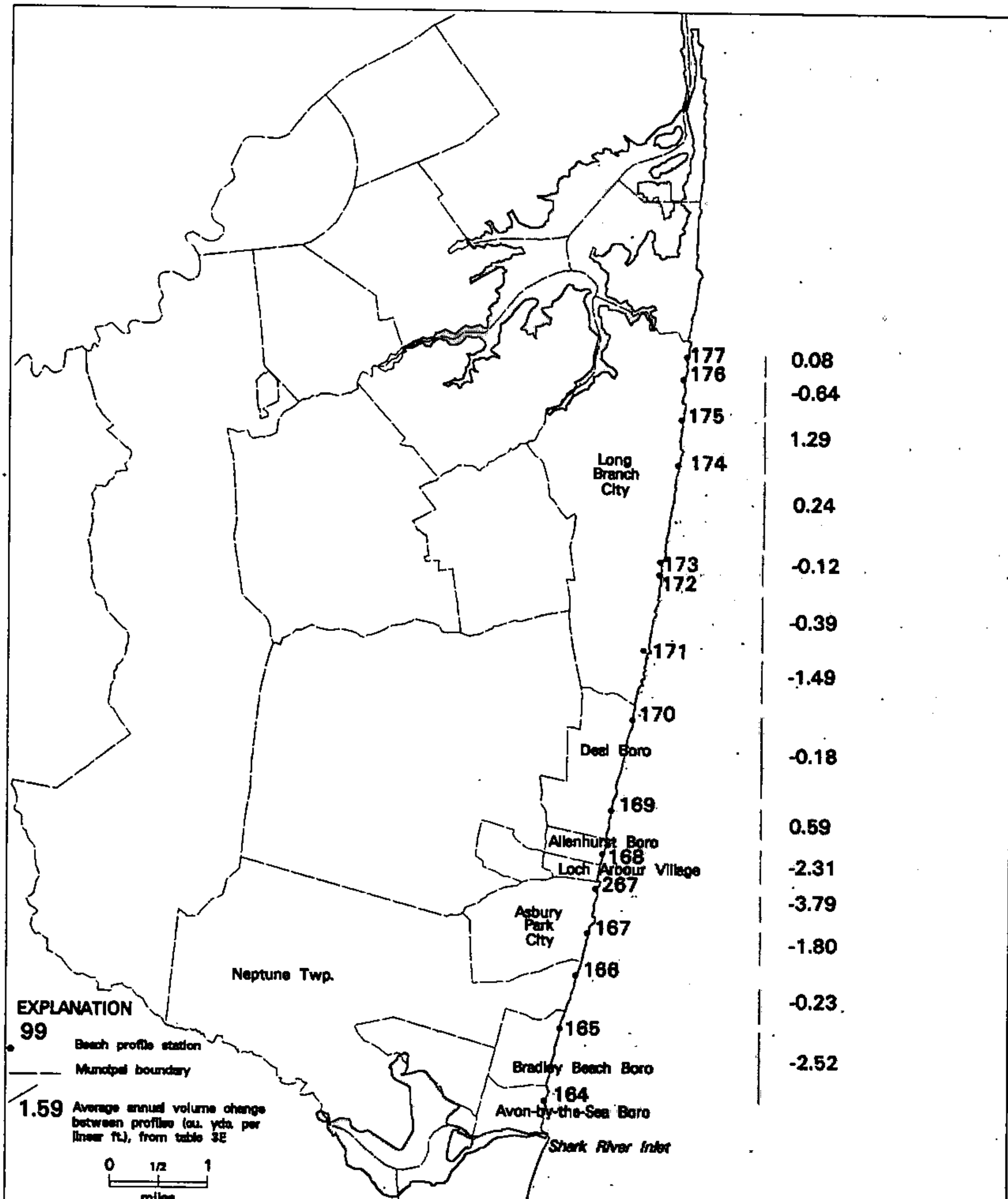


Figure 5. Map of Reach 3, Long Branch to Shark River Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Table 3A. Profile stations - Long Branch to Shark River Inlet, Monmouth County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
177	735841W	401905N	18.92	404 Ocean Ave., Long Branch City
176	735840W	401848N	22.72	Seven Presidents Park, Long Branch City
175	735843W	401826N	22.52	N. Broadway Ave., Long Branch City
174	735847W	401757N	24.96	Morris and Pavilion Ave., Long Branch City
173	735858W	401705N	31.34	West End Ave., Long Branch City
172	735859W	401701N	14.39	South of West End Ave., Long Branch City
171	735907W	401620N	30.59	Pullman Ave., Elberon, Long Branch City
170	735923W	401525N	10 (est.)[4]	Roosevelt Ave., Deal Borough
169	735934W	401441N	25.22	Darlington Ave., Deal Borough
168	735942W	401407N	10 (est.)[4]	Corlies Ave. and Boardwalk, Allenhurst Borough
267	735947W	401339N	16.20	7th Ave., Asbury Park City
167	735954W	401317N	13.00	3rd Ave., Asbury Park City
166	740007W	401247N	18.47	Ocean Pathway, Ocean Grove, Neptune Twp.
165	740022W	401213N	18.90	McCabe Ave., Bradley Beach Borough
164	740030W	401130N	15.30	Sylvania Ave., Avon-by-the-Sea Borough

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.
[4] Estimated, not measured.

Table 3B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
Entire Reach		Under evaluation for a massive replenishment project by Army Corps of Engineers.		
Long Branch City		No activity noted.		
Deal Borough		No activity noted.		
Allenhurst Borough	1989	Sand redistribution	35-40,000	NA
Loch Arbour Village		No activity noted.		
Asbury Park City		No activity noted.		
Neptune Twp.		No activity noted.		
Bradley Beach Borough	1990	Construction of 2 new groins, and repair of 3 groins.		
Avon-By-The-Sea Borough		No activity noted.		

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 3C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
164	281.70	246.90	259.00	12.03	-13.70
165	238.90	169.10	208.96	27.52	-57.71
166	351.57	327.54	340.17	9.39	-12.10
167	323.07	287.72	302.54	11.76	16.14
267	302.54	253.32	272.15	18.21	-26.30
168	34.96	14.81	18.51	7.27	0.47
169	319.12	254.91	274.88	22.54	34.03
170	26.36	20.28	23.42	2.21	2.07
171	295.00	246.85	255.42	17.50	-1.77
172	205.41	139.70	172.79	25.79	-22.26
173	253.88	185.14	205.12	22.82	-56.81
174	189.86	146.03	161.17	17.24	21.74
175	160.11	99.06	133.63	20.73	27.50
176	362.13	279.80	307.35	31.15	4.30
177	188.92	158.46	174.85	12.48	28.66

[1] Data summarized from table 2 of Profiles 164-177.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 164-177.

Table 3D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
164	7.41	-21.42	-5.03	9.51	-30.15
165	5.54	-13.31	-0.01	6.94	-0.04
166	11.65	-12.47	-0.45	9.97	-2.70
167	17.92	-36.69	-3.15	19.57	-18.92
267	4.27	-14.19	-4.43	6.78	-26.59
168	79.56	-53.90	-0.19	48.51	-1.16
169	9.48	-10.75	1.37	8.02	8.20
170	16.95	-21.51	-1.73	15.38	-10.38
171	10.63	-9.14	-1.25	7.17	-7.49
172	19.89	-24.23	0.47	16.19	2.82
173	5.36	-7.21	-0.71	4.16	-4.27
174	7.43	-13.38	1.19	7.59	7.14
175	19.79	-9.26	1.40	10.41	8.41
176	28.64	-23.32	-2.68	18.34	-16.07
177	10.15	-7.22	2.82	6.32	17.05

[1] Data summarized from table 1 of Profiles 164-177.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 164-177.

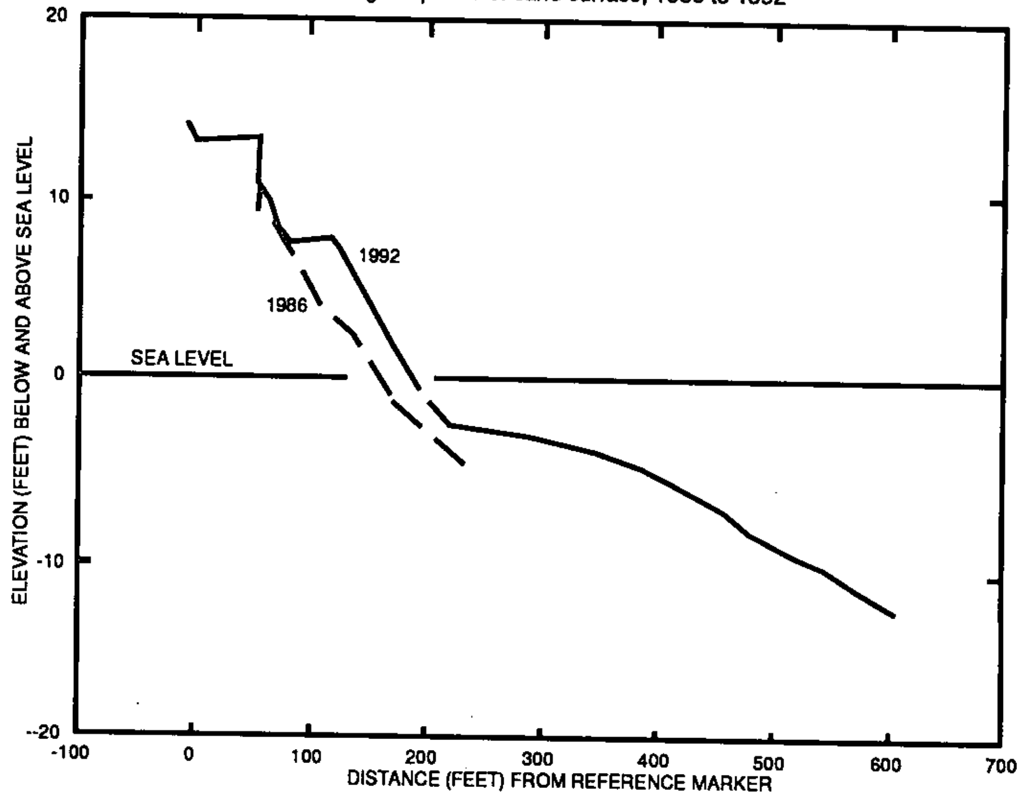
Table 3E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
164-165	4,300	-2.52	-10,836	2,188
165-166	3,700	-0.23	-851	1,850
166-167	3,000	-1.80	-5,400	1,953
167-267	2,300	-3.79	-8,717	1,551
267-168	2,900	-2.31	-6,699	2,691
168-169	3,400	0.59	2,006	2,993
169-170	4,750	-0.18	-855	3,490
170-171	5,800	-1.49	-8,642	4,315
171-172	4,200	-0.39	-1,638	2,558
172-173	500	-0.12	-60	316
173-174	5,200	0.24	1,248	3,149
174-175	2,900	1.29	3,741	1,655
175-176	2,400	-0.64	-1,536	1,244
176-177	1,700	0.08	136	961

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 3, Profile 177
404 Ocean Avenue, Long Branch City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

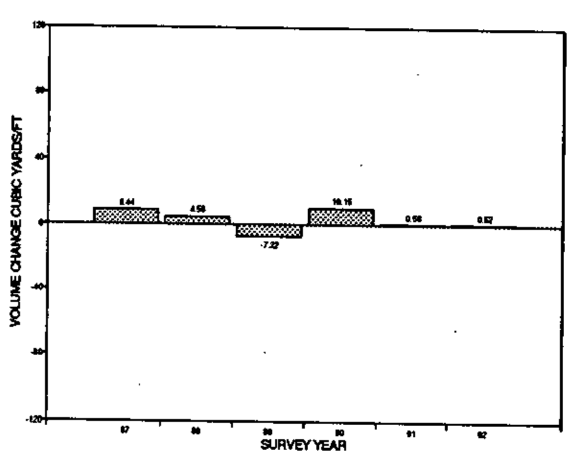


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	4.12	4.32	8.44
1988	-0.48	5.06	4.58
1989	-1.36	-5.86	-7.22
1990	5.22	4.93	10.15
1991	2.28	-1.70	0.58
1992	-0.23	0.75	0.52
Approximate 6-yr. volume change			17.05
Mean annual volume change			2.84
Standard deviation			6.32

[1] Negative value denotes loss of sand

Graph 2

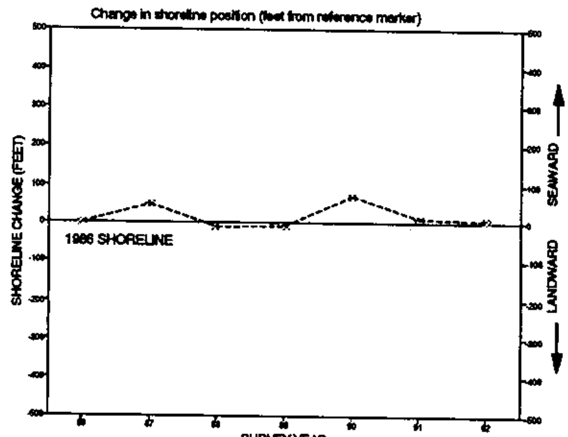


Table 2

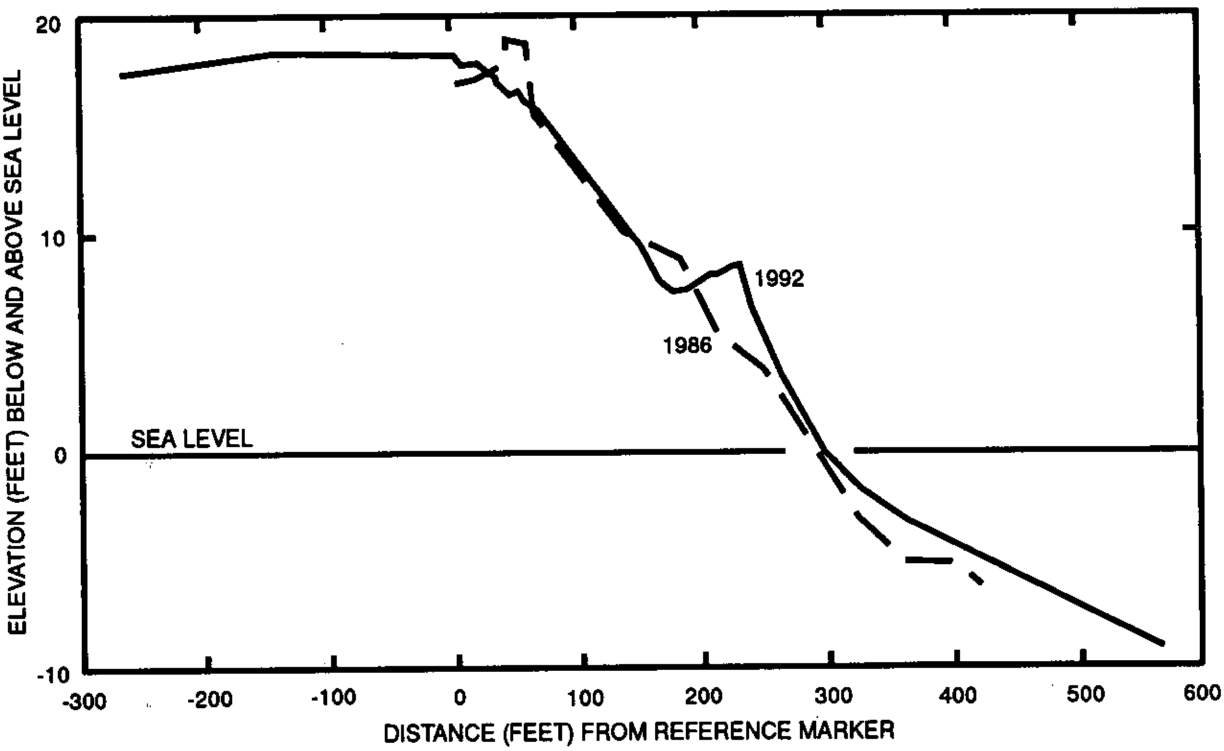
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/11	158.46	
1987	10/07	182.70	24.24
1988	10/12	172.86	14.40
1989	10/12	158.96	0.50
1990	10/16	174.95	16.49
1991	10/22	188.92	30.46
1992	10/26	187.12	28.66
Net shoreline change, 1986-1992 [3]			28.66
Mean annual distance from ref. mkr., 1986-1992 [3]			174.85
Standard deviation			12.48

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile 176
Seven Presidents Park, Long Branch City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

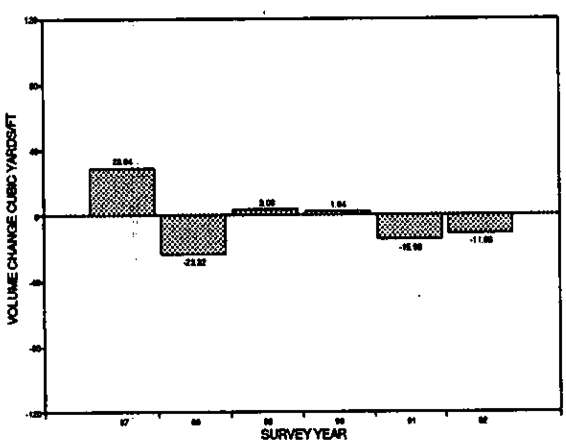


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	15.61	13.03	28.64
1988	-12.05	-11.27	-23.32
1989	4.55	-1.47	3.08
1990	1.64	0.00	1.64
1991	-5.52	-9.51	-15.03
1992	-1.57	-9.51	-11.08
Approximate 6-yr. volume change			-16.07
Mean annual volume change			-2.68
Standard deviation			18.34

[1] Negative value denotes loss of sand

Graph 2

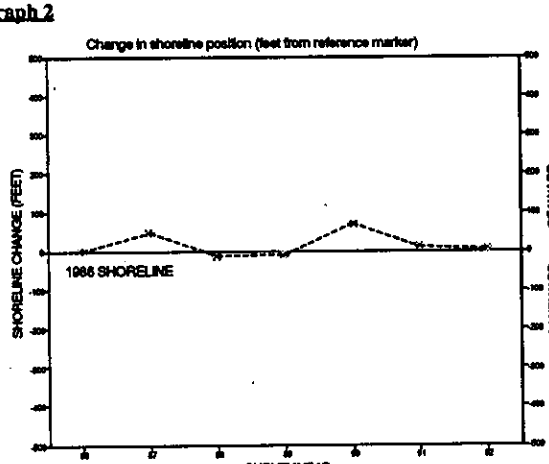


Table 2

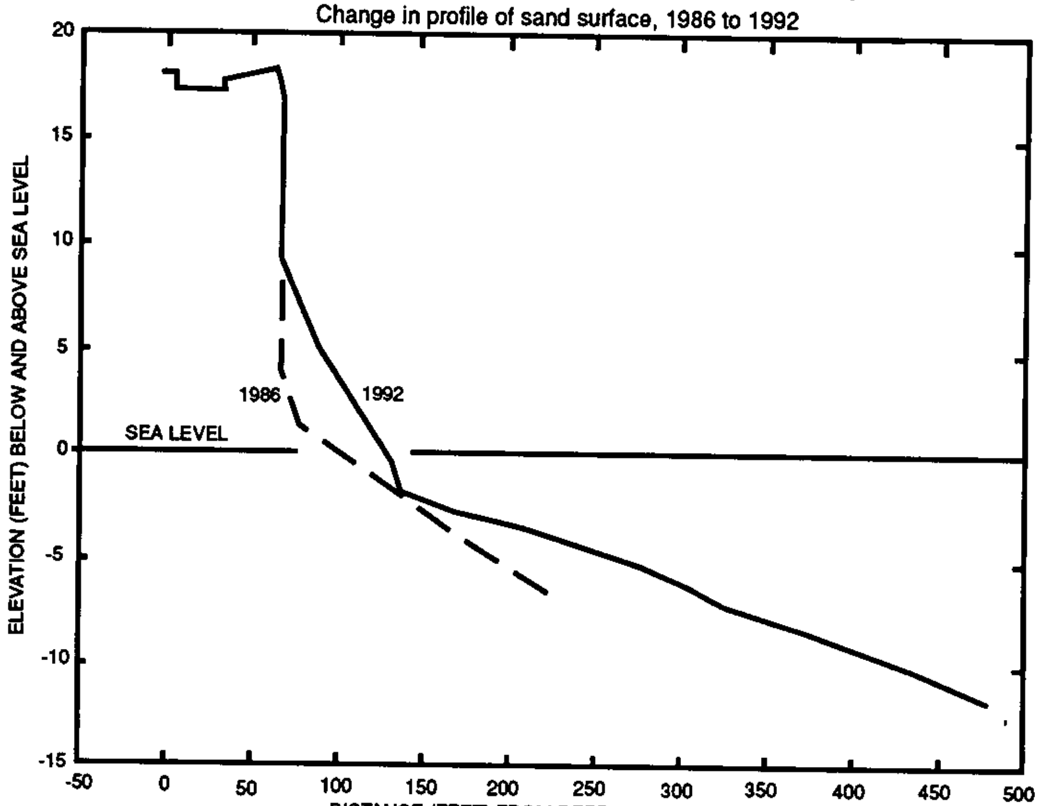
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/12	291.22	
1987	10/07	339.17	47.95
1988	10/12	279.80	-11.42
1989	10/12	282.64	-8.58
1990	10/16	362.13	70.91
1991	10/22	300.99	9.77
9192	10/27	295.52	4.30
Net shoreline change, 1986-1992 [3]			4.30
Mean annual distance from ref. mkr., 1986-1992 [3]			307.35
Standard deviation			31.15

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile 175
North Broadway Avenue, Long Branch City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

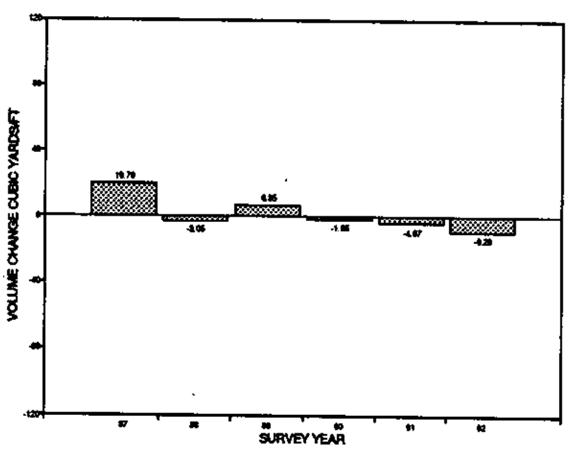


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	10.53	9.26	19.79
1988	-3.93	0.88	-3.05
1989	5.55	1.3-	6.85
1990	-2.27	0.42	-1.85
1991	-0.06	-4.01	-4.07
1992	-1.97	-7.29	-9.26
Approximate 6-yr. volume change			8.41
Mean annual volume change			1.40
Standard deviation			10.41

[1] Negative value denotes loss of sand

Graph 2

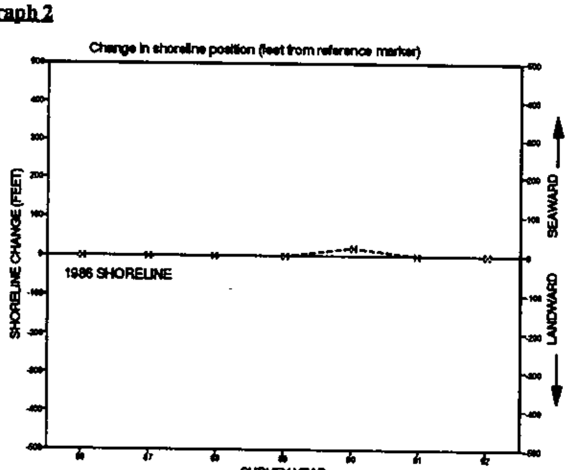


Table 2

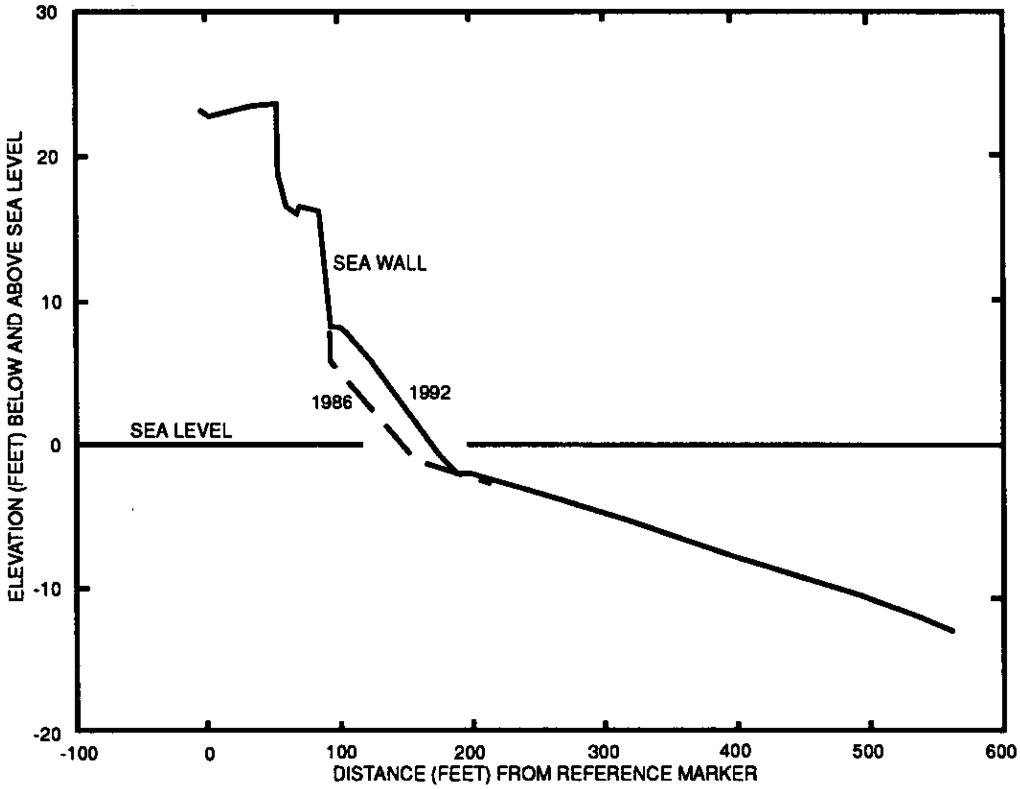
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/12	99.06	
1987	10/07	152.67	53.61
1988	10/12	119.65	20.59
1989	10/12	160.11	61.05
1990	10/16	135.29	36.23
1991	10/22	142.08	43.02
1992	10/28	126.56	27.50
Net shoreline change, 1986-1992 [3]			27.50
Mean annual distance from ref. mkr., 1986-1992 [3]			133.63
Standard deviation			20.73

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile 174
Morris and Pavilion Avenues, Long Branch City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

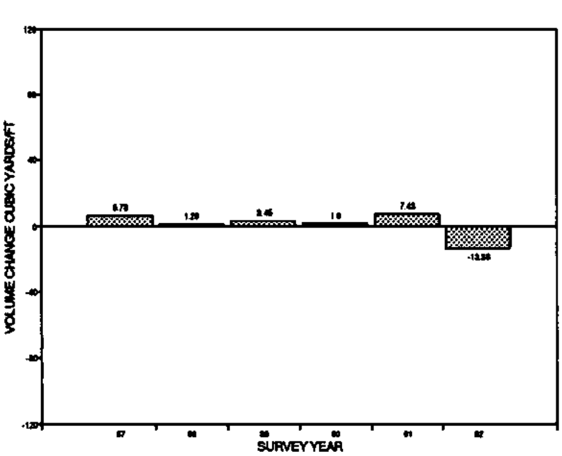


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	4.03	2.75	6.78
1988	-2.98	4.24	1.26
1989	-0.95	-12.43	-13.38
1990	0.95	2.50	3.45
1991	2.05	-0.45	1.60
1992	4.77	2.66	7.43
Approximate 6-yr. volume change			7.14
Mean annual volume change			1.19
Standard deviation			7.59

[1] Negative value denotes loss of sand

Graph 2

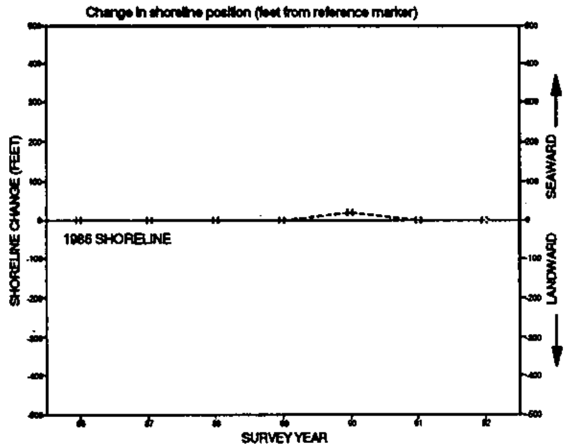


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/12	146.03	
1987	10/07	172.27	26.24
1988	10/12	189.86	43.83
1989	10/10	138.83	-7.20
1990	10/16	160.24	14.21
1991	10/23	153.17	7.14
1992	10/28	167.77	21.74
Net shoreline change, 1986-1992 [3]			21.74
Mean annual distance from ref. mkr., 1986-1992 [3]			161.17
Standard deviation			17.24

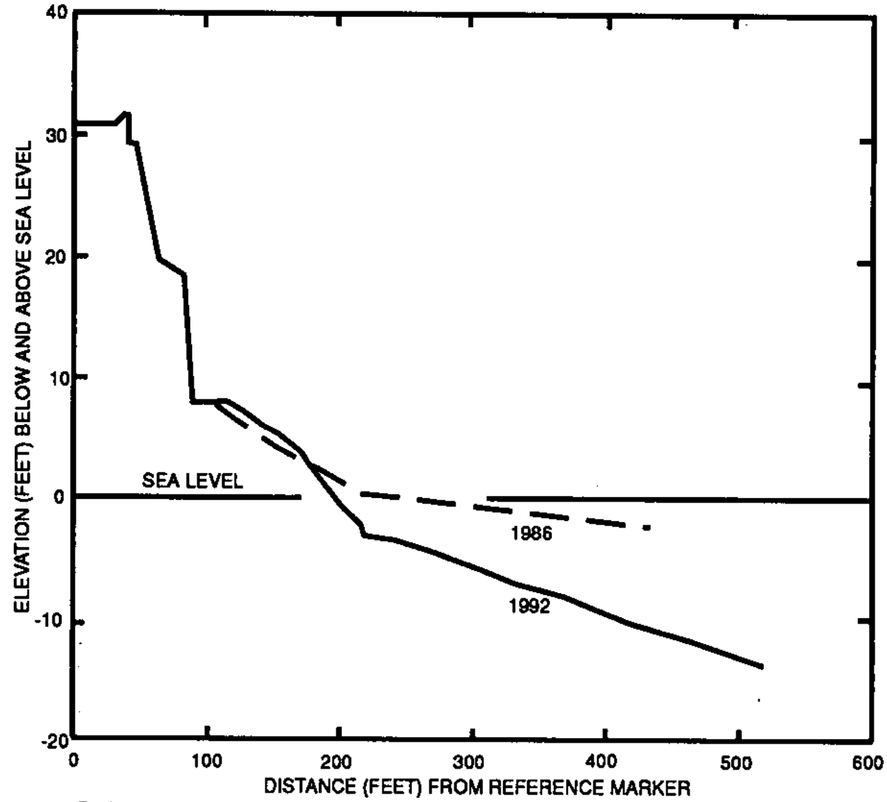
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 3, Profile 173
West End Avenue, Long Branch City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

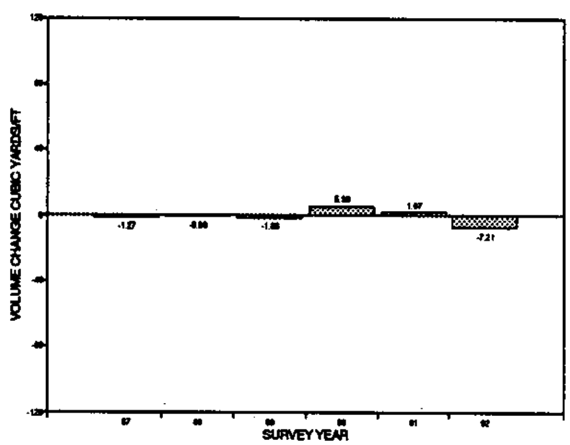


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-1.27	NA	-1.27
1988	-1.06	0.1	-0.96
1989	-3.88	2.02	-1.86
1990	3.91	1.45	5.36
1991	4.81	-3.14	1.67
1992	-1.75	-5.46	-7.21
Approximate 6-yr. volume change			-4.27
Mean annual volume change			-0.71
Standard deviation			4.16

[1] Negative value denotes loss of sand

Graph 2

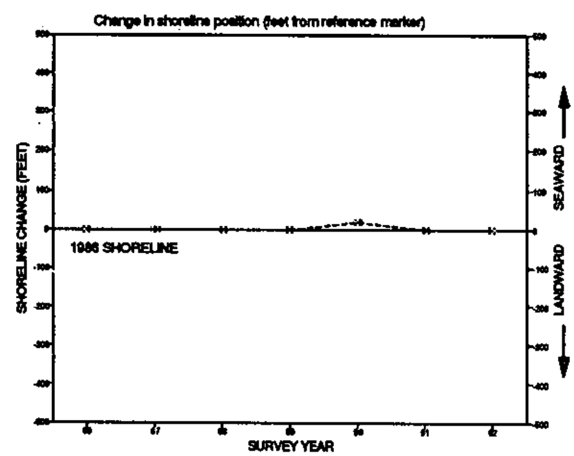


Table 2

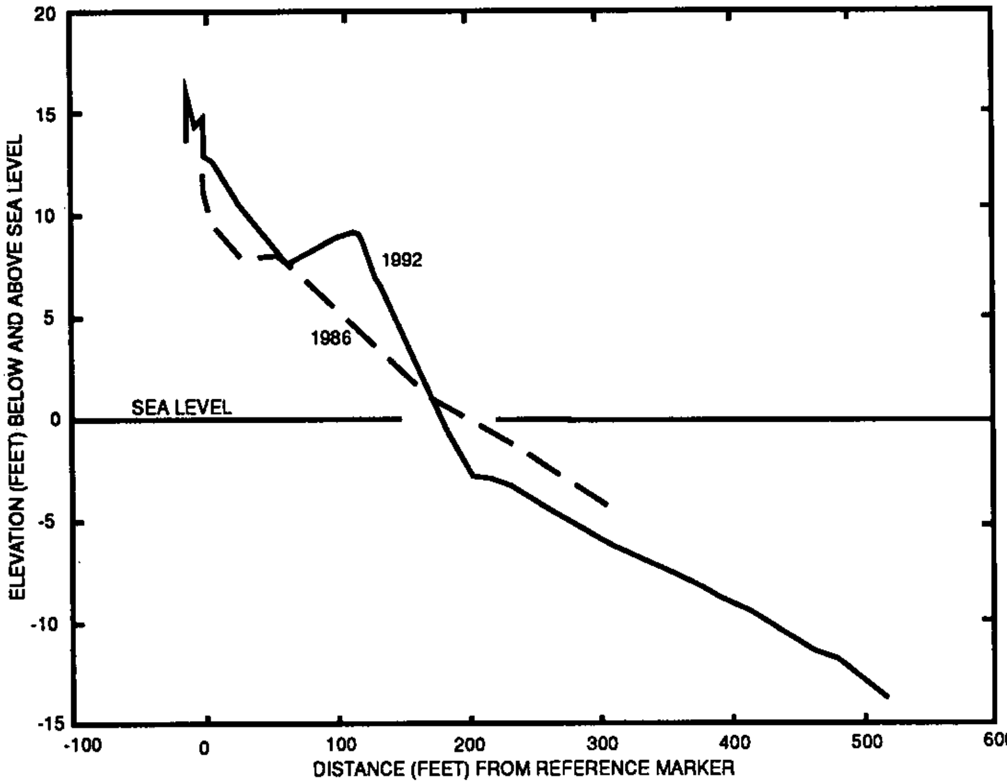
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/12	253.88	
1987	10/06	190.64	-63.24
1988	10/12	196.72	-57.16
1989	10/10	185.14	-68.74
1990	10/17	206.96	-46.92
1991	10/23	205.44	-48.44
1992	10/28	197.07	-56.81
Net shoreline change, 1986-1992 [3]			-56.81
Mean annual distance from ref. mkr., 1986-1992 [3]			205.12
Standard deviation			22.82

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3 Profile 172
South of West End Avenue, Long Branch City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

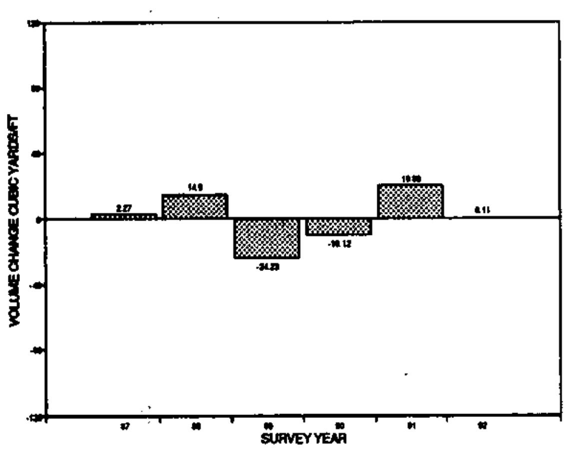


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	7.23	-4.96	2.27
1988	9.81	5.09	14.90
1989	-14.20	-10.03	-24.23
1990	-6.96	-3.16	-10.12
1991	15.81	4.08	19.89
1992	1.34	-1.23	0.11
Approximate 6-yr. volume change			2.82
Mean annual volume change			0.47
Standard deviation			16.19

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

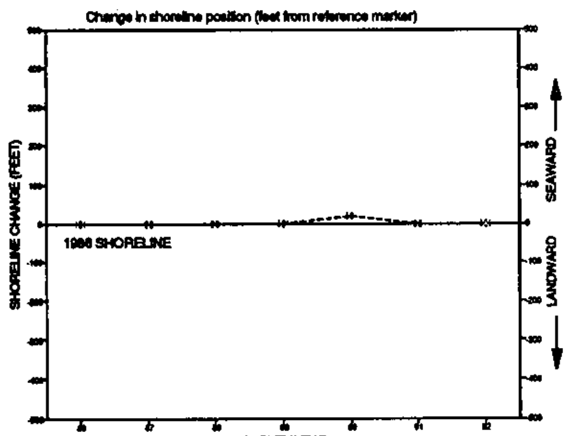


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/13	202.92	
1987	10/06	164.79	-38.13
1988	10/12	205.41	2.49
1989	10/10	144.59	-58.33
1990	10/17	139.70	-63.22
1991	10/23	171.45	-31.47
1992	10/28	180.66	-22.26
Net shoreline change, 1986-1992 [3]			-22.26
Mean annual distance from ref. mkr., 1986-1992 [3]			172.79
Standard deviation			25.79

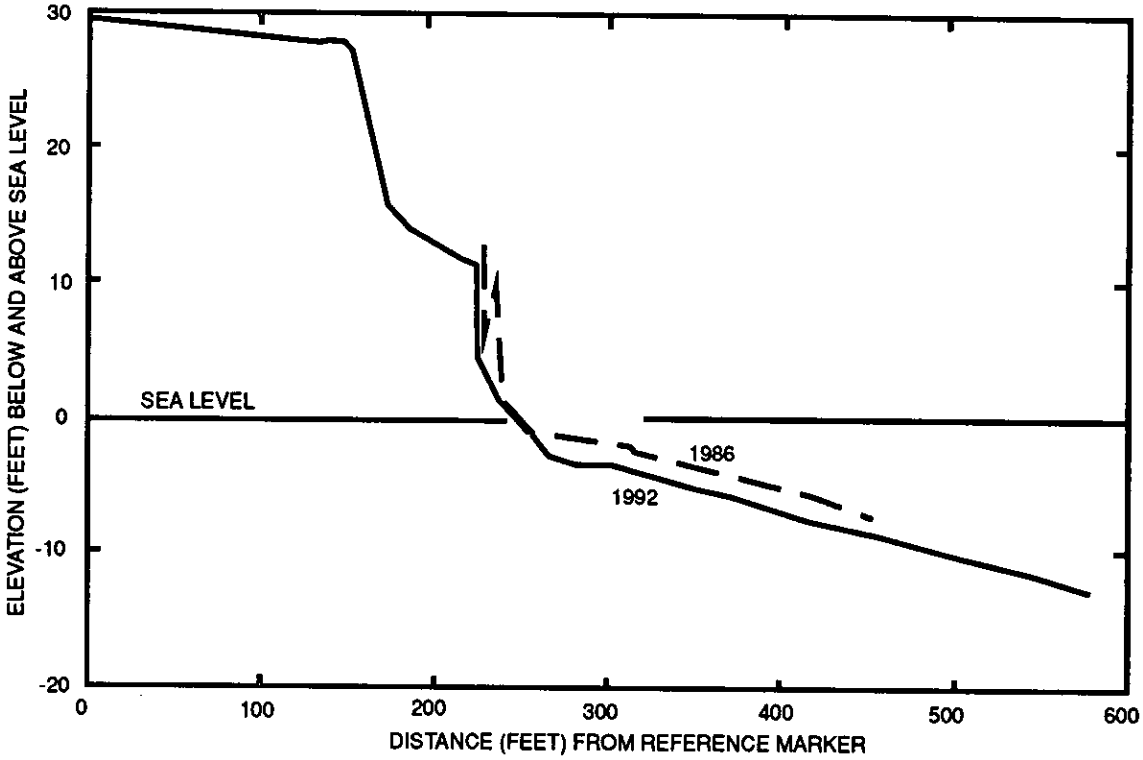
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 3, Profile 171
Pullman Avenue, Elberon, Long Branch City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

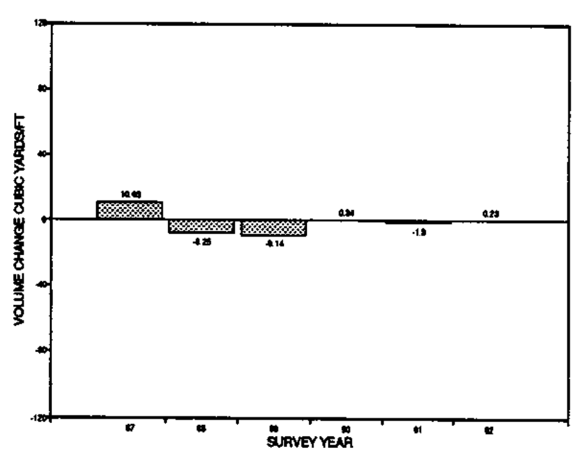


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	2.13	8.50	10.63
1988	-1.45	-6.80	-8.25
1989	-0.56	-8.58	-9.14
1990	-0.14	0.48	0.34
1991	-2.10	0.80	-1.30
1992	-1.05	1.28	0.23
Approximate 6-yr. volume change			-7.49
Mean annual volume change			-1.25
Standard deviation			7.17

[1] Negative value denotes loss of sand

Graph 2

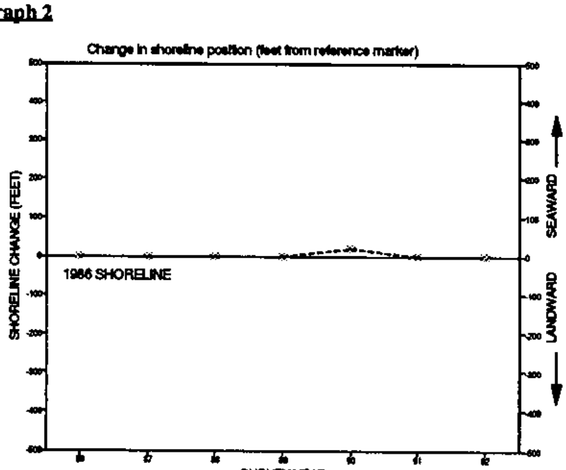


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/13	250.10	
1987	10/06	295.00	44.90
1988	10/13	250.12	0.02
1989	10/10	246.85	-3.25
1990	10/17	247.64	-2.46
1991	10/23	249.88	-0.22
1992	10/28	248.33	-1.77
Net shoreline change, 1986-1992 [3]			-1.77
Mean annual distance from ref. mkr., 1986-1992 [3]			255.42
Standard deviation			17.50

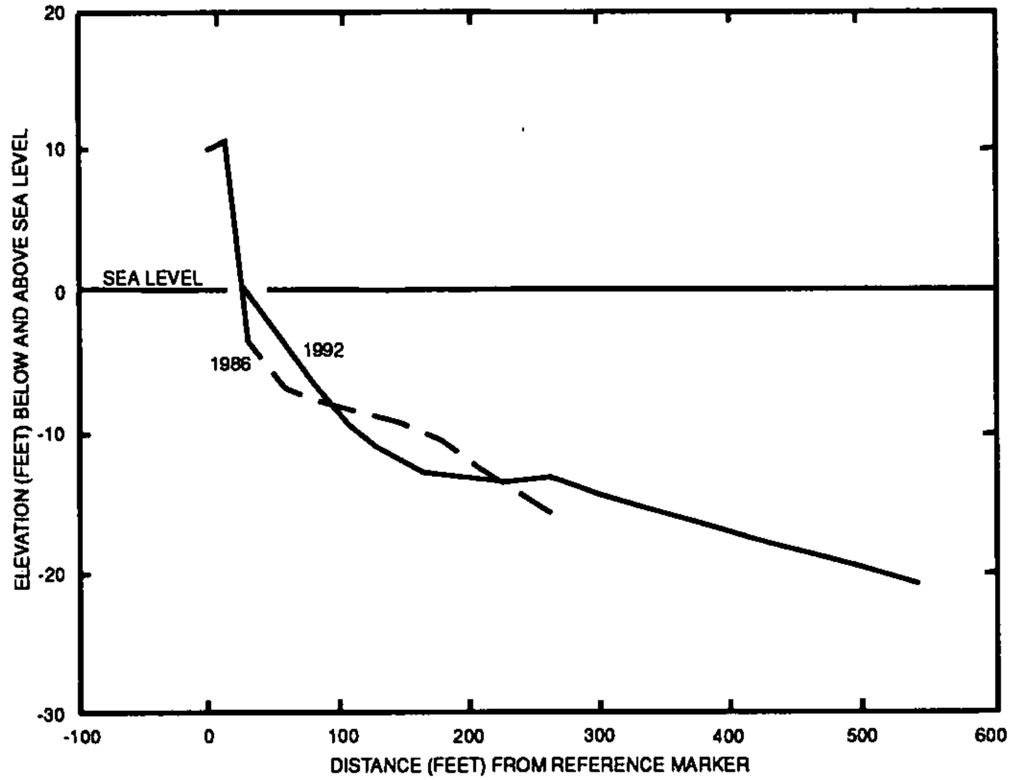
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 3, Profile 170
Roosevelt Avenue, Deal Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

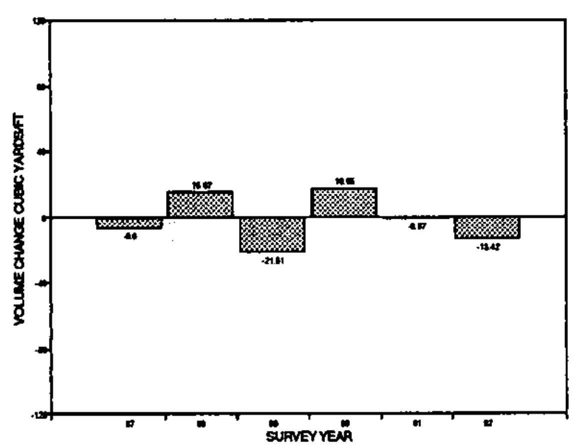


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-1.05	-5.55	-6.60
1988	0.72	14.35	15.07
1989	-0.28	-21.23	-21.51
1990	-0.08	17.03	16.95
1991	0.31	-1.18	-0.87
1992	0.17	-13.59	-13.42
Approximate 6-yr. volume change			-10.38
Mean annual volume change			-1.73
Standard deviation			15.38

[1] Negative value denotes loss of sand

Graph 2

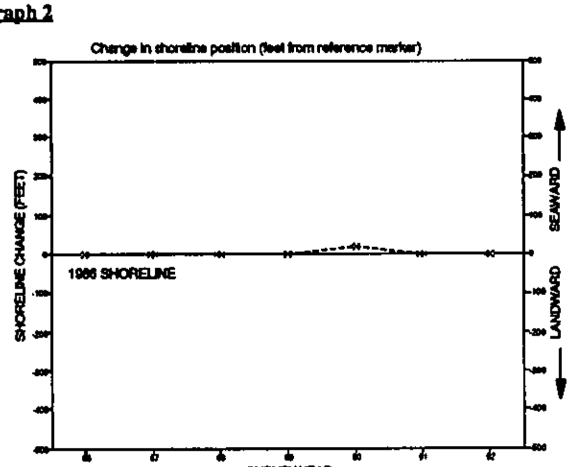


Table 2

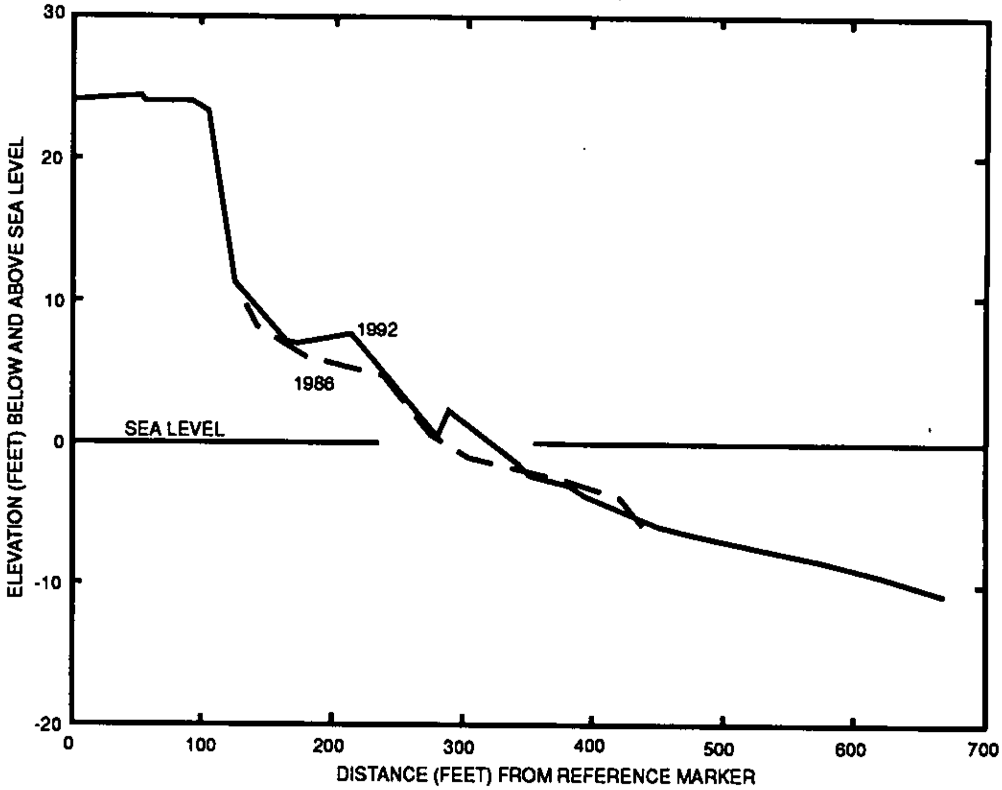
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/13	24.29	
1987	10/06	20.28	-4.01
1988	10/13	24.16	-0.13
1989	10/10	20.69	-3.60
1990	10/17	23.33	-0.96
1991	10/25	24.85	0.56
1992	10/22	26.36	2.07
Net shoreline change, 1986-1992 [3]			2.07
Mean annual distance from ref. mkr., 1986-1992 [3]			23.42
Standard deviation			2.21

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile169
Darlington Avenue, Deal Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

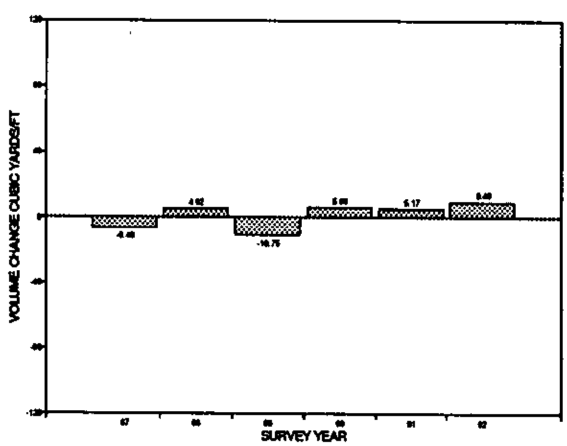


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-2.03	-4.45	-6.48
1988	2.99	1.93	4.92
1989	-0.51	-10.24	-10.75
1990	-0.73	6.59	5.86
1991	2.99	2.18	5.17
1992	4.34	5.14	9.48
Approximate 6-yr. volume change			8.20
Mean annual volume change			1.37
Standard deviation			8.02

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

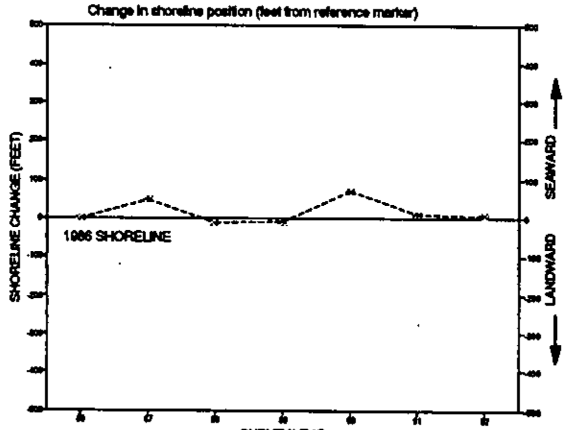


Table 2

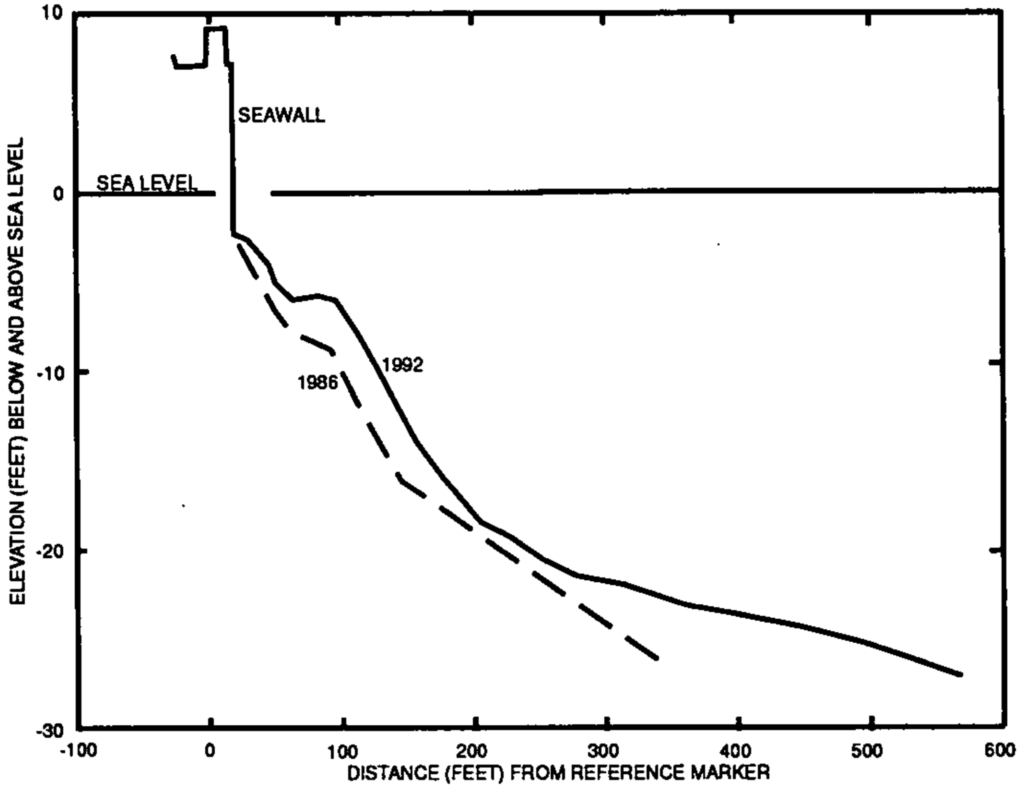
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/13	285.09	
1987	10/06	259.44	-25.65
1988	10/13	256.36	-28.73
1989	10/10	254.91	-30.18
1990	10/17	272.82	-12.27
1991	10/25	276.44	-8.65
1992	10/29	319.12	34.03
Net shoreline change, 1986-1992 [3]			34.03
Mean annual distance from ref. mkr., 1986-1992 [3]			274.88
Standard deviation			22.54

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile 168
Corlies Avenue, Allenhurst Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

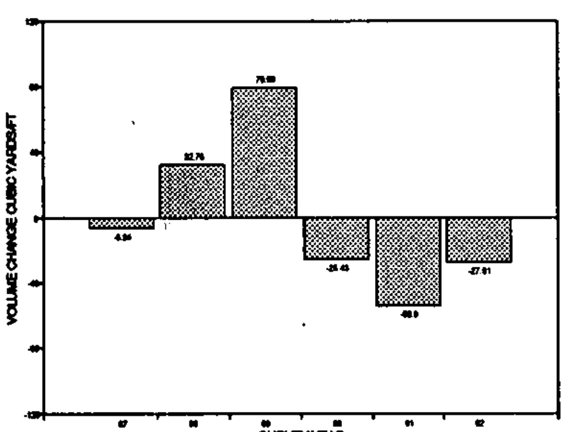


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-0.01	-6.33	-6.34
1988	-0.35	33.11	32.76
1989	-0.09	79.65	79.56
1990	0.74	-26.17	-25.43
1991	-0.60	-53.30	-53.90
1992	0.08	-27.89	-27.81
Approximate 6-yr. volume change			-1.16
Mean annual volume change			-0.19
Standard deviation			48.51

[1] Negative value denotes loss of sand

Graph 2

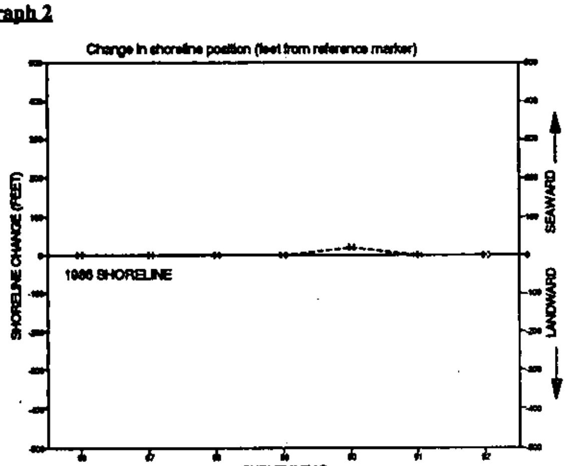


Table 2

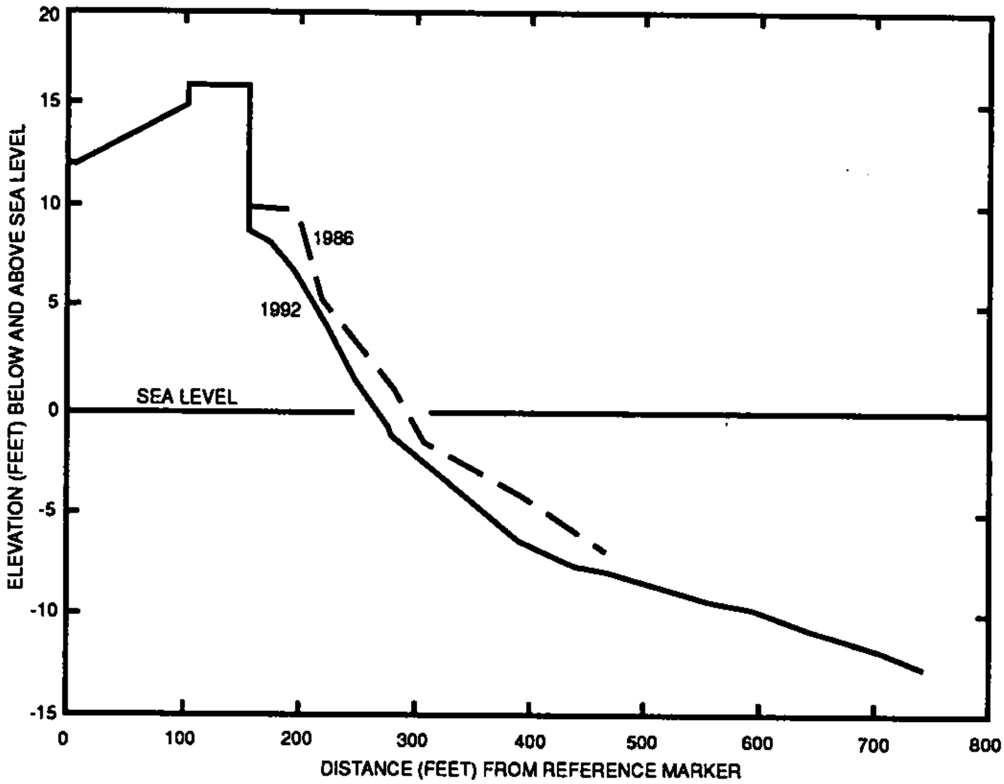
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/14	15.75	
1987	10/06	15.63	-0.12
1988	10/13	14.81	-0.94
1989	10/10	15.99	0.24
1990	10/17	34.96	19.21
1991	10/25	16.21	0.46
1992	10/29	16.22	0.47
Net shoreline change, 1986-1992 [3]			0.47
Mean annual distance from ref. mkr., 1986-1992 [3]			18.51
Standard deviation			7.27

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile 267
8th Avenue, Asbury Park City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

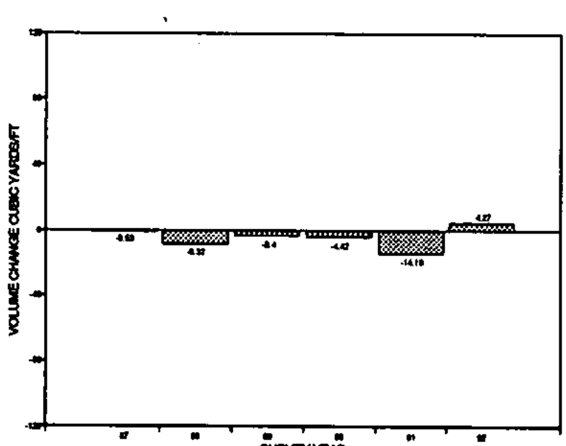


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-1.90	1.37	-0.53
1988	-5.63	-2.69	-8.32
1989	5.42	-8.82	-3.40
1990	-7.64	3.22	-4.42
1991	1.49	2.78	4.27
1992	-0.20	-13.99	-14.19
Approximate 6-yr. volume change			-26.59
Mean annual volume change			-4.43
Standard deviation			6.78

[1] Negative value denotes loss of sand

Graph 2

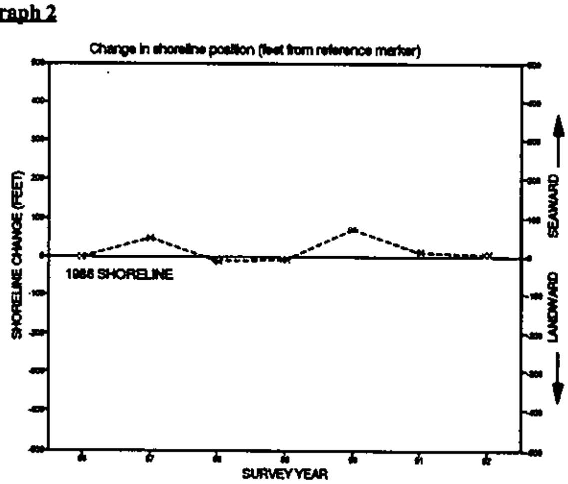


Table 2

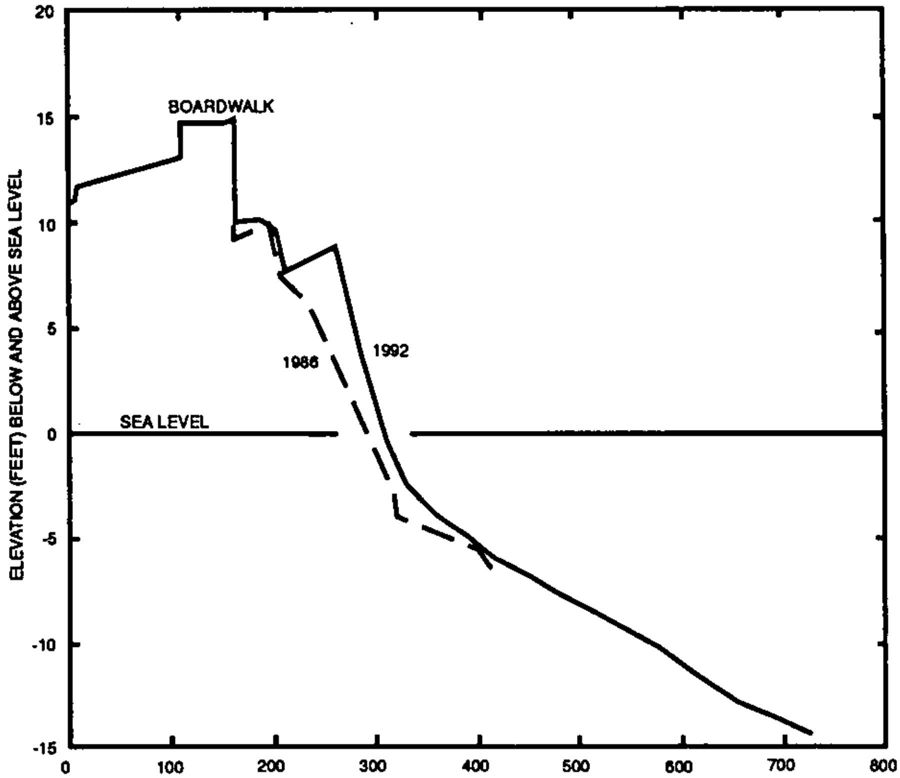
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/14	290.65	
1987	10/08	302.44	11.79
1988	10/13	259.04	-31.61
1989	10/13	274.70	-15.95
1990	10/18	253.32	-37.33
1991	10/25	260.52	-30.13
1992	11/11	264.35	-26.30
Net shoreline change, 1986-1992 [3]			-26.30
Mean annual distance from ref. mkr., 1986-1992 [3]			272.15
Standard deviation			18.21

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile167
3rd Avenue, Asbury Park City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

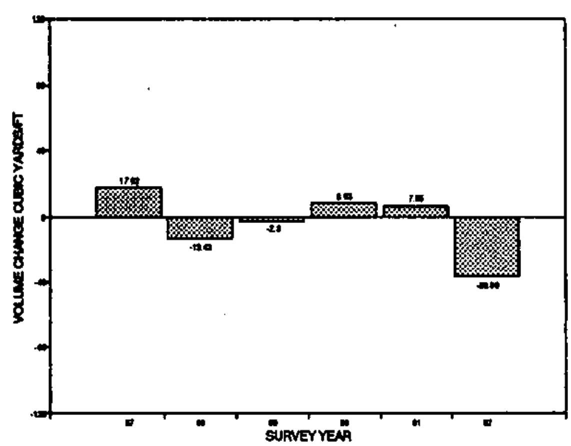


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	10.78	7.14	17.92
1988	-7.56	-5.87	-13.43
1989	4.77	-7.07	-2.30
1990	0.06	8.47	8.53
1991	-1.87	8.92	7.05
1992	4.87	-41.56	-36.69
Approximate 6-yr. volume change			-18.92
Mean annual volume change			-3.15
Standard deviation			19.57

[1] Negative value denotes loss of sand

Graph 2

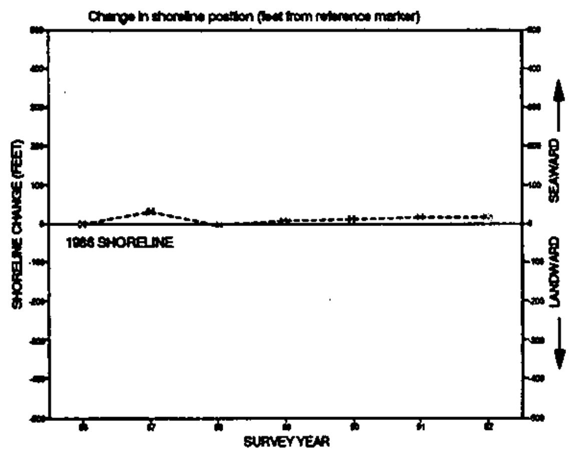


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/15	292.03	
1987	10/08	323.07	31.04
1988	10/13	287.72	-4.31
1989	10/13	297.80	5.77
1990	10/18	301.64	9.61
1991	10/25	307.37	15.34
1992	10/29	308.17	16.14
Net shoreline change, 1986-1992 [3]			16.14
Mean annual distance from ref. mkr., 1986-1992 [3]			302.54
Standard deviation			11.76

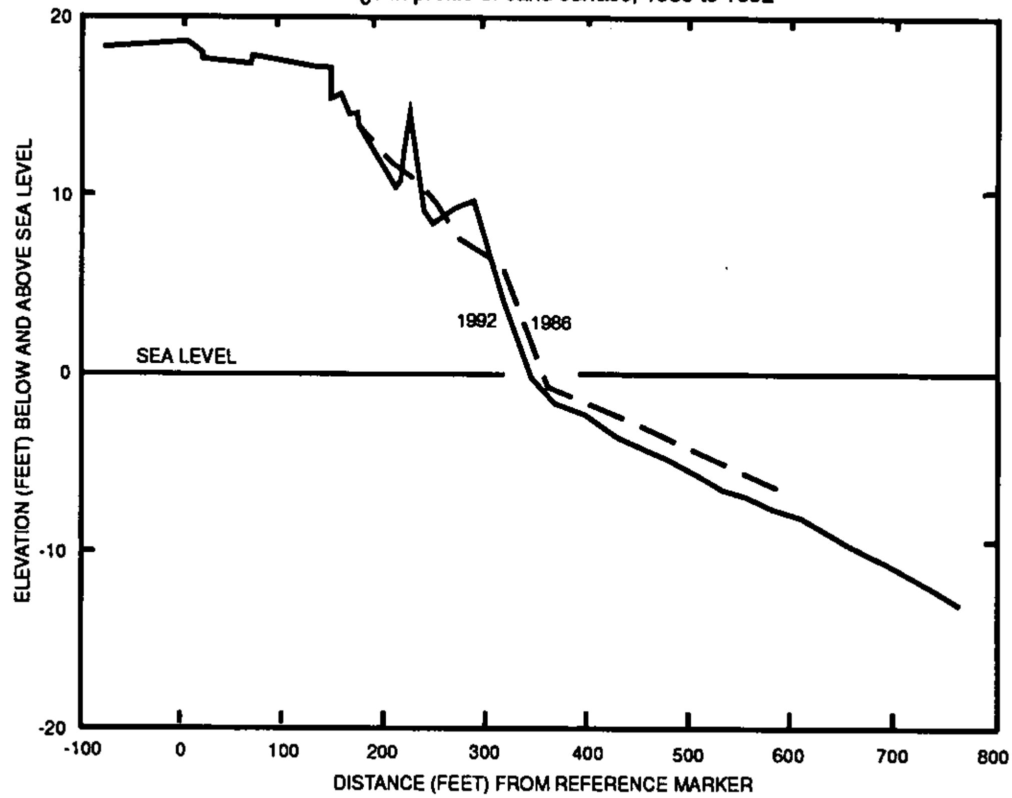
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 3, Profile 166
Ocean Pathway, Ocean Grove, Neptune Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

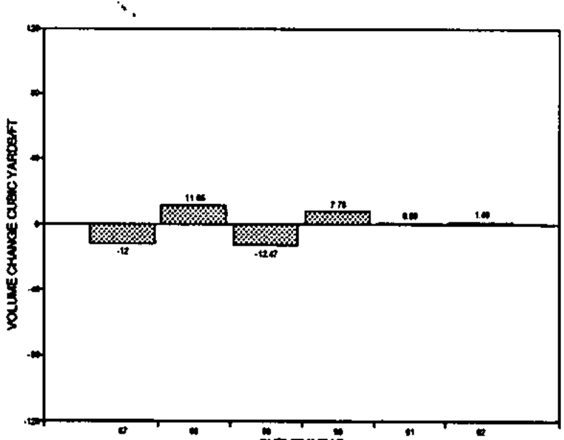


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-6.54	-5.46	-12.00
1988	4.13	7.52	11.65
1989	-2.04	-10.43	-12.47
1990	3.25	4.53	7.78
1991	1.12	-0.24	0.88
1992	-0.02	1.48	1.46
Approximate 6-yr. volume change			-2.70
Mean annual volume change			-0.45
Standard deviation			9.97

[1] Negative value denotes loss of sand

Graph 2

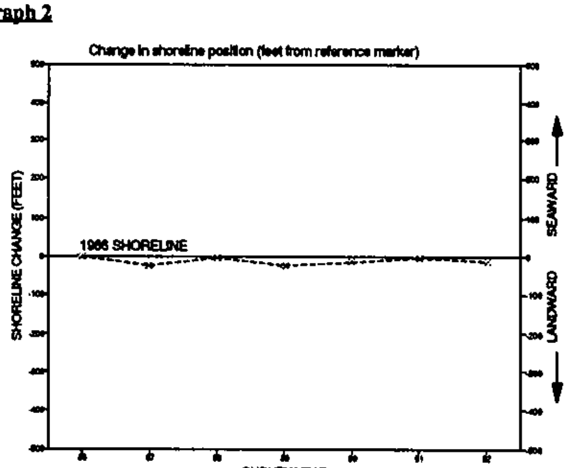


Table 2

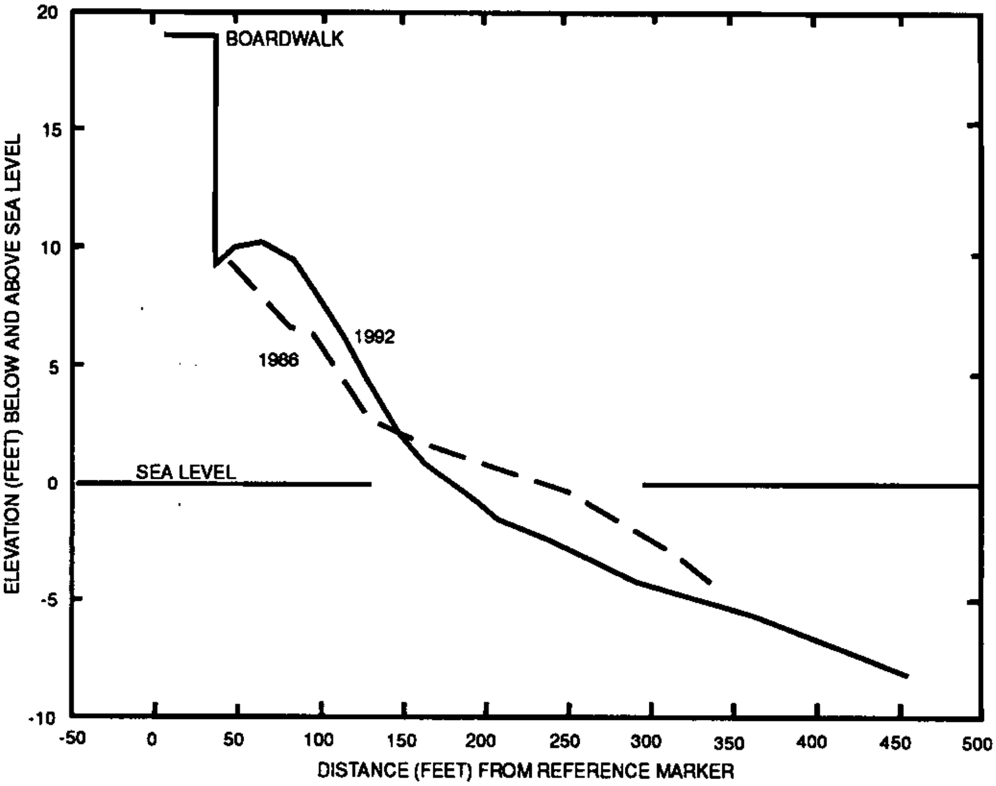
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/15	351.57	
1987	10/08	327.54	-24.03
1988	10/14	349.15	-2.42
1989	10/13	329.80	-21.77
1990	10/18	337.05	-14.52
1991	10/25	346.61	-4.96
1992	10/29	339.47	-12.10
Net shoreline change, 1986-1992 [3]			-12.10
Mean annual distance from ref. mkr., 1986-1992 [3]			340.17
Standard deviation			9.39

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile 165
McCabe Avenue, Bradley Beach Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

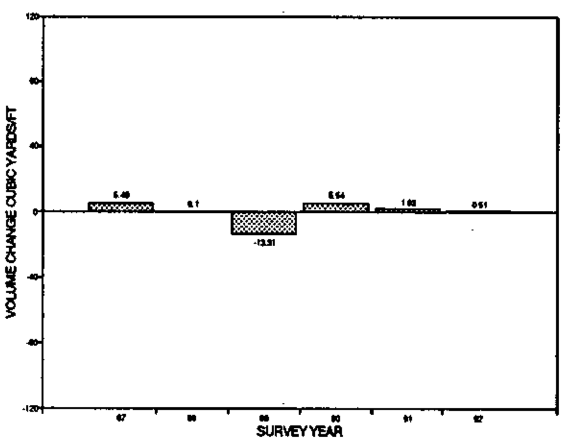


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]			
Year	Above mean sea level	Below mean sea level	Annual total
1987	4.14	1.35	5.49
1988	0.83	-0.73	0.10
1989	-8.31	-5.00	-13.31
1990	1.02	4.52	5.54
1991	5.16	-3.53	1.63
1992	1.73	-1.22	0.51
Approximate 6-yr. volume change			-0.04
Mean annual volume change			-0.01
Standard deviation			6.94

[1] Negative value denotes loss of sand

Graph 2

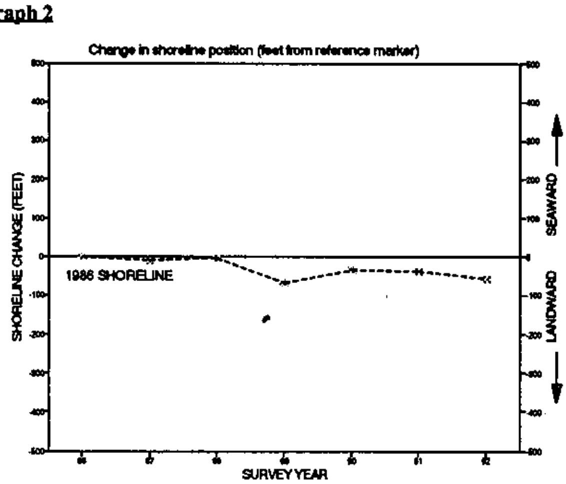


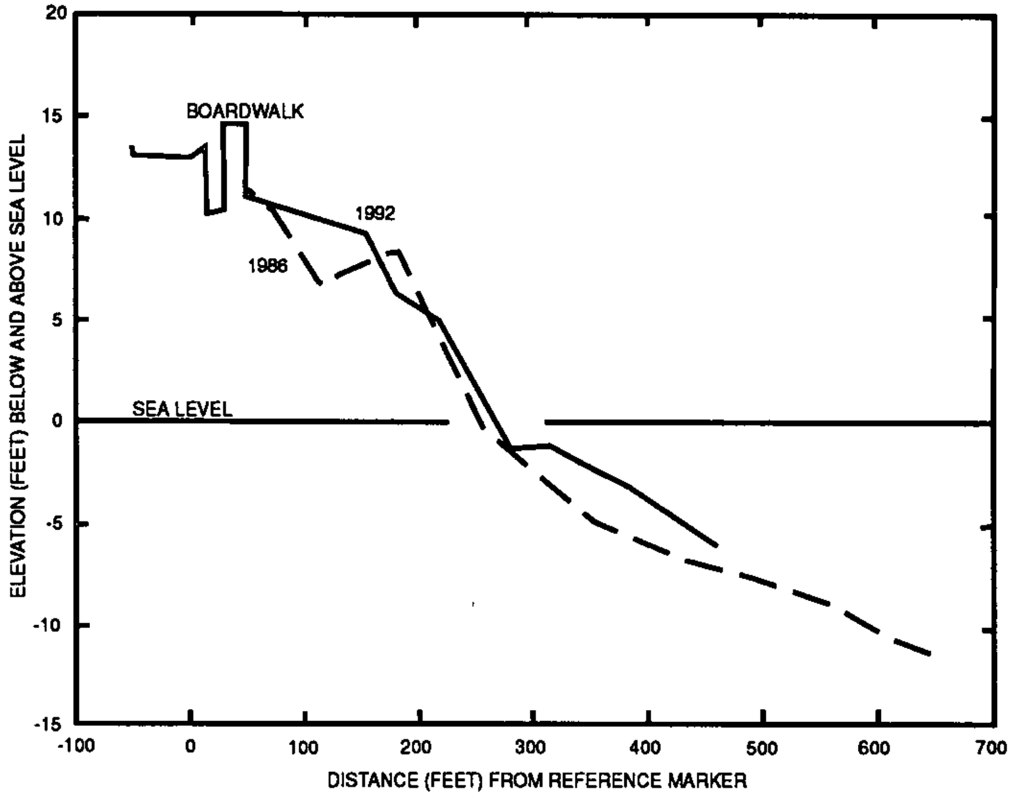
Table 2

SHORELINE CHANGE IN FEET			
Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/15	238.90	
1987	10/08	231.18	-7.72
1988	10/14	235.78	-3.12
1989	10/14	169.16	-69.74
1990	10/18	205.86	-33.04
1991	10/25	200.67	-38.23
1992	10/30	181.19	-57.71
Net shoreline change, 1986-1992 [3]			-57.71
Mean annual distance from ref. mkr., 1986-1992 [3]			208.96
Standard deviation			27.52

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 3, Profile 164
Sylvania Avenue, Avon-by-the-Sea Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

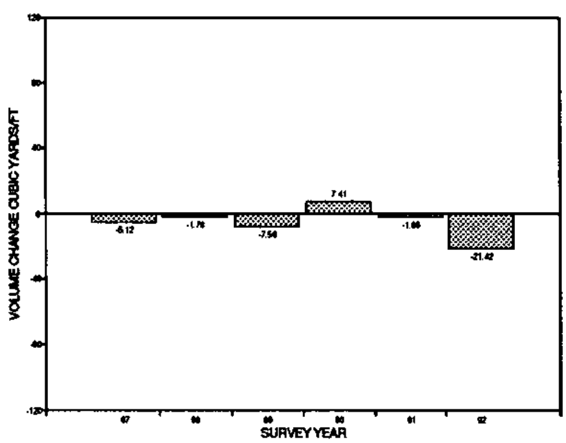


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-1.51	-3.61	-5.12
1988	-3.47	1.69	-1.78
1989	3.23	-10.81	-7.58
1990	-4.36	11.77	7.41
1991	-0.16	-1.50	-1.66
1992	0.08	-21.50	-21.42
Approximate 6-yr. volume change			-30.15
Mean annual volume change			-5.03
Standard deviation			9.51

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

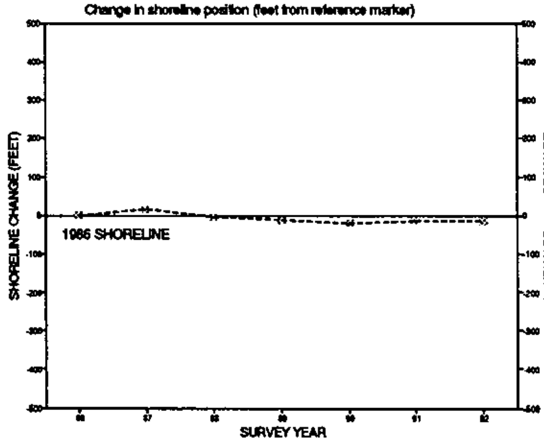


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/15	265.84	
1987	10/08	281.70	15.86
1988	10/14	262.17	-3.67
1989	10/13	254.12	-11.72
1990	10/18	246.90	-18.94
1991	10/25	250.14	-15.70
1992	10/30	252.14	-13.70
Net shoreline change, 1986-1992 [3]			-13.70
Mean annual distance from ref. mkr., 1986-1992 [3]			259.00
Standard deviation			12.03

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

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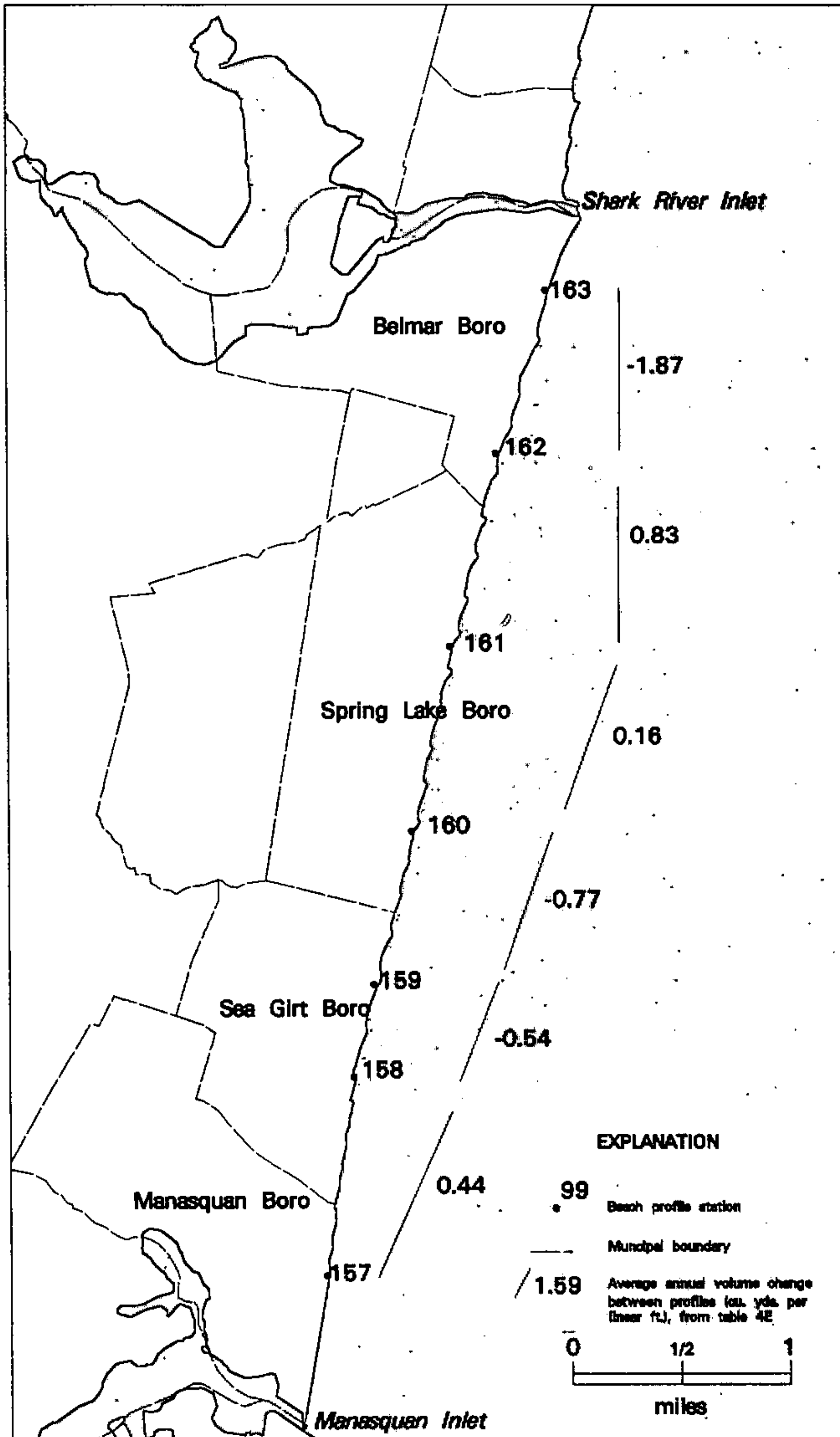


Figure 6. Map of Reach 4, Shark River Inlet to Manasquan Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Table 4A. Profile stations - Shark River Inlet to Manasquan Inlet, Monmouth County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
163	740039W	401053N	15.83	5th Ave., Belmar Borough
162	740058W	401012N	17.43	18th Ave., Belmar Borough
161	740115W	400924N	18.61	Brighton Ave., Spring Lake Borough
160	740127W	400837N	13.15	Salem Ave., Spring Lake Borough
159	740139W	400758N	13.75	New York Ave., Sea Girt Borough
158	740148W	400735N	20.60	Trenton Ave., Sea Girt Borough
157	740203W	400647N	22.18	Riddle Way and 1st Ave., Manasquan Borough

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.

Table 4B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity
Entire Reach		Under evaluation for a massive replenishment project by Army Corps of Engineers.
Belmar Borough		No activity noted.
Spring Lake Borough	1987	Wreck Pond outlet flume rehabilitated.
Sea Girt Borough		No activity noted.
Manasquan Borough		No activity noted.

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 4C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
157	229.59	185.65	200.10	13.90	1.96
158	317.38	286.28	302.65	11.91	-1.52
159	403.76	372.50	382.41	12.30	-17.48
160	337.56	318.58	328.30	7.26	0.91
161	231.99	199.73	214.57	12.15	12.96
162	360.70	297.20	317.93	20.52	6.33
163	410.28	348.59	364.32	20.95	-2.39

[1] Data summarized from table 2 of Profiles 157-163.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 157-163.

Table 4D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
157	11.67	-13.57	0.04	9.25	0.23
158	11.70	-7.13	0.85	7.25	5.10
159	7.00	-15.67	-1.93	8.50	-11.58
160	8.89	-8.23	0.38	6.40	2.30
161	8.28	-3.60	-0.05	4.58	-0.32
162	11.48	-5.10	1.71	6.31	10.23
163	-1.06	-16.59	-5.46	5.75	-32.75

[1] Data summarized from table 1 of Profiles 157-163.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 157-163.

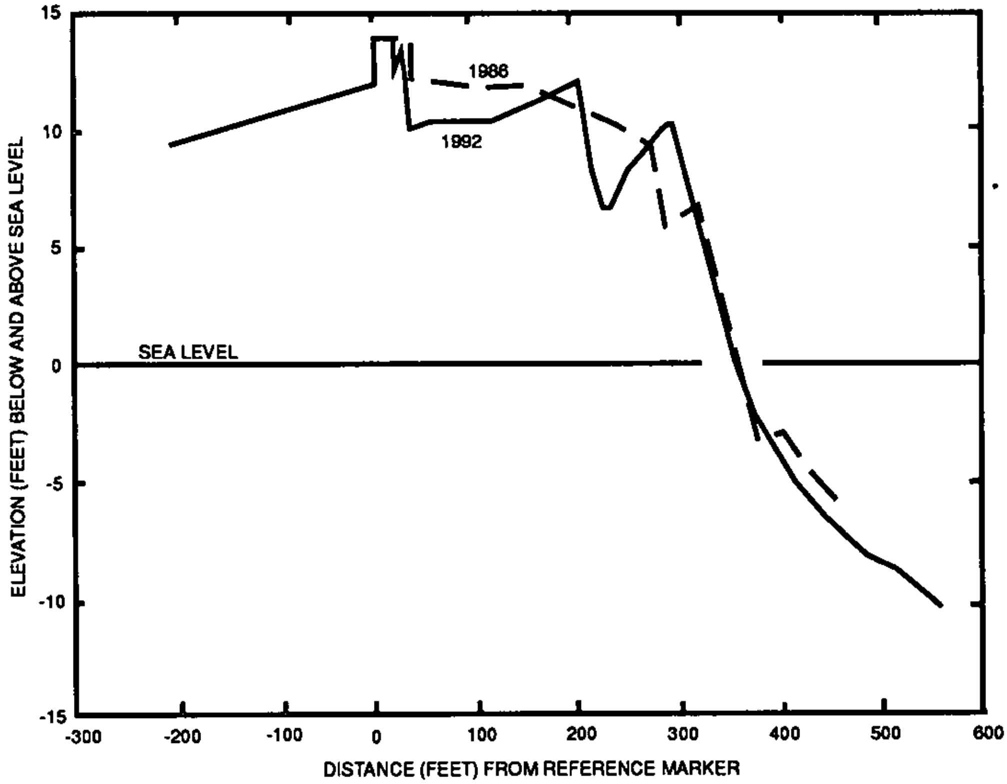
Table 4E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
157-158	5,000	0.44	2,200	2,986
158-159	2,300	-0.54	-1,242	1,512
159-160	4,150	-0.77	-3,195	2,835
160-161	4,800	0.16	768	2,641
161-162	5,000	0.83	4,150	2,714
162-163	4,400	-1.87	-8,228	2,531

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 4, Profile 163
5th Avenue, Belmar Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

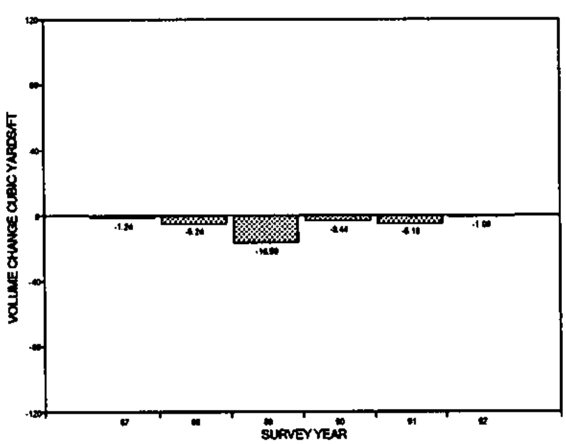


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-0.95	-0.29	-1.24
1988	-1.60	-3.64	-5.24
1989	2.41	-19.00	-16.59
1990	-3.44	0.00	-3.44
1991	-5.18	0.00	-5.18
1992	-0.12	-0.94	-1.06
Approximate 6-yr. volume change			-32.75
Mean annual volume change			-5.46
Standard deviation			5.75

[1] Negative value denotes loss of sand

Graph 2

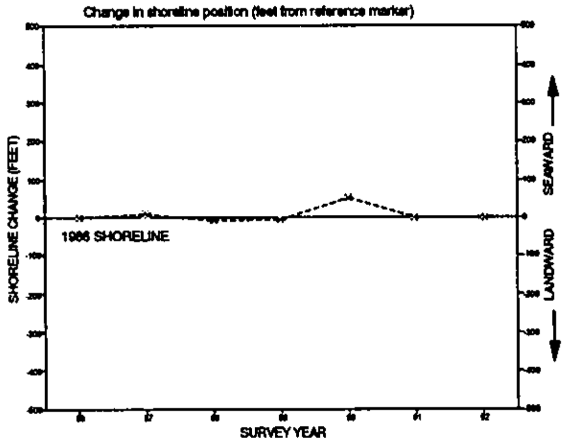


Table 2

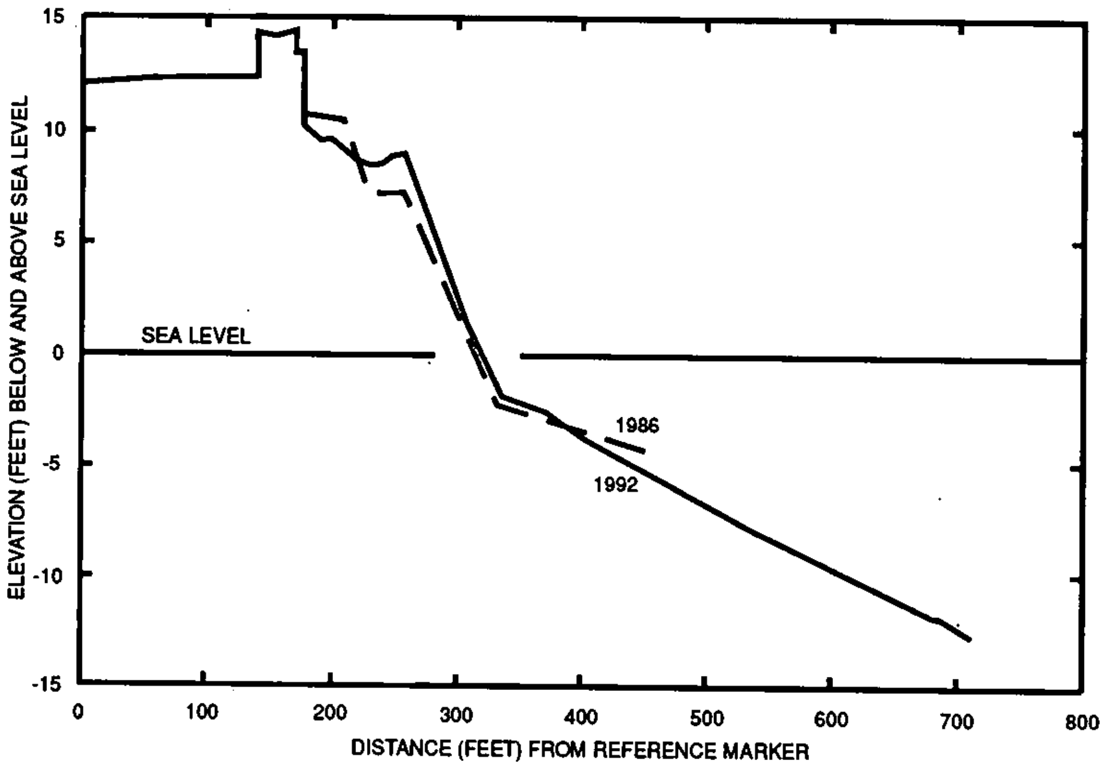
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/15	358.97	
1987	10/08	365.79	6.82
1988	10/14	348.59	-10.38
1989	10/13	352.80	-6.17
1990	10/18	410.28	51.31
1991	10/25	357.22	-1.75
1992	10/30	356.58	-2.39
Net shoreline change, 1986-1992 [3]			-2.39
Mean annual distance from ref. mkr., 1986-1992 [3]			364.32
Standard deviation			20.95

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 4, Profile 162
18th Avenue, Belmar Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

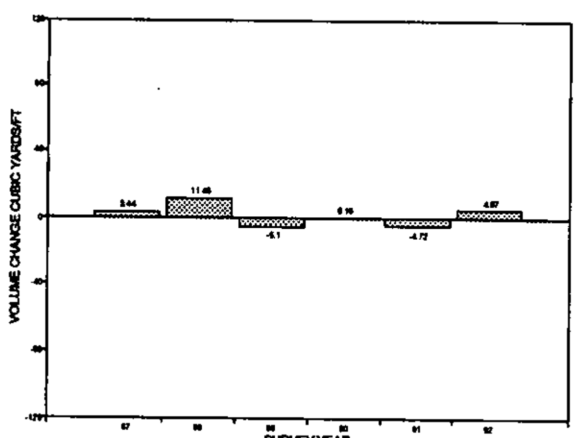


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	0.93	2.51	3.44
1988	3.77	7.71	11.48
1989	-5.10	0.00	-5.10
1990	-1.33	1.49	0.16
1991	-1.24	-3.48	-4.72
1992	5.63	-0.66	4.97
Approximate 6-yr. volume change			10.23
Mean annual volume change			1.71
Standard deviation			6.31

[1] Negative value denotes loss of sand

Graph 2

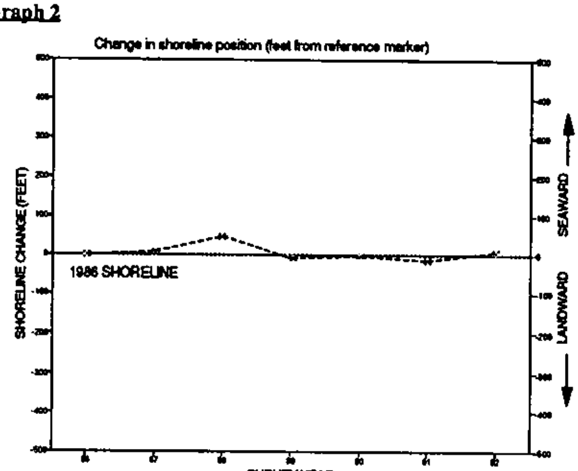


Table 2

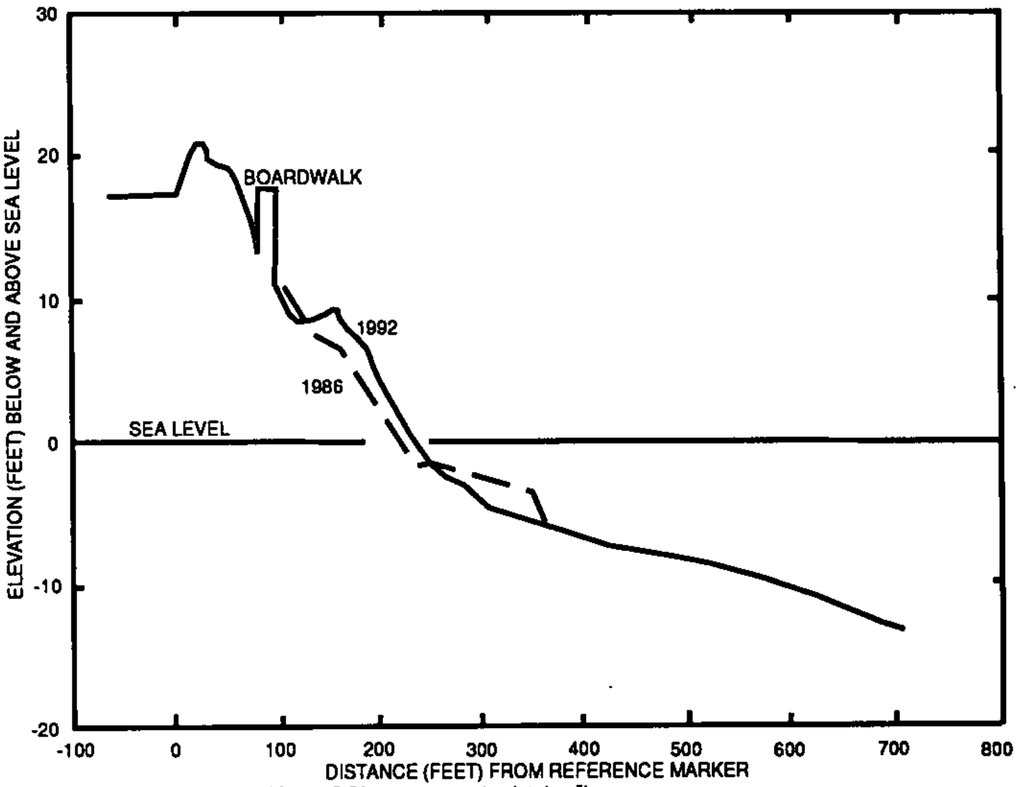
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/16	312.50	
1987	10/08	321.18	8.68
1988	10/14	360.70	48.20
1989	10/09	305.16	-7.34
1990	10/19	309.94	-2.56
1991	10/23	297.20	-15.30
1992	11/10	318.83	6.33
Net shoreline change, 1986-1992 [3]			6.33
Mean annual distance from ref. mkr., 1986-1992 [3]			317.93
Standard deviation			20.52

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 4, Profile 161
Brighton Avenue, Spring Lake Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

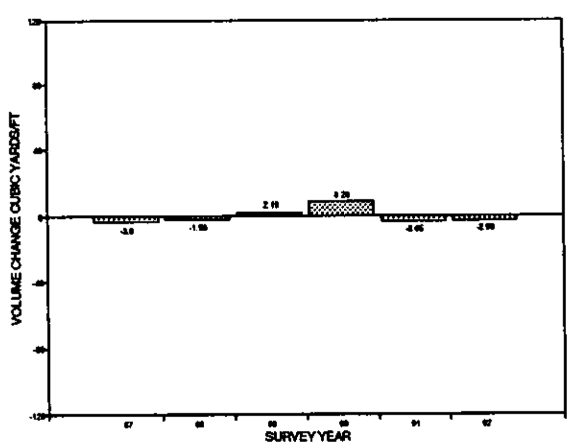


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-2.07	-1.53	-3.60
1988	-1.14	-0.42	-1.56
1989	4.40	-2.21	2.19
1990	0.58	7.70	8.28
1991	1.11	-4.16	-3.05
1992	5.06	-7.64	-2.58
Approximate 6-yr. volume change			-0.32
Mean annual volume change			-0.05
Standard deviation			4.58

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

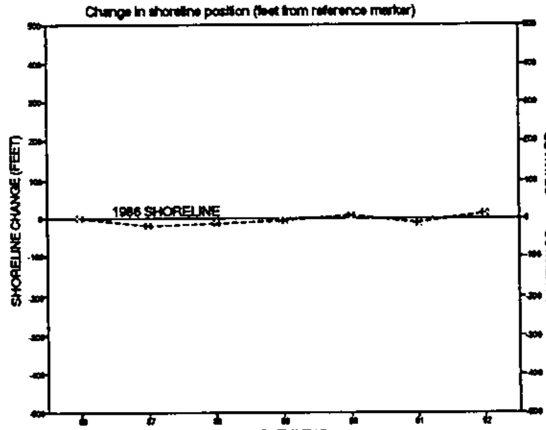


Table 2

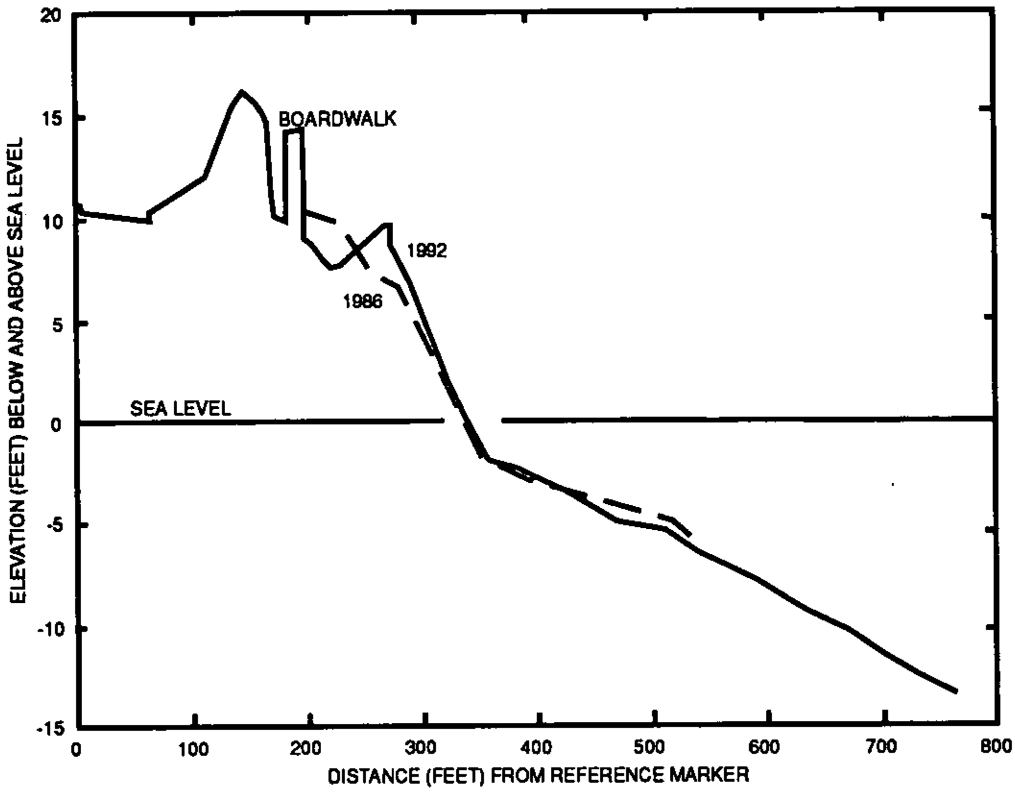
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/16	219.03	
1987	10/08	199.73	-19.30
1988	10/14	203.35	-15.68
1989	10/09	211.91	-7.12
1990	10/19	227.63	8.60
1991	10/23	208.34	-10.69
1992	11/10	231.99	12.96
Net shoreline change, 1986-1992 [3]			12.96
Mean annual distance from ref. mkr., 1986-1992 [3]			214.57
Standard deviation			12.15

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 4, Profile 160
Salem Avenue, Spring Lake Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

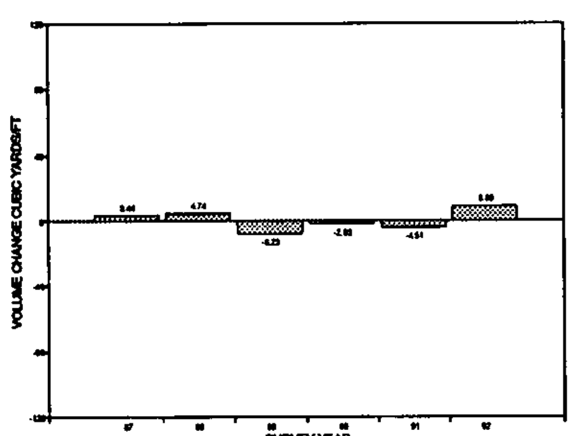


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	2.75	0.69	3.44
1988	0.28	4.46	4.74
1989	-1.79	-6.44	-8.23
1990	-0.25	-1.78	-2.03
1991	-3.87	-0.64	-4.51
1992	6.36	2.53	8.89
Approximate 6-yr. volume change			2.30
Mean annual volume change			0.38
Standard deviation			6.40

[1] Negative value denotes loss of sand

Graph 2

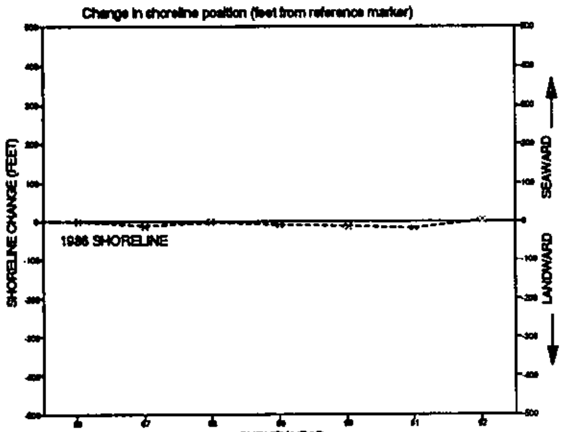


Table 2

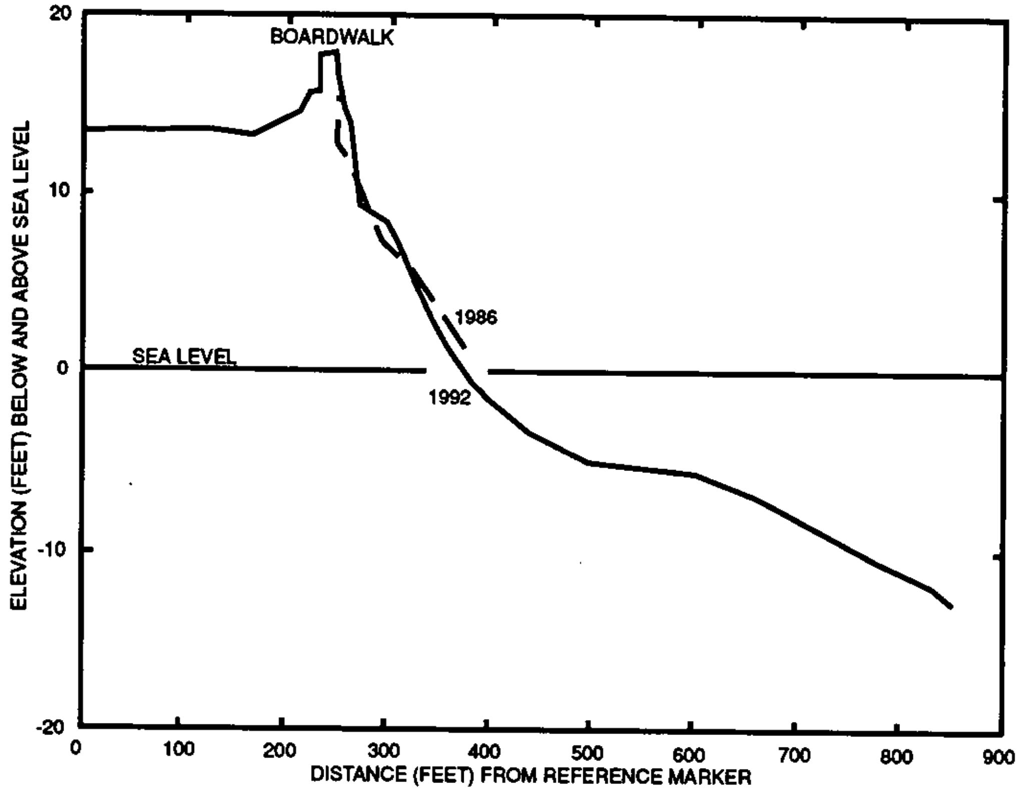
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/16	336.65	
1987	10/08	323.12	-13.53
1988	10/10	331.84	-4.81
1989	10/09	327.06	-9.59
1990	10/19	323.27	-13.38
1991	10/23	318.58	-18.07
1992	11/10	337.56	0.91
Net shoreline change, 1986-1992 [3]			0.91
Mean annual distance from ref. mkr., 1986-1992 [3]			328.30
Standard deviation			7.26

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 4, Profile 159
New York Avenue, Sea Girt Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

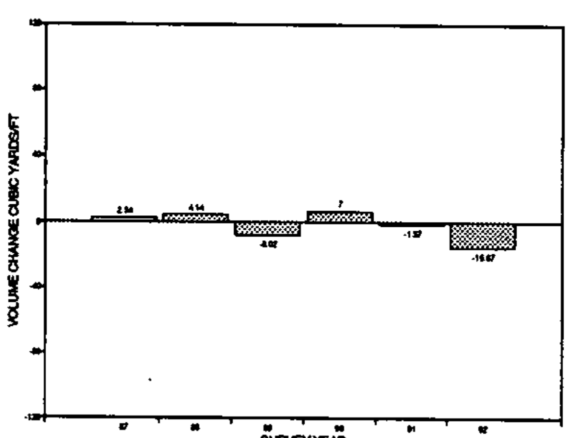


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	2.34	NA	2.34
1988	2.76	1.38	4.14
1989	-3.23	-4.79	-8.02
1990	0.16	6.84	7.00
1991	4.54	-5.91	-1.37
1992	-6.93	-8.74	-15.67
Approximate 6-yr. volume change			-11.58
Mean annual volume change			-1.93
Standard deviation			8.50

[1] Negative value denotes loss of sand

Graph 2

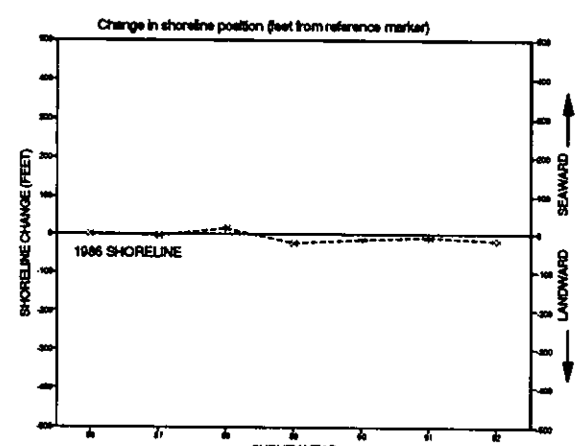


Table 2

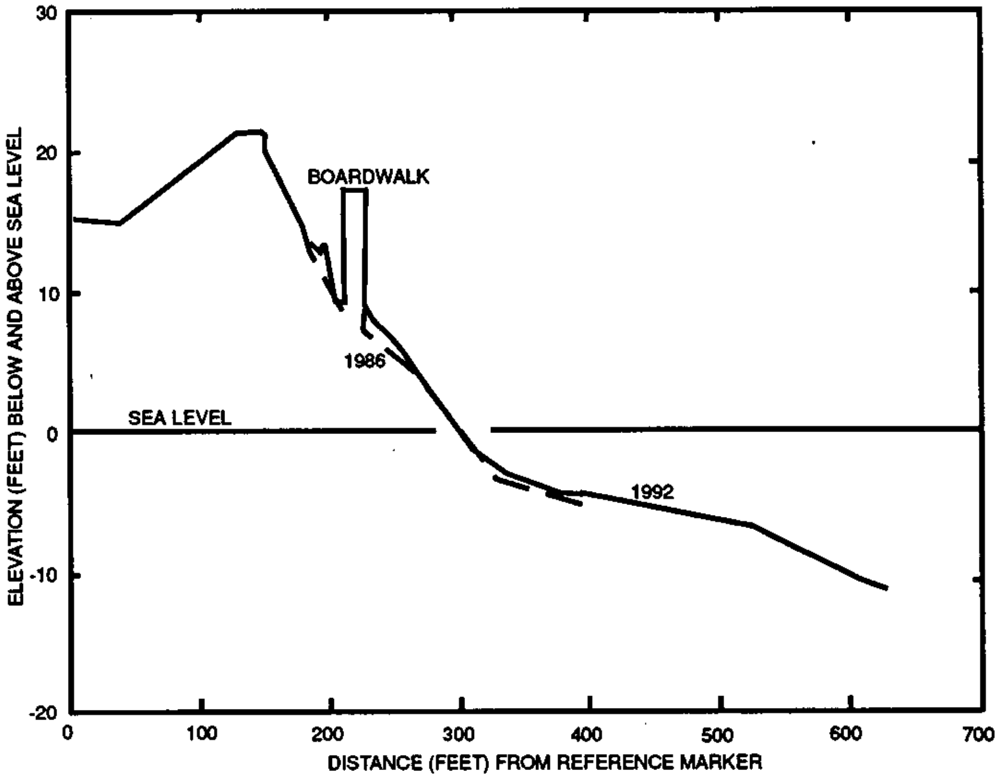
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/09	389.98	
1987	10/22	386.81	-3.17
1988	10/10	403.76	13.78
1989	10/09	367.82	-22.16
1990	10/19	374.44	-15.54
1991	10/23	381.54	-8.44
1992	11/10	372.50	-17.48
Net shoreline change, 1986-1992 [3]			-17.48
Mean annual distance from ref. mkr., 1986-1992 [3]			382.41
Standard deviation			12.30

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 4, Profile 158
Trenton Avenue, Sea Girt Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

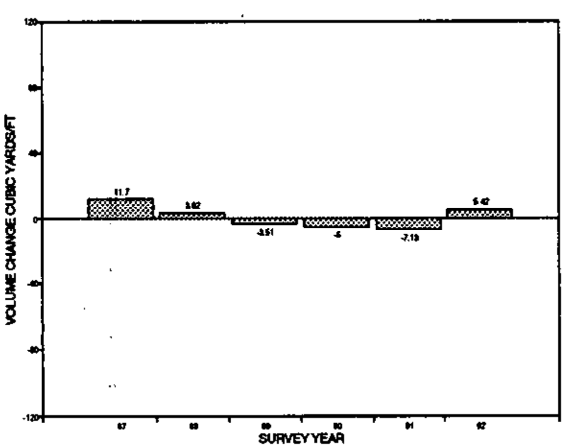


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	3.24	8.46	11.70
1988	4.58	-0.96	3.62
1989	-1.90	-1.61	-3.51
1990	-5.13	0.13	-5.00
1991	-1.33	-5.80	-7.13
1992	2.76	2.66	5.42
Approximate 6-yr. volume change			5.10
Mean annual volume change			0.85
Standard deviation			7.25

[1] Negative value denotes loss of sand

Graph 2

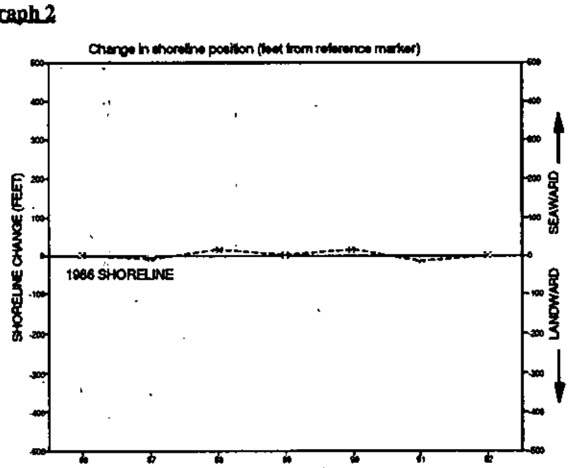


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/11	300.76	
1987	10/21	292.67	-8.09
1988	10/10	318.45	17.69
1989	10/09	303.77	3.01
1990	10/19	317.38	16.62
1991	10/23	286.28	-14.48
1992	11/10	299.24	-1.52
Net shoreline change, 1986-1992 [3]			-1.52
Mean annual distance from ref. mkr., 1986-1992 [3]			302.65
Standard deviation			11.91

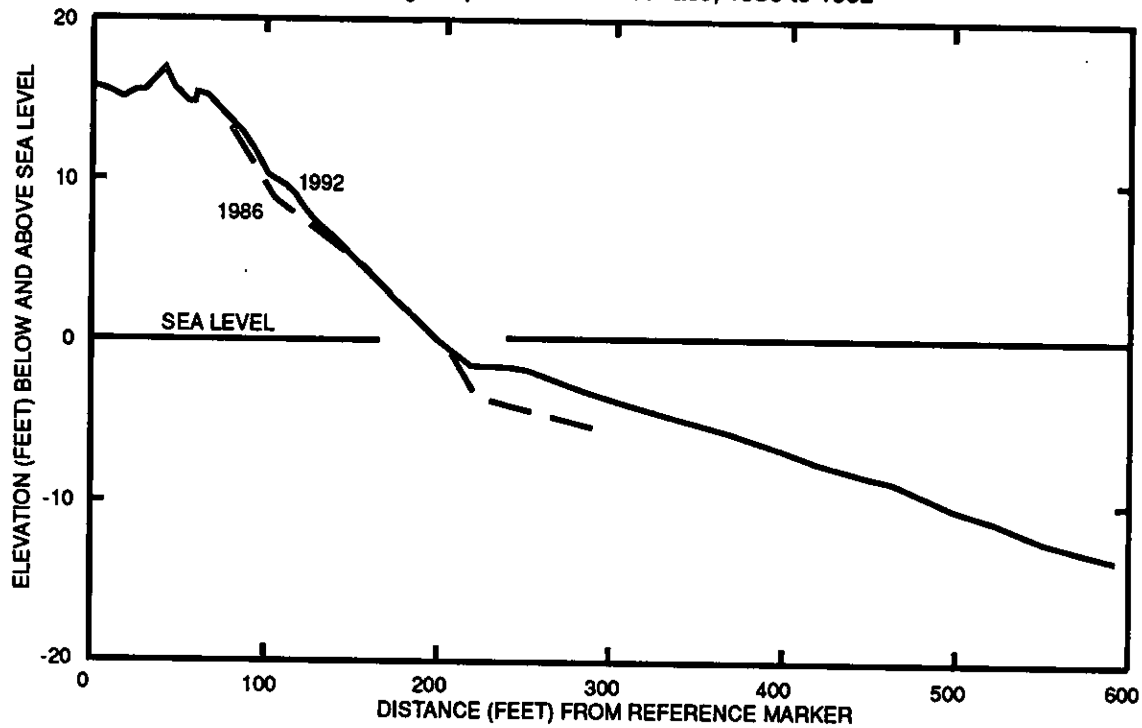
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 4, Profile 157
Riddle Way and 1st Avenue, Manasquan Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

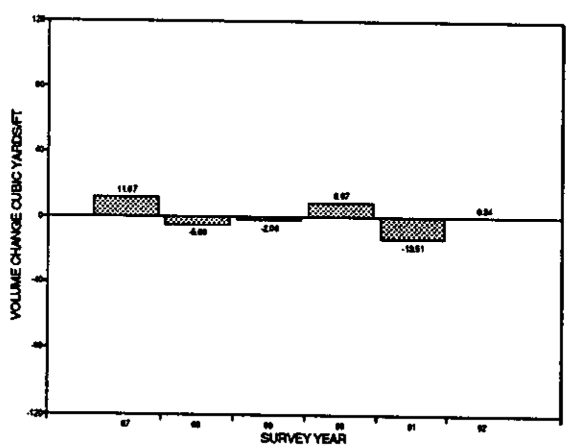


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	2.80	8.87	11.67
1988	-2.76	-2.32	-5.08
1989	2.34	-4.40	-2.06
1990	3.33	5.54	8.87
1991	-9.81	-3.70	-13.51
1992	7.23	-6.89	0.34
Approximate 6-yr. volume change			0.23
Mean annual volume change			0.04
Standard deviation			9.25

[1] Negative value denotes loss of sand

Graph 2

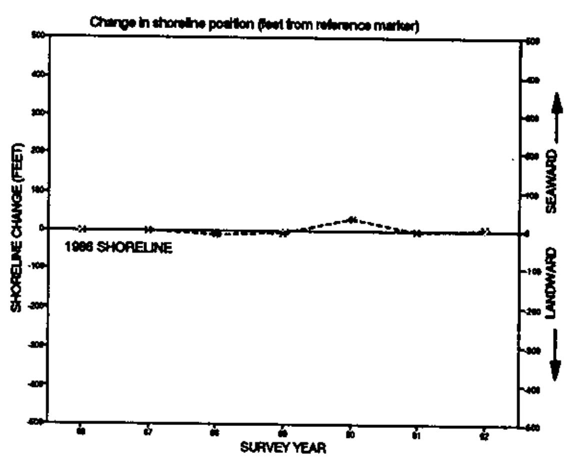


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/11	198.84	
1987	10/27	196.87	-1.97
1988	10/10	185.65	-13.19
1989	10/09	192.86	-5.98
1990	10/19	229.59	30.75
1991	11/23	196.09	-2.75
1992	11/09	200.80	1.96
Net shoreline change, 1986-1992 [3]			1.96
Mean annual distance from ref. mkr., 1986-1992 [3]			200.10
Standard deviation			13.90

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

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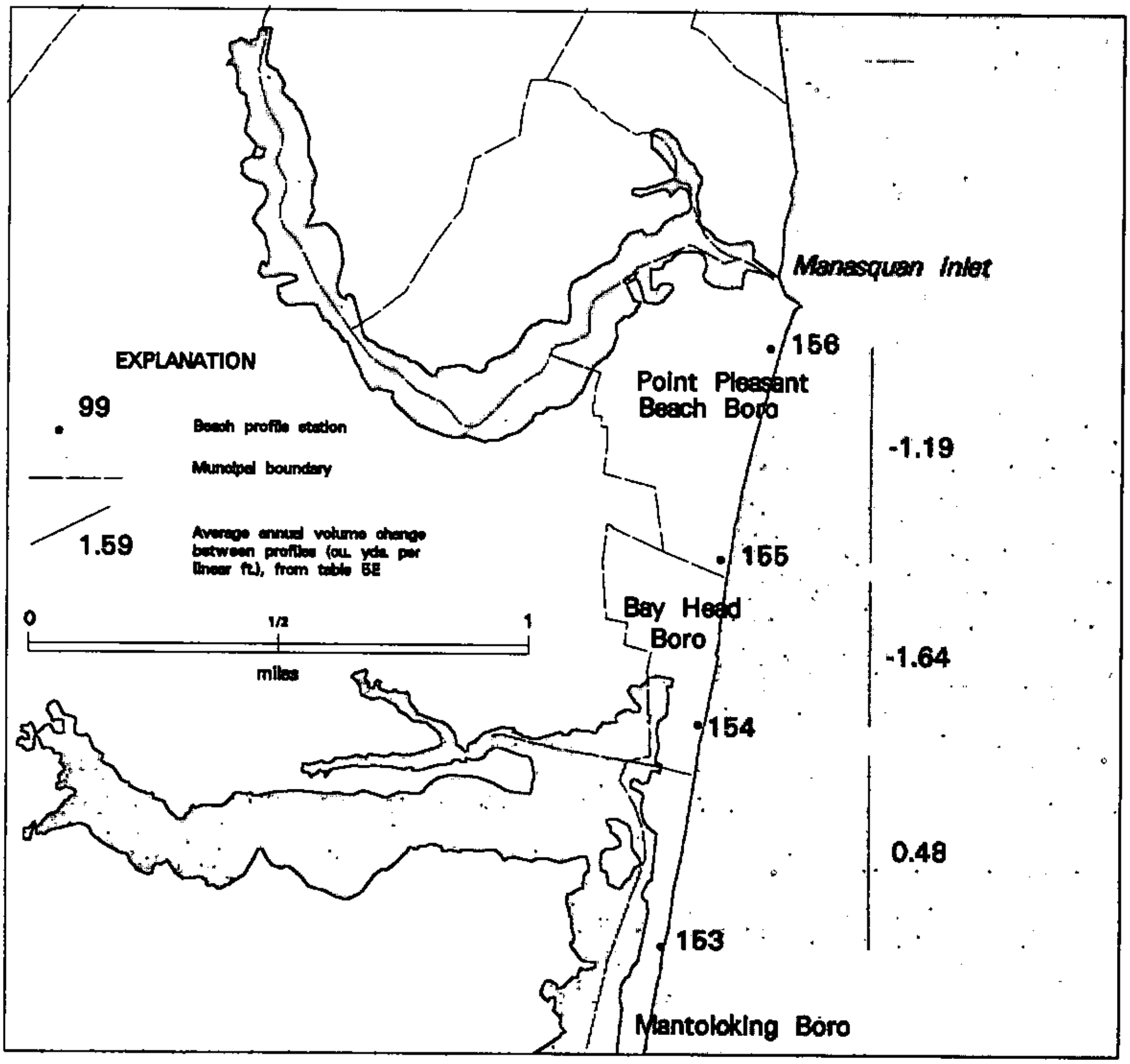


Figure 7. Map of Reach 5, Manasquan Inlet to Mantoloking, showing municipalities, profile locations, and calculated volume change between profiles.

Table 5A. Profile stations - Manasquan Inlet to Mantoloking Borough, Ocean County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
156	740208W	400547N	18.32	Water St., Point Pleasant Beach Borough
155	740230W	400438N	13.96	Maryland Ave., Point Pleasant Beach Borough
154	740240W	400344N	19.06	Johnson Ave., Bay Head Borough

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.

Table 5B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
Point Pleasant Beach Borough	1985	Sand redistribution into sand dunes at public beach	2-3,000	NA
Bay Head Borough		No activity noted.		

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 5C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
154	267.59	177.97	226.11	29.05	65.76
155	434.23	367.13	382.88	23.71	3.73
156	486.51	404.09	445.62	25.39	18.92

[1] Data summarized from table 2 of Profiles 154-156.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 154-156.

Table 5D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
153[3]	30.33	-31.22	-1.13	22.81	-6.79
154	16.40	-6.92	2.09	8.16	12.54
155	20.52	-27.92	-5.38	17.35	-32.30
156	31.90	-24.29	2.99	21.04	17.91

[1] Data summarized from table 1 of Profiles 154-156.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 154-156.
[3] Profile 153 included from Reach 6 to calculate volume change between profiles 153 and 154, although it is outside Reach 5.

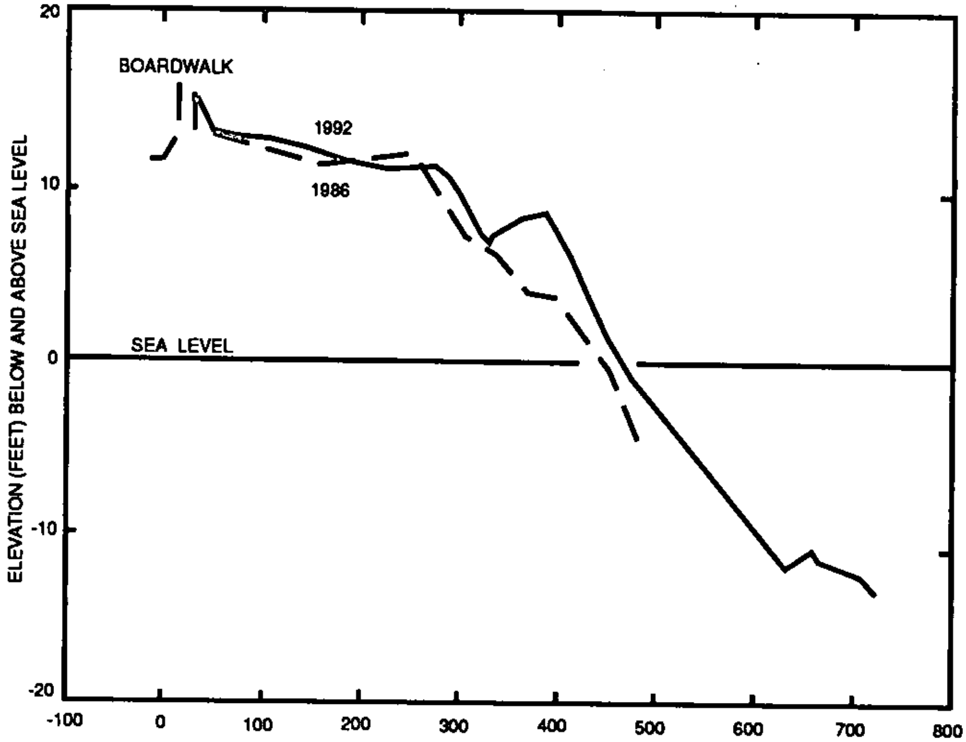
Table 5E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
153-154	8,000	0.48	3,840	4,528
154-155	5,700	-1.64	-9,348	3,047
155-156	7,200	-1.19	-8,568	4,179

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 5, Profile 156
Water Street, Point Pleasant Beach Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

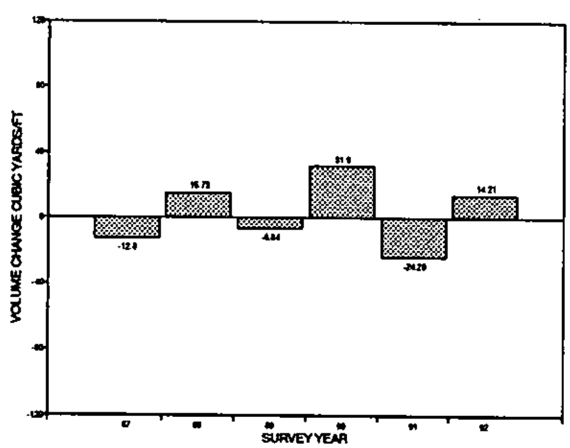


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-6.21	-6.59	-12.80
1988	9.24	6.49	15.73
1989	-6.21	-0.63	-6.84
1990	31.90	0.00	31.90
1991	-14.71	-9.58	-24.29
1992	5.52	8.69	14.21
Approximate 6-yr. volume change			17.91
Mean annual volume change			2.99
Standard deviation			21.04

[1] Negative value denotes loss of sand

Graph 2

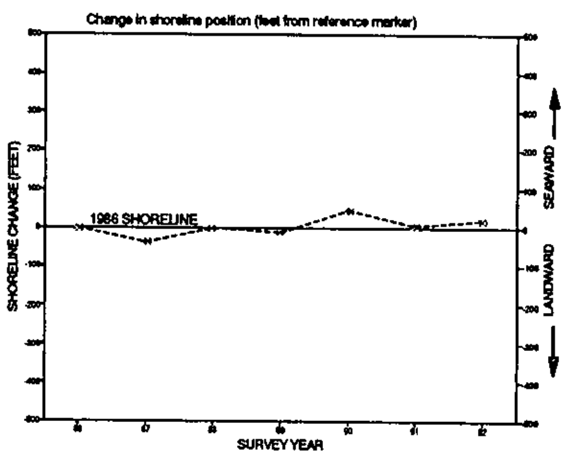


Table 2

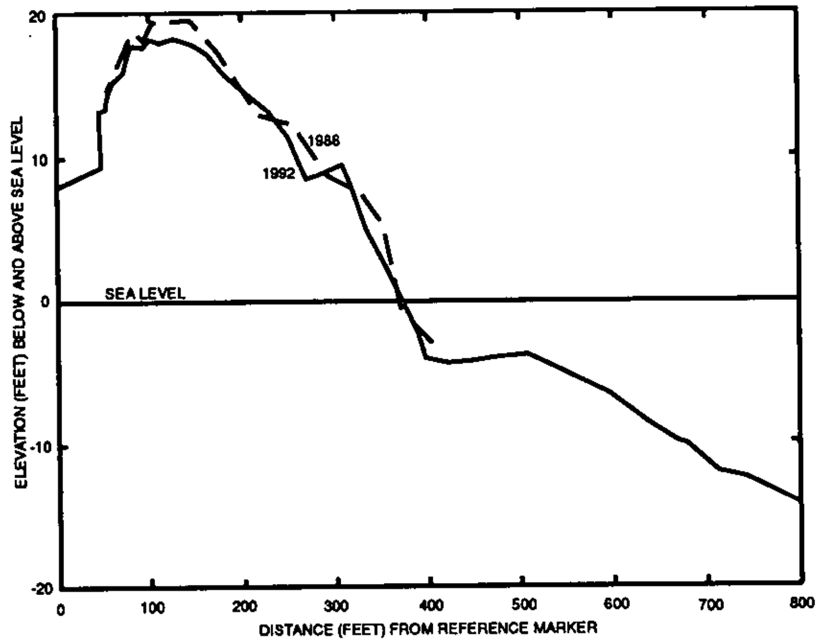
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/12	443.37	
1987	10/22	404.09	-39.28
1988	10/25	443.40	0.03
1989	10/26	432.24	-11.13
1990	11/05	486.51	43.14
1991	11/23	447.46	4.09
1992	11/25	462.29	18.92
Net shoreline change, 1986-1992 [3]			18.92
Mean annual distance from ref. mkr., 1986-1992 [3]			445.62
Standard deviation			25.39

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 5, Profile 155
Maryland Avenue, Point Pleasant Beach Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

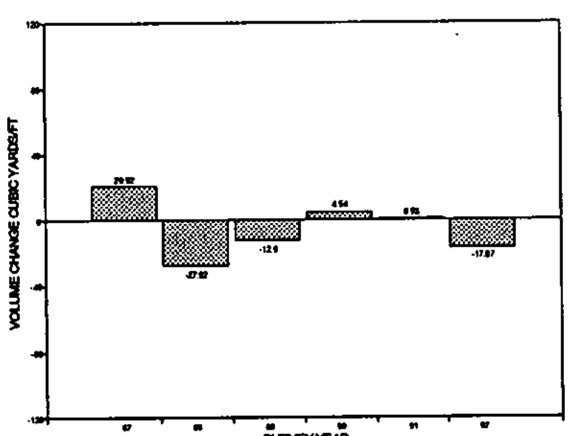


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	20.52	NA	20.52
1988	-12.18	-15.74	-27.92
1989	-9.00	-3.90	-12.90
1990	2.04	2.50	4.54
1991	-5.30	5.83	0.53
1992	-4.24	-12.83	-17.07
Approximate 6-yr. volume change			-32.30
Mean annual volume change			-5.38
Standard deviation			17.35

[1] Negative value denotes loss of sand

Graph 2

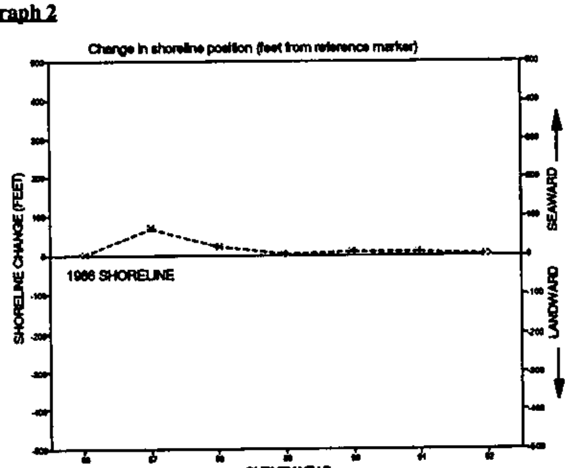


Table 2

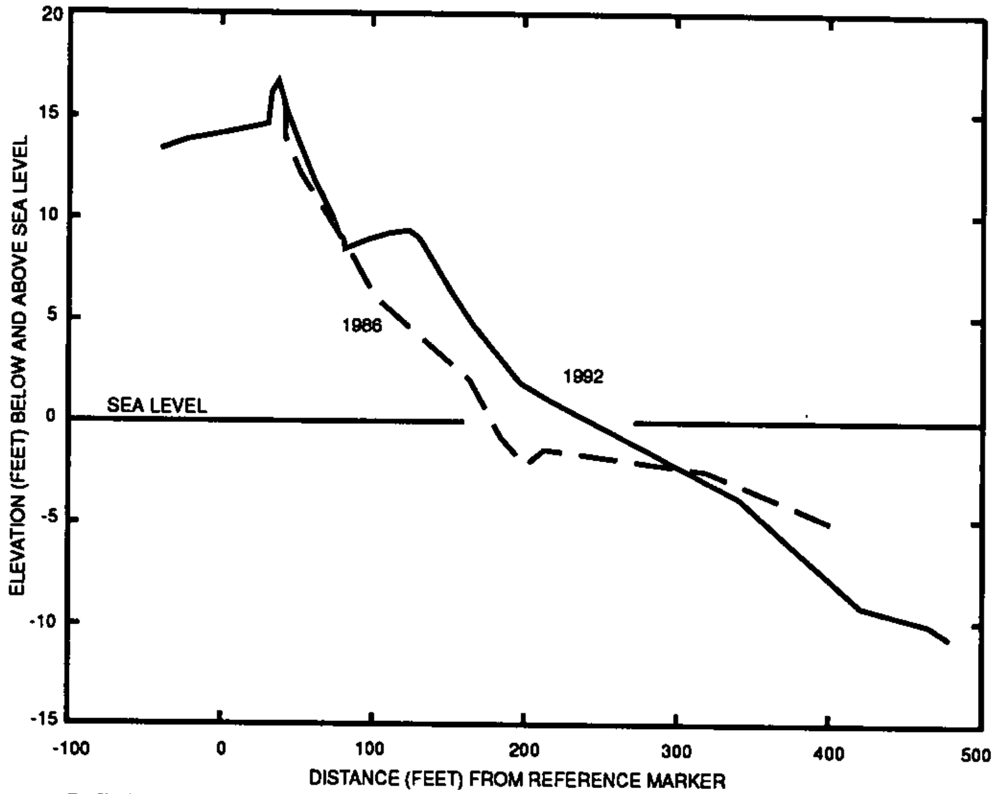
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/12	367.13	
1987	10/22	434.23	67.10
1988	10/25	388.97	21.84
1989	10/26	370.12	2.99
1990	11/05	373.79	6.66
1991	11/23	375.06	7.93
1992	11/25	370.86	3.73
Net shoreline change, 1986-1992 [3]			3.73
Mean annual distance from ref. mkr., 1986-1992 [3]			382.88
Standard deviation			23.71

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 5, Profile 154
Johnson Avenue, Bay Head Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

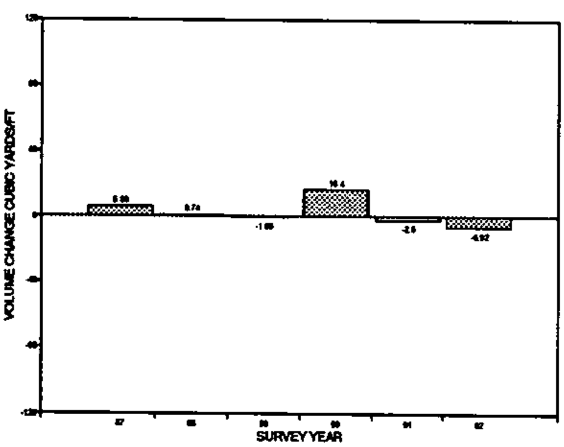


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	7.87	-1.99	5.88
1988	-2.77	3.51	0.74
1989	-0.78	-0.28	-1.06
1990	17.09	-0.69	16.40
1991	-10.24	7.74	-2.50
1992	6.69	-13.61	-6.92
Approximate 6-yr. volume change			12.54
Mean annual volume change			2.09
Standard deviation			8.16

[1] Negative value denotes loss of sand

Graph 2

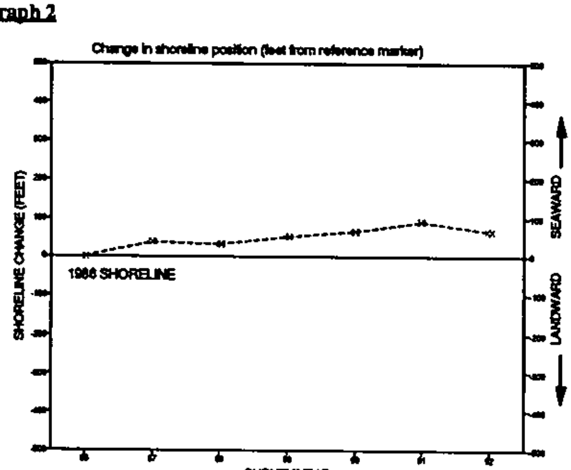


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/12	177.97	
1987	10/22	214.27	36.30
1988	10/25	208.33	30.36
1989	10/26	228.95	50.98
1990	11/05	241.94	63.97
1991	11/23	267.59	89.62
1992	11/25	243.73	65.76
Net shoreline change, 1986-1992 [3]			65.76
Mean annual distance from ref. mkr., 1986-1992 [3]			226.11
Standard deviation			29.05

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

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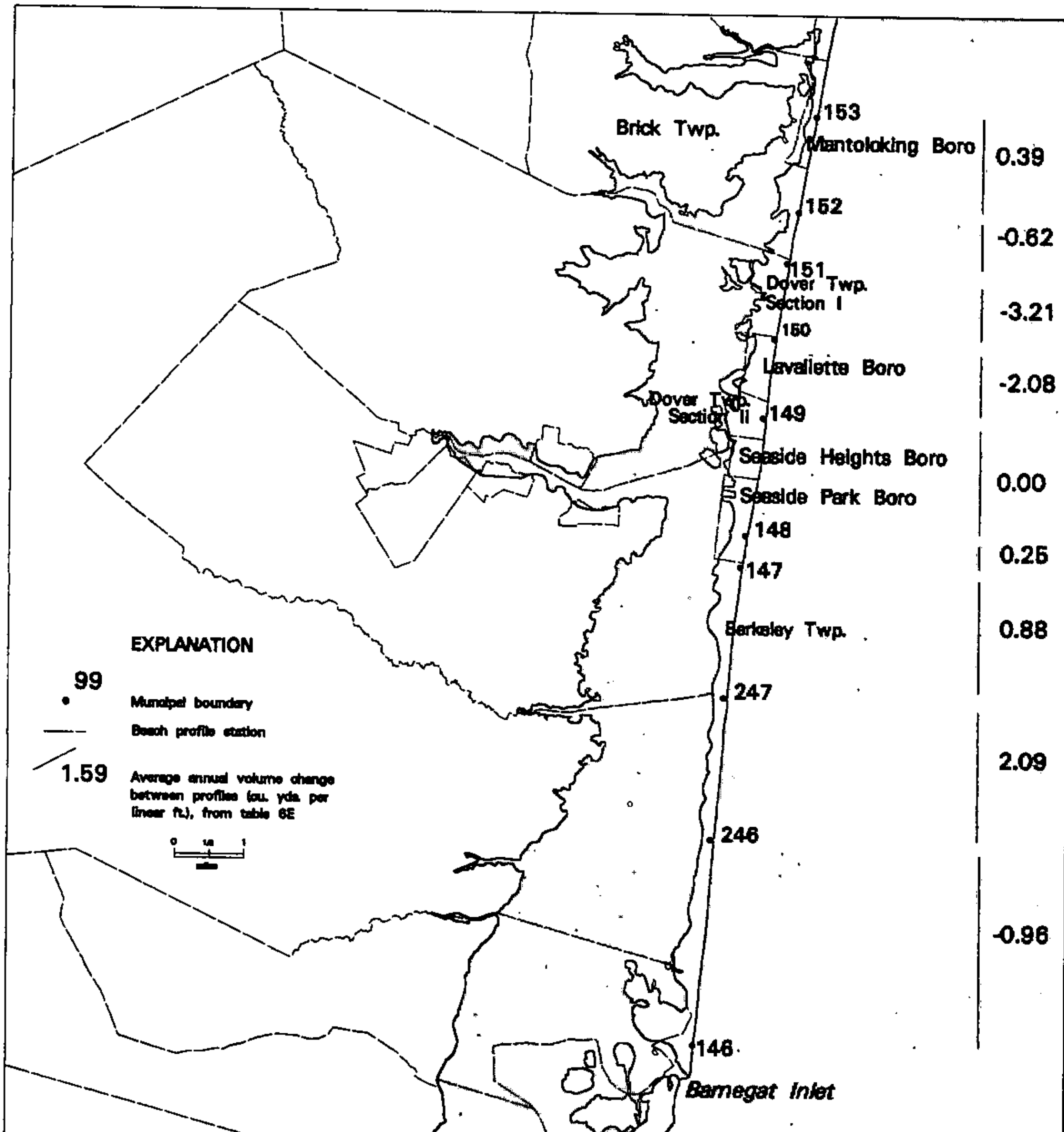


Figure 8. Map of Reach 6, Mantoloking to Barnegat Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Table 6A. Profile stations - Mantoloking to Barnegat Inlet, Ocean County

Beach profile station	Location: Longitude[1]	Location: Latitude[1]	Elevation (ft.)[2]	Site description 3
153	740257W	400228N	22.40	1117 Ocean Ave., Mantoloking Borough
152	740321W	400049N	10.30	Public Beach no. 3, Brick Twp.
151	740337W	395956N	24.16	1st St., Normandy Beach, Dover Twp.
150	740354W	395837N	20.71	White Ave., Lavallette Borough
149	740409W	395715N	19.37	8th Ave., Ortley Beach, Dover Twp.
148	740433W	395513N	16.28	4th Ave., Seaside Park Borough
147	740440W	395440N	21.81	6th Lane, Midway Beach, Berkeley Twp.
247	740503W	395225N	20.84	North site, Island Beach State Park, Berkeley Twp.
246	740521W	394957N	17.96	Middle site, Island Beach State Park, Berkeley Twp.
146	740545W	394625N	21.27	South site, Island Beach State Park, Berkeley Twp.

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.

Table 6B. Beach replenishment and construction activities, 1985-1992[1]

Municipality	Date
Mantoloking Borough	No activity noted.
Brick Twp.	No activity noted.
Dover Twp.	No activity noted.
Lavallette	No activity noted.
Seaside Heights Borough	No activity noted.
Seaside Park Borough	No activity noted.
Berkeley Twp.	No activity noted; southern 9 miles are a natural area.

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 6C. Shoreline change, 1986-1992 by profile in feet[1]

Profile	Max.[2]	Min.[2]	Mean[2]	Standard deviation	Net change[3]
146	437.43	397.68	357.46	158.30	-0.68
246	270.57	229.70	215.84	96.31	-29.67
247	291.87	255.00	275.04	14.45	22.19
147	519.96	459.82	485.35	18.62	-44.52
148	431.92	398.34	414.90	10.15	-19.41
149	323.51	255.00	293.64	26.73	10.79
150	343.27	268.78	294.29	23.69	-53.88
151	215.97	152.96	182.60	23.75	-23.12
152	374.53	349.81	366.21	8.80	-7.58
153	312.65	281.70	303.08	11.05	1.96

[1] Data summarized from table 2 of Profiles 146-153.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 146-153.

Table 6D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline[1]

Profile	High	Low	Mean volume change[2]	Standard deviation[2]	Net change[2]
146	8.67	-38.86	-3.94	18.10	-23.66
246	17.44	-22.47	2.01	17.20	8.04
247	12.25	-10.32	2.18	10.41	13.05
147	14.20	-21.53	-0.42	13.01	-2.52
148	13.26	-19.80	0.92	12.54	5.55
149	22.87	-12.10	-0.91	12.95	-5.43
150	9.74	-13.74	-3.26	8.40	-19.57
151	16.65	-23.86	-3.16	17.05	-18.94
152	11.01	-11.76	1.92	8.81	9.58
153	30.33	-31.22	-1.13	22.81	-6.79

[1] Data summarized from table 1 of Profiles 146-153.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 146-153.

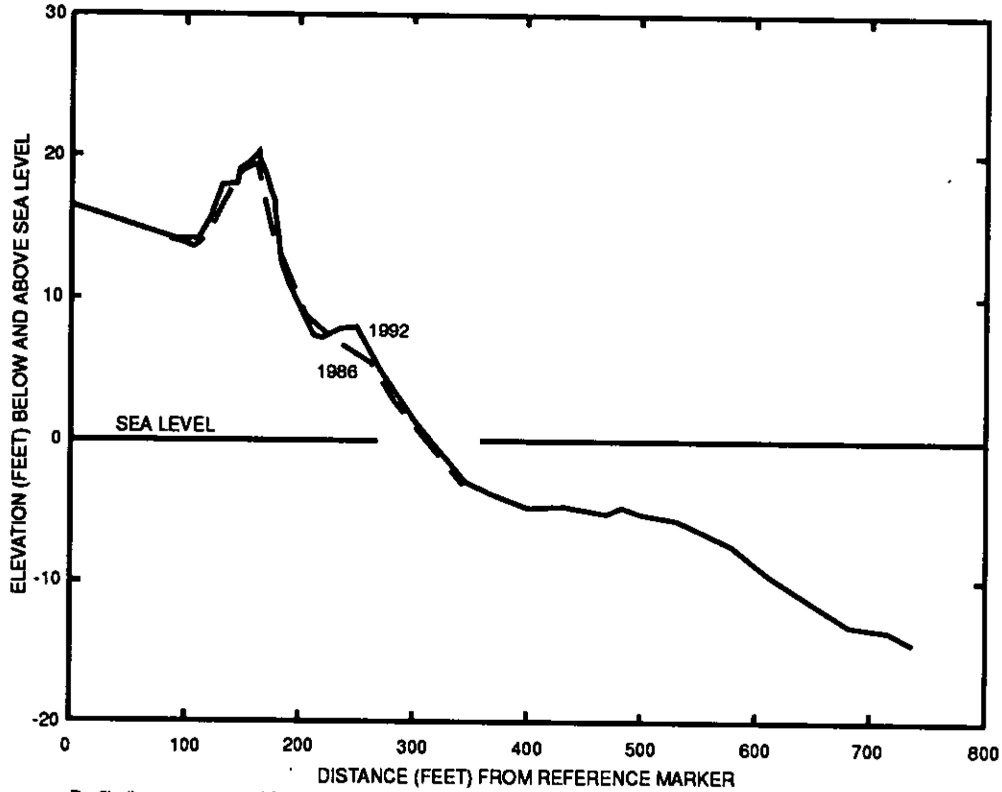
Table 6E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards[1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.)[2]	Projected volume change between profiles (cu. yds.)[3]	Hypothetical replenishment volume (cu. yds.)[4]
146-246	21,500	-0.96	-20,640	11,033
246-247	15,000	2.09	31,350	8,475
247-147	13,800	0.88	12,144	4,062
147-148	3,500	0.25	875	1,992
148-149	12,750	0.00	0	7,980
149-150	9,300	-2.08	-19,344	5,377
150-151	7,500	-3.21	-24,075	3,627
151-152	5,300	-0.62	-3,286	2,302
152-153	10,300	0.39	4,017	5,073

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 6, Profile 153
1117 Ocean Avenue, Mantoloking Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

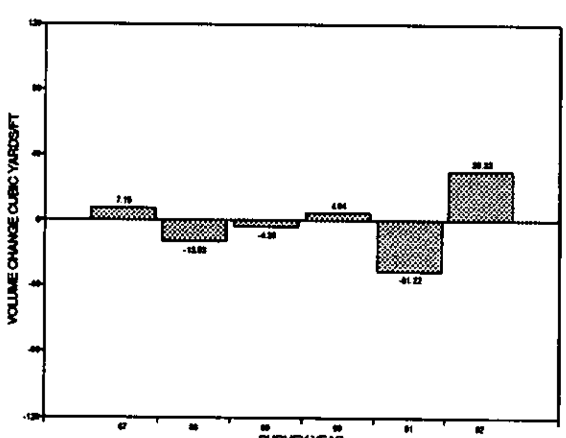


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	6.85	0.30	7.15
1988	-3.10	-10.43	-13.53
1989	-3.63	-0.73	-4.36
1990	3.96	0.88	4.84
1991	-13.91	-17.31	-31.22
1992	12.88	17.45	30.33
Approximate 6-yr. volume change			-6.79
Mean annual volume change			-1.13
Standard deviation			22.81

[1] Negative value denotes loss of sand

Graph 2

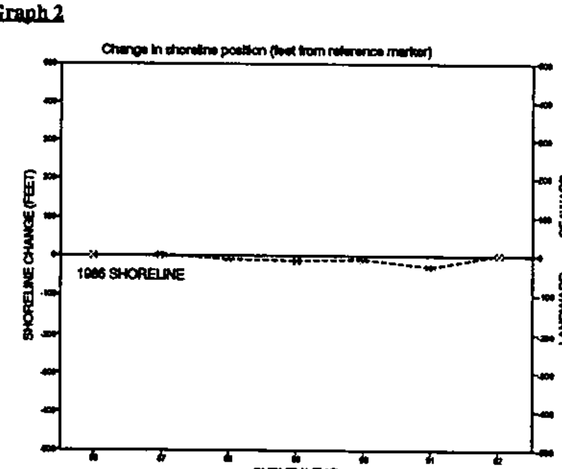


Table 2

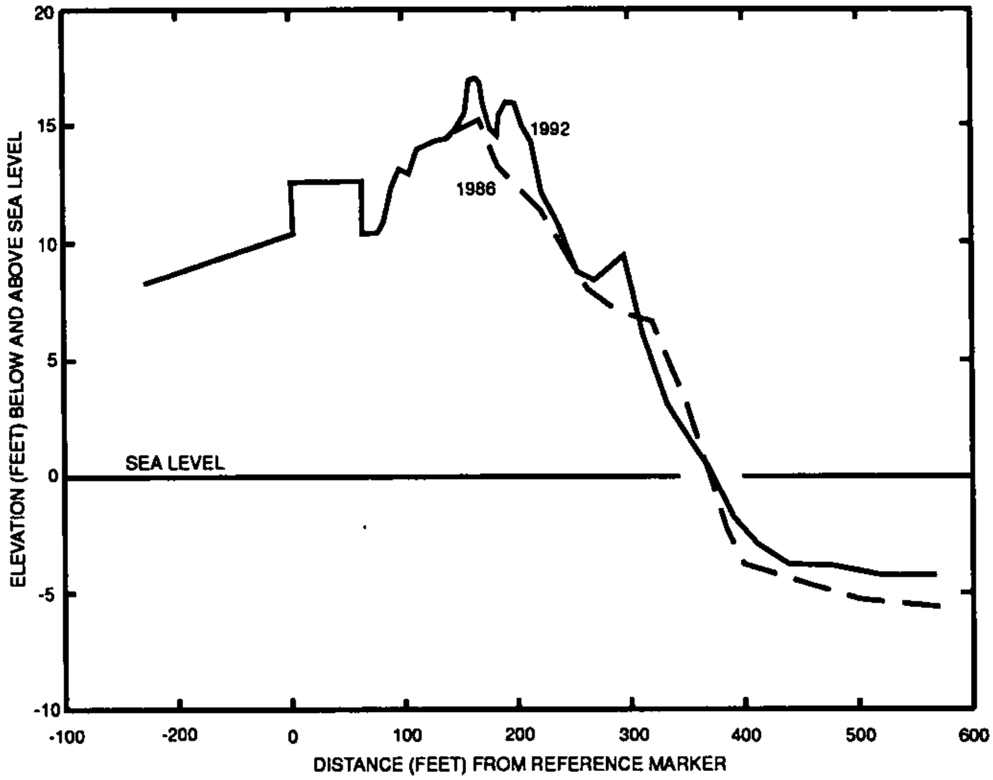
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/12	310.69	
1987	10/24	313.52	2.83
1988	10/25	300.97	-9.72
1989	10/26	299.68	-11.01
1990	11/05	302.32	-8.37
1991	11/07	281.70	-28.99
1992	11/24	312.65	1.96
Net shoreline change, 1986-1992 [3]			1.96
Mean annual distance from ref. mkr., 1986-1992 [3]			303.08
Standard deviation			11.05

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 6, Profile 152
Public Beach Number 3, Brick Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

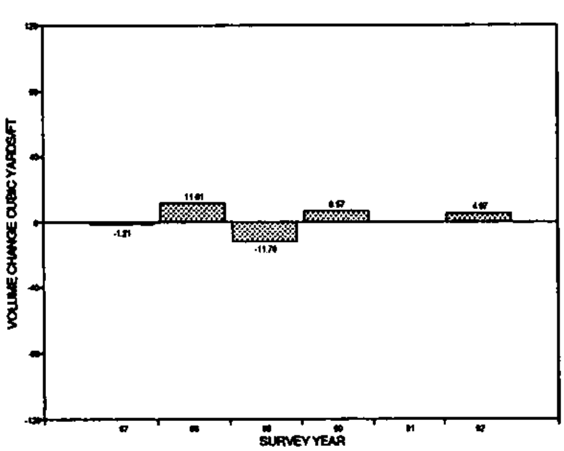


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	0.73	-1.94	-1.21
1988	8.48	2.53	11.01
1989	-11.52	-0.24	-11.76
1990	7.25	-0.68	6.57
1991	-1.41	-0.75	-2.16
1992	2.14	2.83	4.97
Approximate 6-yr. volume change			9.58
Mean annual volume change			1.92
Standard deviation			8.81

[1] Negative value denotes loss of sand

Graph 2

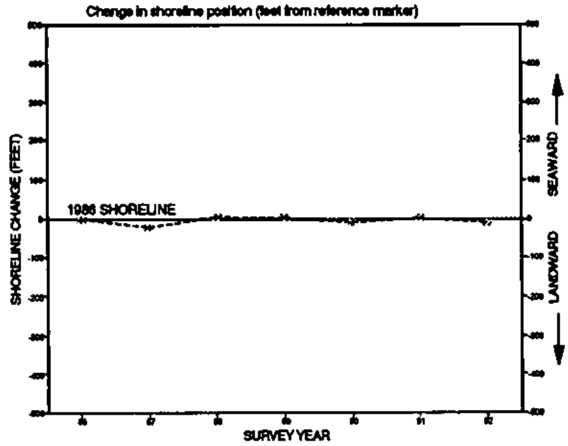


Table 2

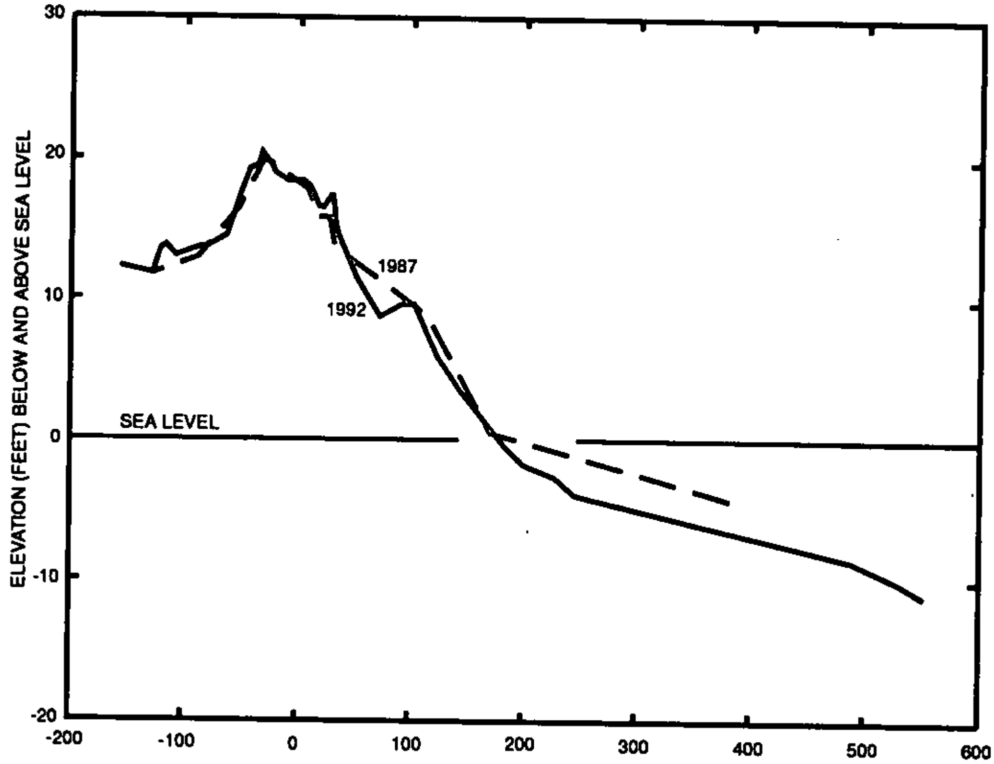
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/11	370.16	
1987	10/24	349.81	-20.35
1988	11/07	374.53	4.37
1989	10/26	372.01	1.85
1990	11/05	361.63	-8.53
1991	11/23	372.77	2.61
1992	11/24	362.58	-7.58
Net shoreline change, 1986-1992 [3]			-7.58
Mean annual distance from ref. mkr., 1986-1992 [3]			366.21
Standard deviation			8.80

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 6, Profile 151
1st Street, Normandy Beach, Dover Township

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

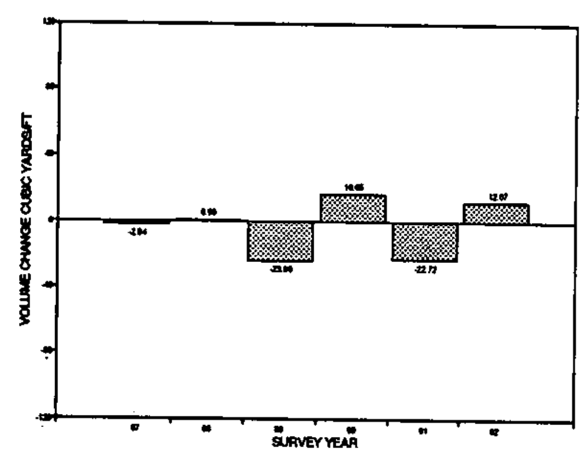


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-2.73	0.69	-2.04
1988	4.18	-3.22	0.96
1989	-10.21	-13.65	-23.86
1990	6.77	9.88	16.65
1991	-10.36	-12.36	-22.72
1992	6.12	5.95	12.07
Approximate 6-yr. volume change			-18.94
Mean annual volume change			-3.16
Standard deviation			17.05

[1] Negative value denotes loss of sand

Graph 2

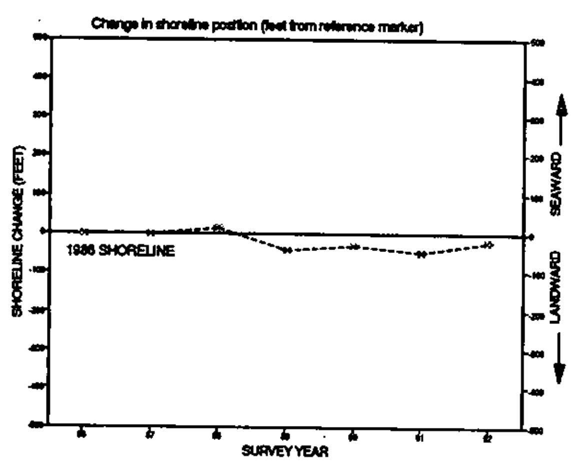


Table 2

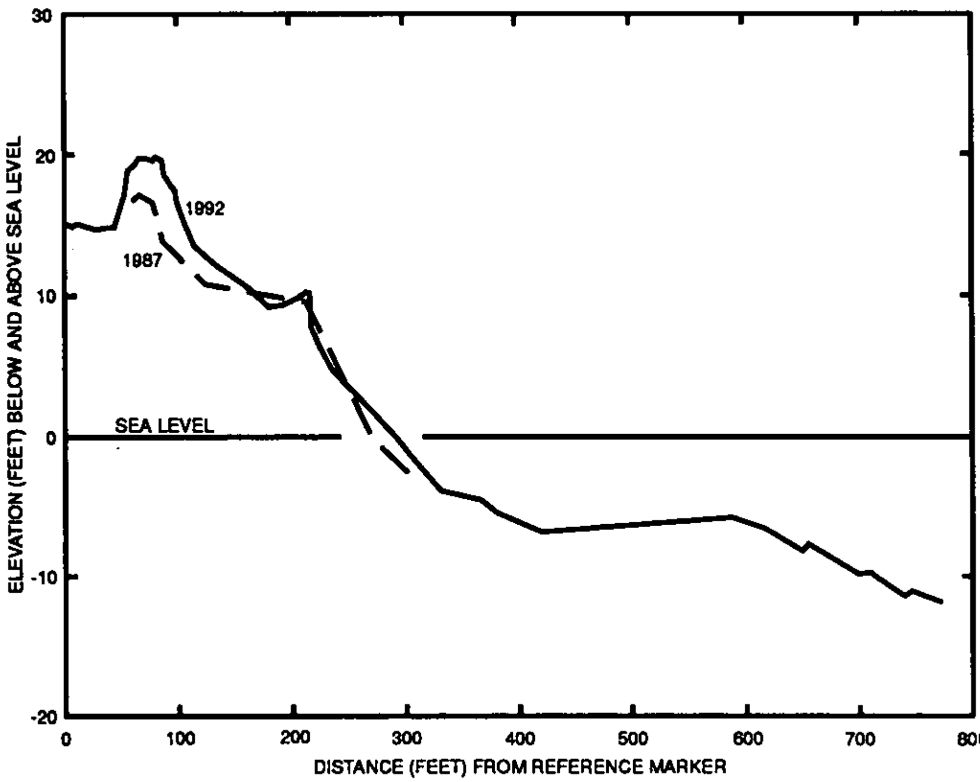
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/11	201.91	
1987	10/22	199.57	-2.34
1988	11/07	215.97	14.06
1989	10/27	158.93	-42.98
1990	11/06	170.04	-31.87
1991	11/22	152.96	-48.95
1992	11/24	178.79	-23.12
Net shoreline change, 1986-1992 [3]			-23.12
Mean annual distance from ref. mkr., 1986-1992 [3]			182.60
Standard deviation			23.75

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 6, Profile 150
White Aveue, Lavallette Borough

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

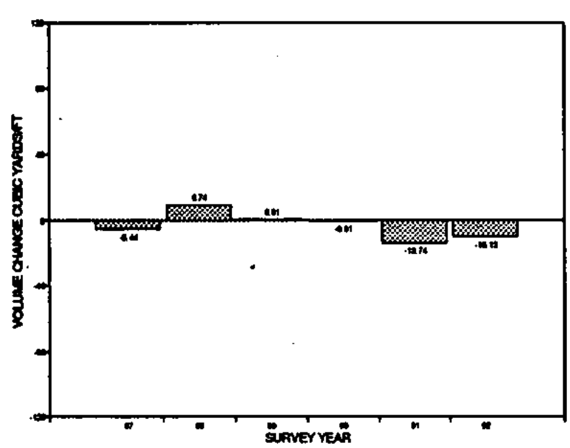


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-5.44	NA	-5.44
1988	8.82	0.92	9.74
1989	-0.17	0.78	0.61
1990	0.17	-0.78	-0.61
1991	-2.88	-10.86	-13.74
1992	3.52	-13.65	-10.13
Approximate 6-yr. volume change			-19.57
Mean annual volume change			-3.26
Standard deviation			8.40

[1] Negative value denotes loss of sand

Graph 2

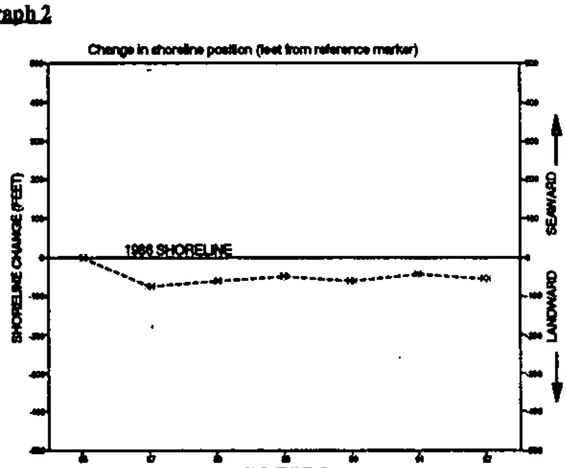


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/10	343.27	
1987	10/22	268.78	-74.49
1988	11/07	282.87	-60.40
1989	10/27	293.07	-50.20
1990	11/06	282.87	-60.40
1991	11/22	299.76	-43.51
1992	11/23	289.39	-53.88
Net shoreline change, 1986-1992 [3]			-53.88
Mean annual distance from ref. mkr., 1986-1992 [3]			294.29
Standard deviation			23.69

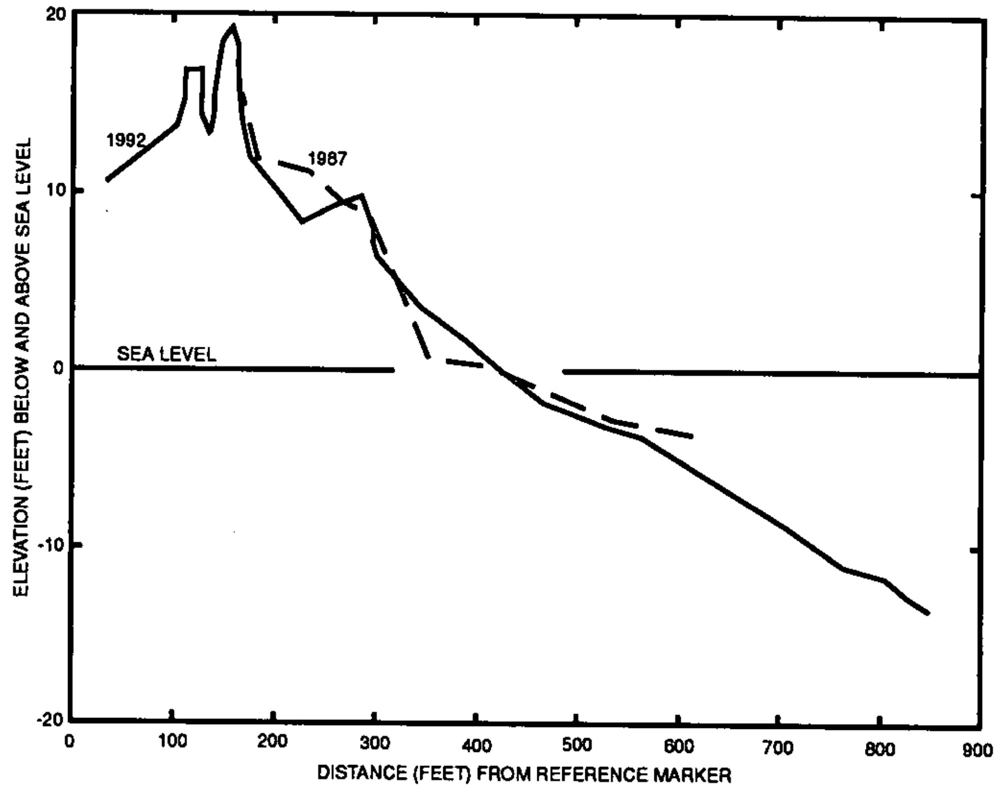
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 6, Profile 149
8th Avenue, Ortley Beach, Dover Township

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

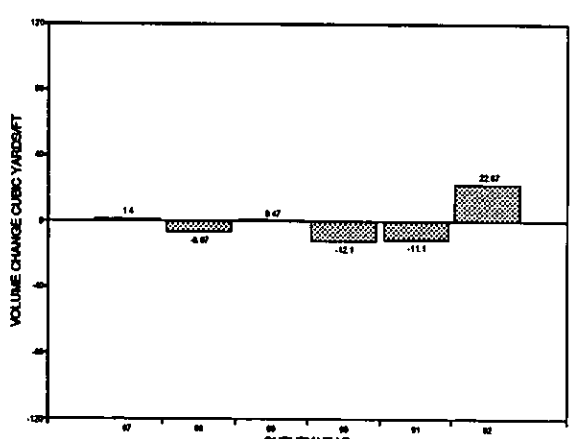


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-0.98	2.38	1.40
1988	4.06	-11.03	-6.97
1989	-8.98	9.45	0.47
1990	0.48	-12.58	-12.10
1991	-2.61	-8.49	-11.10
1992	7.66	15.21	22.87
Approximate 6-yr. volume change			-5.43
Mean annual volume change			-0.91
Standard deviation			12.95

[1] Negative value denotes loss of sand

Graph 2

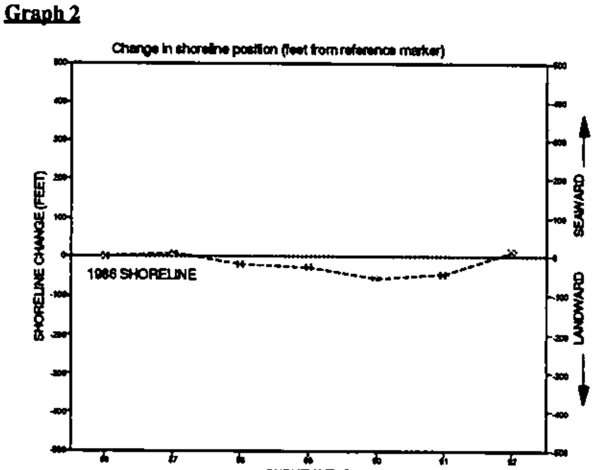


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/10	312.72	
1987	10/23	320.26	7.54
1988	11/07	293.69	-19.03
1989	10/27	283.66	-29.06
1990	11/06	255.00	-57.72
1991	11/22	266.63	-46.09
1992	11/23	323.51	10.79
Net shoreline change, 1986-1992 [3]			10.79
Mean annual distance from ref. mkr., 1986-1992 [3]			293.64
Standard deviation			26.73

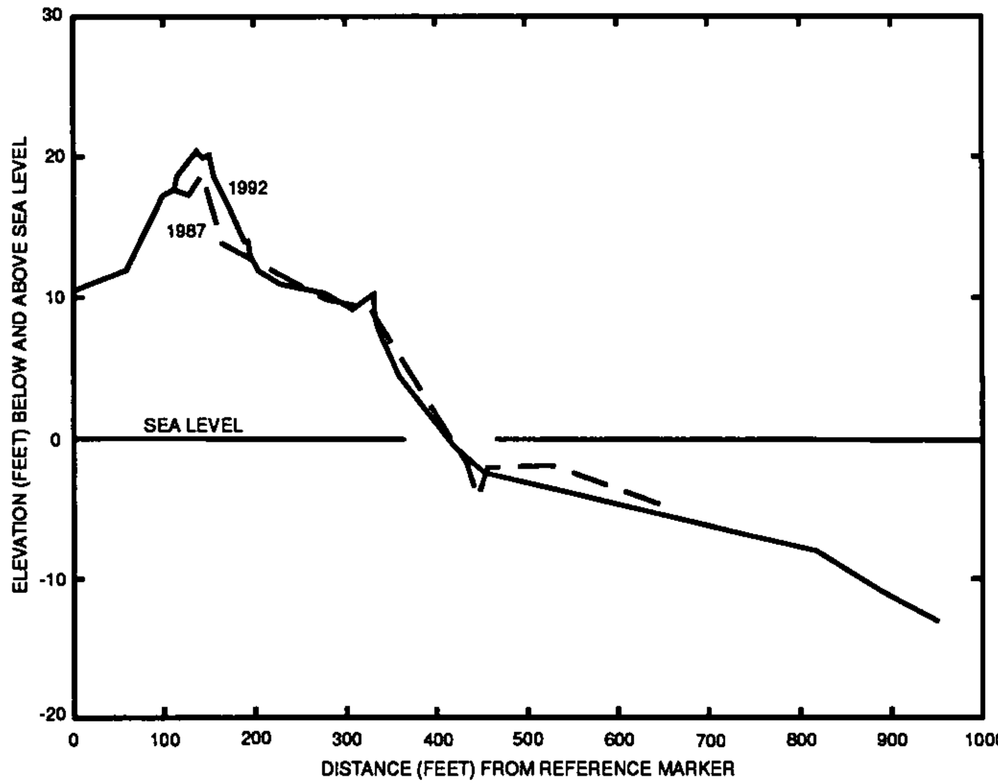
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 6, Profile 148
4th Avenue, Seaside Park Borough

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

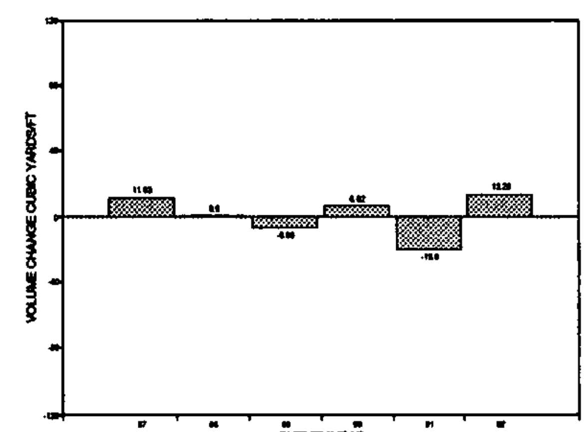


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	9.03	2.60	11.63
1988	0.05	0.45	0.50
1989	-5.30	-1.36	-6.66
1990	5.60	1.02	6.62
1991	0.97	-20.77	-19.80
1992	1.26	12.00	13.26
Approximate 6-yr. volume change			5.55
Mean annual volume change			0.92
Standard deviation			12.54

[1] Negative value denotes loss of sand

Graph 2

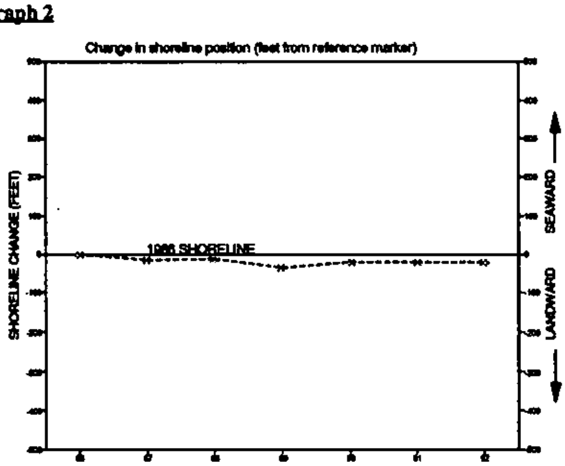


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/10	431.92	
1987	10/23	416.84	-15.08
1988	11/16	420.22	-11.7
1989	10/27	398.34	-33.58
1990	11/06	413.37	-18.55
1991	11/22	411.07	-20.85
1992	11/23	412.51	-19.41
Net shoreline change, 1986-1992 [3]			-19.41
Mean annual distance from ref. mkr., 1986-1992 [3]			414.90
Standard deviation			10.15

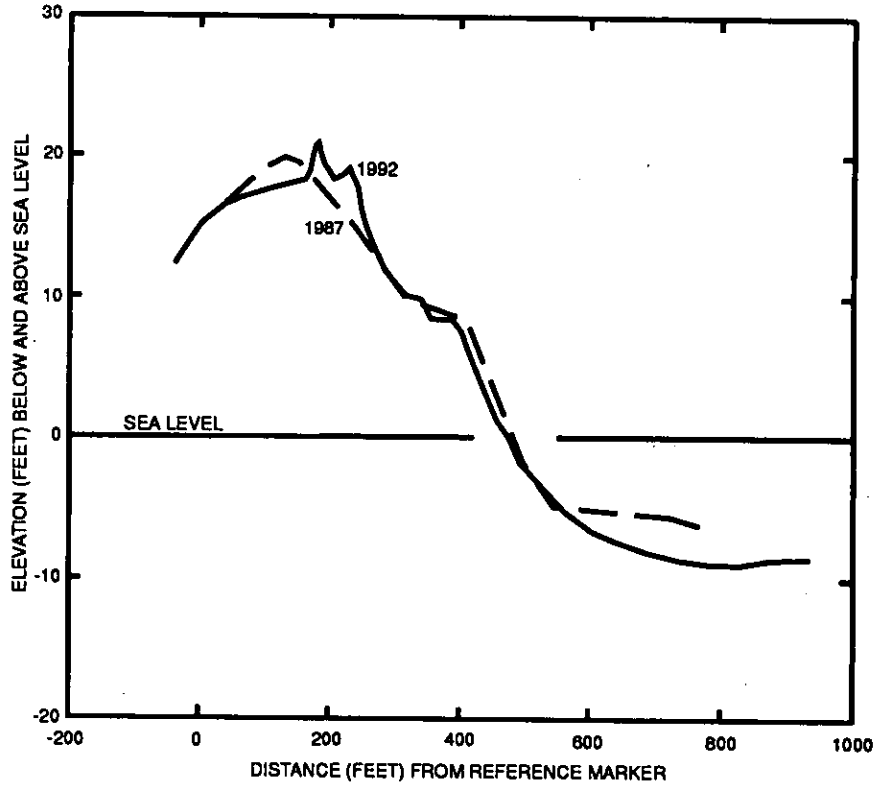
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 6, Profile 147
6th Lane, Midway Beach, Berkeley Township

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

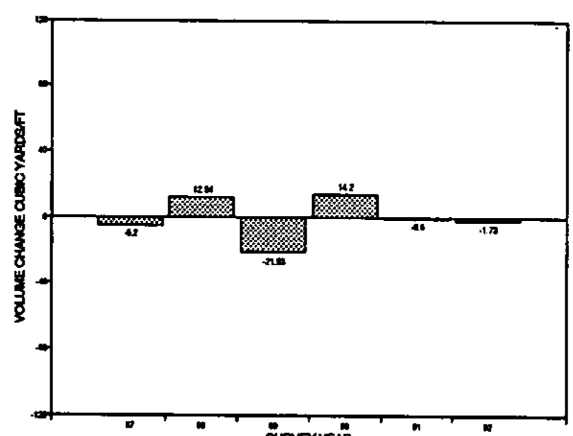


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	3.17	-8.37	-5.20
1988	5.64	6.70	12.34
1989	-15.74	-5.79	-21.53
1990	12.35	1.85	14.20
1991	0.24	-0.84	-0.60
1992	-4.93	3.20	-1.73
Approximate 6-yr. volume change			-2.52
Mean annual volume change			-0.42
Standard deviation			13.01

[1] Negative value denotes loss of sand

Graph 2

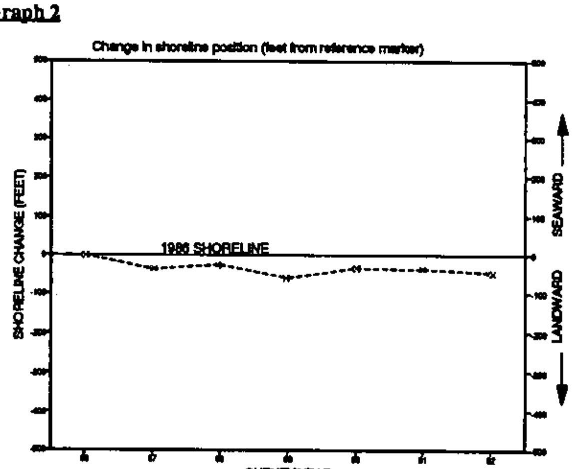


Table 2

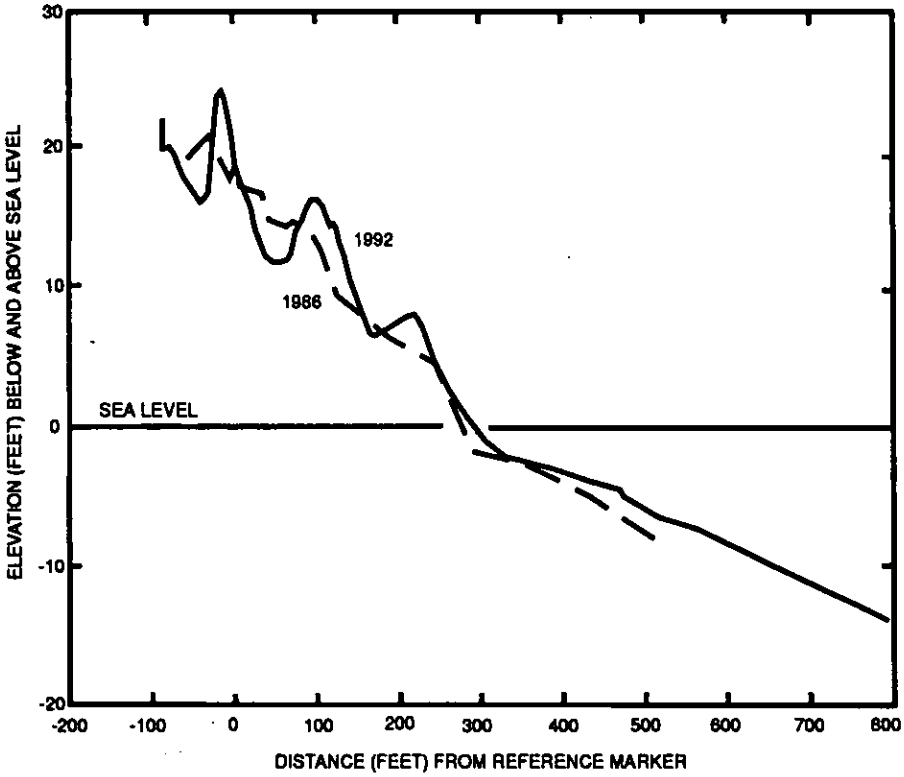
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/10	519.96	
1987	10/23	480.74	-39.22
1988	11/16	495.05	-24.91
1989	10/27	459.82	-60.14
1990	11/18	485.20	-34.76
1991	11/22	481.23	-38.73
1992	11/11	475.44	-44.52
Net shoreline change, 1986-1992 [3]			-44.52
Mean annual distance from ref. mkr., 1986-1992 [3]			485.35
Standard deviation			18.62

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 6, Profile 247
North Site, Island Beach State Park, Berkeley Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

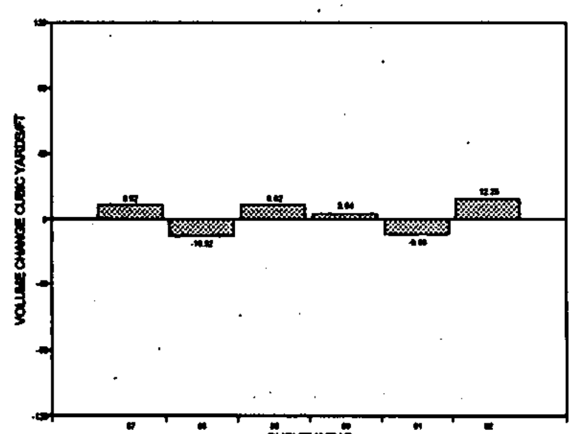


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	7.27	1.25	8.52
1988	-4.01	-6.31	-10.32
1989	3.45	5.17	8.62
1990	3.29	0.35	3.64
1991	-5.70	-3.96	-9.66
1992	8.04	4.21	12.25
Approximate 6-yr. volume change			13.05
Mean annual volume change			2.18
Standard deviation			10.41

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

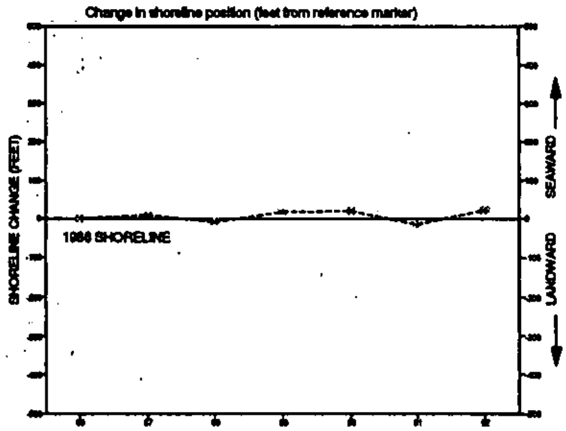


Table 2

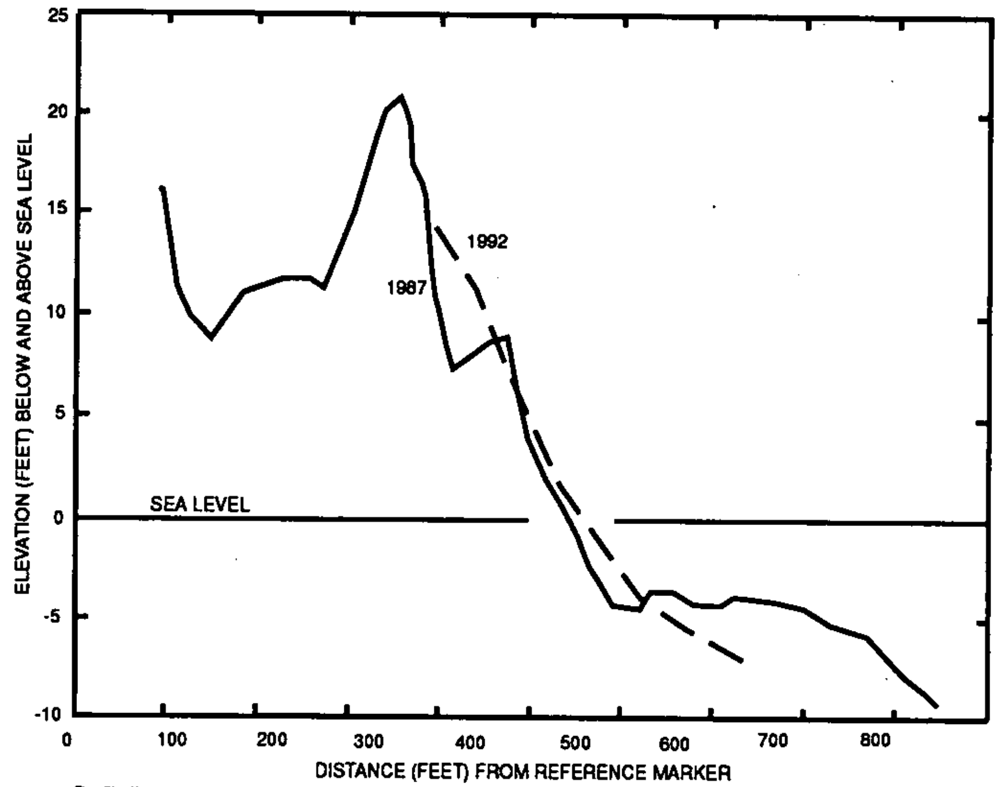
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/22	269.68	
1987	10/23	275.32	5.64
1988	11/09	259.34	-10.34
1989	10/25	285.38	15.70
1990	11/18	288.66	18.98
1991	11/20	255.00	-14.68
1992	11/11	291.87	22.19
Net shoreline change, 1986-1992 [3]			22.19
Mean annual distance from ref. mkr., 1986-1992 [3]			275.04
Standard deviation			14.45

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 6, Profile 246
Middle Site, Island Beach State Park, Berkeley Township

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

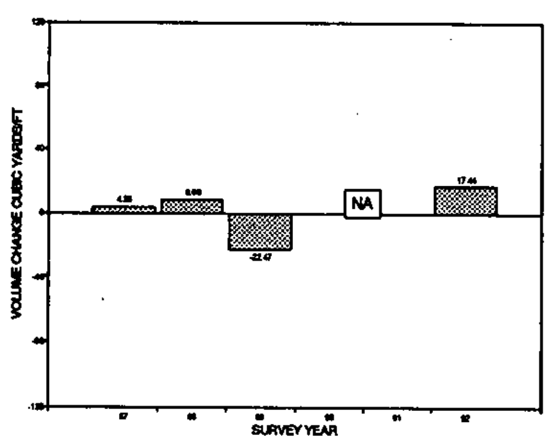


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	4.55	-0.17	4.38
1988	0.54	8.15	8.69
1989	-15.93	-6.54	-22.47
1990	NA	NA	
1991	NA	NA	
1992	3.45	13.99	17.44
Approximate 6-yr. volume change			8.04
Mean annual volume change			2.01
Standard deviation			17.20

[1] Negative value denotes loss of sand

Graph 2

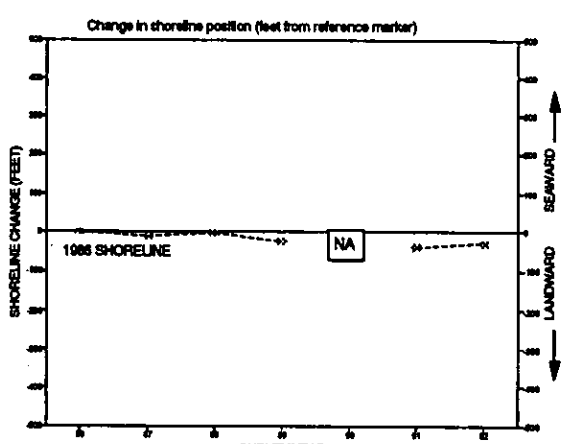


Table 2

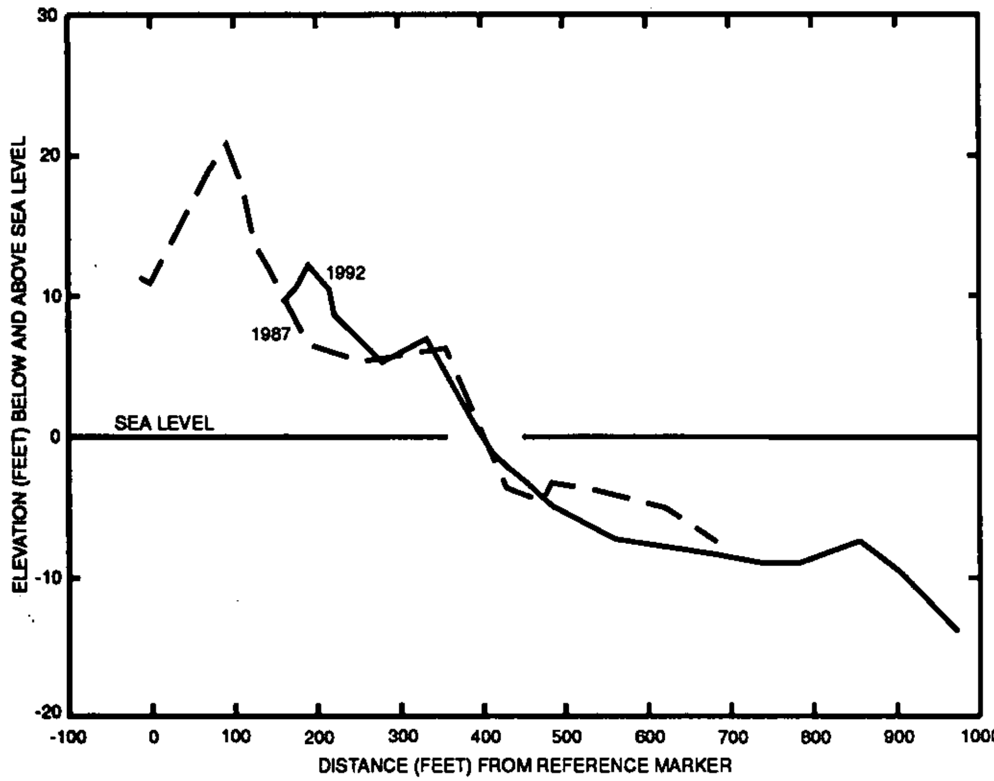
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/22	270.57	
1987	10/23	260.05	-10.52
1988	11/09	266.25	-4.32
1989	10/25	243.44	-27.13
1990	11/18	NA	NA
1991	11/20	229.70	-40.87
1992	11/11	240.90	-29.67
Net shoreline change, 1986-1992 [3]			-29.67
Mean annual distance from ref. mkr., 1986-1992 [3]			215.84
Standard deviation			96.31

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 6, Profile 146
South Site, Island Beach State Park, Berkeley Township

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

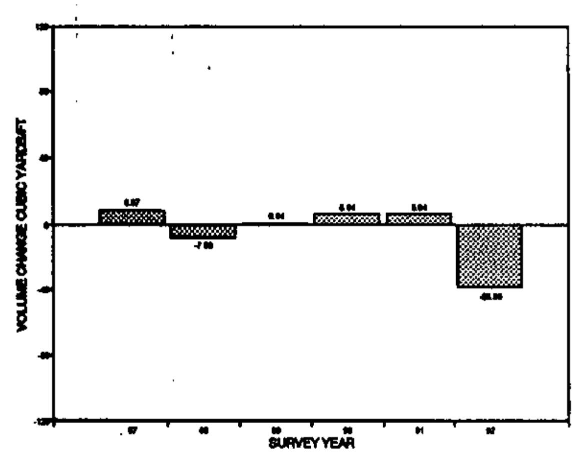


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	1.54	7.13	8.67
1988	-2.18	-5.41	-7.59
1989	4.22	-3.38	0.84
1990	-9.49	NA	-9.49
1991	14.21	-7.57	6.64
1992	-6.54	-32.32	-38.86
Approximate 6-yr. volume change			-23.66
Mean annual volume change			-3.94
Standard deviation			18.10

[1] Negative value denotes loss of sand

Graph 2

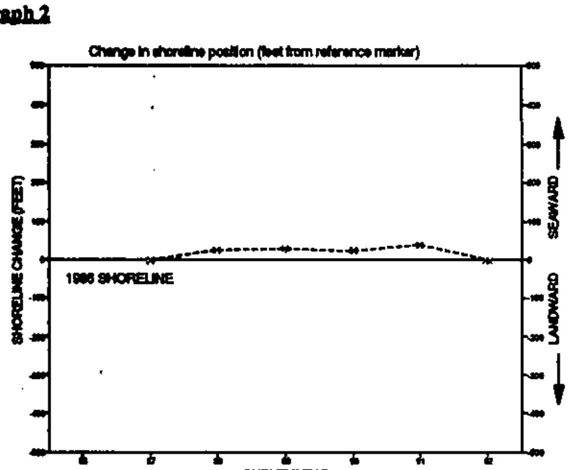


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	NA	NA	NA
1987	10/23	398.36	
1988	11/09	422.05	23.69
1989	10/25	427.68	29.32
1990	11/18	419.02	20.66
1991	11/20	437.43	39.07
1992	11/11	397.68	-0.68
Net shoreline change, 1986-1992 [3]			-0.68
Mean annual distance from ref. mkr., 1986-1992 [3]			357.46
Standard deviation			158.30

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

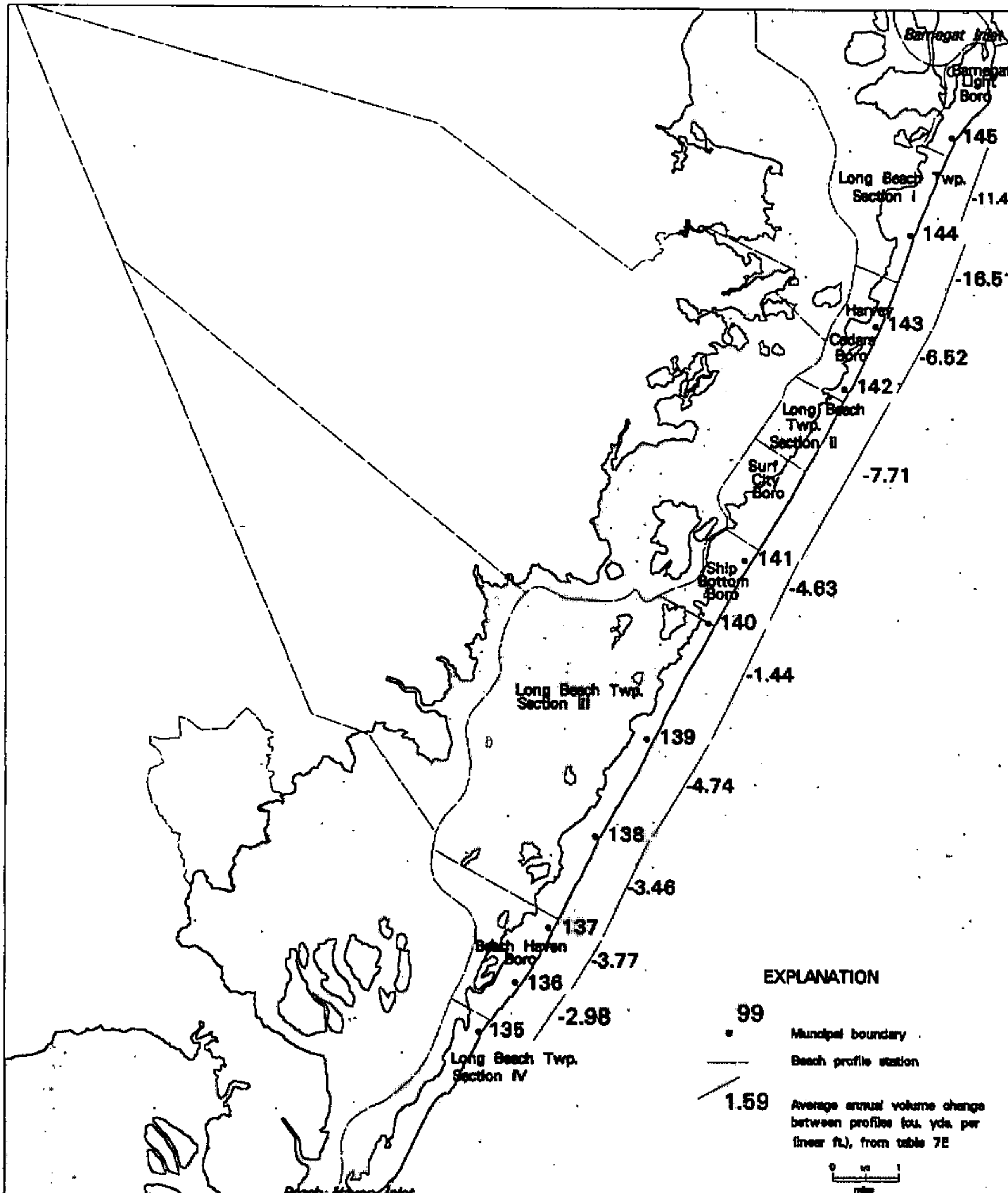


Figure 9. Map of Reach 7, Barnegat Inlet to Beach Haven Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Table 7A. Profile stations - Barnegat Inlet to Beach Haven Inlet (Long Beach Island), Ocean County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.)[2]	Site description 3
145	740646W	394433N	15.62	26th St., Barnegat Light Borough
144	740730W	394315N	21.09	Labain St., Long Beach Twp.
143	740807W	394202N	18.71	E. 73rd St., Harvey Cedars Borough
142	740840W	394112N	11.17	Greystone Ave., Harvey Cedars Borough
141	741026W	393855N	21.21	8th St., Ship Bottom Borough
140	741105W	393805N	17.74	32nd St., Long Beach Twp.
139	741210W	393632N	18.92	Massachusetts Ave., Long Beach Twp.
138	741305W	393514N	16.50	Ocean Ave., and Old Whaling Rd., Long Beach Twp.
137	741355W	393401N	19.14	Taylor Ave., Beach Haven Borough
136	741430W	393317N	15.19	Dolphin Ave. and Atlantic Ave., Beach Haven Borough
135	741509W	393238N	12.81	Webster Ave., Long Beach Twp.

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.

Table 7B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
Entire Reach	1993	Sand dune reconstruction at many locations following 12/92 storm. Some sand trucked in from mainland sources.	75,000	10,000
Barnegat Light Borough	1991	Southern inlet jetty redesigned to parallel northern jetty.		
	1992	Portion of dredged sand from Barnegat Inlet placed on beach.	75,000	NA
Long Beach Twp. (Section 1)	1992	Portion of dredged sand from Barnegat Inlet placed on beach.	175,000	NA
Harvey Cedars Borough		No activity noted.		
Long Beach Twp. (Section 2)		No activity noted.		
Surf City Borough		No activity noted.		
Ship Bottom Borough		No activity noted.		
Long Beach Twp. (Section 3)		No activity noted.		
Beach Haven Borough		No activity noted.		
Long Beach Twp. (Section 4)		Southern 1.6 miles are a natural area.		

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 7C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
135	417.92	330.33	366.86	31.23	20.62
136	295.32	207.59	252.61	30.03	-87.73
137	342.41	302.23	319.72	14.61	-24.5
138	315.43	272.03	295.58	15.97	-39.71
139	262.78	179.97	220.75	29.40	-27.14
140	376.36	334.36	351.68	15.56	-19.64
141	298.81	239.39	280.75	20.80	-50.74
142	513.56	427.11	456.60	29.19	-31.91
143	234.33	194.03	207.78	16.21	-30.66
144	237.35	220.87	231.88	5.79	-0.09
145	441.18	396.52	420.75	13.55	-26.17

[1] Data summarized from table 2 of Profiles 135-145.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 135-145.

Table 7D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
135	11.03	-15.66	0.21	9.57	1.27
136	5.79	-21.57	-6.17	10.47	-37.02
137	10.53	-15.09	-1.37	9.36	-8.21
138	5.98	-14.51	-5.55	7.62	-33.28
139	15.41	-33.06	-3.93	17.42	-23.58
140	14.79	-15.99	1.04	11.35	6.21
141	10.04	-66.24	-10.31	27.87	-61.87
142	27.83	-49.94	-5.11	29.48	-30.64
143	7.26	-33.37	-7.93	13.76	-47.55
144	10.81	-127.43	-25.09	50.95	-150.54
145	17.37	-7.95	2.28	11.79	13.69

[1] Data summarized from table 1 of Profiles 135-145.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 135-145.

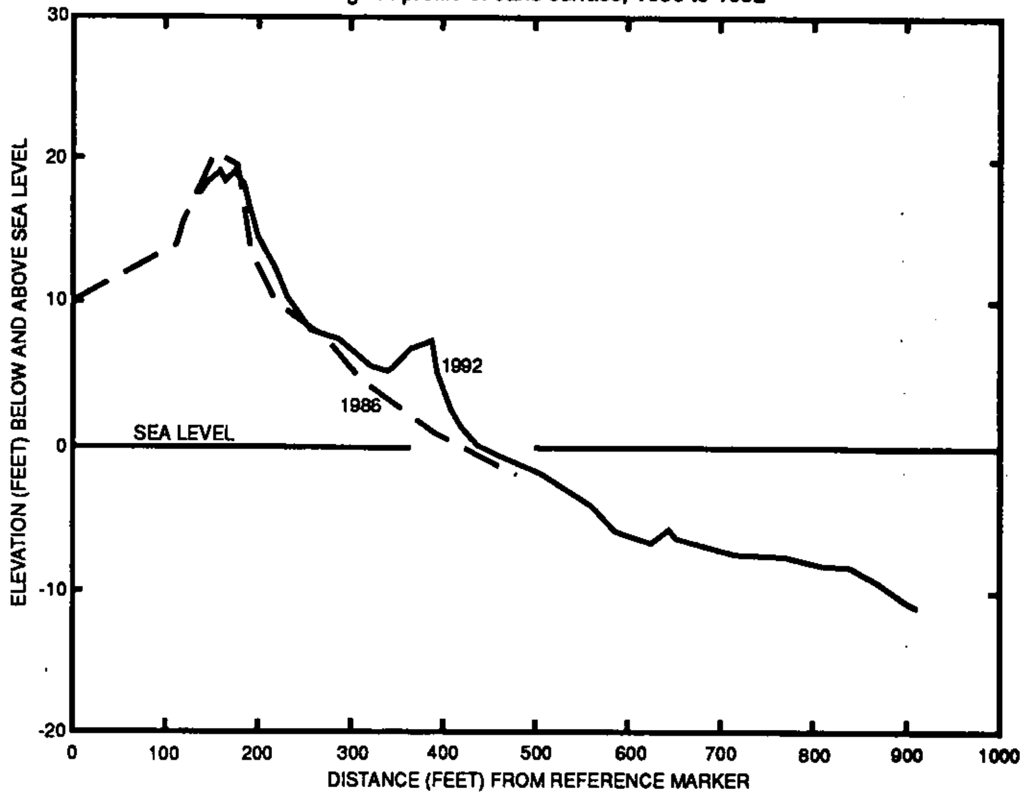
Table 7E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.)[2]	Projected volume change between profiles (cu. yds.)[3]	Hypothetical replenishment volume (cu. yds.)[4]
135-136	5,000	-2.98	-14,900	1,490
136-137	5,200	-3.77	-19,604	2,679
137-138	8,300	-3.46	-28,718	5,033
138-139	8,900	-4.74	-42,186	4,849
139-140	10,900	-1.44	-15,696	4,856
140-141	6,100	-4.63	-28,243	2,835
141-142	17,000	-7.71	-131,070	10,925
142-143	5,700	-6.52	-37,164	3,823
143-144	8,100	-16.51	-133,731	4,374
144-145	8,700	-11.40	-99,180	4,754

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 7, Profile 145
26th Street, Barnegat Light Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

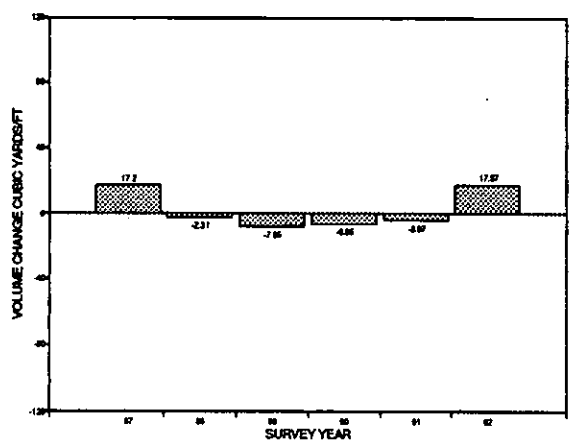


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]			
Year	Above mean sea level	Below mean sea level	Annual total
1987	17.73	-0.53	17.20
1988	2.41	-4.72	-2.31
1989	-9.72	1.77	-7.95
1990	6.07	-12.72	-6.65
1991	-6.34	2.37	-3.97
1992	6.52	10.85	17.37
Approximate 6-yr. volume change			13.69
Mean annual volume change			2.28
Standard deviation			11.79

[1] Negative value denotes loss of sand

Graph 2

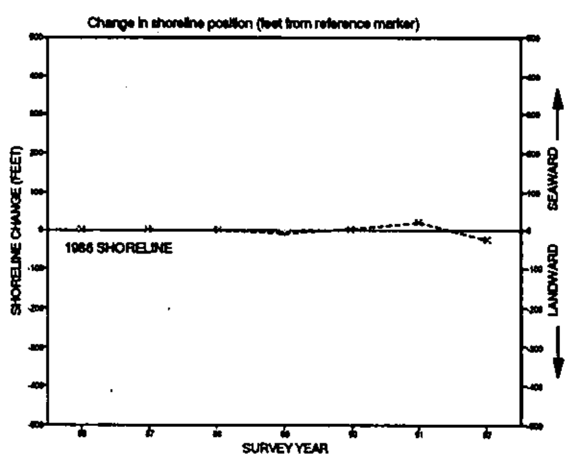


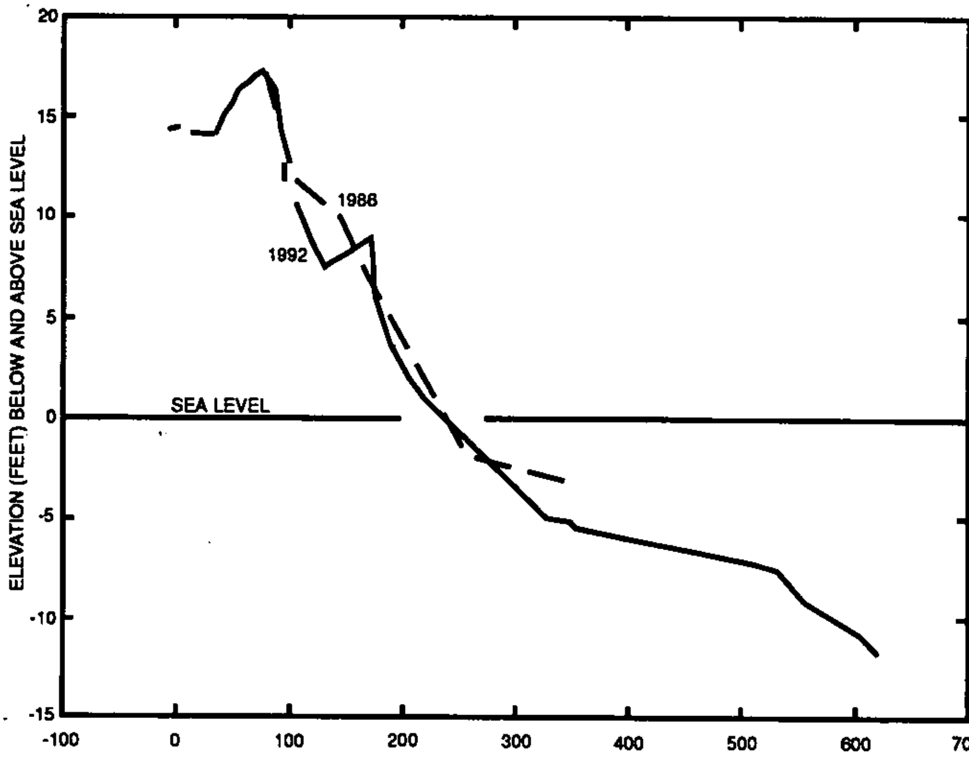
Table 2

SHORELINE CHANGE IN FEET			
Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/26	422.69	
1987	10/26	423.24	0.55
1988	11/08	422.17	-0.52
1989	11/01	413.25	-9.44
1990	11/12	426.20	3.51
1991	11/21	441.18	18.49
1992	11/20	396.52	-26.17
Net shoreline change, 1986-1992 [3]			-26.17
Mean annual distance from ref. mkr., 1986-1992 [3]			420.75
Standard deviation			13.55

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 144
Labaia Street, Long Beach Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

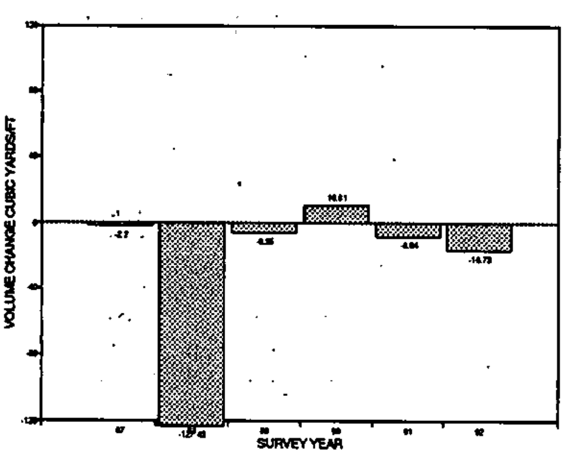


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-2.99	0.79	-2.20
1988	2.57	-130.00	-127.43
1989	2.10	-8.45	-6.35
1990	1.99	8.82	10.81
1991	-8.42	-0.22	-8.64
1992	-2.56	-14.17	-16.73
Approximate 6-yr. volume change			-150.54
Mean annual volume change			-25.09
Standard deviation			50.95

[1] Negative value denotes loss of sand

Graph 2

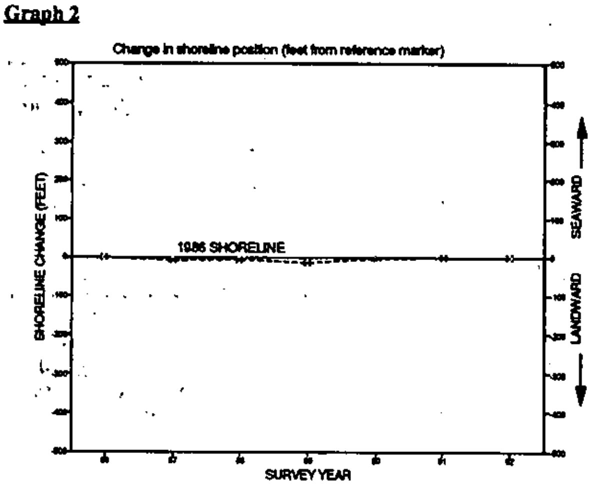


Table 2

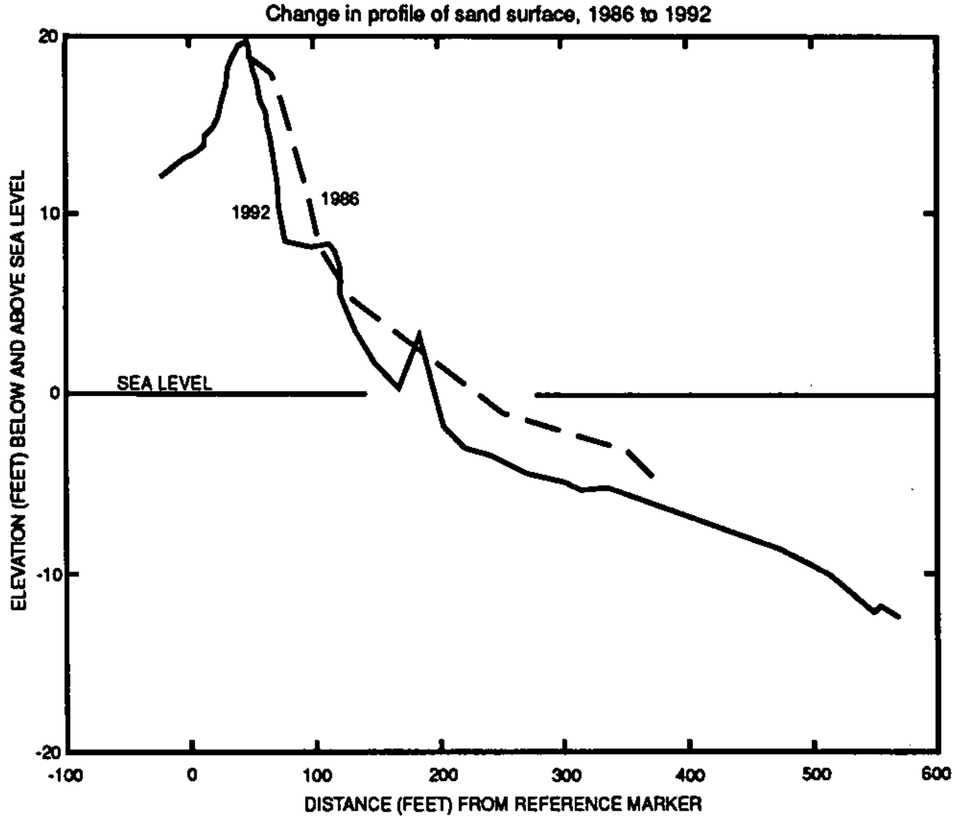
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/25	237.35	
1987	10/26	229.75	-7.60
1988	11/08	230.34	-7.01
1989	11/01	220.87	-16.48
1990	11/12	231.92	-5.43
1991	11/21	235.64	-1.71
1992	11/20	237.26	-0.09
Net shoreline change, 1986-1992 [3]			-0.09
Mean annual distance from ref. mkr., 1986-1992 [3]			231.88
Standard deviation			5.79

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 143
East 73rd Street, Harvey Cedars Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

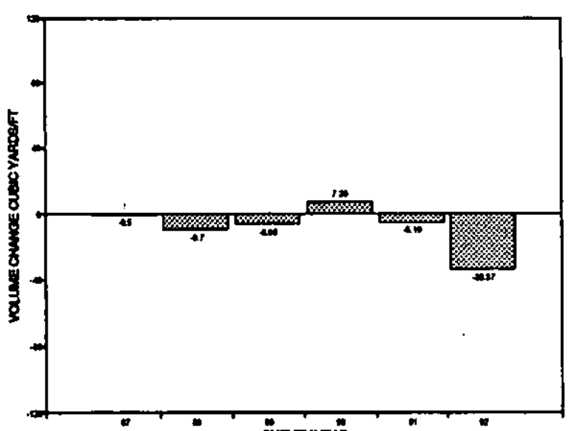


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	2.79	-3.29	-0.50
1988	-5.37	-4.33	-9.70
1989	-5.25	-0.80	-6.05
1990	3.99	3.27	7.26
1991	-8.52	3.33	-5.19
1992	-1.84	-31.53	-33.37
Approximate 6-yr. volume change			-47.55
Mean annual volume change			-7.93
Standard deviation			13.76

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

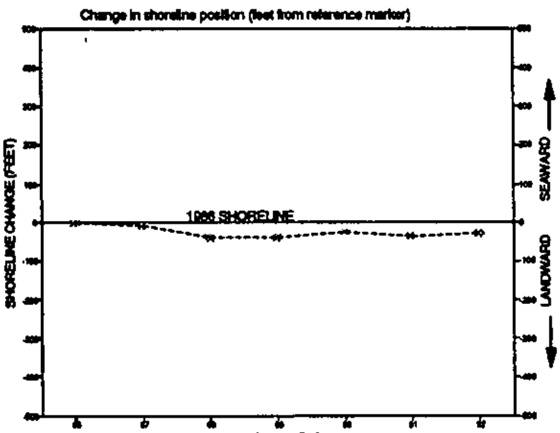


Table 2

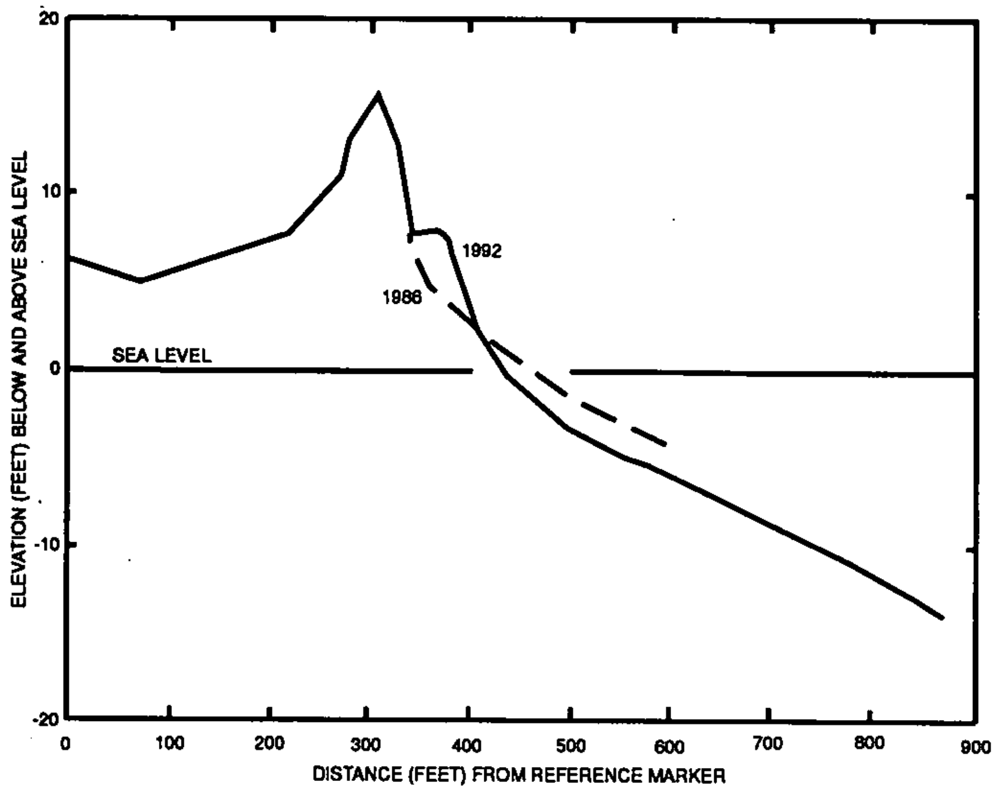
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/25	234.33	
1987	10/26	225.98	-8.35
1988	11/08	194.03	-40.30
1989	11/01	194.56	-39.77
1990	11/12	206.74	-27.59
1991	11/21	195.15	-39.18
1992	11/20	203.67	-30.66
Net shoreline change, 1986-1992 [3]			-30.66
Mean annual distance from ref. mkr., 1986-1992 [3]			207.78
Standard deviation			16.21

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 142
Greystone Avenue, Harvey Cedars Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

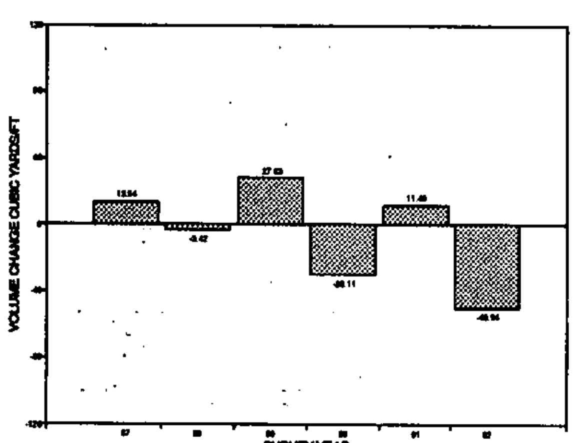


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	12.39	1.15	13.54
1988	-1.28	-2.14	-3.42
1989	16.14	11.69	27.83
1990	-13.63	-16.48	-30.11
1991	-2.32	13.78	11.46
1992	-11.05	-38.89	-49.94
Approximate 6-yr. volume change			-30.64
Mean annual volume change			-5.11
Standard deviation			29.48

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

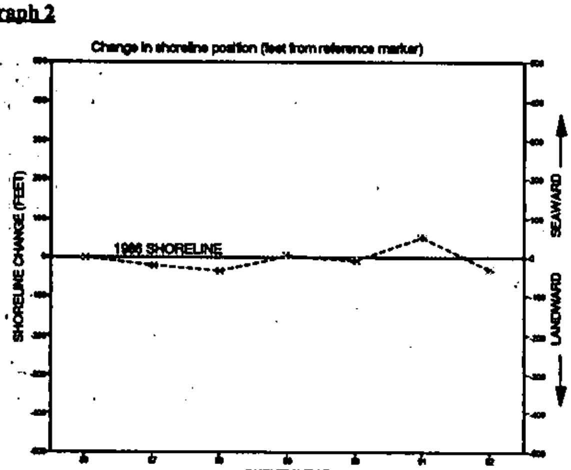


Table 2

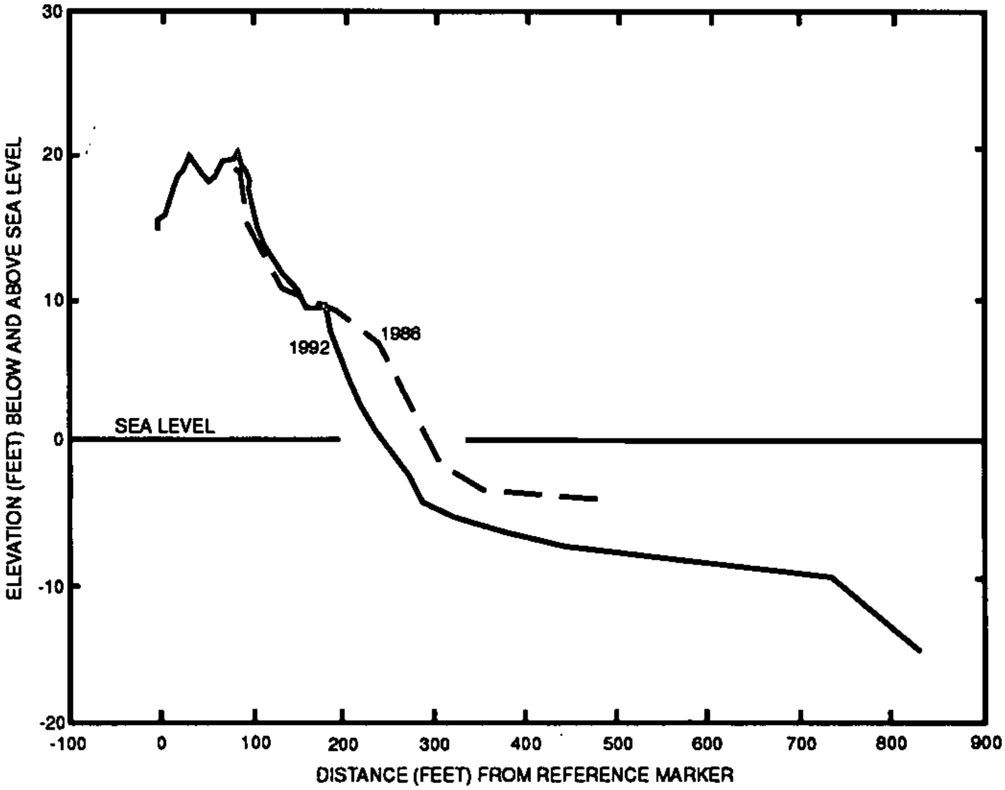
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/25	462.77	
1987	10/02	441.72	-21.05
1988	11/08	427.11	-35.66
1989	11/01	465.18	2.41
1990	11/12	454.99	-7.78
1991	11/21	513.56	50.79
1992	11/13	430.86	-31.91
Net shoreline change, 1986-1992 [3]			-31.91
Mean annual distance from ref. mkr., 1986-1992 [3]			456.60
Standard deviation			29.19

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 141
8th Street, Ship Bottom Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

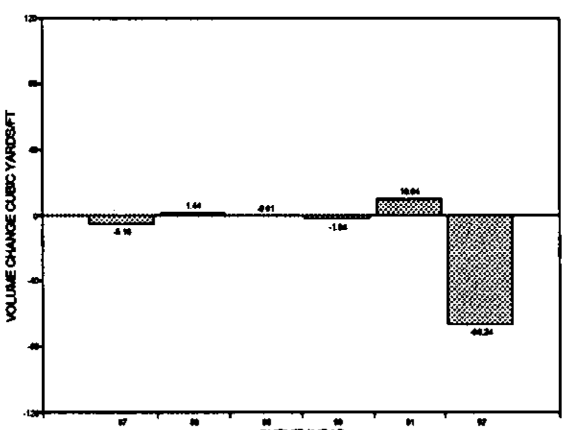


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-2.84	-2.32	-5.16
1988	-1.13	2.57	1.44
1989	-0.01	0.00	-0.01
1990	-1.94	0.00	-1.94
1991	6.63	3.41	10.04
1992	-15.56	-50.68	-66.24
Approximate 6-yr. volume change			-61.87
Mean annual volume change			-10.31
Standard deviation			27.87

[1] Negative value denotes loss of sand

Graph 2

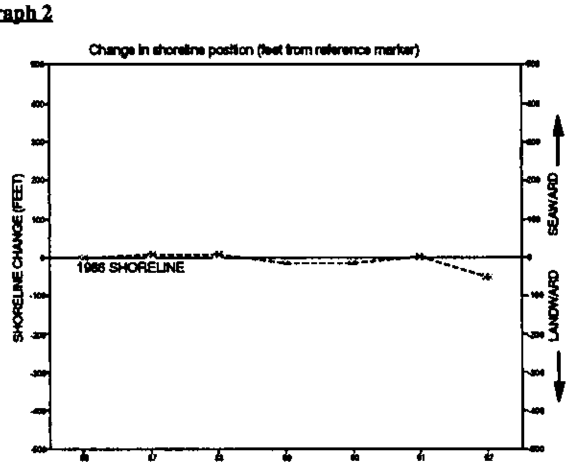


Table 2

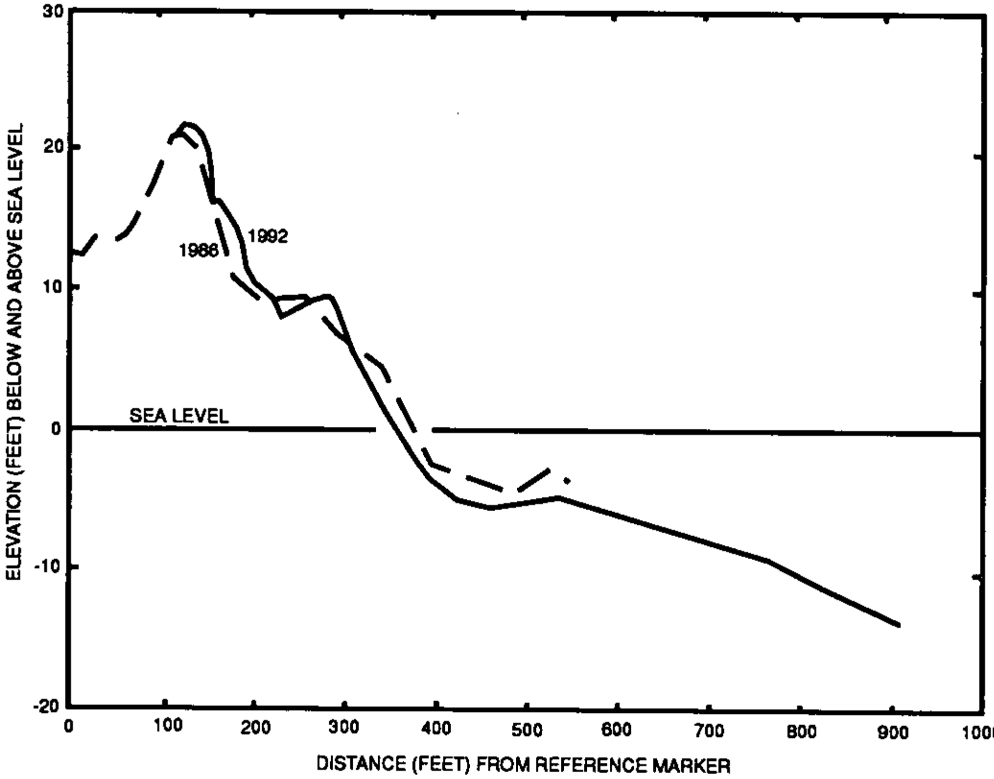
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/25	290.13	
1987	10/02	298.81	8.68
1988	11/08	297.12	6.99
1989	11/02	275.09	-15.04
1990	11/19	273.29	-16.84
1991	11/21	291.44	1.31
1992	11/13	239.39	-50.74
Net shoreline change, 1986-1992 [3]			-50.74
Mean annual distance from ref. mkr., 1986-1992 [3]			280.75
Standard deviation			20.80

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 140
32nd Street, Long Beach Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

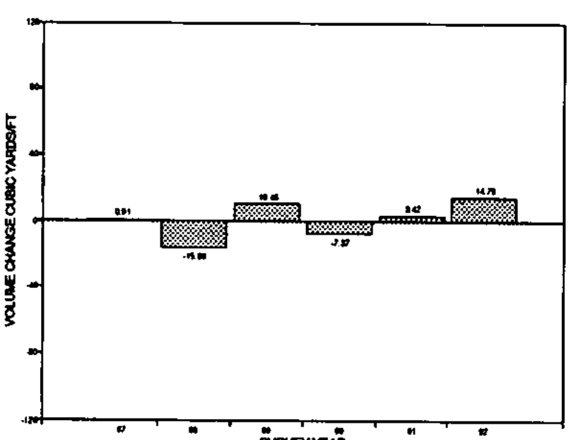


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	1.63	-0.72	0.91
1988	-10.85	-5.14	-15.99
1989	7.03	3.42	10.45
1990	-4.11	-3.26	-7.37
1991	4.55	-1.13	3.42
1992	2.98	11.81	14.79
Approximate 6-yr. volume change			6.21
Mean annual volume change			1.04
Standard deviation			11.35

[1] Negative value denotes loss of sand

Graph 2

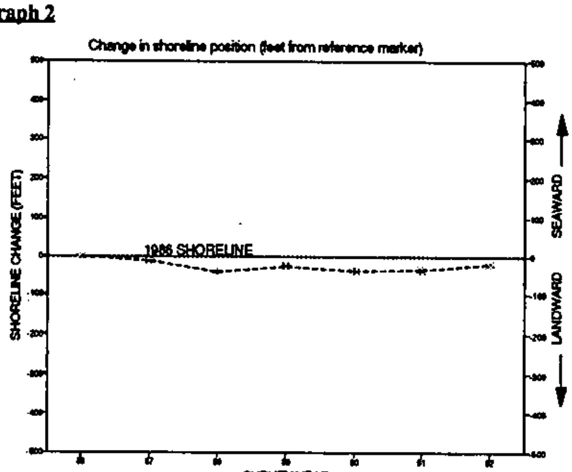


Table 2

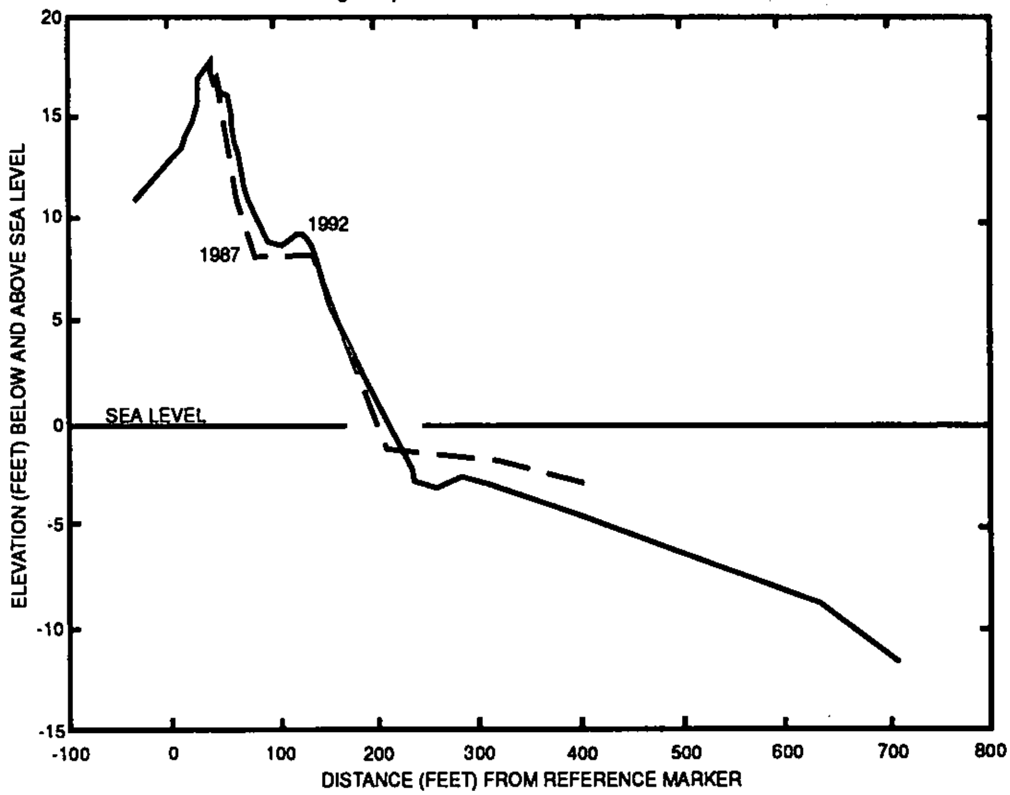
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/26	376.36	
1987	10/02	365.64	-10.72
1988	12/07	334.46	-41.90
1989	11/01	350.69	-25.67
1990	11/19	337.61	-38.75
1991	11/21	340.30	-36.06
1992	11/13	356.72	-19.64
Net shoreline change, 1986-1992 [3]			-19.64
Mean annual distance from ref. mkr., 1986-1992 [3]			351.68
Standard deviation			15.56

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 139
Massachusetts Avenue, Long Beach Township

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

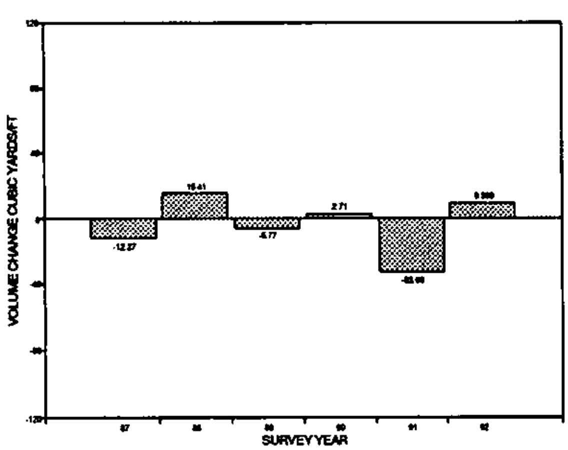


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-11.78	-0.49	-12.27
1988	17.69	-2.28	15.41
1989	-5.77	0.00	-5.77
1990	2.71	0.00	2.71
1991	-18.35	-14.71	-33.06
1992	9.46	-0.06	9.40
Approximate 6-yr. volume change			-23.58
Mean annual volume change			-3.93
Standard deviation			17.42

[1] Negative value denotes loss of sand

Graph 2

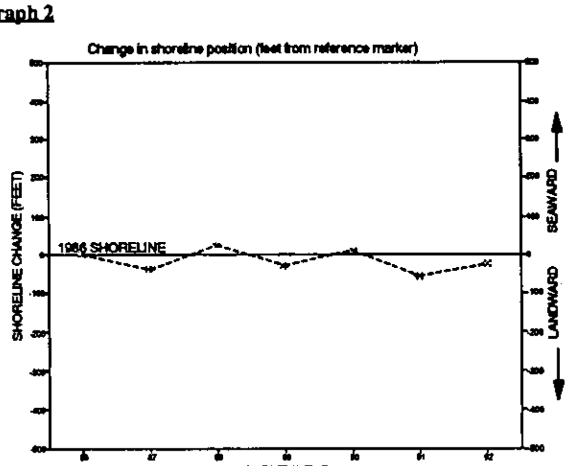


Table 2

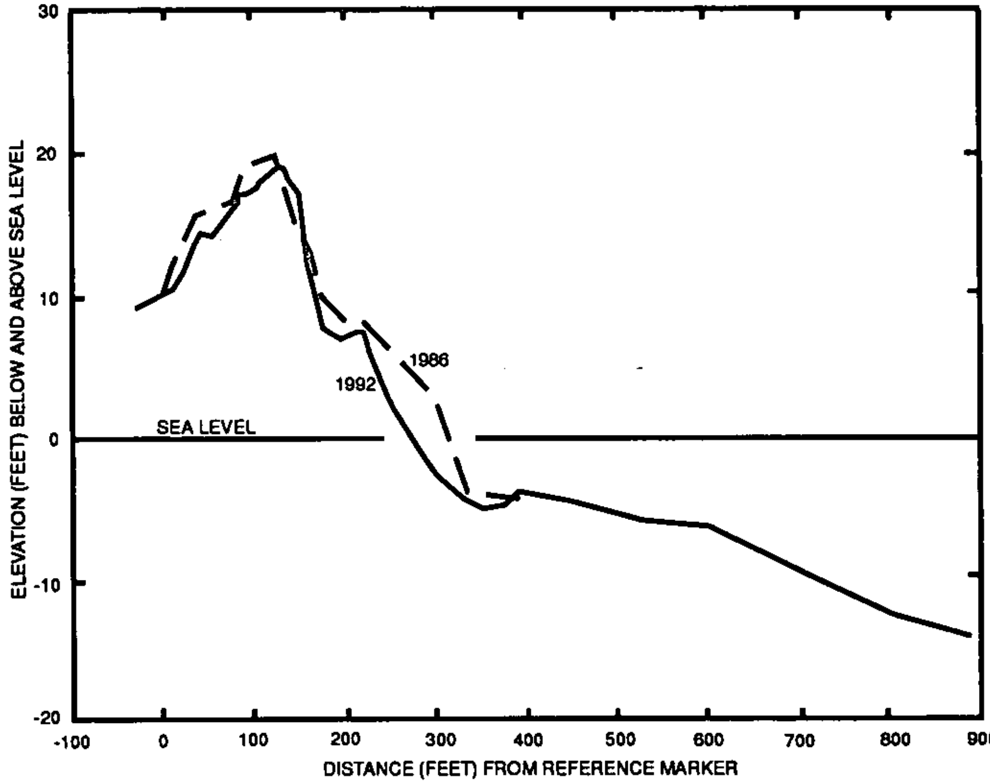
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/26	237.66	
1987	10/26	198.01	-39.65
1988	12/07	262.78	25.12
1989	11/02	208.90	-28.76
1990	11/19	247.39	9.73
1991	11/19	179.97	-57.69
1992	11/13	210.52	-27.14
Net shoreline change, 1986-1992 [3]			-27.14
Mean annual distance from ref. mkr., 1986-1992 [3]			220.75
Standard deviation			29.40

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 138
Ocean Avenue and Old Whaling Road, Long Beach Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

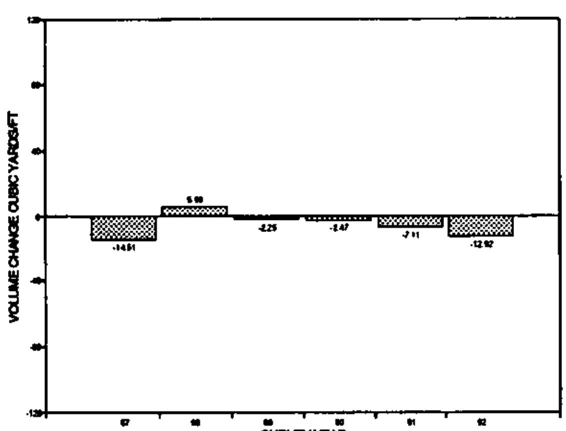


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-12.10	-2.41	-14.51
1988	3.84	2.14	5.98
1989	-0.65	-1.60	-2.25
1990	-0.88	-1.59	-2.47
1991	-4.98	-2.13	-7.11
1992	-4.24	-8.68	-12.92
Approximate 6-yr. volume change			-33.28
Mean annual volume change			-5.55
Standard deviation			7.62

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

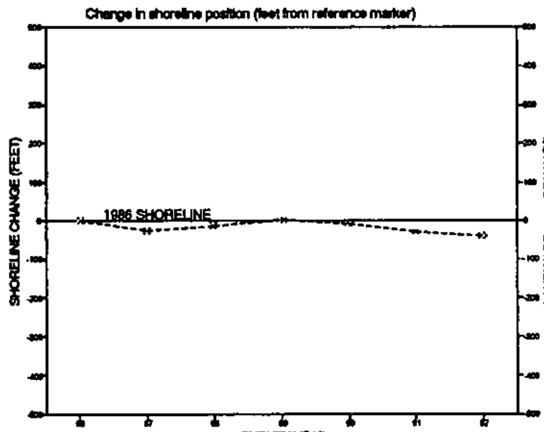


Table 2

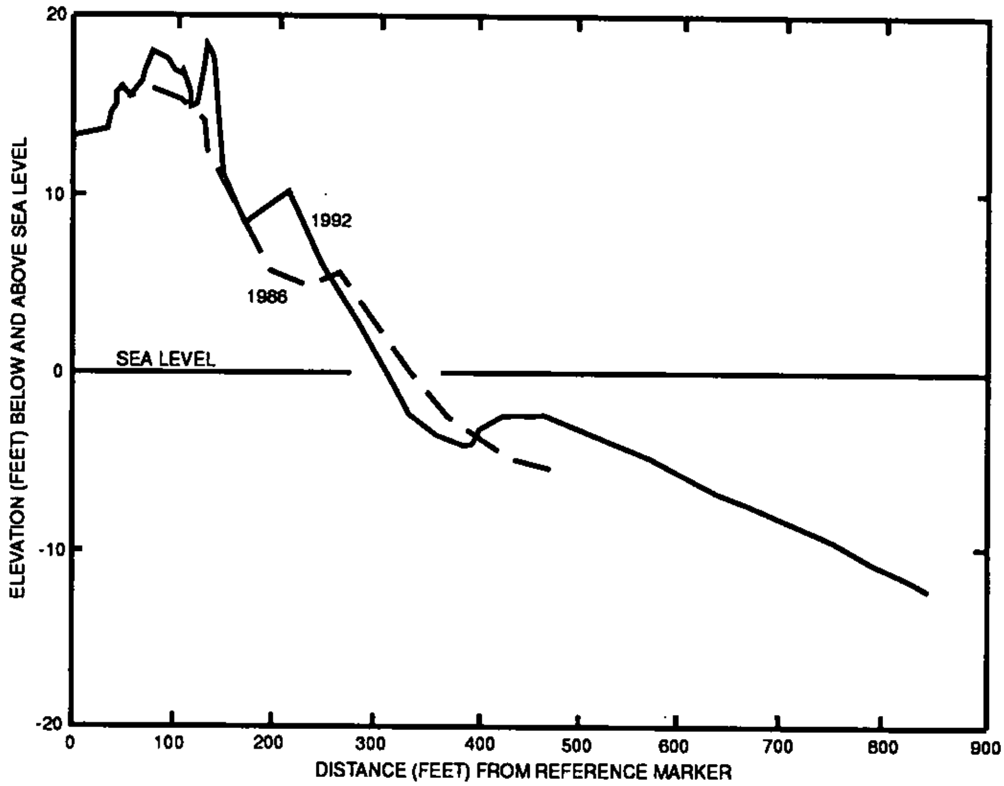
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/26	311.74	
1987	10/01	285.17	-26.57
1988	12/07	297.57	-14.17
1989	11/01	315.43	3.69
1990	11/15	303.54	-8.20
1991	11/19	283.56	-28.18
1992	11/12	272.03	-39.71
Net shoreline change, 1986-1992 [3]			-39.71
Mean annual distance from ref. mkr., 1986-1992 [3]			295.58
Standard deviation			15.97

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 137
Taylor Avenue, Beach Haven Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

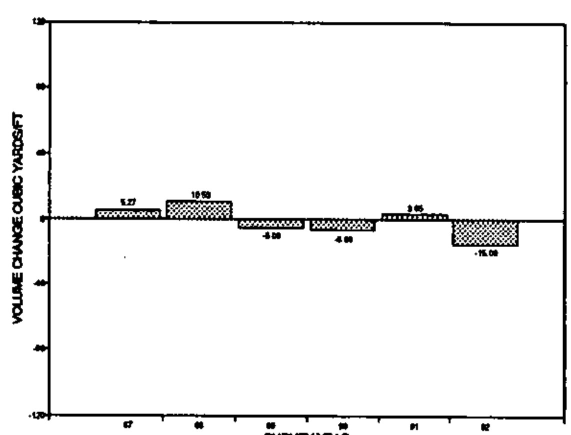


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	6.09	-0.82	5.27
1988	9.10	1.43	10.53
1989	-4.75	-0.34	-5.09
1990	-1.71	-5.17	-6.88
1992	0.49	2.56	3.05
1991	1.54	-16.63	-15.09
Approximate 6-yr. volume change			-8.21
Mean annual volume change			-1.37
Standard deviation			9.36

[1] Negative value denotes loss of sand

Graph 2

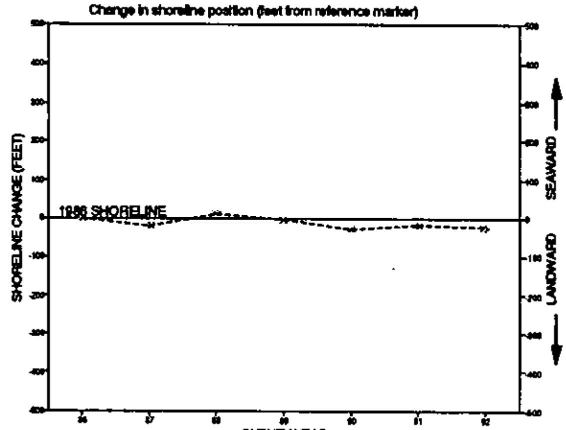


Table 2

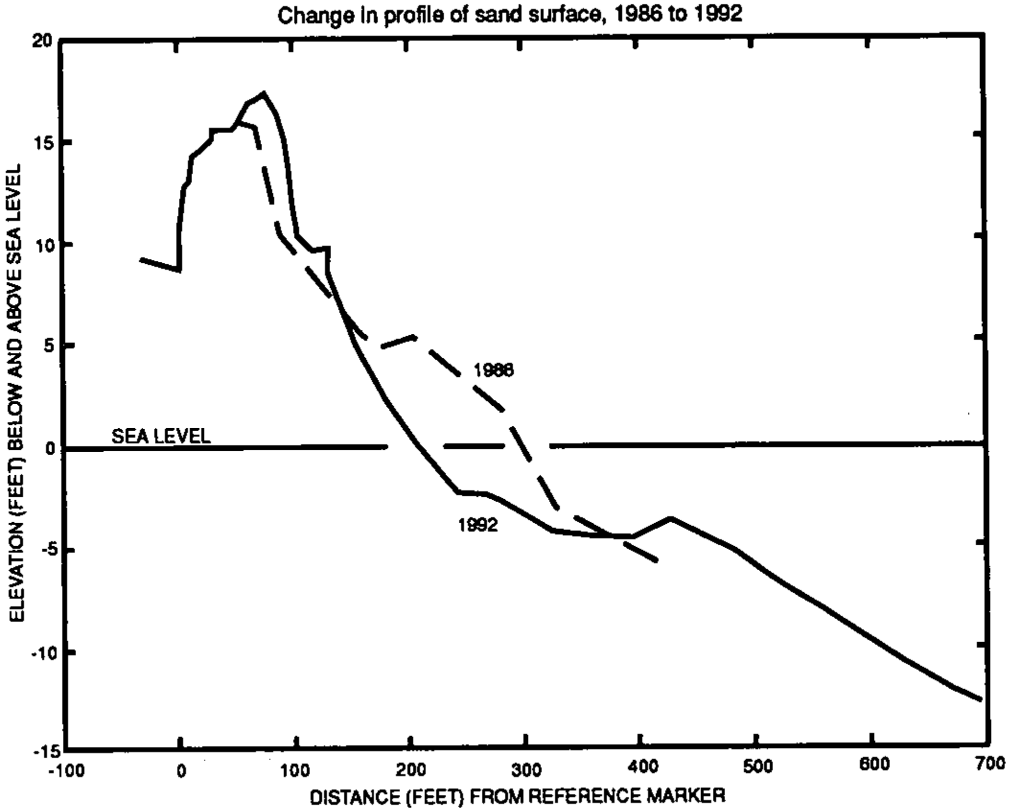
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/05	331.38	
1987	10/01	312.80	-18.58
1988	12/07	342.41	11.03
1989	11/02	328.46	-2.92
1990	11/15	302.23	-29.15
1991	11/19	313.88	-17.50
1992	11/12	306.88	-24.50
Net shoreline change, 1986-1992 [3]			-24.50
Mean annual distance from ref. mkr., 1986-1992 [3]			319.72
Standard deviation			14.61

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 136
Dolphin Avenue and Atlantic Avenue, Beach Haven Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

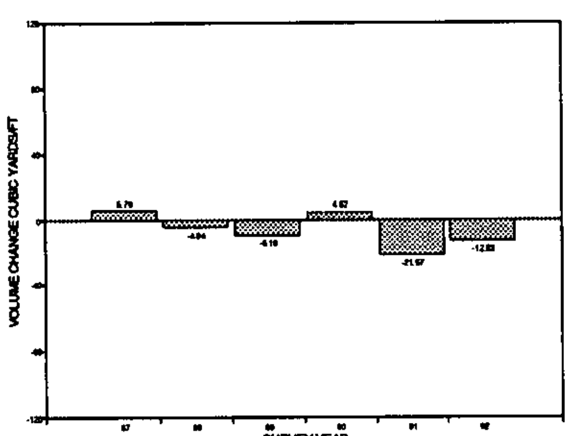


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	7.37	-1.58	5.79
1988	-4.91	0.87	-4.04
1989	-4.70	-4.49	-9.19
1990	1.50	3.02	4.52
1991	-8.70	-12.87	-21.57
1992	1.81	-14.34	-12.53
Approximate 6-yr. volume change			-37.02
Mean annual volume change			-6.17
Standard deviation			10.47

[1] Negative value denotes loss of sand

Graph 2

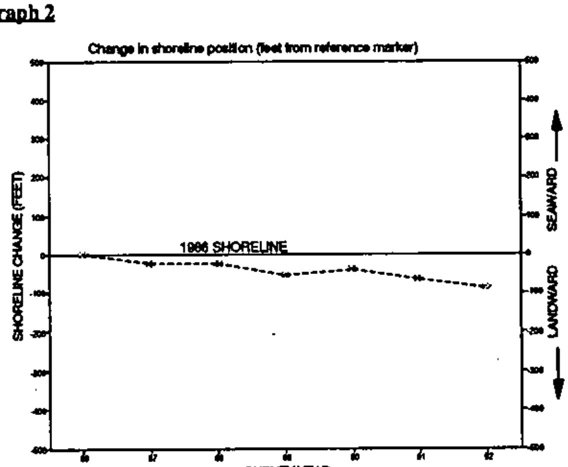


Table 2

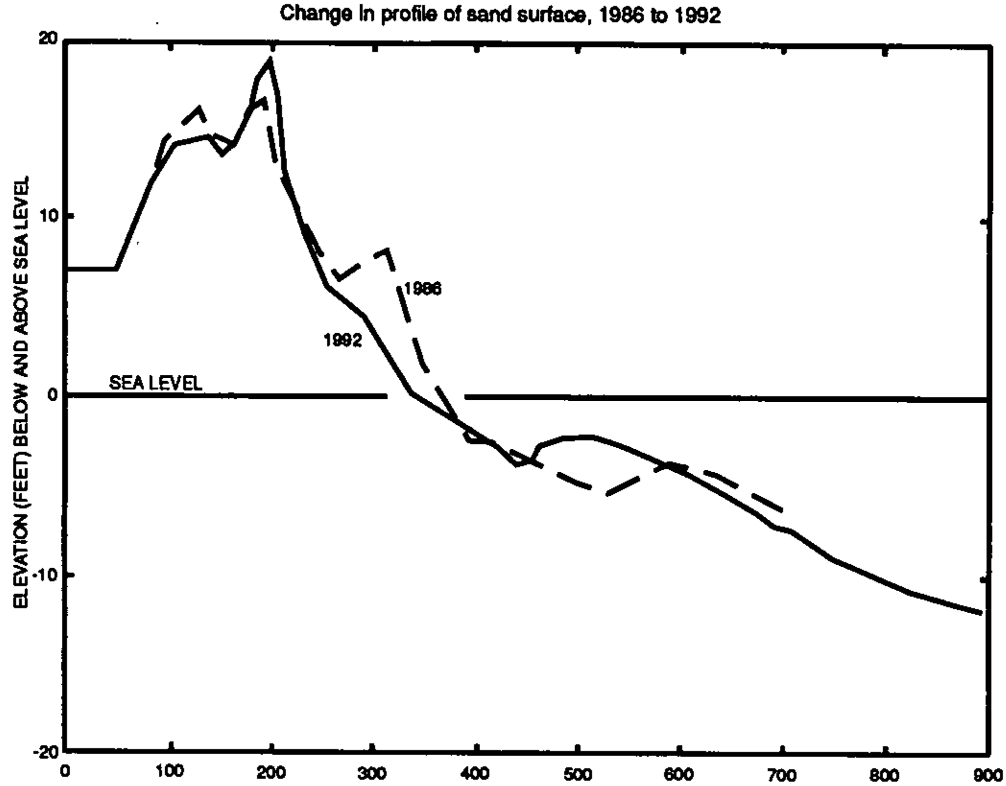
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	12/05	295.32	
1987	10/01	271.67	-23.65
1988	12/06	272.91	-22.41
1989	11/03	240.43	-54.89
1990	11/15	252.99	-42.33
1991	11/19	227.37	-67.95
1992	11/12	207.59	-87.73
Net shoreline change, 1986-1992 [3]			-87.73
Mean annual distance from ref. mkr., 1986-1992 [3]			252.61
Standard deviation			30.03

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 7, Profile 135
Webster Avenue, Long Beach Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

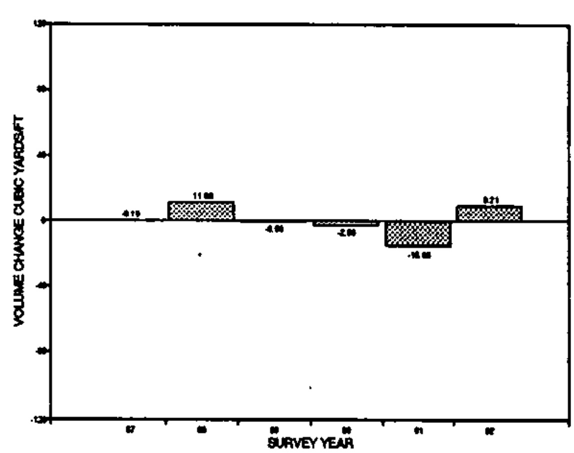


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-0.19	NA	-0.19
1988	11.03	NA	11.03
1989	4.07	-4.63	-0.56
1990	4.29	-6.85	-2.56
1991	-13.12	-2.54	-15.66
1992	6.51	2.70	9.21
Approximate 6-yr. volume change			1.27
Mean annual volume change			0.21
Standard deviation			9.57

[1] Negative value denotes loss of sand

Graph 2

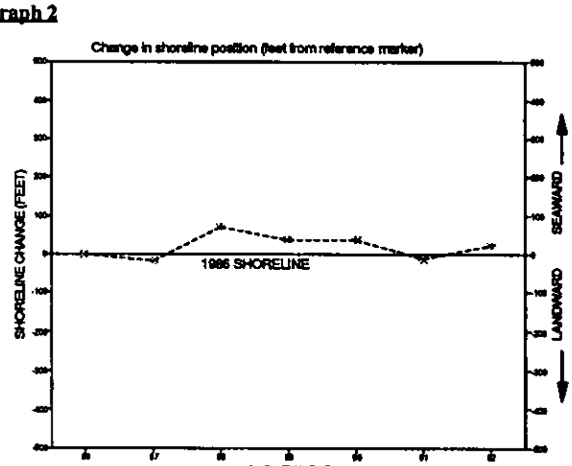


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/21	347.89	
1987	10/01	330.33	-17.56
1988	12/06	417.92	70.03
1989	11/03	382.87	34.98
1990	11/15	384.78	36.89
1991	11/19	335.70	-12.19
1992	11/12	368.51	20.62
Net shoreline change, 1986-1992 [3]			20.62
Mean annual distance from ref. mkr., 1986-1992 [3]			366.86
Standard deviation			31.23

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

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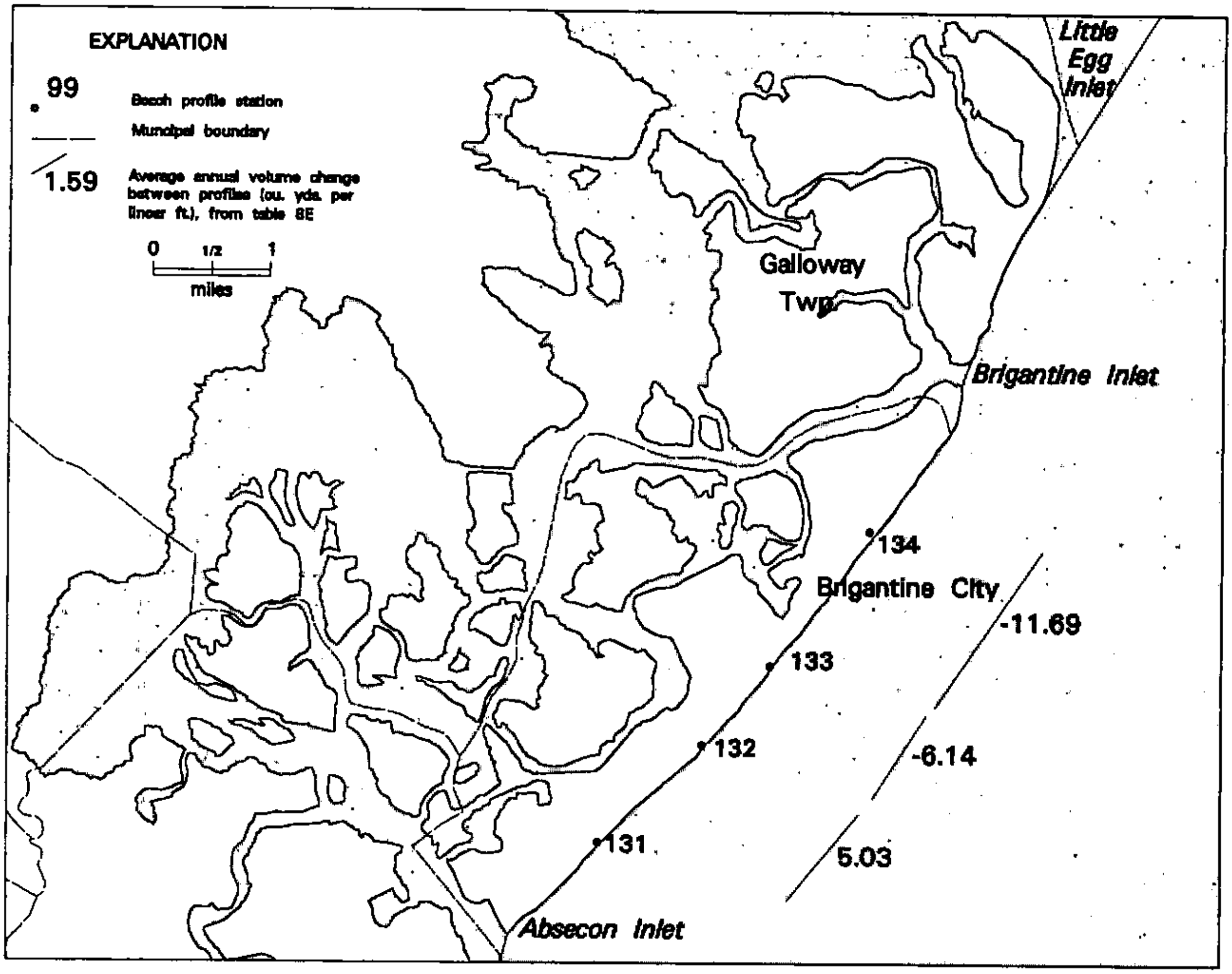


Figure 10. Map of Reach 8, Little Egg Inlet to Absecon Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Table 8A. Profile stations - Little Egg Inlet to Absecon Inlet (Pullen Island and Brigantine Island), Atlantic County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
134	742037W	392527N	10 (est.)[4]	Green Acres Tract, Brigantine City
133	742134W	392432N	18.89	N. 4th St., Brigantine City
132	742218W	392356N	9.82	S. 15th St., Brigantine City
131	742327W	392313N	16.67	S. 43rd St., Brigantine City

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.
[4] Estimated, not measured.

Table 8B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity
Galloway Twp.		Natural area with very active accretion and erosion taking place. No activity noted.
Brigantine City		Northern 2 miles of Brigantine Island are part of natural area. No activity noted.

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 8C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
131	1147.51	993.13	1092.60	54.49	146.21
132	320.70	215.30	245.18	38.73	-57.75
133	455.91	299.90	367.43	62.24	-156.01
134	404.24	213.68	229.25	166.42	-190.56

[1] Data summarized from table 2 of Profiles 131-134.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 131-134.

Table 8D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
131	31.15	-23.24	11.48	19.58	68.89
132	16.18	-17.35	-1.42	14.57	-8.49
133	3.65	-36.13	-10.86	17.64	-65.17
134	11.32	-70.12	-12.53	29.85	-75.15

[1] Data summarized from table 1 of Profiles 131-134.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 131-134.

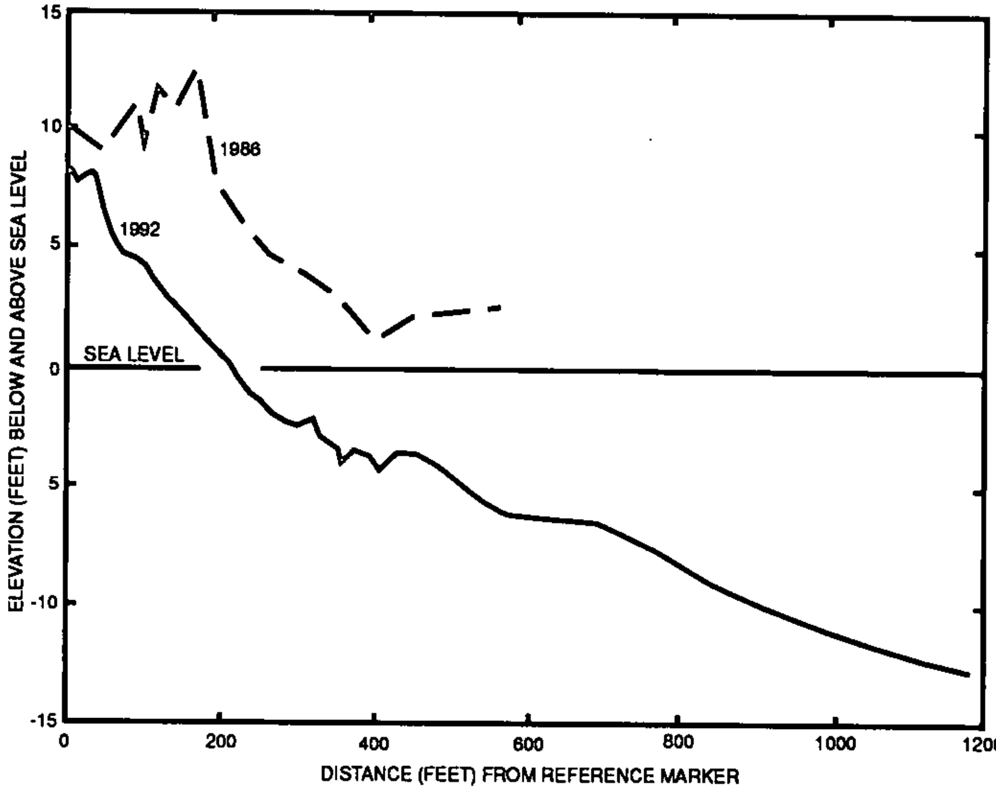
Table 8E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
131-132	7,000	5.03	35,210	4,748
132-133	5,200	-6.14	-31,928	3,406
133-134	7,000	-11.69	-81,865	3,129

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 8, Profile 134
Green Acres Tract, Brigantine City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

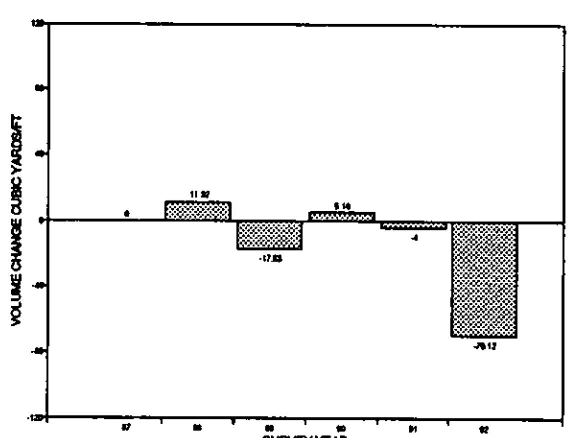


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1988	9.38	1.94	11.32
1989	-17.53	0.00	-17.53
1990	5.77	-0.59	5.18
1991	-1.61	-2.39	-4.00
1992	-35.82	-34.30	-70.12
Approximate 6-yr. volume change			-75.15
Mean annual volume change			-12.53
Standard deviation			29.85

[1] Negative value denotes loss of sand

Graph 2

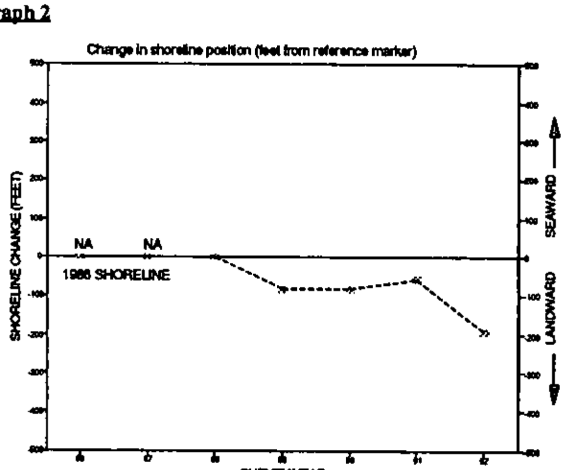


Table 2

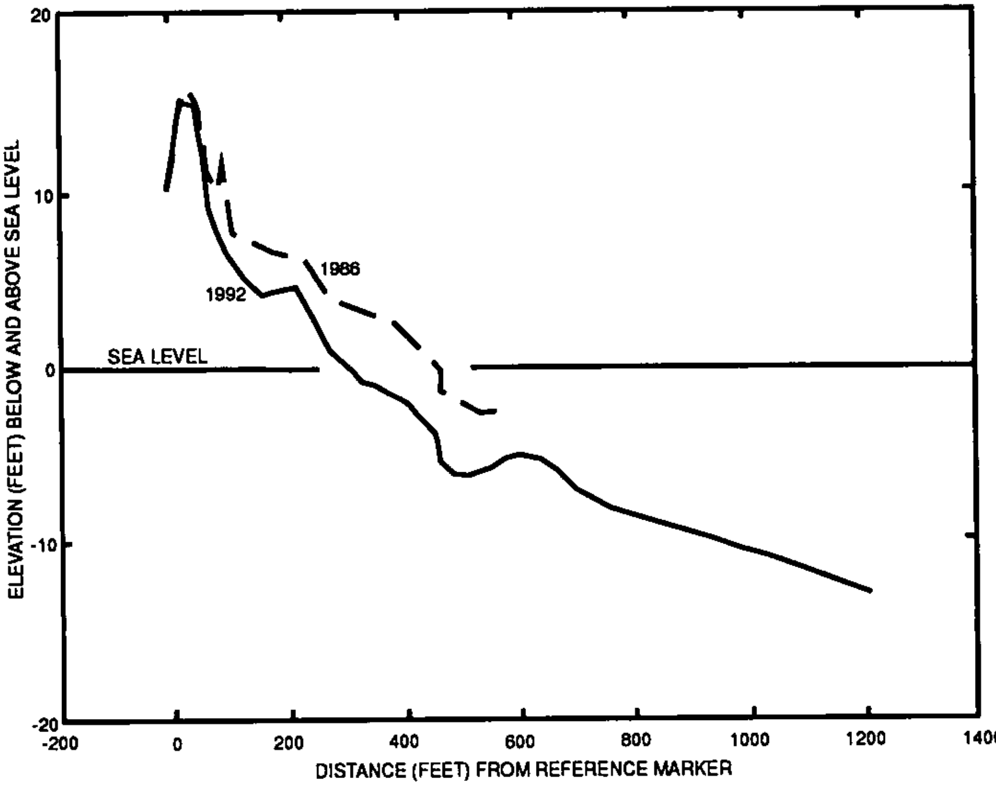
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1988	09/29	404.24	
1989	10/23	320.83	-83.41
1990	10/22	320.85	-83.39
1991	10/18	345.14	-59.1
1992	11/06	213.68	-190.56
Net shoreline change, 1988-1992 [3]			-190.56
Mean annual distance from ref. mkr., 1986-1992 [3]			229.25
Standard deviation			166.42

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 8, Profile 133
North 4th Street, Brigantine City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

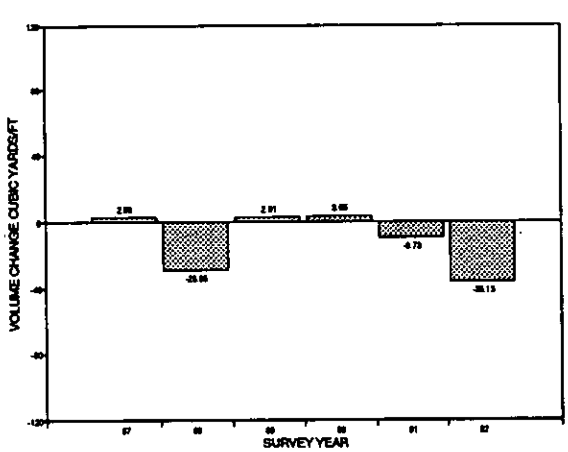


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	0.86	2.12	2.98
1988	-14.46	-14.39	-28.85
1989	1.96	0.95	2.91
1990	5.23	-1.58	3.65
1991	-4.78	-4.95	-9.73
1992	-22.78	-13.35	-36.13
Approximate 6-yr. volume change			-65.17
Mean annual volume change			-10.86
Standard deviation			17.64

[1] Negative value denotes loss of sand

Graph 2

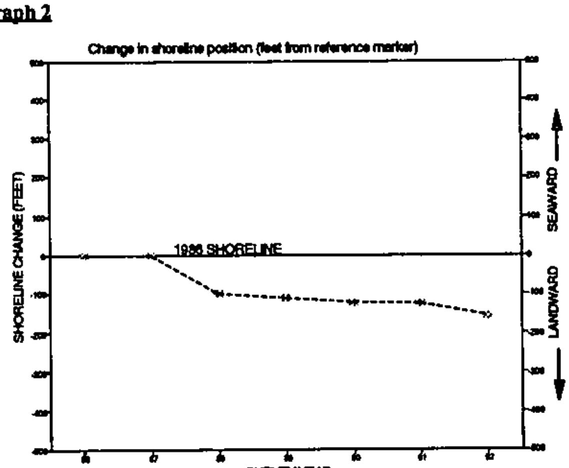


Table 2

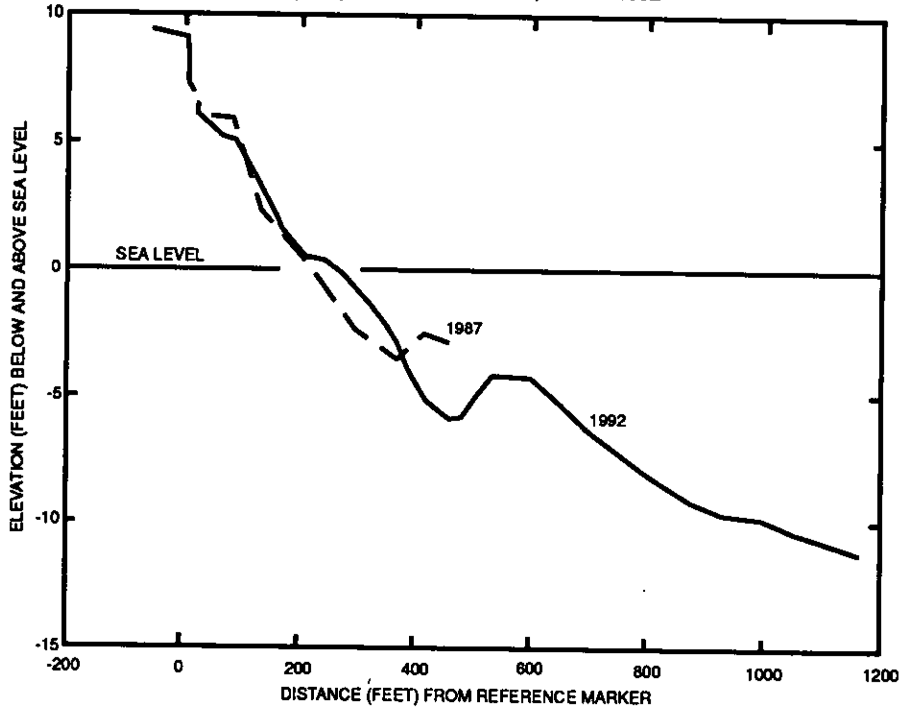
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/21	455.91	
1987	10/03	454.29	-1.62
1988	09/29	355.18	-100.73
1989	10/23	344.04	-111.87
1990	10/22	333.40	-122.51
1991	10/18	329.26	-126.65
1992	11/06	299.90	-156.01
Net shoreline change, 1986-1992 [3]			-156.01
Mean annual distance from ref. mkr., 1986-1992 [3]			367.43
Standard deviation			62.24

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 8, Profile 132
South 15th Street, Brigantine City

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

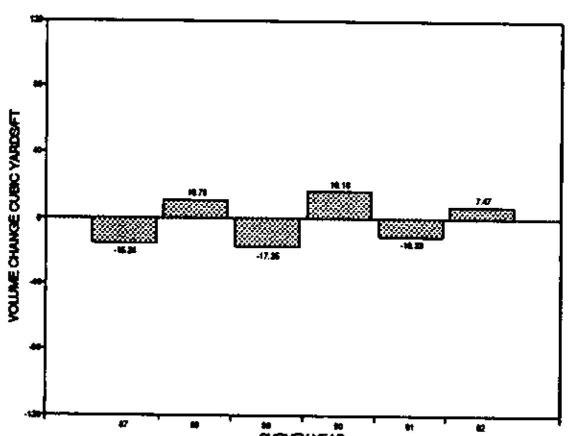


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-15.24	NA	-15.24
1988	4.14	6.64	10.78
1989	-10.71	-6.64	-17.35
1990	6.82	9.36	16.18
1991	-0.70	-9.63	-10.33
1992	1.50	5.97	7.47
Approximate 6-yr. volume change			-8.49
Mean annual volume change			-1.42
Standard deviation			14.57

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

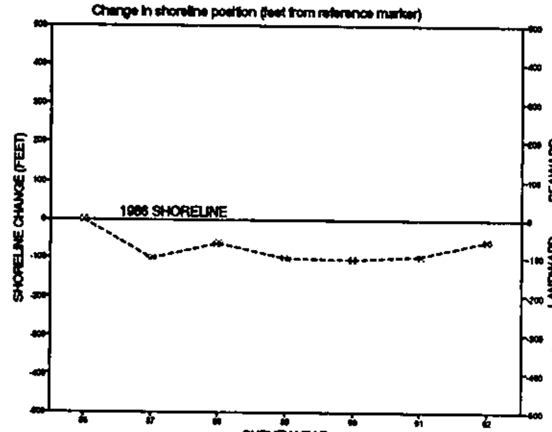


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/09	320.70	
1987	10/27	217.11	-103.59
1988	09/29	257.52	-63.18
1989	10/23	218.76	-101.94
1990	10/22	215.30	-105.40
1991	10/18	223.91	-96.79
1992	11/06	262.95	-57.75
Net shoreline change, 1986-1992 [3]			-57.75
Mean annual distance from ref. mkr., 1986-1992 [3]			245.18
Standard deviation			38.73

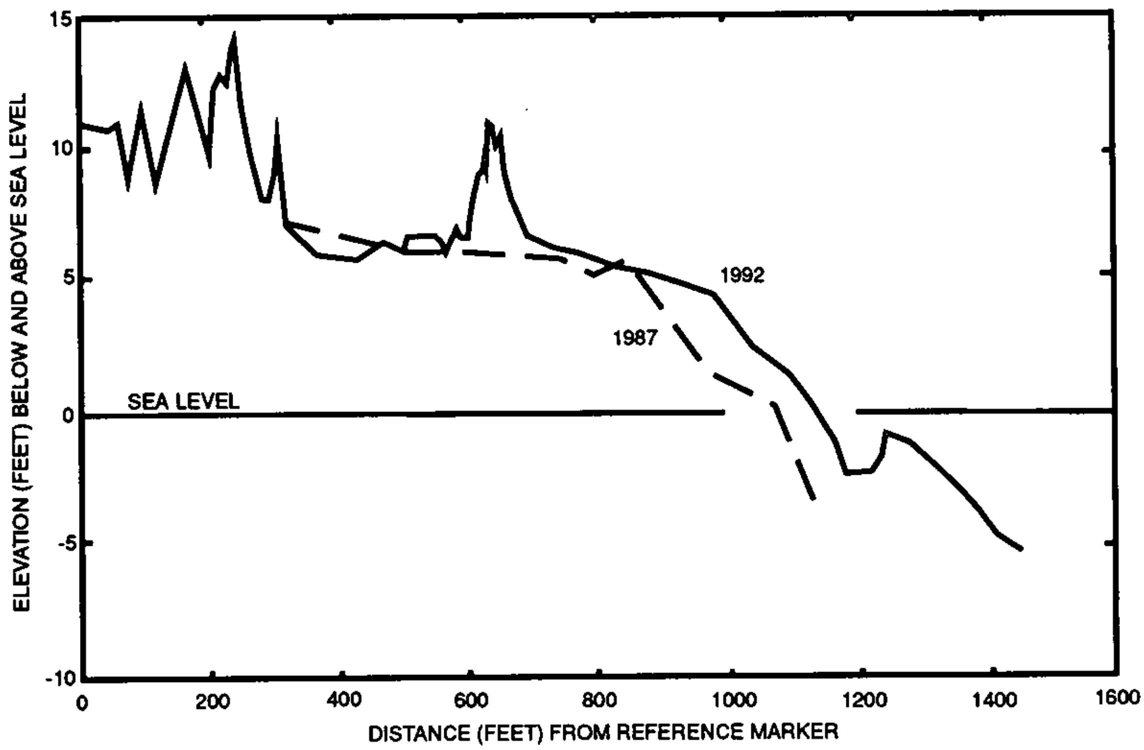
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 8, Profile 131
South 43rd Street, Brigantine City

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

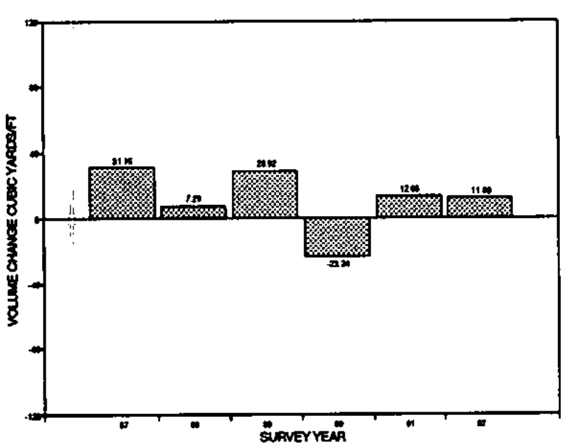


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	31.15	0.00	31.15
1988	5.77	1.52	7.29
1989	25.77	3.15	28.92
1990	-18.33	-4.91	-23.24
1991	7.35	5.53	12.88
1992	8.47	3.42	11.89
Approximate 6-yr. volume change			68.89
Mean annual volume change			11.48
Standard deviation			19.58

[1] Negative value denotes loss of sand

Graph 2

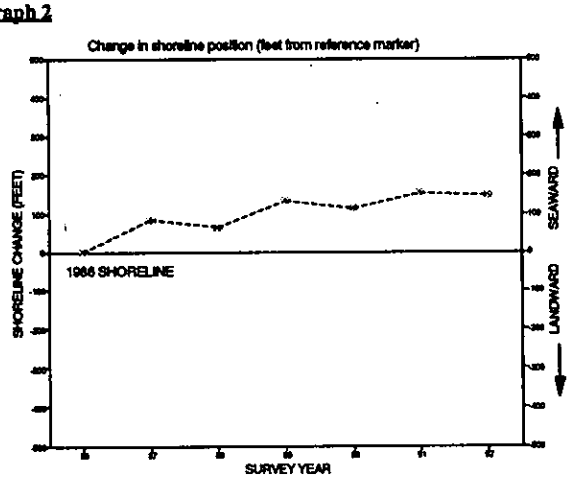


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/09	993.13	
1987	10/27	1078.80	85.67
1988	09/29	1057.47	64.34
1989	10/23	1126.01	132.88
1990	10/22	1105.94	112.81
1991	10/18	1147.51	154.38
1992	11/06	1139.34	146.21
Net shoreline change, 1986-1992 [3]			146.21
Mean annual distance from ref. mkr., 1986-1992 [3]			1092.60
Standard deviation			54.49

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

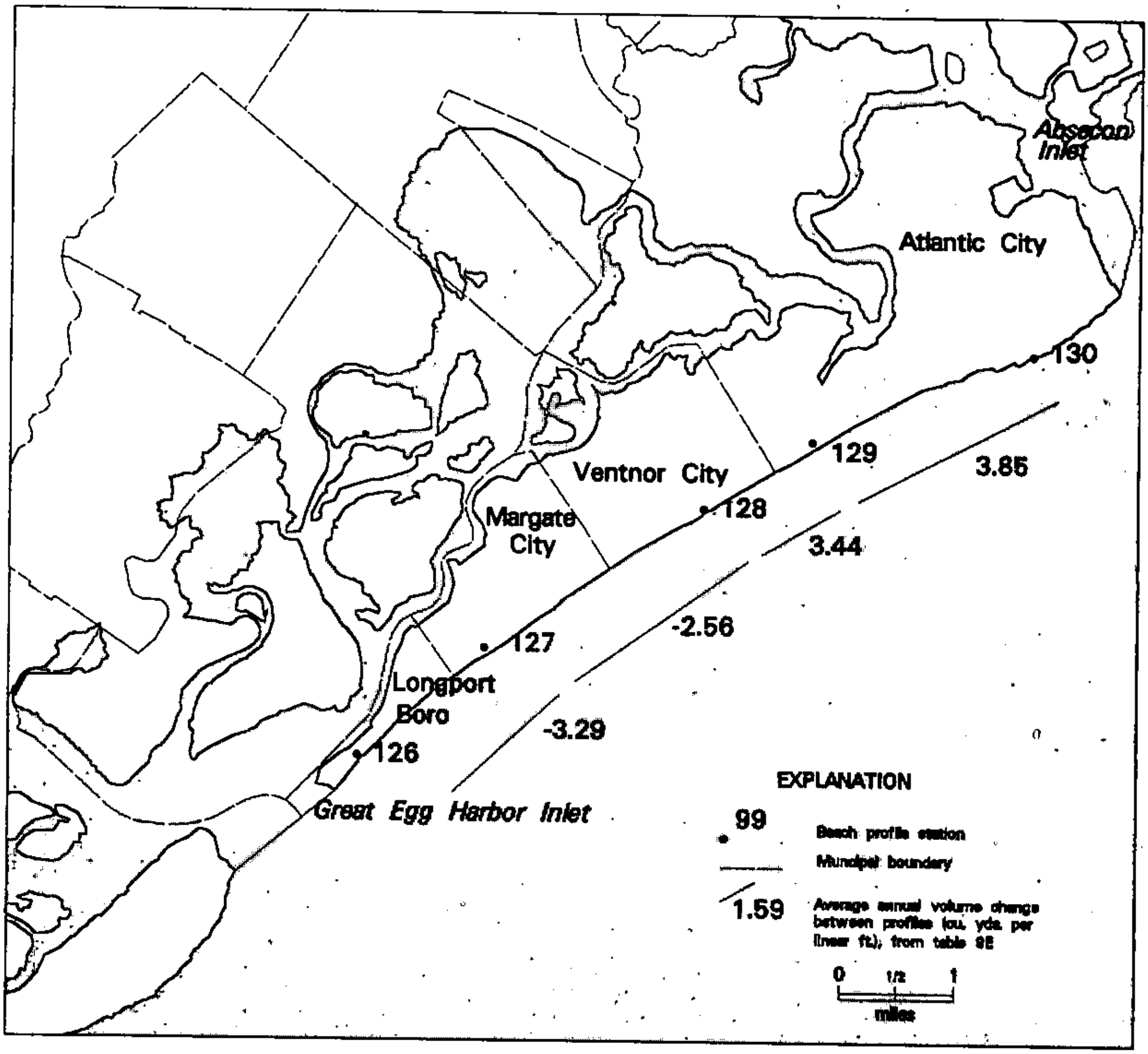


Figure 11. Map of Reach 9, Absecon Inlet to Great Egg Harbor Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Reach 9 - Abscon Inlet to Great Egg Harbor Inlet (Absecon Island), Atlantic County

Table 9A. Profile stations - Abscon Inlet to Great Egg Harbor Inlet (Absecon Island), Atlantic County

Beach profile station	Location: Longitude [1]	Latitude [1]	Elevation (ft.) [2]	Site description 3
130	742518W	392123N	8.96	N. Carolina Ave., Atlantic City
129	742727W	392044N	9.48	Raleigh Ave., Atlantic City
128	742830W	392014N	11.84	Dorset Ave., Ventnor City
127	743038W	391912N	13.46	S. Benson St., Margate City
126	743152W	391824N	15.44	17th St., Longport Borough

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.

Table 9B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Length of shoreline (linear ft.)
Atlantic City	1986	Replenishment	1,000,000	12,000
Ventnor City		No activity noted.		
Margate City	1991	Redistribution into sand dunes.	3,000	4,000
Longport Borough	1990	Replenishment with sand dredged from Great Egg Harbor Inlet.	129,000	1,500

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 9C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
126	260.23	115.01	197.68	50.59	64.05
127	453.53	364.87	400.83	35.36	-58.19
128	427.37	339.70	387.68	27.65	3.16
129	523.77	431.39	463.27	34.10	54.32
130	469.54	376.49	414.71	30.94	-5.10

[1] Data summarized from table 2 of Profiles 126-130.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 126-130.

Table 9D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
126	44.33	-23.87	-0.14	27.15	-0.86
127	9.73	-29.77	-6.44	13.90	-38.66
128	25.59	-13.75	1.31	13.71	7.88
129	30.89	-23.59	5.58	19.23	33.49
130	33.08	-17.58	2.13	19.56	12.81

[1] Data summarized from table 1 of Profiles 126-130.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 126-130.

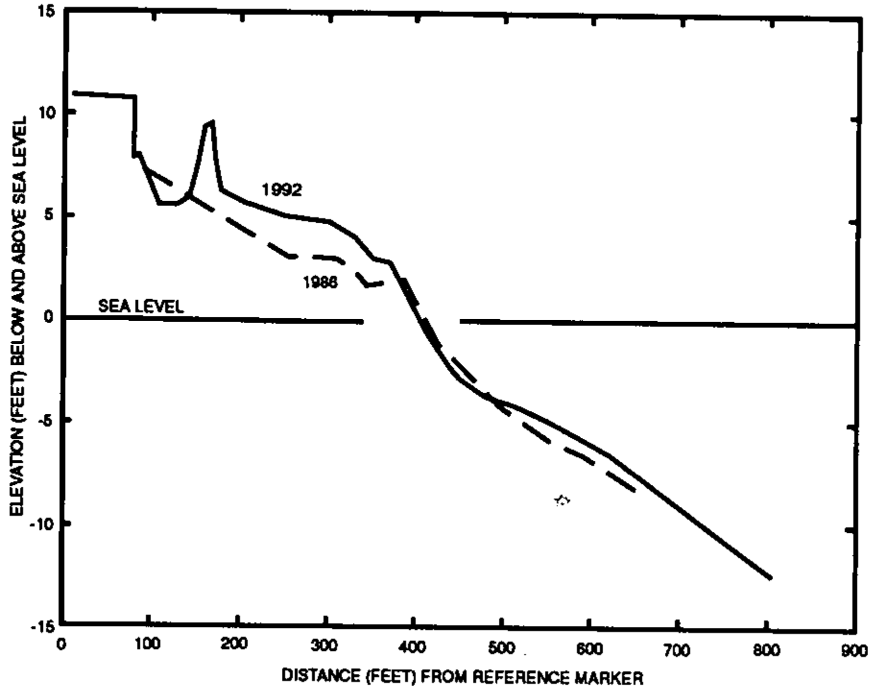
Table 9E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
126-127	7,500	-3.29	-24,675	3,796
127-128	12,000	-2.56	-30,720	6,309
128-129	5,500	3.44	18,920	2,245
129-130	11,000	3.85	42,350	3,832

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 9, Profile 130
North Carolina Avenue, Atlantic City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

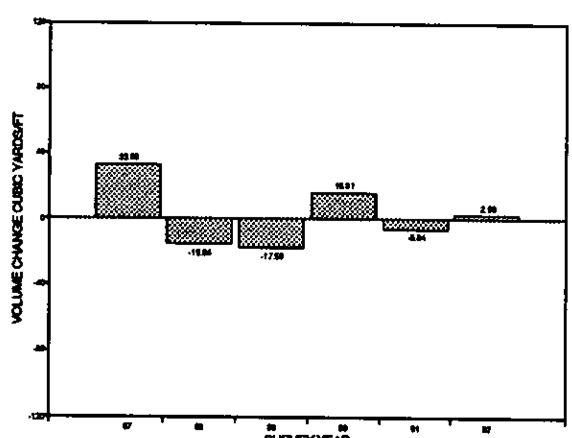


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	17.96	15.12	33.08
1988	-5.44	-10.20	-15.64
1989	-12.46	-5.12	-17.58
1990	9.12	6.69	15.81
1991	-2.42	-3.42	-5.84
1992	7.35	-4.37	2.98
Approximate 6-yr. volume change			12.81
Mean annual volume change			2.13
Standard deviation			19.56

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

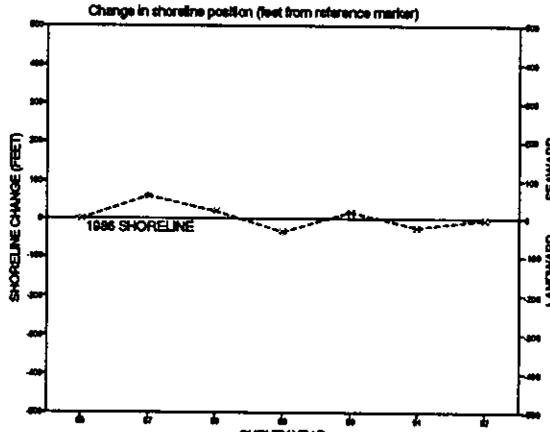


Table 2

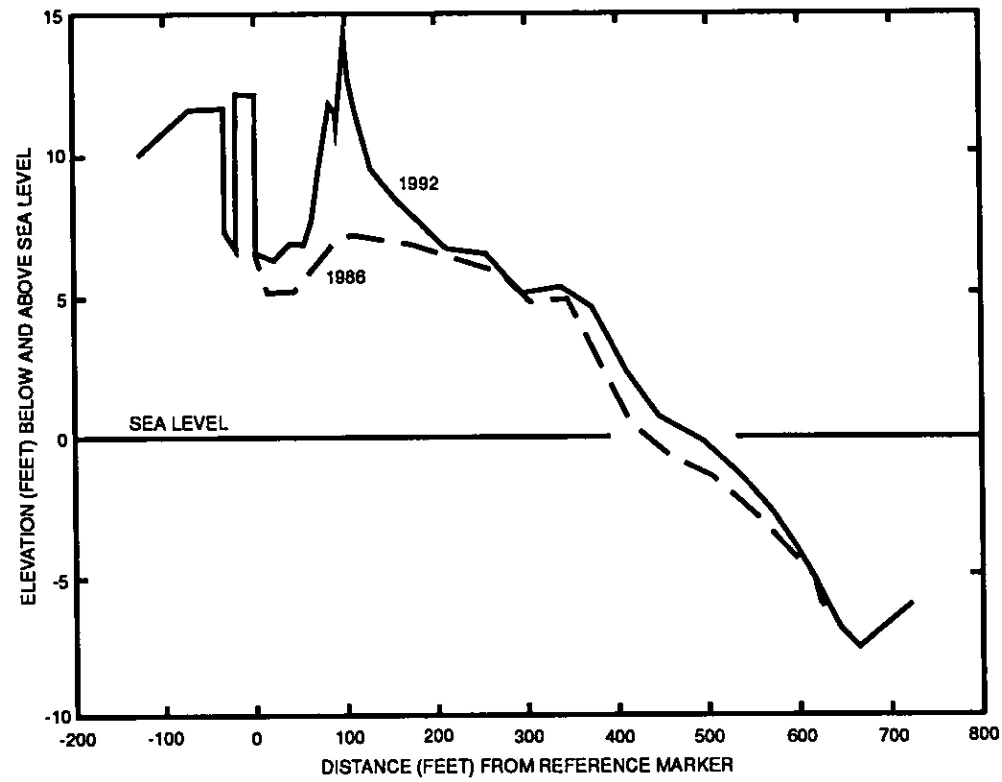
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/06	409.96	
1987	10/03	469.54	59.58
1988	10/06	429.72	19.76
1989	09/28	376.49	-33.47
1990	10/30	426.01	16.05
1991	11/18	386.37	-23.59
1992	10/21	404.86	-5.10
Net shoreline change, 1986-1992 [3]			-5.10
Mean annual distance from ref. mkr., 1986-1992 [3]			414.71
Standard deviation			30.94

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 9, Profile 129
Raleigh Avenue, Atlantic City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

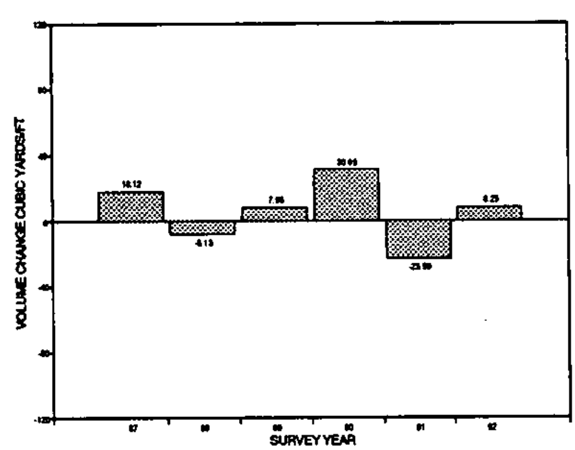


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	5.83	12.29	18.12
1988	-1.00	-7.13	-8.13
1989	-4.12	12.07	7.95
1990	23.63	7.26	30.89
1991	-18.06	-5.53	-23.59
1992	17.58	-9.33	8.25
Approximate 6-yr. volume change			33.49
Mean annual volume change			5.58
Standard deviation			19.23

[1] Negative value denotes loss of sand

Graph 2

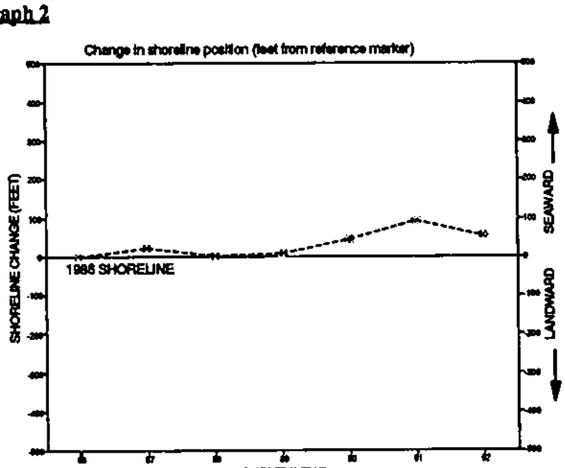


Table 2

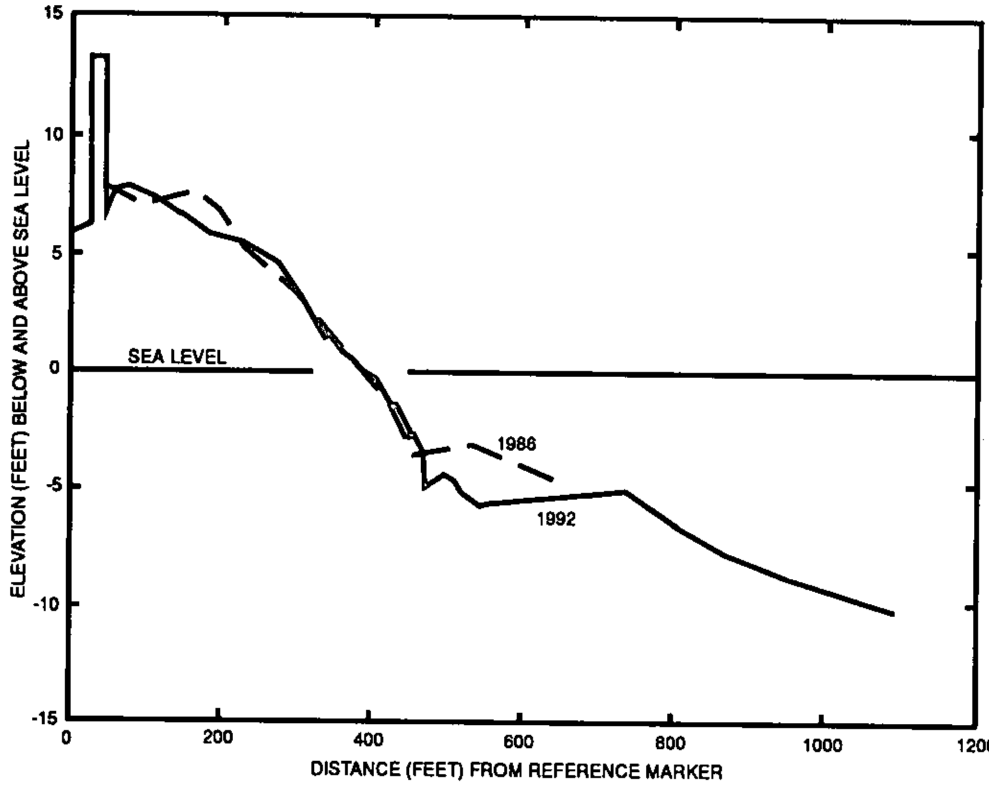
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/06	431.39	
1987	11/02	454.03	22.64
1988	10/06	433.31	1.92
1989	09/28	438.08	6.69
1990	10/30	476.60	45.21
1991	11/18	523.77	92.38
1992	10/21	485.71	54.32
Net shoreline change, 1986-1992 [3]			54.32
Mean annual distance from ref. mkr., 1986-1992 [3]			463.27
Standard deviation			34.10

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 9, Profile 128
Dorset Avenue, Ventnor City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

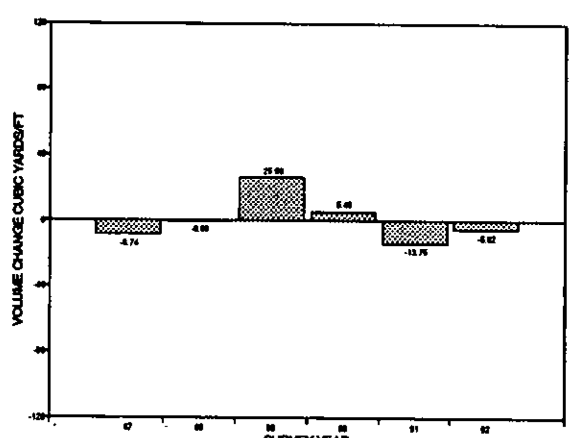


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-0.37	-8.37	-8.74
1988	-9.12	8.44	-0.68
1989	7.84	17.75	25.59
1990	8.33	-2.87	5.46
1991	-8.50	-5.25	-13.75
1992	1.17	-6.79	-5.62
Approximate 6-yr. volume change			7.88
Mean annual volume change			1.31
Standard deviation			13.71

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

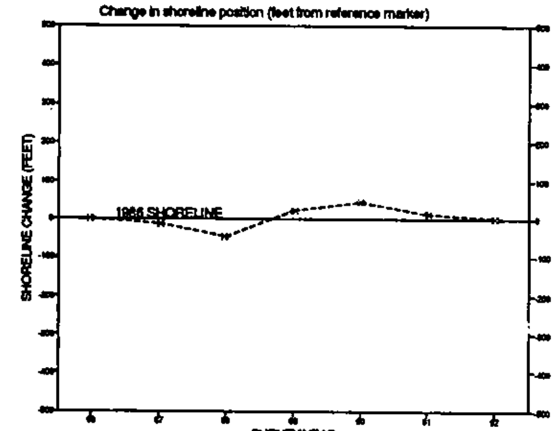


Table 2

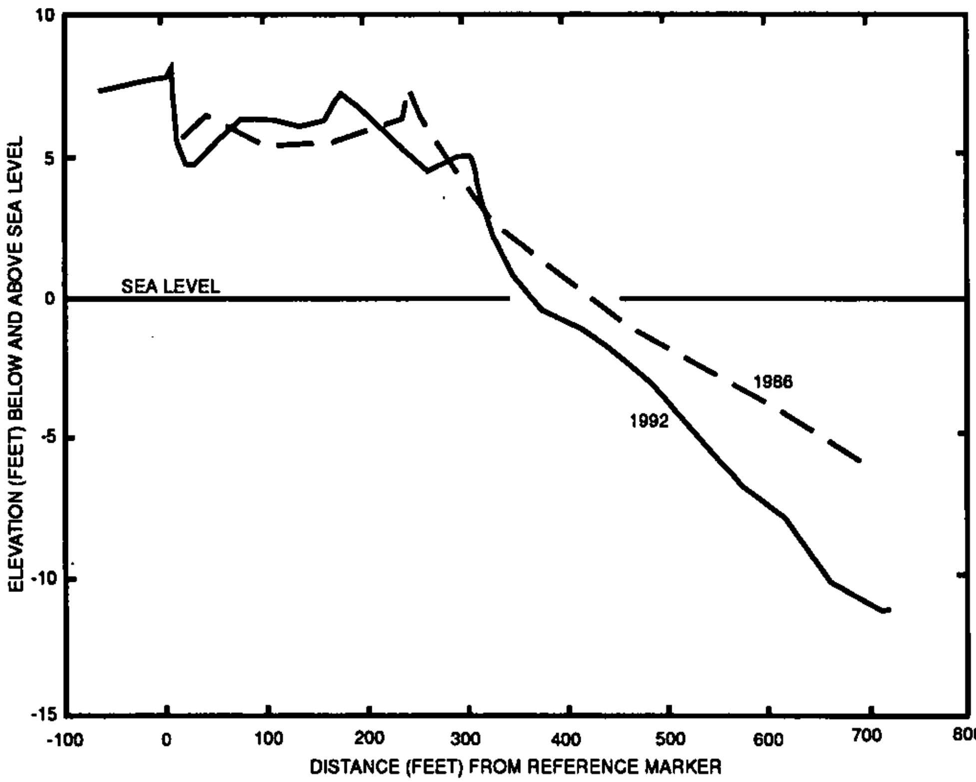
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/17	384.57	
1987	11/02	371.12	-13.45
1988	10/06	339.70	-44.87
1989	09/28	405.95	21.38
1990	10/29	427.37	42.80
1991	11/18	397.29	12.72
1992	10/21	387.73	3.16
Net shoreline change, 1986-1992 [3]			3.16
Mean annual distance from ref. mkr., 1986-1992 [3]			387.68
Standard deviation			27.65

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 9, Profile 127
South Benson Street, Margate City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

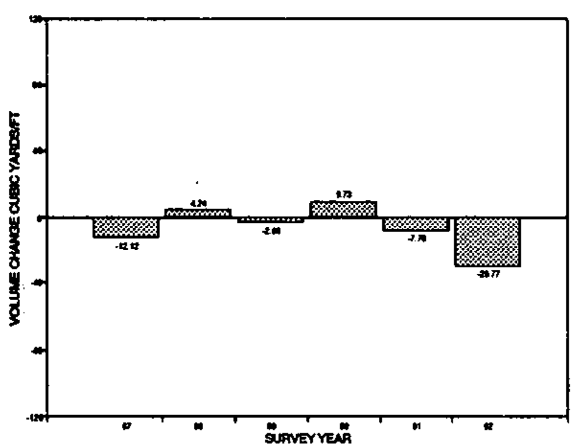


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	0.58	-12.70	-12.12
1988	-6.61	10.85	4.24
1989	3.22	-6.20	-2.98
1990	0.73	9.00	9.73
1991	3.51	-11.27	-7.76
1992	-4.18	-25.59	-29.77
Approximate 6-yr. volume change			-38.66
Mean annual volume change			-6.44
Standard deviation			13.90

[1] Negative value denotes loss of sand

Graph 2

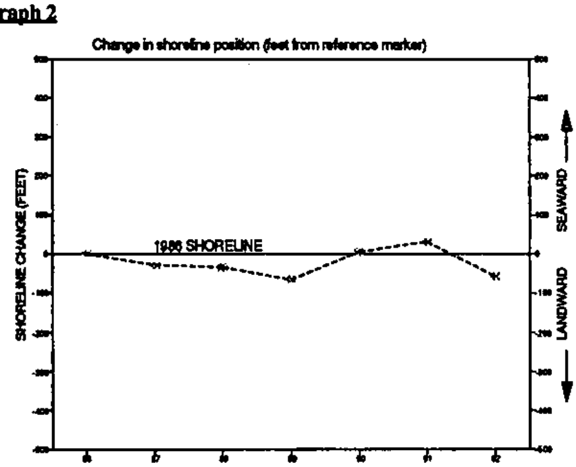


Table 2

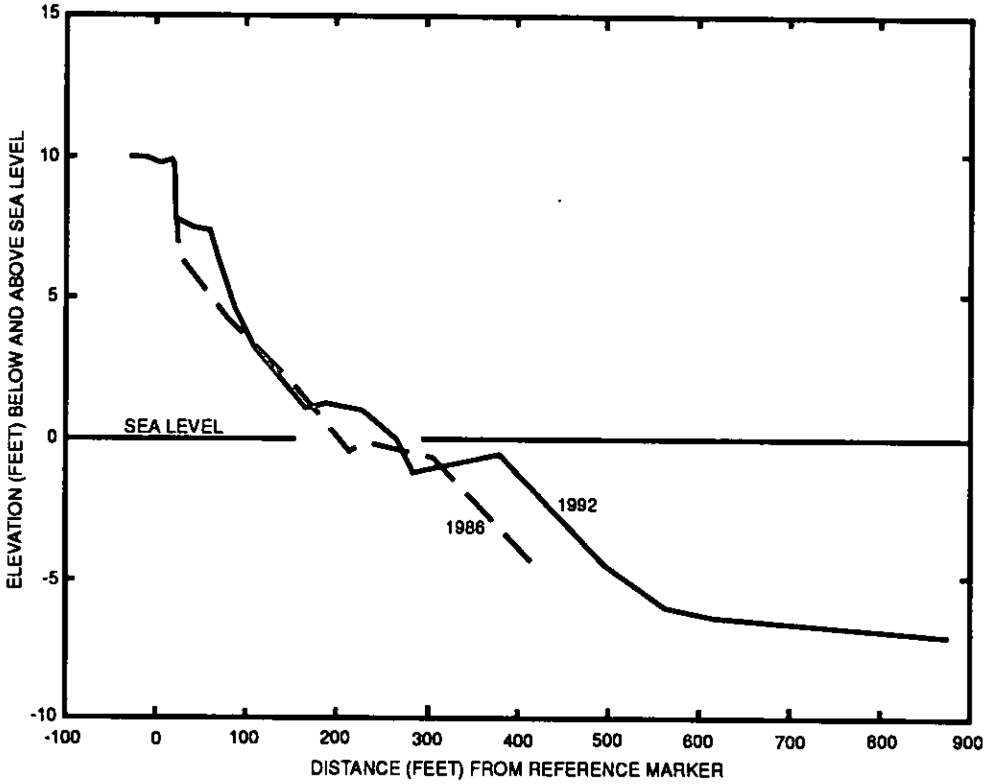
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/17	423.06	
1987	11/02	392.29	-30.77
1988	10/07	388.77	-34.29
1989	09/28	355.92	-67.14
1990	10/29	427.36	4.30
1991	11/18	453.53	30.47
1992	11/04	364.87	-58.19
Net shoreline change, 1986-1992 [3]			-58.19
Mean annual distance from ref. mkr., 1986-1992 [3]			400.83
Standard deviation			35.36

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 9, Profile 126
17th Street, Longport Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

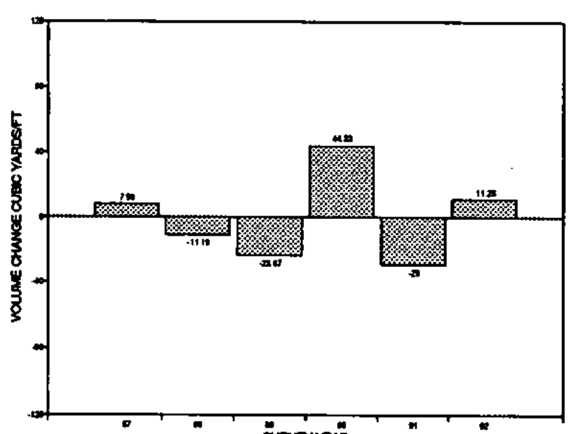


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]			
Year	Above mean sea level	Below mean sea level	Annual total
1987	5.79	1.80	7.59
1988	-8.13	-3.06	-11.19
1989	-8.70	-15.17	-23.87
1990	25.06	19.27	44.33
1991	-16.65	-12.35	-29.00
1992	9.14	2.14	11.28
Approximate 6-yr. volume change			-0.86
Mean annual volume change			-0.14
Standard deviation			27.15

[1] Negative value denotes loss of sand

Graph 2

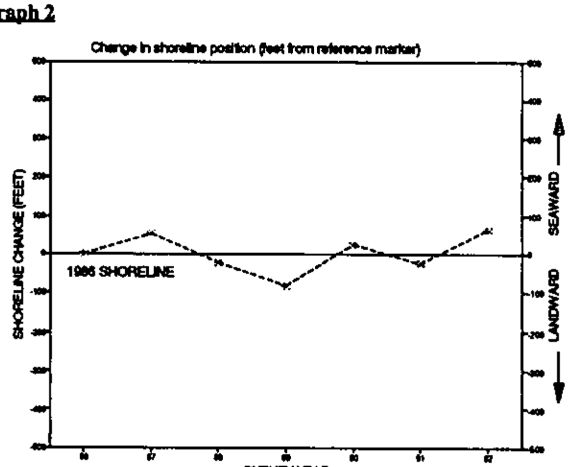


Table 2

SHORELINE CHANGE IN FEET			
Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/17	196.18	
1987	11/02	248.46	52.28
1988	10/07	172.75	-23.43
1989	09/28	115.01	-81.17
1990	10/29	222.01	25.83
1991	11/18	169.10	-27.08
1992	11/04	260.23	64.05
Net shoreline change, 1986-1992 [3]			64.05
Mean annual distance from ref. mkr., 1986-1992 [3]			197.68
Standard deviation			50.59

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

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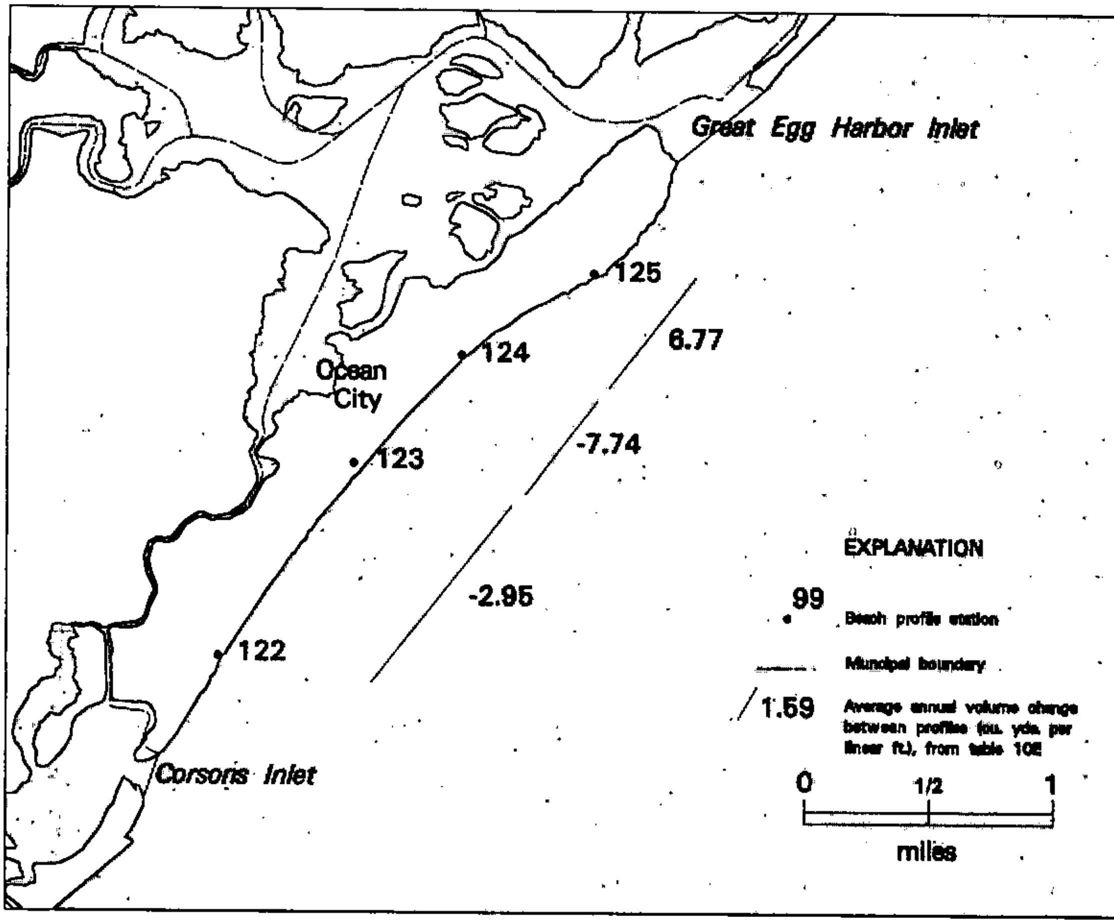


Figure 12. Map of Reach 10, Great Egg Harbor Inlet to Corsons Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Table 10A. Profile stations - Great Egg Harbor Inlet to Corsons Inlet (Peck Beach), Ocean City, Cape May County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
125	743357W	391636N	11.10	6th St., Ocean City
124	743523W	391553N	14.63	20th St., Ocean City
123	743632W	391500N	14.77	34th St., Ocean City
122	743808W	391322N	15.05	56th St., Ocean City

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.

Table 10B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
Ocean City	1989	Replenishment of North Beach	250,000	3,000
	1992	Replenishment	2,550,000	21,000
		Southern 1 mile of island is State Park.		

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 10C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
122	409.22	306.92	354.63	41.05	-102.30
123	458.17	409.30	428.60	15.18	-48.87
124	245.31	100.72	174.08	47.05	-144.59
125	593.81	91.53	224.53	167.56	403.81

[1] Data summarized from table 2 of Profiles 122-125.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 122-125.

Table 10D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
122	14.94	-21.56	-0.97	14.16	-5.84
123	4.95	-28.81	-4.93	13.93	-29.56
124	5.74	-44.70	-10.56	18.63	-63.36
125	128.88	-12.60	24.11	58.93	120.54

[1] Data summarized from table 1 of Profiles 122-125.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 122-125.

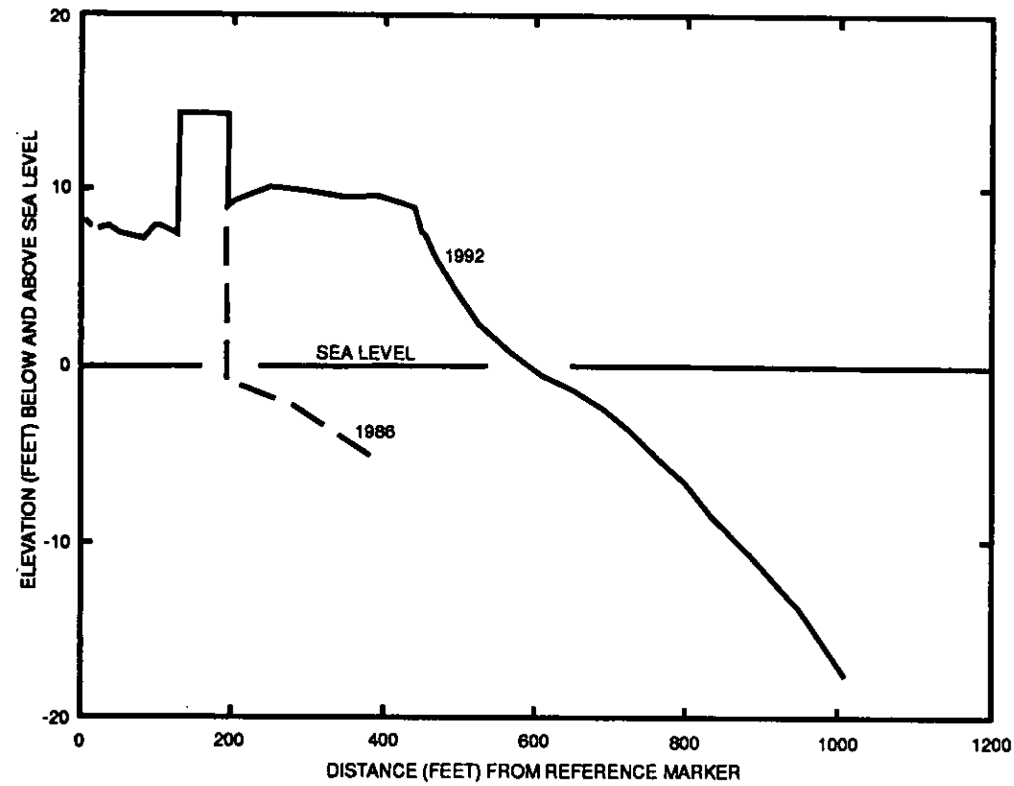
Table 10E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
122-123	12,500	-2.95	-36,875	7,350
123-124	7,800	-7.74	-60,372	4,545
124-125	8,100	6.77	54,837	4,877

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 10, Profile 125
6th Street, Ocean City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

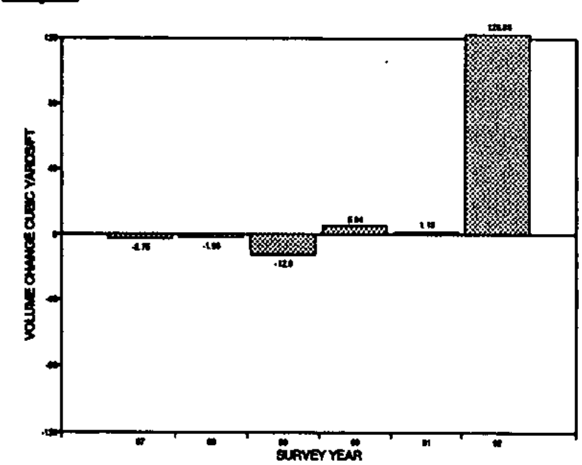


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	0.37	-3.12	-2.75
1988	-1.21	-0.75	-1.96
1989	-39.62	27.02	-12.60
1990	2.83	2.21	5.04
1991	32.15	-30.97	1.18
1992	128.88	0.00	128.88
Approximate 6-yr. volume change			120.54
Mean annual volume change			24.11
Standard deviation			58.93

[1] Negative value denotes loss of sand

Graph 2

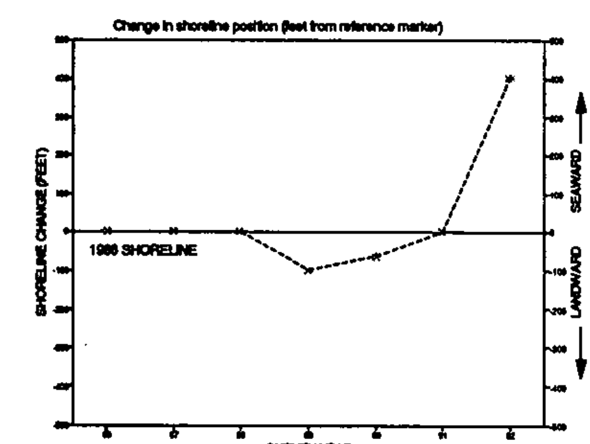


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/17	190.00	
1987	09/24	189.99	-0.01
1988	09/28	189.99	-0.01
1989	10/16	91.53	-98.47
1990	10/10	126.40	-63.60
1991	10/02	189.99	-0.01
1992	10/13	593.81	403.81
Net shoreline change, 1986-1992 [3]			403.81
Mean annual distance from ref. mkr., 1986-1992 [3]			224.53
Standard deviation			167.56

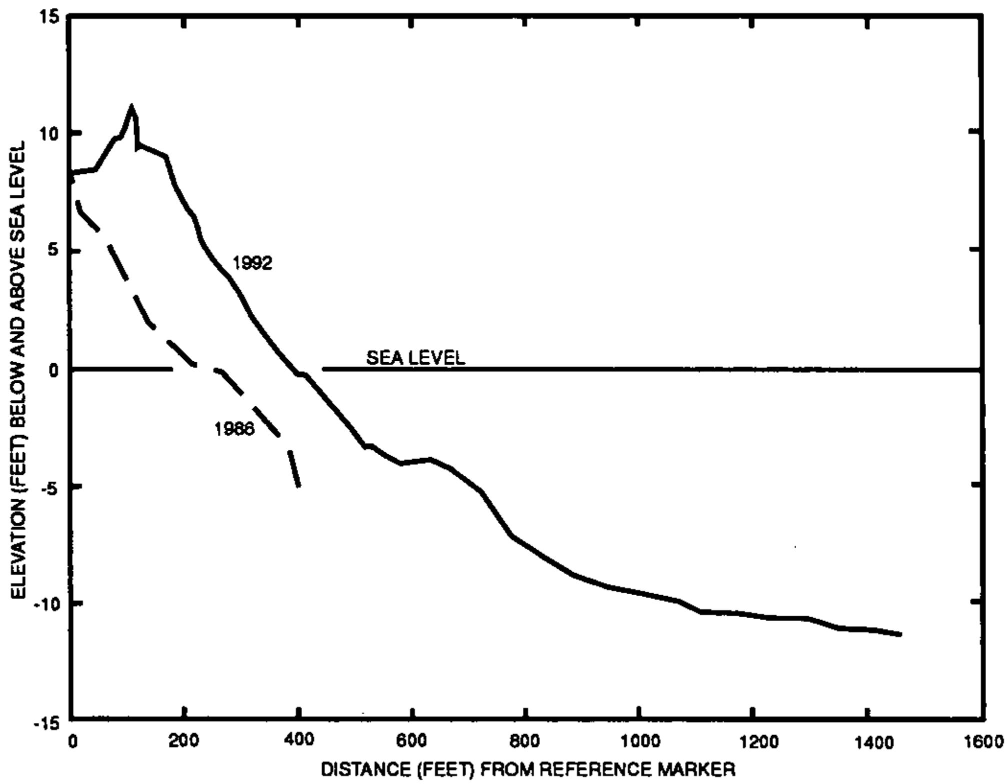
[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

Reach 10, Profile 124
20th Street, Ocean City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

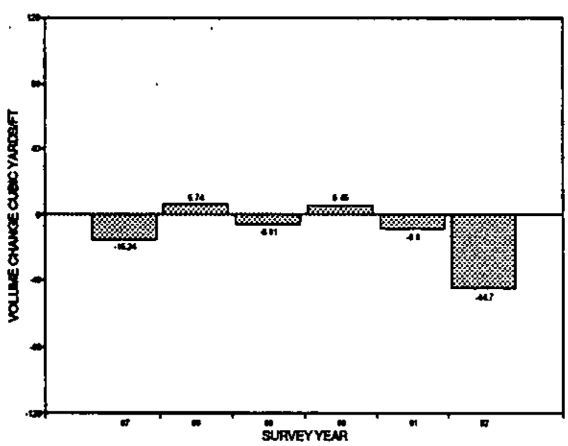


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-4.79	-10.45	-15.24
1988	4.36	1.38	5.74
1989	-1.58	-4.23	-5.81
1990	-1.96	7.41	5.45
1991	-4.41	-4.39	-8.80
1992	-7.47	-37.23	-44.70
Approximate 6-yr. volume change			-63.36
Mean annual volume change			-10.56
Standard deviation			18.63

[1] Negative value denotes loss of sand

Graph 2

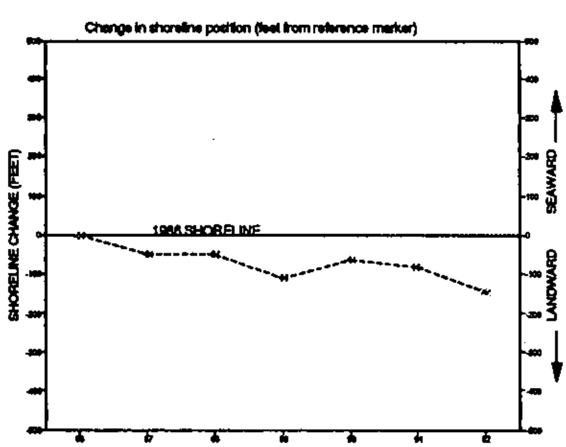


Table 2

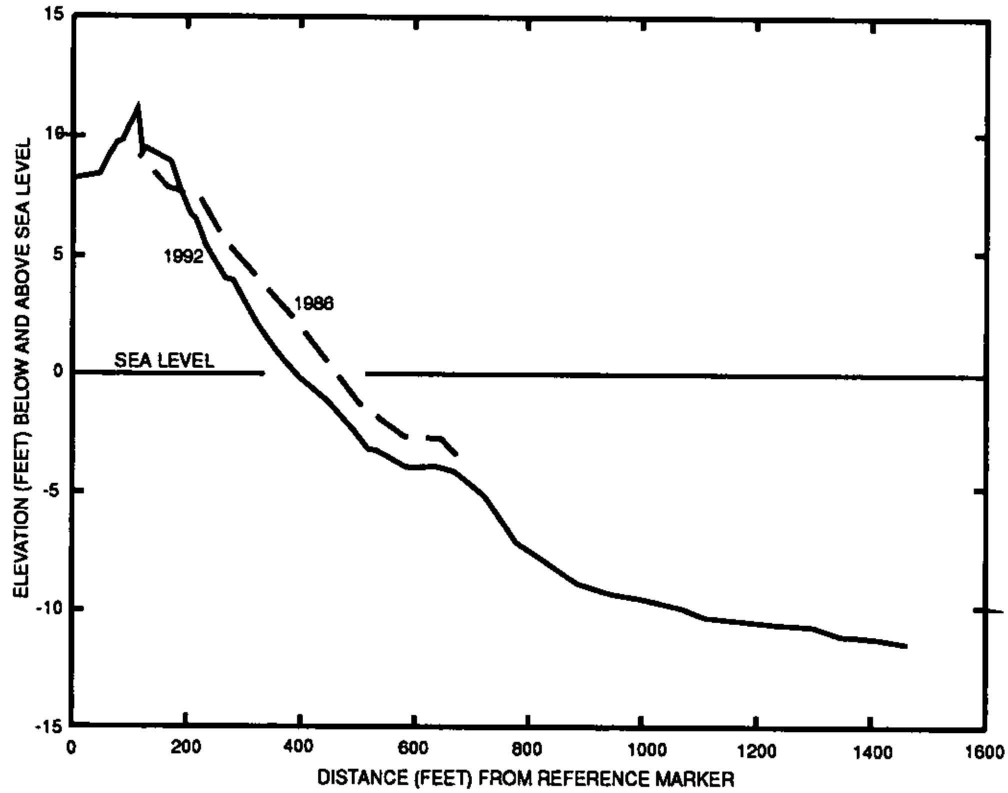
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/17	245.31	
1987	09/24	196.83	-48.48
1988	09/28	196.92	-48.39
1989	10/16	133.77	-111.54
1990	10/10	181.45	-63.86
1991	10/02	163.55	-81.76
1992	10/13	100.72	-144.59
Net shoreline change, 1986-1992 [3]			-144.59
Mean annual distance from ref. mkr., 1986-1992 [3]			174.08
Standard deviation			47.05

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 10, Profile 123
34th Street, Ocean City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

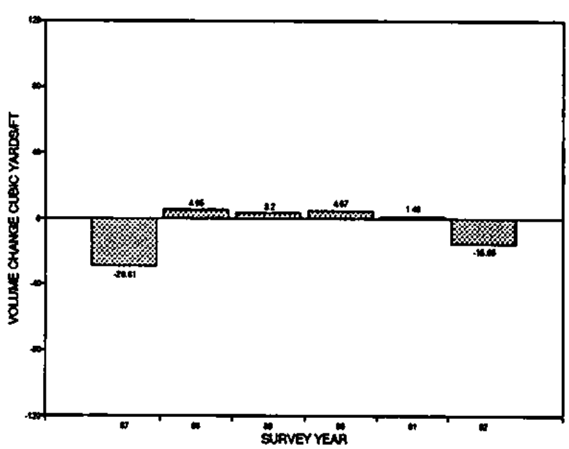


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-15.15	-13.66	-28.81
1988	5.58	-0.63	4.95
1989	-3.73	6.93	3.20
1990	7.61	-2.94	4.67
1991	-1.43	2.91	1.48
1992	-15.44	0.39	-15.05
Approximate 6-yr. volume change			-29.56
Mean annual volume change			-4.93
Standard deviation			13.93

[1] Negative value denotes loss of sand

Graph 2

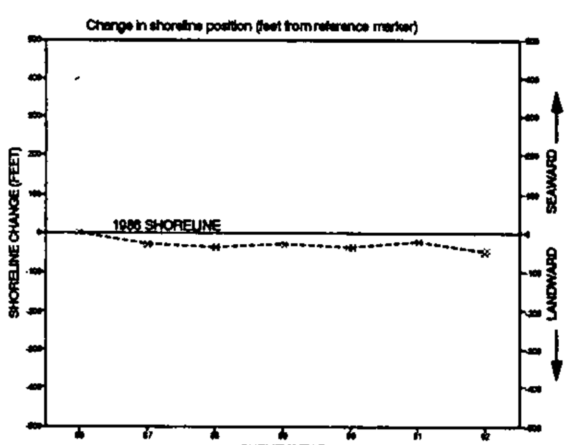


Table 2

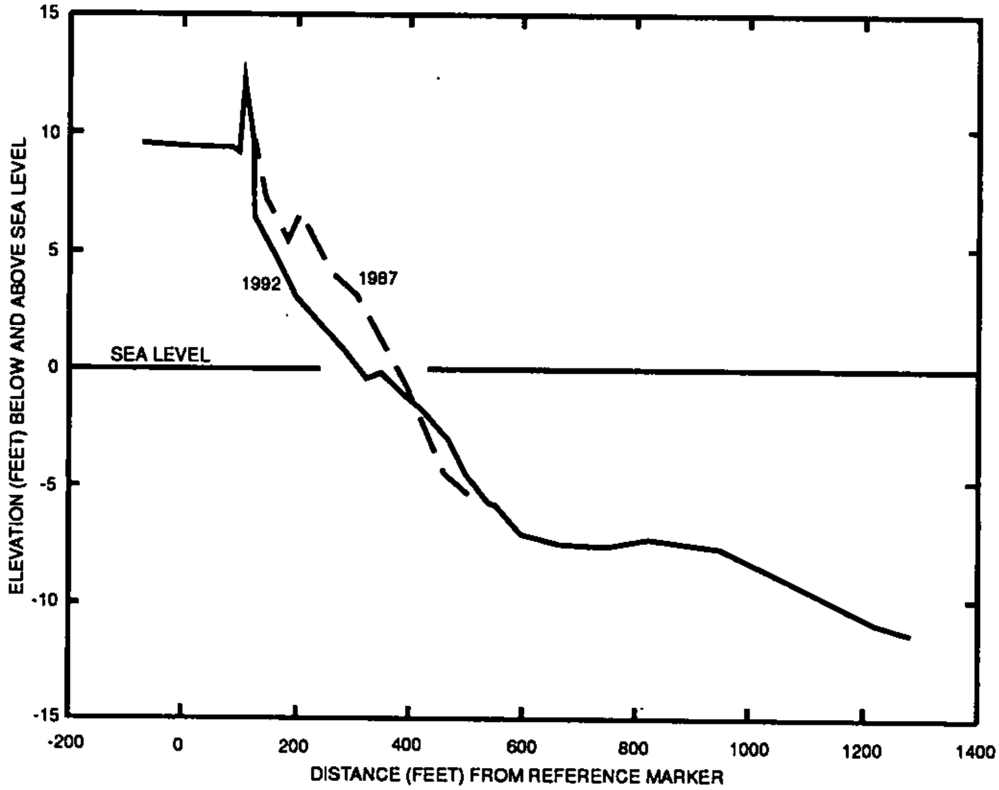
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/17	458.17	
1987	09/24	428.14	-30.03
1988	09/28	421.20	-36.97
1989	10/16	428.20	-29.97
1990	10/10	421.31	-36.86
1991	10/02	433.87	-24.30
1992	10/13	409.30	-48.87
Net shoreline change, 1986-1992 [3]			-48.87
Mean annual distance from ref. mkr., 1986-1992 [3]			428.60
Standard deviation			15.18

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 10, Profile 122
56th Street, Ocean City

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

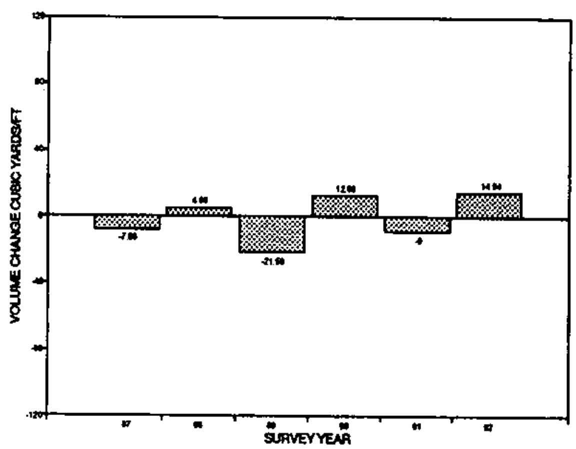


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-1.08	-6.48	-7.56
1988	-0.81	5.47	4.66
1989	-17.45	-4.11	-21.56
1990	10.68	2.00	12.68
1991	-3.44	-5.56	-9.00
1992	10.41	4.53	14.94
Approximate 6-yr. volume change			-5.84
Mean annual volume change			-0.97
Standard deviation			14.16

[1] Negative value denotes loss of sand

Graph 2

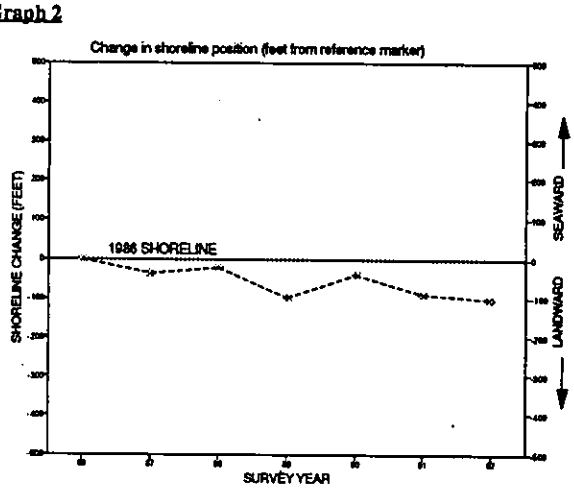


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/18	409.22	
1987	09/24	374.10	-35.12
1988	09/28	387.58	-21.64
1989	10/03	312.08	-97.14
1990	10/10	373.10	-36.12
1991	10/02	319.43	-89.79
1992	10/13	306.92	-102.30
Net shoreline change, 1986-1992 [3]			-102.30
Mean annual distance from ref. mkr., 1986-1992 [3]			354.63
Standard deviation			41.05

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

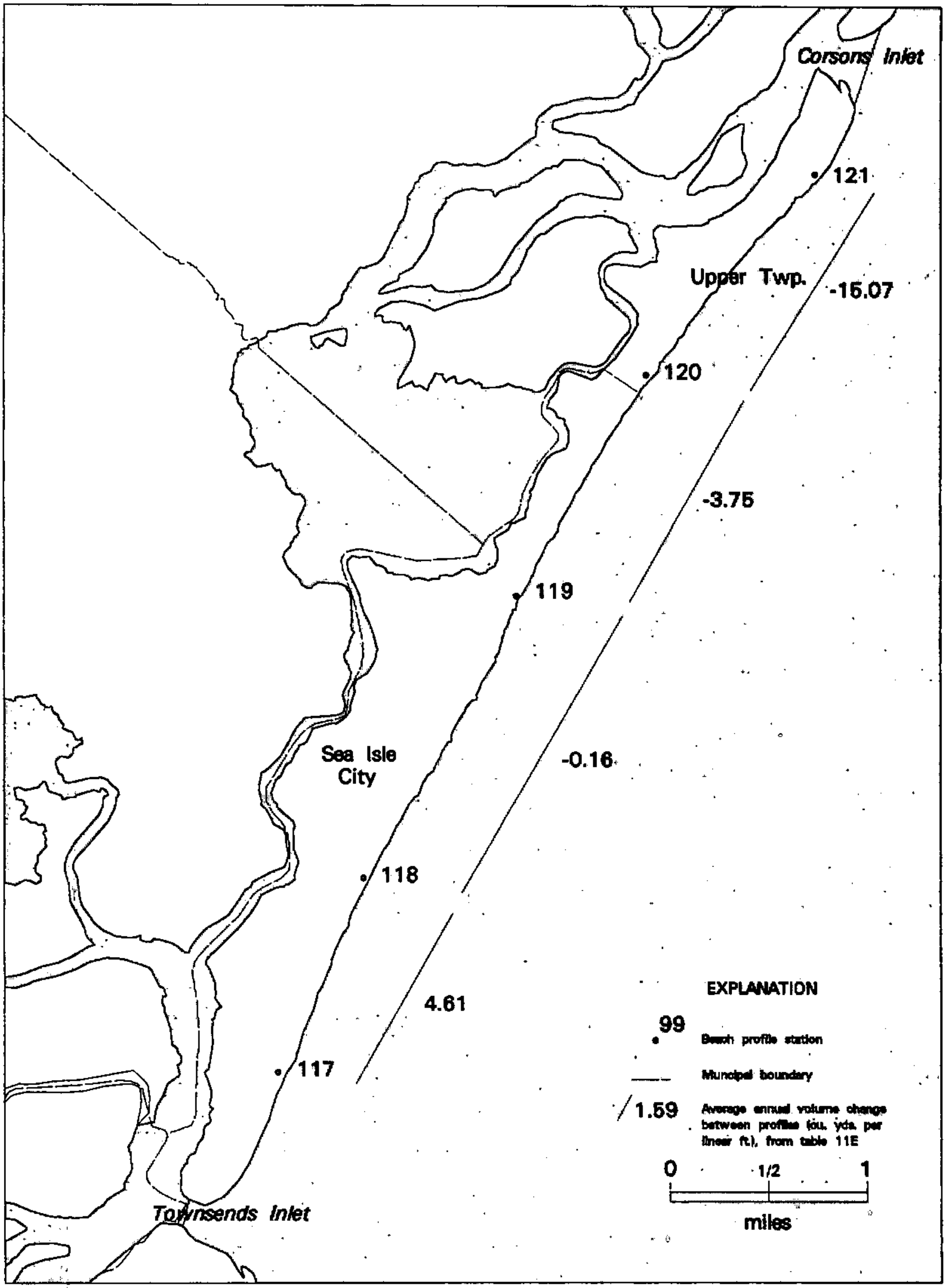


Figure 13. Map of Reach 11, Corsons Inlet to Townsends Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Table 11A. Profile stations - Corsons Inlet to Townsends Inlet (Ludlam Beach), Cape May County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
121	743904W	391153N	13.29	Williams Road, Strathmere, Upper Twp.
120	744008W	391057N	11.83	1st Ave., Upper Twp.
119	744054W	390956N	12.28	25th Ave., Sea Isle City
118	744155W	390839N	13.18	57th Ave., Sea Isle City
117	744226W	390745N	14.19	80th Ave., Sea Isle City

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.

Table 11B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
Upper Twp.	1984	Replenishment in Strathmere	520,000	8,115
	1992	Replenishment at Whale Beach	23,000	2,300
	1992	Sand redistribution started following 12/92 storm.	NA	NA
Sea Isle City	1984	Replenishment	800,000	NA
	1987	Ongoing replenishment and sand dune construction started, working south from 78th street.	150,400	4,500
	1992	Replenishment between 77th and 82nd streets.	375,000	1,800

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 11C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
117	440.55	249.23	312.12	66.93	120.36
118	539.14	485.35	522.17	19.52	-3.93
119	384.13	331.66	350.43	19.65	-6.01
120	428.27	386.96	398.07	19.83	-6.96
121	559.84	388.41	502.08	68.70	-154.32

[1] Data summarized from table 2 of Profiles 117-121.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 117-121.

Table 11D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
117	16.49	-22.08	11.74	40.95	70.44
118	17.86	-16.55	-2.51	13.61	-15.08
119	16.54	-17.78	2.19	12.48	13.16
120	19.19	-49.24	-9.69	24.62	-58.13
121	60.90	-110.90	-20.46	58.64	-122.75

[1] Data summarized from table 1 of Profiles 117-121.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 117-121.

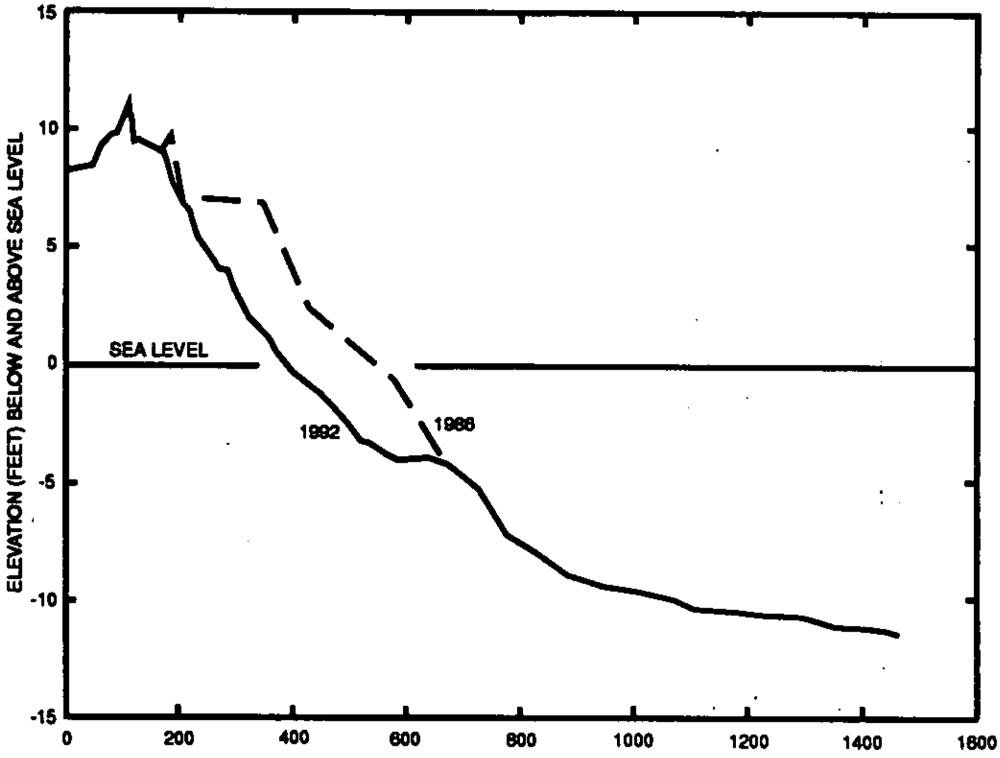
Table 11E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
117-118	6,100	4.61	28,121	4,851
118-119	9,000	-0.16	-1,440	6,467
119-120	7,400	-3.75	-27,750	3,537
120-121	7,200	-15.07	-108,540	4,142

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 11, Profile 121
Williams Road, Upper Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

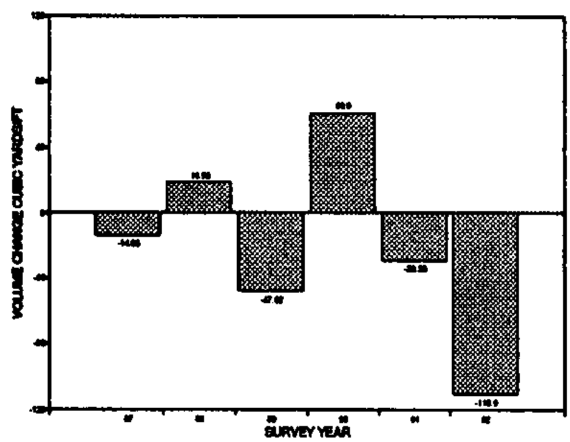


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-10.21	-3.82	-14.03
1988	4.10	14.43	18.53
1989	-16.80	-31.12	-47.92
1990	39.16	21.74	60.90
1991	-5.28	-24.05	-29.33
1992	-48.42	-62.48	-110.90
Approximate 6-yr. volume change			-122.75
Mean annual volume change			-20.46
Standard deviation			58.64

[1] Negative value denotes loss of sand

Graph 2

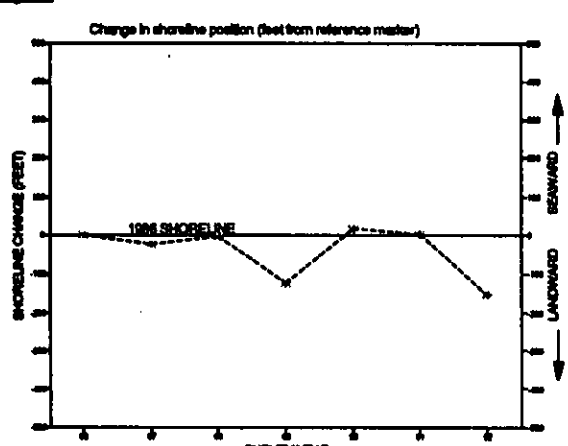


Table 2

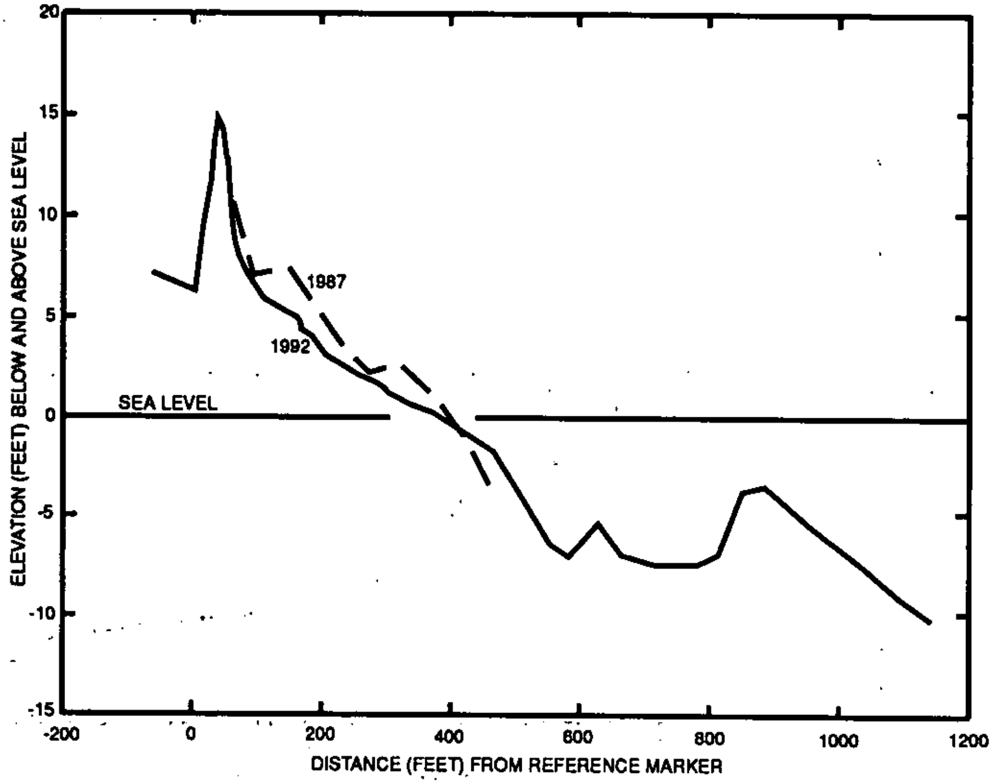
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/18	542.73	-
1987	09/23	519.49	-23.24
1988	11/18	538.80	-3.93
1989	10/03	419.40	-123.33
1990	10/11	559.84	17.11
1991	10/08	545.91	3.18
1992	10/23	388.41	-154.32
Net shoreline change, 1986-1992 [3]			-154.32
Mean annual distance from ref. mkr., 1986-1992 [3]			502.08
Standard deviation			68.70

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 11, Profile 120
1st Avenue, Upper Township

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

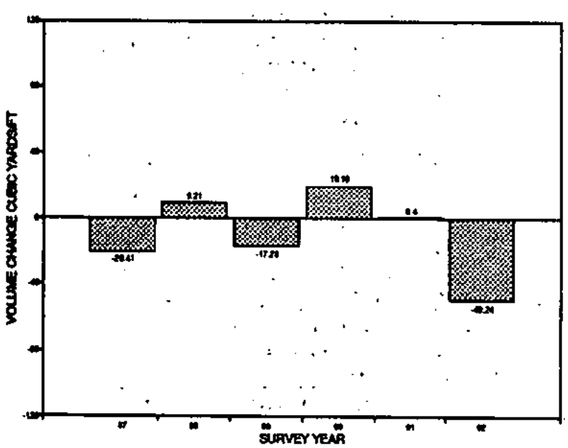


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-2.41	-18.00	-20.41
1988	6.56	2.65	9.21
1989	-12.03	-5.25	-17.28
1990	13.62	5.57	19.19
1991	-1.60	2.00	0.40
1992	-20.30	-28.94	-49.24
Approximate 6-yr. volume change			-58.13
Mean annual volume change			-9.69
Standard deviation			24.62

[1] Negative value denotes loss of sand

Graph 2

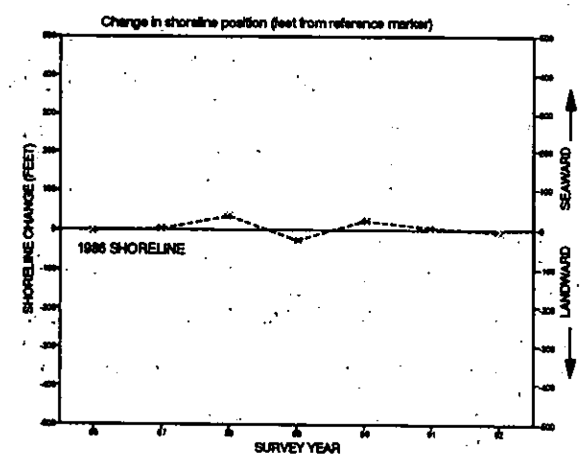


Table 2

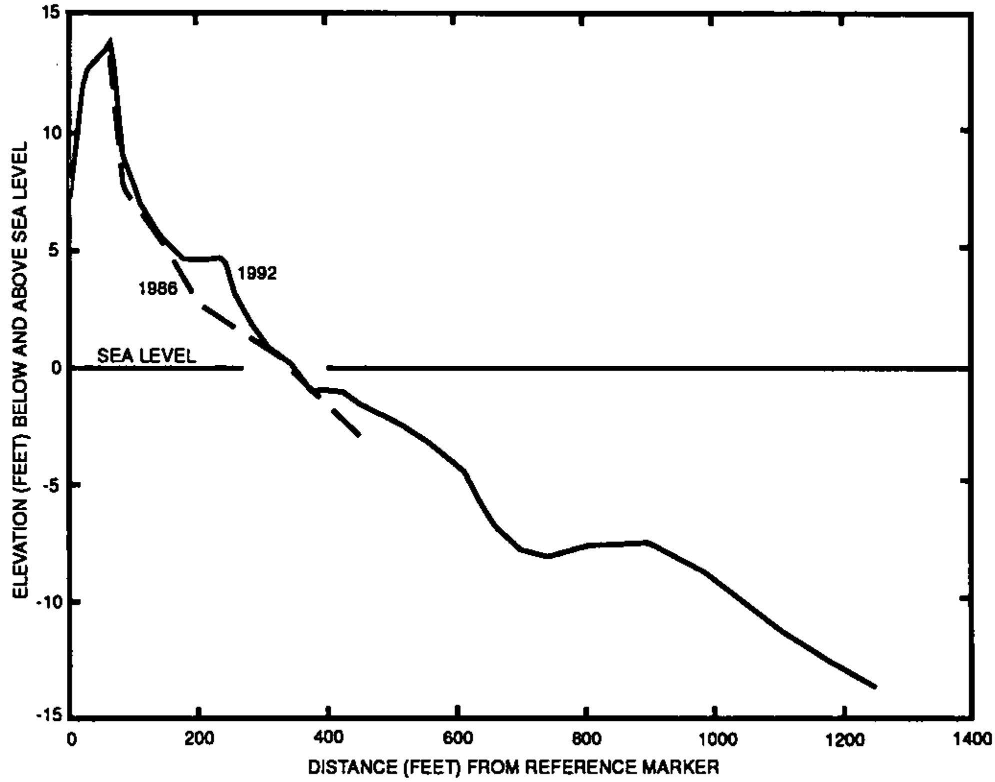
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/18	393.92	
1987	09/23	395.90	1.98
1988	11/18	428.27	34.35
1989	10/03	366.69	-27.23
1990	10/11	415.85	21.93
1991	10/08	398.92	5.00
1992	10/23	386.96	-6.96
Net shoreline change, 1986-1992 [3]			-6.96
Mean annual distance from ref. mkr., 1986-1992 [3]			398.07
Standard deviation			19.83

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 11, Profile 119
25th Avenue, Sea Isle City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

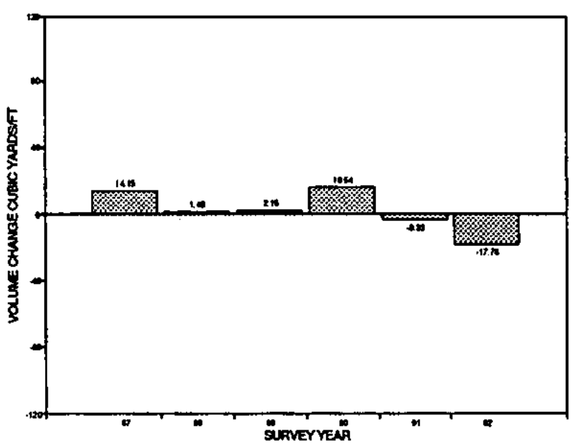


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	12.91	1.24	14.15
1988	-0.64	2.07	1.43
1989	-1.27	3.42	2.15
1990	12.88	3.66	16.54
1991	-1.79	-1.54	-3.33
1992	-12.49	-5.29	-17.78
Approximate 6-yr. volume change			13.16
Mean annual volume change			2.19
Standard deviation			12.48

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

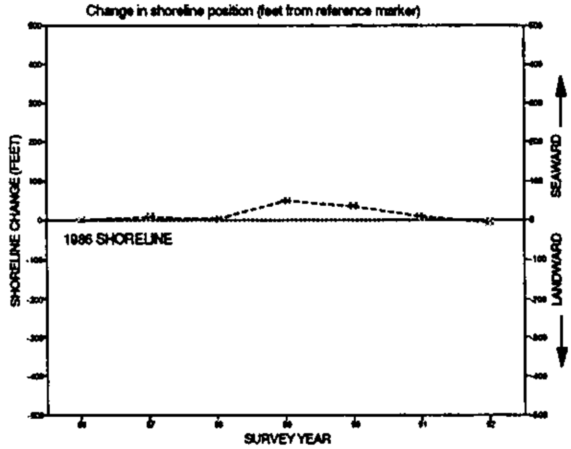


Table 2

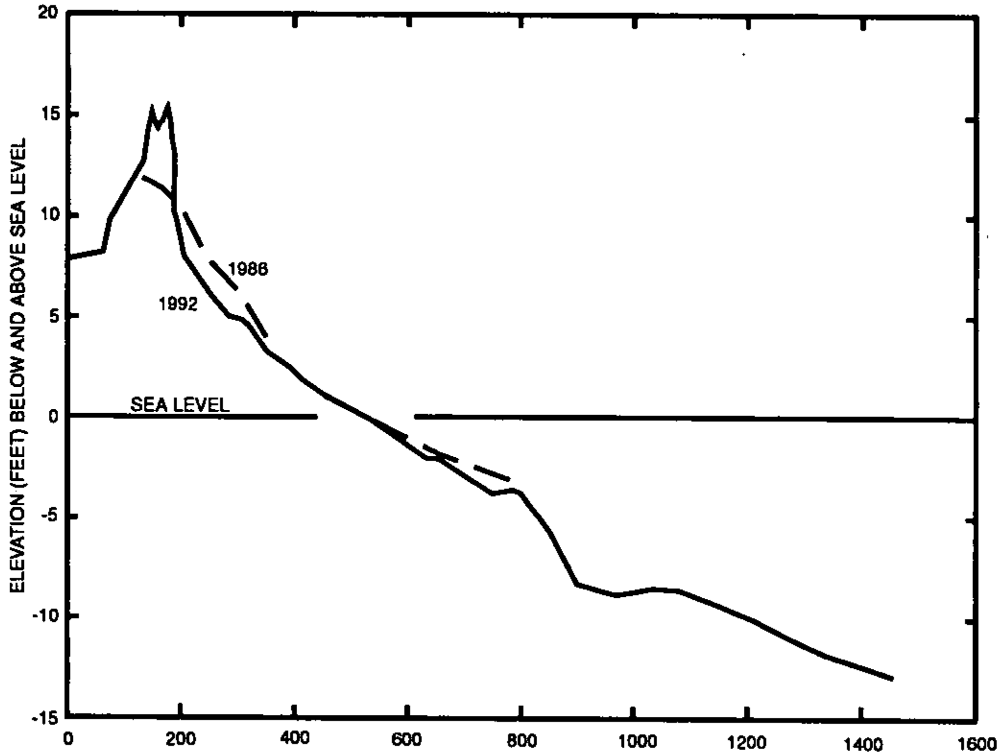
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/18	337.67	
1987	09/23	344.12	6.45
1988	11/18	338.85	1.18
1989	09/27	384.13	46.46
1990	10/11	371.89	34.22
1991	10/08	344.72	7.05
1992	10/23	331.66	-6.01
Net shoreline change, 1986-1992 [3]			-6.01
Mean annual distance from ref. mkr., 1986-1992 [3]			350.43
Standard deviation			19.65

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 11, Profile 118
57th Street, Sea Isle City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

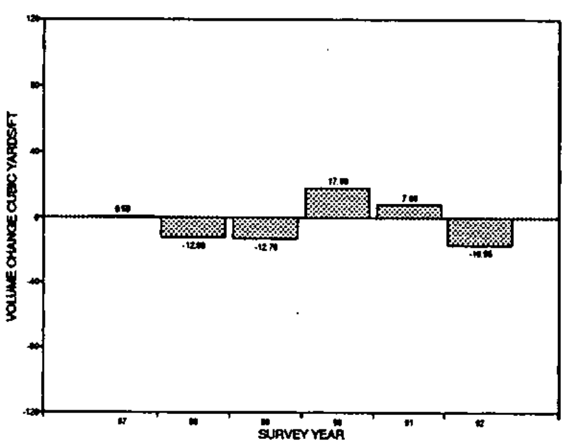


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	5.48	-4.89	0.59
1988	-4.01	-8.07	-12.08
1989	-7.83	-4.93	-12.76
1990	9.13	8.73	17.86
1991	8.50	-0.64	7.86
1992	-13.96	-2.59	-16.55
Approximate 6-yr. volume change			-15.08
Mean annual volume change			-2.51
Standard deviation			13.61

[1] Negative value denotes loss of sand

Graph 2

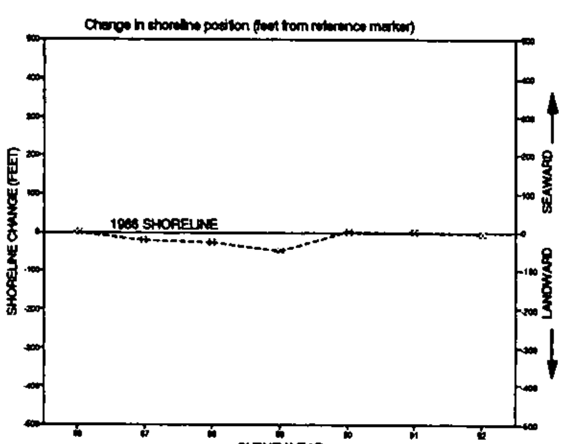


Table 2

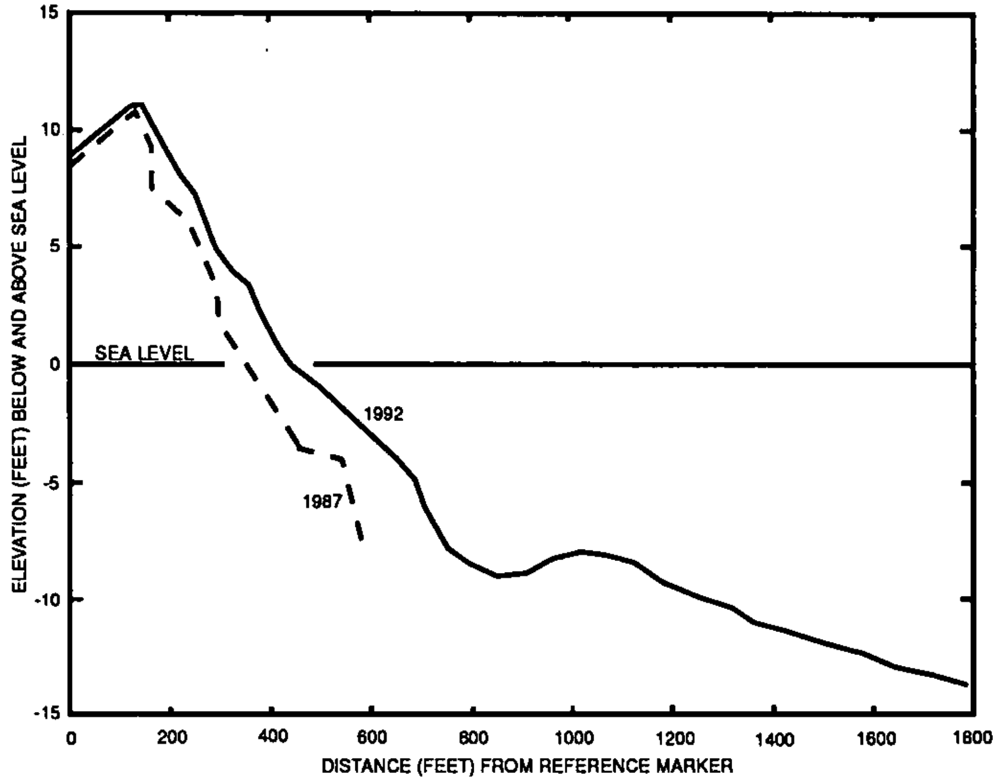
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	11/18	535.74	
1987	09/23	516.83	-18.91
1988	11/18	510.21	-25.53
1989	09/27	485.35	-50.39
1990	10/12	539.14	3.40
1991	10/08	536.13	0.39
1992	10/23	531.81	-3.93
Net shoreline change, 1986-1992 [3]			-3.93
Mean annual distance from ref. mkr., 1986-1992 [3]			522.17
Standard deviation			19.52

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 11, Profile 117
80th Avenue, Sea Isle City

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

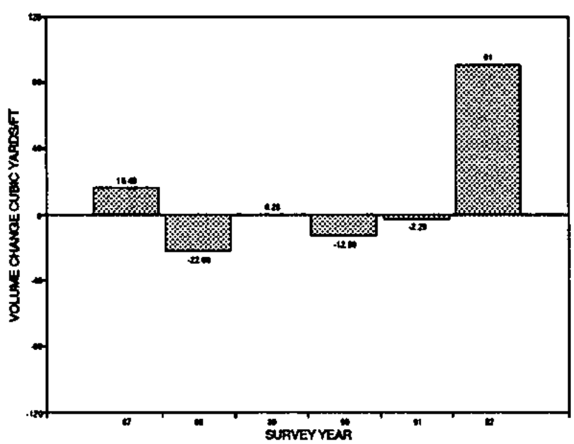


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	16.11	0.38	16.49
1988	-11.65	-10.43	-22.08
1989	-5.64	5.92	0.28
1990	-2.22	-10.74	-12.96
1991	3.75	-6.04	-2.29
1992	39.11	51.89	91.00
Approximate 6-yr. volume change			70.44
Mean annual volume change			11.74
Standard deviation			40.95

[1] Negative value denotes loss of sand

Graph 2

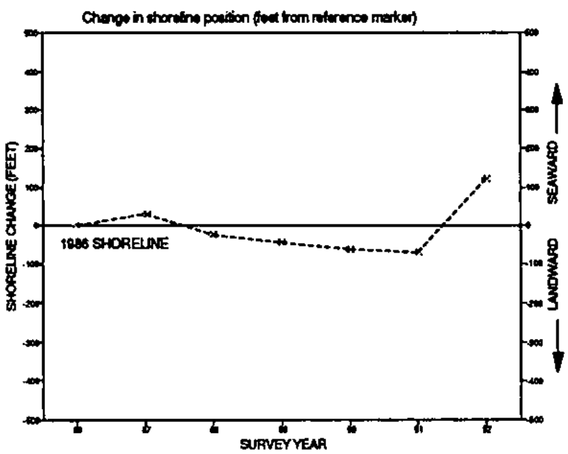


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/31	320.19	
1987	09/22	350.49	30.30
1988	11/18	294.18	-26.01
1989	09/25	273.71	-46.48
1990	10/12	256.52	-63.67
1991	10/08	249.23	-70.96
1992	10/23	440.55	120.36
Net shoreline change, 1986-1992 [3]			120.36
Mean annual distance from ref. mkr., 1986-1992 [3]			312.12
Standard deviation			66.93

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).

[2] Minus sign indicates migration landward.

[3] Actual survey date to actual survey date.

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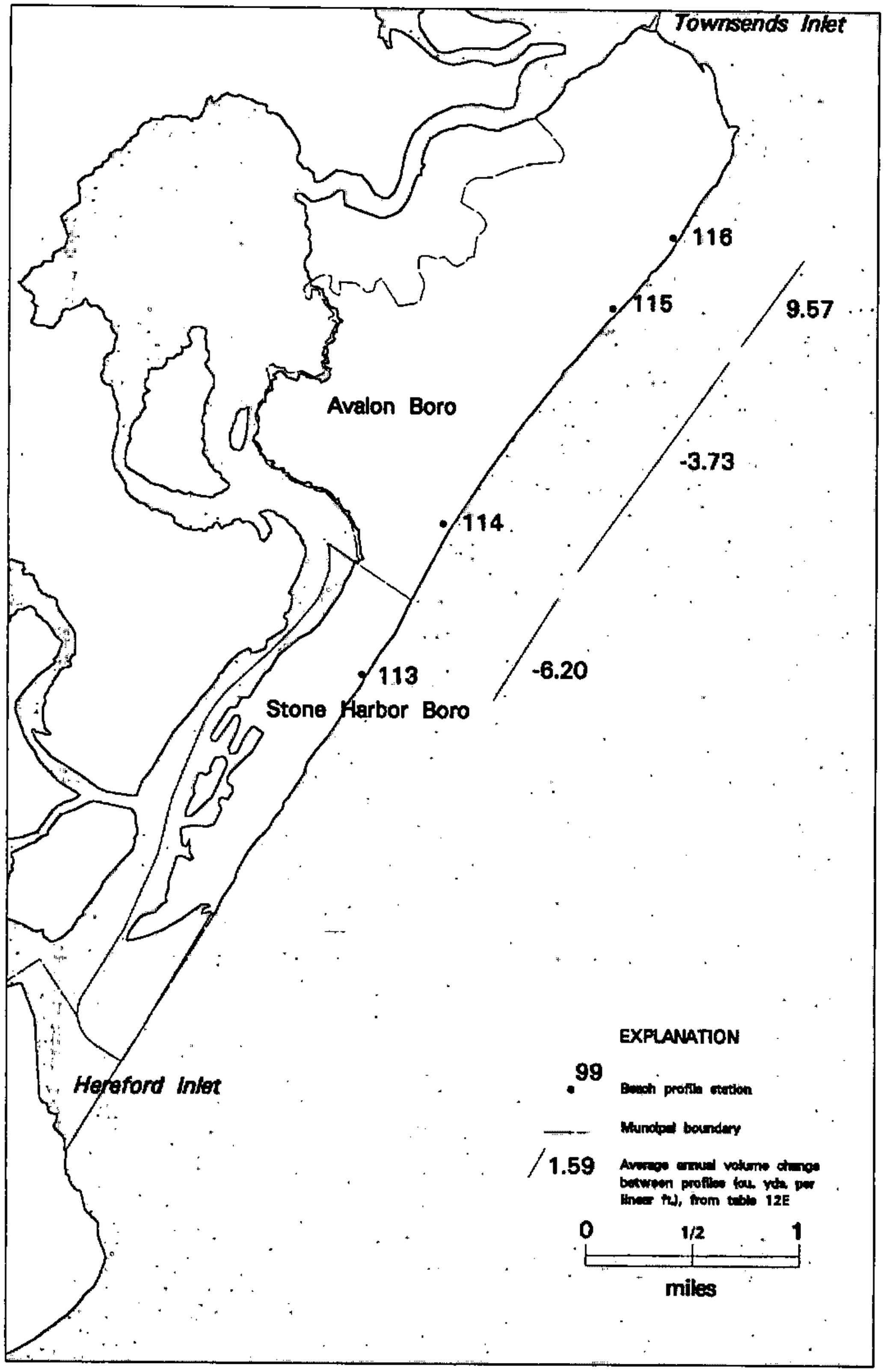


Figure 14. Map of Reach 12, Townsends Inlet to Hereford Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Table 12A. Profile stations - Townsends Inlet to Hereford Inlet (Seven Mile Beach), Cape May County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
116	744246W	390548N	14.03	23rd St., Avalon Borough
115	744317W	390524N	16.85	35th St., Avalon Borough
114	744432W	390408N	10.25	70th St., Avalon Borough
113	744511W	390322N	17.90	90th St., Stone Harbor Borough

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.

Table 12B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
Avalon Borough	1985	Inlet revetment extension from 15th to 17th street.		
	1987	Replenishment	1,379,066	7,100
	1990	"	400,000	"
	1992	"	350,000	"
	1989	Sand redistribution, from gaining to losing beaches.	60,000	Variable
	1990	"	"	"
	1991	"	"	"
Stone Harbor		No activity noted.		

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 12C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
113	460.49	319.76	359.15	47.09	-118.73
114	506.04	458.90	482.48	19.63	-14.62
115	879.37	818.79	847.98	21.98	-24.65
116	653.48	378.24	516.78	95.05	275.24

[1] Data summarized from table 2 of Profiles 113-116.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 113-116.

Table 12D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
113	8.36	-38.12	-7.16	16.89	-42.95
114	14.75	-43.06	-5.25	22.58	-31.51
115	8.12	-12.69	-2.21	7.09	-13.25
116	75.03	-26.66	21.36	34.08	128.13

[1] Data summarized from table 1 of Profiles 113-116.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 113-116.

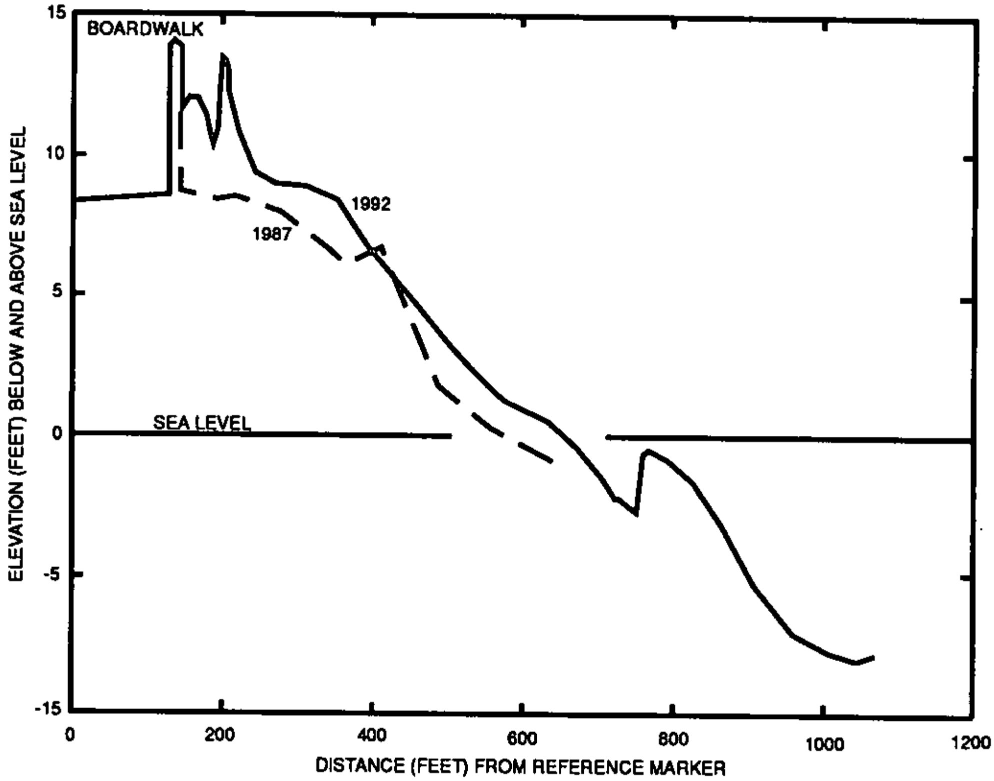
Table 12E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
113-114	5,500	-6.20	-34,100	4,035
114-115	10,000	-3.73	-37,300	6,103
115-116	3,400	9.57	32,538	1,865

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 12, Profile 116
23rd Street, Avalon Borough

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

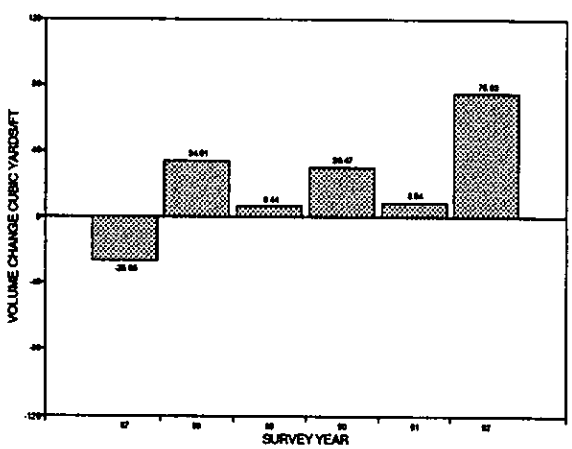


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-26.66	NA	-26.66
1988	21.35	12.66	34.01
1989	4.08	2.36	6.44
1990	20.31	10.16	30.47
1991	5.30	3.54	8.84
1992	38.12	36.91	75.03
Approximate 6-yr. volume change			128.13
Mean annual volume change			21.36
Standard deviation			34.08

[1] Negative value denotes loss of sand

Graph 2

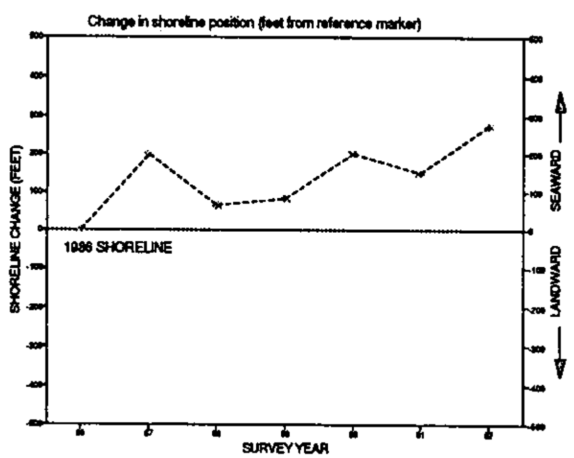


Table 2

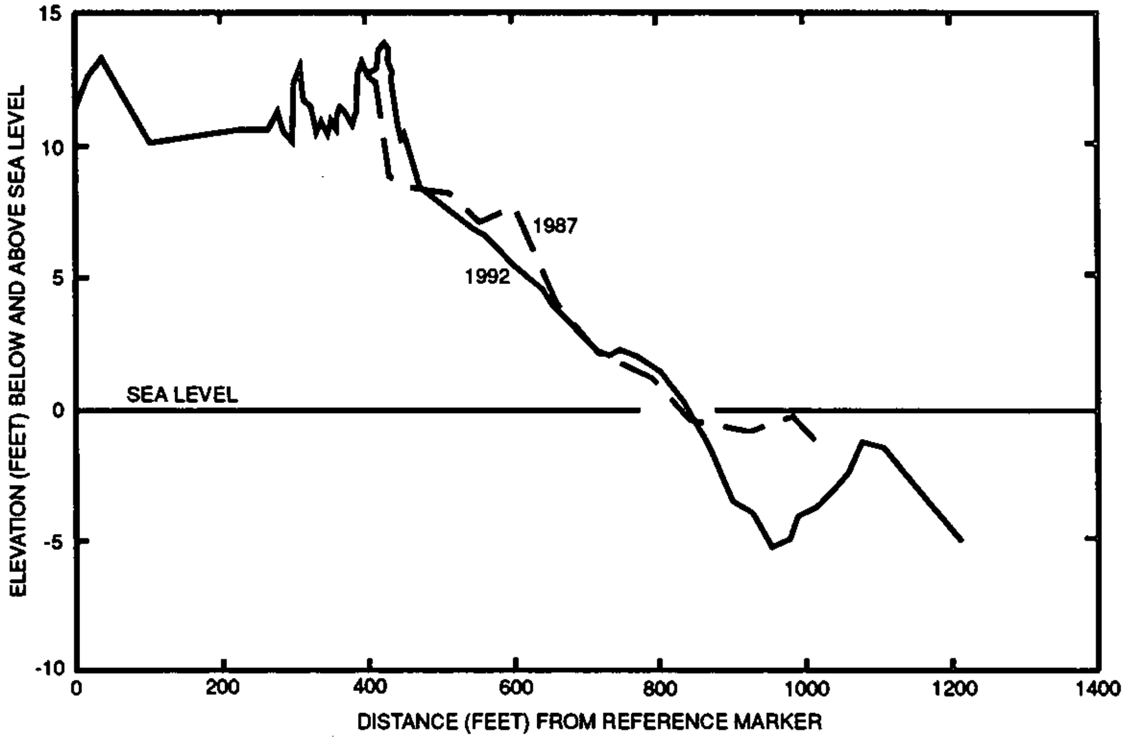
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/31	378.24	
1987	09/14	575.18	196.94
1988	10/27	442.18	63.94
1989	09/25	459.51	81.27
1990	10/12	579.34	201.10
1991	10/08	529.55	151.31
1992	10/08	653.48	275.24
Net shoreline change, 1986-1992 [3]			275.24
Mean annual distance from ref. mkr., 1986-1992 [3]			516.78
Standard deviation			95.05

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 12, Profile 115
35th Street, Avalon Borough

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

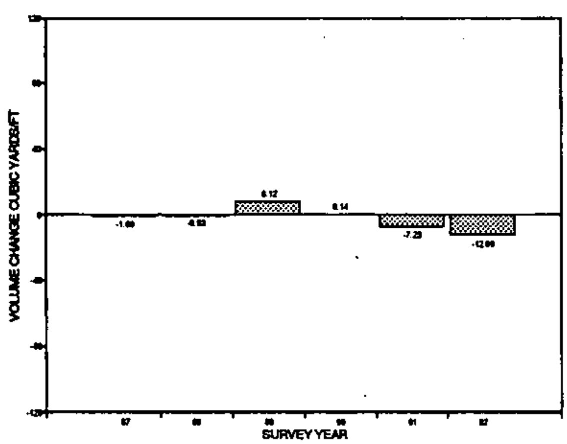


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-1.06	NA	-1.06
1988	13.56	-14.09	-0.53
1989	5.58	2.54	8.12
1990	-4.15	4.29	0.14
1991	-9.36	2.13	-7.23
1992	-6.90	-5.79	-12.69
Approximate 6-yr. volume change			-13.25
Mean annual volume change			-2.21
Standard deviation			7.09

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

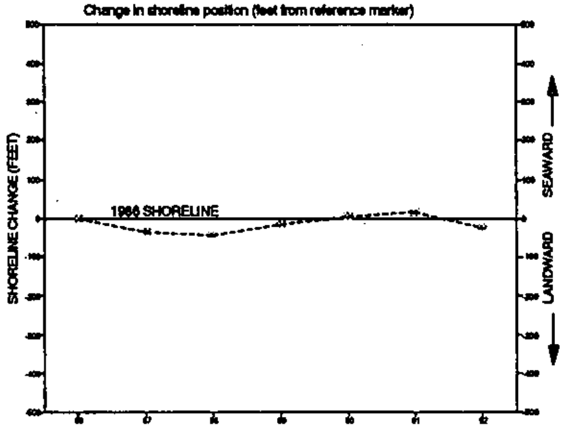


Table 2

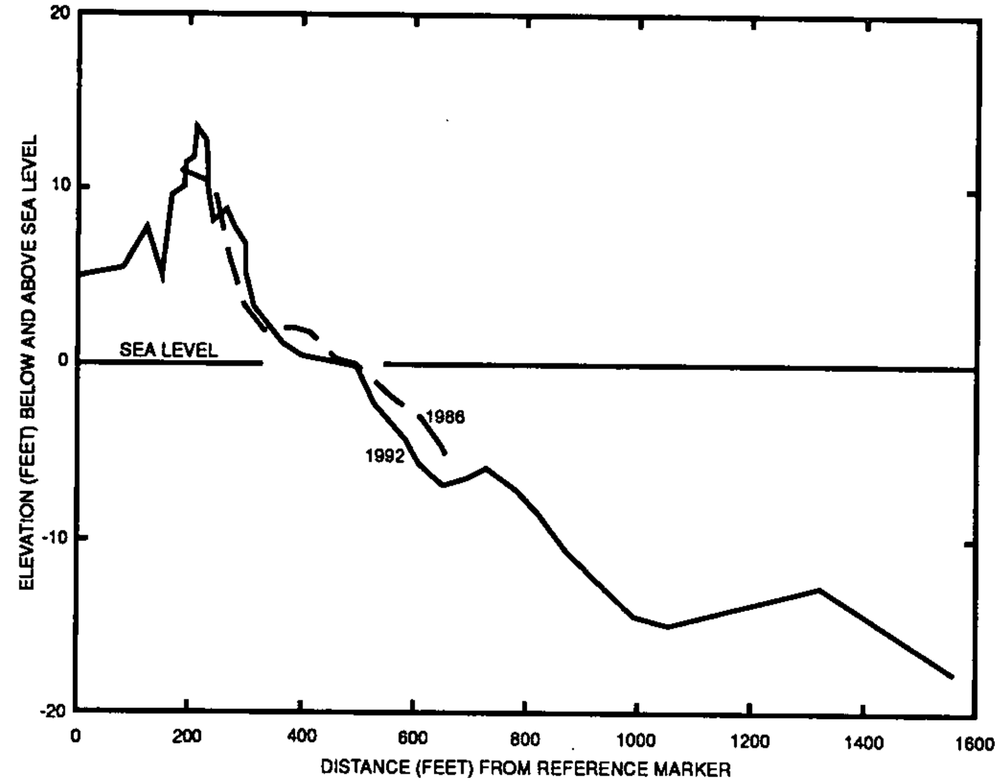
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/31	861.55	
1987	09/15	827.50	-34.05
1988	10/27	818.79	-42.76
1989	09/25	845.61	-15.94
1990	10/12	866.16	4.61
1991	10/08	879.37	17.82
1992	10/09	836.90	-24.65
Net shoreline change, 1986-1992 [3]			-24.65
Mean annual distance from ref. mkr., 1986-1992 [3]			847.98
Standard deviation			21.98

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 12, Profile 114
70th Street, Avalon Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

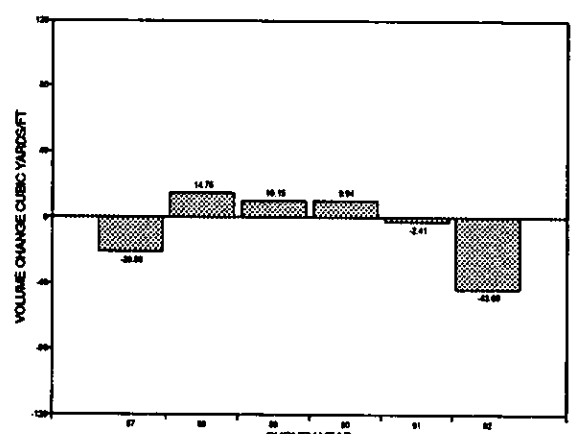


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-7.13	-13.75	-20.88
1988	4.65	10.10	14.75
1989	5.11	5.04	10.15
1990	1.21	8.73	9.94
1991	3.67	-6.08	-2.41
1992	-6.44	-36.62	-43.06
Approximate 6-yr. volume change			-31.51
Mean annual volume change			-5.25
Standard deviation			22.58

[1] Negative value denotes loss of sand

Graph 2

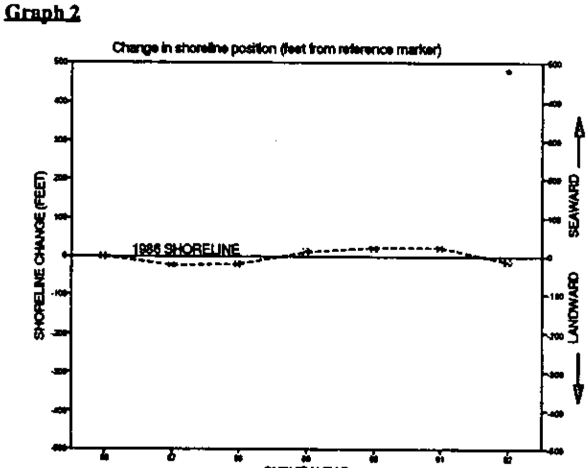


Table 2

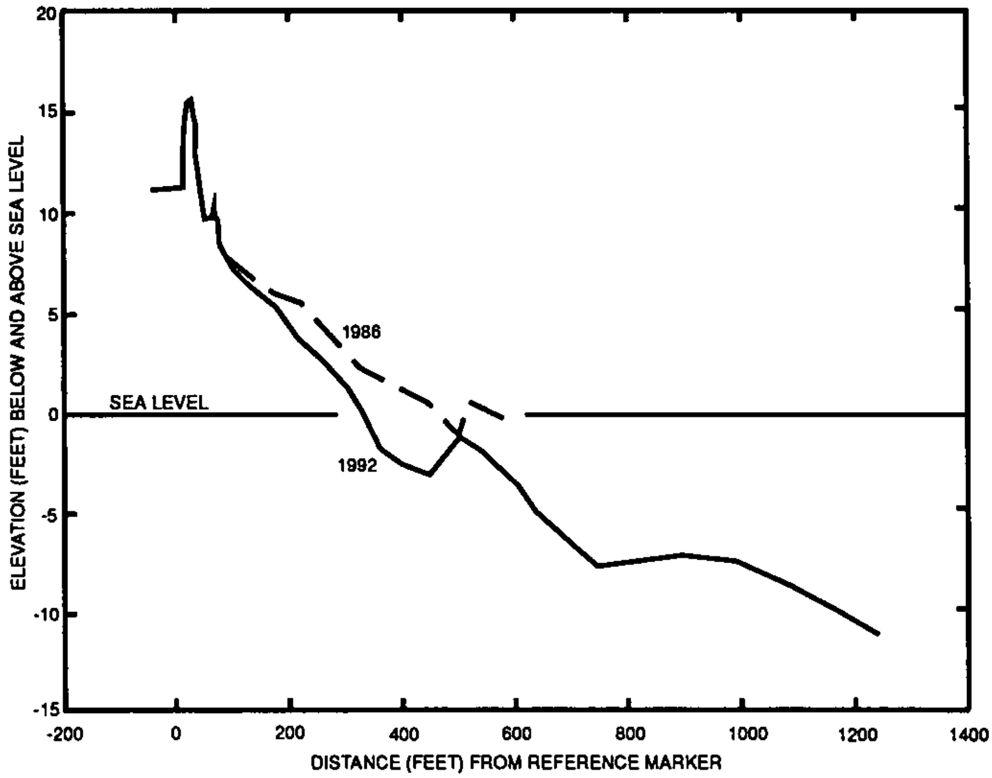
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/30	482.80	
1987	09/15	458.90	-23.90
1988	10/27	463.59	-19.21
1989	09/15	491.97	9.17
1990	10/12	505.91	23.11
1991	10/08	506.04	23.24
1992	10/09	468.18	-14.62
Net shoreline change, 1986-1992 [3]			-14.62
Mean annual distance from ref. mkr., 1986-1992 [3]			482.48
Standard deviation			19.63

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 12, Profile 113
90th Street, Stone Harbor Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

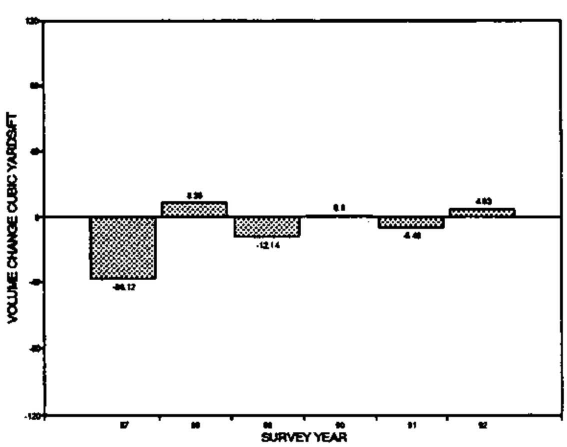


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OS SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-18.05	-20.07	-38.12
1988	11.22	-2.86	8.36
1989	-1.73	-10.41	-12.14
1990	-6.02	6.82	0.80
1991	-0.83	-5.65	-6.48
1992	2.54	2.09	4.63
Approximate 6-yr. volume change			-42.95
Mean annual volume change			-7.16
Standard deviation			16.89

[1] Negatve value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

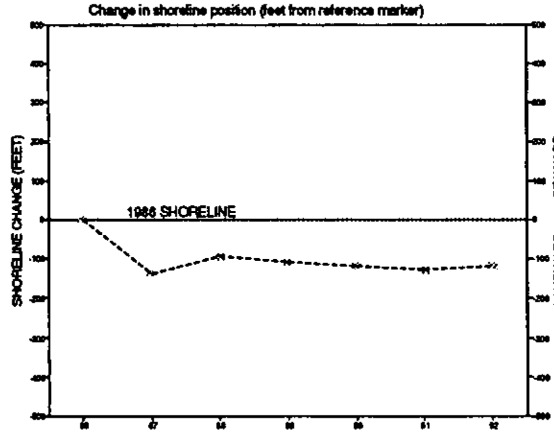


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/30	460.49	
1987	09/15	319.76	-140.73
1988	10/27	365.91	-94.58
1989	09/15	353.56	-106.93
1990	10/27	341.76	-118.73
1991	11/04	330.80	-129.69
1992	10/12	341.76	-118.73
Net shoreline change, 1986-1992 [3]			-118.73
Mean annual distance from ref. mkr., 1986-1992 [3]			359.15
Standard deviation			47.09

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

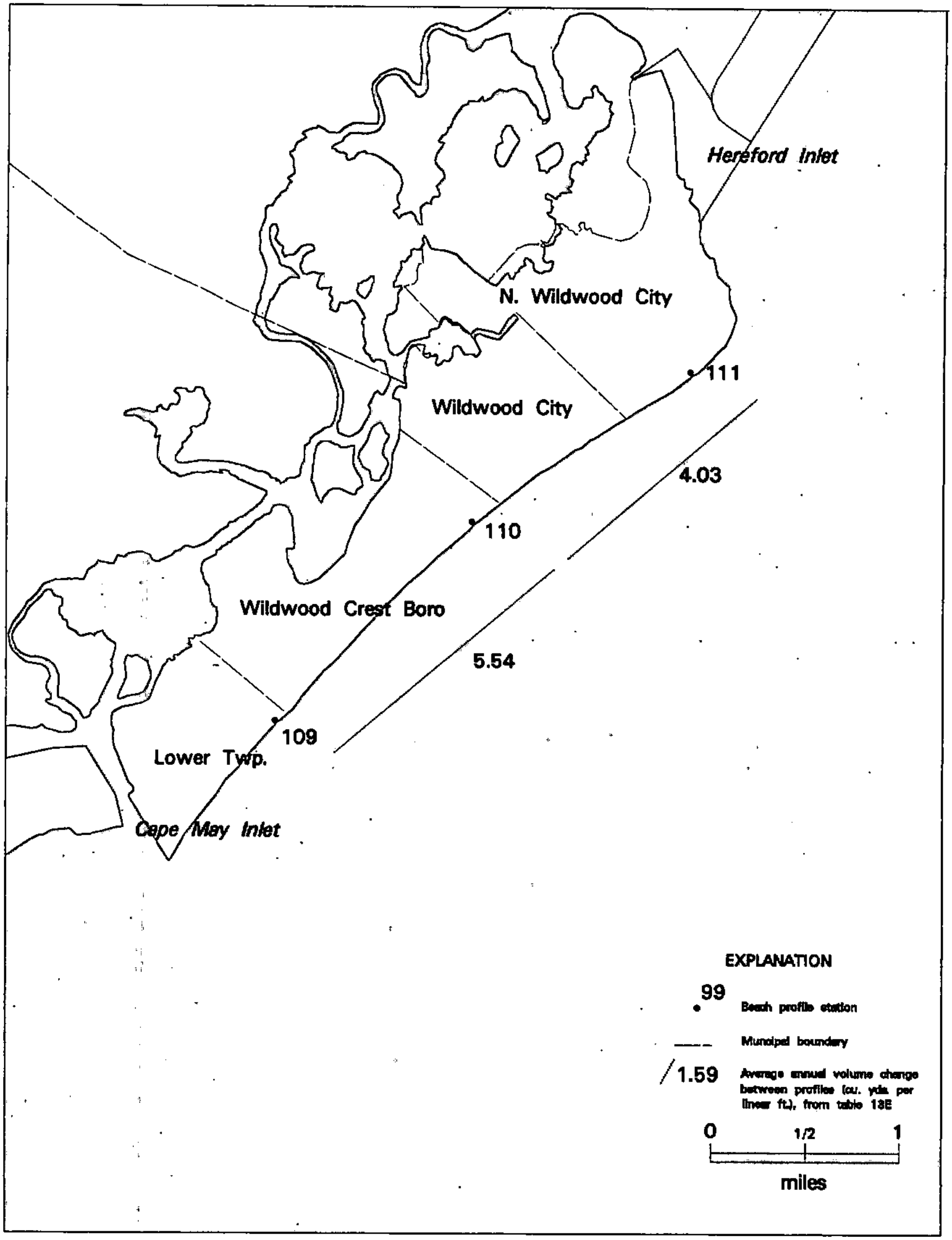


Figure 15. Map of Reach 13, Hereford Inlet to Cape May Inlet, showing municipalities, profile locations, and calculated volume change between profiles.

Reach 13 - Hereford Inlet to Cape May Inlet (Five Mile Beach), Cape May County

Table 13A. Profile stations - Hereford Inlet to Cape May Inlet (Five Mile Beach), Cape May County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
111	744732W	385933N	10.79	15th Ave., N. Wildwood City
110	744922W	385835N	10.50	Crease Ave., Wildwood City
109	745101W	385718N	10 (est.)[4]	Raleigh Ave., Lower Twp.

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.
[4] Estimated, not measured.

Table 13B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
North Wildwood City	1985	Replenishment and redistribution of sand dredged from Hereford Inlet.	100,000	NA
	1989	"	100,000	NA
	1990	"	NA	NA
	1991	Sand redistribution	NA	NA
Wildwood City	1990	Redistribution of sand dredged from Hereford Inlet and transferred from North Wildwood Beach.	NA	NA
	1991	Sand redistribution	NA	NA
Wildwood Crest Borough		No activity noted.		
Lower Twp.		No activity noted. Southern 1.2 miles of Island is part of U.S. Coast Guard Station (USCG).		

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 13C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
109	565.42	410.43	468.91	50.82	-113.51
110	954.56	752.49	846.04	73.01	141.22
111	1416.39	1091.96	1260.53	111.31	-324.43

[1] Data summarized from table 2 of Profiles 109-111.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 109-111.

Table 13D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
109	25.61	-21.27	-0.12	17.45	-0.72
110	110.31	-108.13	11.21	71.45	67.24
111	52.28	-55.64	-3.14	41.09	-18.84

[1] Data summarized from table 1 of Profiles 109-111.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 109-111.

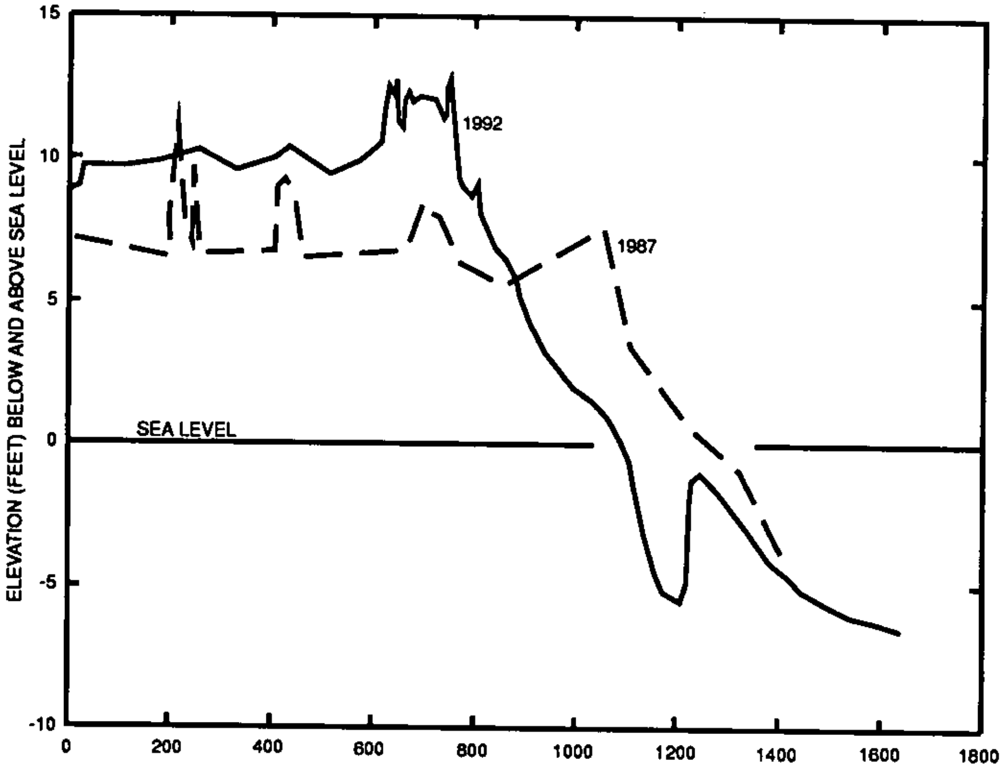
Table 13E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
109-110	11,000	5.54	60,940	4,141
110-111	10,000	4.03	40,300	4,845

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 13, Profile 111
15th Avenue, North Wildwood City

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

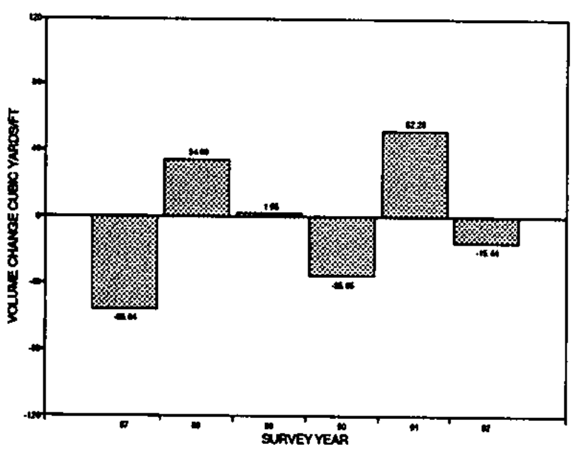


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR[1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-55.64	0.00	-55.64
1988	28.26	5.80	34.06
1989	6.48	-4.93	1.55
1990	-35.65	0.00	-35.65
1991	53.10	-0.82	52.28
1992	-0.99	-14.45	-15.44
Approximate 6-yr. volume change			-18.84
Mean annual volume change			-3.14
Standard deviation			41.09

[1] Negative value denotes loss of sand

Graph 2

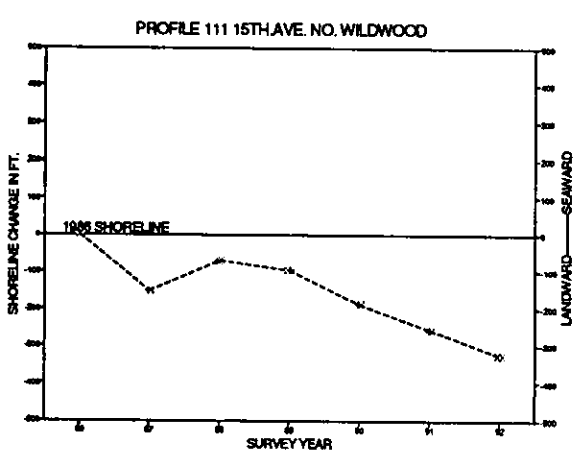


Table 2

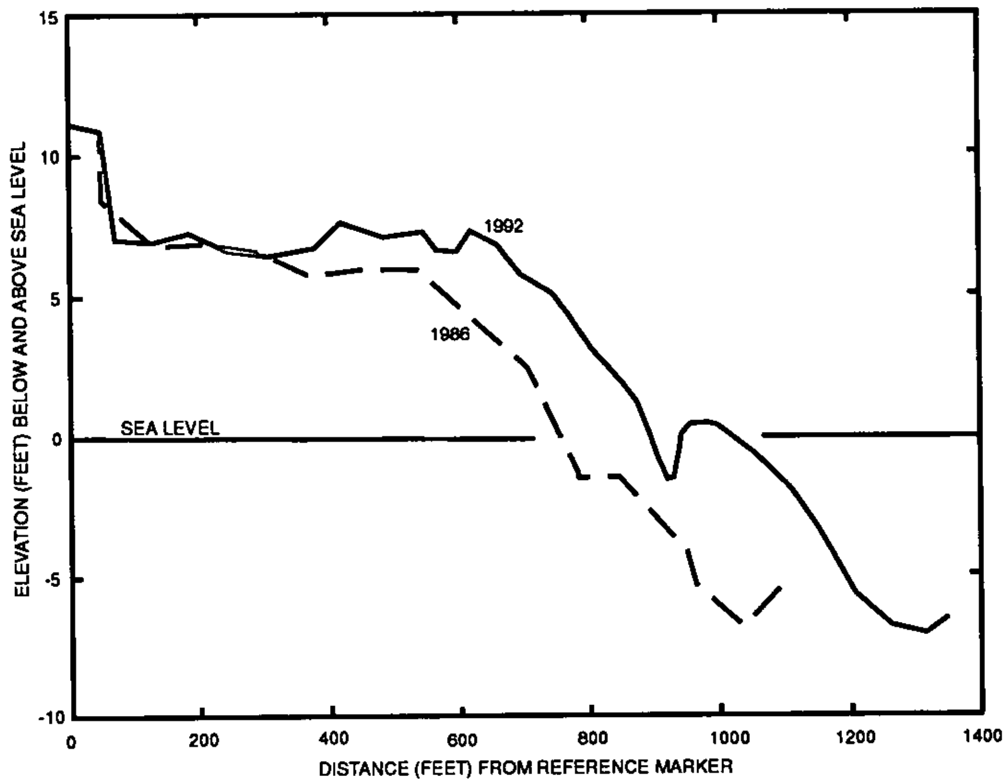
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker[1]	Change from 1986 shoreline[2]
1986	10/29	1416.39	
1987	09/22	1264.52	-151.88
1988	11/10	1344.29	-72.1
1989	09/15	1318.58	-97.81
1990	10/05	1228.49	-187.9
1991	11/04	1159.50	-256.89
1992	10/14	1091.96	-324.43
Net shoreline change, 1986-1992[3]			-324.43
Mean annual distance from ref. mkr., 1986-1992[3]			1260.53
Standard deviation			111.31

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 13, Profile 110
Cresse Avenue, Wildwood City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

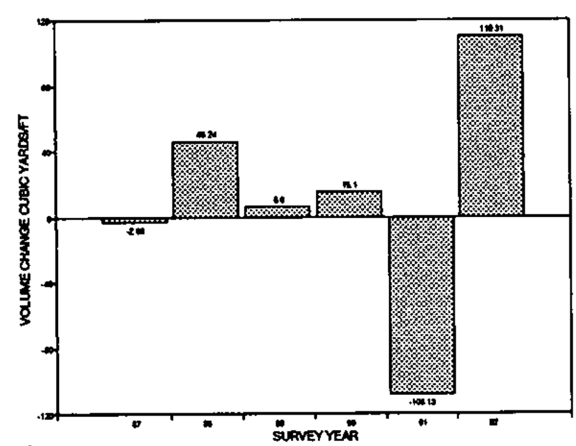


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR[1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-6.76	3.88	-2.88
1988	38.77	7.47	46.24
1989	3.48	3.12	6.60
1990	10.93	4.17	15.10
1991	-79.33	-28.80	-108.13
1992	79.58	30.73	110.31
Approximate 6-yr. volume change			67.24
Mean annual volume change			11.21
Standard deviation			71.45

[1] Negative value denotes loss of sand

Graph 2

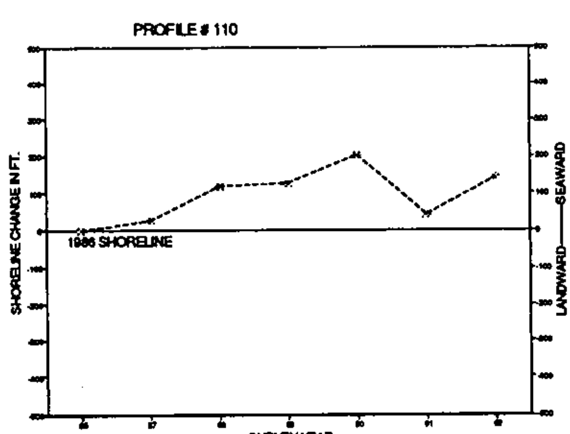


Table 2

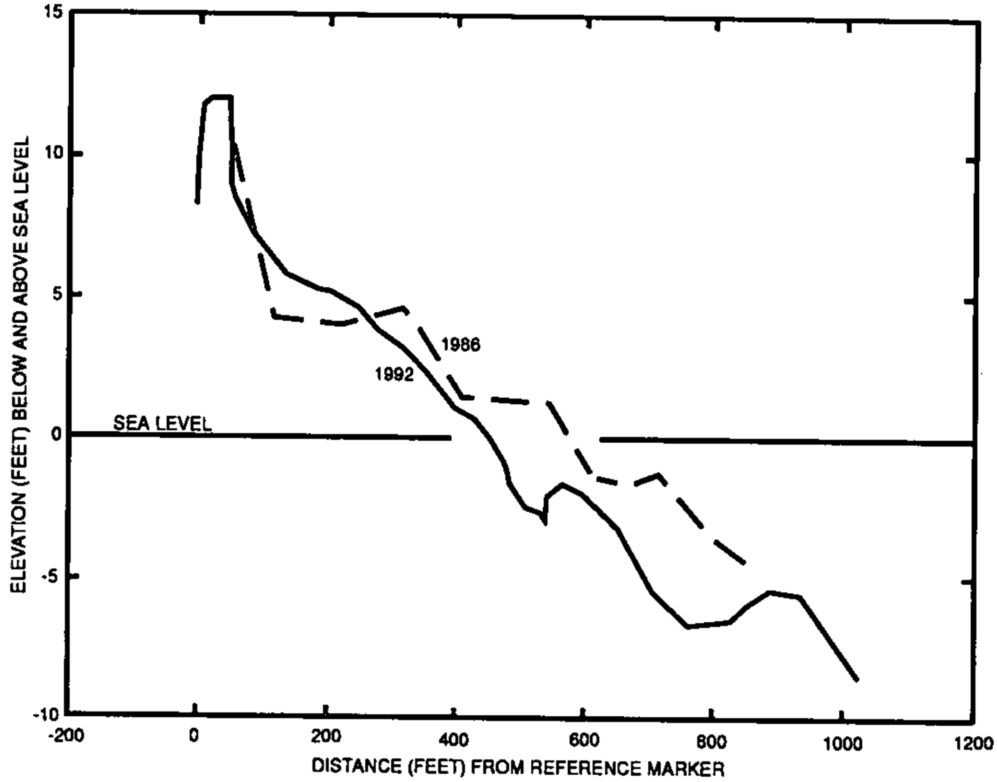
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker[1]	Change from 1986 shoreline[2]
1986	10/30	752.49	
1987	09/18	777.27	24.78
1988	11/10	871.84	119.35
1989	09/13	878.60	126.11
1990	10/05	954.56	202.07
1991	11/04	793.80	41.31
1992	10/14	893.71	141.22
Net shoreline change, 1986-1992[3]			141.22
Mean annual distance from ref. mkr., 1986-1992[3]			846.04
Standard deviation			73.01

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 13, Profile 109
Raleigh Avenue, Lower Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

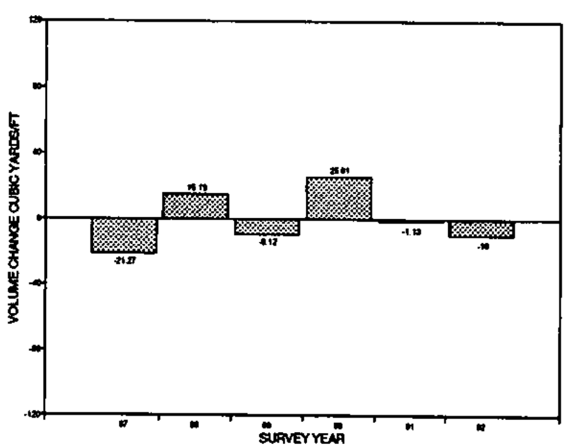


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	0.35	-21.62	-21.27
1988	7.38	7.81	15.19
1989	-1.02	-8.10	-9.12
1990	12.09	13.52	25.61
1991	-12.11	10.98	-1.13
1992	0.26	-10.26	-10.00
Approximate 6-yr. volume change			-0.72
Mean annual volume change			-0.12
Standard deviation			17.45

[1] Negative value denotes loss of sand

Graph 2

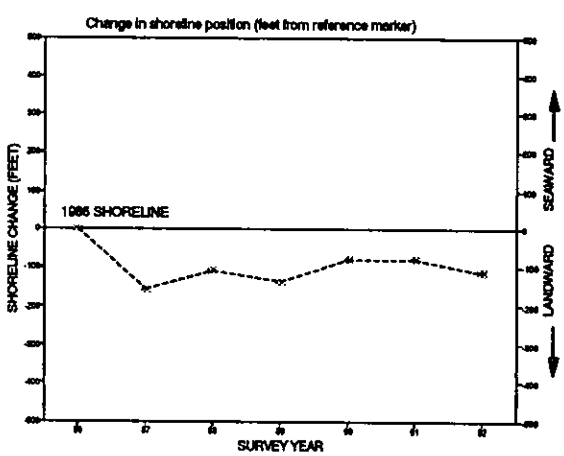


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/29	565.42	
1987	09/18	410.43	-154.99
1988	11/10	456.53	-108.89
1989	09/13	426.93	-138.49
1990	10/05	485.35	-80.07
1991	11/04	485.79	-79.63
1992	10/14	451.91	-113.51
Net shoreline change, 1986-1992 [3]			-113.51
Mean annual distance from ref. mkr., 1986-1992 [3]			468.91
Standard deviation			50.82

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

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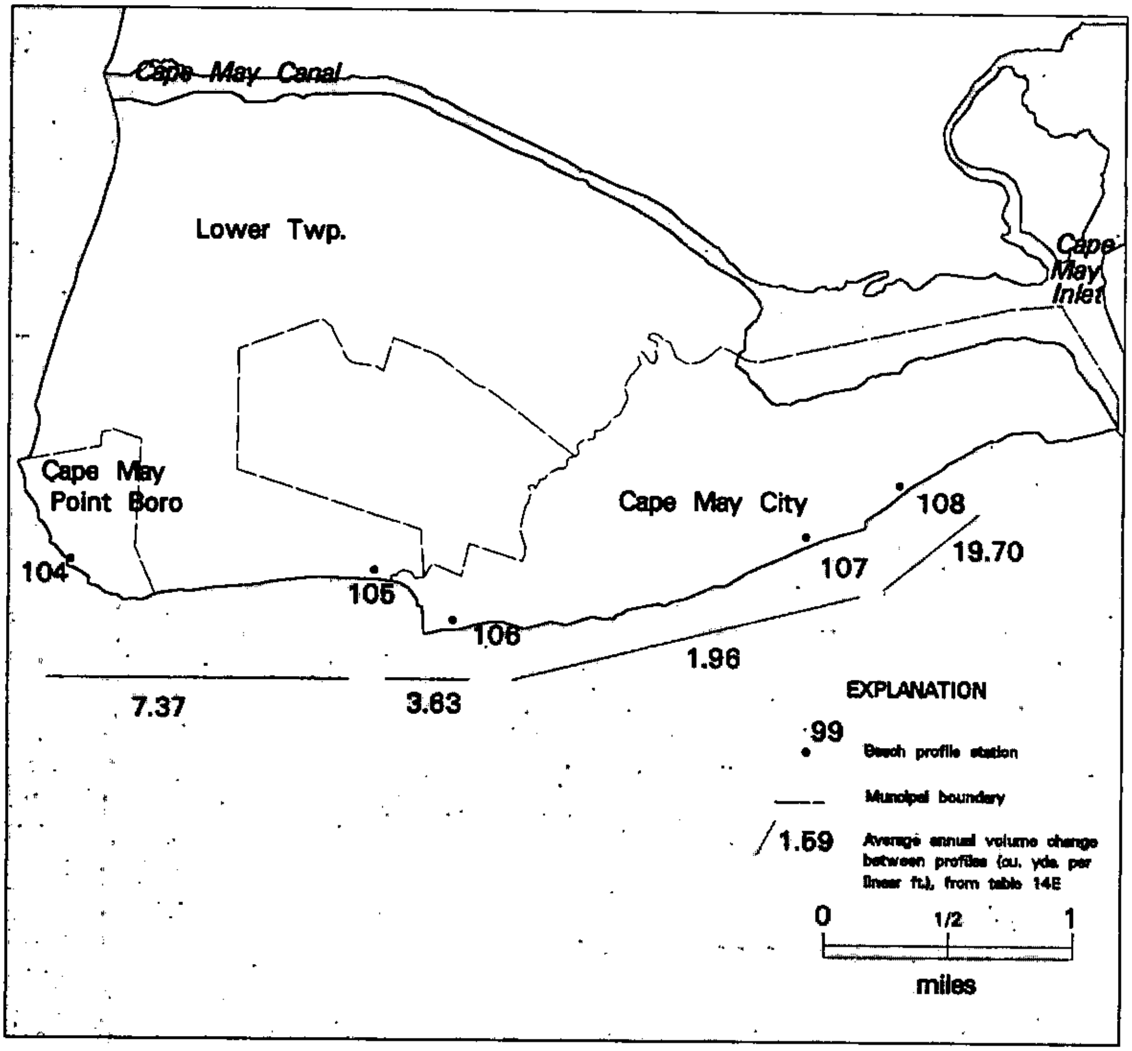


Figure 16. Map of Reach 14, Cape May Inlet to Lower Township, showing municipalities, profile locations, and calculated volume change between profiles.

Table 14A. Profile stations - Cape May Inlet to Lower Township, Cape May County

Beach profile station	Location: Longitude [1]	Location: Latitude [1]	Elevation (ft.) [2]	Site description 3
108	745328W	385620N	10 (est.)[4]	Cape May Beach Club, Cape May City
107	745357W	385605N	11.82	Baltimore Ave., Cape May City
106	745555W	385545N	14.42	Broadway and Beach Ave., Cape May City
105	745622W	385554N	7.07	Nature Conservancy, Lower Twp.
104	745803W	385601N	12.35	St. Peter's Church, Cape May Point Borough

[1] In degrees, minutes, seconds.
[2] Elevation of reference marker is in feet above or below sea level, NGVD (National Geodetic Vertical Datum of 1929).
[3] Location of beach profile survey stations estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps.
[4] Estimated, not measured.

Table 14B. Beach replenishment and construction activities, 1985-1992 [1]

Municipality	Date	Activity	Replenishment [2]: Volume of sand (cu. yds.)	Replenishment [2]: Length of shoreline (linear ft.)
	1990	Army Corps begins major 50 year replenishment project for entire Reach, using sand from offshore shoals.		
Cape May City		Eastern 1 mile of area is part of U.S. Coast Guard Station (USCG).		
	1989	Replenishment at USCG with sand dredged from Cape May Inlet.	465,000	NA
	1991	Replenishment with sand from offshore borrow area.	800,000	12,000
	1992	"	500,000	12,000
Lower Twp.		Western 2,000 ft of Twp. is State Park.		
	1986	Dune construction in State Park with sand from stockpile of Cape Canal dredge material.	47,000	3,600
	1986	"	40,000	4,300
Cape May Point Borough	1992	Replenishment with sand from stockpile of Cape May Canal dredge material.	42,000	1,350

[1] Data from New Jersey Dept. of Environmental Protection, Division of Engineering and Construction, Spring, 1994.
[2] NA, data not available.

Table 14C. Shoreline change, 1986-1992 by profile in feet [1]

Profile	Max. [2]	Min. [2]	Mean [2]	Standard deviation	Net change [3]
104	414.91	374.09	392.67	14.10	-40.82
105	653.77	314.57	441.29	120.79	322.99
106	424.22	253.93	321.17	52.52	-170.29
107	351.36	151.04	214.56	92.58	183.14
108	582.19	329.10	436.78	103.93	253.09

[1] Data summarized from table 2 of Profiles 104-108.
[2] The maximum, minimum and mean distances from the reference marker, 1986-1992 based on annual measurements.
[3] Values are summarized from the values listed as "Net shoreline change, 1986-1992" in table 2 of Profiles 104-108.

Table 14D. Approximate volume change, 1986-1992 by profile in cubic yards per linear foot of shoreline [1]

Profile	High	Low	Mean volume change [2]	Standard deviation [2]	Net change [2]
104	10.84	-12.84	-4.40	8.83	-26.38
105	66.76	-26.25	19.14	32.11	114.85
106	14.14	-34.67	-11.88	19.45	-71.27
107	91.03	-4.92	15.80	37.24	94.79
108	69.49	2.03	23.60	26.53	141.60

[1] Data summarized from table 1 of Profiles 104-108.
[2] Mean annual volume change, 1986-1992, standard deviation, and approximate 6-year volume change from table 1 of Profiles 104-108.

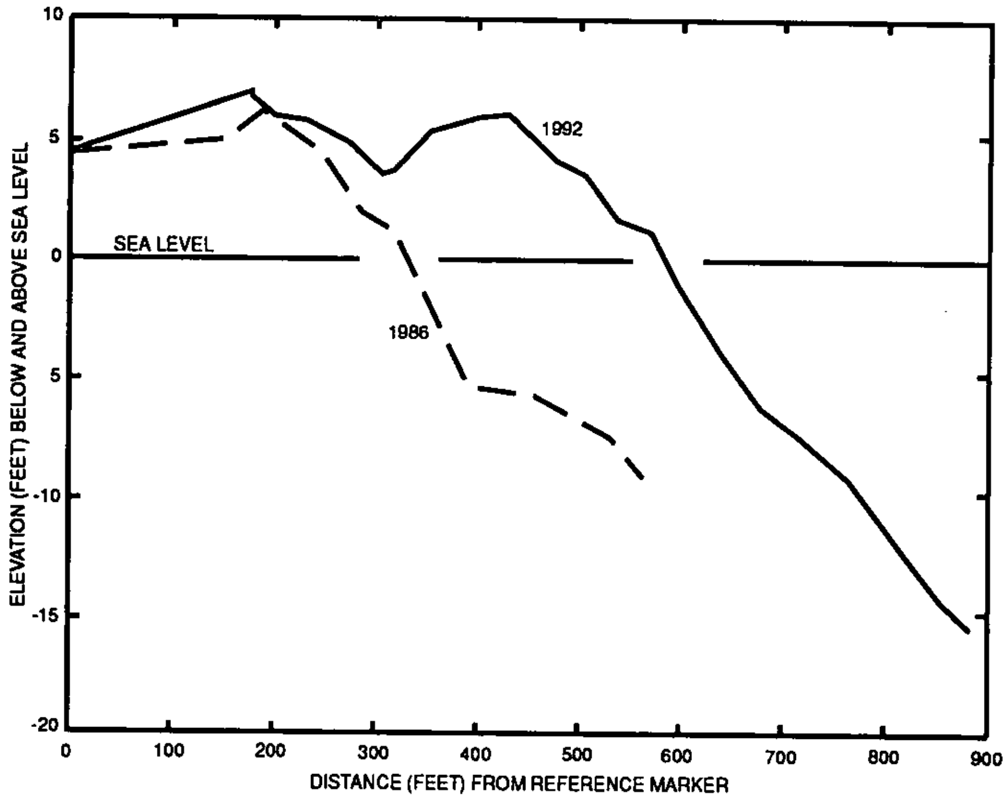
Table 14E. Projected volume change and hypothetical replenishment volume for intervals between profiles in cubic yards [1]

Profile station interval	Distance between profiles (linear ft.)	Average annual volume change (cu. yds. per linear ft.) [2]	Projected volume change between profiles (cu. yds.) [3]	Hypothetical replenishment volume (cu. yds.) [4]
104-105	9,600	7.37	70,752	4,988
105-106	8,300	3.63	30,129	4,657
106-107	2,200	1.96	4,312	1,136
107-108	8,800	19.70	173,360	5,326

[1] Projected values only. The calculated values listed here in the three righthand columns are based on the assumption that the profile conditions extend from each profile to the midway point between profiles and that there are no engineered structures between them.
[2] Average of the mean annual volume change values from Table 1 of the 2 profiles in the lefthand column. This value is listed for shoreline intervals between profiles on the accompanying reach map.
[3] Projected volume change between profiles calculated as the average annual volume change multiplied by the distance between profiles.
[4] Hypothetical replenishment volume calculated utilizing the ISRP Program to find the volume required to extend the 1992 beach profile 1 foot seaward from the 5-foot land surface elevation along slope of profile.

Reach 14, Profile 108
Cape May Beach Club, Cape May City

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

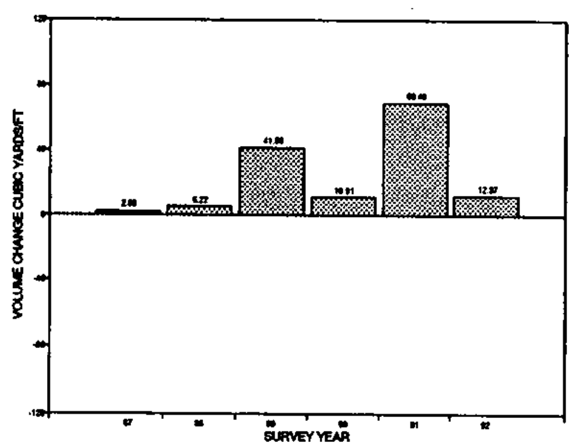


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	4.70	-2.67	2.03
1988	2.15	3.07	5.22
1989	9.51	32.07	41.58
1990	8.83	2.08	10.91
1991	23.56	45.93	69.49
1992	3.92	8.45	12.37
Approximate 6-yr. volume change			141.60
Mean annual volume change			23.60
Standard deviation			26.53

[1] Negative value denotes loss of sand

Graph 2

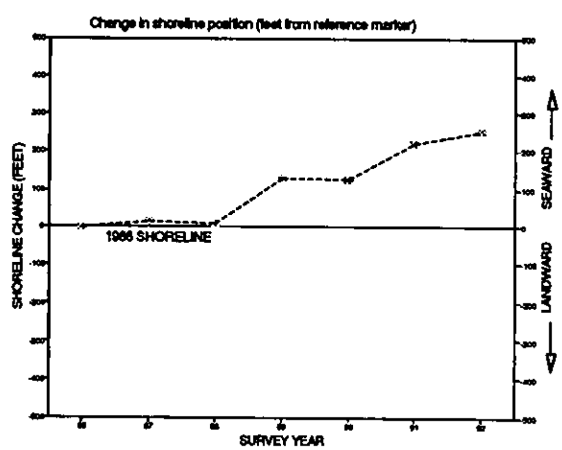


Table 2

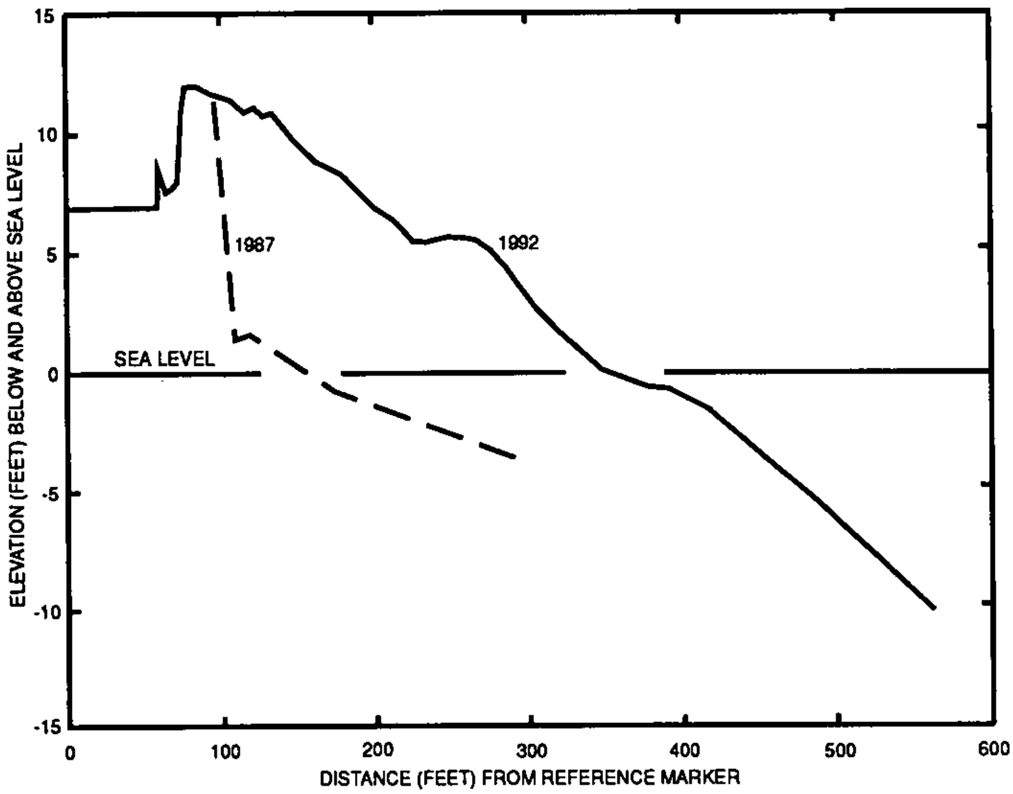
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/29	329.10	
1987	09/18	343.66	14.56
1988	11/04	337.16	8.06
1989	09/13	458.74	129.64
1990	10/04	457.78	128.68
1991	11/05	548.80	219.7
1992	10/15	582.19	253.09
Net shoreline change, 1986-1992 [3]			253.09
Mean annual distance from ref. mkr., 1986-1992 [3]			436.78
Standard deviation			103.93

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 14, Profile 107
Baltimore Avenue, Cape May City

Change in profile of sand surface, 1987 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

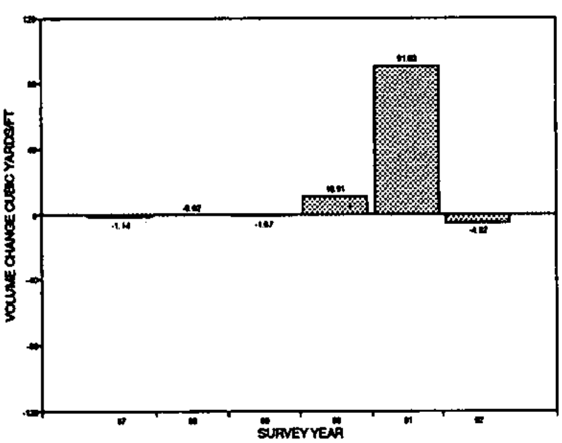


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mena sea level	Annual total
1987	-0.02	-1.12	-1.14
1988	-0.58	0.56	-0.02
1989	0.03	-1.10	-1.07
1990	0.49	10.42	10.91
1991	91.03	0.00	91.03
1992	-10.14	5.22	-4.92
Approximate 6-yr. volume change			94.79
Mean annual volume change			15.80
Standard deviation			37.24

[1] Negative value denotes loss of sand

Graph 2

Change in shoreline position (feet from reference marker)

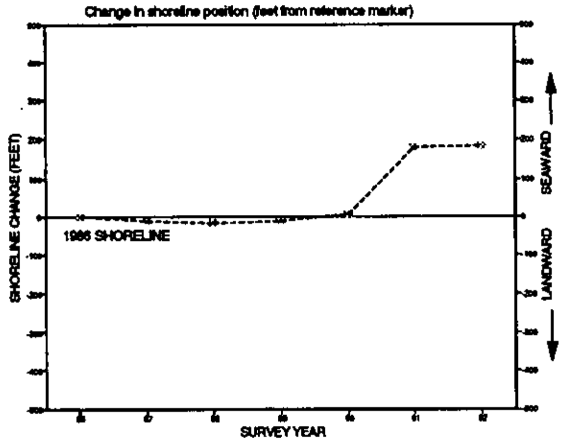


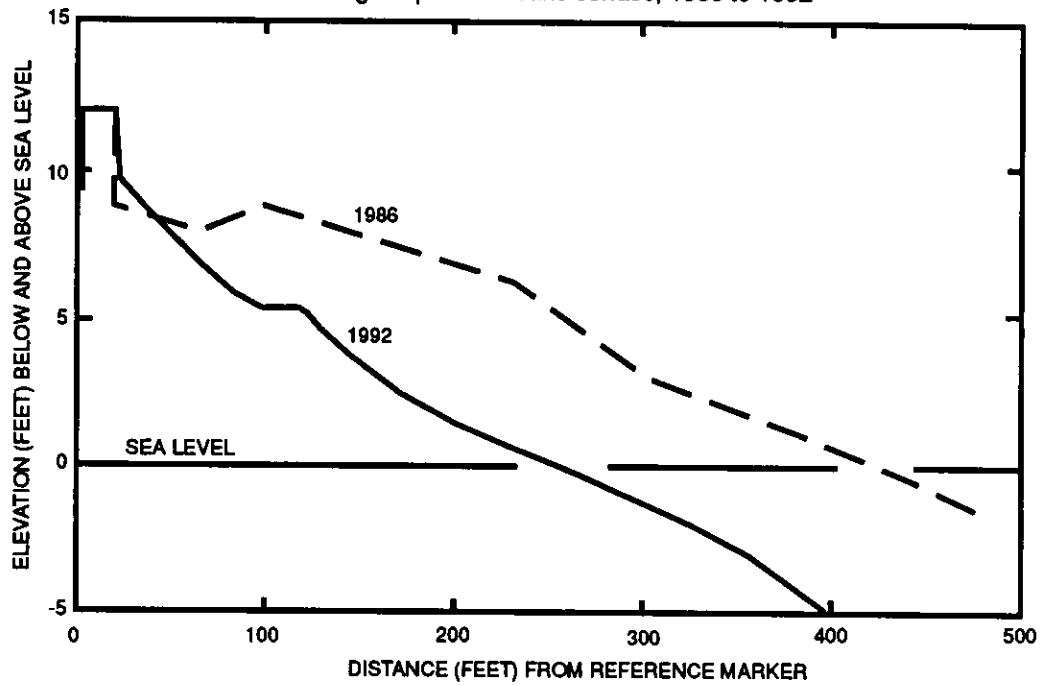
Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/28	168.22	
1987	09/18	155.44	-12.78
1988	11/04	151.04	-17.18
1989	09/13	154.69	-13.53
1990	10/04	173.39	5.17
1991	11/05	347.80	179.58
1992	10/06	351.36	183.14
Net shoreline change, 1986-1992 [3]			183.14
Mean annual distance from ref. mkr., 1986-1992 [3]			214.56
Standard deviation			92.58

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 14, Profile 106
Broadway and Beach Avenue, Cape May City



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

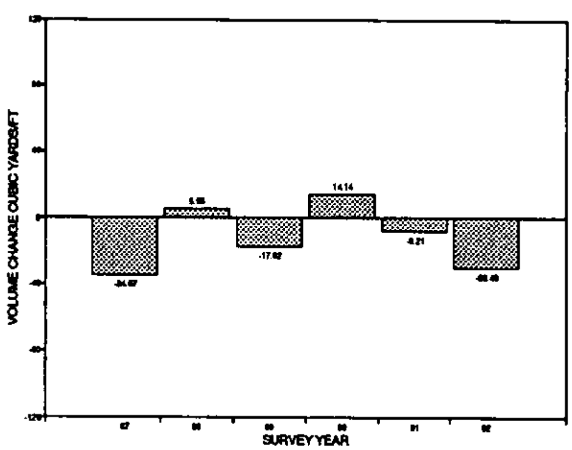


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-25.58	-9.09	-34.67
1988	3.49	2.06	5.55
1989	-7.98	-9.64	-17.62
1990	4.31	9.83	14.14
1991	-4.07	-4.14	-8.21
1992	-14.07	-16.39	-30.46
Approximate 6-yr. volume change			-71.27
Mean annual volume change			-11.88
Standard deviation			19.45

[1] Negative value denotes loss of sand

Graph 2

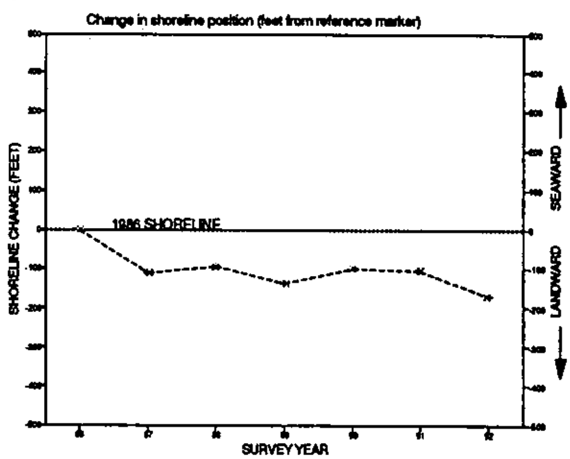


Table 2

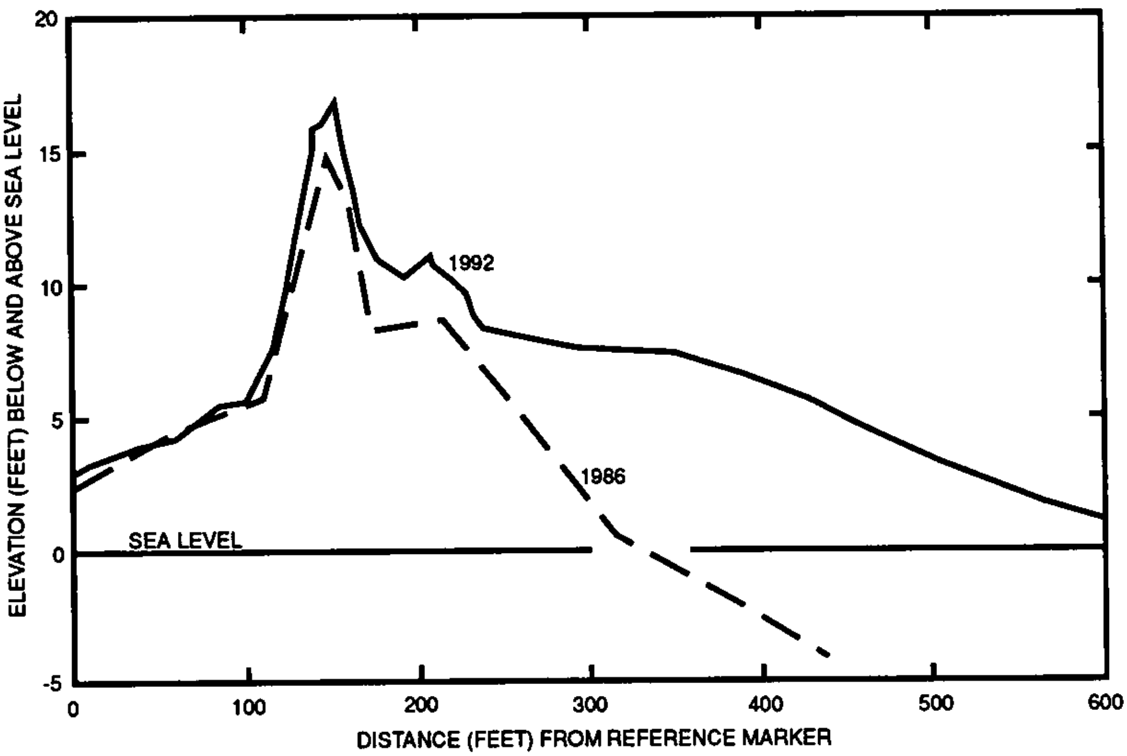
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shreline [2]
1986	10/28	424.22	
1987	09/17	312.81	-111.42
1988	11/04	330.54	-93.68
1989	09/13	285.91	-138.31
1990	10/04	322.30	-101.92
1991	11/05	318.51	-105.71
1992	10/06	253.93	-170.29
Net shoreline change, 1986-1992 [3]			-170.29
Mean annual distance from ref. mkr., 1986-1992 [3]			321.17
Standard deviation			52.52

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 14, Profile 105
Nature Conservancy, Lower Township

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

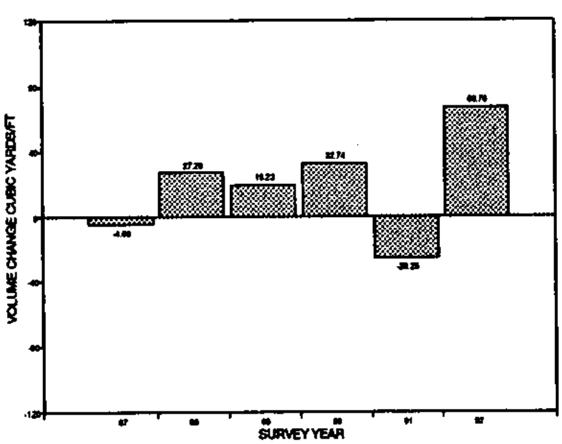


Table 1

Year	Above mean sea level	Below mean sea level	Annual total
1987	-0.31	-4.58	-4.89
1988	19.42	7.84	27.26
1989	13.84	5.39	19.23
1990	17.24	15.50	32.74
1991	-0.03	-26.22	-26.25
1992	20.84	45.92	66.76
Approximate 6-yr. volume change			114.85
Mean annual volume change			19.14
Standard deviation			32.11

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

[1] Negative value denotes loss of sand

Graph 2

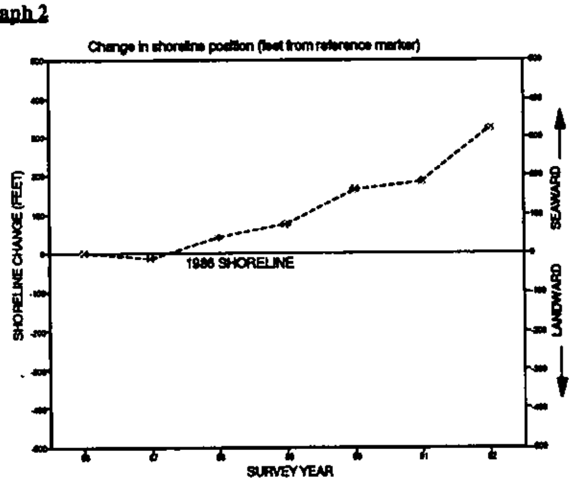


Table 2

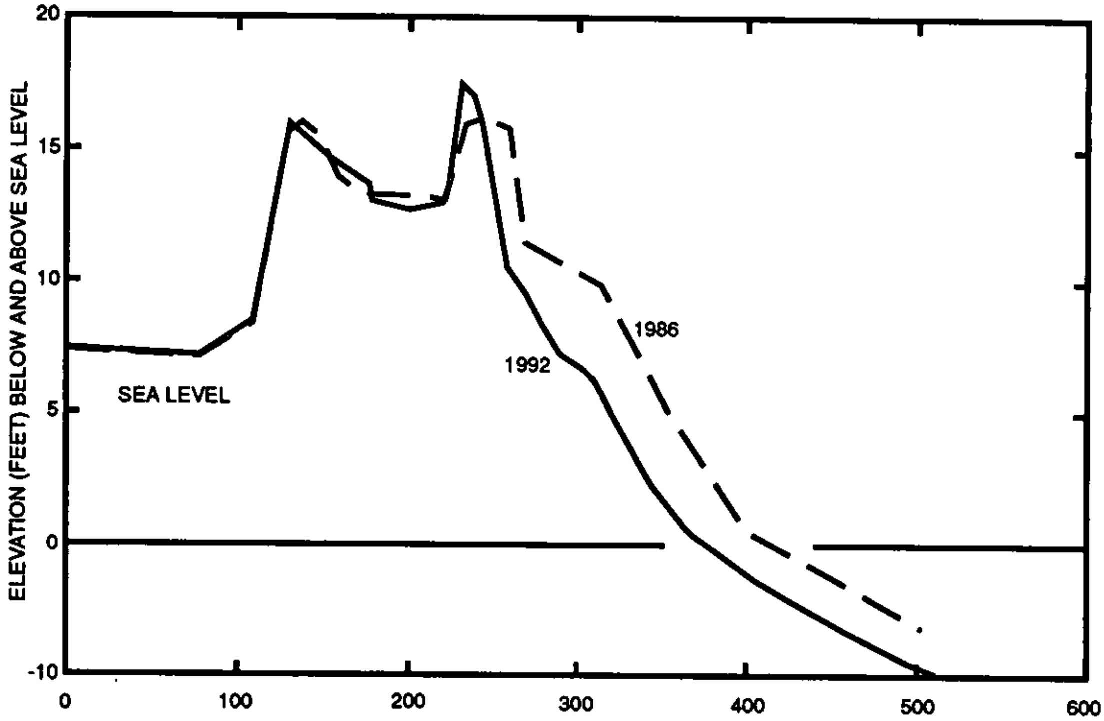
SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from refernce marker [1]	Change from 1986 shoreline [2]
1986	10/28	330.78	
1987	09/17	314.57	-16.21
1988	10/04	373.11	42.33
1989	09/13	406.80	76.02
1990	10/03	495.87	165.09
1991	11/05	514.16	183.38
1992	10/06	653.77	322.99
Net shoreline change, 1986-1992 [3]			322.99
Mean annual distance from ref. mkr., 1986-1992 [3]			441.29
Standard deviation			120.79

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

Reach 14, Profile 104
St. Peter's Church, Cape May Point Borough

Change in profile of sand surface, 1986 to 1992



Profile lines constructed from 35-50 measurement points/profile.

Graph 1

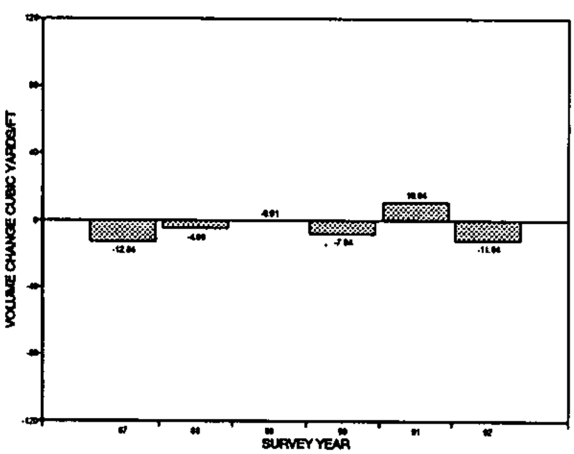


Table 1

APPROXIMATE GAIN OR LOSS OF SAND IN CUBIC YARDS PER LINEAR FOOT OF SHORELINE PER YEAR [1]

Year	Above mean sea level	Below mean sea level	Annual total
1987	-9.02	-3.82	-12.84
1988	-3.13	-1.56	-4.69
1989	-1.47	1.46	-0.01
1990	-3.89	-3.95	-7.84
1991	8.01	2.83	10.84
1992	-9.48	-2.36	-11.84
Approximate 6-yr. volume change			-26.38
Mean annual volume change			-4.40
Standard deviation			8.83

[1] Negative value denotes loss of sand

Graph 2

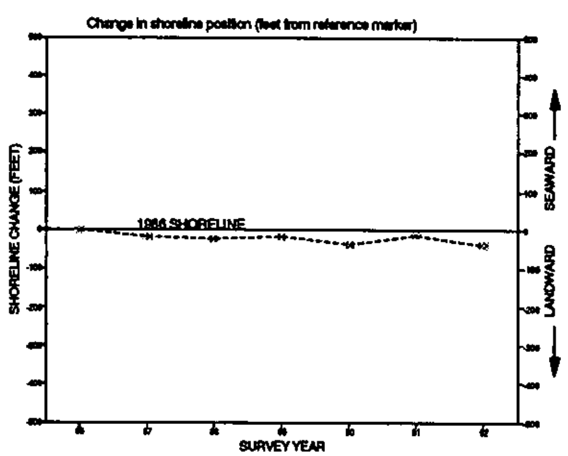


Table 2

SHORELINE CHANGE IN FEET

Year	Date of survey	Distance from reference marker [1]	Change from 1986 shoreline [2]
1986	10/23	414.91	
1987	09/17	397.90	-17.01
1988	10/04	390.16	-24.75
1989	09/12	396.66	-18.25
1990	09/12	376.31	-38.6
1991	11/06	398.66	-16.25
1992	10/22	374.09	-40.82
Net shoreline change, 1986-1992 [3]			-40.82
Mean annual distance from ref. mkr., 1986-1992 [3]			392.67
Standard deviation			14.10

[1] Distance measured from reference marker to mean high tide. Location of reference marker shown in Farrell (1993).
[2] Minus sign indicates migration landward.
[3] Actual survey date to actual survey date.

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NOTES

GLOSSARY

accretion - (of beach) The gradual addition of new beach to old by deposition of sediment.

acoustic interface - The contact between earth layers which reflects and refracts the seismic signal.

aliasing - Frequency ambiguity resulting from the sampling process.

anthropogenic - Produced by human activity.

barrier island - A long narrow coastal island which protects shallow landward lagoons from the open ocean.

bathymetry - Depth of the bed of the ocean or other body of water.

borehole geophysics - The general field of geophysics based on the lowering of various measuring probes into a well.

calcareous - Containing calcium carbonate.

coast - A strip of land that extends from the seashore inland to the first change in terrain features.

coastal plain - A low broad plain that has its margin on an oceanic shore.

Cretaceous - The final geologic period in the Mesozoic era extending from 135 to 65 million years ago.

deconvolution - An operation or algorithm used to enhance the resolution of the seismic signal.

depth of penetration - An estimate of the effective depth to which a geophysical technique can be used to gain useful subsurface information.

digital filtering - Computer-based method of screening seismic data.

echosounder - A device for measuring water depth by timing sonic reflections.

erosion - The process by which the soil and rock of the earths's crust are worn away.

eustatic - A worldwide rise or fall in sea level.

fluvial - Of or pertaining to rivers.

geomorphic - Pertaining to the form of the earth or its surface features.

Holocene - The latter part of the Cenozoic era extending from 8 thousand years ago to the present.

horizontal stacking - A method of summing a signal by repetition, thus producing a composite record.

inlet - A small narrow opening in the shoreline through which water passes.

isobath - Line of equal water depth.

isopach - A line drawn on a map to indicate equal thickness of a specific unit.

joule - A metric (SI) unit of energy.

lithofacies - The aspect, appearance, and characteristics of a rock unit.

lithology - The description of rocks based upon their physical characteristics and chemical composition.

macrofossil - A fossil large enough to be studied without the aid of a microscope.

Miocene - An epoch of the late Tertiary period, extending from 25 to 5 million years ago.

outcrop - That part of a geologic formation or structure which appears at the surface of the earth. Includes underwater exposures.

paleobathymetry - Depth of the bed of an ancient ocean or other body of water.

Pleistocene - An epoch of the Quaternary period, after the Pliocene of the tertiary and before Holocene. It began two to three million years ago and lasted until the start of the Holocene, about eight thousand years ago.

profile section - Diagram or drawing that shows along a given line the configuration or slope of the surface of the ground as it would appear if intersected by a vertical plane. The vertical scale is often exaggerated.

Quaternary - Latest period of the Cenozoic era extending from 2 to 3 million years ago to the present.

sediment - Solid fragmental material transported and deposited by wind, water or ice, chemically precipitated or secreted by organisms that forms in layers in loose unconsolidated form.

seismic - Pertaining to an earthquake or vibration of the earth including those that are artificially induced.

seismic reflection - The energy or wave from a seismic source which has been reflected by an acoustic contrast between rock units.

seismograph - An instrument that records vibrations of the earth.

shoreline - The intersection of a body of water and the beach.

shotpoint - The origin of seismic energy used during a seismic survey.

sparker - A high-voltage underwater electrical discharge.

spit - A small fingerlike point of land projecting into a body of open water.

stratigraphy - Study of layers or strata of sediments and sedimentary rocks.

Tertiary - The first period of the Cenozoic era, extending from 65 to 2 million years ago.

unconsolidated - (material) Sediment whose particles are unstratified or not cemented together, occurring at the surface or at depth.

vibracore - A cored sample extracted from underwater unconsolidated sediments with a vibrating drilling pipe.